

# REGIONAL ECONOMIC OUTLOOK: ASIA AND PACIFIC BACKGROUND PAPER NO. 1

## Asia as the Cycle Matures<sup>1</sup>

October 2018

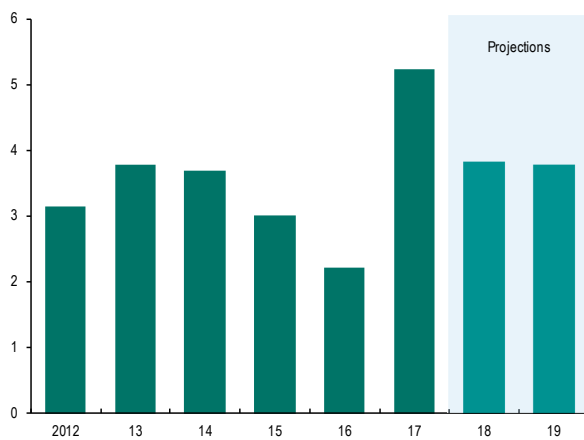
---

<sup>1</sup> This *Regional Economic Outlook: Asia and Pacific* background paper was prepared by Pablo Lopez Murphy (lead) and Ananya Shukla, under the guidance of Koshy Mathai. Substantial inputs were provided by Angana Banerji, Geoffrey Bannister, Patrick Blagrove, David Corvino, Albe Gjonbalaj, Sandile Hlatshwayo, Gee Hee Hong, Keiko Honjo (RES), Bo Jiang, Anh Van Le, Anne Oeking, Shanaka J. Peiris, Tahsin Saadi Sedik, Jarkko Turunen, and country teams. Alessandra Balestieri and Socorro Santayana provided excellent production assistance. The projections in this paper are based on data available as of September 18, 2018, and includes comments from other IMF departments and some Executive Directors.

## Global Context

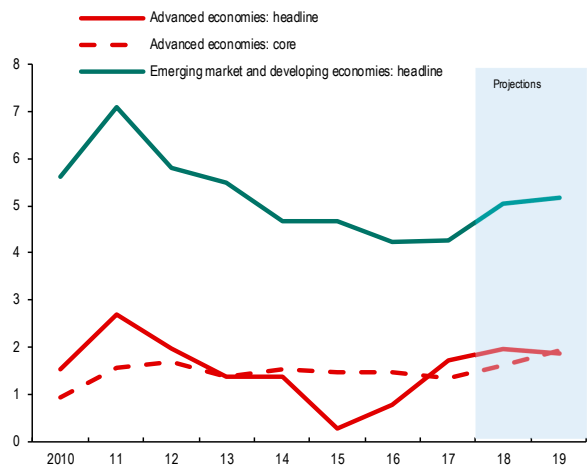
The global expansion that began two years ago appears to have peaked and become less synchronized across economies. While economic activity moderated in advanced economies during the first half of 2018 compared to 2017, it remained steady in emerging economies. GDP growth was lower than expected in the euro area and United Kingdom. Meanwhile, in the United States, domestic demand continued to be buoyant, underpinned by low unemployment and a temporary fiscal expansion. Among emerging economies, growth remained strong in Emerging Asia but weakened in Brazil, Argentina, and Turkey. Several downside risks highlighted in the April 2018 *World Economic Outlook* (WEO) have increased or partially materialized, such as rising trade tensions and sharp capital outflows from emerging economies with weaker fundamentals. With this more mixed global growth picture, there are already signs that trade is slowing (Figure 1). Oil prices have increased by 13 percent since the April 2018 WEO, largely reflecting supply shortfalls. Headline inflation has picked up as a result in both advanced and emerging economies (Figure 2). Core inflation rose in the United States close to 2 percent as the labor market tightened further. It also inched up in the euro area and Japan, but remained low. Core inflation in emerging markets was generally more stable.

**Figure 1. World: Volume of Total Exports of Goods and Services**  
(Percentage points; year over year)



Sources: IMF, World Economic Outlook database; and IMF staff calculations.

**Figure 2. Price Inflation: Headline and Core**  
(Percentage points; year over year)



Sources: IMF, World Economic Outlook database; and IMF staff calculations.

Financial conditions have tightened in emerging economies since the April 2018 WEO, although they have remained supportive in advanced economies. With the US Federal Reserve's two rate hikes since March 2018 and the European Central Bank's recent announcement of a path toward monetary policy normalization in the euro area, the dollar has appreciated, capital flows to emerging markets have begun

to reverse (Figure 3), and in some economies, especially those with weaker fundamentals, financial conditions have tightened sharply. Escalating trade tensions and tighter financial conditions had an adverse impact on equity markets in most emerging economies, including those in Asia.

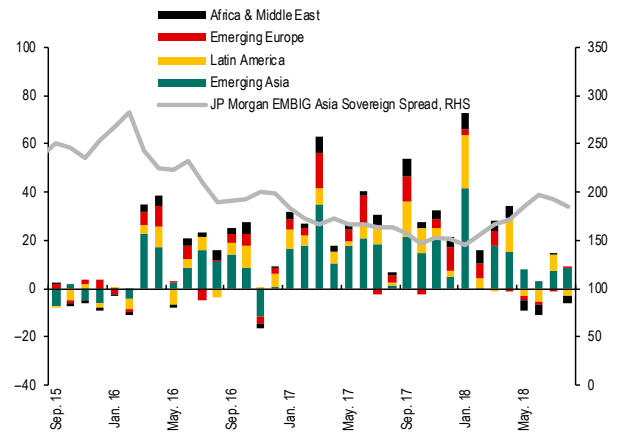
Looking ahead, global growth for 2018–19 is projected at 3.7 percent, 0.2 percent lower than projected in the April 2018 WEO, but well above its level during 2012–16. The baseline forecast assumes gradually tightening financial conditions and healthy trade growth. Advanced economies are projected to grow at 2.3 percent in 2018 before easing to 2.1 percent in 2019 as output gaps close and monetary policy becomes less accommodative. Emerging market and developing economies are projected to grow at 4.7 percent in 2018–19 (Figure 4). Individual country prospects have changed on account of the differential impact of higher oil prices, tighter financial conditions, and idiosyncratic domestic factors.

Risks around the baseline forecast are now seen as tilted more to the downside in the near term, whereas in the April 2018 WEO they were viewed as balanced, given the possibility that the recovery could again prove stronger than expected. This, however, now seems less likely given the weak growth outturns in the first half of 2018 in several large economies, the moderation in high-frequency economic indicators, tighter financial conditions in vulnerable economies, and the risk of a further escalation of trade actions. Geopolitical tensions and delays in addressing challenges of inequality and climate change could also adversely impact the outlook.

## Regional Developments

GDP growth outturns in the first half of 2018 were softer than in 2017, especially in advanced economies. In contrast, growth remained robust in emerging economies and broadly in line with expectations (Figure 5). Headline inflation inched up in several economies on account of higher oil prices and currency depreciation (Figures 6, 7, and 8). Export growth generally slowed in early 2018 (Figure 9) as import growth stalled in advanced economies (especially Japan and the euro area). Current account surpluses in the region narrowed, and many economies decreased their holding of foreign reserves during 2018 (Figure 10).

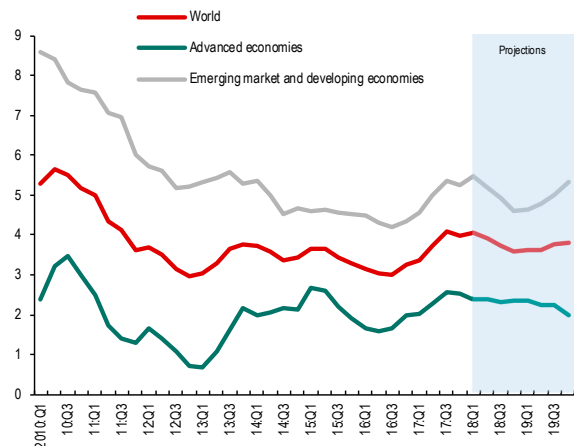
**Figure 3. Total Portfolio Flows**  
(Billions of US dollars; basis points)



Sources: Bloomberg Finance L.P.; Institute of International Finance; national sources; and IMF staff calculations.

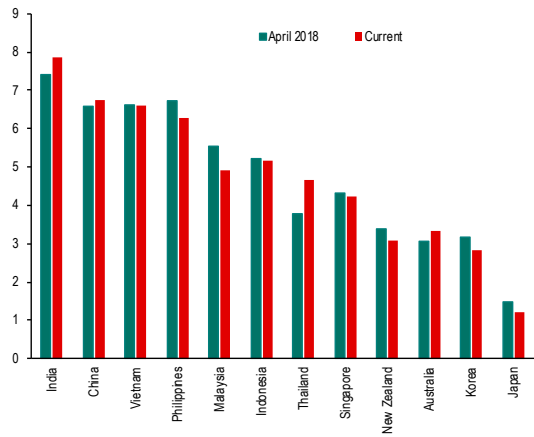
Note: RHS = right scale; Data as of August 31, 2018.

**Figure 4. Real GDP Growth**  
(Percentage points; year over year)



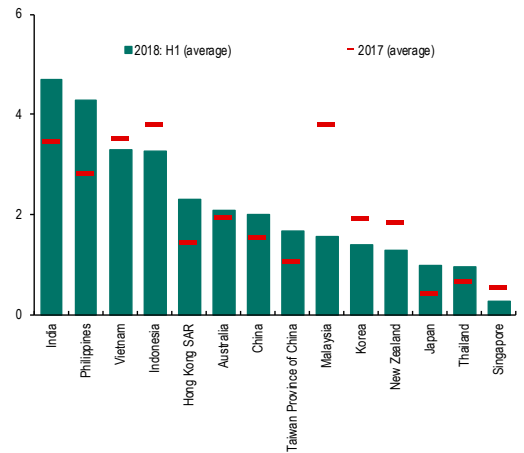
Sources: IMF, World Economic Outlook database; and IMF staff calculations.

**Figure 5. Selected Asia: Real GDP Growth**  
(Percentage points; year over year, 2018:H1)

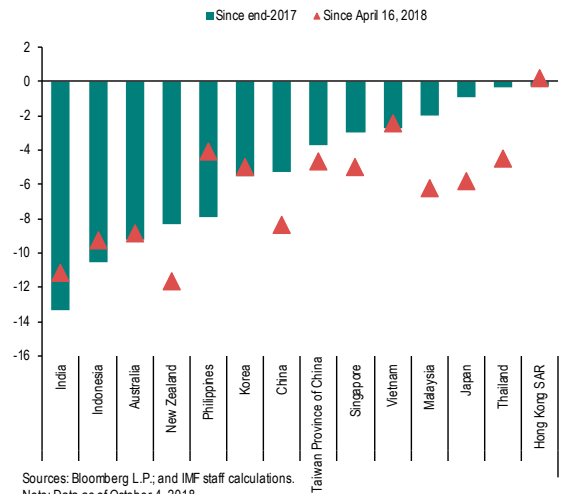


Source: IMF, World Economic Outlook database.  
Note: H1= first half.

**Figure 6. Selected Asia: Headline Inflation**  
(Percentage points; year over year)

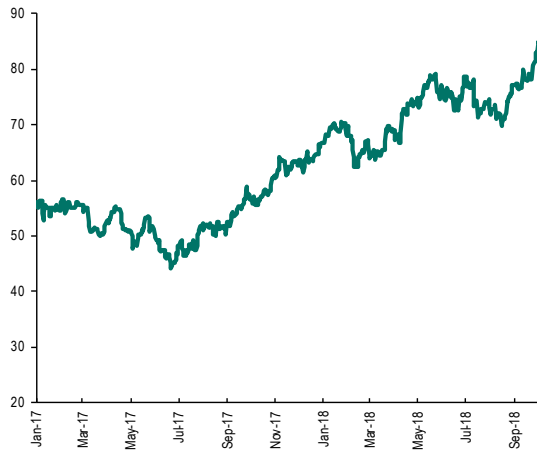


**Figure 8. Bilateral Exchange Rate Movements against US Dollar**  
(Percentage points; positive = local currency appreciation)



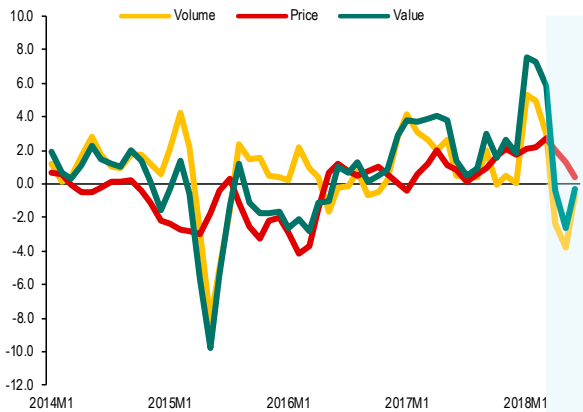
Sources: Bloomberg L.P., and IMF staff calculations.  
Note: Data as of October 4, 2018.

**Figure 7. Oil Price Movements**  
(Brent Spot Price)



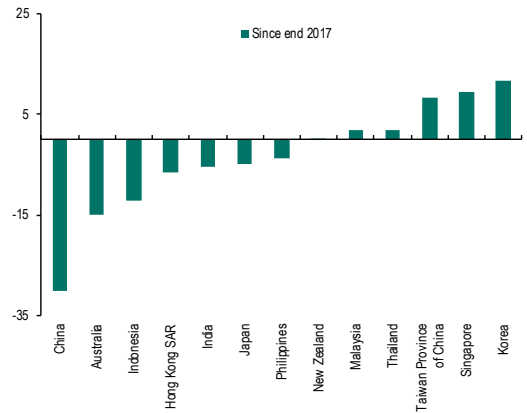
Source: Bloomberg L.P.  
Note: Data as of October 5, 2018.

**Figure 9. Emerging Asia: Exports**  
(Growth rate, 3 month moving average)



Sources: CPB Netherlands Bureau for Economic Policy Analysis, and IMF staff calculations.  
Note: Data as of July 31, 2018.

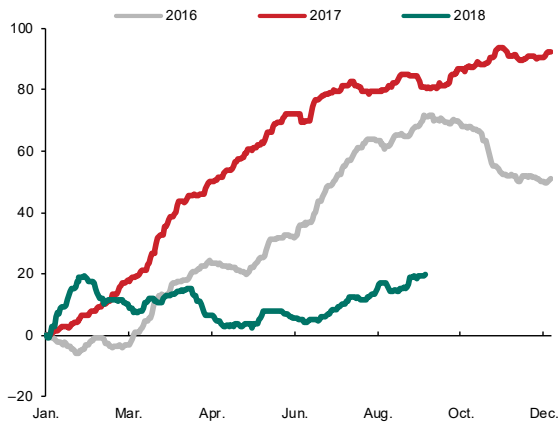
**Figure 10. Selected Asia: Foreign Exchange Reserve Accumulation**  
(Billions of US dollars)



Sources: CEIC Data Company Ltd.; Haver Analytics; and IMF staff calculations.  
Note: Data as of August 31, 2018 except for India (as of July 31, 2018).

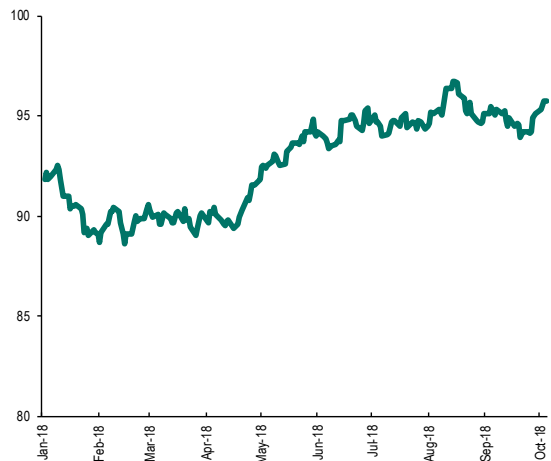
Financial conditions tightened in some large Asian economies in response to US policy normalization, rising global trade tensions, and the recent volatility in China and large emerging economies in other regions. Cumulative portfolio inflows in 2018 were far below the levels reached in 2016–17 on account of large outflows during the second quarter (Figure 11), with a pickup in nonresident sales of portfolio debt securities, as the US dollar started to appreciate (Figure 12). Asian equity indices (Figure 13) and exchange rates were negatively affected by trade tensions, while bond yields and spreads generally increased (Figure 14). Some central banks in the region raised policy rates (Figure 15), responding to inflation and exchange rate pressures, while some others directly intervened to support their domestic currencies. The recent volatility of Asian assets has been comparable in some respects to that seen during the taper tantrum, but Asia has been affected much less than other regions and more tied to developments in China.

**Figure 11. Asia: Cumulative Portfolio Flows**  
(Billions of US dollars)



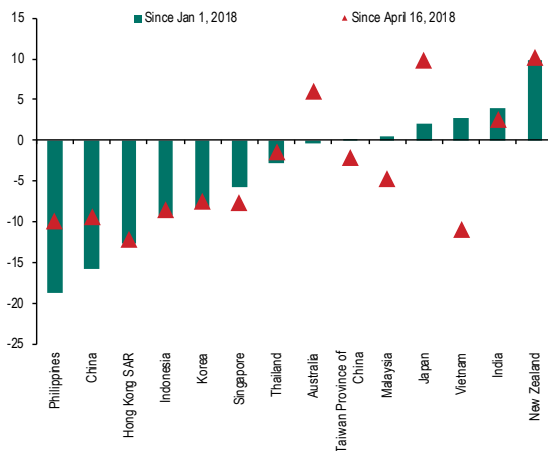
Sources: Bloomberg Finance L.P.; Haver Analytics; and IMF staff estimates.  
Note: Equities coverage: Indonesia, India, Korea, the Philippines, Sri Lanka, Taiwan Province of China, Thailand, and Vietnam; bonds coverage: Indonesia, India, Korea, and Thailand; Data as of October 5, 2018.

**Figure 12. US Dollar Index**



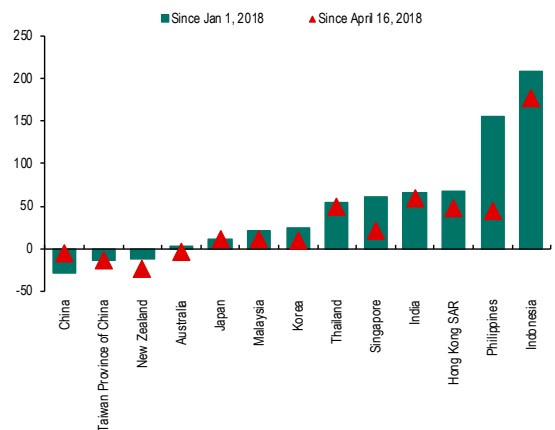
Source: CEIC Data Company Ltd. Note: Higher value implies appreciation.  
Note: Data as of October 4, 2018.

**Figure 13. Selected Asia: Equity Price Movements**  
(Percentage points)



Sources: Bloomberg L.P.; and IMF staff calculations.  
Note: Data as of October 4, 2018.

**Figure 14. Asia: Ten-Year Sovereign Bond Yields**  
(Basis Points)

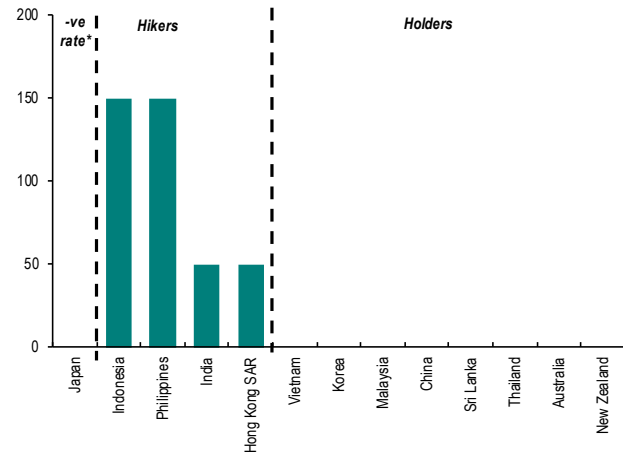


Source: Bloomberg L.P.  
Note: Data as of October 5, 2018.

Developments in individual Asian economies were as follows:

- China's** growth remains strong, though momentum has weakened. Investment growth slowed notably from 6 percent year-over-year in June to 4.1 percent in August, led by a sharp decline in infrastructure investment. Retail sales expanded more moderately and unemployment rose from 4.8 percent in June to 5 percent in August. Headline Consumer Price Index (CPI) inflation remained contained at around 2 percent, while strong Producer Price Index (PPI) inflation moderated. Financial conditions have remained broadly stable as the authorities have offset external pressures and the impact of financial tightening related to stricter regulatory policies by easing monetary policy. Credit growth continued to slow to 10.1 percent year-over-year in August, down from around 14 percent at end-2017, driven by the contraction in shadow banking. Equity prices have declined substantially and the renminbi has depreciated 7 percent against the US dollar since mid-June. Money market rates have declined, reflecting monetary easing. The current account surplus continued declining in line with the trend of recent years.

**Figure 15. Selected Asia: Policy Rate Actions**  
(Basis points)



Sources: Haver Analytics; Bloomberg L.P.; and IMF staff calculations.  
Note: Cutters/Hikers/Holders are classified based on policy action since March 2018; China: 7-day reverse repo rate. The new policy rate series was applied for Indonesia in April 2016. Data as of Oct 5, 2018.

- In **Japan**, after a temporary contraction in the first quarter of 2018, the economy rebounded briskly in the second quarter. The contraction in the first quarter was driven by a temporary decline of private consumption. This component of domestic demand recovered in the second quarter. Net exports contributed negatively to growth, as exports slowed and imports strengthened on the back of strong domestic demand. Inflation softened in early 2018 and then gained momentum in recent months, with headline and core inflation reaching 1.3 and 0.4 percent year-over-year, respectively, in August.
- In **India**, following disruptions related to the demonetization in November 2016 and the rollout of the Goods and Services Tax in July 2017, GDP growth slowed to a four-year low of 6.7 percent in FY2017/18. However, a recovery is now under way. Growth reached 7.7 percent year-over-year in the first quarter of 2018. Headline inflation averaged 3.6 percent in FY2017/18, a 17-year low, reflecting low food prices on a return to normal monsoon rainfall and agricultural reforms, subdued domestic demand, and currency appreciation. Inflation declined to 3.7 percent year-over-year in August from 4.2 percent in July, driven by food prices.
- Growth in **Korea** was a solid 3.1 percent in 2017 and 2.9 percent in the first half of 2018, supported by steadily increasing consumption and buoyant external demand. However, investment has slowed and unemployment has risen, especially among low-skilled workers. Headline and core inflation remained subdued, at 1.4 and 0.9 percent year-over-year,

respectively, in August, suggesting slack in the economy. External imbalances are large, but the current account surplus declined to 5.1 percent of GDP in 2017, with some further narrowing in the first half of 2018 by around 2.5 percentage points of GDP (year-over-year), driven by strong imports and higher commodity prices.

- In *Australia*, annual growth picked up to 3.3 percent in the first half of 2018, the strongest pace since 2013, with solid private business and residential investment more than offsetting the drag from delays in the implementation of public investment plans and drought. Inflation remained soft as consumer prices rose 2.1 percent year-over-year in the second quarter of 2018 amid tepid wage growth. Core inflation was 1.9 percent year-over-year and has now undershot the inflation target band of 2 to 3 percent for 10 consecutive quarters. In *New Zealand*, GDP growth in the second quarter of 2018 accelerated to 2.8 percent year-over-year from 2.6 percent in the first quarter. Headline inflation reached 1.5 percent year-over-year in the second quarter, while core inflation was 1 percent, near the floor of the inflation target range of 1 to 3 percent.
- GDP growth in *Hong Kong SAR* remained strong in the first half of 2018. Private consumption was the main contributor to growth, supported by a tight labor market, continued growth in real wages, and tourism inflows from Mainland China. Despite rising trade tensions, exports expanded 8 percent year-over-year in the first half of 2018, with 5 percent increase in volumes.

## Association of Southeast Asian Nations (ASEAN)

- *Indonesia's* growth ticked down to 5.2 percent (year-over-year) in the first half of 2018 from 5.1 percent in 2017, as the pickup in domestic demand more than offset the larger drag from net exports. Since February, Indonesia has been facing market pressures on account of higher US interest rates and oil prices, as well as the stronger dollar. Indonesia has been affected more than other emerging markets in Asia, but substantially less than some emerging markets in other regions. Since January, the rupiah has depreciated by 10 percent against the US dollar, equity prices have fallen by 8 percent, and 10-year government bond yields have risen by 180 basis points. Bank Indonesia raised its policy rate to 5.75 percent in an attempt to stabilize the rupiah.
- In *Thailand*, GDP recorded the quickest pace of expansion in five years on the back of a pickup in private consumption and robust foreign demand. Economic activity increased 4.8 percent year-over-year in the first half of 2018, well above the prior semester's solid 4.2 percent year-over-year expansion. Headline inflation remained subdued and reached 1.6 percent year-over-year in August, partly reflecting low fresh food prices, but also persistently weak core inflation, at 0.8 percent. The recent bout of market volatility has had some impact on Thailand's foreign exchange market, while the impact on sovereign bond yields remains benign.
- In *Singapore*, real GDP grew by 3.6 percent in 2017, compared to 2.4 percent in 2016, and strengthened further to 4 percent year-over-year in the first half of 2018. Headline inflation turned positive in 2017, after two years of deflation, but remained subdued at 0.7 percent year-over-year in August.
- In *Malaysia*, real GDP grew by 4.9 percent year-over-year in the first half of 2018, compared to 5.9 percent in 2017, as lower contributions from private investment and public spending were

partially offset by strong private consumption growth supported by improved labor market conditions. Headline inflation dropped from 3.8 percent in 2017 to 1.6 percent year-over-year during the first half of 2018 on account of productivity gains, lower food price inflation, currency appreciation, a suspension of adjustment in domestic fuel prices as of March, and a zero-rating of the Goods and Services Tax as of June 1. Higher dividend outflows drove the current account surplus to 2.7 percent of GDP in the first half of 2018 from 3 percent of GDP in 2017.

- Growth in the *Philippines* reached 6.7 percent in 2017 and 6.3 percent year-over-year in the first half of 2018, led by strong public investment. Inflation rose to 6.4 percent year-over-year in August, exceeding the upper bound of the inflation target band of 2 to 4 percent. The rise in global oil prices, the weaker peso, higher excise taxes, and above-trend growth have contributed to rising price pressures.
- Economic performance was strong in much of the rest of ASEAN as well. In *Vietnam*, growth reached 7.1 percent year-over-year in the first half of 2018, continuing a remarkable performance driven by strong exports, foreign direct investment inflows, and tourism. Inflation reached 4 percent year-over-year in August, but core inflation remained subdued at 1.5 percent year-over-year. In *Myanmar*, the economy rebounded strongly in 2017/18 from the temporary slowdown in 2016/17. *Cambodia's* economy continues to grow at around 7 percent, supported by higher public spending and robust construction and tourism activity, while inflation recorded 3 percent year-over-year in June. In *Lao P.D.R.*, high frequency indicators are consistent with a slight moderation in growth. Tourism arrivals remained sluggish and private sector credit is growing slower than nominal GDP. Inflation is picking up slightly because of the pass-through from higher oil prices but is expected to remain at around 2 percent in 2018. And in *Brunei Darussalam*, real GDP growth was stronger than expected in 2017, rebounding to 1.3 percent, supported by both the oil and gas sector and the rest of the economy. Inflation, in negative territory since 2014, rebounded slightly to -0.2 percent in 2017 and turned positive in early 2018.

## Other Economies

- Performance in other frontier economies was generally strong, with some exceptions. In *Bangladesh*, real GDP growth in FY2018 is projected to have further accelerated to 7.5 percent, led by strong private consumption and investment, while inflation eased to 5.5 percent by the end of FY2018, after temporarily rising on account of flood-related agricultural damage. *Nepal's* economy has made a strong recovery from the 2015 earthquakes and trade disruptions, growing at 6.3 percent in FY2017/18, while inflation fell to a multiyear low of 4.2 percent as a consequence of low food inflation. In *Sri Lanka*, following subdued growth in 2017 on account of weather-related shocks, a gradual recovery is under way as robust growth in services and manufacturing is partly offset by a contraction in the construction sector. And in *Mongolia*, growth accelerated from 5.1 percent in 2017 to 6.3 percent year-over-year in the first quarter of 2018 on the back of strong services. Fiscal performance also continues to be robust, with a 3.4 percent of GDP primary surplus in the first quarter of 2018.
- Growth in Pacific Island countries remained around 2.6 percent in 2017, broadly unchanged from the year before. In *Fiji*, growth jumped to 3 percent given the recovery from Cyclone Winston, while in *Papua New Guinea* and *Timor-Leste*, growth stayed relatively subdued,



partly reflecting weak commodity export prices. Cyclone Gita caused widespread destruction in a number of economies, including *Tonga* and *Samoa*.

## Regional Outlook

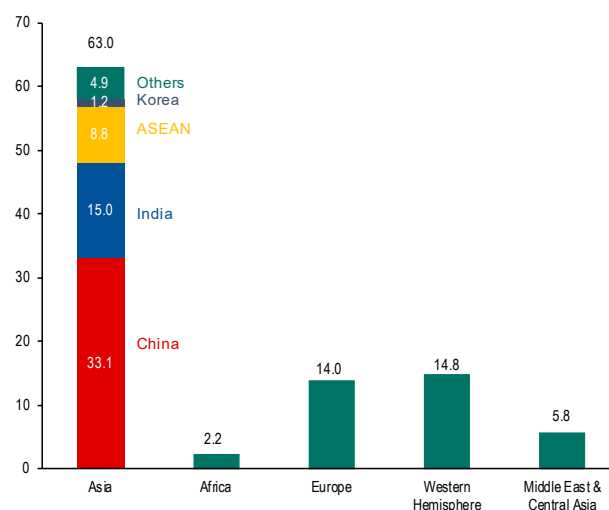
Although the near-term outlook for Asia remains positive, supported by steady global momentum and broadly accommodative policies, downside risks are more pronounced than in the spring. Asia continues to be the main growth engine of the world (Figure 16) and is projected to grow by 5.6 percent in 2018 (unchanged from what was projected in April) and 5.4 percent in 2019, down by 0.2 percent from April (Table 1), and to moderate to lower growth rates in the medium term.

Inflation is projected to increase to 2.7 percent in 2018 and 2.9 percent in 2019, in line with higher commodity prices (Table 2). However, it is expected to remain below inflation targets for several economies. Current account balances are expected to narrow with higher oil prices (Table 3).

The near-term outlook for individual Asian economies is as follows:

- The near-term outlook in *China* remains stable, as the authorities have shifted their policy priority from deleveraging to stabilizing growth. The State Council meeting in mid-June and the Politburo meeting at the end of July emphasized the need to stabilize domestic demand and manage the pace of deleveraging, especially with the changing external environment. Growth projections for 2018 remain unchanged, but were marked down for 2019 from 6.4 to 6.2 percent. This reflects the impact of US tariffs announced on September 17 on a list of products imported from China worth \$200 billion, and offsetting policy action, mainly via stimulating investment and credit. The current account surplus will likely be smaller than earlier forecast on account of less favorable terms of trade. Headline inflation is projected to reach 2.2 and 2.4 percent in 2018 and 2019, respectively, slightly lower than before, given weaker-than-expected recent outturns.

**Figure 16. Contribution to Global Growth by Region**  
(Percentage points, 2018 estimates)



Source: IMF, *World Economic Outlook* and IMF staff estimates.  
Note: Regional categories based on IMF classification, ASEAN: Association of Southeast Asian Nations.

**Table 1. Asia: Real GDP Growth***(Percent change, year over year)*

	Estimates and Latest Projections					Difference from April 2018 World Economic Outlook		
	2015	2016	2017	2018	2019	2017	2018	2019
<b>Asia</b>	<b>5.6</b>	<b>5.4</b>	<b>5.7</b>	<b>5.6</b>	<b>5.4</b>	<b>0.0</b>	<b>0.0</b>	<b>-0.2</b>
<b>Advanced economies (AEs)</b>	<b>1.8</b>	<b>1.7</b>	<b>2.4</b>	<b>2.1</b>	<b>1.8</b>	<b>0.1</b>	<b>0.1</b>	<b>-0.1</b>
Australia	2.5	2.6	2.2	3.2	2.8	-0.1	0.2	-0.3
New Zealand	4.2	4.1	3.0	3.1	3.0	0.0	0.2	0.1
Japan	1.4	1.0	1.7	1.1	0.9	0.0	-0.1	0.0
Hong Kong SAR	2.4	2.2	3.8	3.8	2.9	0.0	0.2	-0.3
Korea	2.8	2.9	3.1	2.8	2.6	0.0	-0.2	-0.3
Taiwan Province of China	0.8	1.4	2.9	2.7	2.4	0.1	0.8	0.4
Singapore	2.2	2.4	3.6	2.9	2.5	0.0	0.0	-0.2
<b>Emerging markets and developing economies (EMDEs)<sup>1</sup></b>	<b>6.8</b>	<b>6.5</b>	<b>6.5</b>	<b>6.5</b>	<b>6.3</b>	<b>0.0</b>	<b>0.0</b>	<b>-0.3</b>
Bangladesh	6.8	7.2	7.4	7.3	7.1	0.3	0.3	0.1
Brunei Darussalam	-0.4	-2.5	1.3	2.3	5.1	0.8	1.3	-2.9
Cambodia	7.0	7.0	6.9	6.9	6.8	0.0	0.0	0.0
China	6.9	6.7	6.9	6.6	6.2	0.0	0.0	-0.2
India <sup>2</sup>	8.2	7.1	6.7	7.3	7.4	0.0	-0.1	-0.4
Indonesia	4.9	5.0	5.1	5.1	5.1	0.0	-0.2	-0.4
Lao P.D.R.	7.3	7.0	6.9	6.8	7.0	0.1	0.0	0.0
Malaysia	5.1	4.2	5.9	4.7	4.6	0.0	-0.6	-0.4
Myanmar	7.0	5.9	6.8	6.4	6.8	0.1	-0.5	-0.2
Mongolia	2.4	1.2	5.1	6.2	6.3	0.0	1.2	0.0
Nepal	3.3	0.6	7.9	6.3	5.0	0.4	1.3	1.0
Philippines	6.1	6.9	6.7	6.5	6.6	0.0	-0.2	-0.2
Sri Lanka	5.0	4.5	3.3	3.7	4.3	0.2	-0.3	-0.2
Thailand	3.0	3.3	3.9	4.6	3.9	0.0	0.7	0.1
Vietnam	6.7	6.2	6.8	6.6	6.5	0.0	0.0	0.0
<b>Pacific island countries and other small states</b>	<b>4.5</b>	<b>3.0</b>	<b>2.6</b>	<b>1.4</b>	<b>4.1</b>	<b>-0.4</b>	<b>-2.3</b>	<b>0.2</b>
Bhutan	6.2	7.3	7.4	5.8	4.8	1.4	-1.3	-2.8
Fiji	3.8	0.7	3.0	3.2	3.4	-0.8	-0.3	0.0
Kiribati	10.3	1.1	3.1	2.3	2.4	0.0	0.0	0.0
Maldives	2.2	4.5	4.8	4.7	5.0	0.0	-0.3	0.0
Marshall Islands	2.0	3.6	2.5	2.3	2.2	0.6	0.5	0.5
Micronesia	3.9	2.9	2.0	1.4	0.9	0.0	0.0	0.0
Nauru	2.8	10.4	4.0	-2.4	-1.0	0.0	0.6	-1.0
Palau	10.1	0.0	-3.7	0.8	2.2	-2.7	-0.2	-1.8
Papua New Guinea	5.3	1.6	2.5	-1.1	3.8	0.0	-4.0	1.2
Samoa	1.6	7.1	2.5	1.8	3.2	0.1	-0.7	0.4
Solomon Islands	2.5	3.5	3.5	3.4	2.9	0.3	0.4	0.0
Timor-Leste	4.0	5.3	-4.6	0.8	5.0	-4.1	-2.0	-0.7
Tonga	3.5	4.2	2.5	2.9	5.5	-0.6	-0.3	2.6
Tuvalu	9.1	3.0	3.2	4.3	4.1	0.0	0.8	1.0
Vanuatu	0.2	3.5	4.2	3.8	3.5	0.0	0.0	0.0
<b>ASEAN<sup>3</sup></b>	<b>4.8</b>	<b>4.8</b>	<b>5.3</b>	<b>5.2</b>	<b>5.1</b>	<b>0.0</b>	<b>-0.1</b>	<b>-0.2</b>
<b>ASEAN-5<sup>4</sup></b>	<b>4.5</b>	<b>4.6</b>	<b>5.1</b>	<b>5.0</b>	<b>4.8</b>	<b>0.0</b>	<b>0.0</b>	<b>-0.3</b>
<b>EMDEs excluding China and India</b>	<b>5.1</b>	<b>5.1</b>	<b>5.5</b>	<b>5.5</b>	<b>5.4</b>	<b>0.0</b>	<b>0.0</b>	<b>-0.2</b>

Sources: IMF, World Economic Outlook database; and IMF staff estimates and projections.

1/ Emerging Market and Developing Economies (EMDEs) excluding Pacific island countries and other small states.

2/ India's data are reported on a fiscal year basis. Its fiscal year starts from April 1 and ends on March 31.

3/ ASEAN is comprised of Brunei Darussalam, Cambodia, Indonesia, Lao P.D.R., Malaysia, Myanmar, the Philippines, Singapore, Thailand, and Vietnam.

4/ ASEAN-5 is comprised of Indonesia, Malaysia, the Philippines, Singapore, and Thailand.

**Table 2. Asia: Consumer Prices***(Percent change, year over year)*

	Estimates and Latest Projections					Difference from April 2018 <i>World</i> <i>Economic Outlook</i>		
	2015	2016	2017	2018	2019	2017	2018	2019
<b>Asia</b>	<b>2.2</b>	<b>2.3</b>	<b>2.1</b>	<b>2.7</b>	<b>2.9</b>	<b>0.0</b>	<b>-0.2</b>	<b>0.0</b>
<b>Advanced economies (AEs)</b>	<b>0.7</b>	<b>0.5</b>	<b>1.0</b>	<b>1.4</b>	<b>1.6</b>	<b>0.0</b>	<b>0.0</b>	<b>0.1</b>
Australia	1.5	1.3	2.0	2.2	2.3	0.0	0.0	-0.1
New Zealand	0.3	0.6	1.9	1.4	1.7	0.0	-0.3	-0.4
Japan <sup>1</sup>	0.8	-0.1	0.5	1.2	1.3	0.0	0.1	0.2
Hong Kong SAR	3.0	2.4	1.5	2.3	2.1	0.0	0.1	0.0
Korea	0.7	1.0	1.9	1.5	1.8	0.0	-0.2	-0.1
Taiwan Province of China	-0.6	1.0	1.1	1.5	1.3	0.5	0.2	0.0
Singapore	-0.5	-0.5	0.6	1.0	1.4	0.0	-0.2	0.4
<b>Emerging markets and developing economies (EMDEs)<sup>2</sup></b>	<b>2.7</b>	<b>2.8</b>	<b>2.4</b>	<b>3.0</b>	<b>3.2</b>	<b>0.0</b>	<b>-0.3</b>	<b>-0.1</b>
Bangladesh	6.2	5.7	5.6	6.0	6.1	-0.1	0.0	0.1
Brunei Darussalam	-0.4	-0.7	-0.2	0.4	0.5	-0.1	0.3	0.2
Cambodia	1.2	3.0	2.9	3.3	3.3	0.0	0.0	0.1
China	1.4	2.0	1.6	2.2	2.4	0.0	-0.3	-0.2
India <sup>3</sup>	4.9	4.5	3.6	4.7	4.9	0.0	-0.3	-0.1
Indonesia	6.4	3.5	3.8	3.4	3.8	0.0	-0.1	0.4
Lao P.D.R.	1.3	1.6	0.8	0.9	4.5	0.0	-1.4	1.4
Malaysia	2.1	2.1	3.8	1.0	2.3	0.0	-2.2	-0.1
Myanmar	10.0	6.8	4.0	6.0	5.8	-1.1	0.5	0.0
Mongolia	5.9	0.5	4.6	7.6	8.0	0.0	1.2	1.2
Nepal	7.2	9.9	4.5	4.2	5.0	0.0	-1.8	-0.8
Philippines	0.7	1.3	2.9	4.9	4.0	-0.3	0.7	0.2
Sri Lanka	2.2	4.0	6.5	4.8	4.8	0.0	0.0	0.0
Thailand	-0.9	0.2	0.7	0.9	0.9	0.0	-0.5	0.2
Vietnam	0.6	2.7	3.5	3.8	4.0	0.0	0.0	0.0
<b>Pacific island countries and other small states</b>	<b>4.1</b>	<b>4.4</b>	<b>4.0</b>	<b>3.6</b>	<b>3.5</b>	<b>0.2</b>	<b>0.8</b>	<b>0.8</b>
Bhutan	7.6	7.6	5.8	4.6	4.9	2.4	0.5	0.3
Fiji	1.4	3.9	3.4	3.9	3.2	0.0	0.6	0.2
Kiribati	0.6	1.9	0.4	2.5	2.5	-1.8	0.0	0.0
Maldives	1.9	0.8	2.3	1.7	2.7	-0.5	0.2	1.0
Marshall Islands	-2.2	-1.5	0.0	1.4	1.5	-0.7	0.3	0.0
Micronesia	-0.2	0.5	0.5	2.0	2.0	0.0	0.0	0.0
Nauru	9.8	8.2	5.1	3.8	2.5	0.0	1.8	0.5
Palau	0.9	-1.0	0.9	2.5	2.3	0.0	0.5	0.3
Papua New Guinea	6.0	6.7	5.4	4.2	3.8	0.2	1.3	1.3
Samoa	1.9	0.1	1.3	3.4	3.0	0.0	0.5	0.5
Solomon Islands	-0.6	0.5	0.5	1.0	1.6	0.9	-0.3	0.2
Timor-Leste	0.6	-1.3	0.6	1.8	2.7	0.0	0.0	0.0
Tonga	-1.1	2.6	7.4	5.2	5.3	-0.6	2.2	2.8
Tuvalu	3.1	3.5	4.1	4.2	3.7	1.7	1.5	1.2
Vanuatu	2.5	0.8	3.1	4.8	3.4	0.0	0.0	0.0
<b>ASEAN<sup>4</sup></b>	<b>3.2</b>	<b>2.3</b>	<b>2.9</b>	<b>2.9</b>	<b>3.2</b>	<b>-0.1</b>	<b>-0.3</b>	<b>0.3</b>
<b>ASEAN-5<sup>5</sup></b>	<b>3.2</b>	<b>2.1</b>	<b>2.9</b>	<b>2.6</b>	<b>2.9</b>	<b>0.0</b>	<b>-0.4</b>	<b>0.2</b>
<b>EMDEs excluding China and India</b>	<b>3.7</b>	<b>2.9</b>	<b>3.4</b>	<b>3.3</b>	<b>3.6</b>	<b>-0.1</b>	<b>-0.3</b>	<b>0.2</b>

Sources: IMF, World Economic Outlook database; and IMF staff estimates and projections.

1/ 2019 headline inflation will include the effects from value-added tax (VAT) rate increase of October 2019.

2/ Emerging Market and Developing Economies (EMDEs) excluding Pacific island countries and small states.

3/ India's data are reported on a fiscal year basis. Its fiscal year starts from April 1 and ends on March 31.

4/ ASEAN is comprised of Brunei Darussalam, Cambodia, Indonesia, Lao P.D.R., Malaysia, Myanmar, the Philippines, Singapore, Thailand and Vietnam.

5/ ASEAN-5 is comprised of Indonesia, Malaysia, the Philippines, Singapore, and Thailand.

**Table 3. Asia: Current Account Balance***(Percent of GDP)*

	Estimates and Latest Projections					Difference from April 2018 <i>World Economic Outlook</i>		
	2015	2016	2017	2018	2019	2017	2018	2019
<b>Asia</b>	2.7	2.5	2.1	1.5	1.4	0.0	-0.3	-0.4
<b>Advanced economies (AEs)</b>	3.9	4.4	4.2	3.9	3.9	0.0	-0.3	-0.2
Australia	-4.6	-3.3	-2.6	-2.8	-3.1	-0.3	-0.9	-0.8
New Zealand	-3.1	-2.3	-2.7	-3.6	-3.8	0.0	-1.0	-0.8
Japan	3.1	3.9	4.0	3.6	3.8	0.0	-0.2	0.1
Hong Kong SAR	3.3	4.0	4.3	3.4	3.1	1.3	0.3	-0.1
Korea	7.7	7.0	5.1	5.0	4.7	0.0	-0.5	-1.1
Taiwan Province of China	14.2	13.7	14.5	13.8	13.6	0.7	0.2	0.1
Singapore	18.6	19.0	18.8	18.5	18.3	0.0	-0.4	-0.4
<b>Emerging markets and developing economies (EMDEs)<sup>1</sup></b>	2.0	1.4	0.9	0.1	0.1	0.0	-0.5	-0.5
Bangladesh	1.9	0.6	-2.0	-3.2	-2.7	-0.8	-1.2	-0.4
Brunei Darussalam	16.7	12.9	16.7	7.8	17.4	10.6	2.8	4.3
Cambodia	-9.0	-8.6	-8.5	-10.8	-10.6	0.3	-0.1	-1.1
China	2.7	1.8	1.4	0.7	0.7	0.0	-0.5	-0.5
India <sup>2</sup>	-1.1	-0.6	-1.9	-3.0	-2.5	0.1	-0.7	-0.4
Indonesia	-2.0	-1.8	-1.7	-2.4	-2.4	0.0	-0.5	-0.5
Lao P.D.R.	-18.0	-13.0	-12.1	-13.9	-12.3	0.9	1.0	1.4
Malaysia	3.0	2.4	3.0	2.9	2.3	0.0	0.5	0.1
Myanmar	-5.1	-3.9	-4.3	-5.3	-5.7	1.0	0.1	-0.1
Mongolia	-4.0	-6.3	-10.4	-8.3	-10.8	-1.6	-1.9	-2.5
Nepal	5.0	6.3	-0.4	-8.2	-6.3	0.0	-4.6	-3.2
Philippines	2.5	-0.4	-0.8	-1.5	-1.5	-0.4	-1.0	-0.9
Sri Lanka	-2.3	-2.1	-2.6	-2.9	-2.7	0.3	-0.2	-0.2
Thailand	8.0	11.7	11.2	9.1	8.1	0.4	-0.2	-0.5
Vietnam	-0.1	2.9	2.5	2.2	2.0	-1.6	-0.8	-0.4
<b>Pacific island countries and other small states</b>	4.2	5.8	7.0	6.8	7.3	3.0	0.7	1.7
Bhutan	-28.3	-29.4	-22.8	-22.8	-15.0	-2.3	-3.2	0.9
Fiji	-2.2	-2.9	-5.7	-4.7	-4.0	-1.2	0.5	0.5
Kiribati	46.7	19.4	9.0	16.9	7.1	0.0	-0.1	0.0
Maldives	-7.4	-24.5	-19.5	-18.2	-15.2	2.6	-0.2	0.0
Marshall Islands	15.0	7.6	-0.3	-0.6	-1.0	-5.8	-5.1	-4.8
Micronesia	4.2	3.3	3.6	3.2	3.1	0.0	0.0	0.0
Nauru	-9.5	1.7	4.1	-7.7	-7.5	3.4	-7.0	-7.6
Palau	-7.7	-11.7	-18.1	-17.5	-17.2	-4.5	-4.1	-3.4
Papua New Guinea	12.0	24.1	24.5	23.4	23.6	7.7	3.2	4.4
Samoa	-3.1	-4.7	-2.3	-3.1	-4.5	-1.0	-1.3	-1.1
Solomon Islands	-3.0	-3.9	-4.2	-6.4	-8.3	0.2	-1.4	-1.9
Timor-Leste	6.6	-21.6	-10.2	-1.2	-2.6	2.8	21.4	22.1
Tonga	-12.0	-6.9	-11.6	-17.1	-14.1	-0.7	-5.0	-2.2
Tuvalu	-52.8	23.2	4.2	3.5	-2.0	23.4	24.0	27.7
Vanuatu	-10.7	-4.6	-1.5	-8.5	-7.6	7.5	0.7	1.0
<b>ASEAN<sup>3</sup></b>	3.4	3.8	3.7	3.0	2.8	0.0	-0.2	-0.2
<b>ASEAN-5<sup>4</sup></b>	4.0	4.3	4.2	3.6	3.2	0.0	-0.1	-0.3
<b>EMDEs excluding China and India</b>	1.1	1.5	1.1	0.3	0.1	-0.2	-0.4	-0.4

Sources: IMF, World Economic Outlook database; and IMF staff estimates and projections.

1/ Emerging Market and Developing Economies (EMDEs) excluding Pacific island countries and other small states.

2/ India's data are reported on a fiscal year basis. Its fiscal year starts from April 1 and ends on March 31.

3/ ASEAN is comprised of Brunei Darussalam, Cambodia, Indonesia, Lao P.D.R., Malaysia, Myanmar, the Philippines, Singapore, Thailand and Vietnam.

4/ ASEAN-5 is comprised of Indonesia, Malaysia, the Philippines, Singapore, and Thailand.

- In *Japan*, the economy is projected to expand by 1.1 percent in 2018. After a temporary dip in the first quarter, the economy is expected to be return to a moderate and above-potential growth path for the remainder of 2018. Inflation has been revised up from 1.1 to 1.2 percent mainly on account of rising global energy prices. Over the medium term, growth is expected to converge toward potential, decelerating further to 0.9 percent in 2019. Given tepid wage growth, inflation is likely to remain below the 2 percent target. The Bank of Japan strengthened its commitments to accommodative policy in late July through forward guidance, communicating its intention to maintain ultra-low policy rates for an extended period of time, taking into account economic uncertainties, including the effects of the scheduled consumption tax hike in October 2019. The current account surplus is projected to moderate to 3.6 percent of GDP in 2018 because of softer-than-expected exports in the first half of 2018.
- In *India*, the economy is projected to grow at 7.3 percent in FY2018/19 and 7.4 percent in FY2019/20, revised down by 0.1 and 0.4 percentage points, respectively, due to higher oil prices and further monetary policy tightening. Near-term growth will be underpinned by strengthening investment and robust private consumption. The current account deficit has been revised up to 3 percent of GDP in FY2018/19 because of rising oil prices and strong demand for imports. Headline inflation is projected at 4.7 percent in FY2018/19, above the mid-point of the Reserve Bank of India's target band for headline inflation, as demand conditions tighten along with higher oil prices and agricultural minimum support prices. Medium-term growth is expected to rise to 7¾ percent, reflecting ongoing structural reforms, including the productivity-enhancing effects of the Goods and Services Tax.
- In *Korea*, GDP growth in 2018 is projected to continue at around 2.8 percent. Private consumption will likely remain solid, supported by the government's measures, while government spending will expand at a more rapid pace. The strong contribution of investment to GDP growth is expected to fade in 2018, as construction investment slows. Exports will likely continue to grow at a robust pace. Inflation is projected to remain subdued amid persistent slack in the labor market. External imbalances will persist, and in 2018 the current account balance is projected to remain around 5 percent of GDP, owing to continued robust export growth.
- *Australia* is approaching the final leg of its economic rebalancing after the end of the mining boom of the 2000s. With recent strong employment growth and higher infrastructure spending as a catalyst, conditions for an acceleration in activity and above-trend growth seem in place. The output gap should be closing and inflation is forecast to return to the midpoint of the target range within the next three years. The baseline outlook assumes a soft landing in the housing market, with price growth slowing gradually, reflecting increased supply, demand shifts toward renting, and eventually higher interest rates. In *New Zealand*, growth is expected to remain around 3 percent, driven initially by higher spending supporting infrastructure and structural reform. Inflation should pick up, gradually converging toward the midpoint of the 1 to 3 percent target range.
- In *Hong Kong SAR*, growth for 2018 has been revised up by 0.2 percentage points to 3.8 percent, mainly on account of a stronger-than-expected fiscal impulse in the recently released FY2018/19 budget and the still favorable global trade environment. Over the longer term, high income inequality and an aging population could weigh on prospects.

## ASEAN

- Growth in **Indonesia** is projected at 5.1 percent in 2018-19. A weaker-than-expected outturn in the first quarter of 2018 and tighter financial conditions explain the downward revision in 2018–19. Consumption is expected to rise modestly along with credit growth, while inflation should rise slightly to near the center of the band (2.5 to 4.5 percent), reflecting rupiah depreciation and higher commodity prices. The current account deficit is expected to rise to 2.4 percent of GDP in 2018 from 1.7 percent in 2017. Over the medium term, real GDP growth is projected at 5½ percent.
- In **Thailand**, growth momentum is projected to continue in 2018 and 2019, while domestic and external imbalances narrow only gradually. Export dynamism is expected to continue, while domestic demand remains sluggish, recovering only in the medium term. Real GDP growth for 2018 has been revised up from 3.9 to 4.6 percent given the stronger-than-expected outturn in the first half of 2018. Inflation is projected to remain below the 2.5 percent midpoint of the target range (1 to 4 percent) under current policies. The current account surplus is projected to decline but still remain very large.
- **Singapore**'s economy is on a strong cyclical upswing. Growth has recovered to a three-year high, led by externally oriented sectors that benefited from the synchronized global expansion. Economic momentum is becoming more broad based, helping to reduce the labor market slack. Growth is expected at 2.9 percent in 2018, above the potential rate, increasingly supported by domestic demand. Inflation is subdued but expected to rise modestly. The current account surplus remains large.
- In **Malaysia**, growth is expected to moderate further to 4.7 percent in 2018 and 4.6 percent in 2019, mostly on account of lower contributions from public domestic demand and some normalization in net exports and private consumption in 2019. Given the temporary impact of changes in indirect taxes and a normalization of core inflation, headline inflation is projected to drop to an average of 1 percent in 2018 but bounce back to 2.3 percent in 2019.
- In the **Philippines**, real GDP is projected to grow at 6.5 percent in 2018, led by strong domestic demand. The government's infrastructure push and stable foreign direct investment are expected to accelerate investment growth. Private consumption is projected to remain robust, underpinned by remittances and rising employment. Despite the recent policy rate increases to 4.5 percent, inflation is projected to remain above the 4 percent target upper bound in 2018 and stay in the upper half of the band (2 to 4 percent) during 2019–20.
- The outlook is favorable for much of the rest of ASEAN as well. Growth in **Vietnam** is projected at 6.6 percent in 2018, reflecting the growth momentum of trading partners and rising potential growth at home, while inflation is forecast to rise to just under the 4 percent target, led by higher oil prices and gradual increases in administered prices. In **Myanmar**, growth is expected to pick up toward the estimated potential of about 7 percent over the medium term, reflecting continued large foreign direct investment inflows and an improvement in public investment spending and efficiency. **Cambodia**'s medium-term growth is projected to moderate to about 6 percent on account of a maturation in credit and real estate cycles, coupled with ongoing challenges in increasing economic diversification and competitiveness. Growth in **Lao**

*P.D.R.* is expected to continue at about 7 percent in the near and medium term, while in *Brunei Darussalam*, growth is expected to accelerate to 2.3 percent in 2018, reflecting the rejuvenation of oil fields and continuing support from infrastructure projects.

## Other Economies

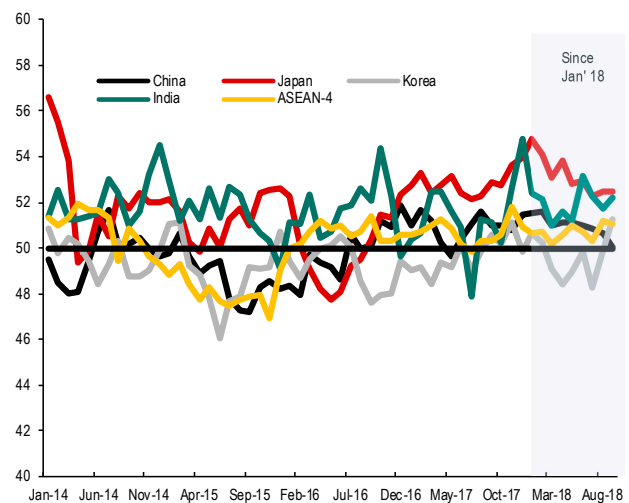
- The outlook for other frontier economies is mostly positive. In *Bangladesh*, growth is projected to remain robust at around 7.3 percent in FY2018/19, supported by strong investment, while inflation rises to 6 percent, close to the Bangladesh Bank's target, reflecting higher fuel prices. In *Nepal*, growth is expected to moderate to 5 percent in FY2018/19, underpinned by robust private consumption from strong remittance inflows as well as increased government spending. Inflation is expected to rise to 5 percent as food prices normalize and activity begins to run up against capacity constraints. Supported by continued growth in services and a modest recovery in agriculture and construction, real GDP growth in *Sri Lanka* is projected to normalize but remain below 4 percent in 2018. Despite recent increases in fuel and food prices, inflation is projected to remain at around 5 percent, the midpoint of the Central Bank of Sri Lanka's target band. In *Mongolia*, stronger coal prices and expanding credit will support continued strong growth and a revised growth forecast from 5 to 6.2 percent in 2018. Inflation is expected to remain below 8 percent.
- Growth in *Pacific Island countries* is expected to decline to around 1.4 percent in 2018, mainly reflecting the earthquake in Papua New Guinea, then rebound to 4.1 percent in 2019. Inflation is expected to remain low in most economies.

## Risks

The balance of risks has shifted to the downside in the near term and remains, as in the April 2018 *Regional Economic Outlook: Asia and Pacific*, tilted to the downside over the medium term. Growth in Asia is less likely to be stronger than projected in the near term given the outcomes during the first half of 2018 and the signals from forward-looking indicators (Figure 17). Sources of near-term downside risks include those outlined below.

**Trade tensions between the United States and China.** Following tariff increases in early 2018 on washing machines and solar cells, as well as steel and aluminum, the United States announced on June 15 a list of products imported from China (worth \$50 billion) that will be subject to a 25 percent tariff. China announced retaliation on a similar scale. On September 17, the United States announced a further \$200 billion in imports from China that would be subject to a tariff starting at 10 percent and rising to 25 percent by year-end. China, in turn, announced tariffs on an

**Figure 17. Manufacturing Purchasing Managers' Indices**  
(50+= expansion; seasonally adjusted)



Sources: Haver Analytics; and IMF staff calculations.

Note: ASEAN-4: Indonesia, Malaysia, the Philippines and Thailand; Data as of September 31, 2018.

additional \$60 billion of US imports. The United States has also suggested that an additional \$267 billion of goods (covering nearly all remaining Chinese imports) may be hit with tariffs, and it has separately proposed tariffs on the automotive sector that would affect many other countries. Sustained trade tensions could further undermine confidence, hurt financial markets, disrupt supply chains in the region, and discourage investment and trade. Greater protectionism could also make tradable consumer goods less affordable and boost inflation. IMF (2018a) considers some scenarios in which trade tensions escalate further.

***Tighter global financial conditions.*** Signs of higher-than-expected inflation in the United States could lead the Federal Reserve to tighten monetary policy at a faster pace than currently priced in by markets, with negative spillovers to Asia through reduced capital flows and higher funding costs. A sudden deterioration of risk appetite, rising trade tensions, and political and policy uncertainty could also lead to tighter conditions. Box 1 uses a macro model to analyze the impact of tighter global financial conditions in emerging Asia and the scope for monetary policy to mitigate the impact. The impact of tighter financial conditions will be higher in economies that tighten monetary policy to contain depreciation pressures. Tighter global financial conditions could also have an impact on growth through many channels not fully captured by the macro model. Two of them are:

- ***Higher US dollar funding costs.*** The April 2018 *Global Financial Stability Report* documents that US banks play only a limited role in the large bank lending in dollars that takes place outside the United States. Many non-US banks in Asia provide dollar funding to corporates in the region. The Federal Reserve's interest rate increases and the gradual reduction of securities holdings on its balance sheet are pushing up US dollar funding costs. Box 2 shows that, in addition, persistent deviations from covered interest parity in Asian economies since the global financial crisis have, by affecting hedging costs, been an important driver of US dollar funding rates.
- ***Corporate debt vulnerabilities.*** In the aftermath of the global financial crisis, corporate leverage in emerging Asia has risen and has the potential to amplify shocks as global liquidity conditions tighten, interest rates rise, and growth slows. Box 3 shows that Asia's corporate sector remains highly vulnerable to a tightening in global financial conditions as higher interest rates and currency depreciation increase the probability of default of Asian firms, especially those with foreign currency debt.

***Home-grown risks.*** Macro policies in China have been focused on addressing longstanding financial vulnerabilities, but the shift in priorities toward stabilizing growth may mean slower progress on deleveraging and thus heightened medium-term risks for China and the entire region. Slower progress than envisaged in the implementation of structural reforms could hold back medium-term growth in India. Moreover, while Japan's accommodative monetary policy is helping offset tighter global financial conditions, market speculation of changes to the policy framework could have unintended knock-on effects to global markets. Economies also face their own domestic risks, including from high private sector leverage in some countries such as Korea and inflated real-estate markets in Australia and Hong Kong SAR.

***Climate change and natural disasters.*** Extreme weather events could continue to have a significant economic impact on the region, and especially on small and low-income economies with smaller buffers. Lee, Zhang, and Nguyen (2018) document that during 1980–2016, 204 natural disasters were recorded in



the 12 economies in the Pacific, implying a nearly 50 percent chance of a country being hit in any given year, and disasters caused damage averaging 14 percent of GDP.

## Medium and Long-Term Challenges

Potential growth has slowed in several advanced economies in Asia in the last few years on account of slower growth of the working-age population, more moderate investment rates, and lower total factor productivity growth (Box 4). Emerging economies in Asia have been catching up fast in income levels with advanced economies, but a large gap remains. An even larger gap exists when considering a broader measure of welfare that captures not only income but also consumption, health, inclusiveness, and the environment (Box 5). Thus, over the medium and long terms, the priority is to boost potential growth in a broader sense. The medium- and long-term outlook is affected by at least four challenges: rebalancing, population aging, declining productivity growth, and digitalization, which could also be a new driver of growth.

**Rebalancing.** Emerging Asia turned into an economic powerhouse in recent decades in large part on account of an outward-oriented strategy. Exports from the region to the rest of the world grew sharply, facilitating a phenomenal economic boom in the region. But with slowing growth in advanced economies, it has become clear that rebalancing toward domestic demand is needed to sustain high GDP growth rates and to help correct global imbalances. This ongoing challenge has resurfaced as an important priority given recent trade tensions. IMF (2018a) examines the role that further trade and investment integration within Asia could play as a growth engine as trade with the rest of the world slows.

**Population aging.** Asia is undergoing a demographic transition marked by slowing population growth and aging, reflecting declining fertility rates since the late 1960s and, to a lesser extent, rising life expectancy. The speed of aging in Asia is remarkable. An aging population implies, in principle, a lower contribution from labor to growth, and as shown in the April 2017 *Regional Economic Outlook: Asia and Pacific*, there is a chance that parts of Asia may “grow old before they grow rich.” Box 6 shows that raising female labor force participation can be an important way to counter the negative economic effects of aging.

**Productivity slowdown.** Like many other regions, Asia has experienced a productivity growth slowdown since the global financial crisis, as documented in the April 2017 *Regional Economic Outlook: Asia and Pacific*. IMF (2018b) extends the analysis using firm-level data showing that “corporate dynamism” has declined in Asia as the share of young firms has declined and the share of “zombie” firms (typically with low productivity) has increased in several Asian economies since the global financial crisis. Resolving so-called “zombie congestion”—the absorption of resources by marginal firms, to the detriment of more dynamic potential competitors—while promoting more innovative startups could help to improve aggregate productivity growth.

**Digitalization.** A new wave of digital innovation is reshaping the global economy, and Asia has been at the forefront in several areas. The digital revolution entails opportunities and challenges. The widespread use of robots, for instance, may boost productivity growth substantially, but it also risks raising structural unemployment if alternative opportunities for displaced labor cannot be created. IMF (2018c) argues that

comprehensive policies and fresh thinking are needed to harness the benefits of the digital revolution and to help make this a new engine of growth for the region.

## Policies

Policies and reforms should seek to maintain the current expansion, contain risks, and strengthen resilience to growing downside risks. Policies should also raise medium-term growth, enhancing its inclusiveness. Given the diversity of cyclical positions, structural constraints, and available policy space, policy priorities differ across economies.

Given low inflation and negative output gaps in most advanced economies in the region, monetary policy should generally remain accommodative. Fiscal policy should focus on building buffers, supporting inclusive long-term growth, and reducing excessive external imbalances. More specifically:

- In economies where domestic demand is weak, the current account is large, and there is fiscal space, fiscal policy should play a more active role in supporting activity and rebalancing the economy (Korea, Thailand, Singapore). In China, a gradual withdrawal of fiscal support is warranted to preserve policy space and ensure broader macroeconomic sustainability. The composition of fiscal policy should support the needed rebalancing from investment to private consumption.
- Where there are fiscal sustainability risks, near-term fiscal support for growth and reflation should be embedded in a credible medium-term fiscal framework (Japan). In economies where large fiscal imbalances entail risks to macroeconomic stability, fiscal consolidation should continue relying on high-quality measures to contain adverse distributional implications (India). Where current account deficits are large, fiscal consolidation is essential (Sri Lanka, Cambodia, Mongolia). Where growth is strong, economies need to build fiscal buffers that they can use in bad times (small states).

Emerging market and developing economies need to enhance resilience through an appropriate policy mix to reduce vulnerability to tightening financial conditions, sharp currency movements, and capital flow reversals. In economies with flexible exchange rates, currencies should be allowed to depreciate to their new equilibrium level, monitoring the effects of depreciations on private and public sector balance sheets and on domestic inflation. Exchange rate flexibility should be supported by appropriate monetary or fiscal tightening consistent with price stability and fiscal sustainability. Foreign exchange intervention should be used only to deal with disorderly market conditions. Given the global strength of the US dollar, economies should avoid fixing or giving the impression of fixing their exchange rates, or else risk depleting their reserves and undermining policy credibility. Changes to subsidies and transfers should be avoided to allow full pass-through and relative price adjustments. Economies facing limited policy flexibility should consider capital flow measures only in crisis or imminent crisis situations and not as a substitute for needed macroeconomic adjustment.

In other cases the following steps are needed:

- Economies where growth is sluggish and inflation is below target should avoid excessively tightening financial conditions and support growth by allowing the exchange rate to adjust,

which would complement monetary policy in achieving its inflation objective (Thailand). In Japan a sustained accommodative monetary stance in line with recent announcements is desirable to reflate the economy.

- In economies where inflation is above target, monetary tightening should continue in support of meeting the inflation target (India, Philippines).
- Economies with exchange rate pegs (Singapore) or dollarized economies (Cambodia) should turn to fiscal policy to support the peg.

Financial policies, including micro and macroprudential policies, should reduce vulnerabilities to tightening financial conditions. Supervisors should guard against the buildup of currency and/or maturity mismatches by ensuring that banks and/or corporates are following foreign exchange hedging and other regulations appropriately and checking on the quality of hedging counterparties. As a contingency measure, to help ease liquidity concerns and provide insurance against a sudden stop, economies with sufficient foreign exchange reserves could consider introducing longer-term swap lines with banks to facilitate orderly balance sheet unwinding of foreign exchange positions.

Reining in excess credit growth (China) and supporting healthy bank balances sheets (India) is important to improve resiliency and boost medium-term growth prospects.

To strengthen medium-term prospects, economies should prioritize supply-side measures that raise potential output and productivity, including investing in physical and digital infrastructure, boosting labor force participation where aging is a drag to the labor supply, and enhancing labor force skills. Structural reforms should alleviate infrastructure bottlenecks, strengthen the business environment, upgrade human capital, and ensure access to opportunities for all segments of society. Barriers to intraregional trade should be eliminated.

**Box 1. The Impact of Tighter Global Financial Conditions on Emerging Asia<sup>1</sup>**

*Financial conditions in advanced economies remain accommodative, but could tighten suddenly following a change in risk sentiment or a reassessment of the speed of interest rate increases in the United States. In response, the reduction in capital inflows to Asia could intensify and broaden, as experienced during recent capital outflow episodes. The impact would vary depending on economies' fundamentals and the space for countercyclical macroeconomic policies, especially the ability of monetary policy to provide stimulus during a time of heightened global financial volatility.*

The implications of tighter global financial conditions for economies in Asia are considered using the IMF's Flexible System of Global Models. A scenario is constructed that features a faster-than-expected increase in historically low US long-term borrowing costs—these rise 50 basis points in 2018 and an additional 50 basis points in 2019 before gradually returning to baseline thereafter. This increase depresses investment and consumption in the United States, reducing demand for imports from trade partners. In addition, this increase in long-term borrowing costs in the United States is assumed to be accompanied by an increase in sovereign and corporate risk premiums in all other countries, which compounds the negative impact on output and investment in countries in Asia. In response to these adverse shocks, the stance of monetary policy is eased in countries that are not constrained by the effective lower bound, providing some offset to the negative effect on investment and output; fiscal policy is assumed to operate via its automatic stabilizers. The combined effect of these two shocks is illustrated by the red line in Figures 1.1 and 1.2.

In such a downside risk scenario of tighter global financial conditions, the ability to lower policy rates to cushion the economy may be more constrained in some economies. Empirical evidence has shown varying degrees of monetary policy autonomy in emerging markets, reflected by domestic policy rates that are susceptible to global interest rate shocks, controlling for the interdependence of economic cycles (Caceres, Carriere-Swallow, and Gruss 2016; Peiris and others 2018).

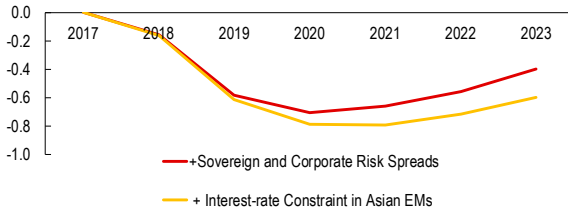
The possibility that Asian emerging markets may be unable or unwilling to provide demand support by easing monetary policy—consistent with a situation in which capital outflows are substantial—is considered by the yellow line in Figure 1.2, and the impact on activity would be much larger. Under such a scenario, monetary policy rates are not reduced to cushion against tightening global financial conditions, and investment falls by about 3 percent (Asian emerging markets, excluding China), relative to a benign, no-shock baseline. GDP is depressed by about 1 percent in the years following the financial tightening in this group of economies, more than double the impact when monetary policy can respond. For Asian advanced economies—where monetary policy is always assumed to have leeway to provide stimulus, outside of Japan—there is a negative spillover effect from weaker output in Asian emerging markets, which further reduces output through the trade channel.

---

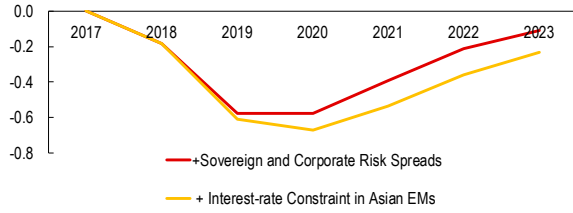
<sup>1</sup>This box was prepared by Patrick Blagrove, Keiko Honjo, and Shanaka J. Peiris.

**Figure 1.1. Asian Advanced Economies**

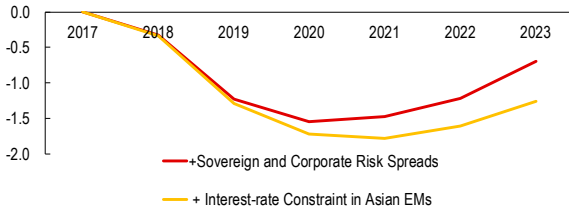
**1. Real GDP, Asian Advanced Economies**  
(Percent difference, level)



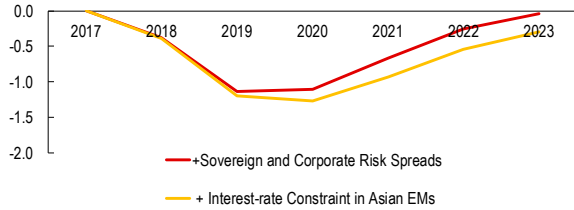
**2. Real GDP, Asian Advanced Economies (excl. Japan)**  
(Percent difference, level)



**3. Real Investment, Asian Advanced Economies**  
(Percent difference, level)

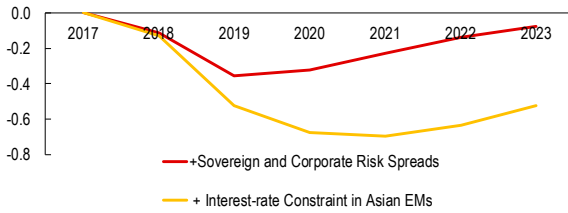


**4. Real Investment, Asian Advanced Economies (excl. Japan)**  
(Percent difference, level)

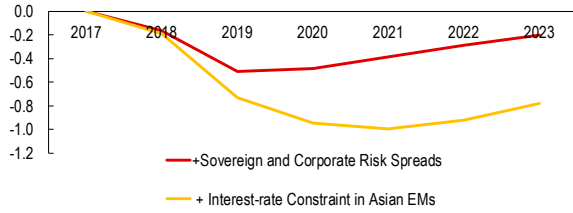


**Figure 1.2. Asian Emerging Economies**

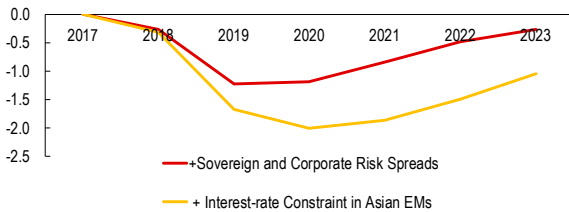
**1. Real GDP, Asian Emerging Economies**  
(Percent difference, level)



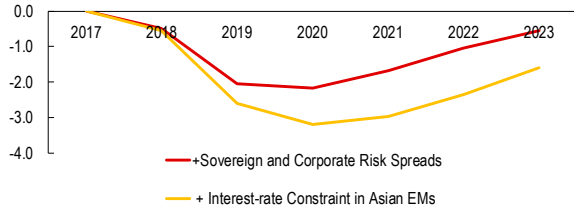
**2. Real GDP, Asian Emerging Economies (excl. China)**  
(Percent difference, level)



**3. Real Investment, Asian Emerging Economies**  
(Percent difference, level)



**4. Real Investment, Asian Emerging Economies (excl. China)**  
(Percent difference, level)



Note: EMs refers to Emerging Markets  
Source: IMF Staff Calculations.

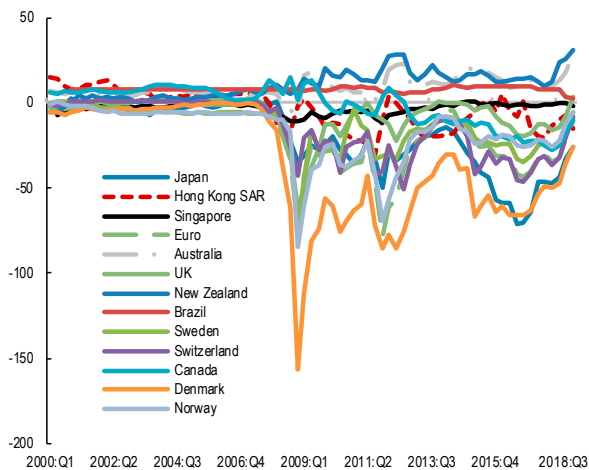
## Box 2. What Do Deviations from Covered Interest Parity and Higher US Dollar Funding Costs Mean for Asia?1

*The ongoing US monetary tightening has put upward pressure on US dollar funding costs. An important but often overlooked component of these funding costs is the cross-currency basis, which suggests there are deviations from covered interest parity.<sup>2</sup> These deviations can be explained by recent regulation that has limited arbitrage opportunities, and by a mismatch in the demand and supply of US dollars. Stable financial intermediation should be supported by policies providing reliable funding alternatives.*

The ongoing US monetary tightening raises concerns about US dollar funding costs for economies with high exposure to the US dollar. For companies and investors in Asia, the dollar is often the currency of choice. The cross-currency basis is an important component of US dollar funding cost. It is a measure of hedging premia, reflecting a cost in addition to interest rate differentials between two currencies. Under covered interest parity, the basis is nil. A negative (positive) basis implies a premium (a discount) the borrower of the US dollar pays to the lender.

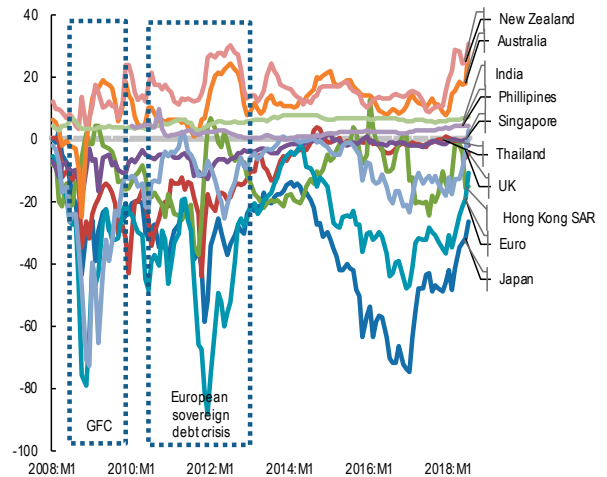
Some Asian economies exhibit persistent deviations from covered interest parity that have not closed since the global financial crisis (Figures 2.1 and 2.2). While some economies such as Australia, New Zealand, and India have consistently experienced positive deviations from covered interest parity, the basis has been negative for economies such as Japan, Korea, and Hong Kong SAR.<sup>3</sup> For Singapore, Thailand, and the Philippines, deviations from covered interest parity have mostly been small.

**Figure 2.1. One-Year Cross-Currency Basis**  
(Basis points, quarterly average)



Sources: Bloomberg; IMF Staff Calculations.

**Figure 2.2. One-Year Cross-Currency Basis**  
(Basis points, monthly average)



Note: Two-year basis in India, Nine-month basis in the Philippines; GFC=Global Financial Crisis. Sources: Bloomberg; and IMF Staff Calculations.

<sup>1</sup> This box was prepared by Gee Hee Hong and Anne Oeking.

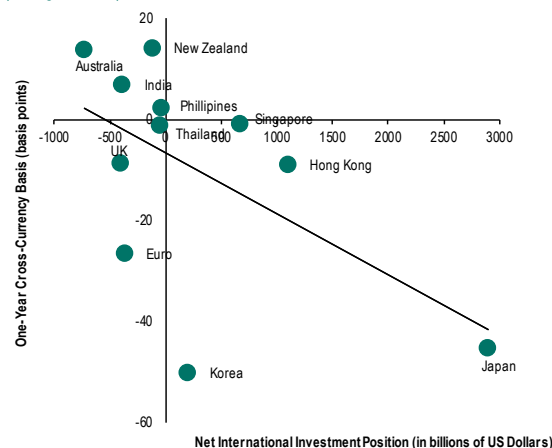
<sup>2</sup> Covered interest parity is a textbook no-arbitrage condition which says that interest rates of two otherwise identical risk-free assets in two currencies should be equal once the foreign currency risk is hedged.

<sup>3</sup> Negative basis for lending US dollars implies that borrowing dollars through the foreign exchange swap market is more expensive than direct funding in the dollar cash market. For a further discussion of the dollar-yen market, see the April 2018 *Global Financial Stability Report*.

Various factors contribute to the deviation from covered interest parity for different time periods:

- *Banks' counterparty credit risks and constraints on the US wholesale funding market.* Negative cross-currency bases were observed for most currencies during the global financial crisis in 2007–08 and the euro area sovereign debt crisis in 2011–12 (Figure 2.2).<sup>4</sup> Since the beginning of 2014, the non-zero cross-currency basis has persisted despite stable credit risk indicators and no significant US dollar funding shortages among banks.<sup>5</sup>
- *Structural factors among different sources of hedging demand and supply for US dollars.*<sup>6</sup> International imbalances exist between investment demand and funding supply across currencies that open covered interest parity deviations. Proxying hedging demand by net international investment positions, a negative relationship is found between net foreign assets and the cross-currency basis (Figure 2.3). For many economies, this reflects banks' net foreign assets. For other economies, the role of institutional investors' hedging demand also plays an important role. For example, in Korea, life insurance companies' hedging demand is estimated to exceed banks' hedging demand by five-fold.
- *Balance sheet constraints for financial intermediaries.* Regulatory reforms since the global financial crisis, such as tighter capital requirements, have increased balance sheet costs imposed on global banks that often act as arbitrageurs in closing covered interest parity deviations.

**Figure 2.3. Net International Investment Position and One-Year Cross-Currency Basis**  
(Average, 2014-17)



Sources: Bloomberg; IMF and Staff Calculations.

Policies to ensure adequate availability of US dollars could help mitigate the impact of a tightening in global financial conditions on financial stability and growth. For instance, central banks' swap lines, which are already in place for some economies to provide foreign exchange liquidity in times of stress, could be tapped to facilitate orderly unwinding of foreign exchange positions. Domestic capital market development for alternative funding instruments could protect domestic borrowers from being overly reliant on US dollar funding.

<sup>4</sup> See Baba, Packer, and Nagano (2008), Baba and Packer (2009), Coffey, Hrungr, and Sarkar (2009), and Mancini Griffolio and Ranaldo (2012) for covered interest parity deviation during the global financial crisis.

<sup>5</sup> The persistence of covered interest parity deviations and US dollar funding premiums in currency swap markets since mid-2014 have been highlighted in Arai and others (2016), BIS (2015), Bank of Japan (2015), Barclays (2015), and Du, Tepper, and Verdelhan (forthcoming).

<sup>6</sup> See Borio and others (2016) and Sushko and others (2016) for further discussion.

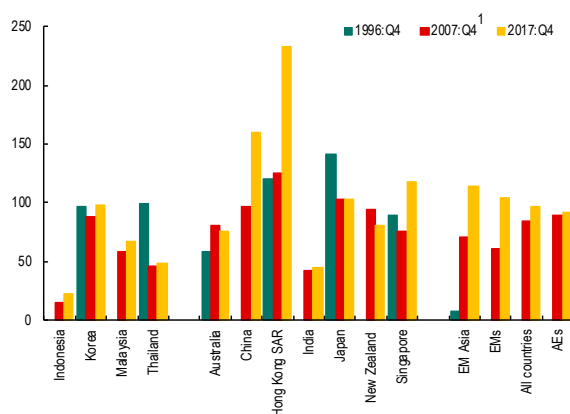
### Box 3. The Turning Tide: How Vulnerable Are Asian Corporates?<sup>1</sup>

*Asia's nonfinancial corporate sector is healthier than it was in the runup to the Asian financial crisis, but it remains highly vulnerable to a tightening of global financial conditions, with currency depreciation and higher global interest rates increasing the probability of default of Asian firms. For example, a currency depreciation of 15 percent would reduce the implicit bond rating capturing the probability of default by one notch.*

Global corporate debt has more than doubled over the past decade. A large share of the growth in corporate debt has come from Asian countries, leading to high corporate debt levels across most of the region. While corporate debt has been rising across the region, most notably in emerging Asia, the buildup of leverage accelerated following the global financial crisis. In emerging Asia, corporate debt increased to about 114 percent of GDP in 2017:Q4 from 71 percent in 2007:Q4. Corporate debt levels in Asia are generally higher than in other regions, particularly in China, Hong Kong SAR, and Singapore (Figure 3.1). The micro data suggest that the share of foreign currency (mainly US dollar) debt has declined over the past decade. At the same time, the average maturity of foreign currency debt has decreased, while that of local currency debt has increased.

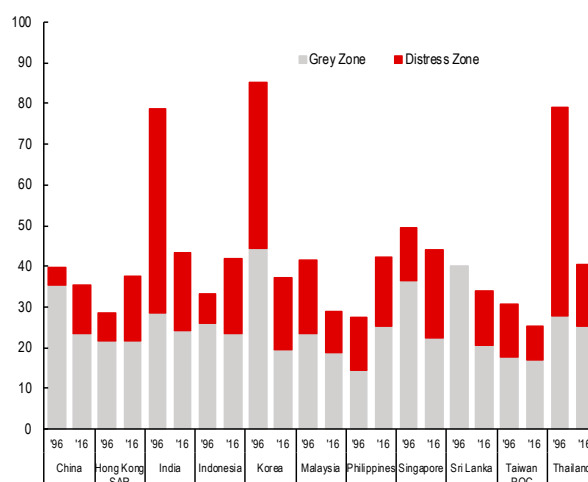
According to the Altman Z-score (Figure 3.2), although Asia's nonfinancial corporate sector is healthier than it was in the runup to the Asian financial crisis,<sup>2</sup> corporate vulnerabilities are higher in some Asian economies, including Hong Kong SAR, Indonesia, the Philippines, and Singapore.

**Figure 3.1. Nonfinancial Corporations Credit**  
(Percent of GDP)



Source: Bank for International Settlements.  
Note: 1/ EMs and All Countries data as of 2008:Q1. AEs: Advanced Economies; EMs: Emerging Markets; EM Asia: Emerging Markets in Asia.

**Figure 3.2. Fraction of Vulnerable Nonfinancial Corporates**  
(Fraction of firms with Z-scores outside the safe zone)



Source: IMF staff calculations.

<sup>1</sup>This box was prepared by Tahsin Saadi Sedik.

<sup>2</sup>The Altman Z-score is a summary measure of corporate vulnerability based on financial ratios of profitability, leverage, liquidity, and solvency. Lower Z-scores are associated with a larger probability of debt distress.



Asia's nonfinancial corporates remain highly vulnerable to a tightening of global financial conditions. Specifically, regression analysis suggests that the probability of financial distress (that is, the inverse of the Z-score) increases with local currency depreciation vis-à-vis the US dollar and with higher global interest rates. For example, a 15 percent currency depreciation is associated with a decline in the Z-score corresponding to a downgrade of corporate rating by one-notch, such as, A to A- (Table 3.1). The intuition behind the results is that a currency depreciation makes the firms' debt burden heavier, especially when the firm borrows heavily in foreign currencies. Similarly, a tightening of US monetary policy significantly increases corporate sector vulnerability in Asia.

**Table 3.1. Altman's Z-score and Bond Rating**

	Z-score	Rating	Z'score	Rating	
	> 8.5	AAA	5.65 - 5.85	BBB-	
	7.60 - 8.15	AA+	5.25 - 5.65	BB+	
	7.30 - 7.60	AA	4.95 - 5.25	BB	
	7.00 - 7.30	AA-	4.75 - 4.95	BB-	Grey Zone
Safe Zone	6.85 - 7.00	A+	4.50 - 4.75	B+	
	6.65 - 6.85	A	4.15 - 4.50	B	
	6.40 - 6.65	A-	3.75 - 4.15	B-	
	6.25 - 6.40	BBB+			
	5.85 - 6.25	BBB	3.20 - 3.75	CCC+	
			2.50 - 3.20	CCC	
		1.75 - 2.50	CCC-	Distress Zone	
		< 1.75	D		

Source: Altman (2005).

Asian policymakers should monitor vulnerable firms, especially those systemically important, as well as banks and other sectors closely linked to them. Such efforts include filling data gaps on corporate sector finances, including foreign currency exposures. Macro and microprudential policies could help limit a further buildup of foreign exchange balance sheet exposures and contain excessive increases in leverage. Asian emerging markets should prepare for an increase in corporate failures and, where needed, reform corporate insolvency regimes.

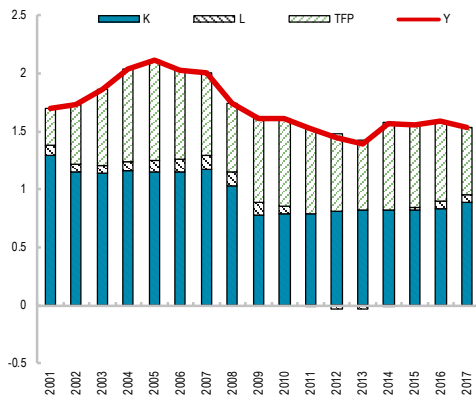
## Box 4. Potential Growth in Asia: Recent Dynamics and Drivers<sup>1</sup>

*In many economies around the world, headwinds from the global financial crisis, as well as slower growth in the working-age population, have depressed potential growth in recent years. This box shows that these factors have also hindered potential growth in a set of advanced and emerging economies in the Asia and Pacific region.*

Recent estimates indicate that potential growth in a set of large advanced and emerging economies declined following the global financial and euro area crises (see Chapter 3 in the April 2015 *World Economic Outlook*). This box examines the recent dynamics of potential growth in a set of 12 economies in the Asia and Pacific region, decomposing estimates into their production-function drivers—capital, labor, and total factor productivity growth. The analysis presented here draws on the potential-growth estimates of IMF country teams and is broadly consistent with IMF (2018b) and (2018c). Data on the share of labor and capital stock for each country are taken from the 2014 Penn World Tables, and that information is extended for 2015–17 using data on gross fixed capital formation.<sup>2</sup> Estimates of potential employment are constructed using data on the working-age population and the trend in the labor force participation rate.<sup>3</sup>

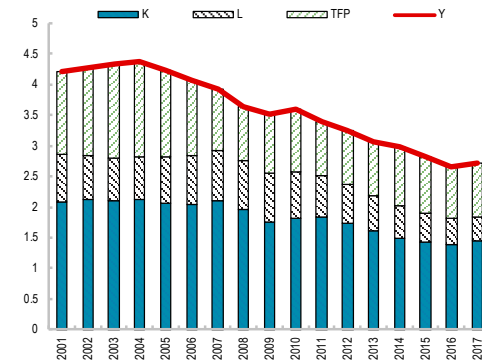
In a group of six advanced economies in Asia, the decline in potential growth witnessed in the aftermath of the global financial crisis has been partly reversed in recent years (Figure 4.1). Each factor of production has seen a modest improvement. However, this rosy picture is considerably different when Japan—whose potential growth rate has recently benefited from less-negative working-age population growth, an increase in trend labor force participation, and an uptick in investment and thus capital-stock growth—is excluded from the analysis (Figure 4.2). For this subgroup, the waning contribution from labor associated with slowing working-age population growth rates, along with moderating investment rates and lower total factor productivity growth, have weighed on potential growth.

**Figure 4.1. Asian Advanced Economies' Potential Growth**  
(Percent)



Sources: Penn World Tables, United Nations, International Labor Organization, and IMF staff calculations.  
Note: K = Capital; L = Labor; Y = Potential Growth; TFP = Total Factor Productivity.

**Figure 4.2. Asian Advanced Economies' Potential Growth Excluding Japan**  
(Percent)



Sources: Penn World Tables, United Nations, International Labor Organization, and IMF staff calculations.  
Note: K = Capital; L = Labor; Y = Potential Growth; TFP = Total Factor Productivity.

<sup>1</sup>This box was prepared by Patrick Blagrove

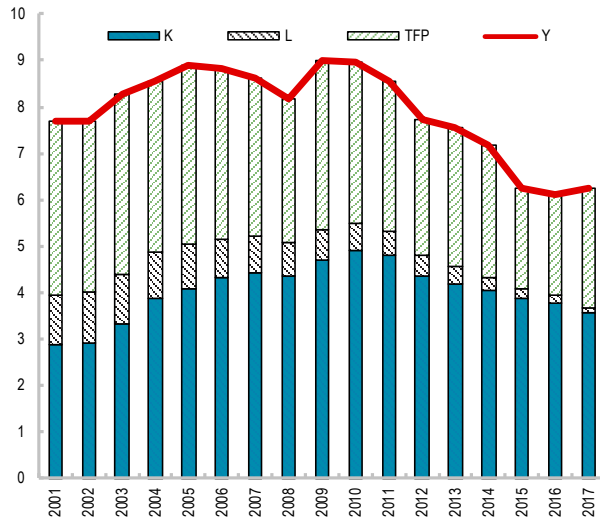
<sup>2</sup> Depreciation rates needed to extend capital-stock estimates are held constant at 2014 values, as is the labor share, for 2015–17. The set of 12 economies includes Australia, China, Hong Kong SAR, Japan, Korea, New Zealand, India, Indonesia, Malaysia, the Philippines, Singapore, and Thailand.

<sup>3</sup> Working-age population data are taken from the United Nations World Population Prospects database. Estimates of trend participation rates are calculated from International Labor Organization data. In the cases of China and India, participation is assumed to be constant throughout the sample, given data constraints.

For a group of six emerging economies in Asia, there has also been a marked slowdown in potential growth since around 2010 (Figure 4.3). The slowdown is explained by lower contributions from capital, labor, and total factor productivity.

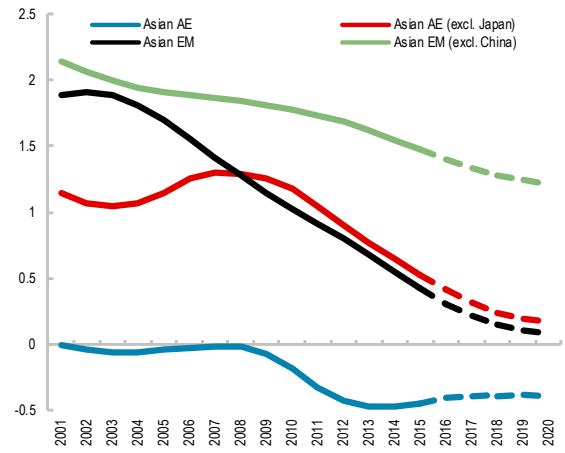
Going forward, the working-age population is expected to continue slowing in most Asian economies (Figure 4.4). Policy action will be needed if potential growth is to be sustained or increased from current levels, including measures that support productive investment, encourage increases in productivity, and better incorporate female and older workers into the labor force.

**Figure 4.3. Asian Emerging Markets' Potential Growth (Percent)**



Sources: Penn World Tables, United Nations, International Labor Organization, and IMF staff calculations. Note: K = Capital; L=Labor; Y=Potential Growth; TFP= Total Factor Productivity.

**Figure 4.4. Working-Age Population Growth Rates (Percent)**



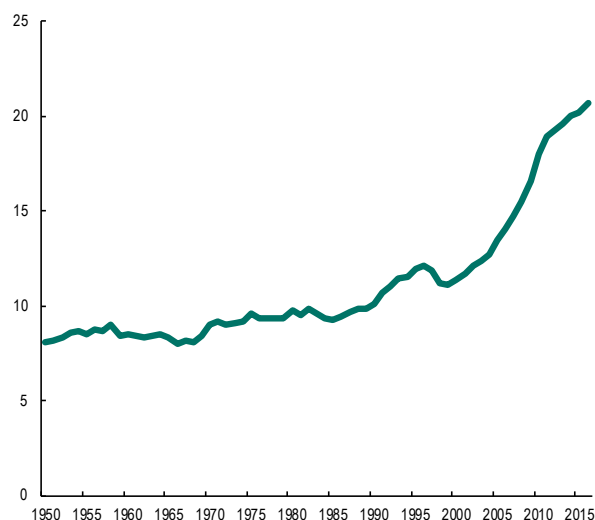
Sources: Penn World Tables, United Nations, International Labor Organization, and IMF staff calculations. Note: AEs: Advanced Economies; EMs: Emerging Markets.

## Box 5. Sustainable Development and Economic Welfare in Asia<sup>1</sup>

Asian economies have made substantial progress in income convergence with respect to the United States, especially in the last 20 years. The catch-up of Asian economies according to a broader measure of welfare was more limited, but could be accelerated by policies geared towards achieving more balanced, inclusive, and environmentally sustainable development outcomes.

Asian economies have achieved significant income convergence with respect to the United States since the end of World War II. GDP per capita in Asia increased from 8 percent of US GDP per capita in 1950 to 21 percent in 2016 (Figure 5.1). The catch-up has been more pronounced since the Asian financial crisis in 1998. A large gap remains in income per capita. Based on current projections there will be further income convergence, and GDP per capita in Asian economies could reach 36 percent of US GDP per capita by 2030. The current gap between Asian economies and the United States when using a broader measure of welfare is larger than the GDP per capita gap. Using a measure of welfare that is a function of selected Sustainable Development Goal indicators, the welfare gap with respect to the United States is 84 percent. In contrast, the income gap is 78 percent. The measure of economic welfare is a function of selected Sustainable Development Goal indicators including income, consumption, life expectancy, income inequality, and greenhouse gas emissions (Jones and Klenow 2016; Bannister and Mourmouras 2017).

**Figure 5.1. Asia GDP per capita**  
(In percent of US GDP Per Capita)



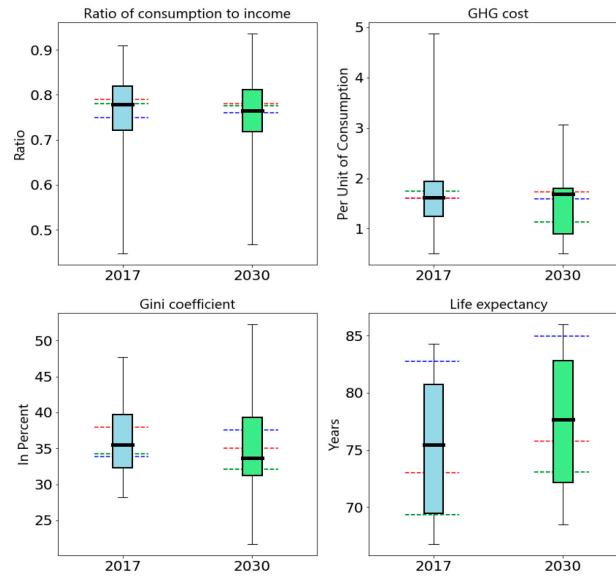
Source: Madison database, 2018.

Under current projections, convergence in economic welfare is likely to lag improvements in income per capita, with the welfare level in the median Asian economy improving from 16 percent of the US level to about 28 percent by 2030. Projected welfare improvements are driven primarily by higher income and life expectancy, leaving significant room for further rebalancing towards more consumption, as well as more inclusive and environmentally sustainable growth (Figure 5.2)

Policies to address sustainable development challenges can lead to significant improvements in welfare. In this context, several countries are in the process of incorporating Sustainable Development Goal priorities into their national development plans. Country-specific development plans also need to account for the costs associated with policies to improve sustainable development, which requires efforts to improve spending efficiency and mobilize higher domestic revenues and other resources, including from the private sector. For some lower-income Asian countries with large sustainable development needs, additional concessional financing from development partners would likely be required.

<sup>1</sup>This box was prepared by Geoff Bannister, David Corvino, Albe Gjonbalaj and Jarkko Turunen.

Figure 5.2. Components of Welfare



Source: IMF staff calculations.

Note: GHG= Greenhouse gas. The black line shows the median for Asia. The blue, red and green dotted lines show the median of high-, middle- and low- income Asia. Ratio of consumption to income is expressed in terms of advanced economy comparator. The Greenhouse gas cost per unit of consumption of advanced countries is 1.4 percent (2017 and 2030). The Gini coefficient of advanced countries is 41.6 percent (2017) and 42.4 percent (2030). Life expectancy in advanced countries is 79 years (2017) and 81.5 years (2030).

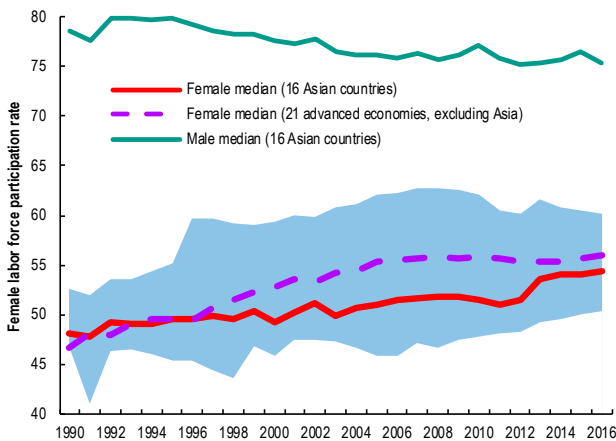
**Box 6. Increasing Female Labor Force Participation in Asia<sup>1</sup>**

*Female labor force participation is trending up across Asia, despite downward pressures related to population aging. The increase in female labor force participation is explained by strong growth as well as structural factors including expansion of the service sector, higher education levels, lower labor market rigidities, and family-friendly policies (for example, childcare provision and maternity job protection). Asian policymakers should aim to adopt family-friendly policies and continue to pursue reforms that support growth.*

Many Asian economies face shrinking labor forces as their populations rapidly age. Bringing more women into the workforce could help counter this trend, raising growth via an expansion in the total labor force. Higher female labor force participation also reduces income inequality, diversifies the economy, and boosts firm profitability (Gonzales and others 2015; Kazandjian and others 2016; Christiansen and others 2016). On average, female labor force participation in Asia increased from 48 percent in 1990 to 54 percent in 2016 (Figure 6.1). In contrast, average male labor force participation has dipped slightly. These trends parallel developments in other regions.

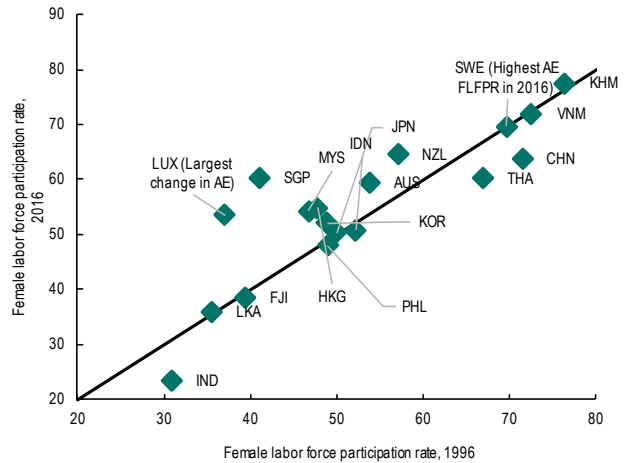
Several economies with low female labor force participation rates before the Asian financial crisis—Australia, Singapore, Malaysia, Hong Kong SAR, and New Zealand—recorded significant (above 10 percentage points) improvements during 1996–2016 (Figure 6.2). Korea marginally improved on historically stagnant or declining participation rates. Together, these gains lifted average female participation rates in Asia. However, other Asian economies have lagged further behind, notably India, Indonesia, the Philippines, and Sri Lanka. Thus, the gap between the better and poor performers in Asia has been increasing over time.

**Figure 6.1. Female Labor Force Participation Rates (Percent)**



Sources: World Bank, World Development Indicators and IMF staff calculations.  
 Note: Due to data unavailability, the figure excludes data for the following countries: Cambodia (1990–91, 2015–16), Fiji (1990–95), China (2011–16); India (1990, 2013–16); and Vietnam (1990–95). Shaded lines show interquartile range.

**Figure 6.2. Female Labor Force Participation Rates (Percent)**



Sources: World Bank, World Development Indicators and IMF staff calculations.  
 Note: Due to data unavailability for 2016, the calculations for Cambodia, China and India were based on 2014, 2010 and 2012, respectively. 2016 data observation is used for Sweden's female labor participation rate instead of 1996. AE: advanced economies. FLFPR: Female Labor Force Participation Rate.

<sup>1</sup> This box was prepared by Angana Banerji, Albe Gjonbalaj, Sandile Hlatshwayo, and Anh Van Le.

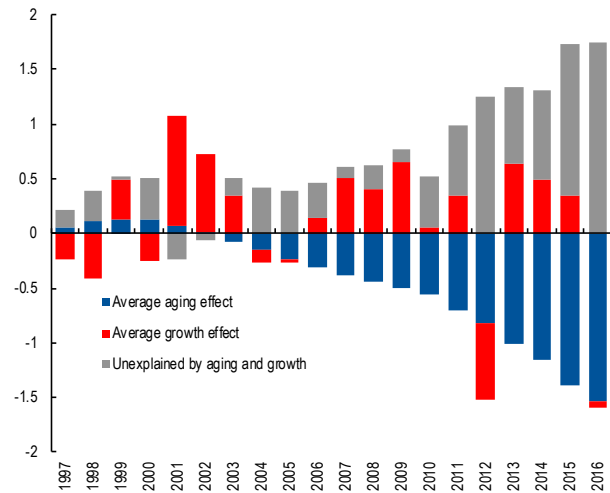
On average, prime-age female workers are participating in the labor force at higher rates than before. However, decomposing changes in the female labor force participation rate shows that aging has reduced the share of prime-age workers in the overall population, thereby reducing the size of the overall improvements in women's participation.

The rise in female labor force participation rates, despite the downward pressures from aging, is partly explained by strong growth in Asian economies in recent years (that is, a stronger economy increases labor demand, bringing more workers—both men and women—into the labor force). Nevertheless, large unexplained components remain even after accounting for the effects of economic cycles and aging on female labor force participation (Figure 6.3). This suggests other factors also play a role in determining female labor force participation in Asia.

Female labor market outcomes are known to be a function of various interrelated factors, including social, structural, and individual characteristics, along with policies. These factors include better infrastructure, legal rights, low adolescent fertility rates, maternity, and childcare. Their impact may vary depending on the economic structure and the level of economic and institutional development. Since Asia is comprised of economies at various stages of economic development, labor market endowments, and policy and institutional settings, some factors are on average less important statistically than others in explaining changes in female labor force participation simply because they only affect smaller subgroups of economies.

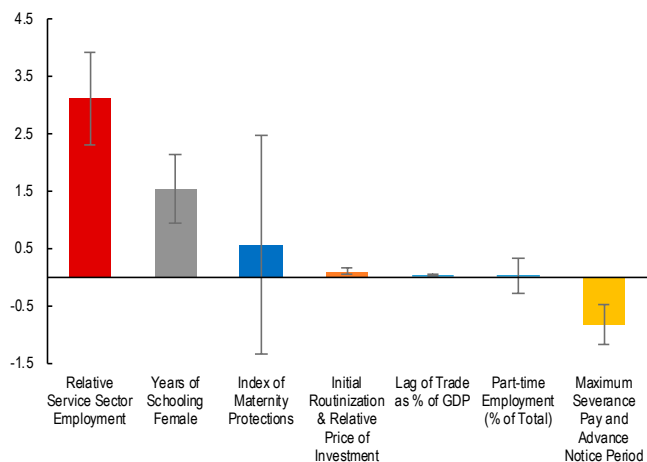
Among Asian economies, higher shares of the service sector relative to the industrial sector, along with higher education levels, stand out as being most closely associated with higher female labor force participation (Figure 6.4). The openness of the economy (measured by the share of trade in GDP) and the pace of urbanization (not shown) have positive but smaller effects on average given the diversity of Asian economies. While automation (or routinization) has been shown to be detrimental to female labor force participation, not all economies in Asia are equally exposed to routinization, given the significant share of agriculture in GDP in some economies. Moreover, a higher cost of automation is positively linked with female labor force participation because it reduces the incentive to automate.

**Figure 6.3. Changes in Female Labor Force Participation Rates, 1997–2016**  
(Percent)



Sources: World Bank, World Development Indicators, International Labour Organization; and IMF staff calculations. Note: Methodology based on Annex 2.3 in April 2018 World Economic Outlook, Chapter 2.

**Figure 6.4. Drivers of Female Labor Force Participation in Asia**  
(Age 25 - 54 years old)



Source: IMF staff calculations.

Note: The bars denote the estimated change in female labor force participation (25 to 54 years of age), from a one-unit increase in the variable. The vertical lines show the 90 percent confidence interval. The underlying regressions all include country and time fixed effects.

Family-friendly policies and structural characteristics proxied by an index of maternity protections and part-time employment that are tailored to address specific constraints faced by women play a positive role. But data gaps, the large informal sector, and limited institutional capacity to enforce legally mandated provisions in some Asian economies tamp down on the size of the overall effects. Finally, labor market rigidities that make it difficult for businesses to let go of unproductive workers can have a chilling effect on employers' decisions to hire female workers.



## References

- Altman, E. 2005. “An Emerging Market Credit Scoring System for Corporate Bonds.” *Emerging Market Review* 6: 3011–323.
- Arai, F. Y. Makabe, Y. Okawara, and T. Nagano. 2016. “Recent Trends in Cross-Currency Basis.” *Bank of Japan Review* (September).
- Baba, N., and F. Packer. 2009. “From Turmoil to Crisis: Dislocations in the FX Swap Market before and after the Failure of Lehman Brothers.” *Journal of International Money and Finance* 28(8): 1350–74.
- Baba, N., F. Packer, and T. Nagano. 2008. “The Spillover of Money Market Turbulence to FX swap and Cross-Currency Swap Markets.” *BIS Quarterly Review* (March), Bank for International Settlements, Basel.
- Bank for International Settlements (BIS). 2015. “Uneasy Calm Awaiting Lift-off.” *BIS Quarterly Review* (December), Bank for International Settlements, Basel.
- Bank of Japan. 2015. “Financial System Report, October.” Financial System and Bank Examination Department, Bank of Japan.
- Bannister, G., and A. Mourmouras. 2017. “Welfare vs Income Convergence and Environmental Externalities.” IMF Working Paper No. 17/271, International Monetary Fund, Washington, DC.
- Blagrove, P., R. Garcia-Saltos, D. Laxton, and F. Zhang. 2015. “A Simple Multivariate Filter for Estimating Potential Output.” IMF Working Paper No. 15/79, International Monetary Fund, Washington, DC.
- Borio, C., R. McCauley, P. McGuire, and V. Sushiko. 2016. “Covered Interest Parity Lost: Understanding the Cross-Currency Basis.” *BIS Quarterly Review* (September), Bank for International Settlements, Basel.
- Caceres, C., Y. Carriere-Swallow, and B. Gruss. 2016. “Global Financial Conditions and Monetary Policy Autonomy.” IMF Working Paper No. 16/108, International Monetary Fund, Washington, DC.
- Christiansen, L., H. Lin, J. Pereira, P. Topalova, and R. Turk. 2016. “Gender Diversity in Senior Positions and Firm Performance: Evidence from Europe.” IMF Working Paper No. 16/50, International Monetary Fund, Washington, DC.
- Coffey, N., W. Hrungrung, and A. Sarkar. 2009. “Capital Constraints, Counterparty Risk, and Deviations from Covered Interest Parity.” Staff Report No. 393, Federal Reserve Bank of New York.
- Du, W., A. Tepper, and A. Verdelhan. Forthcoming. “Deviations from Covered Interest Rate Parity.” *The Journal of Finance*.
- Gonzales, C., S. Jain-Chandra, K. Kochhar, M. Newiak, and T. Zeinullayev. 2015. “Catalyst for Change: Empowering Women and Tackling Income Inequality.” IMF Staff Discussion Note 15/20, International Monetary Fund, Washington, DC.
- International Monetary Fund (IMF). 2018a. “Regional Economic Outlook: Asia and Pacific Background Paper No. 2—Trade in Asia: Going from Tensions Today to Enhanced Intra-regional Integration Tomorrow” (October, Washington, DC).

- \_\_\_\_\_. 2018b. “Regional Economic Outlook: Asia and Pacific Background Paper No. 3—Productivity Growth in Asia: Boosting Firm Dynamism and Weeding out the Zombies” (October, Washington, DC).
- \_\_\_\_\_. 2018c. “Regional Economic Outlook: Asia and Pacific Background Paper No. 4—The Digital Revolution in Asia: Disruptor or New Growth Engine (or Both)?” (October, Washington, DC).
- Jones, C.I., and P. Klenow. 2016. “Beyond GDP? Welfare Across Countries and Time.” *American Economic Review* 106(9): 2426–457.
- Kazandjian, R., L. Kolovich, K. Kochhar, and M. Newiak. 2016. “Gender Equality and Economic Diversification.” IMF Working Paper 16/140, International Monetary Fund, Washington, DC.
- Lee, D., H. Zhang, and C. Nguyen, 2018. “The Economic Impact of Natural Disasters in Pacific Island Countries: Adaptation and Preparedness, IMF Working Paper No.18/08.
- Mancini Griffoli, T., and A. Ranaldo. 2012. “Limits to Arbitrage during the Crisis: Finding Liquidity Constraints and Covered Interest Parity.” Working Paper on Finance No. 1212, University of St. Gallen, School of Finance.
- Peiris, J. and others. 2018. “Monetary and Exchange Rate Policy Responses.” In *The ASEAN Way: Sustaining Growth and Stability*, edited by Ana, Corbacho and Shanaka J. Peiris. Washington, DC: International Monetary Fund.
- Sushko, V., C. Borio, R. McCauley, and P. McGuire. 2016. “Failure of Covered Interest Parity: FX Hedging Demand and Costly Balance Sheets.” BIS Working Paper No. 590, Bank for International Settlements, Basel.

# REGIONAL ECONOMIC OUTLOOK: ASIA AND PACIFIC BACKGROUND PAPER NO. 2

## The Evolving Role of Trade in Asia: Opening a New Chapter<sup>1</sup>

October 2018

---

<sup>1</sup> This *Regional Economic Outlook: Asia and Pacific* background paper was prepared by Shanaka J. Peiris (lead), Jayendu De, Sergei Dodzin, Sandile Hlatshwayo, Vipichbolreach Long, Rui Mano, Dirk Muir, Medha Madhu Nair, Manrique Saenz, and Qianqian Zhang, under the guidance of Koshy Mathai. Alessandra Balestieri, Francisco Landicho, and Socorro Santayana provided excellent production assistance. The paper is based on data available as of September 18, 2018, and includes comments from other IMF departments and some Executive Directors.

## Introduction

Asia has achieved stellar economic success over the past few decades as the region integrated with the global economy. While there are many factors behind Asia’s economic accomplishments—investment in human capital and sound macro policies are among the most important—there can be no doubt that reliance on trade as an engine of growth has been a critical part of Asia’s winning formula. Asian economies are at the center of global value chains (GVCs) in manufacturing (see Chapter 2 of the April 2015 *Regional Economic Outlook: Asia and Pacific*; and Chapter 2 of the April 2016 *World Economic Outlook*) that have boosted productivity among participating firms, especially the manufacturing sector, exposing them more to foreign competition and investment (IMF 2018a). These sectors are also an important source of jobs for a young and growing labor force. Despite the impressive performance, however, the question remains: How long will trade continue to be a driver of Asian growth?

Rising income levels and wages in the region, combined with a less buoyant medium-term outlook in advanced economies, suggests the need for Asia to reconsider its growth model. Trade will still play an important role, but rather than being oriented toward meeting final demand in other regions, it is increasingly likely to serve final demand within Asia (Mano 2016). The “manufacturing for export” growth strategy may also need to evolve—China has not exited the labor-intensive, light manufacturing sectors as quickly as Korea and Japan did in earlier eras, limiting opportunities for other Asian developing economies to follow this approach (Mathai and others 2016). The secular decline in manufacturing’s share in employment, combined with the fast rise in automation (for example, robotics), suggests a shift to a new growth model focused on tradable and digital services (see Chapter 3 of the April 2018 *World Economic Outlook*).

While Asia confronts this structural transformation, its trade-based growth model faces a more immediate threat from increasingly inward-looking policies in advanced economies. Recently enacted tariffs and investment-related actions are significant and would weigh on growth, particularly in China, although policy stimulus there is likely to offset some of the impact. Further tariff escalation has been proposed, and this, along with effects on confidence and financial markets, could have an even more substantial economic impact across the region.

In contrast, a reinvigorated commitment to an open, fair, and rules-based international trade system and negotiations to further liberalize trade at the regional and global level would enhance productivity and raise incomes (IMF, World Bank and WTO 2017). In Asia, trade restrictiveness and so-called “trade costs” remain high (Cerdeiro and Nam 2018), notwithstanding the progress made in cutting goods tariffs as part of the World Trade Organization (WTO) accession process and regional trading arrangements, as well as in reducing nontariff barriers (NTBs) as part of the 2016 WTO trade facilitation agreement (ADB 2017). Reinvigorating reforms in areas where less progress has been made, such as agriculture, is important, while opening new areas in services and digital trade could contribute significantly to global economic growth given the size of these areas, their close links to other sectors, and high trade barriers (IMF, World Bank and WTO 2018). Liberalization of these sectors and foreign investment restrictions would ideally be advanced through multilateral agreements among all WTO members. But where that is not initially possible, the region could still benefit from unilateral liberalization and regional integration; illustrative scenarios in this paper explore such potential benefits.

The paper examines how trade has evolved as a driver of growth in Asia and explores the extent to which it can continue to play this role. It starts by presenting stylized facts on the nature of Asia’s trade and integration in global and regional value chains. It then deploys two models to analyze both the adverse impact of current trade tensions and the benefits to Asia from trade and investment liberalization. One of the IMF’s dynamic stochastic general equilibrium models—the Global Integrated Monetary and Fiscal Model (GIMF)—is used to shed light on the short- and medium term macroeconomic consequences of trade policy changes, while a Ricardian Trade Model (RTM) provides additional detail on how individual economies and sectors would be affected in the long term taking account of GVCs.

The key findings are as follows:

- Trade openness, which rose sharply starting in the late 1990s and early 2000s, has plateaued and in some cases declined since the global financial crisis, reflecting both a global trade slowdown and maturation of GVCs, particularly in China.
- Asia's intraregional trade is the second highest in the world and rising as a share of global trade, but this largely reflects trade of intermediates in GVCs, with most of Asia's domestic value added in exports destined for markets outside the region. The reliance on final demand from outside the region makes Asia vulnerable to trade protectionism in advanced economies.
- Model simulation exercises suggest that recent tariff actions and proposals could weigh heavily on Asian growth. The effects of recently enacted tariffs and retaliation are small but material, especially for China. GDP losses would rise substantially should additional tariffs be implemented, and particularly so if business confidence and financial markets were to be affected. Accounting for these channels, enacted and proposed tariffs and retaliation could cause China's output to fall by up to 1.6 percent over the first two years, and for the region as a whole, GDP could drop by up to 0.9 percent, though the effects would fade over time and could be mitigated by short-term policy stimulus. Aggregate short-term job losses would likely be limited, but certain sectors—particularly those targeted by specific tariffs—could see sizable impacts.
- Asia has benefited from trade liberalization and global integration, but the pace of trade reform has slowed markedly since the global financial crisis, as elsewhere in the world. Asia still suffers from significant trade costs. Restrictions on services and foreign investment remain relatively high, providing scope for a new wave of liberalization that could lift productivity in the region.
- Reforms are ideally advanced through fully multilateral agreements among all WTO members, but the system of global trade rules faces tensions. Irrespective of how current global trade tensions play out, illustrative model simulations suggest that Asian economies could boost their trade and GDP growth through unilateral trade liberalization and regional integration initiatives focused on reducing service trade costs and foreign investment restrictions. Such initiatives would facilitate Asia's rebalancing and reduce its reliance on manufacturing exports to the rest of the world.
- Easing investment restrictions would amplify the benefits of reducing trade costs, particularly in services, where Asia's trade costs and investment restrictions are the greatest. Asia's long-term GDP could rise by 12-15 percent on average, and approaching 20 percent in some economies, if foreign direct investment (FDI) were also liberalized.
- Domestic policies to address trade-related adjustments are critical. Some sectors and economies will be adversely affected by changes in trade and investment patterns. Therefore, active labor market policies—such as job search assistance, training programs, and social safety nets—can, if well-designed and tailored to country circumstances, augment worker skills and facilitate re-employment. These domestic policies can also help overcome resistance by vested interest groups of affected sectors by ensuring that all members of society share in the gains unleashed by liberalization.

This paper first chronicles Asia's experience over the past two decades with trade, focusing both on its level of integration with regional partners relative to the rest of the world and the importance of GVCs. Against this backdrop, the second section illustrates the adverse implications of current and proposed tariffs using the GIMF and RTM. The paper then examines trade costs in Asia before turning to exploring the scope for reducing these costs to benefit from further trade and investment liberalization, including the extent to which Asia can buffer itself against current global tensions, once again referring to the RTM and GIMF.

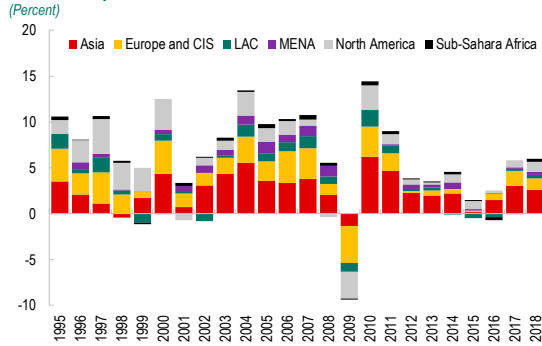
# Stylized Facts on Trade and Participation in Global Value Chains

Since the global financial crisis, Asia has been the key driver of global trade and GDP growth (Figure 1). The sharp rise in trade openness since the late 1990s and early 2000s related to the reduction in most favored nation tariffs across the region, and especially to China's accession to the WTO, spurred an expansion of global trade (see Chapter 2 in the October 2016 *World Economic Outlook*; and Mathai and others 2016). Lower tariffs on intermediate goods and reductions in transport and communication costs helped set the stage for the growing prevalence of GVCs, with components crossing international

**Figure 1. Trade in Asia**

*Asia has been the key driver of global trade...*

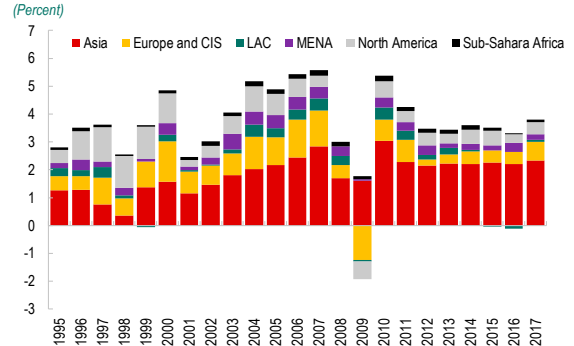
### 1. Global Import Volume Growth



Sources: IMF, *World Economic Outlook*, and IMF staff calculations.  
Note: LAC = Latin America and the Caribbean; MENA = Middle East and North Africa.

*...and growth, especially after the global financial crisis.*

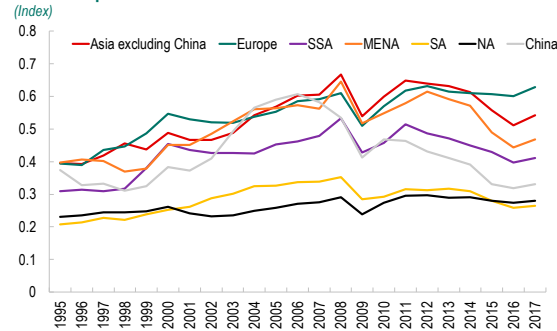
### 2. Global Growth



Sources: IMF, *World Economic Outlook*, and IMF staff calculations.  
Note: LAC = Latin America and the Caribbean; MENA = Middle East and North Africa.

*The sharp rise in trade openness since the late 1990s has tapered off across the region...*

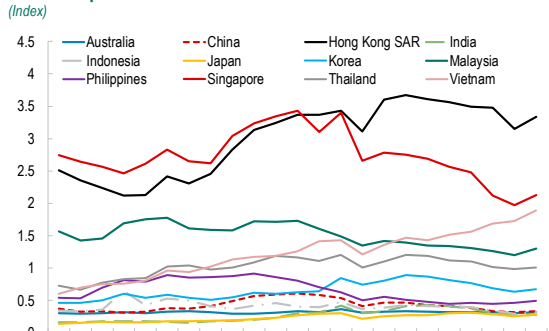
### 3. Trade Openness



Sources: IMF, *World Economic Outlook*; IMF, Direction of Trade database, and IMF staff calculations.  
Note: SSA = Sub-Saharan Africa; MENA = Middle East and North Africa; SA = South America, Central America, and the Caribbean; NA = North America.

*...except in Vietnam.*

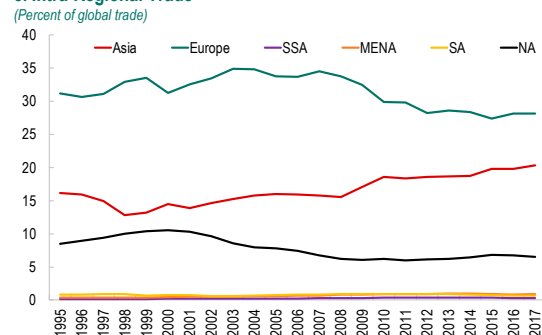
### 4. Trade Openness: Asia



Sources: IMF, *World Economic Outlook*; IMF, Direction of Trade database, and IMF staff calculations.

*Regional integration agreements have also facilitated intraregional trade...*

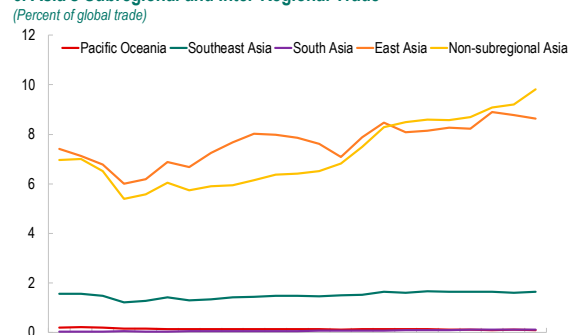
### 5. Intra-Regional Trade



Sources: IMF, *World Economic Outlook*; IMF, Direction of Trade database, and IMF staff calculations.  
Note: SSA = Sub-Saharan Africa; MENA = Middle East and North Africa; SA = South America, Central America, and the Caribbean; NA = North America.

*...mainly trade across Asian subregions and trade within East Asia.*

### 6. Asia's Subregional and Inter-Regional Trade

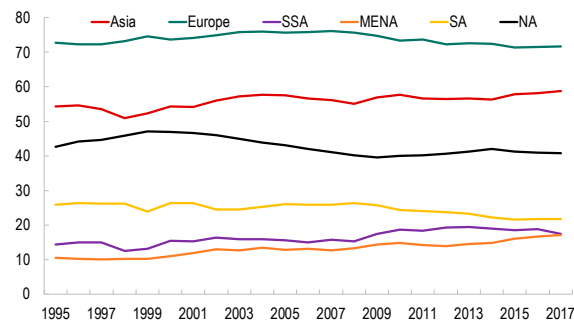


Sources: IMF, *World Economic Outlook*; IMF, Direction of Trade database, and IMF staff calculations.

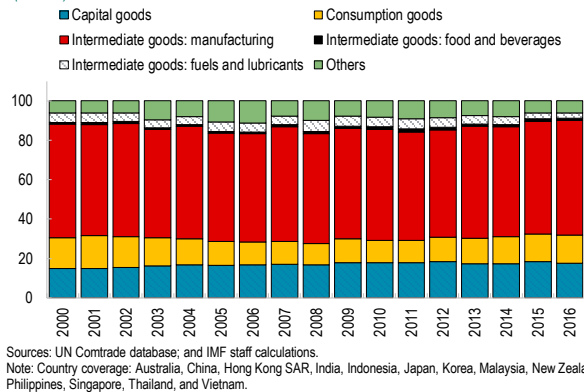
borders numerous times before shipment of the final good. While the rise of GVCs has been ubiquitous across the globe (Figures 2–4), the expansion has been particularly pronounced in China, Korea, Japan, and the Association of Southeast Asian Nations (ASEAN).

Regional integration agreements also facilitated intraregional trade, investment, and the development of regional supply chains, though the coverage and depth of progress has been uneven, especially in recent years (ADB 2017; Chapter 2 in the October 2016 *World Economic Outlook*). Numerous regional trade arrangements have facilitated a rise in intraregional goods trade and brought intraregional tariffs close to zero for a wide array of goods (Figure 2).<sup>2</sup> All Asian subregions (East Asia, Southeast Asia, South Asia, Pacific-Oceania, and the rest of Asia) trade more intensively with other subregions than within themselves, except for East Asia (Figure 1). While trade within subregions has generally stalled since 2010, trade across them has picked up. Asia’s intraregional goods trade is mostly in manufactured intermediate goods, reflecting the region’s participation in GVCs (Figure 3). Asia is second only to Europe in the size of its intraregional trade, which accounts for roughly 20 percent of global trade and is on an upward trajectory (Figure 1). Nearly 60 percent of the region’s total trade is intraregional, that is, within Asia (Figure 2).

**Figure 2. Intra-Regional Trade**  
(Percent of regional trade)



**Figure 3. Intra-Regional Trade**  
(Percent)



Asia’s trade openness and participation in GVCs, however, has plateaued and in some cases (such as China) declined since the global financial crisis (Figures 1 and 4).<sup>3</sup> This may reflect smaller declines in trade costs, reshoring, higher obstacles to cross-border investment, or maturation of GVCs (Constantinescu and others 2015). In the case of China, the lower foreign value added embodied in exports (backward linkages) could be attributed to onshoring, given that China is increasingly producing intermediate inputs domestically (Mathai and others 2016). Chapter 4 of the October 2016 *World Economic Outlook* provides evidence that increased domestic production of intermediates in China has displaced imports from trade partners. This effect has been strongest in recent years as China moves up the value chain.

Low-income Asian economies have, with a few exceptions, not participated significantly in GVCs (Figure 4). Intermediate exports from Asia are largely medium/high-tech manufacturing from advanced and emerging economies, with Vietnam a somewhat rare example of a relatively new emerging market that has gained market share in electronics. Other low-income Asian economies have been more concentrated in low-tech light manufacturing, such as apparel and footwear (for example, Bangladesh, Cambodia and Myanmar). India, Hong Kong SAR, the Philippines, and Singapore stand out in terms of GVC-related service exporters.

<sup>2</sup> See Annex 2 for more on free trade agreements, tariffs, and NTBs. NTBs on goods trade remains high in the region.

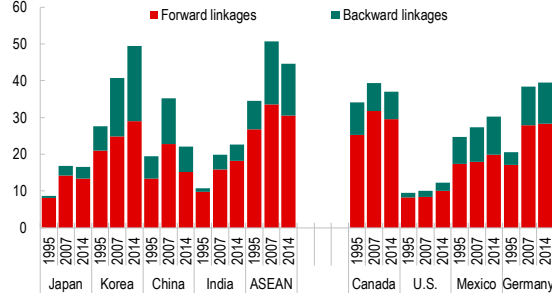
<sup>3</sup> GVC participation is the sum of foreign value added in domestic exports (backward participation) and domestically produced intermediates used in third economies (forward participation) expressed as the ratio to an economy’s gross exports.

**Figure 4. Global Value Chain (GVC) Participation in Asia**

GVC participation has plateaued in Asia...

**1. Participation in Global Value Chains**

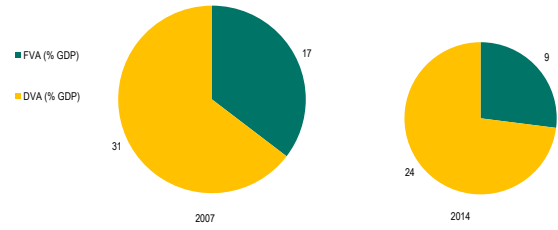
(Percent of GDP)



Sources: TiVA database; and IMF staff calculations.  
 Note: ASEAN includes Indonesia, Malaysia, Philippines, Thailand, and Vietnam. Forward linkages are domestically produced intermediates to be used in third countries, and backward linkages are foreign value added in domestic exports.

... led by a fall in backward linkages in emerging Asia...

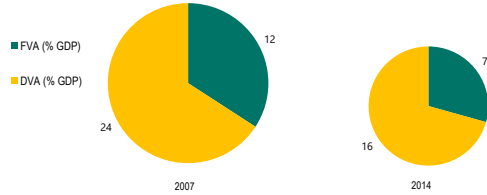
**2. Global Value Chain by Foreign and Domestic Value Added in Emerging Asia, Excluding China**



Sources: Organization for Economic Cooperation and Development, Trade in Value Added database; and IMF staff calculations.  
 Note: FVA is foreign value-added in domestic final demand, with which economies participate in GVCs by using imported inputs in their exports, or called the backward linkages in GVC. DVA is domestic value-added.

especially in China...

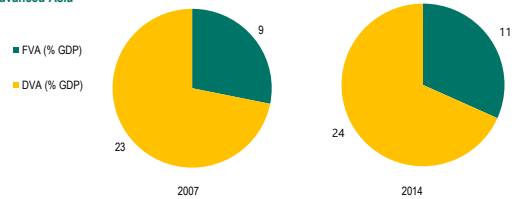
**3. Global Value Chain by Foreign and Domestic Value Added in China**



Sources: Organization for Economic Cooperation and Development, Trade in Value Added database; and IMF staff calculations.  
 Note: FVA is foreign value-added, DVA is domestic value-added.

... while advanced Asia has remained a driver of GVC.

**4. Global Value Chain by Foreign and Domestic Value Added in Advanced Asia**

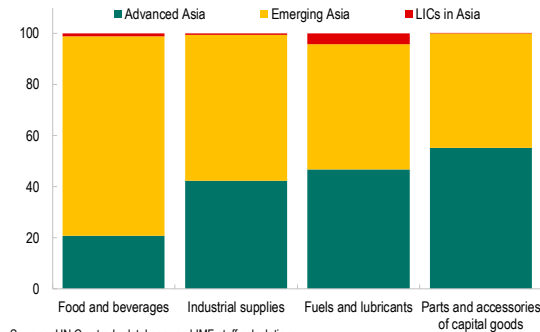


Sources: Organization for Economic Cooperation and Development, Trade in Value Added database; and IMF staff calculations.  
 Note: FVA is foreign value-added, DVA is domestic value-added.

Advanced and emerging Asia drive intermediate goods trade with limited participation by Asian low-income countries...

**5. Asia Intermediate Exports, 2016**

(Percent)

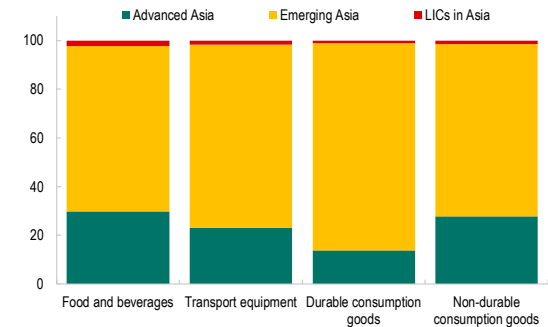


Sources: UN Comtrade database; and IMF staff calculations.  
 Note: LICs = low-income countries.

...while emerging Asia (particularly China) is also the dominant provider of final goods abroad.

**6. Asia Final Exports, 2016**

(Percent)

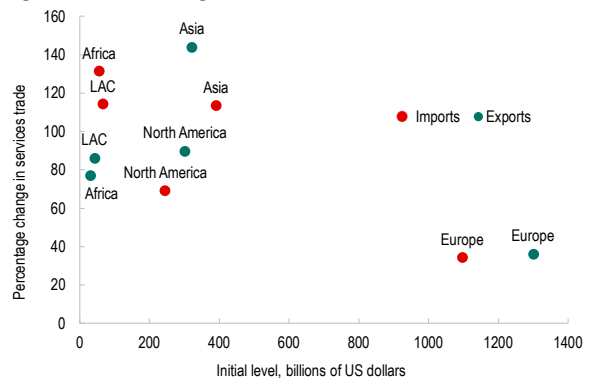


Sources: UN Comtrade database; and IMF staff calculations.  
 Note: LICs = low-income countries.



Globally, trade in services has seen rapid advancements, with information communications and technology (ICT) playing an enabling role. The growth in services trade has occurred even though policy barriers to services trade remain substantial in many regions (IMF, World Bank and WTO 2017). Services make up some two-thirds of global GDP and employment, and a quarter of global trade (nearly half of global trade measured on a value-added basis). Asia's shares of global service imports and exports have both increased, and Asia's service trade is currently second only to the euro area. Overall, Asia has experienced growth across all service sectors, particularly in travel and telecommunications/business services (Figure 5), but the levels of these service exports are still relatively low compared to goods exports, reflecting the higher trade barriers and trade costs.

Figure 5. Percent Change in Services Trade vs. Initial 2005 Level



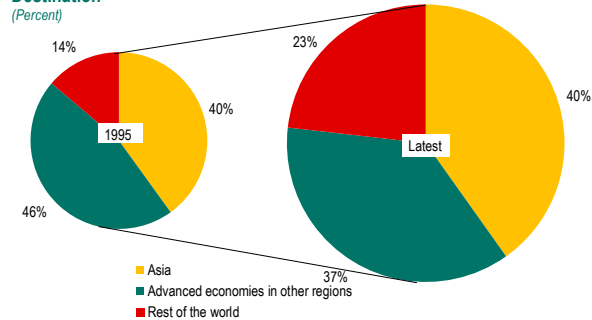
Sources: UN ESCAP Services Trade database, and IMF staff calculations.  
Note: Travel services are excluded. LAC = Latin America and the Caribbean.

To understand how trade relationships in Asia compare with other regions, gravity models are estimated for both goods and services at the economy level (see Annex 1). The results indicate that Asia overtrades in goods (that is, exports more than predicted by the model) by a wide margin relative to most other regions, although the degree of overtrading has decreased since the global financial crisis. Asia also trades more within the region than predicted by the model, which partly reflects the impact of GVCs on trade integration.

When it comes to trade in services, however, Asia has fallen behind other regions. It is now undertrading by a wide margin with respect to the euro area, and in a similar position to Latin America and developing Europe. Intraregional trade in services in Asia has also fallen behind.

Overall, the importance of GVCs and intermediate goods trade linked to final demand in other regions leaves the region exposed to external demand conditions. This was demonstrated in the aftermath of the global financial crisis, from which global trade and regional exports only fully recovered in 2017 following a synchronized global expansion (see Chapter 2 of the October 2016 *World Economic Outlook*, and Chapter 1 of the October 2018 *World Economic Outlook*). While some progress has been made, the majority of export exposure in valued-added terms is still to non-Asian advanced and emerging economies (Figure 6).

Figure 6. Asian Value Added in Exports of Goods and Services by Final Destination



Sources: Organization for Economic Cooperation and Development, Trade in Value Added database, and IMF staff calculations.

## Impact of Trade Tensions

To examine the impact of changes in trade policies leading to trade tensions, the starting point is the work in the Scenario Box in Chapter 1 of the October 2018 *World Economic Outlook*. In this paper, two models are used to explore the impact on Asia. The macroeconomic impact over time comes from a version of the GIMF model, focused on 10 Asian economies, the United States, and the rest of the world, determining both the short-term path and long-term effects across economies. The other model, the RTM, focuses on the long-term changes in trading and production patterns in many sectors in economies with cross-border intersectoral trade.<sup>4</sup>

The trade tensions are decomposed into three channels:<sup>5</sup>

- (1) The short- and long-term *trade channel*, whereby higher tariffs depress the relative demand for imports, a direct effect that is compounded by investment and consumption responses to permanent income losses.
- (2) Short-term *confidence effects*, leading to depressed business confidence. This lowers private business investment demand in 2018 and 2019 before dissipating. Magnitudes are linked to economies' trade openness relative to that of the United States, as in the Scenario Box in Chapter 1 of the October 2018 *World Economic Outlook*, and are broadly consistent with the initial equity market impact of trade policy uncertainty in the region (Box 1).
- (3) Short-term *financial effects*, whereby higher corporate spreads peak in 2019 and are a further drag on private business investment in 2019 and 2020. Magnitudes are linked to historic episodes and current credit ratings (see Box 1.3 in the October 2018 *Global Financial Stability Report*).

In terms of the tariff measures, there are three scenarios, each one building on the previous one:

- (1) The *baseline scenario* includes the tariffs in effect and those announced on September 17, 2018. There is the 25 percent tariff on steel and a 10 percent tariff on aluminum imposed by the United States against a wide range of economies (although mainly China, in Asia), with retaliation against a diverse array of US goods. There is also the 25 percent tariff between the United States and China on \$50 billion of goods. In addition, on September 17, the United States announced a further \$200 billion in imports from China that would be subject to a tariff starting at 10 percent and rising to 25 percent by year's end. China is assumed to retaliate through an array of tariffs (varying from 5 to 15 percent in the fourth quarter of 2018, and rising to a maximum of 25 percent in 2019) on \$60 billion of imports from the United States.
- (2) The *escalation scenario* assumes the United States imposes a 25 percent tariff on all goods imports from China (worth over \$500 billion) and assumes China retaliates against all goods imported from the United States with a uniform tariff of 25 percent.
- (3) The *automobile sector scenario* adds a 25 percent US tariff on imports of cars, trucks, and automobile parts, with retaliation by the economies (especially Japan and Korea in the case of Asia) beyond just the automobile sector so that they can match the value of the tariffs levied by the United States.

Note that the effects of the tariffs in 2018 only cover six months for the baseline tariffs (or three months in the case of China and US tariffs related to the \$200 billion of China's goods), with no effects from the escalation and automobile sector tariff scenarios in 2018, as those tariffs are assumed to be levied starting in 2019.

---

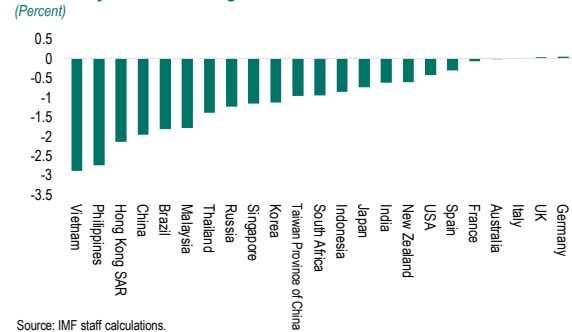
<sup>4</sup> See Annex 3 for further information about the models used in this section.

<sup>5</sup> A potential additional channel through long-term total factor productivity effects is precluded given the short-to-medium-term focus of the impact of trade tensions.

### Box 1. Examining the High-Frequency Effects of Recent Trade Tensions

Recent spikes in trade policy uncertainty have roiled markets as investors and governments adjust to the rapidly shifting trade landscape. A large literature suggests that policy uncertainty raises financial market volatility, lowers stock market returns, and stunts investment through several channels (Dixit and Pindyck 1994; Baker, Bloom, and Davis 2016; Hlathwayo 2017). To explore the effects of the current trade policy uncertainty in the Asian context, a high-frequency daily trade policy uncertainty measure is constructed using news-based big data techniques.<sup>1</sup> The trade policy uncertainty is then used to identify the dates associated with spikes in trade policy uncertainty by choosing the upper quartile of the daily index over the period from April to July 2018. The identified dates or events are used to estimate the impact of trade policy uncertainty shocks on abnormal equity markets in a sample of 26 advanced and emerging markets.

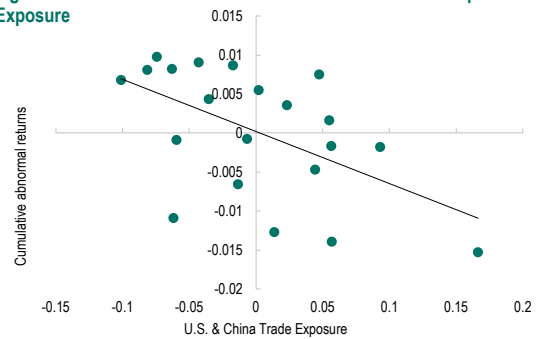
**Figure 1.1. Cumulative Abnormal Returns following 2018 Trade Policy Uncertainty Shocks, Averages**



Source: IMF staff calculations.  
Note: The figure uses abnormal returns calculated based on a constant-mean-return model. Trade shocks based on top 25th percentile of U.S. Trade Policy Uncertainty index.

Abnormal market returns, which serve as a proxy for investor confidence, are negatively impacted by shocks to trade policy uncertainty, with a large degree of heterogeneity in impact (Figure 1.1).<sup>2</sup> Emerging Asia, excluding China, has four times the negative impact as the United States and two times that of Japan. However, an economy-specific comparison uncovers that not all of emerging Asia suffers such losses.

**Figure 1.2. Cumulative Abnormal Returns vs. US & China Export Exposure**



Source: IMF staff calculations.  
Note: Pearson's  $r$  t-stat = 2.8336; based on residuals of variable on GDP per capita PPP. Exposure based on 2016/17 averages of exports to China & US/total exports.

The pattern of market impact suggests that the degree of trade openness may determine the fallout from global trade policy uncertainty. After controlling for differences in per capita purchasing power parity GDP, economies that trade more (total exports plus imports as a percent of GDP) with China and the United States have been worst off in terms of the equity market reaction (Figure 1.2).

<sup>1</sup> The news aggregator Dow Jones Factiva is employed to run the search algorithms.

<sup>2</sup> Market abnormal returns are calculated using a constant-mean-return model and the estimation period covers 2002 to 2018.

In terms of policy responses, governments and central banks are assumed to follow their standard reaction functions, and do not make extraordinary accommodative policy changes. In the case of Japan, the analysis assumes that they are unable to ease (conventional) monetary policy because of the zero lower bound on nominal interest rates. Should the Bank of Japan implement further unconventional monetary policy measures, the decline in Japanese real GDP would be about half as large as the short-term results presented here. In addition, to better capture the potentially disruptive impact of tariffs on extended global value chains, the scenario assumes that firms in the short term have limited ability to substitute between intermediate inputs from different economies, including their own. Over the long term, the substitutability between intermediate inputs is notably higher, in line with that of final goods, as in the Scenario Box in Chapter 1 of the October 2018 *World Economic Outlook*.

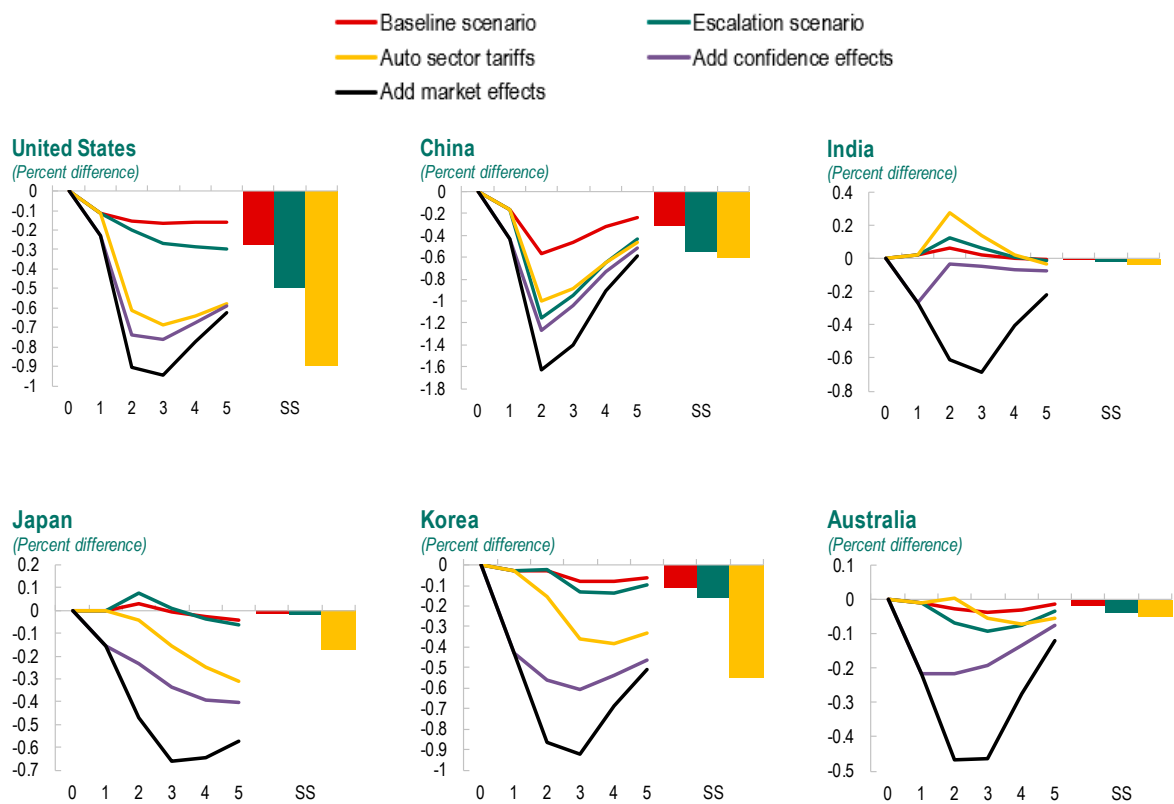
It is important to note that these scenarios are merely illustrative. While the GIMF provides important insights on the cross-border transmission of shocks and the dynamic behavior of the macroeconomy, it cannot capture some of the sectoral distortions that the proposed trade restrictions are likely to generate; this motivates the results from the RTM presented afterward. Given the structure of the model, the impact of higher tariffs on a specific sector of the economy, such as the automobile sector, is derived by

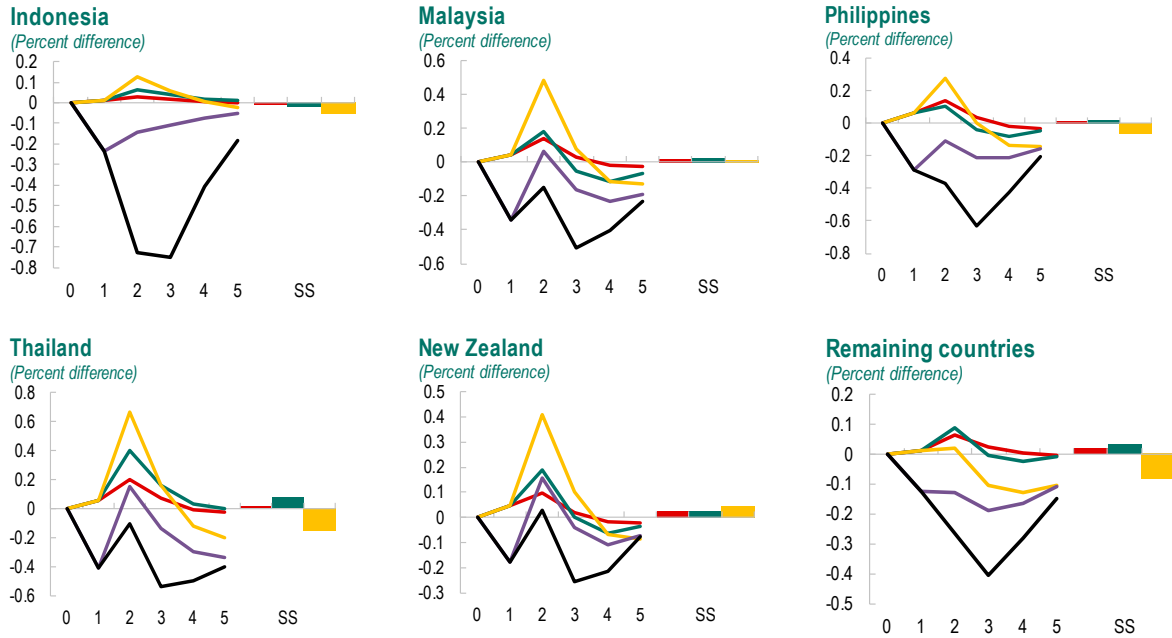
assuming a (much more modest) general increase in tariffs. For instance, if automobiles represent around 15 percent of US imports of final goods, the impact of a 25 percent tariff on the automobile sector would be calculated as the impact of a 3.75 percent tariff on all imported final goods. But using this average tariff assumes that if the United States continues to import automobile parts from economies not subject to tariffs, it will substitute towards economies with intermediate goods exports to the United States (but not necessarily automobiles, such as Indonesia, for example), thereby overstating trade diversion effects. In addition, there is a high degree of uncertainty about the magnitude and persistence of both the confidence and financial market effects. This could turn out to be milder or more severe than assumed here, which, in part, motivates providing them as separate layers. Moreover, the potential for safe-haven flows that might mitigate the impact of the financial market effects in economies like the United States and Japan are not considered.

The effects of recently enacted tariffs and retaliation are small but material, especially for China (Figure 7, red lines). GDP losses would rise substantially should additional tariffs be implemented (Figure 7, green and yellow lines), and particularly so if business confidence and financial markets were to be affected (Figure 7, purple and black lines). For most countries, the output effects of tariffs would fade after a few years, but there could be substantial lasting effects in China, Korea, and the United States (Figure 7, bars).

**Figure 7. Trade Tension Scenarios – Decomposed by Economy in Asia for Real GDP**

*(Percent deviation relative to before trade tensions)*



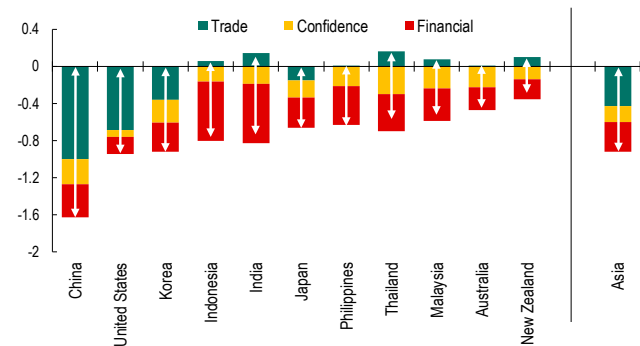


Source: IMF staff calculations.  
 Note: On the horizontal axes, "SS" is the steady-state outcome;

Note: The baseline scenario corresponds to measures that have already been implemented on steel and aluminum, products imported from China (worth \$50 billion) subject to a 25 percent tariff and retaliation from China, and the further \$200 billion in imports from China that is subject to a tariff starting at 10 percent and rising to 25 percent by year-end (China, in turn, announced tariffs on an additional \$60 billion of US imports) that are included in the *World Economic Outlook* baseline projections. The escalation scenario estimates the impact of the United States imposing a 25 percent tariff on a further \$267 billion of imports from China and China responding by raising both the base that tariffs apply to and the tariff rates such that all goods imports from the United States also face a 25 percent tariff (roughly \$130 billion in imports from the United States). The auto sector scenario estimates the impact of the United States following through on the proposal to impose a 25 percent tariff on all imported cars and car parts (worth about \$350 billion). The fourth layer estimates the potential impact that rising trade tensions could have on confidence and thus firms' investment plans. The final layer adds the impact of a potential tightening in financial conditions for corporates.

If all of the channels were in play, enacted and proposed tariffs and retaliation would cause peak GDP losses of 1.6 percent in China and close to 1 percent in the United States; other economies in Asia, many of which supply to China through global value chains and/or are heavily involved in the automotive trade, would also see their economies slowing substantially, and the peak GDP loss for Asia as a whole would be 0.9 percent (see Figure 8 for the peak impact). China's overall losses at 1.6 percent of GDP are also broad-based in its economy—not only are exports weaker from the US tariffs, but so is Chinese production, which lowers the demand for labor and capital. Therefore, investment is hit by 4.6 percent, and labor income falls (both in terms of employment and the real wage for still-employed workers), sending consumption down by 1.9 percent (Figure 9, green lines). If the automobile sector tariffs do not materialize, China would be worse off under the escalation scenario alone (Figure 9, red lines), with real GDP being 1.8 percent lower instead.

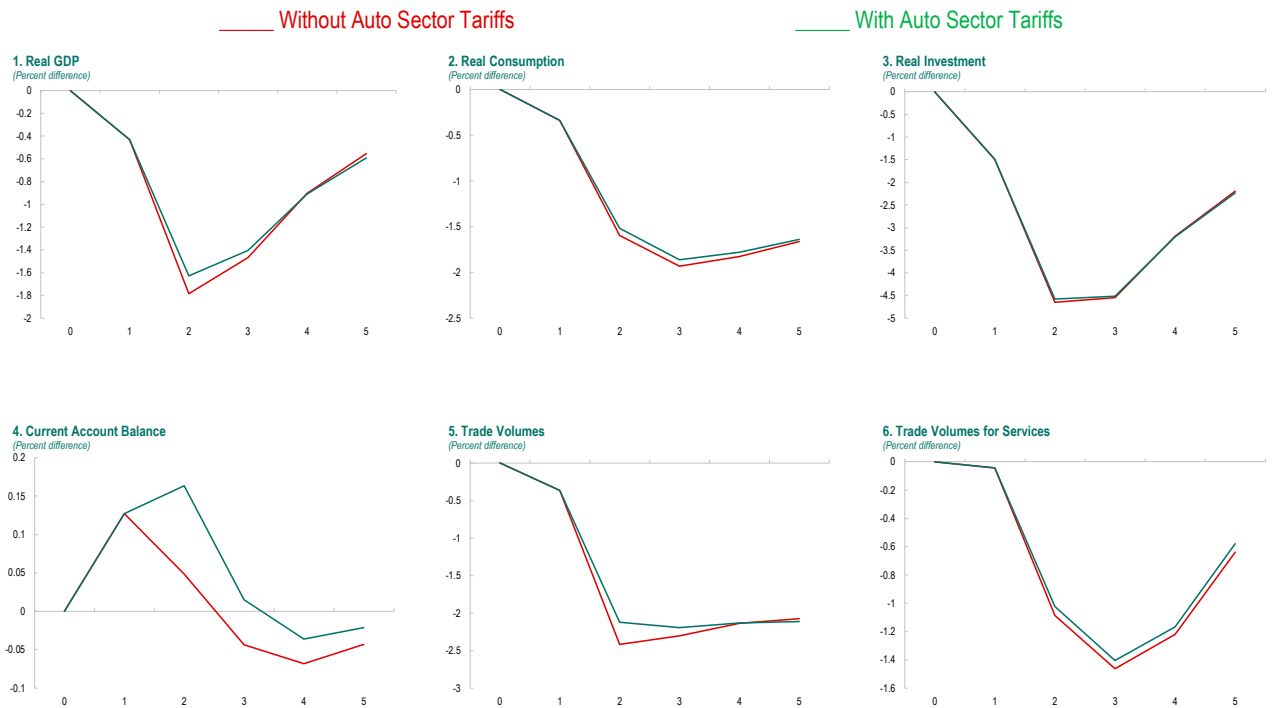
**Figure 8. Trade Tension Scenarios: Peak Impacts on Real GDP**  
 (Percent deviation relative to before trade tensions)



Source: IMF staff calculations.  
 Note: Trade includes baseline, escalation, and auto sector tariffs with confidence and financial market effects as separate layers. Peak responses are generally from 2020.

Elsewhere in Asia, real GDP growth in Korea could fall by around 0.9 percent; in India, Indonesia and Japan by around 0.7 percent; in the Philippines by around 0.6 percent; in Australia, Malaysia, and Thailand by around 0.5 percent; and in New Zealand by only 0.3 percent (Figure 8). The drivers of these losses differ across economies. China loses the most through the trade channel, as confidence and (especially) financial effects are less than in most of the ASEAN economies, given its much larger economy and deeper financial system. Korea and Japan also have stronger trade channel losses (peaking in 2020) because of their roles in the US automobile sector. Some ASEAN economies (Indonesia, Malaysia, the Philippines, and Thailand) suffer a financial effect on the order of 0.4 to 0.6 percent of GDP, highlighting the greater volatility of their financial markets, and linkages with China. India also has a strong negative financial effect, but this is from its own financial vulnerabilities and weaker corporate credit rating, as it has weak links with China. Without having confidence or financial effects, most economies benefit from trade diversion, although, as noted above, these should be considered carefully. They may be overstated in the case of the automobile sector tariffs, since no Asian economy outside of those experiencing those tariffs directly export any significant number of automobiles to the United States.

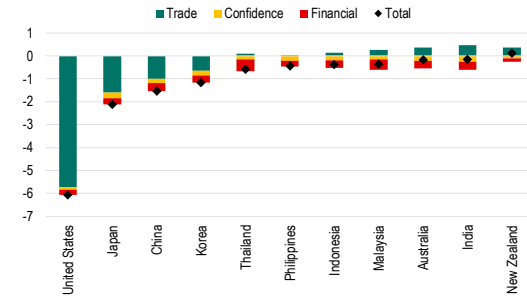
**Figure 9. Trade Tension Scenarios—Impact on China**



Source: IMF staff estimates.

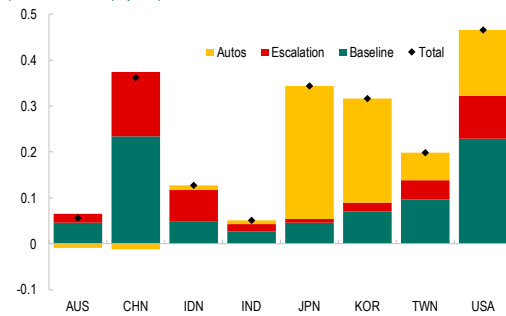
Trade volumes are weaker in general in Asia (Figure 10), led by Japan (2.2 percent), China (more than 1.5 percent) and Korea (almost 1.2 percent). The rest of Asia is around 0.2 to 0.6 percent lower, but once again, driven by the spillovers from confidence and financial market impacts. The trade channel illustrates both the gains from trade diversion in the United States (and less so from China), and the effects of real exchange rate movements. Given that there is a broad-based US dollar appreciation, and a similarly broad-based Chinese renminbi depreciation, imports are cheaper for economies outside of the trade war, which drives up import volumes, which in turn offsets the negative spillovers to export volume from those economies weakened most by the tariffs.

**Figure 10. Trade Tension Scenarios: Peak Impacts on Trade Volumes**  
(Percent deviation relative to before trade tensions)



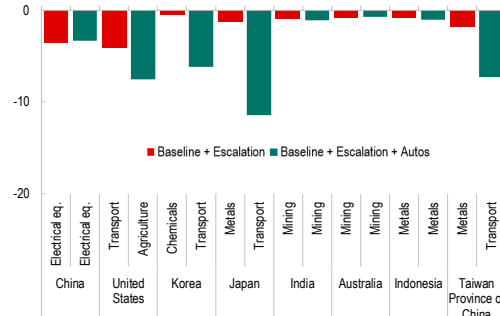
Source: IMF staff calculations.  
Note: Includes baseline, escalation and automobile sector tariffs with confidence and financial market effects. Peak responses (based on GDP) are from 2020, except China and Australia are from 2019.

**Figure 11a. Total Labor Reallocation in the Escalation Scenario**  
(Percent of initial employment)



Source: IMF staff estimates.

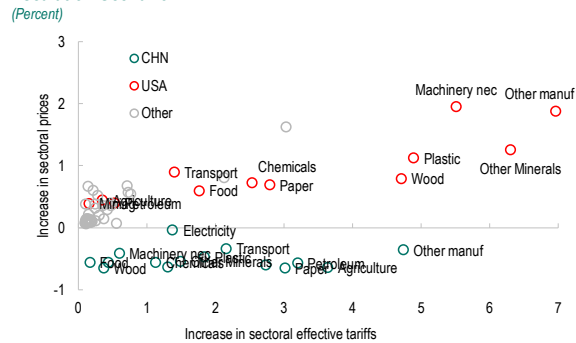
**Figure 11b. Major Sectors with Large Labor Shedding**  
(Percent of sector's initial employment)



Source: IMF staff estimates.

Labor reallocation within each economy remains limited, but certain sectors could see sizable impacts. It ranges only up to 0.3 to 0.4 percent of employment in China, Korea, Japan, and the United States, and even smaller for other Asian economies (Figure 11a). However, some sectors see larger displacements, especially under the escalation and automobile tariff scenarios. In the escalation scenario, China's electrical equipment and the US agricultural sectors shed more than 2 percent of their initial employment. Beyond China and the United States, the metals sector is often the most affected due to the steel and aluminum tariffs. As expected, the transport sector is often the most affected under the automobile tariff scenario and, consistent with the impacts on GDP discussed earlier, labor shedding in the transport sector in Japan, Korea, and Taiwan Province of China reaches around 12, 7, and 8 percent of sectoral employment, respectively (Figure 11b). Many US sectors raise their prices in the escalation scenario after being sheltered by foreign competition and thereby lose competitiveness in international markets, particularly metals (Figure 12, red circles). In measuring sectoral effects, two main channels are at work: trade diversion and supply chain channels (Figure 13).<sup>6</sup>

**Figure 12. Change in Sectoral Tariffs and Producer Prices in the Escalation Scenario**  
(Percent)



Source: IMF staff estimates.

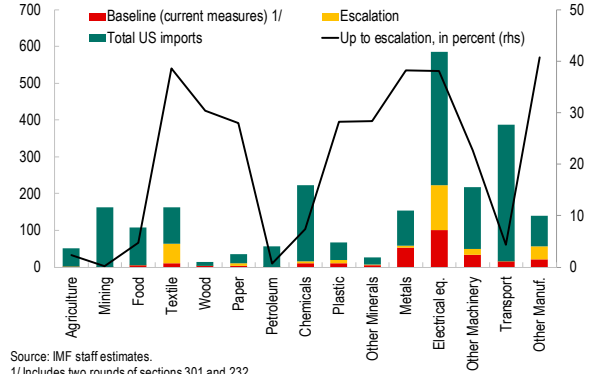
<sup>6</sup> The detailed sectoral effects are only reported for the escalation scenario, where changes in sectoral tariff lines and retaliation are known.



### Figure 13. Assessing Escalation Scenario Using the Ricardian Trade Model (RTM): Trade Diversion and Supply Chain Channels

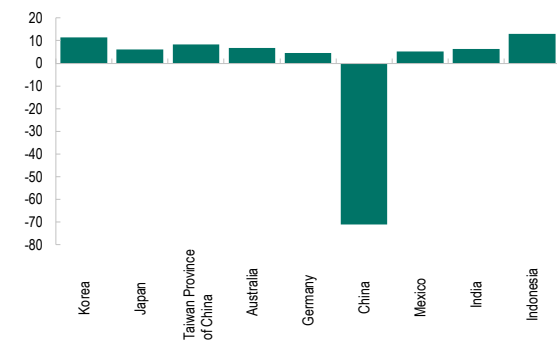
The United States is imposing tariffs chiefly on the metals, and machinery sectors...

#### 1. Trade Actions by the US by Sector



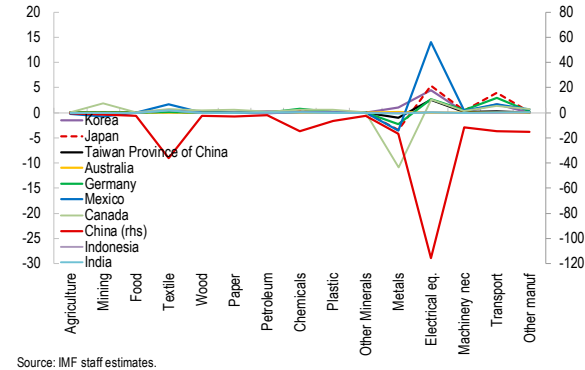
In the RTM, there are two channels – first, trade is diverted as US imports are substituted away from China...

#### 3. Change in Exports to the United States in the Escalation Scenario



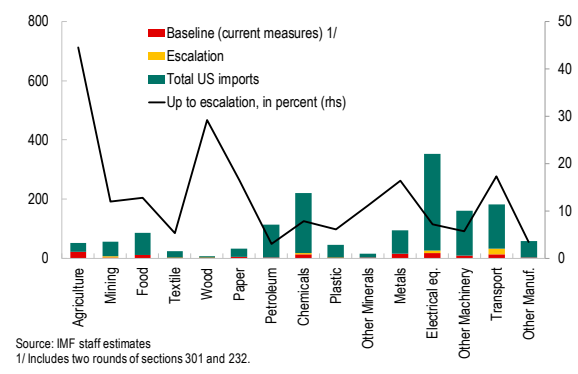
The same channels are at play at the sector level – lower Chinese exports of electrical equipment to the United States are substituted...

#### 5. Change in Exports to the United States in the Escalation Scenario



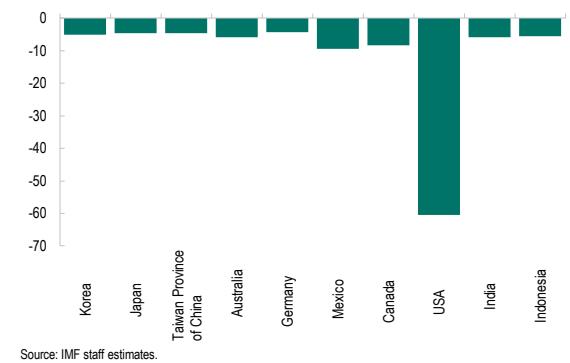
...while trading partners are targeting the US agriculture and metals.

#### 2. Response to US Actions By Sector



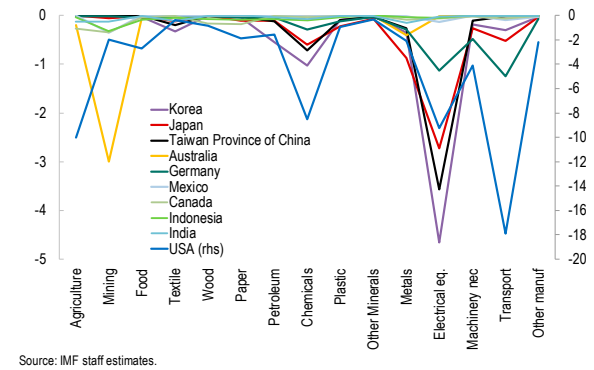
...while the supply chain channel means all economies export less to China.

#### 4. Change in Exports to China in the Escalation Scenario



...while the Asia value chain for electrical equipment supplies less to China.

#### 6. Change in Exports to China in the Escalation Scenario





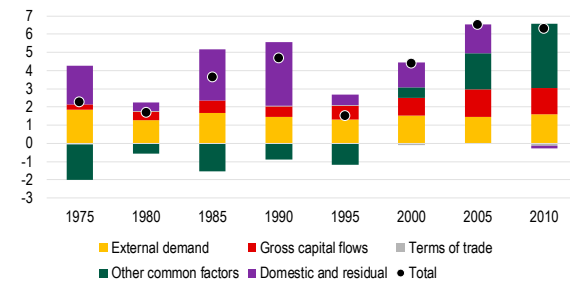
## Role of Trade Liberalization Has Waned, but There Is Scope to Do More

Policies directly aimed at reducing trade costs and reinvigorating trade remain important in light of the potential impact of trade tensions and unfavorable productivity trends in the region.<sup>7</sup> While the role of net exports on the expenditure side of GDP is small in Asia, investment in tradable sectors tends to be large in several Asian economies (Nabar and Syed 2011) and contributes to faster productivity growth (IMF 2018a). Indeed, even as some economies in the region have made efforts to shift their growth models toward domestic consumption, external factors—external demand and financial flows—still account for almost half of the GDP per capita growth (Figure 14; see also Chapter 2 in the April 2017 *World Economic Outlook*).<sup>8</sup> Empirically, the literature finds a close link between the reduction of trade costs, trade expansion and productivity, particularly through participation in GVCs (Crisuolo and Timmis 2017; OECD 2012; Chapter 2 of the April 2015 *Regional Economic Outlook: Asia and Pacific*; Chapter 4 of the October 2016 *World Economic Outlook*). Reducing trade costs—including not only tariffs, but also a broad range of other factors that drive a wedge between the producer price of the exporter and the consumer prices in the importing economy—should thus be a priority.

While lowering tariffs was once a boon to Asia’s growth, the impact of such actions appears to have weakened. Lowering average tariffs significantly increased the region’s growth from 1990 to 2007, but its statistical significance has declined over 2005–17 (Figure 15).<sup>9</sup> This could be related to the waning pace of tariff liberalization in Asia since the global financial crisis and its quantitative impact on growth, although the scope for tariff liberalization was also more limited given the steep reductions since the 1990s.

While tariffs are often at the center of debates on trade barriers, less transparent NTBs can also be a major impediment to trade, particularly for trade in services and foreign investment.

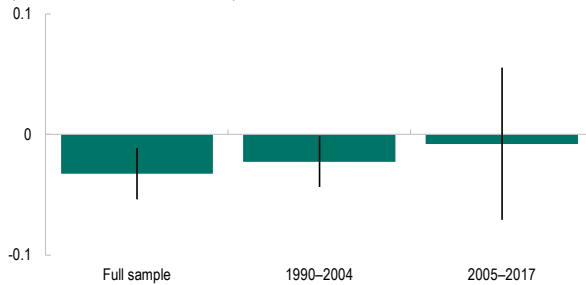
**Figure 14. Average Contribution to GDP per Capita Growth**  
(Percentage points)



Source: IMF *World Economic Outlook*.

Note: The figure shows, for each variable and period, the average contribution to fitted GDP per capita growth across economies. The results are based on the coefficient estimates from the baseline growth regression for the whole sample. \*Other common factors\* corresponds to the estimated time fixed effects (de-meaned). X-axis labels indicate start of a five-year period.

**Figure 15. Shifting Role of Tariff Reduction in Asia**  
(Coefficients with confidence intervals)



Source: IMF staff calculations.

Note: Coefficients and 90 percent confidence levels shown. Includes controls for a constant, external demand, private debt/GDP, inflation, human capital, population growth, institutional characteristics, capital account openness, and initial income level. The results are robust to alternative subsample periods and including controls for gross capital inflows to the region as an alternative to external demand. Robust standard errors used. For more detail on the external conditions controls, see IMF April 2017 *World Economic Outlook*.

<sup>7</sup> Trade liberalization can raise productivity and living standards through a number of channels, even if a robust causal relationship between trade and growth is difficult to detect in cross-country data (Goldberg and Pavcnik 2016; Rodriguez-Clare, forthcoming; Chapter 2 in the October 2016 *World Economic Outlook*).

<sup>8</sup> Results of nonoverlapping five-year panel estimations following Chapter 2 of the April 2017 *World Economic Outlook* show approximate drivers of medium-term growth, as opposed to drivers of business-cycle fluctuations in emerging market and developing economies assessed in Chapter 4 of the April 2014 *World Economic Outlook*.

<sup>9</sup> The impact of tariffs on growth is robust to the control variables used in April 2017 *World Economic Outlook* and new private-debt-to-GDP estimates reported in Mbaye, Moreno Badia, and Chai (2018). Private debt has been a drag on growth in the region.

## How Large Are Trade Costs in Asia?

Historically, trade costs were measured directly using published data on fees, transportation charges, and tariffs. However, such approaches excluded a large portion of trade costs associated with procedures, regulations, differences in language, use of different currencies, and distance, among others. Head and Ries (2001) and Novy (2013) suggest a more holistic measure derived from a micro-founded gravity model in which trade costs can be calculated in a theoretically consistent manner using observed patterns of bilateral trade, production, and absorption across economies. Specifically, trade costs can be expressed as a ratio of within-economy trade to trade across economies.<sup>10</sup> Intuitively, an increase in bilateral trade relative to within-economy trade suggests that bilateral trade costs are falling relative to domestic trade costs.

The analysis indicates that overall trade costs have fallen but remain high in Asia, especially in services (Figure 16). As shown by Duval and Utoktham (2011), policy-related NTBs account for the vast majority (60 to 90 percent) of trade costs, with tariffs and natural trade barriers accounting for the remaining 10 to 30 percent.<sup>11</sup> Moreover, overall trade costs for manufactured goods have fallen less than effective tariff rates, suggesting that policy-related NTBs remain substantial (see Annex 2 for more details).

Comparing the degree of NTB restrictiveness with a single measure is difficult given the broad range of NTB instruments used and the heterogeneity in their impacts. Cerdeiro and Nam (2018) adopt a multi-indicator approach that highlights Asia's high service sector barriers to foreign entry and competition as well as foreign investment restrictions (Figures 17 and 18).

For both emerging and advanced economies, Asian economies are more restrictive than their peer groups across several NTB trade indicators. Restrictions on services trade are among the highest in Asia. The overall index from the World Bank's Service Trade Restrictiveness database shows that advanced and emerging Asia are more restrictive than advanced economies and emerging market economies globally. In a cross-regional comparison, emerging market Asia's service trade restrictiveness is also higher than the EU-20 and Latin America in all dimensions. There are very large gaps between advanced and emerging Asia in retail, financial, and transportation services, showing that Asia has substantial potential for further gains from regional integration in services.

---

<sup>10</sup> Novy (2013) and Head and Ries (2001) are used, while also using sector-specific elasticities for the following:

$$t_{ijkt} = \left( \frac{X_{iikt}X_{jjkt}}{X_{ijkt}X_{jikt}} \right)^{\frac{1}{2(\sigma-1)}} - 1.$$

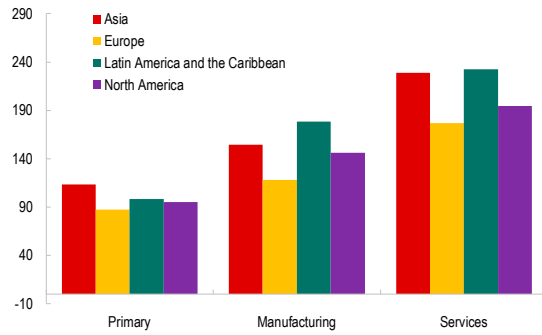
The World Input-Output Database is used to infer domestic trade from output—exports by country-sector-year. The trade costs are expressed in ad valorem terms. Such an approach is sensitive to the choice of trade elasticities, as well as the underlying dataset. The relative comparisons across time and regions are more meaningful than the absolute values of the trade costs.

<sup>11</sup> Natural trade barriers include geography and cultural distance.

## Figure 16. Trade Costs and Tariffs in Asia

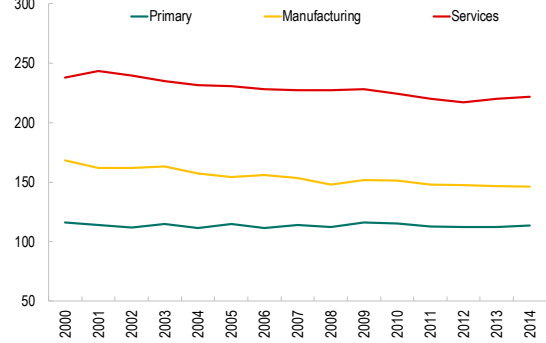
Since the 1990s, tariffs in Asia have come down substantially, more so in advanced than in emerging and developing economies. Despite these tariff reductions, overall trade costs for manufacturing, expressed in ad valorem terms, have come down only slightly and remain high compared to other regions, reflecting slow progress in reducing policy-related NTBs, especially in services.

1. Total Trade Costs, 2000-14 Median  
(Ad valorem, percent)



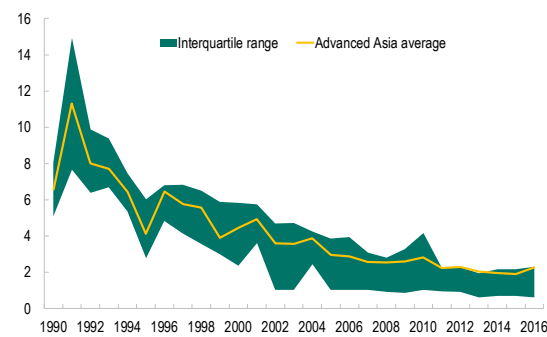
Sources: World Input-Output Database; and IMF staff calculations.

2. Asia's Trade Costs, Median  
(Ad valorem, percent)



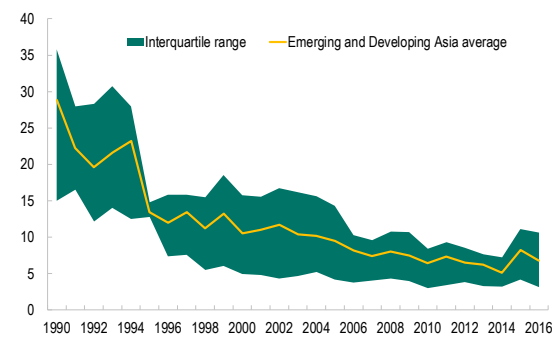
Sources: World Input-Output Database; and IMF staff calculations.

3. Tariffs in Advanced Asia  
(Percent)



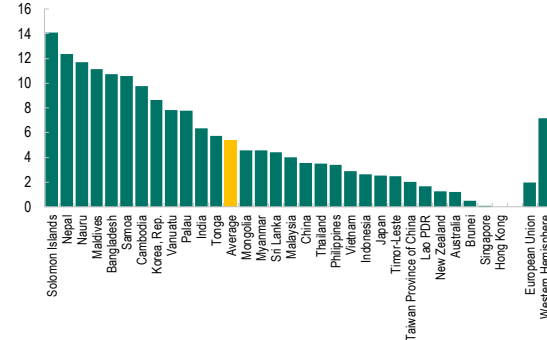
Sources: World Bank, World Integrated Trade Solution database; and IMF staff calculations.

4. Tariffs in Emerging and Developing Asia  
(Percent)



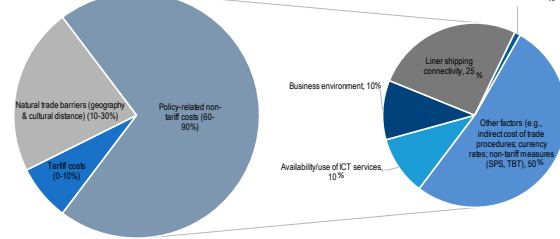
Sources: World Bank, World Integrated Trade Solution database; and IMF staff calculations.

5. Tariffs in Asia Pacific  
(Percent)



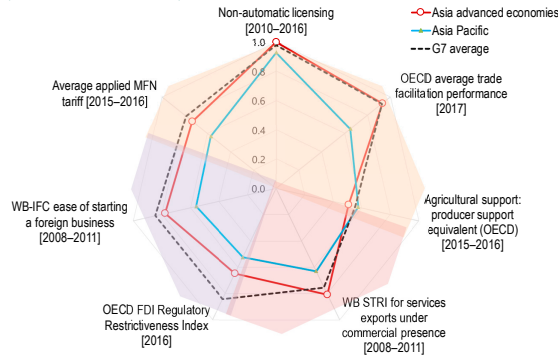
Sources: World Bank, World Integrated Trade Solution database; and IMF staff calculations.

6. Decomposition of Trade Costs in Asia  
(Percent)



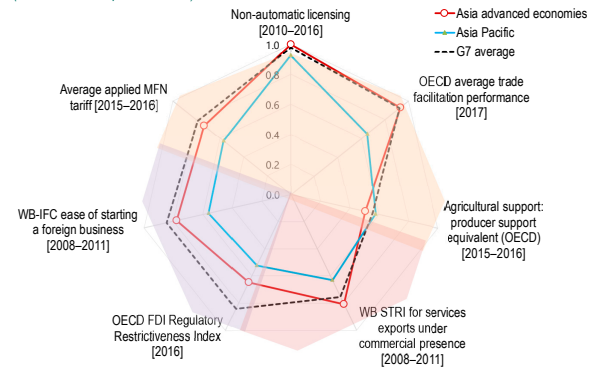
Source: Doval & Uthokham (2011).

**Figure 17. Overall Trade and FDI Regime of Emerging Market Economies**  
(Year of data in square brackets)



Sources: FDI: foreign direct investment; MFN: most favored nation; OECD: Organization for Economic Cooperation and Development; WB STRI: World Bank Services Trade Restrictions Database; WB-IFC: World Bank-International Finance Corporation.

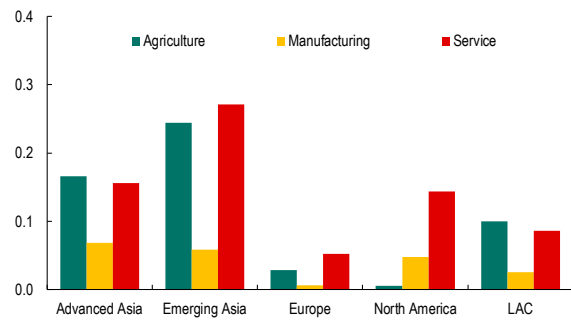
**Figure 18. Overall Trade and FDI Regime of Asia and Advanced Economies**  
(Year of data in square brackets)



Sources: FDI: foreign direct investment; MFN: most favored nation; OECD: Organization for Economic Cooperation and Development; WB STRI: World Bank Services Trade Restrictions Database; WB-IFC: World Bank-International Finance Corporation.

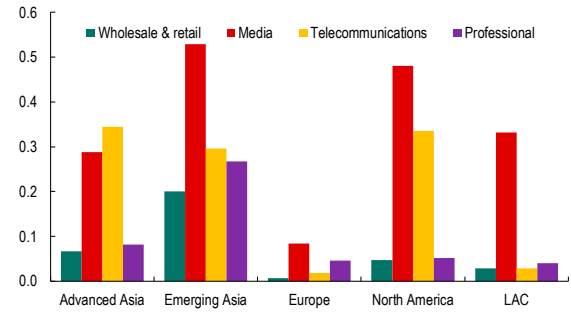
The rapid rise of GVCs in Asia has made complementarities between trade and investment even more relevant. The ease of starting a foreign business in Asia is much more difficult than in the G7 and slightly more difficulty than the G20 average, according to the World Bank’s Ease of Doing Business index and the OECD’s Regulatory Restrictiveness Index. Barriers and restrictions to foreign investment in several sectors are high in Asia. In terms of FDI regulatory restrictiveness, restrictions on investment in all areas (agriculture, manufacturing, and services) are higher in the region compared to Europe, North America, and Latin America (Figure 19). Asia could further remove impediments to investment in service sectors to encourage services trade, especially professional services, wholesale, and retail (Figure 20).

**Figure 19. OECD FDI Regulatory Restrictiveness Index**  
(Higher index = most restrictive)



Sources: Organization for Economic Cooperation and Development, FDI Regulatory Restrictiveness Index; and IMF staff calculations.  
Note: FDI = foreign direct investment; LAC = Latin America and the Caribbean.

**Figure 20. OECD Service FDI Regulatory Restrictiveness Index**  
(Simple average, higher = more restrictive)



Sources: Organization for Economic Cooperation and Development, FDI Regulatory Restrictiveness Index; and IMF staff calculations.  
Note: FDI = foreign direct investment; LAC = Latin America and the Caribbean.

## Benefiting from Further Trade Integration

Given the potentially strong negative impact on parts of Asia from current trade tensions, the region should reexamine its own trade integration strategy and the remaining barriers outlined earlier in this paper. Primarily, further trade liberalization and regional integration should help offset rising protectionism. This in turn could generate a new engine for growth and jobs in the region. Given that goods have been strongly liberalized already, liberalizing trade in services should be the focus. Another area of greater restrictions has been FDI, the liberalization of which could further provide substantial benefits from higher productivity. Therefore, this section explores such increased integration, once again employing the RTM and GIMF to illustrate the potential benefits.

The RTM and GIMF provide different insights. The RTM elaborates more on the long-term trade channel taking account of GVCs and sectoral details, while the GIMF illuminates macroeconomic

dynamics and transmission channels of trade liberalization. More specifically, gains from trade liberalization in the GIMF do not capture the GVC effects that are fully accounted for in the RTM. This extends to the productivity effects, which can compound through many sectors in the structure of the RTM, and across borders, whereas the effects in the GIMF are more confined to movements from intermediate goods to final goods and services, without other cross-sectoral movements. Moreover, because the RTM uses more disaggregated sectors, it has the potential to capture finer FDI restrictions that impair sectoral productivity growth relative to the GIMF.

There are three illustrative trade liberalization and integration scenarios under consideration, with each scenario demonstrating greater openness than the previous one:

- (1) China eliminates goods tariffs and reduces services NTBs for all trading partners (“China Opens”)
- (2) All of Asia eliminates goods tariffs and reduces services NTBs for its trading partners in Asia (“Within Asia”)
- (3) All of Asia eliminates goods tariffs and reduces services NTBs for all its trading partners (“Asia Opens”).

For the third scenario, a variant with FDI liberalization is also considered. FDI liberalization is defined as reducing an economy’s restrictive practices to at least the current average restrictiveness in each sector for a broad cross-section of economies around the world, including advanced economies and emerging markets.

Two primary channels are analyzed for the three scenarios:

- (1) The *trade channel*, which shows the economic effects from cutting tariffs or NTBs, and how they affect domestic economies, and spill over to other economies via their trade linkages; and
- (2) The *productivity channel*, where domestic productivity increases because of the effects outlined in Ahn and others (2016) and spills over to other economies through demand for foreign goods and movements in the real exchange rate.<sup>12</sup>

A potential third channel that Ahn and others (2016) highlighted as a drag on reaping productivity gains from trade liberalization was the presence of restrictions on FDI. Not all Asian economies are restrictive—there is a broad mix of economies, both advanced and emerging with liberal or restrictive regimes. However, the economies with the most to gain from liberalization—China, India, and parts of ASEAN—have substantial (but not necessarily the most) FDI restrictions. The three scenarios are illustrated with possible indicative changes in the economies’ trade policies, focused on tariffs and NTBs:<sup>13</sup>

- (1) *Goods tariffs* should be reduced to the lowest value among Asian economies for each sector (Figure 21). Since most sectors have at least one economy with no tariffs, it was decided for simplicity to reduce all goods tariffs to zero.

---

<sup>12</sup> See Annex 3 for an in-depth explanation of the calibration of the productivity channel for both the RTM and GIMF.

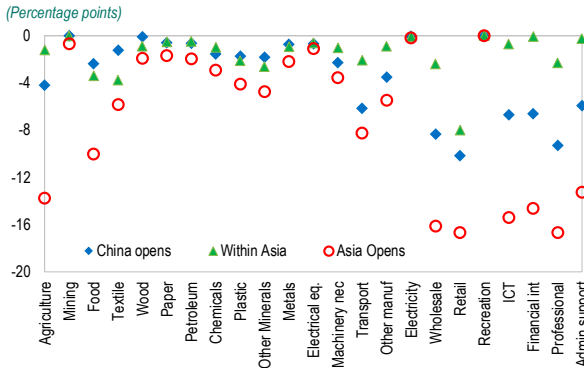
<sup>13</sup> The WTO Trade Facilitation Agreement (TFA), which entered into effect in February 2017, is expected to contribute greatly to further reductions in nontariff and “behind-the-border” barriers related to merchandize goods trade. This section focuses on the remaining scope to reduce goods tariffs and service NTBs. See Chapter 4 in the October 2016 *World Economic Outlook* for estimates of the impact of the TFA.

- (2) *Services NTBs* are reduced by either 10, 20, or 30 percent, based on whether economies are considered to have lower, average, or higher NTBs.<sup>14</sup>

## Understanding Liberalization at the Sector Level and Long-Term Impacts

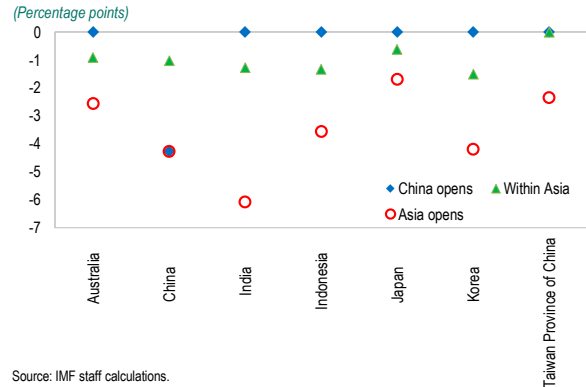
Scenarios 1 to 3 see Asia progressively opening itself to the world (Figure 22). Services, in particular, experience a marked reduction in trade costs, as NTBs are relaxed. Additionally, some goods producing sectors also see large reductions in effective tariffs like agriculture and food processing.

**Figure 21. Change in Tariffs Across Sectors in Each Liberalization Scenarios**  
(Percentage points)



Source: IMF staff calculations.

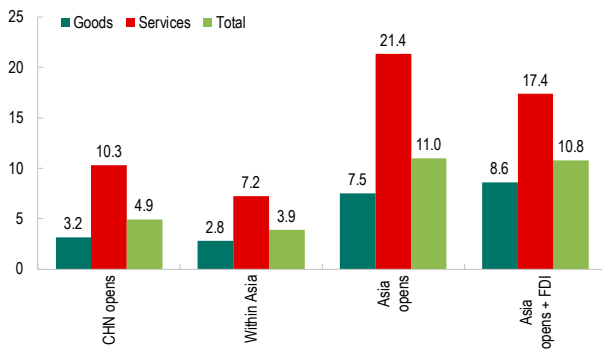
**Figure 22. Change in Tariffs Across Countries in Each Liberalization Scenarios**  
(Percentage points)



Source: IMF staff calculations.

As Asia opens, global trade rises, particularly trade in services. Under scenario 3, assuming FDI restrictions are reduced to the global average, exports of services rise the most (by 17 percent), and exports of goods rise by 9 percent, although goods exports contribute significantly to the increase in world trade given the much larger initial base. Clearly, China sees the largest gains in trade in scenario 1, but several other economies (such as Malaysia and Indonesia) also benefit from the rise of China through regional supply chains. Economies that have the highest tariffs on goods and NTBs in services exhibit the greatest gains in competitiveness and in share of global trade in scenarios 2 and 3 (Figure 23).

**Figure 23. World Trade Rises: Goods 9 Percent, Services 17 Percent**  
(World trade; change from baseline in percent)



Source: IMF staff estimates.  
Note: Asia = Australia, China, India, Indonesia, Japan, Korea, and Taiwan Province of China.

Benefits from trade creation outweigh those of trade diversion, especially for Asian economies (Figure 24). Shifts in comparative advantage at the economy level are significant. As Asia opens, imports of sectors that were relatively restricted surge (Figure 25, black line), and the effect is particularly noticeable where trade costs declined the most—for example, agriculture for India and Korea and services including ICT, financial, and professional services for all Asian economies. But because of the productivity channel, several of these sectors that open to trade become more productive, an effect that dampens imports and boosts exports in those sectors (Figures 25 and 26, red line). These effects are the strongest in sectors with relatively open FDI regimes. For example, Japan develops a comparative

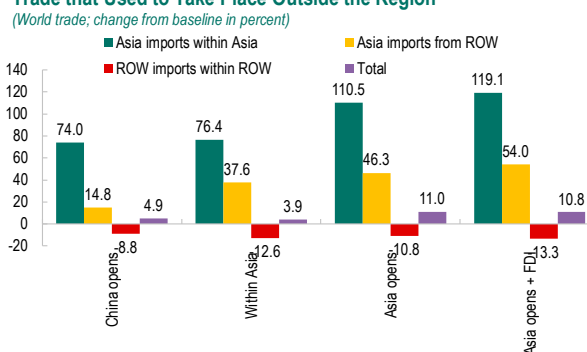
<sup>14</sup> Australia, Cambodia, Hong Kong SAR, Japan, Korea, Lao PDR, Mongolia, New Zealand, and Singapore are considered to have low NTBs; India, Indonesia, and the Philippines, high NTBs; and the remainder of Asia, average NTBs.

advantage in the wholesale sector, as does Australia, which also increases its exports of agricultural goods and professional services. When economies also loosen their FDI restrictions, several sectors achieve large productivity gains and become export drivers. For example, Indonesia develops a comparative advantage in ICT and professional services, China in the transport sector, and Korea in agriculture goods.

Asia's greater openness leads to sizable gains in real income. Asia's long-term GDP per capita rises by 7 percent, and by 15 percent if FDI is also liberalized. To put the latter number in perspective, liberalizing trade and the FDI regime means adding an economy the size of India and Korea combined to the global economy. Services tend to also be more labor-intensive (an effect not captured in the RTM), which would further generate jobs for economies with young and rising populations as well as serve the needs of aging economies. The new service sectors also have higher value added than traditional manufacturing and informal services.

Because of the growth in trade and incomes, Asia also becomes a driver of global demand. Importantly, while there is some trade diversion, that is, Asia progressively takes up a larger share of world trade, overall global trade also increases (Figure 24). This is led primarily by Asian imports—not only intraregional ones but also imports from the rest of the world. Gains are larger when Asia opens to the world (scenario 3, including its variant with FDI liberalization) compared to the other scenarios. Thus, in the remainder of this subsection, the focus is on scenario 3 and its variant.

**Figure 24. Asia Creates New Demand but Also Substitutes Some Trade that Used to Take Place Outside the Region**



Source: IMF staff estimates.  
Note: Asia includes Australia, China, India, Indonesia, Japan, Korea, Taiwan Province of China. ROW = Rest of the world, including economies other than Asia.

Greater global and regional integration supports Asia's economic rebalancing. At the sector level, the structure of production shifts as services become more important and some sectors that were protected benefit from productivity gains by opening up and by loosening FDI restrictions (Figure 27). Labor is also reallocated into services away from agriculture (Figure 28). These changes at the sectoral regional level hide larger shifts within economies that follow the evolution of comparative advantage shown in Figure 26. For example, the primary sector sheds labor as a whole in Asia, but Australia and Korea see some employment growth in agriculture. Moreover, as some economies develop a comparative advantage in the ICT sector, others like China or Korea see it shedding jobs.

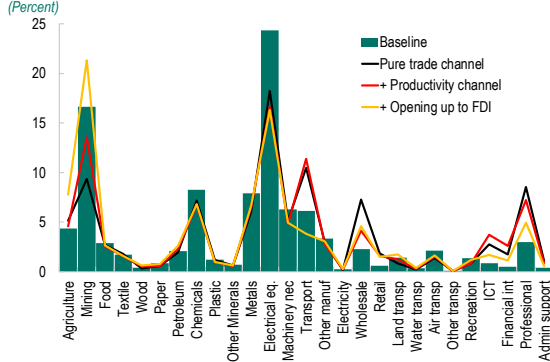
Thus, while rebalancing in Asia progresses, regionally and for individual economies, large dislocations are happening within each economy and policy support is needed to smooth such transitions. Historically, opposition to trade liberalization in Asia can be traced to concerns about labor dislocation in some protected and sensitive sectors, such as agriculture, that have a significant vote base. Negotiating such reforms would likely take many years to accomplish, but domestic policies to address these trade-related adjustments will ensure that all members of society share in the gains unleashed by liberalization and thus help overcome the resistance from vested interest groups.



**Figure 25. How Do Sectoral Import Shares Change in Each Economy After Liberalization?**

*China's imports of transport and professional services rise, except under foreign direct investment (FDI) liberalization where those sectors could become export drivers.*

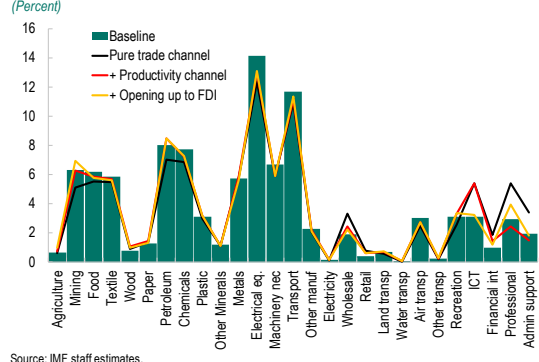
**1. China's Import Share by Sector**



Source: IMF staff estimates.

*Australia sees relatively minor changes to its import patterns due to its starting low trade costs.*

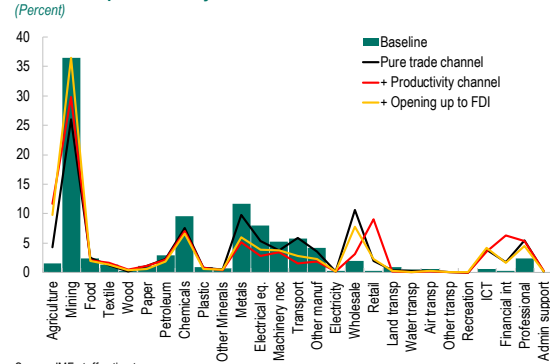
**2. Australia's Import Share by Sector**



Source: IMF staff estimates.

*India imports more agricultural products and services, as these currently face the highest trading costs.*

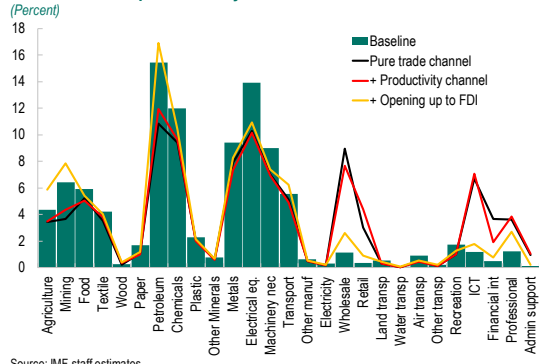
**3. India's Import Share by Sector**



Source: IMF staff estimates.

*Indonesia's imports rise most in services, where trade barriers are presently highest.*

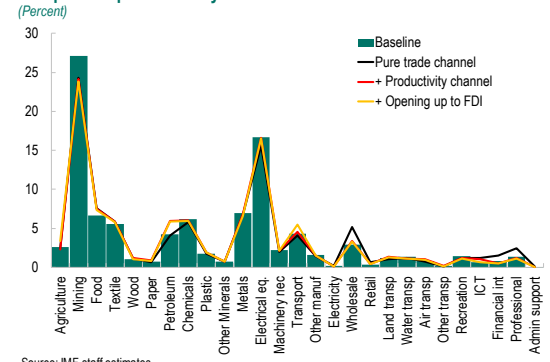
**4. Indonesia's Import Share by Sector**



Source: IMF staff estimates.

*As an already very open economy, Japan's pattern of imports is roughly unchanged.*

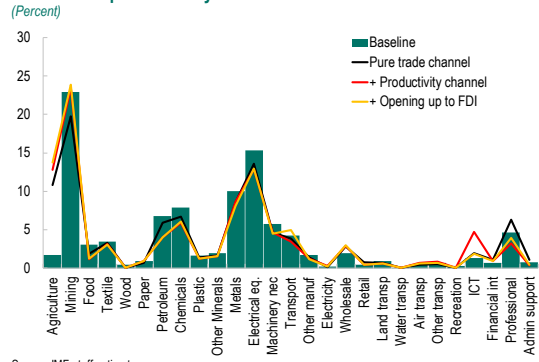
**5. Japan's Import Share by Sector**



Source: IMF staff estimates.

*Korea's imports of agriculture jump remarkably because of the relaxation of high trade barriers in the sector.*

**6. Korea's Import Share by Sector**



Source: IMF staff estimates.

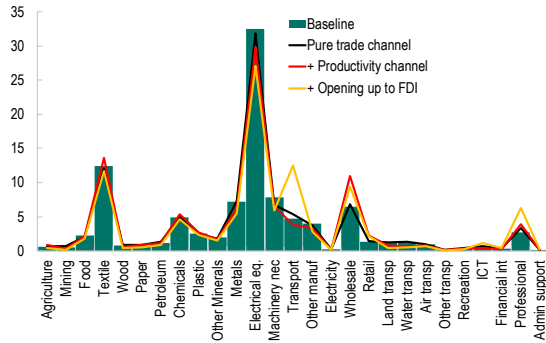


## Figure 26. How Do Sectoral Export Shares Change in Each Economy After Liberalization?

Liberalizing the foreign direct investment (FDI) regime in transport and professional services could spur a new source of comparative advantage for China.

### 1. China's Export Share by Sector

(Percent)

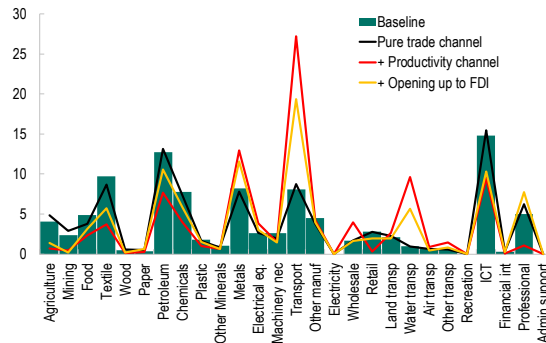


Source: IMF staff estimates.

India could develop a strong comparative advantage in professional services by loosening the FDI regime, while information and communications technology (ICT) is already relatively open to FDI.

### 3. India's Export Share by Sector

(Percent)

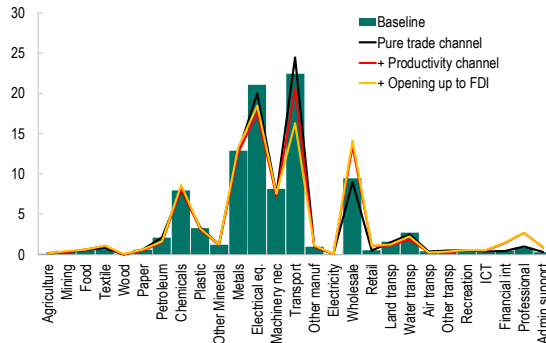


Source: IMF staff estimates.

Japan would see only small changes to its comparative advantage as it is already relatively open.

### 5. Japan's Export Share by Sector

(Percent)

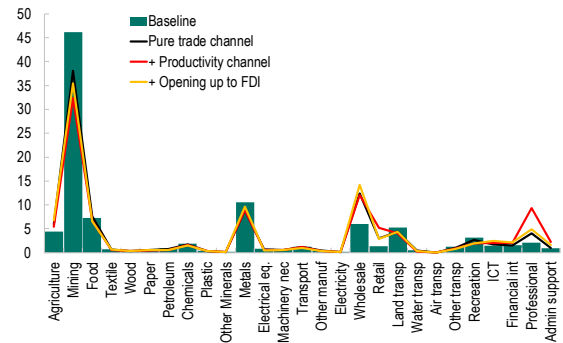


Source: IMF staff estimates.

Australia could export more services and thereby become less dependent on mining exports.

### 2. Australia's Export Share by Sector

(Percent)

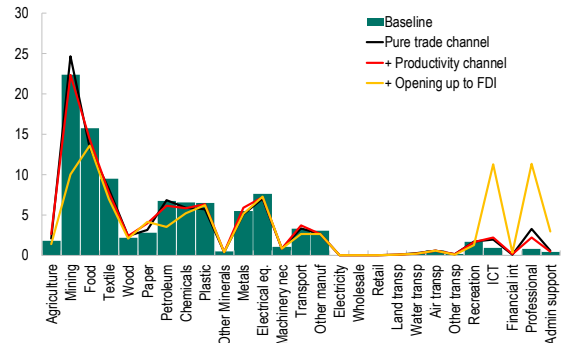


Source: IMF staff estimates.

Indonesia could gain the most from liberalizing FDI in services, particularly ICT and professional and administrative support.

### 4. Indonesia's Export Share by Sector

(Percent)

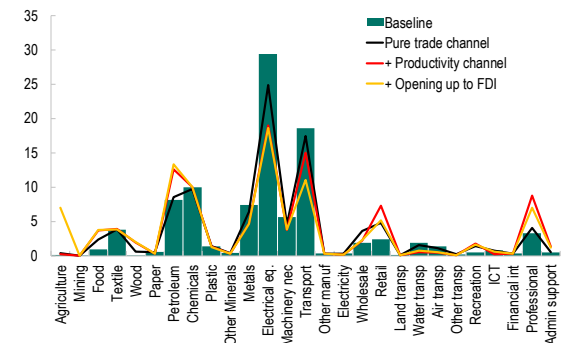


Source: IMF staff estimates.

Korea's opening of agriculture could generate large productivity gains that could turn the sector into a source of export growth.

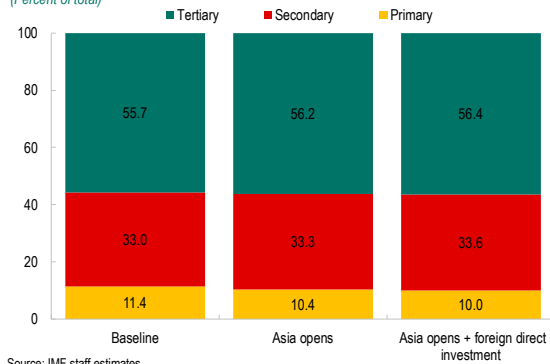
### 6. Korea's Export Share by Sector

(Percent)

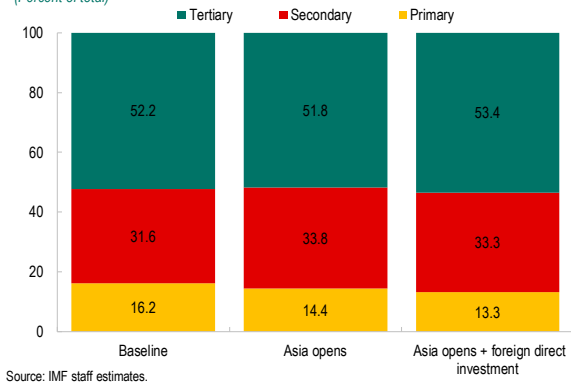


Source: IMF staff estimates.

**Figure 27. Rebalancing in Asia: Value Added by Sector**  
(Percent of total)

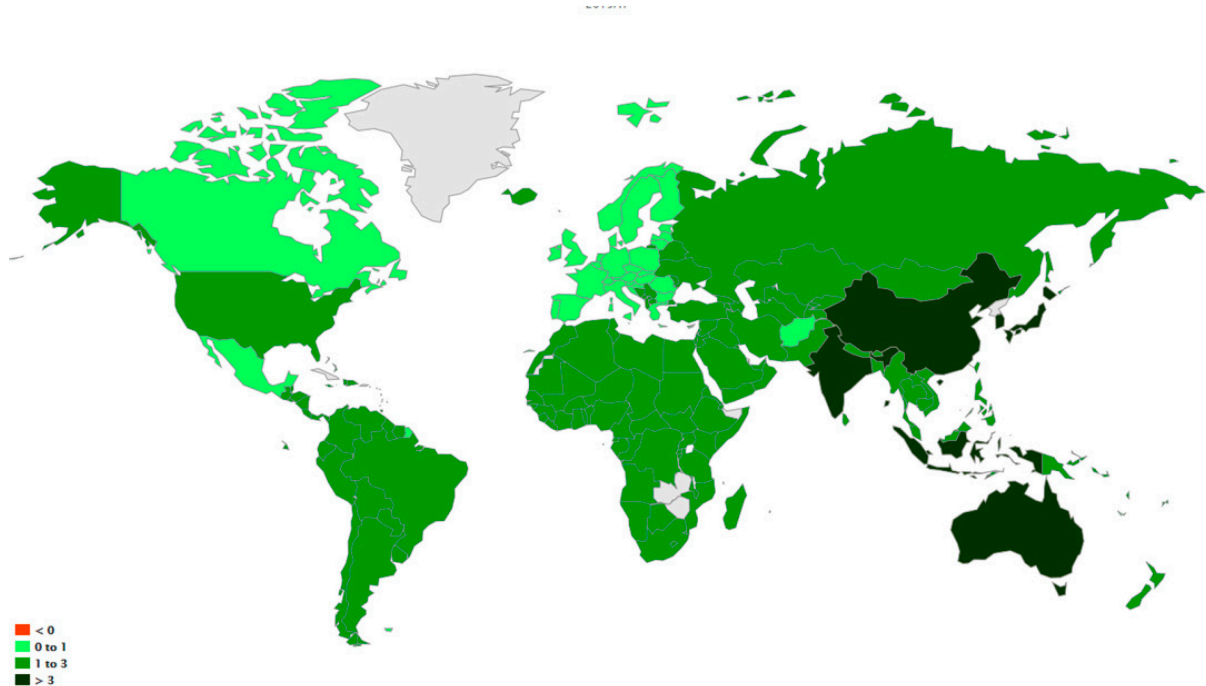


**Figure 28. Rebalancing in Asia: Labor by Sector**  
(Percent of total)



Asia’s liberalization also benefits the global economy. Trade integration reduces consumer prices—directly, through lower tariffs on imported final consumption goods (and related effects from greater competition), and indirectly, through the associated productivity gains. Real wages rise significantly in all Asian economies (Figure 29). Liberalization can also lead to very large increases in the variety of goods available. The rest of the world benefits through access to cheaper goods and new markets in Asia. The sizable reduction in the prices of goods and services outside of Asia, 5 to 6 percent on average, leads to higher real wages across the globe (Figure 29).

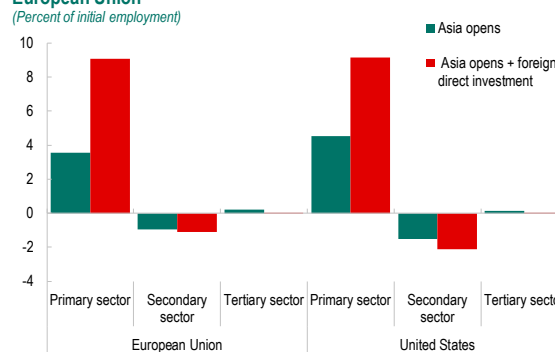
**Figure 29. Global Changes in Real Wages**  
(Percent deviation relative to baseline)



Source: IMF staff estimates.

However, Asia's increased competitiveness in many sectors generates dislocation in some economies (Figure 30). Active policies to redistribute the economy-level gains would be necessary by targeting adversely affected sectors. For example, the secondary sector in the United States and Europe sheds around 1 million workers, or more than 1 percent of initial employment. While there is no one-size-fits-all strategy for mitigating the adjustment costs that can arise from trade, there is room for active labor market policies, social protection, and complementary policies in the areas of education, housing, and credit. Trade policy itself can also play a supporting role (IMF, World Bank and WTO 2017).

**Figure 30. Labor Reallocation in Major Sectors in the United States and European Union**



## Macroeconomic Dynamics and Transmission Channels of Trade Liberalization

The sector and long-term results of the RTM can be further explored by the GIMF to understand the macroeconomic dynamics in transition to the long-term (steady-state) and transmission channels. The potential gains from liberalization focus on medium-to-long-term gains in real GDP, driven by stronger consumption (wealth and income effects), higher investment (to maintain higher productive capacity in the economy), cheaper goods and services (increasing household and firm purchasing power, further stimulating consumption and investment), and increased volume of trade (through some mix of trade creation and trade diversion, with a greater emphasis on trade creation, the more economies that are involved).

The long-term GDP gains in Asia implied by the GIMF are somewhat smaller than the RTM results, but show a similar pattern across scenarios and economies (Figure 31). The real GDP gains are greater with each progressive enlargement of the economies liberalizing with the number of economies to which they open. For example, opening to all economies, even without reciprocation, as is the case for scenario 3, provides more benefits (Figure A3.1 in Annex 3). That emerging Asia has the greatest gains is not surprising, given that this region has the highest tariffs and NTBs, on average, so those economies can (and do) make larger cuts than the others.

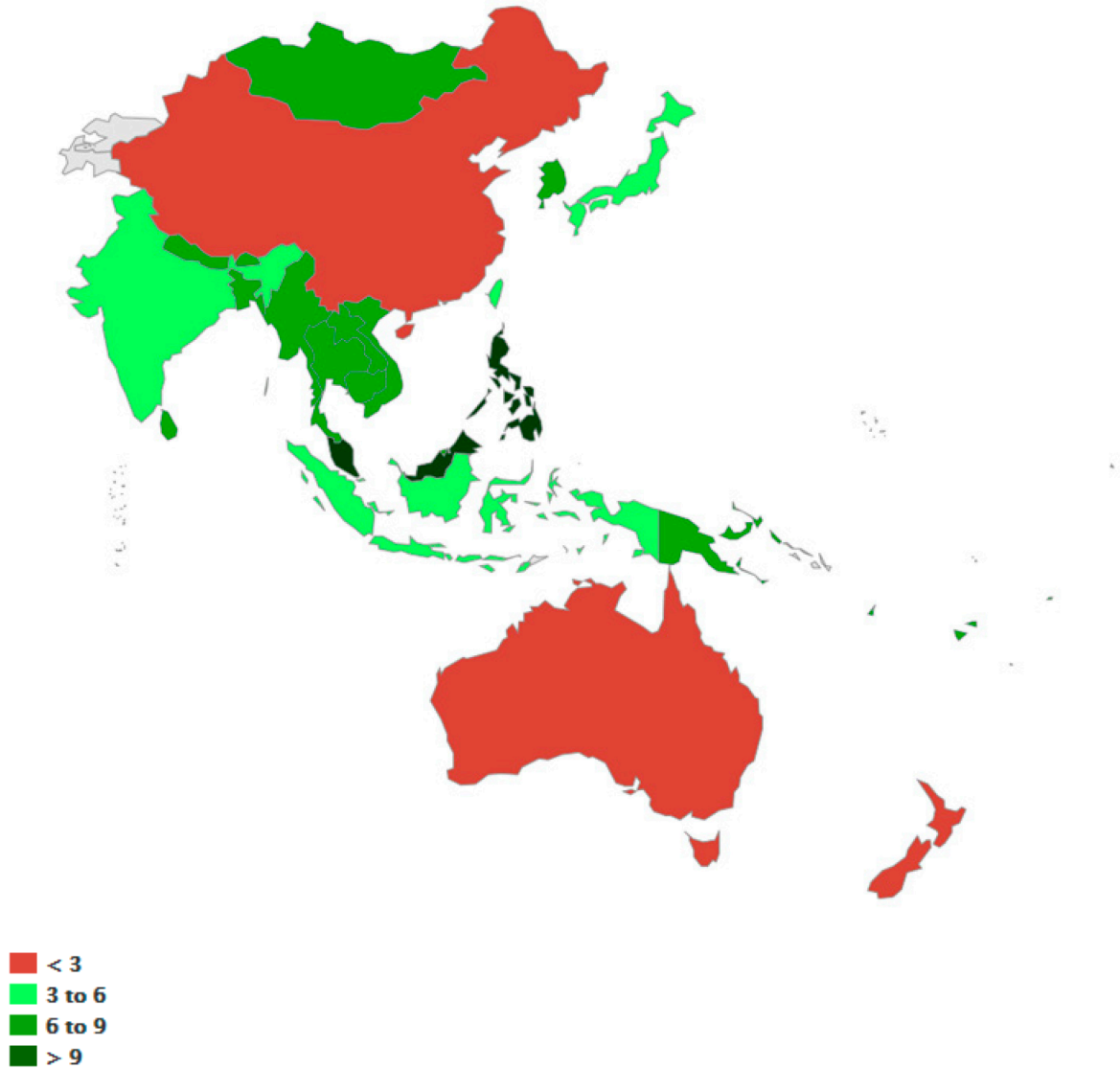
The long-term gains from liberalization are mainly attributable to the productivity channel, albeit with changing trading patterns having a greater impact in the transition in many economies. The productivity gains from goods trade are more extensive, and the impact from NTB cuts in services is a smaller share in the long term than in the short term (Figure 32). Even though percent productivity gains between goods and services are similar over time, services trade only accounts for 20 to 30 percent of total trade, so goods trade generates a larger share of the aggregate productivity gains. Those economies with already-low tariffs (for example, in Advanced Asia) have a more substantial role for services liberalization (Figure 32). Within goods, the productivity gains accrue more to final goods than intermediate goods, since the tariff cuts in final goods are generally much larger (for example, China). However, the tariff elasticity of output favors intermediate goods over final goods, consistent with the trade and GVC literature. Therefore, for most of the rest of emerging Asia, the cuts in intermediate goods tariffs have a greater payoff by increasing GVC participation.

Focusing on services may be even more beneficial than focusing on goods. First, as already noted, most economies have much greater scope for reducing NTBs than tariffs. Second, for economies with both high goods tariffs and high services NTBs, reducing NTBs will be less costly for the government. Lowering tariffs imposes a cost as well as a benefit, as tariffs are also a source of government revenue, not just a cost on consumers. However, lowering NTBs only results in foregoing a cost, not a revenue

source, and therefore may be more attractive. Of course, both alternatives impose transition costs, as they remove protection from sectors that may then shed firms and employment. However, these costs should occur whether a sector is currently experiencing tariffs or NTBs.

**Figure 31. Scenario 3 without Foreign Direct Investment Liberalization: Higher Long-Term Real GDP for Individual Economies**

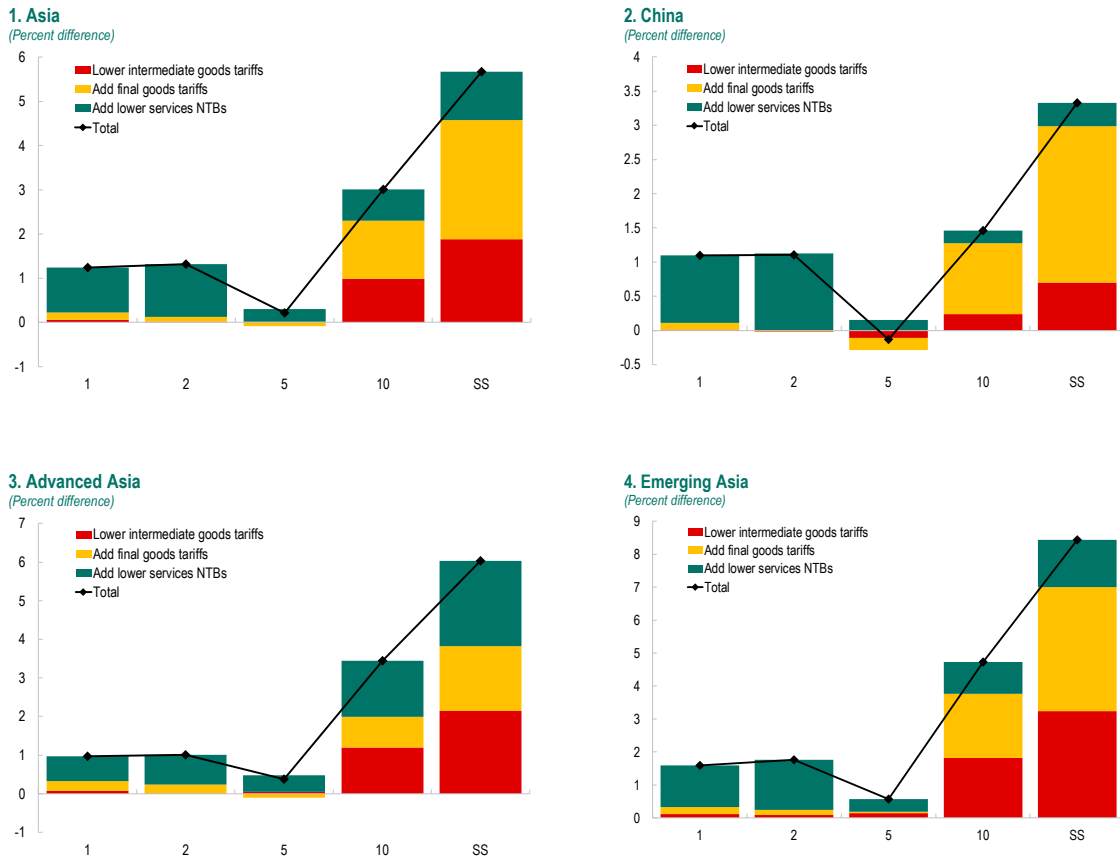
*(Percent deviation relative to baseline)*



Source: IMF staff estimates.

**Figure 32. Scenario 3 – Decomposition of GDP into Tariff and Nontariff Barrier Effects by Economy Groups**

(Percent deviation relative to baseline)



Source: IMF staff estimates.

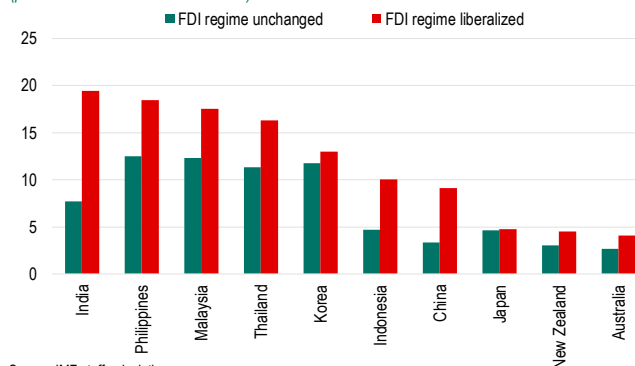
Note: Advanced Asia includes Australia, Hong Kong SAR, Japan, Korea, New Zealand, Singapore and Taiwan Province of China; Emerging Asia includes the rest of Asia excluding China. NTBs: nontariff barriers.

## Liberalizing Foreign Direct Investment and Understanding Its Transmission Channels

As with the RTM, FDI restrictions are reduced to the global average for scenario 3. FDI can increase gains in real GDP in Asia substantially in the medium to long term (11.7 percent when FDI reaches its steady state). The impact varies across Asia (Figure 33). Six percentage points of the 9 percent gain in China's real GDP is attributable to FDI liberalization. Most emerging Asia economies gain substantially from loosening FDI restrictions, especially those with the tightest regimes—India, Indonesia, and Thailand in particular. The lowest gains accrue to Australia, Korea, New Zealand, and Japan. These latter advanced economies have quite liberal FDI regimes to start with, and do not liberalize much—at least half of the gains from Asia-wide FDI liberalization (1 percent for Australia and New Zealand) are therefore spillover effects from their trading partners from elsewhere in Asia.

**Figure 33. Trade Liberalization and the Effects of Foreign Direct Investment Liberalization**

(percent deviation relative to baseline)



Source: IMF staff calculations.  
Note: FDI = foreign direct investment.

FDI liberalization has a strong impact on growth partly through expanding trade volumes (Figure A3.2 in Annex 3). For the behavior of trade volumes, the trade channel is dominant for all the Asia groupings, but the relative importance of FDI liberalization still holds as it does for gains in real GDP. It contributes anywhere from 1.2 percentage points (advanced Asia economies) to 4.6 percentage points (emerging Asia) to long-term trade volumes.

Between consumption and investment (Figure A3.3 in Annex 3), FDI liberalization logically contributes a greater proportion of the gains in investment than it does for consumption. Again, such gains are focused on those parts of Asia that currently have less liberal FDI regimes (for instance, over 60 percent of China's investment gains, versus 50 percent for emerging Asia economies). For investment, the other main channel is the productivity channel, since it is the main source of lower production costs, stimulating demand for factors of production such as capital. That same effect encourages labor demand and hence augments labor income to contribute to consumption, although the price effects from the lower tariffs on consumption goods (and intermediate goods used in their production) still constitute a significant contribution. All regions gain around 2 percentage points of consumption from the lower trade barriers in both the short and long term, as households recognize the permanent downward shift in prices.

## Conclusions and Policy Implications

Asia continues to be the main engine of a global economy fueled by trade. Trade liberalization and openness have helped the region catch up with advanced economies, and hundreds of millions of people have been lifted out of poverty. The region has become more integrated through global and regional value chains in manufacturing exports, albeit with some signs of maturing GVCs and onshoring of production in China. However, rising trade tensions and global policy uncertainties, along with declining productivity and aging societies in Asia and elsewhere, represent headwinds to sustaining Asia's strong growth momentum.

Notwithstanding the rise in intraregional trade, Asia's value added in exports remains destined to final demand outside the region, making the region vulnerable to external demand conditions and protectionism in advanced economies. Recently enacted tariffs and others that have been proposed would have a large impact on emerging Asia, especially China, particularly if they were to affect business confidence and financial markets. The disruptions to global and regional value chains would negatively affect all economies, with significant adjustment costs in some sectors and economies.

Together with the decline in trade openness, maturation of global value chains, and high NTBs, such tensions point to a need for Asia to open a new chapter in trade liberalization. The 2016 WTO Trade Facilitation Agreement, reached despite rising global trade restrictive measures, shows that broad trade agreements can be reached to create a new engine of growth. While trade reforms would ideally be advanced through fully multilateral agreements among all WTO members, plurilaterals could provide another way forward. Further trade liberalization and regional integration would not only help insulate Asia from external demand and policy changes in economies outside the region, it could also develop new sources of regional growth in trade in services, enhance productivity and employment, and promote economic rebalancing. Illustrative unilateral trade liberalization and regional integration initiatives show large gains in terms of economic growth from reducing remaining tariffs on goods and NTBs on services. Easing investment restrictions amplifies the impact of reducing trade costs, particularly in the service sector, where Asia's trade costs and investment restrictions are the greatest. Low-income Asian economies would benefit the most by participating in manufacturing GVCs with both advanced and emerging Asian economies, moving up value chains to high-tech goods and tradable services. Overall, the global economy would also benefit as Asia becomes a more important driver of global demand and rebalances.

In terms of concrete policy implications, broadening and deepening existing or proposed trading arrangements to focus more on service sector liberalization and the easing of FDI restrictions would have the greatest impact on Asia. The digital economy revolution is opening new opportunities for cross-border trade and investment, elevating the roles of policies relating to e-commerce, investment, and services trade. In some economies there is also significant scope to reduce tariffs and NTBs on goods trade to reap dynamic productivity gains from greater participation in GVCs. There will be winners and losers across sectors requiring significant reallocation of labor, which will likely be resisted by those affected in the region. As such, proactive policy support and communication is needed to smooth the adjustment and limit resistance by vested interest groups of specific sectors.

More generally, trade costs can also be reduced by improving regional connectivity and logistics (for example, through productive infrastructure investments) and by tackling behind-the-border barriers such as customs procedures, export taxes, countervailing measures, and technical barriers to trade. Moving towards a customs union or even a common market in Asia encompassing e-commerce, trade in services, and FDI would provide a new driver of growth while providing a timely offset/buffer to rising global trade tensions. That said, the simulations in this paper show that Asia opening up to the world would have the largest impact on the region and global welfare, highlighting the need to continue to support multilateral liberalization and the global trading system.

## Annex 1. Using Gravity Models to Understand Asia's Trade Patterns

To understand how Asia's trade relationships compare with other regions, gravity models are estimated, for both goods and services at the economy level using the following specification:

$$x_{ijt} = \beta_1 GDP_{it} + \beta_2 GDP_{jt} + \beta_3 Dist_{ij} + \beta_4 Cont_{ij} + \varepsilon_{ijt},$$

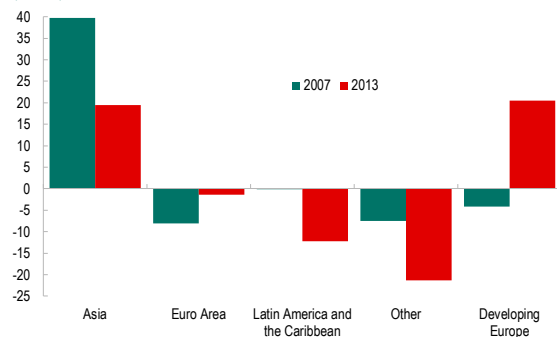
where  $x_{ijt}$  are exports from economy  $i$  to economy  $j$  in year  $t$ ,  $GDP_{it}$  is the GDP of economy  $i$  in year  $t$ ,  $Dist_{ij}$  is the geographical distance from economy  $i$  to economy  $j$ , and  $Cont_{ij}$  is a dummy for contiguity between economy  $i$  and economy  $j$ . Year-specific fixed effects are included to control for worldwide changes in trade over time. Overall trade intensity gaps, used as a measure of overtrading or undertrading by a given region, are calculated as the average value of the residuals obtained when that region is exporting. If the average residual is positive (negative), this indicates overtrading (undertrading), as the region exports, on average, more (less) than predicted by the model. Similarly, positive (negative) intraregional trade intensity gaps are indicative of overtrading (undertrading) within the corresponding region. Figure A1.1 outlines the results from this set of gravity models.

**Figure A1.1. Understanding Asia's Trade Patterns**

Asia over-trades in goods by a wide margin relative to most other regions...

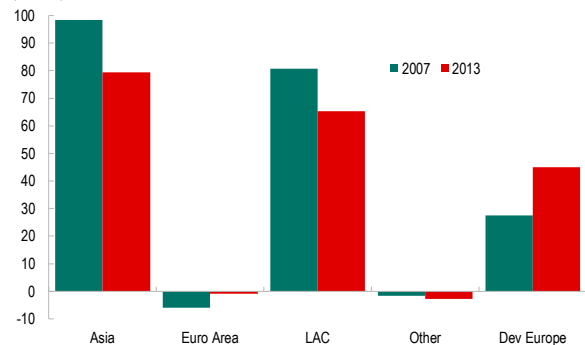
...with intraregional trade in goods also high, partly reflecting global value chains.

**1. Estimated Overall Trade Intensity Gaps in Goods**  
(Percent)



Source: IMF staff estimates.

**2. Estimated Intraregional Trade Intensity Gaps in Goods**  
(Percent)

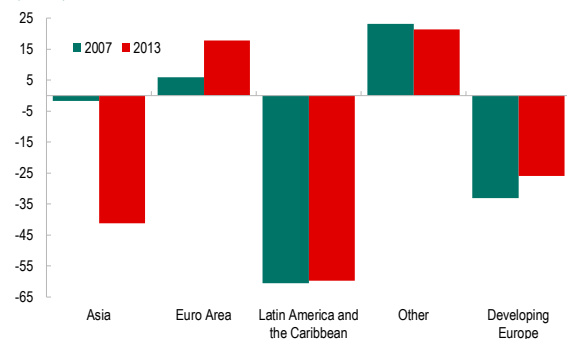


Source: IMF staff estimates.

Asia has been under-trading in services overall and has fallen behind other regions since 2007.

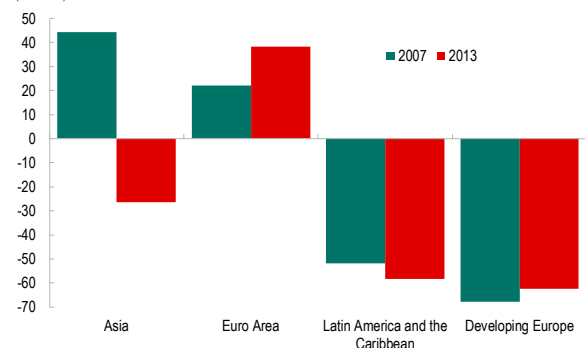
Trade in services within the region has also fallen behind by a significant margin.

**3. Estimated Overall Trade Intensity Gaps in Services**  
(Percent)



Source: IMF staff estimates.

**4. Estimated Intraregional Trade Intensity Gaps in Services**  
(Percent)



Source: IMF staff estimates.

Source: IMF staff estimates.



## Annex 2. A Detailed Look at Trade Costs in Asia

This annex examines some of the main components and evolution of trade costs in Asia, including an examination of tariffs, nontariff barriers, free trade agreements, and transportation and logistical costs of trade.

### Tariffs

Effective tariffs have come down substantially since the early 1990s in both advanced and emerging Asia, albeit with greater dispersion in the latter. The Uruguay Round of trade negotiations that concluded in 1995, along with unilateral trade liberalization, lowered the import-weighted average tariff rates in advanced Asia in the early 1990s and substantially reduced emerging Asia's tariffs with the accession of China to the WTO in 2001. Subsequently, tariff reductions continued, albeit at a more moderate pace determined by regional trading arrangements. In the absence of global and regional tariff agreements since the global financial crisis (except for the Comprehensive and Progressive Agreement for Trans-Pacific Partnership [CP-TPP], which is yet to come into force), tariff declines have been minimal, but with wide variations across Asia. There is still room to bring tariffs down further.

### Nontariff Barriers

The use of NTBs has been on the rise in Asia, albeit at a slower pace in recent years, and NTBs remain high. They include technical barriers to trade, quotas, bailouts, state aid, and trade defense measures, as well as preferences for local industries.

Asia has been less successful in addressing NTBs, especially in services. To gain a comprehensive view of Asia's use of NTBs and areas where there may be room to improve, this annex examines a large range of NTB measures from the WTO, the World Bank's Temporary Trade Barriers database, Global Trade Alert, and the Trade Analysis Information System (TRAIS) database of the United Nations Conference on Trade and Development (UNCTAD) (Figure A2.1). The WTO database suggests that the number of trade measures per year in Asia is naturally higher than in the United States or Latin America. However, World Bank data suggest that the percentage of products covered by these measures is lower than in the United States and Europe, as computed by Bown and Reynolds (2014). Global Trade Alert also suggests that Asia has recorded more discriminatory measures than liberalizing measures (Figure A2.2). Against this backdrop, NTB measures in force in the region increased between 2004 and 2015 but slowed in the past two years. Although the number of measures does not perfectly mirror the magnitude of tension or liberalization, it shows that discriminatory measures in the region have become less popular.

### Free Trade Agreements

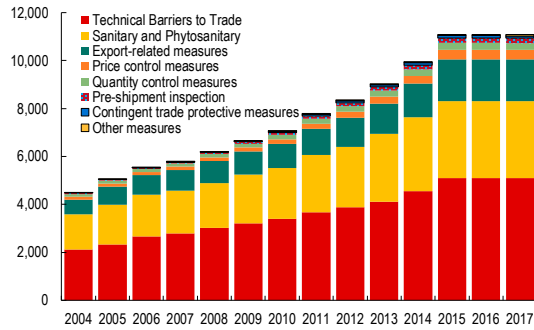
Free trade agreements (FTAs) can reduce trade costs by tackling tariffs and NTBs, including through regulatory cooperation. The number of both bilateral and plurilateral FTAs has continued to grow. Since 2000, the number of multilateral trade agreements has increased continuously in an unprecedented manner. However, recent rising protectionism may undo some of the existing multilateral trade agreements and stymie efforts to engage multilaterally going forward. Progress on broader and deeper trade arrangements more recently holds promise in addressing some NTBs.

The ASEAN FTA lowered intraregional goods tariffs on most products to 0 to 5 percent, excluding some sensitive products. The Pacific Island Countries Trade Agreement came into force in 2006 and has supported liberalization of trade in goods by covering import tariffs and quotas. Compared to earlier agreements, current trade agreements extend beyond goods tariffs. For example, the WTO Trade Facilitation Agreement expedites border procedures. Meanwhile, the Japan-EU Economic Partnership Agreement covers key provisions including trade remedies, trade in services, customs and trade facilitation, and data protection. In addition, the CP-TPP is different given that it tackles both services

Figure A2.1

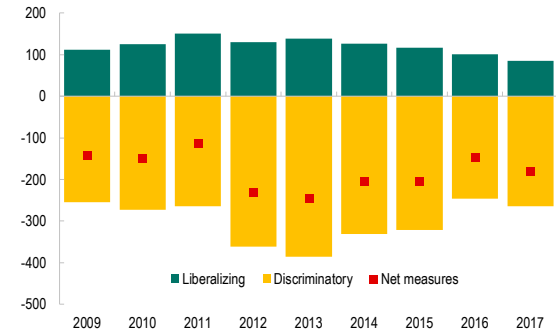
The introduction of new non-tariff measures has slowed down in recent years. However, Asia, especially emerging markets economies, could improve paperless trade facilitation and reduce foreign direct investment restrictiveness on services.

**1. Asia Nontariff Measures**  
(Number of measure)



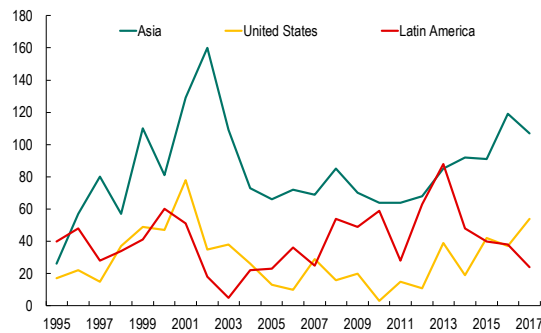
Sources: UNCTAD, TRAINS database; and IMF staff calculations.

**2. Measures Recorded by Global Trade Alert**  
(Number of measures)



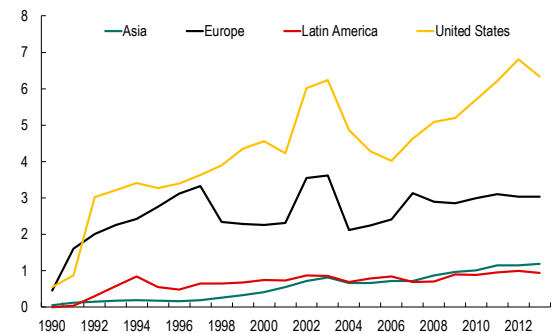
Sources: Global Trade Alert; and IMF staff calculations.

**3. Trade Barrier Initiations**  
(Number of measures)



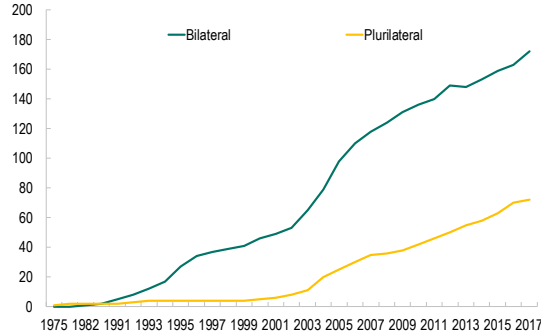
Sources: World Trade Organization; and IMF staff calculations.

**4. Temporary Trade Barriers**  
(Percent of products)



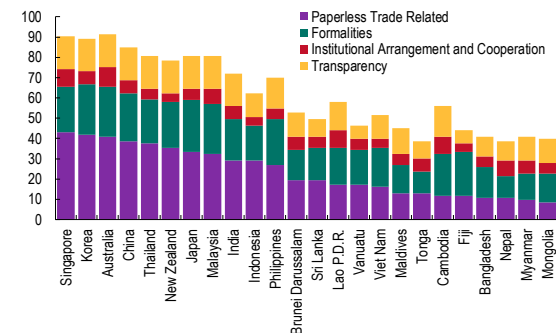
Sources: Bown (2014); World Bank, Temporary Trade Barriers database; and IMF staff calculations.

**5. Asia Free Trade Agreements by Scope**  
(Cumulative number)



Sources: Asian Development Bank; and IMF staff calculation.

**6. Trade Facilitation and Paperless Trade Implementation Score**  
(Score, best=100)



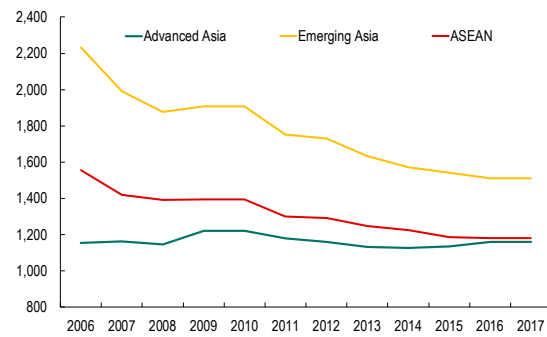
Sources: UN Global Survey on Trade Facilitation and Paperless Trade Implementation.

Figure A2.2

The cost to export has declined, especially for Association of Southeast Asian Nations (ASEAN) economies. Meanwhile, liner shipping connectivity has increased significantly. Despite impressive improvements in cost and connectivity, there is still much room for improvement in enhancing the overall time to export for emerging market economies by advancing paperless trade-related implementation and facilitation.

### 1. Cost to Export

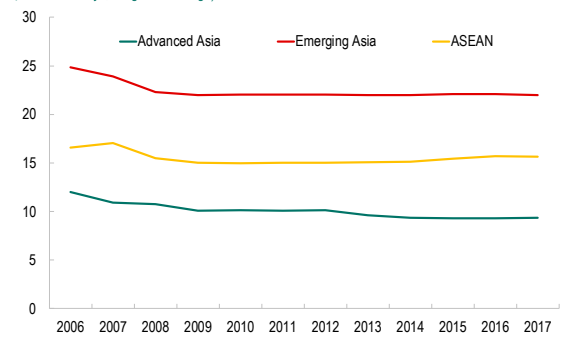
(US dollars, simple average)



Sources: World Bank, Doing Business Indicators; and IMF staff calculations.

### 2. Time to Export

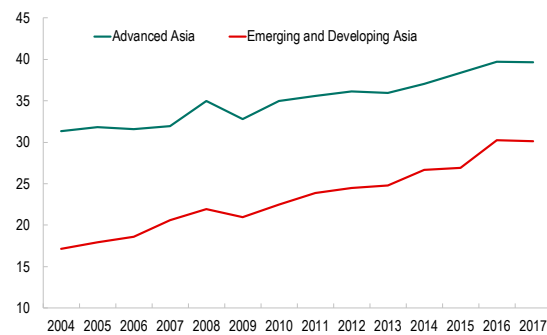
(Number of days, weighted average)



Sources: World Bank, Doing Business Indicators; and IMF staff calculations.

### 3. Liner Shipping Connectivity

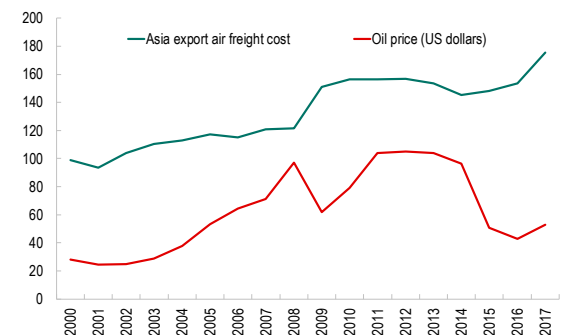
(Index Increasing from 0=100, simple average)



Sources: United Nations Conference on Trade and Development; and IMF staff calculations.

### 4. Asia Air Freight Cost

(Export to the United States, 2010=100)



Sources: U.S. Bureau of Labor Statistics; and IMF staff calculations.

and investment. Newer agreements also typically include more trading partners—for example, the CP-TPP and the Regional Comprehensive Economic Partnership (RCEP) cover more than half of regional GDP. Going forward, the RCEP and new FTAs, while focusing on goods for now, could be expanded to place greater emphasis on FDI, NTBs, and trade in services to enhance trade further.

## Transportation and Logistical Costs of Trade

Time and logistics costs are among the most frequently used indicators to estimate behind-the-border costs. The average time to trade exports for emerging market economies has decreased by seven days, while the cost to export has declined by about 30 percent. (Comparable statistics for advanced economies were broadly flat, from already low levels.) The Liner Shipping Connectivity Index (LSCI) measures how connected an economy is with the global shipping network. Between 2004 and 2017, the LSCI for emerging market economies almost doubled, while it increased by about a third for advanced economies. In addition, air freight cost from Asia to the United States continues to grow despite the recent lower oil prices.

## Annex 3. The Economic Models and Their Extensions

This paper relies on two models, the Ricardian Trade Model (RTM), and the Global Integrated Monetary and Fiscal Model (GIMF), both defined below. Moreover, they are both augmented by a productivity channel that links changes in FDI restrictiveness, tariffs and NTBs with changes in multifactor productivity, as discussed below.

### Global Integrated Monetary and Fiscal Model

The GIMF (documented in Anderson and others, 2013, and in Laxton and others 2010), is used to consider the dynamic impact of trade tensions and liberalization during the transition and broader macroeconomic effects, while still accounting for the long-term impact. Structurally, each economy is close to identical, but with different key steady-state ratios and behavioral parameters, based on a stylized data set consistent with 2015 and 2016, and some long-term trends, primarily related to asset holdings.

Consumption dynamics are driven by saving households and liquidity-constrained households. Saving households face a consumption-leisure choice based on the overlapping generations model of Blanchard (1985), Weil (1987), and Yaari (1965), in which households treat government bonds as wealth, making the model non-Ricardian and endogenizing the long-term determination of the real global interest rate to equilibrate global savings and investment. The real exchange rate serves to adjust each economy's saving position (its current account and associated stock of net foreign assets) relative to the global pool. Liquidity-constrained households cannot save, consuming all their income each period, amplifying the model's non-Ricardian properties in the short term.

Relative to standard versions of the GIMF, this model has a sector for services. Services are produced from tradable and nontradable goods. They are priced as an input for consumption domestically or exported to be consumed by foreigners. Services are exclusively part of consumption, and their demand vis-à-vis consumption goods is relatively inelastic (at 0.9). Consumption of services is a combination of services provided domestically or abroad. This allows for a final price of services that will enter the Consumer Price Index, much as the consumption of services combine with the consumption of goods to define final household consumption.

Private investment relies on the Bernanke-Gertler-Gilchrist (1999) financial accelerator. Investment cumulates to the private capital stock for tradable and nontradable firms, which is chosen by firms to maximize their profits, with a standard inverse relationship between the capital-output ratio and the cost of capital.

The nominal side of the economy depends on implicit Phillips' curves and monetary policy using an inflation-forecast-based interest rate reaction function. Fiscal policy is driven by a sufficiently detailed government sector that can reproduce simplified fiscal accounts for each economy.

Trade is tracked bilaterally among all regions. The flows react to demand, supply, and pricing conditions (that is, the terms of trade and bilateral real exchange rates). There are flows for noncommodity goods and services, and for commodities. Noncommodities trade is further broken into final goods (consumption and investment), consumption services, and intermediate goods. All categories are tracked separately, allowing for the incorporation of differential tariffs and NTBs on consumption, investment, and intermediate goods plus services.

For these exercises, a core version of the GIMF establishes outcomes for eight economies or groups of economies: China, India, Japan, Korea, advanced Asia (comprised of Australia, Hong Kong SAR, Macau SAR, New Zealand, Singapore, and Taiwan Province of China), emerging Asia (comprised of all other Asian and Pacific economies), the United States, and a bloc for the rest of the world. Three satellite versions of the GIMF rely on outcomes from the core model to allow for the computation of six more economies individually: Australia, Indonesia, Malaysia, New Zealand, the Philippines, and Thailand.

## Ricardian Trade Model

The RTM is a multisector, multi-economy computable general equilibrium model used to simulate the long-term sectoral impact of various trade policy scenarios, including tariffs, NTBs (or their tariff-equivalent representations), and effects from productivity changes. The RTM builds on an established quantitative trade literature (Eaton and Kortum, 2002, and Caliendo and Parro, 2015, as detailed in Mano 2016).

The model's strength lies in endogenously capturing production value chains and international trade of goods across sectors. Each economy has a unique production structure of intermediate and final goods, and representative agents that consume and work. The observed patterns of trade in a baseline year are matched exactly, and comparative advantage is inferred from the existing structure of production and trade costs. This comparative advantage benchmark is then used to simulate sectoral prices and economy-wide wages in a new equilibrium under different trade costs. The model is solved in differences following Dekle, Eaton, and Kortum (2007).

The RTM is calibrated to the latest data (2014) in the World Input-Output Dataset (detailed in Timmer and others 2015), featuring 35 sectors (Table A3.1) and 44 economies with rich input-output links and bilateral tariffs from the UNCTAD TRAINS database. The Asian economies included are Australia, China, India, Indonesia, Japan, Korea, and Taiwan Province of China. Sectors are defined according to the International Standard Industrial Classification (ISIC), revision 4.

**Table A3.1. Sectors in the Ricardian Trade Model**

No.	Sector Name
1	Agriculture, forestry and logging, fishing and aquaculture
2	Mining and quarrying
3	Manufacture of food products, beverages and tobacco products
4	Manufacture of textiles, wearing apparel and leather products
5	Manufacture of wood, except furniture
6	Manufacture of paper and paper products, printing
7	Manufacture of coke and refined petroleum products
8	Manufacture of chemicals and pharmaceutical products
9	Manufacture of rubber and plastic products
10	Manufacture of other non-metallic mineral products
11	Manufacture of basic metals and fabricated metal products
12	Manufacture of computer, electronic and optical and electrical equipment
13	Manufacture of machinery n.e.c., repair and installation of machinery
14	Manufacture of motor vehicles, trailers and other transport equipment
15	Manufacture of furniture; other manufacturing
16	Electricity, gas, water, sewage
17	Construction
18	Wholesale and retail trade and repair of motor vehicles and motorcycles
19	Wholesale trade, except of motor vehicles and motorcycles
20	Retail trade, except of motor vehicles and motorcycles
21	Land transport and transport via pipelines
22	Water transport
23	Air transport
24	Warehousing and support activities for transportation
25	Postal and courier activities
26	Accommodation and food service activities
27	Publishing activities, media and ICT
28	Financial service activities
29	Real estate activities
30	Professional services
31	Administrative and support service activities

32	Public administration and defense; compulsory social security
33	Education
34	Human health and social work activities
35	Other service activities

Source: IMF staff estimates.

### Modeling Productivity and the Role of Restrictive FDI Regimes

Both models incorporate a channel linking the level of productivity to the level of tariffs and NTBs. The trade literature extensively documents the impact of trade liberalization on productivity. A recent empirical work by Ahn and others (2016) is used to calibrate that channel. Ahn and others (2016) also demonstrate that restrictive FDI regimes can impede trade liberalization, and they quantify the effect, which can easily be mapped to the RTM, as both use the same sector structure. Sectors in the RTM are then aggregated to inform the same channel in the GIMF. These insights allow for the use of the RTM and GIMF in the further examination of productivity gains and the loosening of FDI restrictions in the liberalization scenarios. The channel was not explored in the trade tensions section.

The productivity channel captures the idea that higher tariffs can either (1) increase input costs or force firms to substitute to less desirable inputs, thereby lowering a sector's productivity; or (2) induce a misallocation of resources toward sectors in which an economy does not have a comparative advantage, and away from more productive sectors. Higher tariffs (or NTBs) will lead to foregone productivity over time.

However, if an economy has a restrictive FDI regime in place, the productivity declines will be less. Industries in which an economy does not hold comparative advantage are already subject to distortions, and additional tariffs will not worsen their productivity substantially.

Given changes in trade costs, the TFP ( $A_n^s$ ) in sector  $s$  and economy  $n$  changes according to:

$$\hat{A}_n^s = \left( \alpha^{out} + \beta^{out} (fdi_n^s - fdi^s) \right) \hat{\tau}_{n,s}^{output} + \left( \alpha^{in} + \beta^{in} (fdi_n^s - fdi^s) \right) \hat{\tau}_{n,s}^{input},$$

where  $\hat{\tau}_{n,s}^{input}$  are tariff changes in the inputs to sector  $s$  in economy  $n$ , and  $\hat{\tau}_{n,k}^{output}$  are tariff changes in sector  $s$  itself. The relevant coefficients are found in a table shared by Ahn and others (2016) includes the interaction of FDI with both input and output tariffs.<sup>15</sup> The coefficients are set as  $\alpha^{out} = -1.09872$ ,  $\beta^{out} = -0.05205$  for output tariffs, and  $\alpha^{in} = -0.05205$ , and  $\beta^{in} = -0.39589$  for input tariffs. The implied sensitivity to either output or input tariffs is capped at zero to preserve the idea that higher tariff costs hurt productivity—a result that could be overturned for very high levels of FDI restrictiveness when implementing the above equation.

### Assumptions on Trade Barriers

To use the models to provide illustrative quantification of trade tensions or trade liberalization, the models require specific assumptions. They are cited below, outlining the specific numbers and sectors that map to equivalent model concepts, effective tariff rates, and effective tariff equivalents for NTBs.

<sup>15</sup> Special thanks to JaeBin Ahn for providing these estimates and for patiently explaining all the details. The specification with two lags was chosen because all coefficients are significant at the 10 percent confidence level except the triple interaction, which is henceforth ignored.

### *Trade Tensions*

For the baseline and escalation scenarios, effective tariffs rates are based on detailed tariff data at harmonized system (HS) six- or eight-digit levels from publicly available sources.<sup>16</sup> These data are processed into effective tariff rates for the RTM's 35 sectors using concordance tables from the World Bank's World Integrated Trade Solution database. Then more highly aggregated effective tariff rates are computed for imports of consumption, investment, and intermediate goods as defined in the GIMF. Effective tariffs related to the automobile sector are only computed for the GIMF, using UN COMTRADE data for sectoral imports and exports on a bilateral basis, and an assumed 25 percent tariff levied by the United States.

### *Trade Liberalization*

Trade liberalization in both the RTM and GIMF are based on three instruments: tariffs on goods, NTBs on services, and FDI regimes that impede productivity gains. They are combined to produce three scenarios with variants.

Liberalization for goods is simple—it is the reduction of the effective tariff rate. For these scenarios, since at least one Asian economy usually has a zero tariff in any given production sector, it is assumed all tariffs are reduced to zero by participating economies when liberalizing. Tariffs are calibrated for the United States and Asia and a large selection of economies to define the rest of the world bloc. The data come from the UNCTAD TRAINS database for 2014 (except for India, Indonesia, and Turkey, which use 2016 data).

Liberalization of services is more difficult, as it must frequently rely on qualitative measures. The standard practice is to quantify NTBs on services using an effective tariff rate equivalent. However, these are difficult to establish, and can range greatly in value. Therefore, three groupings of economies are identified as having either low, average, or high restrictiveness, making 10, 20, or 30 percent cuts in their effective tariff rate equivalent for NTBs, respectively. The degree of restrictiveness is identified using two data sources: the OECD Services Trade Restrictiveness Index, which is current to 2017 but only covers economies from the OECD and nine others (including China, India, and Indonesia); and the World Bank Services Restrictions Database, covering 103 countries but only current to 2007. The groupings used are as follows:

- 1) Low NTBs: Australia, Cambodia, Hong Kong SAR, Japan, Korea, Lao PDR, Mongolia, New Zealand, Singapore
- 2) High NTBs: India, Indonesia, the Philippines
- 3) Average NTBs: all other economies under consideration.

FDI restrictiveness is quantified as the percent gap between the index for FDI restrictiveness for an economy and that of the global average. Data on FDI restrictiveness at the sector level is from the OECD. Sector-level OECD data are mapped to the 35 sectors in the RTM (including all goods and nontravel-related services), which in turn is mapped to the four sectors in the GIMF (aggregates of

---

<sup>16</sup> Tariffs for aluminum and steel come from <https://piie.com/research/piie-charts/who-affected-trumps-steel-and-aluminum-tariffs>, while retaliatory measures come from <https://piie.com/blogs/trade-investment-policy-watch/canada-strikes-back-here-breakdown>, [http://gss.mof.gov.cn/zhengwuxinxi/zhengcefabu/201804/t20180401\\_2857769.html](http://gss.mof.gov.cn/zhengwuxinxi/zhengcefabu/201804/t20180401_2857769.html), <http://www.mofcom.gov.cn/article/ae/ai/201808/20180802773926.shtml>, <https://piie.com/blogs/trade-investment-policy-watch/harley-tariff-trend-setter-not-good-way>, [https://docs.wto.org/dol2fe/Pages/FE\\_Search/FE\\_S\\_S009-DP.aspx?language=E&CatalogueIdList=245263,245266,245272,245249,245254,244331,244332,244335,244292,244291&CurrentCatalogueIdIndex=4&FullTextHash=-1264605332&HasEnglishRecord=True&HasFrenchRecord=False&H](https://docs.wto.org/dol2fe/Pages/FE_Search/FE_S_S009-DP.aspx?language=E&CatalogueIdList=245263,245266,245272,245249,245254,244331,244332,244335,244292,244291&CurrentCatalogueIdIndex=4&FullTextHash=-1264605332&HasEnglishRecord=True&HasFrenchRecord=False&H), and [http://www.dof.gob.mx/nota\\_detalle.php?codigo=5525036&fecha=05/06/2018](http://www.dof.gob.mx/nota_detalle.php?codigo=5525036&fecha=05/06/2018). For the \$200 billion in US tariffs on China's goods, see [https://ustr.gov/sites/default/files/301/2018-0026%20China%20FRN%207-10-2018\\_0.pdf](https://ustr.gov/sites/default/files/301/2018-0026%20China%20FRN%207-10-2018_0.pdf). China's retaliatory tariffs on \$60 billion of US goods come from [http://gss.mof.gov.cn/zhengwuxinxi/zhengcefabu/201808/t20180803\\_2980950.html](http://gss.mof.gov.cn/zhengwuxinxi/zhengcefabu/201808/t20180803_2980950.html) and <https://piie.com/blogs/trade-investment-policy-watch/chinas-60-billion-tariff-announcement>.

intermediate, consumption, and investment goods, plus services excluding travel). Coefficients are computed for Australia, Cambodia, China, Indonesia, India, Japan, Lao PDR, Myanmar, Mongolia, New Zealand, the Philippines, Taiwan Province of China, and Vietnam. The rest of the Asian economies are assumed to have FDI gaps similar to those of other economies (including from outside of Asia) near their per capita income level.

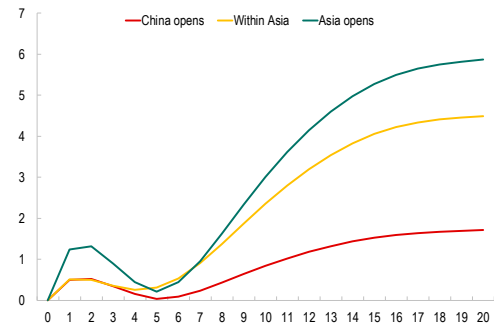
Liberalization in goods tariffs and services NTBs enter directly into the models, and act primarily through relative price channels (and the government revenue channel for tariffs). FDI liberalization is an input to computation of the productivity effect explained above, derived from Ahn and others (2016).

These three instruments then allow for the definition of the three scenarios (“China Opens,” “Within Asia,” and “Asia Opens”) and the variants with the reduction of the restrictiveness of an economy’s FDI regime. Figure A3.1 illustrates dynamics of the three scenarios, without any FDI liberalization. Each scenario provides more gains than the last, growing over time, with a slowdown around five years out, as medium-term restrictions resolve themselves and productivity gains, while beginning to manifest, are not yet perceived as permanent by households and firms. As the productivity gains are understood to be permanent, the gains accelerate to their long-term values.

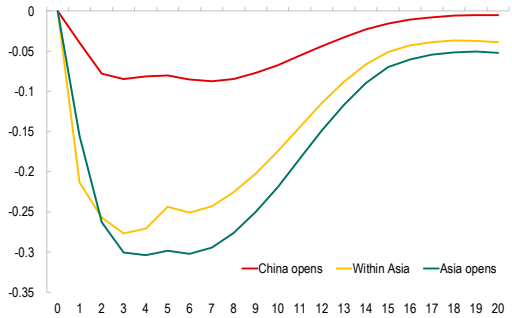


**Figure A3.1 Effects on Asia from Liberalizing Trade in Goods and Services**  
*(Percent deviation relative to baseline, trade and productivity channels only)*

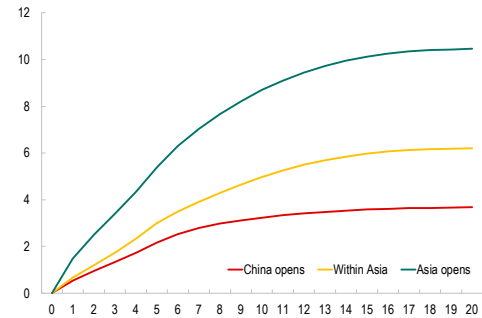
**1. Real GDP**  
*(Percent difference)*



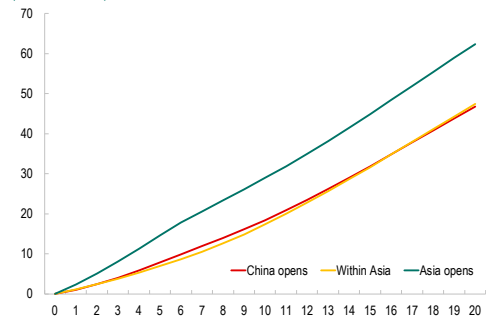
**2. Current Account Balance**  
*(Percent difference)*



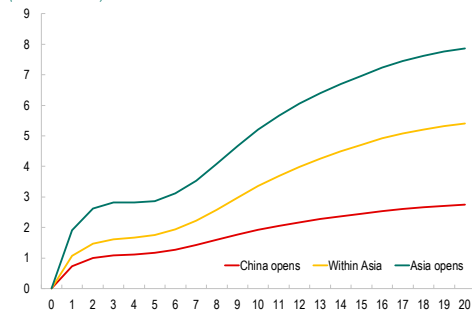
**3. Trade Volumes**  
*(Percent difference)*



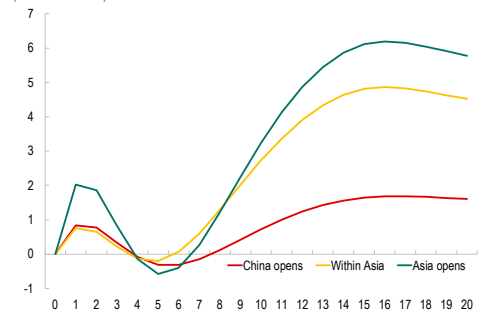
**4. Trade Volumes for Services**  
*(Percent difference)*



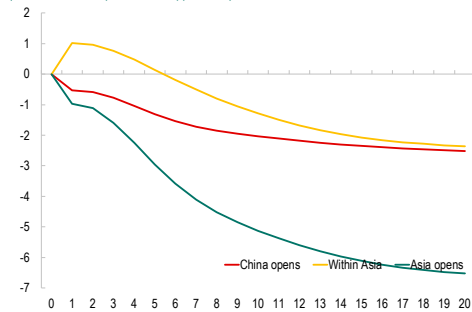
**5. Real Consumption**  
*(Percent difference)*



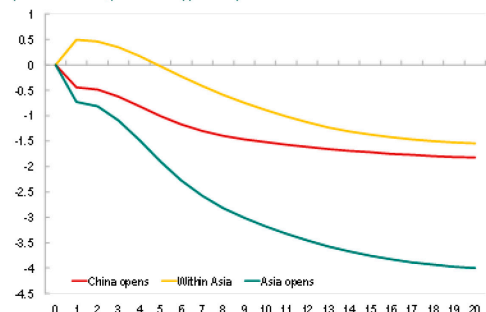
**6. Real Investment**  
*(Percent difference)*



**7. Real Bilateral U.S. Dollars Exchange Rate**  
*(Percent difference; positive is an appreciation)*



**8. Real Effective Exchange Rate**  
*(Percent difference; positive is an appreciation)*



Source: IMF staff calculations.

**Figure A3.2 Scenario 3 with Foreign Direct Investment Liberation, Decomposed by Channels**  
(Percent deviation relative to baseline)



Source: IMF staff estimates.

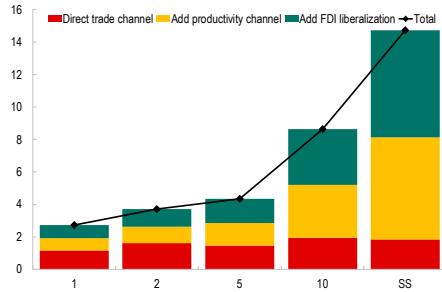
Note: Advanced Asia includes Australia, Hong Kong SAR, Japan, Korea, New Zealand, Singapore and Taiwan Province of China. Emerging Asia includes the rest of Asia excluding China. FDI: foreign direct investment. SS: steady-state outcomes.

**Figure A3.3 Scenario 3 with Foreign Direct Investment Liberalization, Decomposed by Channels**  
*(Percent deviation relative to baseline)*

**Real Consumption**

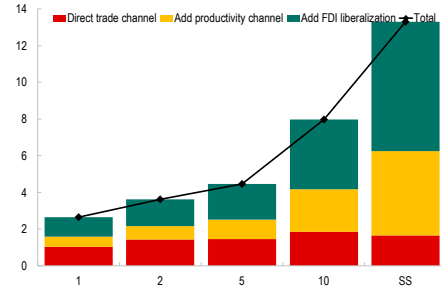
**1. Asia**

*(Percent difference)*



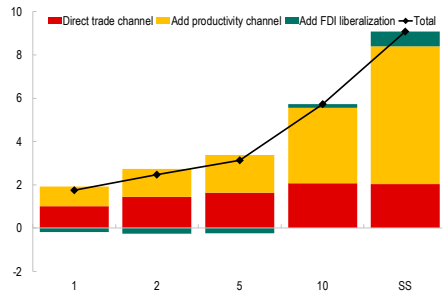
**2. China**

*(Percent difference)*



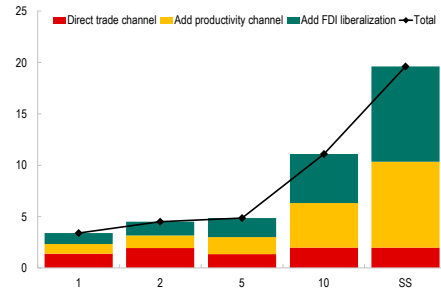
**3. Advanced Asia**

*(Percent difference)*



**4. Emerging Asia**

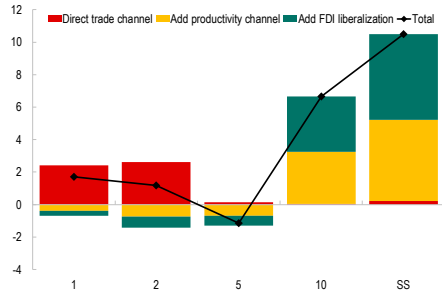
*(Percent difference)*



**Real Investment**

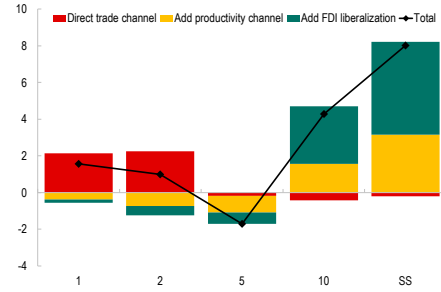
**5. Asia**

*(Percent difference)*



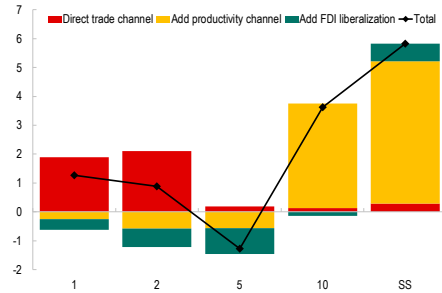
**6. China**

*(Percent difference)*



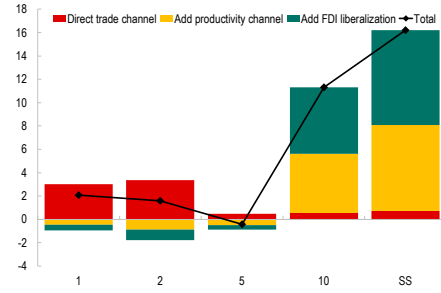
**7. Advanced Asia**

*(Percent difference)*



**8. Emerging Asia**

*(Percent difference)*



Source: IMF staff estimates.

Note: Advanced Asia includes Australia, Hong Kong SAR, Japan, Korea, New Zealand, Singapore and Taiwan Province of China. Emerging Asia includes the rest of Asia excluding China. FDI: foreign direct investment.

## References

- Ahn, J., E. Dabla-Norris, R. Duval, B. Hu and L. Njie. 2016. "Reassessing the Productivity Gains from Trade Liberalization." IMF Working Paper No. 16/77, International Monetary Fund, Washington, DC.
- Anderson, D. B. Hunt, M. Kortelainen, M. Kumhof, D. Laxton, Douglas D. Muir, S. Mursula, and S. Snudden, Stephen. 2013. "Getting to Know GIMF: The Simulation Properties of the Global Integrated Monetary and Fiscal Model." IMF Working Paper No. 13/55, International Monetary Fund, Washington, DC.
- Asian Development Bank (ADB). 2017. *Asian Economic Integration Monitor 2017*. Manila
- Baker, S.R., N. Bloom, and S. Davis. 2016. "Measuring Economic Policy Uncertainty." *Quarterly Journal of Economics* 131(4): 1593–636.
- Bernanke, Ben S., Mark Gertler, and Simon Gilchrist. 1999. "The Financial Accelerator in a Quantitative Business Cycle Framework." *Handbook of Macroeconomics*, edited by J. B. Taylor & M. Woodford pp. 1341–393. Amsterdam: Elsevier.
- Blanchard, O. 1985. "Debts, Deficits and Finite Horizons." *Journal of Political Economy* 93(2): 223–47.
- Bown, C., and K. Reynolds, 2014. "Trade Flows and Trade Disputes." Policy Research Working Paper No. 6979, World Bank, Washington, DC.
- Caliendo, L., and F. Parro. 2015. "Estimates of the Trade and Welfare Effects of NAFTA." *Review of Economic Studies* 82(1): 1–44.
- Cerdeiro, D., and R. Nam. 2018. "A Multidimensional Approach to Trade Policy Indicators." IMF Working Paper No. 18/32, International Monetary Fund, Washington, DC.
- Criscuolo, C., and J. Timmis. 2017. "[The Relationship Between Global Value Chains and Productivity](#)." *International Productivity Monitor* 32: 61–83.
- Dekle, R., J. Eaton, and S. Kortum. 2007. "Unbalanced Trade." *American Economic Review* 97(2): 351–55. Dixit, A., and R. Pindyck. 1994. *Investment Under Uncertainty*. Boston: Princeton University Press.
- Duval, Y., and C. Utoktham. 2011. "Intraregional Trade Costs in Asia: A 'Primer'." Staff Working Paper 01/10, UN ESCAP Trade and Investment Division, United Nations, New York.
- Eaton, J., and S. Kortum. 2002. "Technology, Geography, and Trade." *Econometrica* 70: 1741–779.
- Goldberg, P., and N. Pavcnik. 2016. "The Effects of Trade Policy." In *Handbook of Commercial Policy*, edited by K. Bagwell and R. Staiger. New York: Elsevier North Holland.

- Head, K., and J. Ries, J. 2001. Increasing Returns Versus National Product Differentiation as an Explanation for the Pattern of US-Canada Trade. *American Economic Review* 91(4): 858–76.
- Hlatshwayo, S. 2017. “New Perspectives on Policy Uncertainty.” Doctoral Dissertation, University of California, Berkeley.
- International Monetary Fund (IMF). 2018a. “Regional Economic Outlook: Asia and Pacific Background Paper No. 3—Productivity Growth in Asia: Boosting Firm Dynamism and Weeding out the Zombies,” Washington, DC, October.
- . 2015 “Reaping the Benefits from Global Value Chains” Chapter 2 of the *Regional Economic Outlook: Asia and Pacific*, Washington DC, April.
- International Monetary Fund (IMF), World Bank, and the World Trade Organization (WTO). 2017. *Making Trade an Engine of Growth for All: The Case for Trade and for Policies to Facilitate Adjustment*. Washington, DC: International Monetary Fund.
- . 2018. *Reinvigorating Trade and Inclusive Growth*. Washington, DC: International Monetary Fund.
- Laxton, Douglas, Susanna Mursula, Michael Kumhof, and Dirk Muir. 2010. “The Global Integrated Monetary and Fiscal Model (GIMF) – Theoretical Structure.” IMF Working Paper No 10/34, International Monetary Fund, Washington, DC.
- Mano, R. 2016. “Quantifying the Spillovers from China Rebalancing Using a Multi-Sector Ricardian Trade Model.” IMF Working Paper No. 16/219, International Monetary Fund, Washington, DC.
- Mathai, K., G. Gottlieb, G. Hong, S.E. Jung, J. Schmittmann, and J. Yu. 2016. “China’s Changing Trade and the Implications for the CLMV Economies.” Asia Pacific Department Departmental Paper No. 1, International Monetary Fund, Washington, DC.
- Mbaye S., M. Moreno Badia, and K. Chae. 2018. “Global Debt Database: Methodology and Sources.” IMF Working Paper No. 18/111, International Monetary Fund, Washington, DC.
- Nabar, M., and M. Syed. 2011. “The Great Rebalancing Act: Can Investment Be a Lever in Asia?” IMF Working Paper No. 11/35, International Monetary Fund, Washington, DC.
- Novy, D. 2013. “Gravity Redux: Measuring International Trade Costs with Panel Data.” *Economic Inquiry* 51(1): 101–21.
- Organisation for Economic Co-operation and Development (OECD). 2012. “Trade, Growth and Jobs.” Summary of the OECD/ICITE Report on Policy Priorities for International Trade and Jobs. Paris.
- Rodríguez-Clare, A. Forthcoming. “Globalization and the Gains from Trade in Rich and Poor Countries.”

Timmer, M., E. Dietzenbacher, B. Los, R. Stehrer, and G. de Vries. 2015. “An Illustrated User Guide to the World Input–Output Database: The Case of Global Automotive Production.” *Review of International Economics* 23: 575–605.

Weil, P. 1987. “Permanent Budget Deficits and Inflation.” *Journal of Monetary Economics* 20(2): 393–410.

Yaari, M. 1965. “Uncertain Lifetime, Life Insurance, and the Theory of the Consumer.” *Review of Economic Studies* 32(2): 137–50.

# REGIONAL ECONOMIC OUTLOOK: ASIA AND PACIFIC BACKGROUND PAPER NO. 3

## Productivity Growth in Asia: Boosting Firm Dynamism and Weeding out the Zombies<sup>1</sup>

October 2018

---

<sup>1</sup> This *Regional Economic Outlook* background paper was prepared by Manrique Saenz and Katsiaryna Svirydzenka (lead authors), Ryota Nakatani, Anne Oeking, To-Nhu Dao, and Can Sever (summer intern), under the guidance of Lamin Leigh. Alessandra Balestieri, Francis Landicho and Socorro Santayana provided excellent production assistance. The paper is based on data available as of September 18, 2018, and includes comments from other IMF departments and some Executive Directors.

*Using firm-level data, this background paper to the October 2018 Asia and Pacific Regional Economic Outlook shows that Asia's productivity growth slowdown has been driven by a decline in firm dynamism, the rise of "zombie" firms, and resource misallocation that came with it. Growing financial constraints, such as excessive leverage, also seem to have played a role. Policymakers should aim to foster innovation and trade openness, help firms address their debt overhang, and take measures to ensure active entry and exit so that nonviable zombie firms do not absorb resources that could be better deployed in other enterprises. Without such steps, the scale of the zombie problem could reach that of some southern European countries.*

## Introduction

As noted in IMF (2018a), Asia continues to be the global economy's main growth engine but faces the challenge of how to sustain its strong performance. Chapter 3 of the 2017 *Regional Economic Outlook: Asia and Pacific* shows that productivity in a number of countries in Asia slowed after the global financial crisis

(Figure 1) primarily as a result of declines in investment in research and development (R&D), trade openness, and foreign direct investment (FDI). However, studies of other regions have shown that "micro" dynamics affecting performance within firms and across sectors also play an important role in productivity.

This paper uses firm-level data to explore "micro" drivers of productivity in Asia. It first examines the role of firm dynamism—the speed at which businesses are born, grow or decline, and exit—as a driver of productivity growth in the region over the past decade. Theory and evidence suggest that firm dynamism contributes to aggregate productivity growth through the continuous reallocation of resources toward higher valued and productive activities (Decker and others 2016; Brandt, Van Biesebroeck, and Zhang 2012; Foster, Haltiwanger, and Krizan 2001). The paper then focuses on the proportion of "zombie" firms—businesses that continue operating and competing for resources despite their financial difficulties—and their impact on healthy firms and on the efficiency of resource allocation. The paper examines two macroeconomic trends or events that may partly underlie the productivity slowdown: (1) the ongoing sectoral shift from agriculture to manufacturing and services; and (2) the global financial crisis, which led to a temporary collapse in demand and a tightening of financial conditions, as well as a buildup of corporate leverage in its aftermath. As part of the above analysis, the paper also studies the impact of other relevant variables—including trade openness, foreign ownership, and investment in intangibles—on productivity growth.

### **The main findings of the paper are as follows:**

- Asia's productivity growth slowdown has been associated with a decline in firm dynamism. First, the analysis finds that the share of young firms and startups has been declining in Asia. This is important because younger firms tend to grow faster, invest more in intangible capital, and have higher productivity growth. Second, the analysis finds that so-called "zombie congestion" (McGowan and others 2017)—the failure of nondynamic firms to exit—has increased in several Asian economies over the last decade. This has decreased aggregate productivity—as zombie firms tend to be less productive—and dampened the productivity of healthy firms and slowed the efficient reallocation of capital towards more productive firms.
- The global financial crisis affected firm productivity in Asia through weaker global demand (trade channel), but also through tighter financial conditions (financial channel). While the impact from weaker demand on productivity was temporary, financial tightening had a more persistent effect. Looser financial conditions after the global financial crisis help explain the rise of the zombie



problem and the leverage buildup, which indicates that more firms would be affected during the next financial shock.<sup>2</sup>

- A number of other factors help raise productivity growth. The analysis finds that firms that invest more in R&D and other forms of intangible capital tend to have higher productivity growth. This is also the case for firms located in export-oriented sectors and for firms that are foreign-owned.

**Given these findings, the main policy recommendations are as follows:**

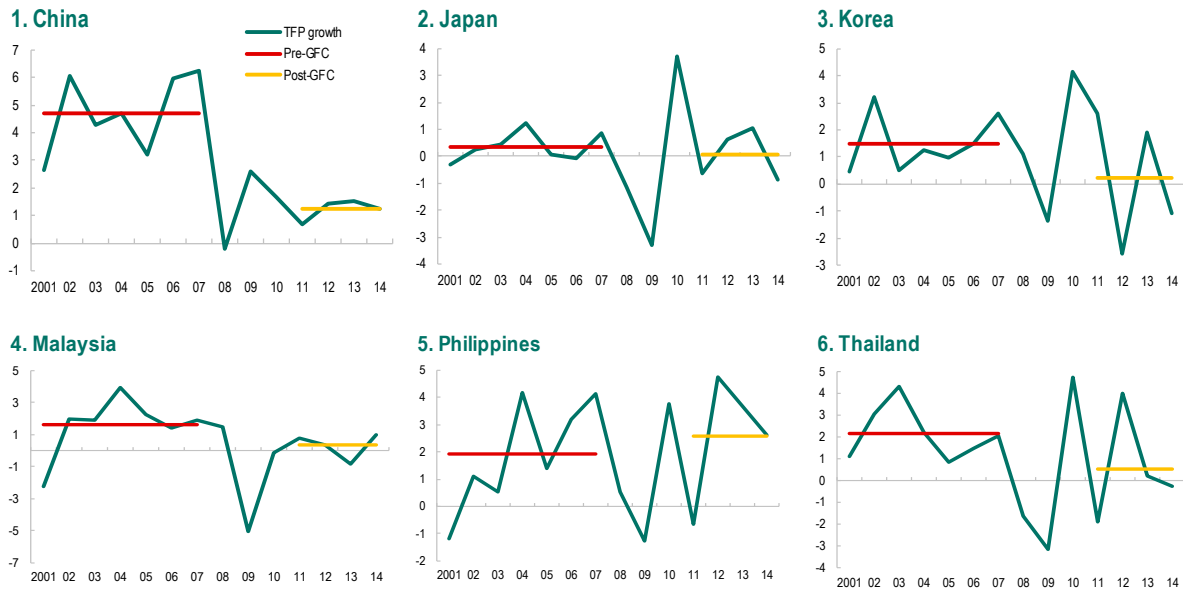
- *Foster firm dynamism.* This would require reducing barriers to entry and facilitating resource reallocation through the exit of nonviable firms. This could be achieved by (1) lifting barriers to competition in goods markets; (2) increasing labor market flexibility; (3) improving insolvency regimes; and (4) reviewing credit guarantees and other support schemes.
- *Address debt overhang and avoid undue buildup of leverage* by (1) facilitating judicious debt resolution and corporate restructuring plans; (2) adopting adequate institutional frameworks and implementing supportive tax measures and financial sector policies; (3) implementing appropriate microprudential and macroprudential policies to avoid the excessive buildup of leverage; and (4) reducing debt bias in tax systems.
- *Foster innovation and trade openness* by reaping the benefits of new technologies and boosting total factor productivity (TFP) through intangible capital deepening, including R&D. Policies include fiscal incentives for intangible investment, patent policy, and competition in research grants. Economies should also continue to facilitate international trade and foreign investment to stimulate competition and knowledge transfer, which would also help boost firm dynamism. In this respect, the current trade tensions discussed in IMF (2018b) could dampen trends toward intangible capital deepening in Asia by increasing policy uncertainty for firms.

This paper first documents the stylized facts on firm dynamism in Asia—measured by firm age and zombie congestion—and analyses how firm dynamism and other factors affect productivity at the firm level during normal times. It then assesses the role of macroeconomic events—sectoral shifts and financial crises—on firm-level productivity. The paper concludes with policy recommendations and suggestions for structural reforms to lift productivity growth. The details of the estimated regressions and the results are presented in the annexes.

---

<sup>2</sup>Sectoral shifts can explain some of the productivity slowdown for China, but do not seem to play a significant role as drivers of firm productivity in the other economies examined (Japan, Korea, Malaysia, and the Philippines). Rather than the sectoral shift, the decline in firm dynamism and the persistent impact of corporate leverage help explain the heretofore unexplained productivity growth slowdown, as shown below.

**Figure 1. Aggregate Total Factor Productivity Growth (Percent)**



Source: Penn World Tables.

Note: GFC: global financial crisis; TFP = total factor productivity.

## Firm Dynamism and Productivity Growth

Firm dynamism affects output and productivity growth through two channels: the entry of more productive firms and the exit of less productive firms.<sup>3</sup> First, to the extent that new entrants are more productive than the incumbents, their entry will raise aggregate productivity. Second, as less productive firms exit, aggregate productivity will increase not only directly but also indirectly, as their exit frees up resources that can then be reallocated to more productive firms. As a result, firm dynamism facilitates productivity-enhancing reallocation of resources within an industry, as Decker and others (2016) note. For example, Brandt and others (2012), find that nearly three-quarters of the productivity growth in China over 1998–2007 came from entry-exit behavior.

This paper measures firm dynamism in two ways: firm age and zombie firms. The share of young firms says something about the ease of entry into the economy. The share of zombie firms—which despite their financial difficulties continue operating and competing for resources with more productive firms—says something about the ease of exit.

The data used are from Orbis,<sup>4</sup> a cross-country longitudinal dataset of mostly unlisted firms (around 99 percent of the sample) and small and medium-sized firms provided by Bureau van Dijk. The dataset has rich information on firms' production activities and financial variables based on balance sheets and income statements. Although Orbis has data for other Asian economies, the focus on firm-level TFP restricts the analysis to six Asian economies (China, Japan, Korea, Malaysia, Philippines, Thailand) during 2003–15, for which firm-level TFP can be estimated for a relatively large number of firms (see Annex 2

<sup>3</sup> See Annex 1 for more formal details.

<sup>4</sup> The authors thank Romain Duval and his unit in the IMF's Research Department for making available the Orbis firm-level data, and Yevgeniya Korniyenko from the IMF's Strategy, Policy, and Review Department for making available the Orbis firm-ownership data.

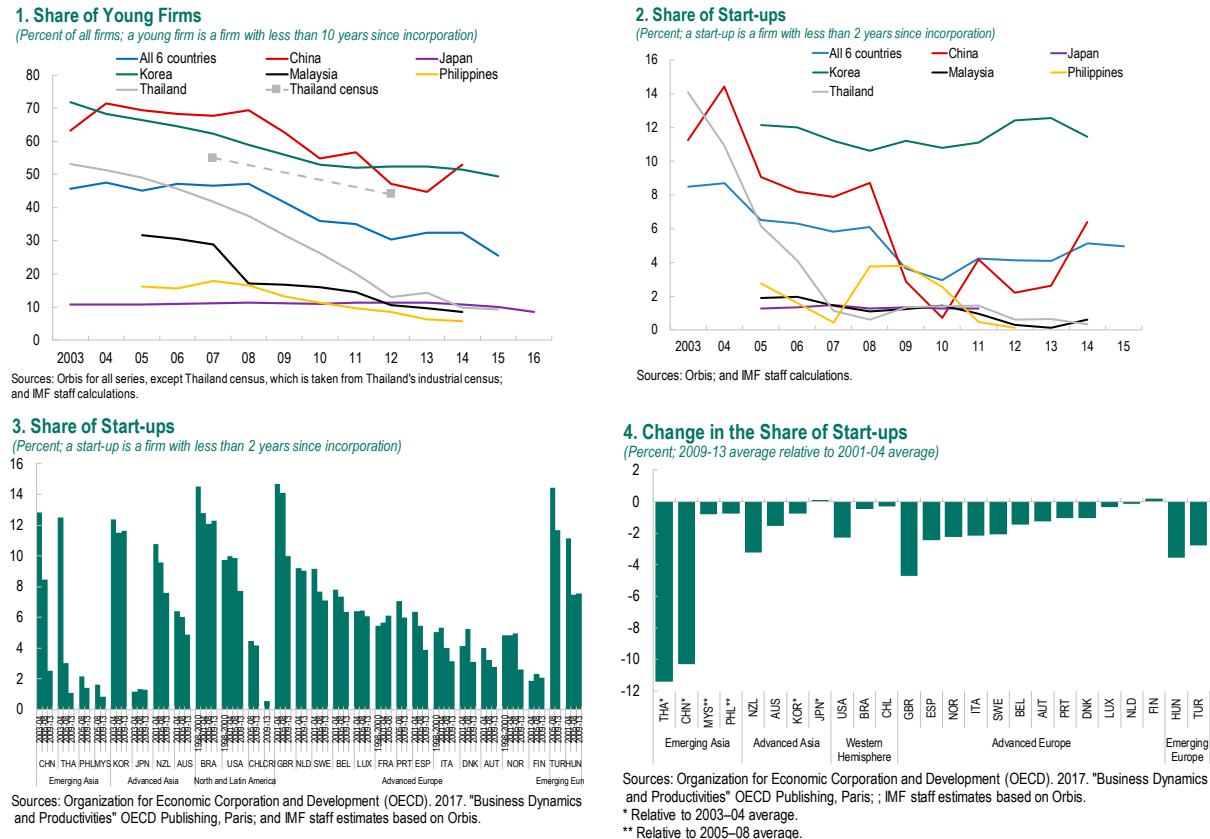
for more details). Consequently, the results may not be representative of all economies in the regions, especially those that are at an earlier stage of development<sup>5</sup>.

## Role of Age and Other Firm Characteristics

That firm dynamism has been waning in Asia is suggested by at least two indicators: the share of firms 10 years old or younger, and the share of start-ups, which are firms two years old or younger (Figure 2). The overall share of young firms in the Orbis sample declined from 45 percent in 2003 to 25 percent in 2015. In Korea, for example, the share of young firms declined from 72 to 49 percent over the same period. On the other hand, that share in Japan remained relatively stable at about 10 percent. While these results are based on the Orbis sample, census data for Thailand support these findings, indicating a decrease in the share of young firms of 12 percentage points between 2007 and 2012. It seems that the decline in start-up rates in China and Thailand is larger than in Europe, the United States, and Latin America.

Why is this important? Although younger firms have lower TFP levels, on average, they generate higher TFP growth—a result that holds in five of the six economies examined (Figure 3). Younger firms are generally smaller, but grow faster (in terms of assets), have lower leverage, and invest more in intangible capital than older firms. Young firms are more prevalent in sectors open to trade, where competition tends to be stronger.

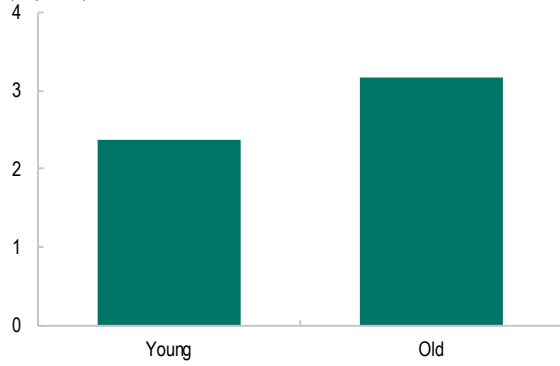
**Figure 2. Firm Dynamism**



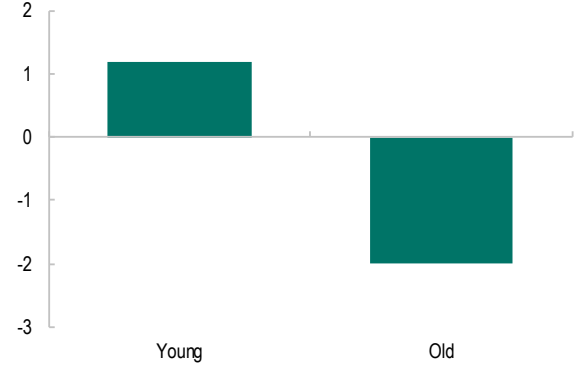
<sup>5</sup> See Di Mauro and others (2018) for efforts to improve firm-level data collection across Asia and their preliminary findings.

**Figure 3. Firm Characteristics by Age**  
(In percent unless otherwise indicated)

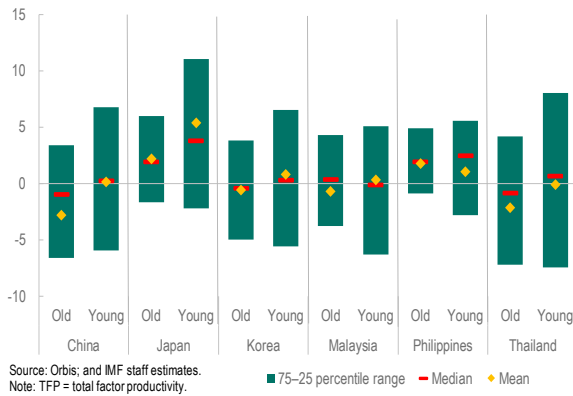
**1. TFP Level**  
(Log TFP)



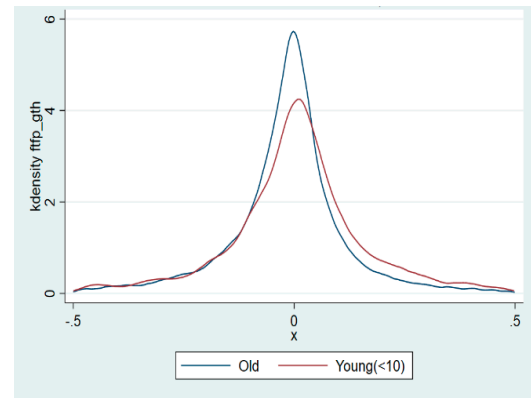
**2. TFP Growth**  
(Percentage points)



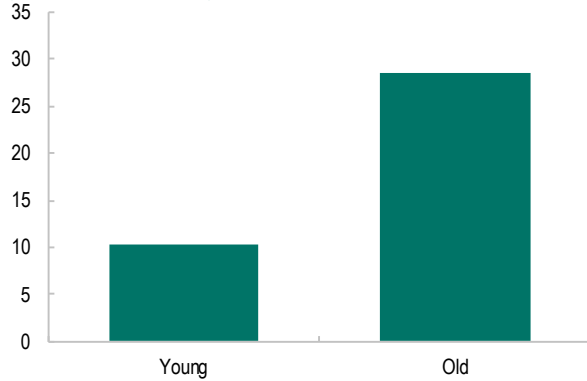
**3. Average Difference in TFP growth: Young versus Old Firms, 2014**  
(Threshold is above/below 10 years since date of incorporation)



**4. Thailand: TFP Growth Distribution, 2014**  
(Kernel density distribution across TFP growth rates)



**5. Total Assets**  
(In millions of US dollars)



**6. Growth in Total Assets**

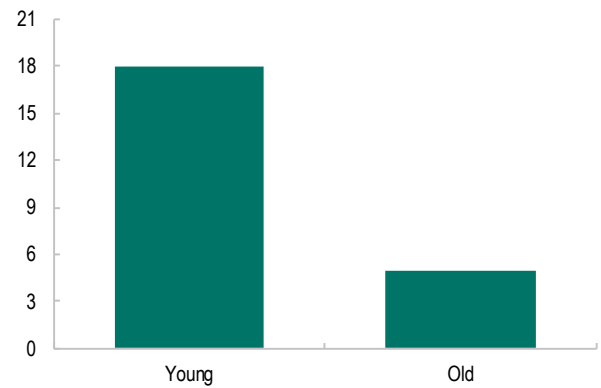
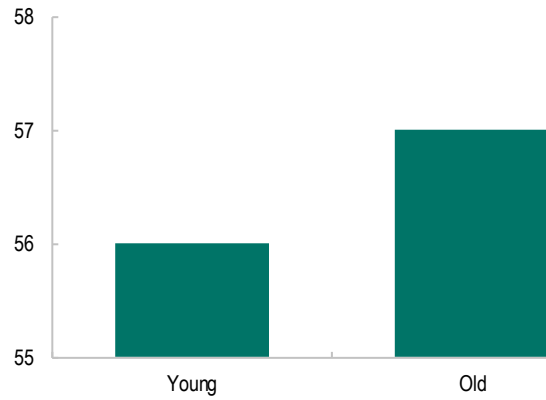
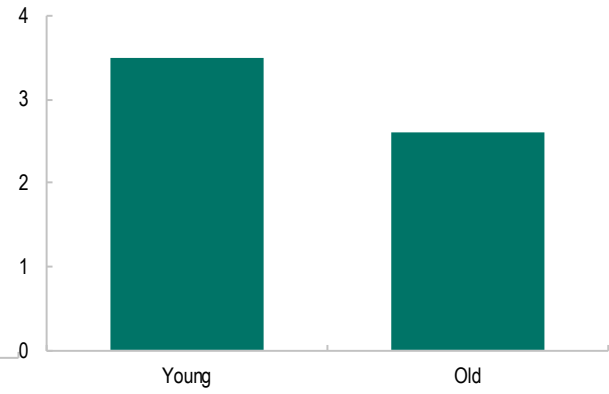
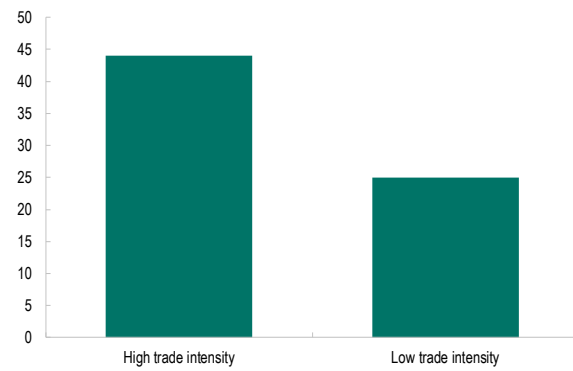
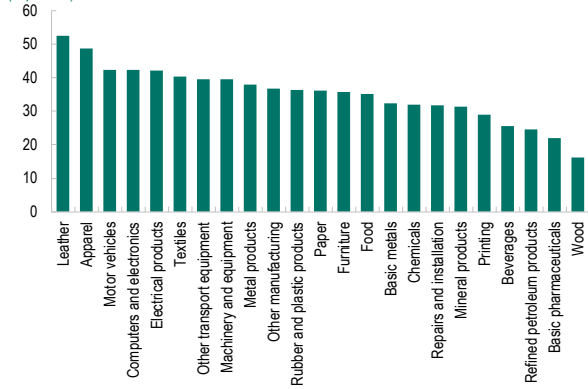


Figure 3. (continued)

7. Leverage (Liabilities/Assets)



8. Intangibility (Intangible Assets/Total Fixed Assets)

9. Share of Young Firms: High versus Low Trade Intensity Industries, 2014  
(In percent)10. Share of Young Firms in Manufacturing Sector, 2014  
(In percent)

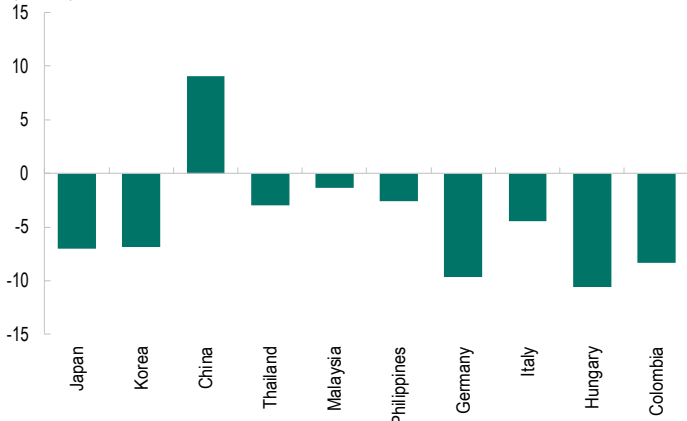
Sources: Orbis; and IMF staff estimates.

Note: "Young" refers to firms less than 10 years old. "Old" refers to firms 10 years old or older. TFP: total factor productivity.

To more formally assess the link between firm characteristics and TFP growth, a panel regression approach is employed.<sup>5</sup> The econometric results indicate that, in general, firm dynamism affects productivity in Asia. Specifically, younger firms have higher productivity growth. In addition, the share of intangible assets, operation in more export-intensive sectors, and foreign ownership also contribute to higher productivity growth. Other variables, such as firm size and leverage, matter as well. The results indicate the following (see Annex 3 for detailed regression results):

- Firm age:* Younger firms generally have higher productivity growth. This holds for every economy in the sample except China (Figure 4), where the impact of firm age on productivity is positive but not statistically significant. For example, a one-year-old firm in Japan is associated with 3.5 percent higher productivity growth than a 10-year old firm. In the Philippines, the same age difference would account for 1.3 percent higher TFP growth, as the estimated coefficient is smaller in absolute value. The contribution of age to productivity in Asia is somewhat smaller in absolute terms than in a sample of European economies, reflecting smaller marginal impacts of age on productivity growth.

**Figure 4. Contribution of Average Firm Age to TFP Growth (Percent)**



Sources: Orbis; and IMF staff calculations.

Note: Contribution is estimated coefficients multiplied by mean age value per country. TFP: total factor productivity.

- Firm leverage:* A marginal increase in leverage is associated with higher productivity growth during normal times, although this effect is somewhat smaller when firms start off from higher leverage levels. As will be shown in subsequent sections, during crises, the impact of leverage on productivity becomes negative and persists well beyond the crisis.
- Investment in intangibles:* Intangible capital deepening leads to higher productivity growth.<sup>6</sup> The effectiveness of an additional unit of intangible capital (as a share of fixed assets) in fostering productivity varies over time, across economies, and across industry types. It is higher in companies with higher intangible capital. It is also higher in Japan than in Korea, although the difference between the two economies has declined since the global financial crisis (Figure 5 and Annex 4). At the same time, intangible capital appears to contribute significantly more to productivity in Germany, Italy, and Hungary than in Japan and Korea (Figure 6), even though the level of R&D expenditure in Europe is substantially lower than in Japan and Korea (Figure 7). The impact of the digital economy on productivity is further examined in IMF (2018c).

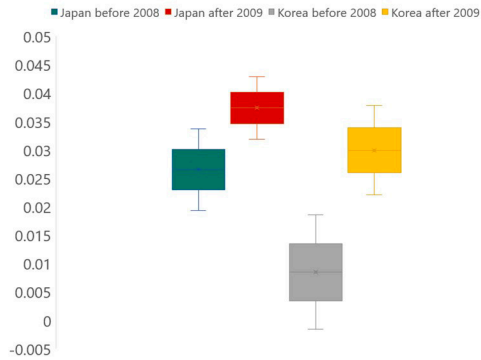
<sup>5</sup> The methodological setup is described in the Annex 3.

<sup>6</sup> Intangible assets in the Orbis dataset include R&D expenses, but also goodwill and all other expenses with a long-term effect. Data on R&D expenditure are limited, and therefore the chapter focuses instead on intangible assets, for which enough observations are available for Japan, Korea, Thailand, and Malaysia.

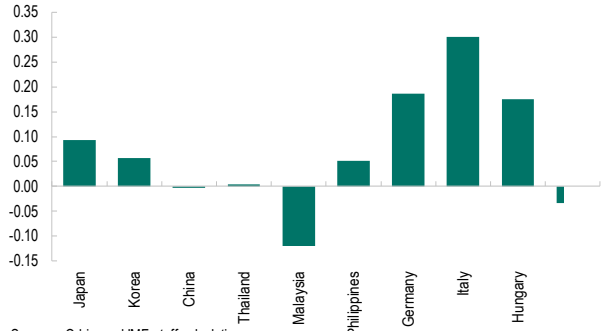
- *Openness to trade:* Firms in sectors with higher export shares in total output have higher productivity growth than those in lower trade-intensity sectors.<sup>7</sup> This result is consistent with others in the literature (De Loecker 2013). Firms more exposed to global demand, however, may also be more affected by a global shock (like the global financial crisis), even if, on average, they have higher productivity growth. This topic is discussed further in the following section.

**Figure 5. Impact of Intangible Investment on Productivity in Japan and Korea**

(Regression coefficient; whiskers are for  $\beta \pm 2$  standard errors)



**Figure 6. Contribution of Average Intangibility to TFP Growth (Percent)**



Sources: Orbis; and IMF staff calculations.

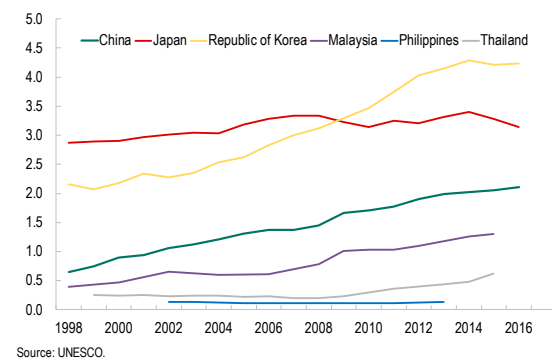
Note: The contribution is the estimated coefficients multiplied by mean intangibility per country. Countries with statistically significant coefficients (at the 10 percent level) are shown. TFP: total factor productivity.

- *Foreign ownership:* Defined as nonresident ownership of more than 50 percent of a firm's capital, foreign ownership is associated with 0.5 percent higher TFP growth. This is consistent with results in the literature pointing to the productivity benefits from foreign ownership (Doms and Jensen 1998; Hallward-Driemeier, Iarossi, and Sokoloff 2002; IMF 2018b). Foreign competition, high knowledge intensity, and access to wider networks, overall, are associated with higher productivity.
- *Firm size:* Larger firms in general exhibit higher productivity growth. Since the regression analysis also controls for firm age, this result implies that, given two firms with the same age, the larger firm would generally have higher productivity growth.
- *Convergence:* Firms that start off with lower TFP levels have higher TFP growth rates, all else being equal. As a result, over time, TFP in these firms tends to converge to that of more productive firms.

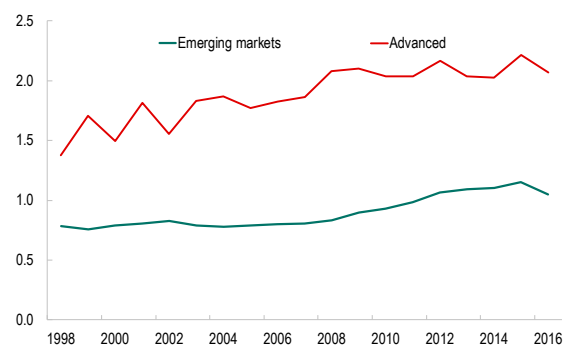
<sup>7</sup> Due to very scarce data on firm-level exports in the sample used, this analysis is done using data only for China, Japan, and Korea, and using industry-level ratios of exports to gross output from the World Input-Output Database.

## Figure 7. Gross Domestic Expenditure on Research & Development

1. Asia: R&D Expenditure  
(In percent of GDP)



2. Europe: R&D Expenditure  
(In percent of GDP)



## Zombie Firms and Resource Misallocation

A number of studies show that the current productivity slowdown masks a widening performance gap between more productive and less productive firms (Andrews, Criscuolo, and Gal 2015 and 2016). This divergence is driven not just by firms at the frontiers of their industry, pushing the technological boundaries, but also by stagnating productivity growth of laggard companies that have failed to innovate and adopt the leaders' best practices.

In well-functioning markets, one would expect strong incentives for productive companies to aggressively expand and drive out less productive ones. However, the opposite has happened in the United States, Europe, and elsewhere. The propensity for high-productivity companies to expand and low-productivity companies to downsize or exit the market has declined over time. This pattern is evident in the United States (Decker and others 2016) and is particularly stark in southern Europe (McGowan and others 2017), where scarce capital has been increasingly misallocated to low-productivity firms.

The survival of weak companies interferes with the process of creative destruction and drags down average productivity. In addition, such firms take up scarce resources, and their prolonged survival (or their delayed restructuring) inflates wages relative to productivity, depresses market prices, and undermines investment—all of which increases barriers to entry of new firms, deters the expansion of productive companies, particularly startups, and amplifies the mismatch of skills. The effects of such credit misallocation can be amplified by loose monetary policy, as it lowers the opportunity cost for banks to bet on the resurrection of failing firms via forbearance.

Historically, the distortionary effect of zombie firms on healthy firms has been analyzed in the context of the Japanese macroeconomic stagnation in the 1990s. These studies show that resource misallocation in Japan deteriorated during the 1990s (Kwon, Narita, and Narita 2015). A seminal paper by Caballero, Hoshi, and Kashyap (2008) finds that investment, employment, and productivity growth for healthy firms fell as the share of zombies in their industry rose.<sup>8</sup> More recently, zombie firms have become a concern in China. Studies have shown a strong linkage between zombie firms and state-owned enterprises and a

<sup>8</sup> See also Ahearne and Shinada (2005), Peek and Rosengren (2005), Hoshi (2006), and Fukuda and Nakamura (2011).



negative impact on aggregate productivity (Tan, Huang, and Woo 2016; Lam and others 2017; Chen and Shen 2017). These findings are consistent with the predictions that zombies crowd the market and that the congestion has real effects on healthy firms in the economy.

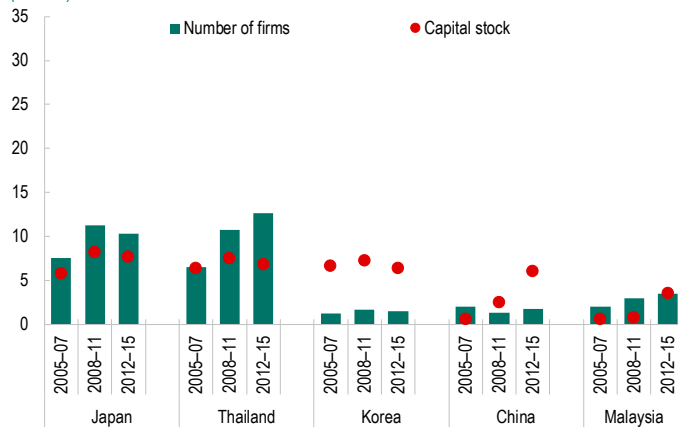
The baseline specification for the analysis follows the approach of the Organization for Economic Cooperation and Development (OECD), described in McGowan and others (2017). It defines the firm as a zombie in 2015 if it is 10 years old or older and has had an interest coverage ratio of less than one for three consecutive years (2013–15). The interest coverage ratio is defined as the ratio of earnings before interest and taxes (EBIT) to interest paid.

There has been an increase in both the prevalence of zombie firms and the capital resources sunk into them (Figure 8)<sup>9</sup>. The present analysis confirms the finding by Caballero, Hoshi, and Kashyap (2008) that there is still a zombie problem in Japan. Zombies constitute about 10 percent of firms and account for 8 percent of total capital stock. This number is on par with the levels McGowan and others (2017) find for Spain and Italy, although capital shares seem to be higher in Europe. The analysis also confirms the finding that corporate restructuring coupled with a more favorable macroeconomic environment in Japan have recently revived many of these firms (Fukuda and Nakamura 2011). Thailand seems to have a zombie problem of similar magnitude to Japan. In Korea, while the total number of zombie firms is small, the share of capital resources sunk into these firms is on par with Japan at about 7 percent. An increase is also seen in the share of zombies in China and Malaysia. In China, the zombie capital share recently reached 6 percent, on par with the levels of Japan, Korea, and Thailand. Should the zombie problem be left unaddressed, it could reach the scale of some southern European economies (Figure 8, Panel 2).

**Figure 8. Zombie Shares**

**1. Asia: Number and Share in Capital of Zombies**

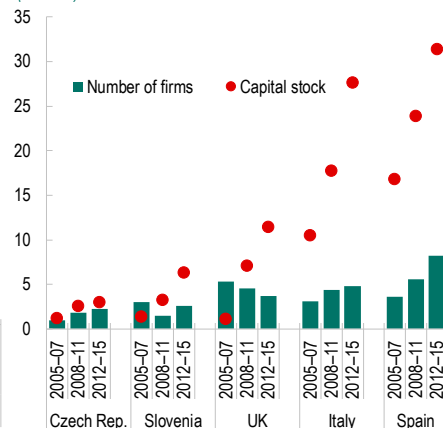
(Percent)



Sources: Orbis; and IMF staff calculations.

**2. Europe: Zombies Shares**

(Percent)



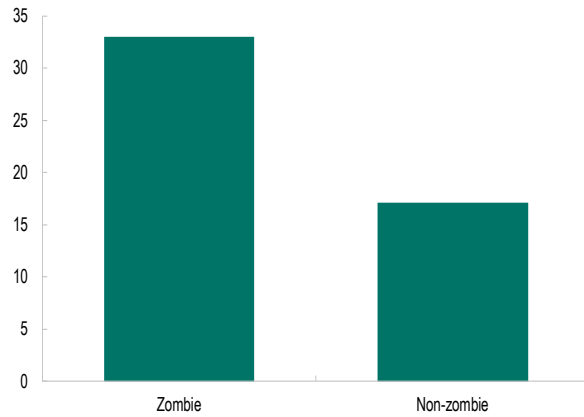
Zombie firms in Asia tend to be older, larger, more leveraged, and have less intangible investment (Figure 9). This could reflect older and larger firms receiving government subsidies (to limit the employment loss due to their closure) and benefiting from bank forbearance (to preserve relationship banking or to avoid recognizing losses on the bank balance sheet). The analysis also finds that zombies are predominant in

<sup>9</sup> Cross-country comparisons should be interpreted with care given idiosyncratic factors, including varying levels of corporate subsidies and other support.

traditional sectors, such as petroleum products, chemicals, printing and paper, textiles, basic metals, and (in the case of China) shipbuilding, rather than more knowledge-intensive sectors such as computers, electronics, and machinery (Figure 10). This could partially explain why less intangible investment is seen in zombie firms.

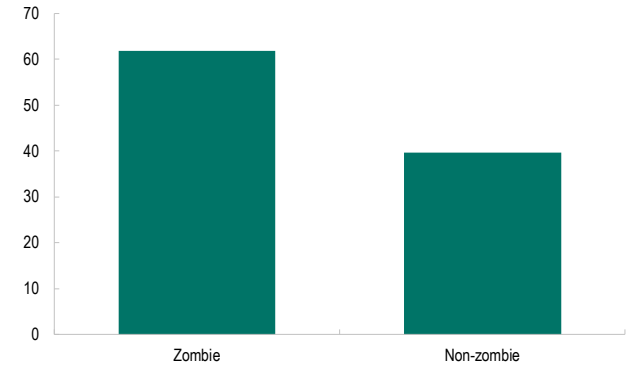
**Figure 9. Zombie Properties, 2014**

**1. Age**  
(Years)



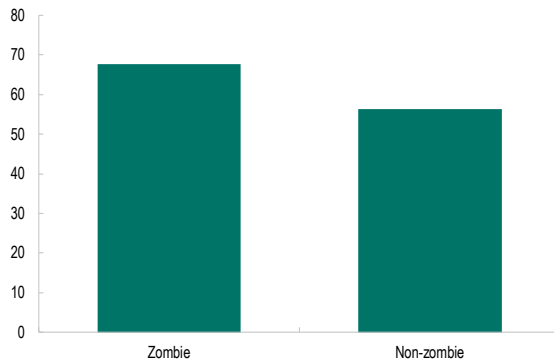
**2. Size**

(Total assets in millions of U.S. dollars)



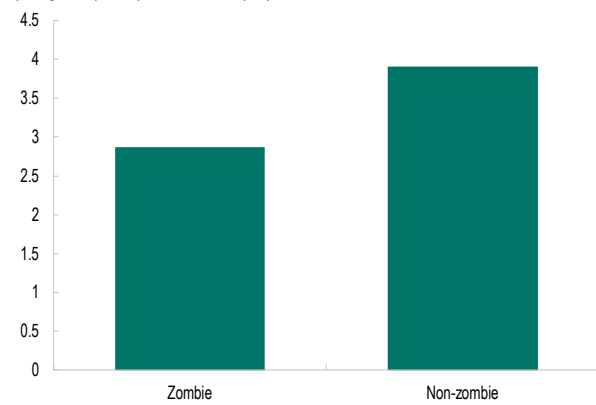
**3. Leverage**

(Total liabilities in percent of total assets)

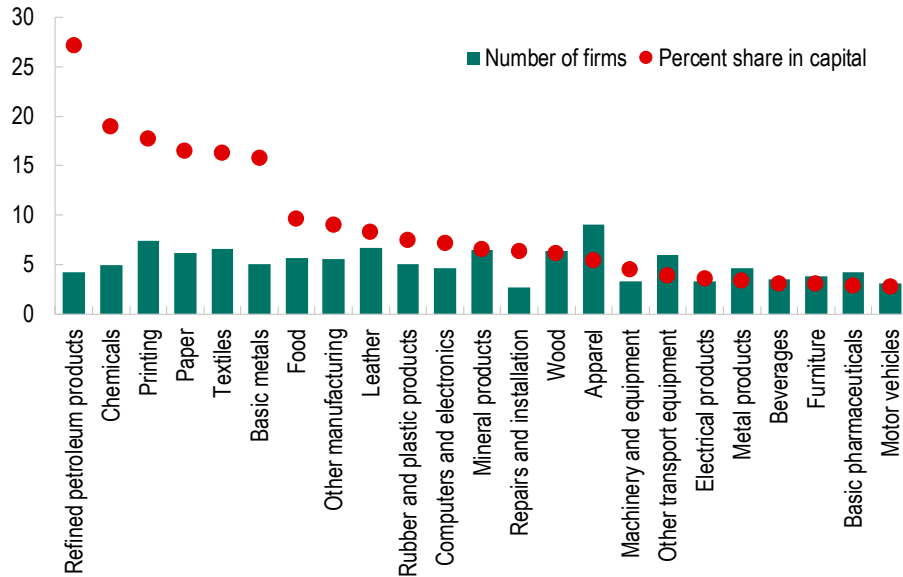


**4. Intangibility**

(Intangible capital in percent of total capital)



Sources: Orbis; and IMF staff estimates.

**Figure 10. Number and Share in Capital of Zombies, 2014**

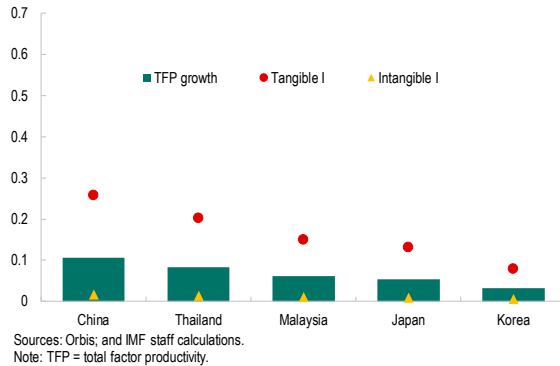
Sources: Orbis; and IMF staff calculations.

Controlling for firm leverage, size, age, and intangibility, the regression analysis indicates that productivity growth is 1.4 percentage points higher among non-zombies than among zombies. Hence, an increase in the share of zombie firms directly impacts aggregate productivity even if there were no negative spillovers to non-zombies (see Annex 5).

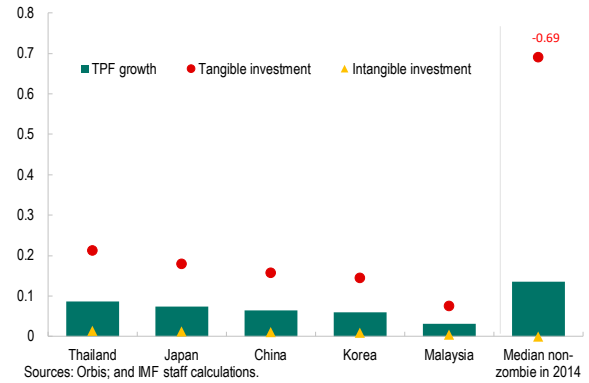
Moreover, a higher number of zombie firms and a larger share of capital sunk into zombie firms have negative effects on healthy firms' productivity and tangible and intangible investment. Based on these results, Figure 11 simulates how much more a typical non-zombie firm located in a representative four-digit industry<sup>10</sup> would have invested in tangible and intangible capital and increased its productivity growth if the share of zombie firms had stayed at its 2005 level. For example, if the zombie shares had stayed at their 2005 level, the increase in yearly growth of tangible investment in healthy firms by 2014 would have ranged from 0.07 percent in Korea (where the ratio of zombies has remained relatively stable) to 0.25 percentage points in China (where the increase in zombies has been the steepest). Productivity growth would have been up to 0.1 percent higher in 2014.

<sup>10</sup> The 2005 zombie shares in a representative industry are proxied by the country-level average in 2005.

**Figure 11. Counterfactual Loss for a Typical Non-Zombie Firm due to an Increase in the Zombie Share from 2005–14**  
(Percentage points)



**Figure 12. Potential Gains from Cutting the Share of Zombies by Half, 2014**  
(Percentage points)



Potential gains from addressing zombies could be large. Figure 12 illustrates the potential gains to investment and productivity from reducing the zombie capital share in a representative four-digit industry in 2014 by half.<sup>11</sup> If interpreted causally, these results suggest that cutting zombie shares by half could increase annual TFP growth by between 0.03 percent (in Malaysia) and 0.09 percent (in Thailand). Similarly, reducing zombie shares could increase growth in tangible investment between 0.08 and 0.21 percentage points per year. By comparison, a median non-zombie firm in 2014 had TFP growth of 0.14 percentage points, tangible investment growth of -0.69 percentage points, and intangible investment growth of zero percentage points. This means that the performance of a typical non-zombie firm would increase by between 20 to 60 percent in terms of TFP growth and 10 to 30 percent in terms of tangible investment growth.

The two scenarios above illustrate losses and gains in a representative industry for a typical non-zombie firm. Some industries with higher zombie shares would gain much more from the reduction in zombies. On the other hand, in industries with a lower zombie share, there would be less room for gains.

The analysis also finds evidence of resource misallocation. While in general more productive firms increase their tangible investment at a faster rate, a higher presence of zombies reduces their ability to do so (see Annex 5). Cutting zombie shares by half in each economy allows the difference in capital growth between high- and low-productivity firms to increase between 0.3 percentage points (for Malaysia) and 0.9 percentage points (for Thailand) (Figure 13).<sup>12</sup> Capital growth rates at the high-productivity firms would increase between 1.5 and 4 percentage points.

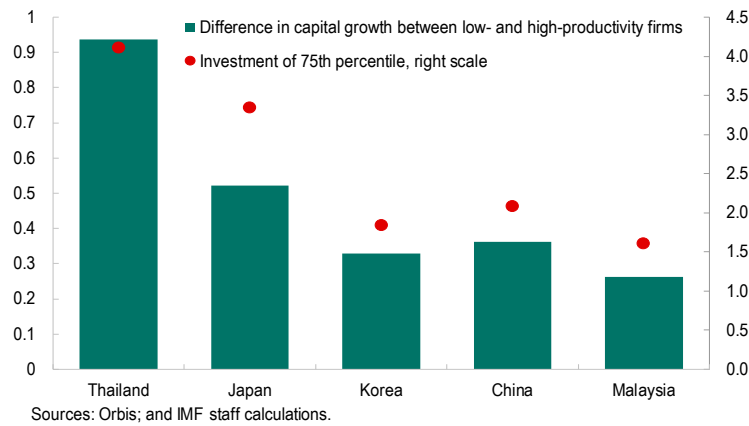
In summary, waning firm dynamism has been an important factor contributing to the productivity slowdown in Asia. The share of young firms (which are generally seen as more productive) has declined over the last decade and zombie firms have increased significantly in several economies, hampering efficient resource allocation. Going forward, addressing the root causes for this phenomenon should help

<sup>11</sup> The 2014 zombie shares in a representative industry are proxied by the country-level average in 2014.

<sup>12</sup> The simulations are done by comparing the capital accumulation rate of firms at the 75th percentile of the TFP level (representing high-productivity firms) and that of firms at the 25th percentile (representing low-productivity firms).

sustain the region's long-run economic growth. Other variables are also important in promoting productivity growth, including opening the economy to international trade and foreign investment, and facilitating intangible investment, including R&D, to promote TFP growth at the firm's intensive margin. The next section turns to macroeconomic trends or events that could have contributed significantly to the observed slowdown, including by diminishing firm dynamism.

**Figure 13. Impact on Capital Reallocation from Cutting the Zombie Share by Half in 2014**  
(Percentage points)



## Macroeconomic Events and Productivity Growth

This section examines the impact on productivity of two macroeconomic phenomena that have affected Asia and many other regions: (1) the shift of resources across sectors of the economy; and (2) the global financial crisis. The reallocation of labor in Asia from agriculture to manufacturing may have been a force stimulating strong business entry rates into the manufacturing sector, where average productivity was higher. The shift from agriculture to manufacturing has already plateaued in several Asian economies, and the current shift toward services may no longer be contributing as much to aggregate productivity growth. At the same time, the sectoral shift toward services, where productivity typically grows more slowly, may also help explain part of the productivity slowdown. The second macroeconomic event, the global financial crisis, may have affected productivity because global demand for Asian exports declined sharply and financial conditions tightened. Both channels may have contributed to a decline in firm dynamism and productivity growth in Asia.

### The Effect of Sectoral Shifts in Asia

Sectors can contribute to aggregate productivity growth in two ways: through increases in productivity within the sector (the *within effect*) or by reallocating inputs from less productive to more productive sectors (the *between effect*).<sup>13</sup> The latter measures the impact of the sectoral shift on productivity. This section follows Timmer and de Vries (2009) in performing this decomposition.<sup>14</sup> The shift-share analysis

<sup>13</sup> The sectoral analysis relies on labor productivity at the aggregate level. Labor productivity is positively correlated with TFP, but not directly comparable in either levels or growth rates. Due to data limitations on wage bills and numbers of employees, it is not possible to employ the firm-level analyses with labor productivity.

<sup>14</sup> Besides the within effect, the modified shift-share analysis (as introduced in Timmer and de Vries 2009) calculates the between effect (or structural change effect) by comparing labor productivity in sectors with expanding

compares results for the period prior to the global financial crisis (2003–08) and the period following the crisis (2011–16), focusing on the three broad sectors in an economy: agriculture, industry, and services. The main findings are as follows (Figure 14):

- Total labor productivity growth rates in Asia slowed after the global financial crisis for all but one (the Philippines) of the economies examined, as indicated by the total height of the columns in panel 1 of Figure 14.
- A significant part of the productivity growth slowdown in China between 2002–08 and 2011–16 reflected smaller gains from shifting resources from agriculture to manufacturing. This can be seen in the decline in the grey segment in panel 1 of Figure 14. This results from the fact that most of the shift in labor from agriculture now goes to services (red segments) instead of manufacturing (Figure 14, panel 2). The productivity gains from this sectoral shift seem much more limited, given lower labor productivity in that sector.
- In the other Asian economies<sup>15</sup>, the role of sectoral shifts as a source of productivity gains was much more limited. (Figure 14, panel 1). The slowdown in these economies reflected mainly a slowdown in manufacturing productivity. For example, in Korea and Malaysia, the contribution to productivity from within the manufacturing sector declined by more than 1.3 percentage points between 2003–08 and 2011–15, while the contribution from between-sector shifts remained almost null.

Hence, the sectoral shift did not contribute significantly to the productivity slowdown in the economies examined except for China because the structural transformation had already occurred in these economies. The within-sector slowdown, however, does point to the possible role of TFP drivers at the firm and sectoral levels.

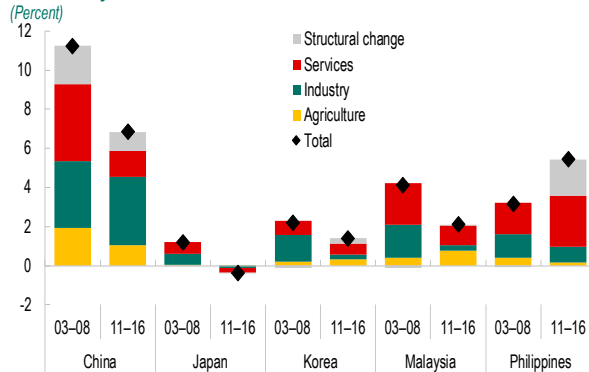
---

employment relative to average labor productivity in shrinking sectors. Thus, the between effect is more positive for sectors with relatively higher labor productivity than for shrinking sectors, and more negative for those expanding sectors with relatively lower labor productivity.

<sup>15</sup> Due to a structural break in the data, the analysis was not conducted for Thailand.

**Figure 14. Sectoral Shifts in Asia**

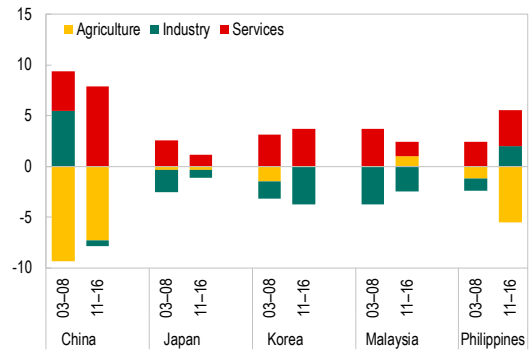
**1. Contribution from within Sector Productivity Growth and Structural Change (Reallocation of Labor across Sectors) to Aggregate Labor Productivity**



Sources: Groningen Growth and Development Centre; Organization for Economic Cooperation and Development; CEIC; and IMF staff calculations.

**2. Change in Employment Shares by Sector**

(Change in share in percent, over time period)



## What Was the Impact of the Global Financial Crisis?

This section examines the role of the global financial crisis in reducing TFP growth at the firm level through two possible channels: weaker global demand and a tightening of financial constraints. The role of weaker global demand is tested by examining whether firms that depend more on exports saw a sharper slowdown in TFP than others. The role of tightening financial constraints is tested by examining whether firms that were more leveraged before the crisis experienced a sharper slowdown. The methodology consists of a difference-in-differences approach similar to the one used by Duval, Hong, and Timmer (2017) to assess the impact of financial constraints on advanced economies during the global financial crisis (see Annex 6 for more details).

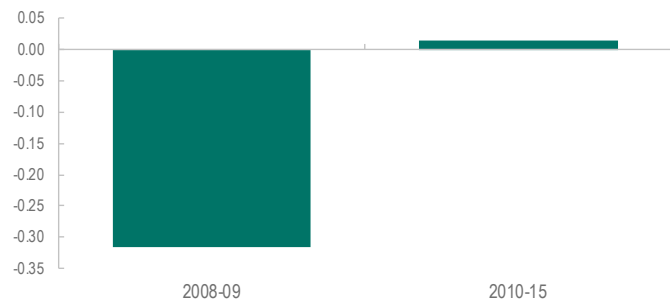
### Role of Weak Global Demand in the Productivity Slowdown

Firms in export sectors are typically seen to be more productive than other firms, at least during normal times (De Loecker 2013). The breakdown in global demand observed during the global financial crisis, however, likely had a stronger effect on firms that relied more closely on trade for their business. One possible explanation is that firms were unable to shed labor and decommission capital as quickly as demand contracted, and thus their output fell more than their inputs did. This section measures the change in the TFP growth rate from before the global financial crisis (2003–07) to the crisis and postcrisis period (2008–15) for each firm. It then relates this change in growth rates to the precrisis trade intensity of each firm's sector.<sup>16</sup> Controls for the precrisis levels of firms' TFP, age, size, leverage, and stock of intangible capital are included. The methodology also includes country-sector fixed effects to account for the possibility that the TFP slowdown may be explained by elements that are sector- and country-specific.

<sup>16</sup> A sector's trade intensity is measured as the ratio of total exports to gross output at the sector level. World Input-Output Tables are used to calculate the ratio of exports to gross output at the two-digit sectoral level.

The econometric results point to a larger slowdown during the global financial crisis years (2008–09) among firms that were more open to trade than among firms that were less open. Firms in sectors where 14.3 percent of gross output was exported experienced a greater slowdown (by 0.3 percentage points) than firms in sectors where virtually none of the output was exported before the crisis (Figure 15). In the post crisis period (2010–15), however, the average productivity slowdown was not significantly different for firms in closed than in open sectors, an indication that the impact of the crisis on productivity through weaker global demand was not persistent.

**Figure 15. Impact of Average Trade Openness on Post-GFC TFP Growth**  
(Percentage points)



Source: IMF staff calculations.

Note: GFC: global financial crisis; TFP: total factor productivity.

The fact that firms in more open sectors had a sharper slowdown (decline in TFP growth rate) during the crisis is not inconsistent with the previous section's result that firms in more open sectors have higher productivity growth. First, the sharper slowdown is limited to 2008–09 and does not persist beyond the crisis. Second, despite the sharper slowdown, firms in more open sectors could have started off with TFP growth that was high enough that the slowdown still left them with higher TFP growth rates than their peers in closed sectors.

### Role of Financial Constraints

The empirical literature has documented that high corporate leverage (as a proxy for preexisting balance sheet weakness) dampened TFP growth and investment in tangible and intangible capital in advanced economies following the global financial crisis (Duval, Hong, and Timmer 2017; Kalemli-Ozcan, Laeven, and Moreno 2018). Applying the same methodology as described above to leverage, this section relates the productivity growth slowdown of each firm during and after the global financial crisis to the firm's precrisis leverage ratio (defined as total liabilities/total assets). Controls for the precrisis level of a firm's TFP, age, size, and stock of intangible capital are included in the regression analysis. As above, country-sector fixed effects are included.

The econometric results indicate that firms with higher precrisis leverage experienced a stronger TFP slowdown during the global financial crisis. The estimates imply that a firm with a leverage ratio equal to the average level observed in 2007 (61 percent) would experience a TFP slowdown 0.4 percentage points larger than firms with no leverage. Moreover, the impact of leverage on the TFP growth slowdown persisted well beyond the crisis years, during 2010–15, with an impact close to 0.5 percentage points for firms at 57 percent leverage (Figure 16).

**Figure 16. Impact of Precrisis Leverage on Post-GFC TFP Growth**  
(Percentage points)



Source: IMF staff calculations.

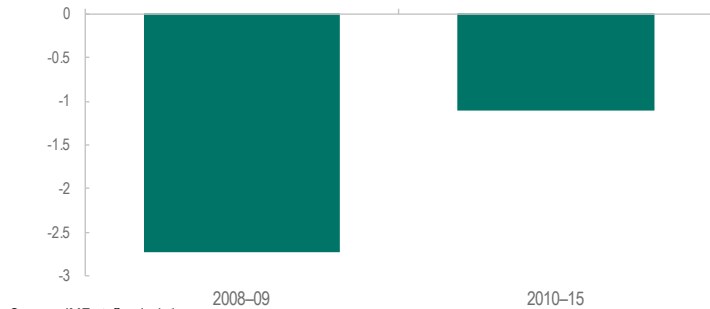
Note: GFC: global financial crisis; TFP: total factor productivity.



Through what channel does leverage impact productivity? One possible channel is by limiting access to funding for investment during the crisis period. As shown in the previous section, investment in intangible assets (which includes R&D) is one important driver of productivity. Similarly, tangible investment can contribute to TFP growth to the extent that it incorporates new and better technology.

The analysis finds that precrisis leverage has a statistically significant and negative impact on tangible investment growth during the crisis years (2008–09) and some of this impact persists through 2010–15. Specifically, firms with leverage at the 2007 average experienced a slowdown in tangible investment 2.5 percentage points larger than firms with no leverage (Figure 17). Precrisis leverage also has a negative and statistically significant impact on the growth rate of intangible investment during 2008–09, but the impact is not statistically significant thereafter. The temporary reduction in intangible investment, however, has a persistent impact on the stock of intangible assets, thereby also contributing to the persistent impact on productivity growth.

**Figure 17. Impact of Precrisis Leverage on Post-GFC Tangible Investment (Percentage points)**

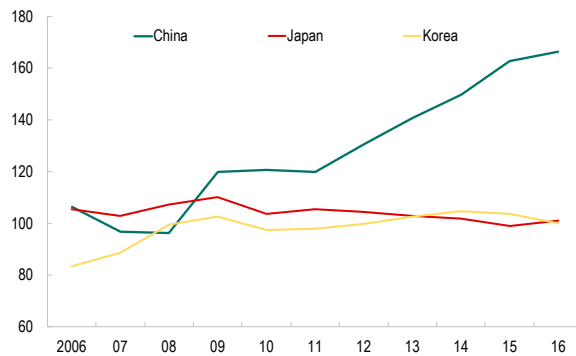


Source: IMF staff calculations.  
Note: GFC: global financial crisis; TFP: total factor productivity.

In summary, Asian firms that went into the global financial crisis with a weaker balance sheet (as measured by leverage) saw their productivity growth and investment slow significantly more than firms with stronger balance sheets. The long period of loose monetary policy and easy international credit conditions that followed led to an increase in corporate debt in many Asian economies (Figure 18). If this increased debt is left unaddressed, it poses a significant risk to productivity growth when financial conditions tighten. It will be important to address high leverage to improve TFP growth and reduce vulnerabilities to future episodes of financial tightening.

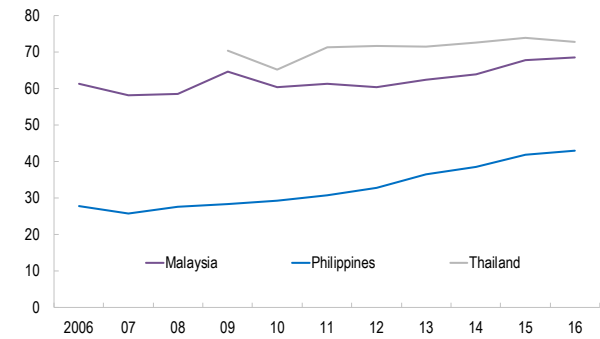
**Figure 18. Corporate Leverage in Asia**

**1. Corporate Debt: China, Japan, and Korea (In percent of GDP)**



Sources: Bank of International Settlements; Dealogic; and IMF staff calculations.

**2. Corporate Debt: Malaysia, the Philippines, and Thailand (In percent of GDP)**



## Conclusions and Policy Implications

This paper set out to uncover the main drivers of the productivity growth slowdown in Asia at the firm level. It first showed that the slowdown has been driven in part by a decline in firm dynamism. The share of young firms has fallen, while that of zombie firms has risen. This contributed to the slowdown because young firms are more productive, while zombie firms not only have lower productivity growth, but also hamper the efficient allocation of resources towards more productive firms. Second, Asia, like other regions, was hit hard by the global financial crisis, which particularly affected highly leveraged firms and intangible investment. This partly contributed to a zombie problem, worsening exit and hindering entry. Finally, the paper has established that higher productivity growth at the firm level is associated with investing more in intangible assets (for example, by conducting more R&D), belonging to exporting sectors, or being foreign-owned.

Given these findings, there are three broad and interrelated areas on which Asian policymakers could focus to lift productivity growth going forward: (1) foster firm dynamism by facilitating entry and exit; (2) address debt overhang; and (3) foster innovation and trade openness.

Policies to promote entry could include lifting barriers to competition in goods markets and promoting labor market flexibility to facilitate the reallocation of resources. Arnold and others (2014) show a positive downstream effect on the manufacturing sector from service sector reform, while Lanau and Topalova (2016) find that industry outcomes improve after the removal of competition barriers, which have additional positive effects on downstream sectors. Dougherty, Frisanchio, and Krishna (2013) show that firms in labor-intensive industries increased productivity after labor market reforms in their states. According to the OECD, several Asian economies have high product market regulation (Figure 19).

Exit policies and excessive leverage are closely intertwined. They include improving foreclosure and insolvency frameworks (Andrews, McGowan, and Millot 2017), facilitating judicious debt resolution and corporate restructuring plans, limiting bank forbearance, and resolving nonperforming loans. Policy initiatives that support small and medium businesses (SMEs) could be preventing companies from exiting. Japan, Korea, and Thailand appear to have some of the largest amount of SME credit guarantees (Figure 20). Well-targeted tax policies could allow for shifting the capital structure from debt to equity, reducing leverage, and boosting firm investment in both tangible and intangible capital.<sup>18</sup> Adopting adequate institutional frameworks and implementing appropriate micro and macroprudential policies should help avoid the excessive buildup of leverage in the future.

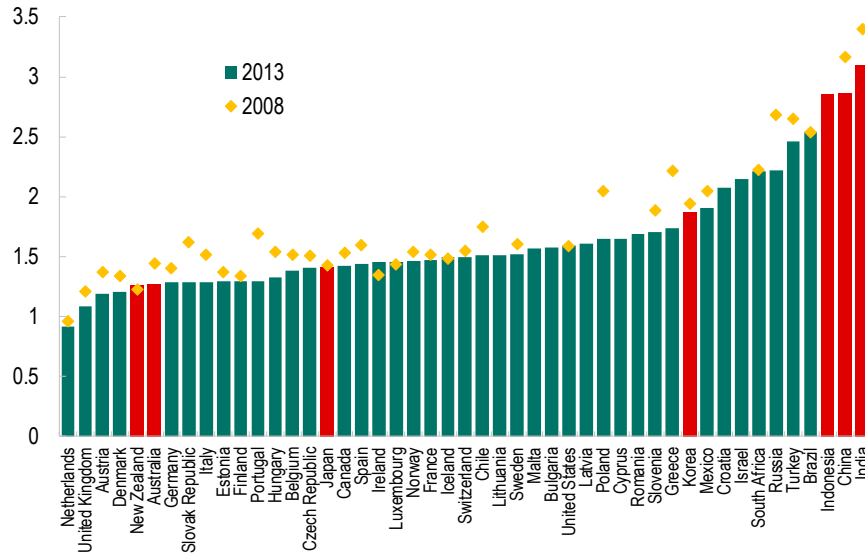
Finally, encouraging innovation and opening to foreign competition could support dynamism and lift productivity. Fiscal incentives for some form of intangible investment are already in place in some parts of Asia, but their scope could be broadened. Other policies include intellectual property regimes with protection sufficient to promote innovation (while avoiding undue limitations on competition), and competition in research grants. Direct subsidies for intangible investment should be assessed carefully. As shown by Acemoglu and others (2017), R&D subsidies to the incumbents encourage the survival and expansion of low-productivity firms and discourage exit. Economies could also continue to open economies to international trade and foreign investment, as integration with international markets stimulates competition, knowledge transfer, and higher productivity growth.

---

<sup>18</sup> Recent papers support the role of well-targeted tax policies in stimulating intangible capital deepening, including R&D spending (Rao 2016). Chapter 2 of the April 2017 *Fiscal Monitor* highlights that reducing tax discrimination by capital asset types and financing can help tilt firms' decisions toward investments that are more productive and help address the resource misallocation challenge and boost TFP growth.

**Figure 19. Overall Product Market Regulation**

(Index scale from 0 to 6 from least to most restrictive)

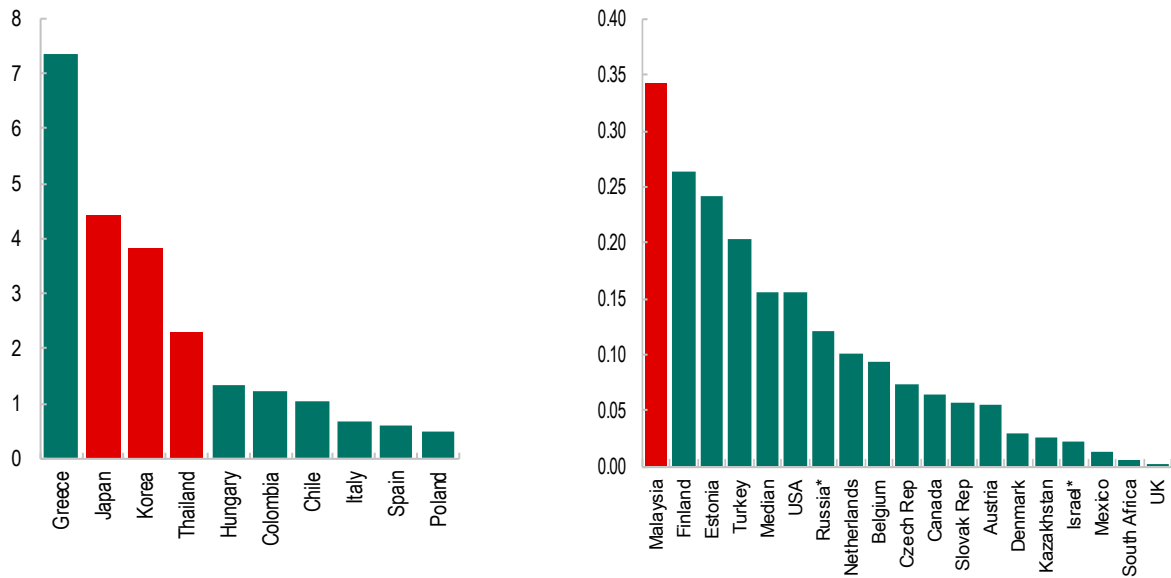


Sources: OECD Product Market Regulation Database; and Koske and others (2015).

Note: The OECD Indicators of Product Market Regulation are a comprehensive and internationally comparable set of indicators that measure the degree to which policies promote or inhibit competition. They are based on (1) state control (public ownership and involvement in business operations); (2) barriers to entrepreneurship (complexity of regulatory procedure, administrative burdens on start-ups, regulatory protection of incumbents); and (3) barriers to trade and investment.

**Figure 20. Government Loan Guarantees to Small and Medium Enterprises**

(Percent of GDP)



Source: OECD (2018) "Financing SMEs and Entrepreneurs 2018: An OECD Scoreboard."

Note: The median value refers to all depicted countries in both graphs.

\*Data for 2015 were used because 2016 data were not available.

## Annexes: Research, Database, and Econometric Methodology

### Annex 1. Theoretical Framework for Firm Dynamism

In the spirit of the Schumpeterian endogenous growth model, Hopenhayn (1992) proposed the theoretical underpinnings of how firm creation and destruction are related to aggregate productivity. In his model, firms face idiosyncratic productivity shocks as a source of uncertainty. The process for firm-specific shocks, the cost of entry, and production technology determine the equilibrium distribution and the entry/exit rate. One important implication of the model is that the high cost of entry would yield a lower degree of dynamism by discouraging entry and exit of firms. The higher cost of entry reduces the rate of entry of new firms and protects incumbents (especially large firms, but not necessarily more productive firms). As these forces reduce competitive pressures on incumbents, this in turn dampens innovation. Thus, overall productivity would be affected negatively.

More formally, assume a production technology for a firm  $n$  is given by  $y_n = a_n k$ , where  $y$  is a firm's output,  $a$  is productivity, and  $k$  is capital. Suppose that entry is costly. A new entrant  $e$  needs to pay an additional cost  $E$  per unit of capital that it will rent. As a result, profit of a potential entrant becomes  $\pi_e = a_e k - rk - Ek$  if it enters the industry, where  $r$  is the rental rate of capital. Based on its optimal entry-exit decision, a potential new entrant will start operating, as long as  $a_e > r + E$ . Thus, entry cost would create a wedge between the lower limit of productivity to enter and the rental rate of capital. Similarly, suppose that exit is costly. An incumbent needs to pay a cost  $X$  per unit of capital that it rented to exit. As a result, the profit of an incumbent is given by  $\pi_i^o = a_i k - rk$ , if it continues to operate, and becomes  $\pi_i^x = -Xk$ , if it exits. Hence, an incumbent will continue to operate, as long as  $a_i > r - X$ . In sum, if entry and exit are costly, there are potential entrants with productivity higher than the rental rate  $a_e > r$ , but that cannot enter due to barriers to entry. The combination of these two forces will give rise to zombie congestion and thus lower economy-wide aggregate productivity.

### Annex 2. Details on the Firm-Level Dataset

Firm-level data are constructed using Orbis, a cross-country longitudinal dataset of mostly unlisted firms (around 99 percent of the sample) provided by Bureau van Dijk. The dataset has rich information on firms' production activities and financial variables based on balance sheets and income statements. The analysis also uses the Orbis ownership database.

#### Sample Selection: Economies and Years

Although Orbis has data for other Asian economies, the focus in this paper on TFP restricts the sample to six Asian economies (China, Japan, Korea, Malaysia, the Philippines, and Thailand) for which enough data, including data on TFP growth, are available.

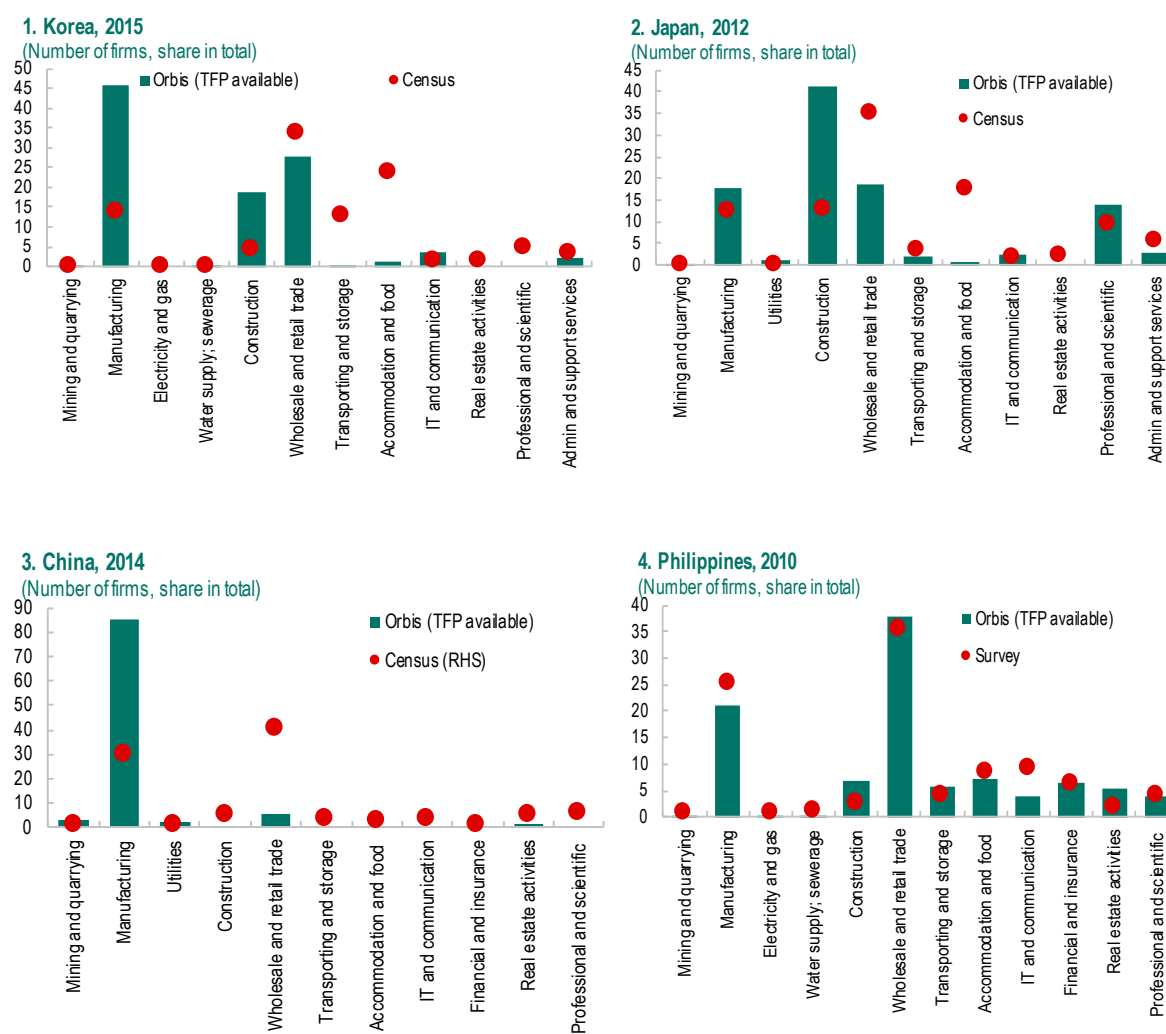
In terms of the time span, the analysis uses 2003–15 due to data limitations. In years earlier than 2003 and later than 2015, most economies do not have a good amount of observations. The analysis uses firms in the nonfarm, nonfinancial business sector, which corresponds to the two-digit industry codes 5-82 in NACE Revision 2, which includes both manufacturing and a number of service sectors (for example, real estate and profession/scientific/technical activities) following Duval, Hong, and Timmer (2017).

## Data Cleaning

There are two main steps to clean up the Orbis dataset: (1) cleaning of reporting mistakes; and (2) quality checks on consistency. Cleaning of reporting mistakes is mainly related to eliminating observations with negative real variables (for example, negative total assets). Quality check is about ensuring the consistency of balance sheet variables. Diez, Fan, and Villegas-Sanchez (forthcoming) provide a detailed description of the dataset and the cleaning process, mainly following the procedure proposed by Gal (2013), Kalemli-Özcan and others (2015) and Gopinath and others (2017).

Figure A2.1 compares the Orbis database with census data in terms of the distribution of firms across sectors. As shown, manufacturing, wholesale, and construction seem fairly well represented in the sample, at least in terms of the share of firms being close to that in census data.

**Figure A 2.1. Orbis Sample Broadly Comparable to the Distribution of Firms across Sectors in the Economy (Percent)**



Sources: Orbis; and IMF staff calculations

Note: TFP: total factor productivity.

### Annex 3. Baseline Panel Regression

The baseline setup is a panel regression that captures the relationship between firm-level characteristics (Table A3.1) and TFP growth as follows:

$$\Delta TFP_{icst} = \beta x_{icst} + \gamma_i + \delta_{cst} + \varepsilon_{icst}, \quad (\text{A3.1})$$

where  $c$ ,  $s$ , and  $t$  stand for country, sector, and year, respectively. The dependent variable  $\Delta TFP_{icst}$  is the annual growth in TFP for firm  $i$ . The vector  $x_{icst}$  includes variables of interest, namely firm-level variables such as the intangibility of a firm's fixed assets and a logarithm of age, as well as firm-level control variables such as logarithm of total assets, lagged TFP level, and leverage ratio (both the linear term and the square of it).

<b>Table A3.1</b>	
<b>Firm level Variables</b>	
<b>Variable</b>	<b>Definition</b>
TFP	Estimated based on the method proposed by Gandhi, Navarro, and Rivers (2017)
Age	The current year minus the date of incorporation plus 1. We use logarithm of this value
Interest coverage ratio (ICR)	The ratio of EBIT (earnings before interest and tax) to interest paid
Leverage	The ratio of total liabilities to total assets
Intangibility	The ratio of intangible fixed assets to total fixed assets
Size	Total assets (in US dollars). We use logarithm of this value
Intangible investment	The net change in intangible fixed assets normalized by lagged total assets
Tangible investment	The net change in tangible fixed assets normalized by lagged total assets
Foreign ownership	A dummy variable indicating that more than 50 percent of a firm is owned by foreigners

Source: Orbis; and IMF staff calculations  
Note: TFP: total factor productivity.

Firm fixed effects  $\gamma_i$  are included to control for the impact of firm-level, time-invariant, and unobservable characteristics on TFP growth. Standard errors are clustered at the firm level. Further, country-sector-year fixed effects,  $\delta_{cst}$ , are also included. A sector means a four-digit NACE (Revision 2) industry in this analysis, which allows for controlling for shocks within narrowly defined industries. Hence, the specification controls for any shocks or policy changes that are common across firms at the country-sector-year level. These sets of fixed effects serve the goal to isolate the impact of firm-level, time-varying characteristics on firm TFP growth. Although it is hard to interpret the results causally, the extensive set of fixed effects allows for eliminating omitted variable bias to a large extent. The regression results are provided in Table A3.2.

Once the impact of time-variant firm-level characteristics on TFP growth is explored, we modify equation (A3.1) to answer two separate questions. The first is whether foreign-owned firms have higher growth in TFP than domestically owned firms. For this purpose, a dummy variable is added that indicates whether a firm is foreign-owned.<sup>18</sup> The results are shown in Annex Table 3.3. The second question explores whether firms in more trade-oriented sectors are experiencing higher TFP growth (Alcalá and Ciccone 2004). For purposes here, we add a proxy for sector-level trade openness, measured as the ratio of export to gross output for each country-sector. We use the time-period lagged value of this variable to

<sup>18</sup> Since this variable is not time-variant, we drop firm fixed effects in this set of analysis.

alleviate concerns regarding endogeneity in general.<sup>19</sup> The regression results are provided in Table A3.4 and the magnitude of these impacts is illustrated in Figure A3.1.

Given that around half of the firm-year observations report intangibility as zero, we employ an alternative analysis for intangibility by focusing only on the firms that always have a reasonable amount of intangibles over the sample period. We run our baseline regression by eliminating firms that have (1) less than 1 percent intangibility; and (2) less than 10 percent intangibility at any point over the period. The analysis finds that the impact is highly significant in both cases, with larger coefficient estimates compared to the baseline result (Table A3.5), and that the contributions to productivity growth are much larger (Figure A3.1).

---

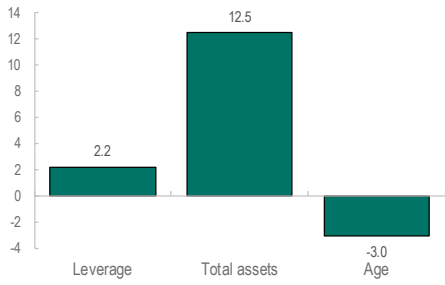
<sup>19</sup> Since Orbis does not have data on firm-level exports for our sample, we do this analysis using a measure of trade openness at the sector level. We measure trade openness in each country-two-digit sector due to data availability. Note that we drop country-sector-year fixed effects in this specification. Instead, country-sector, country-year, and sector-year fixed effects are used separately.

Table A3.2	Table A3.3																																					
<p><b>Panel A: Firm-level drivers of TFP</b></p> <table border="1"> <thead> <tr> <th>Variable</th> <th>TFP growth</th> </tr> </thead> <tbody> <tr> <td>TFP<sub>t-1</sub></td> <td>-0.621*** (0.003)</td> </tr> <tr> <td>Leverage<sub>t-1</sub></td> <td>0.062*** (0.003)</td> </tr> <tr> <td>Leverage<sup>2</sup><sub>t-1</sub></td> <td>-0.007** (0.003)</td> </tr> <tr> <td>Intangibility<sub>t-1</sub></td> <td>0.015*** (0.003)</td> </tr> <tr> <td>Total assets</td> <td>0.060*** (0.001)</td> </tr> <tr> <td>Age</td> <td>-0.023*** (0.001)</td> </tr> <tr> <td>Country-Industry-Year F.E.</td> <td>Yes</td> </tr> <tr> <td>Firm F.E.</td> <td>Yes</td> </tr> <tr> <td>Observations</td> <td>3 291 433</td> </tr> <tr> <td>R square</td> <td>0.452</td> </tr> </tbody> </table> <p>***, **, and * indicate 1, 5, and 10 percent</p>	Variable	TFP growth	TFP <sub>t-1</sub>	-0.621*** (0.003)	Leverage <sub>t-1</sub>	0.062*** (0.003)	Leverage <sup>2</sup> <sub>t-1</sub>	-0.007** (0.003)	Intangibility <sub>t-1</sub>	0.015*** (0.003)	Total assets	0.060*** (0.001)	Age	-0.023*** (0.001)	Country-Industry-Year F.E.	Yes	Firm F.E.	Yes	Observations	3 291 433	R square	0.452	<p><b>Panel B: Foreign ownership and TFP</b></p> <table border="1"> <thead> <tr> <th>Variable</th> <th>TFP growth</th> </tr> </thead> <tbody> <tr> <td>Foreign</td> <td>0.005*** (0.001)</td> </tr> <tr> <td>Country-Industry-Year F.E.</td> <td>Yes</td> </tr> <tr> <td>Firm controls</td> <td>Yes</td> </tr> <tr> <td>Observations</td> <td>488 744</td> </tr> <tr> <td>R square</td> <td>0.105</td> </tr> </tbody> </table> <p>***, **, and * indicate 1, 5, and 10 percent</p>		Variable	TFP growth	Foreign	0.005*** (0.001)	Country-Industry-Year F.E.	Yes	Firm controls	Yes	Observations	488 744	R square	0.105		
Variable	TFP growth																																					
TFP <sub>t-1</sub>	-0.621*** (0.003)																																					
Leverage <sub>t-1</sub>	0.062*** (0.003)																																					
Leverage <sup>2</sup> <sub>t-1</sub>	-0.007** (0.003)																																					
Intangibility <sub>t-1</sub>	0.015*** (0.003)																																					
Total assets	0.060*** (0.001)																																					
Age	-0.023*** (0.001)																																					
Country-Industry-Year F.E.	Yes																																					
Firm F.E.	Yes																																					
Observations	3 291 433																																					
R square	0.452																																					
Variable	TFP growth																																					
Foreign	0.005*** (0.001)																																					
Country-Industry-Year F.E.	Yes																																					
Firm controls	Yes																																					
Observations	488 744																																					
R square	0.105																																					
<p>Source: Orbis; and IMF staff calculations Note: F.E.: fixed effects TFP: total factor productivity.</p>	<p>Source: Orbis; and IMF staff calculations Note: F.E.: fixed effects TFP: total factor productivity.</p>																																					
Table A3.4	Table A3.5																																					
<p><b>Panel C: Trade intensity and TFP</b></p> <table border="1"> <thead> <tr> <th>Variable</th> <th>TFP growth</th> </tr> </thead> <tbody> <tr> <td>Trade intensity<sub>t-1</sub></td> <td>0.033*** (0.005)</td> </tr> <tr> <td>Country- Year F.E.</td> <td>Yes</td> </tr> <tr> <td>Country- Industry F.E.</td> <td>Yes</td> </tr> <tr> <td>Industry- Year F.E.</td> <td>Yes</td> </tr> <tr> <td>Firm controls</td> <td>Yes</td> </tr> <tr> <td>Firm F.E.</td> <td>Yes</td> </tr> <tr> <td>Observations</td> <td>2 704 922</td> </tr> <tr> <td>R square</td> <td>0.473</td> </tr> </tbody> </table> <p>***, **, and * indicate 1, 5, and 10 percent</p>	Variable	TFP growth	Trade intensity <sub>t-1</sub>	0.033*** (0.005)	Country- Year F.E.	Yes	Country- Industry F.E.	Yes	Industry- Year F.E.	Yes	Firm controls	Yes	Firm F.E.	Yes	Observations	2 704 922	R square	0.473	<table border="1"> <thead> <tr> <th>Variable</th> <th>Min(Intangibility) &gt; 1 percent</th> <th>Min(Intangibility) &gt; 10 percent</th> </tr> </thead> <tbody> <tr> <td>Intangibility<sub>t-1</sub></td> <td>0.042*** (0.007)</td> <td>0.077*** (0.016)</td> </tr> <tr> <td>Country-Industry-Year F.E.</td> <td>Yes</td> <td>Yes</td> </tr> <tr> <td>Firm F.E.</td> <td>Yes</td> <td>Yes</td> </tr> <tr> <td>Observations</td> <td>318 223</td> <td>48 044</td> </tr> <tr> <td>R square</td> <td>0.485</td> <td>0.304</td> </tr> </tbody> </table> <p>***, **, and * indicate 1, 5, and 10 percent</p>		Variable	Min(Intangibility) > 1 percent	Min(Intangibility) > 10 percent	Intangibility <sub>t-1</sub>	0.042*** (0.007)	0.077*** (0.016)	Country-Industry-Year F.E.	Yes	Yes	Firm F.E.	Yes	Yes	Observations	318 223	48 044	R square	0.485	0.304
Variable	TFP growth																																					
Trade intensity <sub>t-1</sub>	0.033*** (0.005)																																					
Country- Year F.E.	Yes																																					
Country- Industry F.E.	Yes																																					
Industry- Year F.E.	Yes																																					
Firm controls	Yes																																					
Firm F.E.	Yes																																					
Observations	2 704 922																																					
R square	0.473																																					
Variable	Min(Intangibility) > 1 percent	Min(Intangibility) > 10 percent																																				
Intangibility <sub>t-1</sub>	0.042*** (0.007)	0.077*** (0.016)																																				
Country-Industry-Year F.E.	Yes	Yes																																				
Firm F.E.	Yes	Yes																																				
Observations	318 223	48 044																																				
R square	0.485	0.304																																				
<p>Source: Orbis; and IMF staff calculations Note: F.E.: fixed effects TFP: total factor productivity.</p>	<p>Source: Orbis; and IMF staff calculations Note: F.E.: fixed effects</p>																																					



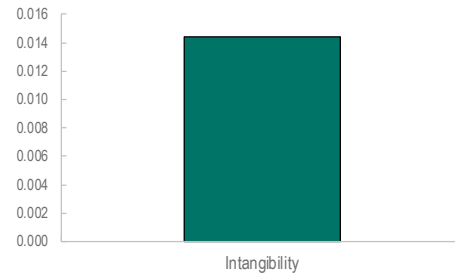
Figure A3.1.

### 1. Impact on TFP Growth from Interquartile Increase in RHS Variables (In percent)



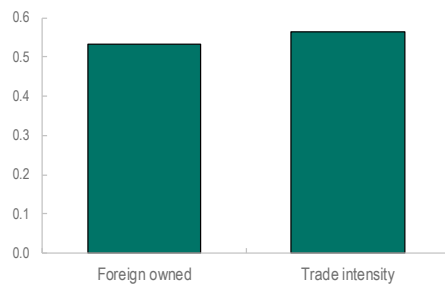
Note: Interquartile variation in leverage is from 40 to 77 percent, in total assets and in age is from 8 to 32 years. TFP: total factor productivity.

### 2. Impact on TFP Growth from Interquartile Increase in Intangibility (In percent)



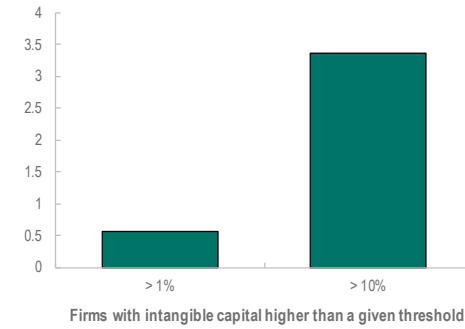
Note: Interquartile variation in intangibility is 1 percentage point increase. TFP: total factor productivity.

### 3. Impact on TFP Growth from Foreign Ownership and Trade Intensity (In percent)



Note: Assumes variation in trade intensity from the 25th (0.2 percent) to the 75th percentile (17 percent). TFP: total factor productivity.

### 4. Impact of Intangible Investment for a Mean Firm (In percent)



Note: Coefficient in >1% and >10% sample times the mean level of intangibles: 13.1 percent in the >1% sample and 43.6 percent in the >10% sample. TFP: total factor productivity.

Source: IMF staff calculations.

## Annex 4. Cross-Country Comparison of Firm-Level Productivity Drivers

This section studies productivity drivers in each economy by comparing the contributions of each factor across economies over time. To analyze time series variation of each productivity enabler, a country-specific balanced panel dataset is constructed from the Orbis database. The results of regressions using each set of country data are shown in Table A4.1, which reveals three interesting results.

First, the coefficient on the linear leverage term is positive and the one on quadratic leverage term is negative for all economies. This result is consistent with the theory that net benefits to leverage rise for firms with low leverage but decrease as leverage becomes high. Interestingly, the linear term is statistically significant at the 1 percent level for all Asian economies, while the statistical significance of the quadratic term differs across economies. For highly leveraged economies such as Japan, Korea, and China, the quadratic term is statistically significant at the 1 percent level, whereas the significance level is low for Thailand and Malaysia. This can be explained by the fact that for the economies with high corporate leverage, there is enough sample variation in the leverage variable, which allows for estimating the statistically significant nonlinear relationship between productivity and leverage. Furthermore, the contribution of leverage to productivity growth is calculated as the estimated coefficient on leverage multiplied by the mean value of leverage in each economy, and it is compared across economies (Figure A4.1, panel 1). It can be seen that the magnitude of the leverage effect on productivity growth is different across economies. For example, the impact is larger for Malaysia and Philippines, in line with economies outside Asia, but is very small for China.

Second, in most economies, the negative coefficient on age variable in Table A4.1 indicates that younger firms tend to have higher productivity growth. However, China is exceptional (Figure A4.1, panel 3). Namely, the sign of the estimated coefficient is opposite from other economies, implying that younger firms show lower productivity growth. This may be attributed to the fact that, in China, there are lots of firms that enter the market but exit quickly because they do not necessarily succeed in business. This result points to the importance of looking at the economy-specific circumstances when deriving policy implications.

Third, the effects of intangible assets on productivity are heterogeneous across economies. In the sample of six Asian economies, only Japan and Korea show a positive and statistically significant impact of intangible capital, although the impact is smaller for Korea (Table A4.1). This may reflect the fact that Korea invested a lot in R&D and became one of the economies with the highest R&D share in GDP but did not necessarily become the top runner of productivity growth. Another interesting finding is that the impact of intangibility on productivity is different across regions (Figure A4.1, panel 2). For instance, some European economies such as Germany, Italy, and Hungary show a larger positive impact of intangible capital than Asian economies. Note that our (unreported) regressions based on the subsample period show that the impact of intangible assets on productivity has become more prominent recently in Japan and Korea.

As for other variables, estimated coefficients are statistically significant at the 5 percent level with expected signs. Negative coefficients on lagged productivity level confirm the productivity convergence story, and positive coefficients on firm size indicate that larger firms have higher productivity growth. In terms of contribution to productivity growth, panel 4 of Figure A4.1 shows that the size of a firm is very important for Malaysian companies. Another finding is that each factor's contribution to productivity growth does not change a lot over time within firms.

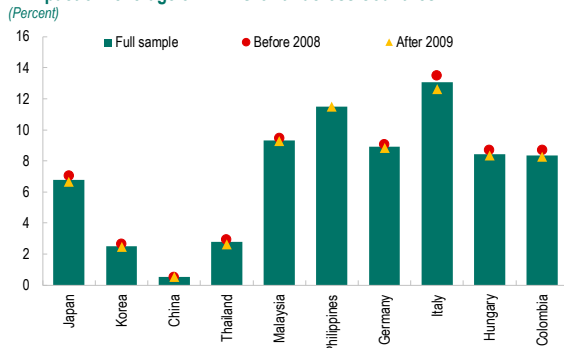
Country	Japan	Korea	China	Thailand	Malaysia	Philippines
TFP Level $t-1$	-0.5955*** (0.0008)	-0.6651*** (0.0014)	-0.8553*** (0.0027)	-0.5539*** (0.0019)	-0.6775*** (0.0145)	-0.7956*** (0.0301)
Leverage $t-1$	0.1376*** (0.0032)	0.0572*** (0.0056)	0.0184*** (0.0041)	0.0698*** (0.0077)	0.2935*** (0.0917)	0.4018*** (0.1029)
Leverage $t-1$ × Leverage $t-1$	-0.0419*** (0.0027)	-0.0152*** (0.0053)	-0.0136*** (0.0039)	-0.0146* (0.0080)	-0.1575* (0.0916)	-0.2983*** (0.0951)
Size $t$	0.0844*** (0.0004)	0.0497*** (0.0007)	0.0064*** (0.0005)	0.0794*** (0.0011)	0.1348*** (0.0114)	0.0267** (0.0111)
Age $t$	-0.0208*** (0.0012)	-0.0297*** (0.0017)	0.0420*** (0.0024)	-0.0115*** (0.0034)	-0.0044 (0.0353)	-0.0079 (0.0340)
Intangibility $t-1$	0.0398*** (0.0022)	0.0143*** (0.0032)	-0.0007 (0.0025)	0.0072 (0.0100)	-0.0188 (0.0352)	0.0396 (0.0794)
Time Period	2002-2015	2003-2015	2005-2014	2003-2015	2006-2014	2009-2015
4 Digit Industry-Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,406,707	569,356	264,390	294,919	5,976	1,789
R-squared	0.446	0.456	0.620	0.376	0.536	0.677

\*significant at 10%, \*\*significant at 5%, \*\*\*significant at 1%.

Source: Orbis; and IMF staff calculations  
Note: TFP: total factor productivity.

**Figure A4.1.**

**1. Impact of Leverage on TFP Growth across Countries**



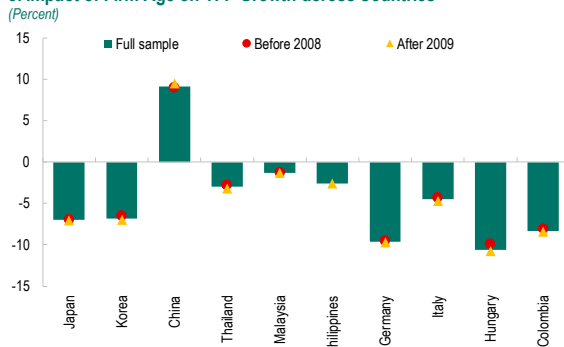
Note: The estimated coefficients multiplied by mean value based on balanced country panel data.

**2. Impact of Intangibility on TFP Growth across Countries**



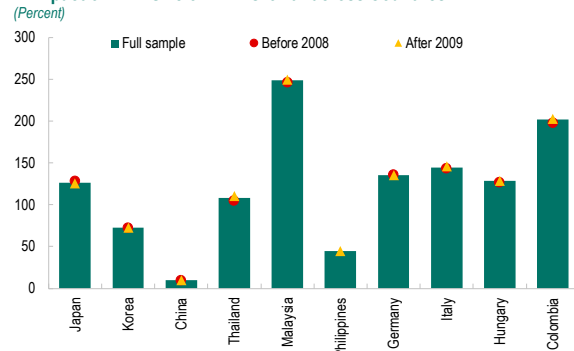
Note: The estimated coefficients multiplied by mean value based on balanced country panel data. Countries with statistically significant coefficients (at the 10 percent level) are shown.

**3. Impact of Firm Age on TFP Growth across Countries**



Note: The estimated coefficients multiplied by mean value based on balanced country panel data.

**4. Impact of Firm Size on TFP Growth across Countries**



Note: The estimated coefficients multiplied by mean value based on balanced country panel data.

## Annex 5. Zombie Firms

This paper follows the OECD approach of McGowan and others (2017) to define a firm as a zombie if it is 10 years old or older and has had an interest coverage ratio (ICR) less than one for three consecutive years. The three-year window is used to address the concerns regarding the business cycle effects on the prevalence of zombie firms. The ICR is estimated using financial expense data instead of interest paid in order to have better coverage. The financial expense series in Orbis is defined as the sum of interest paid and the write-off of financial assets. We use the average ratio of interest paid to financial expense in observations where both are available to approximate interest payments based on financial expenses for a wider sample. The ICR is preferable to earlier zombie definitions, which range from less restrictive (firms with negative profits) to more restrictive (firms likely receiving subsidized credit). The ICR measure captures additional channels other than subsidized credit through which zombie firms may be kept alive, such as nonperforming loans and government guarantees. The zombie analysis here focuses on manufacturing firms (NACE Revision 2, four-digit sectors 10-33), similar to the parallel work on resource misallocation.

To assess the impact of zombie firms, we explore the distortionary effects of zombie congestion on the performance of non-zombie firms (equation A5.1) and on the extent of productivity-enhancing capital reallocation (equation A5.2). The baseline econometric specification follows McGowan and others (2017) and Caballero, Hoshi, and Kashyap (2008) to estimate the following regressions:

$$Y_{isct} = \beta_1 nonZ_{isct} + \beta_2 nonZ_{isct} * Z_{sct} + \beta_3 Firm\ controls_{isct-1} + \delta_{sct} + \varepsilon_{isct} \quad (A5.1)$$

$$K\ growth_{isct} = \gamma_1 TFP_{isct-1} + \gamma_2 TFP_{isct-1} * Z_{sct} + \gamma_3 Firm\ controls_{isct-1} + \delta_{sct} + \varepsilon_{isct}, \quad (A5.2)$$

where  $Y_{isct}$  refers to a measure of activity (productivity growth, tangible and intangible investment in percent of total assets) in firm  $i$ , in industry  $s$ , in country  $c$ , at time  $t$ ;  $K\ growth_{isct}$  is the change in real tangible or intangible capital stock;  $TFP_{isct-1}$  is the firm productivity level;  $nonZ_{isct}$  is a dummy equal to 1 if a firm is a non-zombie firm;  $Z_{sct}$  is either the number of zombie firms or the share of industry capital sunk in zombie firms;  $Firm\ controls_{isct-1}$  are lagged and include leverage, share of intangible assets in total assets, firm size as measured by total assets, and firm age as measured by years since the date of incorporation; and  $\delta_{sct}$  are interacted country, industry, and year fixed effects to control for unobserved time-varying country-industry-specific shocks. Robust standard errors are clustered at the country-industry-year level.

We expect  $\beta_2$  to be negative to the extent that zombie congestion reduces the ability or incentives of non-zombie firms to invest in tangible and nontangible assets and as a result their productivity growth. The coefficient on the non-zombie dummy  $\beta_1$  should be positive, as non-zombie firms are expected to be more productive, but it could be negative if zombie firms receive very increasingly large subsidies.

We expect  $\gamma_1$  to be positive because firms with higher productivity are expected to attract resources and grow, while  $\gamma_2$  should be negative if the presence of zombie firms distorts the efficiency of capital reallocation.

Tables A5.1 and A5.2 show the results. Figure A5.1 shows the distribution of zombie firms across country sectors in terms of the number of firms and the share of capital sunk in zombie firms.

**Table A5.1. Capital Owned by Zombie Firms and the Number of Zombie Firms**

<b>Panel A: Capital owned by zombie firms</b>				<b>Panel B: Number of zombie firms</b>			
Variable	(1) TFP growth	(2) Tangible investment	(3) Intangible investment	(1) TFP growth	(2) Tangible investment	(3) Intangible investment	
Nonzombie	0.014*** (0.001)	0.013*** (0.001)	0.001** (0.000)	0.014*** (0.001)	0.034*** (0.002)	0.001 (0.001)	
Nonzombie*Zombie share	-0.016*** (0.006)	-0.039*** (0.009)	-0.003** (0.001)	-0.014* (0.008)	-0.258*** (0.015)	-0.004 (0.003)	
Country-Industry-Year F.E.	Yes	Yes	Yes	Yes	Yes	Yes	
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes	
Observations	1 104 651	1 099 617	979 519	1 104 651	1 099 617	979 519	
R square	0.085	0.014	0.084	0.085	0.014	0.084	

\*\*\*, \*\*, and \* indicate 1, 5, and 10 percent significance level, respectively.

\*\*\*, \*\*, and \* indicate 1, 5, and 10 percent significance level, respectively.

Source: Orbis; and IMF staff calculations

Note: F.E.: fixed effects; TFP: total factor productivity

**Table A5.2****Panel C: Capital allocation and capital share of zombie firms**

	(1) Tangible investment	(2) Intangible investment
TFP <sub>t-1</sub>	0.264*** (0.012)	0.001 (0.001)
TFP <sub>t-1</sub> *Zombie share	-0.242*** (0.022)	-0.001 (0.003)
Country-Industry-Year F.E.	Yes	Yes
Firm controls	Yes	Yes
Observations	954 723	845 694
R square	0.424	0.431

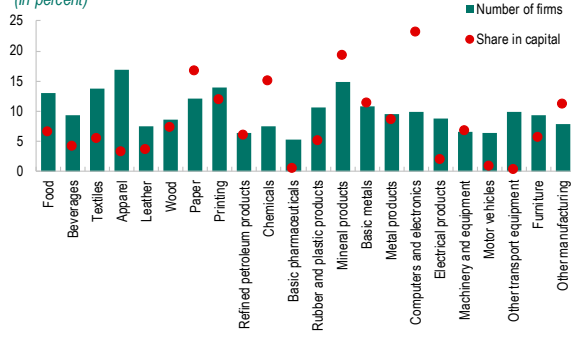
\*\*\*, \*\*, and \* indicate 1, 5, and 10 percent significance level, respectively.

Source: Orbis; and IMF staff calculations

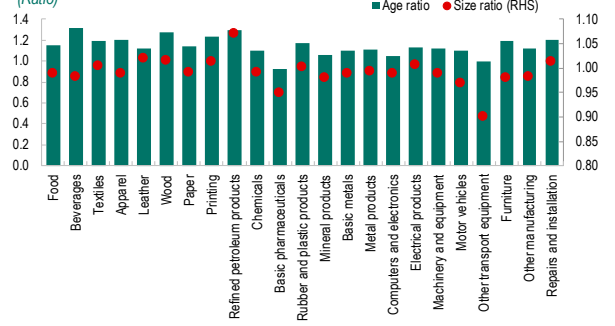
Note: \*\*\*, \*\*, and \* indicate 1, 5, and 10 percent significance levels, respectively. F.E.: fixed effects; TFP: total factor productivity.

### Figure A5.1. Economy-Level Data

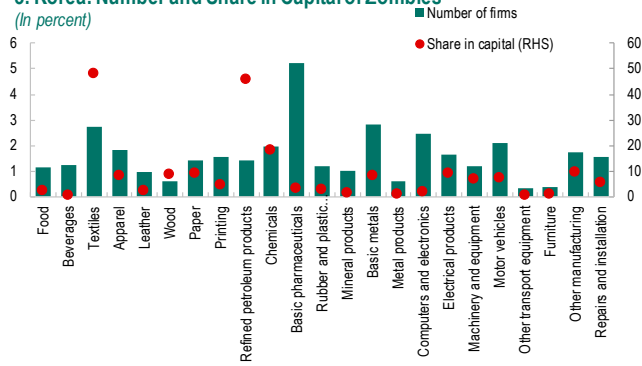
1. Japan: Number and Share in Capital of Zombies (In percent)



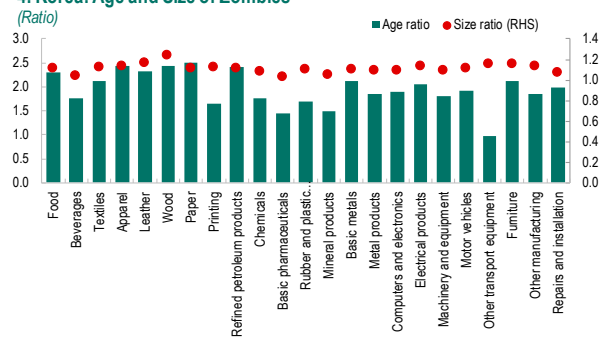
2. Japan: Age and Size of Zombies (Ratio)



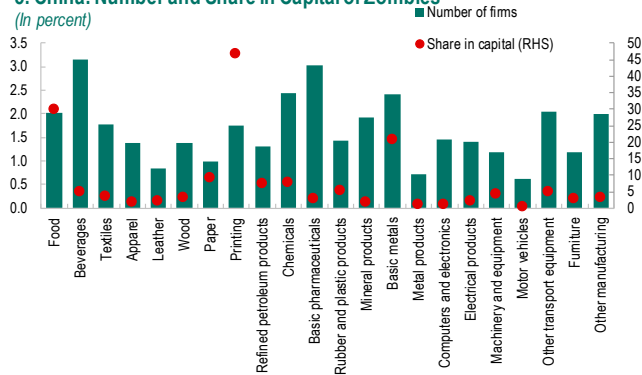
3. Korea: Number and Share in Capital of Zombies (In percent)



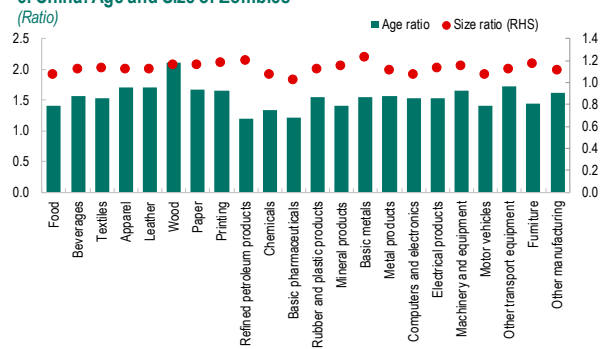
4. Korea: Age and Size of Zombies (Ratio)



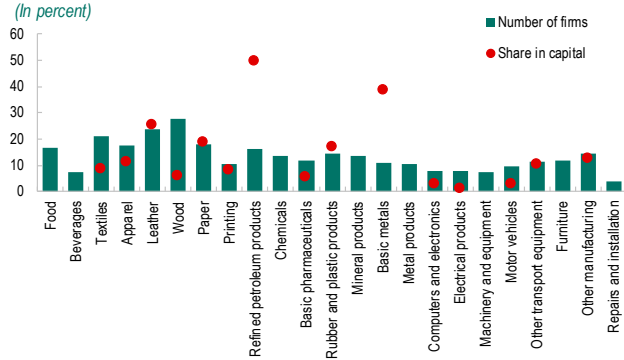
5. China: Number and Share in Capital of Zombies (In percent)



6. China: Age and Size of Zombies (Ratio)



7. Thailand: Number and Share in Capital of Zombies (In percent)



8. Thailand: Age and Size of Zombies (Ratio)

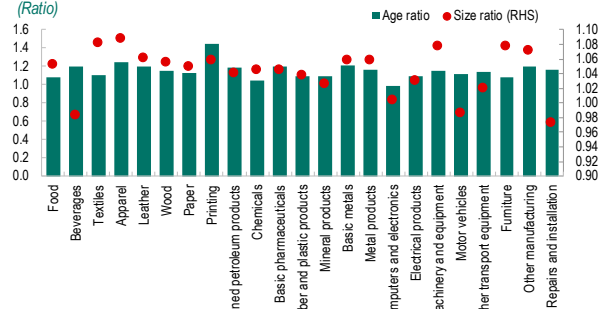
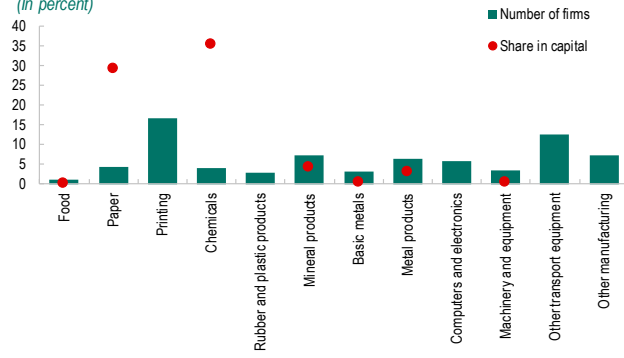
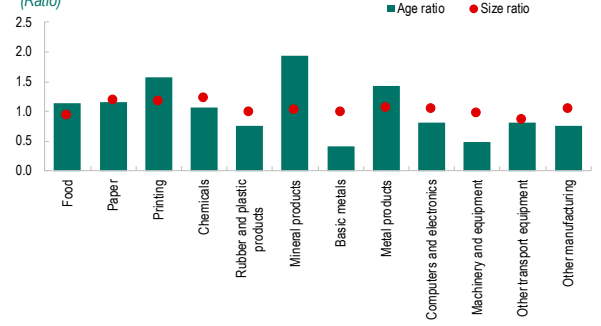


Figure A5.1 (continued)

9. Malaysia: Number and Share in Capital of Zombies  
(In percent)



10. Malaysia: Age and Size of Zombies  
(Ratio)



Sources: Orbis; and IMF staff calculations.

## Annex 6. Impact of the Global Financial Crisis: Differences-in-Differences Model

The empirical strategy used in this paper is a differences-in-differences model that compares the difference in TFP growth between firms with large versus low precrisis balance sheet vulnerabilities, before and after the tightening in credit conditions in 2008 after the collapse of Lehman Brothers. It is similar to Duval, Hong, and Timmer (2017), who analyze the impact of financial frictions on firm TFP growth in advanced economies. The baseline regression is as follows

$$\Delta TFP_{ics}^{post-pre} = \beta_1 Leverage_{ics(pre-crisis)} + \beta_2 x_{ics(pre-crisis)} + \delta_{cs} + \varepsilon_{ics}. \quad (A6.1)$$

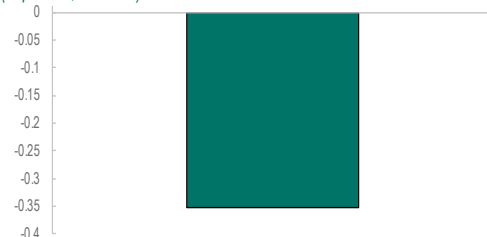
The dependent variable is the difference in the average annual growth rates between the postcrisis and precrisis periods in firm TFP. The precrisis period is defined as 2003–07. We have several definitions for the postcrisis period. In the baseline, postcrisis period is defined as 2008–15. In order to focus on the crisis period in particular, we also use the 2008–09 window for the postcrisis period. We also define the postcrisis period as 2010–15 to explore the persistence of the impact. The variable of interest is the precrisis average of leverage for firm  $i$ , which is proposed as a proxy for precrisis balance sheet vulnerabilities. Based on the assumption that firms that had higher leverage would face a higher degree of difficulty in accessing external funding following the credit tightening in 2008, we expect  $\beta_1$  to be negative, meaning that TFP in such firms would be lower than in the postcrisis period.

We control for the precrisis average of firm-level characteristics that are included in the panel specification. Since the focus is on the difference in firm TFP growth between postcrisis and precrisis periods, all time-invariant firm characteristics that may drive TFP growth are implicitly controlled for in this specification. We include country-sector fixed effects to control for country-specific shocks (for example, foreign or domestic demand shocks) or policy changes. Thus, we compare TFP growth in firms with high versus low precrisis leverage in the postcrisis period within each country-sector cell. Standard errors are clustered at the country-sector level. The regression results are shown in Table A6.1 and Figure A6.1.

<b>Panel A: The change in TFP growth and leverage</b>			
Variable	(1) 2008-2015	(2) 2008-2009	(3) 2010-2015
Pre-crisis Leverage	-0.010*** (0.001)	-0.007*** (0.001)	-0.009*** (0.001)
Country-Industry F.E.	Yes	Yes	Yes
Firm controls	Yes	Yes	Yes
Observations	333 077	302 525	246 774
R square	0.028	0.03	0.03

Sources: Orbis; and IMF staff calculations

**Figure A6.1. Impact of Leverage on Post-GFC TFP Growth**  
(In percent, 2008–15)



Source: IMF staff calculations.

Note: Assumes interquartile increase in leverage ratio, from 40 to 77 percent. GFC: global financial crisis; TFP: total factor productivity.

Once we establish the link between financial vulnerabilities and TFP growth, we investigate one potential channel, namely investment. In general, credit tightening in highly vulnerable firms may affect investment which would lead to lower TFP growth. We ask whether firms with high precrisis leverage decreased

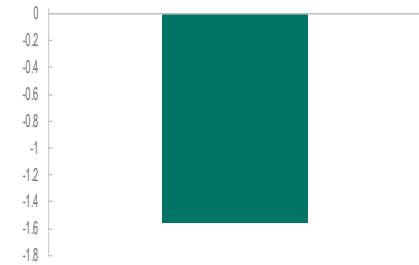


investment more than others in the postcrisis era. To address this question, in panel B we change our dependent variable to the change in average annual investment in the postcrisis period compared to the precrisis period. We employ this analysis both for intangible and tangible investment separately. We note that, in this set of regressions, we control for precrisis average investment as well (Table 6A.2 and Figure A6.2).

**Table A6.2**

<b>Panel B: The change in investment and leverage</b>				
	(1) Tangible investment	(2) Tangible investment	(3) Intangible investment	(3) Intangible investment
	2008-2009	2010-2015	2008-2009	2010-2015
Pre-crisis Leverage	-0.047*** (0.007)	-0.019*** (0.003)	-0.001*** (0.000)	-0.001 (0.000)
Country-Industry F.E.	Yes	Yes	Yes	Yes
Firm controls	Yes	Yes	Yes	Yes
Observations	315 864	243 823	240 364	194 139
R square	0.453	0.766	0.768	0.649

Sources: Orbis; and IMF staff calculations

**Figure A6.2. Impact of Leverage on Post-GFC Investment Growth**  
(In percent, 2008-15)

Source: IMF staff calculations.

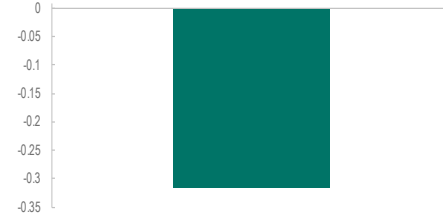
Note: Assumes interquartile increase in leverage ratio, from 40 to 77 percent. GFC: global financial crisis; TFP: total factor productivity.

Finally, the second link we explore is the relationship between trade-openness and TFP. Due to the breakdown in global demand, firms operating in sectors that have been more open to trade may have experienced lower TFP growth in the postcrisis period. We modify our specification in panel C such that we have precrisis average trade openness as an explanatory variable.<sup>20</sup> We cluster standard errors at the sector level (Table A6.3 and Figure A6.3).

**Table A6.3**

<b>Panel C: The change in TFP growth and trade intensity</b>		
	(1) 2008-2009	(2) 2010-2015
Pre-crisis Trade Intensity	-0.022*** (0.007)	0.001 (0.007)
Country F.E.	Yes	Yes
Industry F.E.	Yes	Yes
Firm controls	Yes	Yes
Observations	255 827	202 133
R square	0.018	0.025

Sources: Orbis; and IMF staff calculations

**Figure A6.3. Impact of Trade Intensity on 2008-09 TFP Growth**  
(In percent)

Source: IMF staff calculations.

Note: Assumes interquartile increase in export/output ratio, from 0.7 to 20 percent. TFP: total factor productivity.

<sup>20</sup> Country and sector fixed effects are used separately in this case, instead of country-sector interaction fixed effects.

## References

- Acemoglu, Daron, Ufuk Akcigit, Harun Alp, Nicholas Bloom, and William R. Kerr. 2017. “Innovation, Reallocation, and Growth.” CEPR Discussion Paper No. 12449, Centre for Economic Policy Research, London.
- Ahearne, Alan G., and Naoki Shinada. 2005. “Zombie Firms and Economic Stagnation in Japan.” *International Economics and Economic Policy* 2(4): 363–81.
- Alcalá, F., and A. Ciccone. 2004. “Trade and Productivity.” *The Quarterly Journal of Economics* 119(2): 613–46.
- Andrews, Dan, Chiara Criscuolo, and Peter N. Gal. 2015. “Frontier Firms, Technology Diffusion and Public Policy: Micro Evidence from OECD Countries.” In *OECD: The Future of Productivity. Main Background Papers*. Paris: Organization for Economic Cooperation and Development.
- \_\_\_\_\_. 2016. “The Best versus the Rest: The Global Productivity Slowdown, Divergence Across Firms and the Role of Public Policy.” OECD Productivity Working Paper No. 5, OECD Publishing, Paris.
- Andrews, Dan, Müge Adalet McGowan, and Valentine Millot. 2017. “Confronting the Zombies: Policies for Productivity Revival.” OECD Economic Policy Paper No. 21, OECD Publishing, Paris.
- Arnold, Jens Matthias, Beata Javorcik, Molly Lipscomb, and Aaditya Mattoo. 2014. “Services Reform and Manufacturing Performance: Evidence from India.” *The Economic Journal* 126(590): 1–39.
- Brandt, Loren, Johannes Van Biesebroeck, and Yifan Zhang. 2012. “Creative Accounting or Creative Destruction? Firm-level Productivity Growth in Chinese Manufacturing.” *Journal of Development Economics* 97(2): 339–51.
- Caballero, Ricardo J., Takeo Hoshi, and Anil K. Kashyap. 2008. “Zombie Lending and Depressed Restructuring in Japan.” *American Economic Review* 98(5): 1943–977.
- Chen, Binkai, and Guangjun Shen. 2017. “Zombie Firms and Over-capacity in Chinese Manufacturing.” *China Economic Review* 44 (July): 327–42.
- Decker, Ryan A., John Haltiwanger, Ron S. Jarmin, and Javier Miranda. 2016. “Declining Business Dynamism: Implications for Productivity?” Hutchins Center on Fiscal and Monetary Policy at Brookings Working Paper No. 23, Brookings Institution, Washington, DC.
- De Loecker, Jan. 2013. “Detecting Learning by Exporting.” *American Economic Journal: Microeconomics* 5(3): 1–21.
- Di Mauro, Filippo, Duy Hoang, Andy Feng, Swee Joo Ong, Jeannette Pang. 2018. “Productivity was not that Sluggish in Developing Asia, Afterall. A Firm Level Perspective Using a Novel Dataset.” Productivity Research Network, National University of Singapore mimeo.
- Díez, Federico, Jiayue Fan, and Carolina Villegas-Sanchez. 2018. “Global Declining Competition,”

forthcoming IMF Working Paper.

- Doms, Mark, and J. Bradford Jensen. 1998. "Comparing Wages, Skills, and Productivity between Domestically and Foreign-Owned Manufacturing Establishments in the United States." In *Geography and Ownership as Bases for Economic Accounting*, edited by Baldwin, Robert E., Robert E. Lipsey, and J. David Richardson. Chicago: University of Chicago Press.
- Dougherty, Sean, Veronica Frisancho, and Kala Krishna. 2013. "State-level Labor Reform and Firm-level Productivity in India." *India Policy Forum 2013–14*.
- Duval, Romain, Gee Hee Hong, and Yannick Timmer. 2017. "Financial Frictions and the Great Productivity Slowdown." IMF Working Paper No. 17/129, International Monetary Fund, Washington, DC.
- Foster, Lucia, John C. Haltiwanger, and C. J. Krizan. 2001. "Aggregate Productivity Growth: Lessons from Microeconomic Evidence," NBER Chapters, in: *New Developments in Productivity Analysis*, pages 303-372.
- Fukuda, Shin-ichi, and Jun-ichi Nakamura. 2011. "Why Did 'Zombie' Firms Recover in Japan?" *The World Economy* 34(7): 1124–137.
- Gal, Peter N. 2013. "Measuring Total Factor Productivity at the Firm Level using OECD-ORBIS," OECD Economics Department Working Papers 1049, OECD Publishing.
- Gopinath, Gita, Şebnem Kalemli-Özcan, Loukas Karabarbounis, and Carolina Villegas-Sanchez. 2017. "Capital Allocation and Productivity in South Europe," *The Quarterly Journal of Economics*, Oxford University Press, vol. 132(4), pages 1915-1967.
- Hallward-Driemeier, Mary, Giuseppe Iarossi, and Kenneth L. Sokoloff. 2002. "Exports and Manufacturing Productivity in East Asia: A Comparative Analysis with Firm-level Data." NBER Working Paper No. 8894, National Bureau of Economic Research, Cambridge, MA.
- Hopenhayn, Hugo A. 1992. "Entry, Exit, and Firm Dynamics in Long Run Equilibrium." *Econometrica* 60(5): 1127–150.
- Hoshi, Takeo. 2006. "Economics of the Living Dead." *Japanese Economic Review* 57(1): 30–49.
- International Monetary Fund (IMF). 2017. "Upgrading the Tax System to Boost Productivity," IMF Fiscal Monitor Chapter 2, April 2017.
- \_\_\_\_\_. 2018a. "Asia as the Cycle Matures." Asia and Pacific Department *Regional Economic Outlook* Background Paper No. 1. Washington, DC, October.
- \_\_\_\_\_. 2018b. "Regional Economic Outlook Asia and Pacific Background Paper No. 2—The Evolving Role of Trade in Asia: Opening a New Chapter" (Washington, DC).
- \_\_\_\_\_. 2018c. "Regional Economic Outlook Asia and Pacific Background Paper No. 4—The Digital Revolution in Asia: Disruptor or New Growth Engine (or Both)?" (Washington, DC).

- Kalemli-Ozcan, Sebnem, Luc Laeven, and David Moreno. 2018. "Debt Overhang, Rollover Risk, and Corporate Investment: Evidence from the European Crisis," NBER Working Papers 24555, National Bureau of Economic Research, Inc.
- Kalemli-Ozcan, Sebnem, Bent Sorensen, Carolina Villegas-Sanchez, Vadym Volosovych, and Sevcen Yesiltas. 2015. "How to Construct Nationally Representative Firm Level data from the ORBIS Global Database," NBER Working Papers 21558, National Bureau of Economic Research, Inc.
- Koske, Isabell, Isabelle Wanner, Rosamaria Bitetti, and Omar Barbiero. 2015. "The 2013 Update of the OECD Product Market Regulation Indicators: Policy Insights for OECD and non-OECD Countries." OECD Economics Department Working Paper No. 1200, OECD Publishing, Paris.
- Kwon, Hyeog, Ug, Futoshi Narita, and Machiko Narita. 2015. "Resource Reallocation and Zombie Lending in Japan in the 1990s." *Review of Economic Dynamics* 18: 709–32
- Lam, W. Raphael, Alfred Schipke, Yuyan Tan, and Zhibo Tan. 2017. "Resolving China's Zombies: Tackling Debt and Raising Productivity." IMF Working Paper 17/266, International Monetary Fund, Washington, DC.
- Lanau, Sergi, and Petia Topalova. 2016. "The Impact of Product Market Reforms on Firm Productivity in Italy." IMF Working Paper No. 16/119, International Monetary Fund, Washington, DC.
- McGowan, Adalet Müge Adalet, Dan Berlingieri and Valentine Millot. 2017. "The Walking Dead?: Zombie Firms and Productivity Performance in OECD Countries", OECD Economics Department Working Paper No. 1372, OECD Publishing, Paris.
- Organization for Economic Cooperation and Development (OECD). 2017. "Business Dynamics and Productivity" OECD Publishing, Paris.
- \_\_\_\_\_. 2018. "Financing SMEs and Entrepreneurs 2018: An OECD Scoreboard." OECD Publishing, Paris.
- Peek, Joe, and Eric S. Rosengren. 2005. "Unnatural Selection: Perverse Incentives and the Misallocation of Credit in Japan." *American Economic Review* 95(4): 1144–166.
- Rao, Nirupama. 2016. "Do Tax Credits Stimulate R&D Spending? The Effect of the R&D Tax Credit in Its First Decade." *Journal of Public Economics* 140(C): 1–12.
- Tan, Yuyan, Yiping Huang, and Wing Thyee Woo. 2016. "Zombie Firms and the Crowding-Out of Private Investment in China." *Asian Economic Papers* 15(3).
- Timmer, Marcel P. and Gaaitzen J. de Vries. 2009. "Structural change and growth accelerations in Asia and Latin America: a new sectoral data set." *Cliometrica* 3: 165-190.

# REGIONAL ECONOMIC OUTLOOK: ASIA AND PACIFIC BACKGROUND PAPER NO. 4

## The Digital Revolution in Asia: Disruptor or New Growth Engine (or Both)?<sup>1</sup>

October 2018

---

<sup>1</sup> This *Regional Economic Outlook* background paper was prepared by Tahsin Saadi Sedik (lead), Sally Chen, Tarhan Feyzioglu, Manuk Ghazanchyan, Souvik Gupta, Sarwat Jahan, Juan Manuel Jauregui, Tidiane Kinda, Vipichbolreach Long, Elena Loukoianova, Alexandros Mourmouras, Masahiro Nozaki, Simon Paroutzoglou, Cormac Sullivan, Jiae Yoo, and Longmei Zhang, under the guidance of Kenneth Kang and Koshy Mathai. Substantial inputs were provided by Gee Hee Hong and Todd Schneider. Alessandra Balestieri and Socorro Santayana provided production assistance. The paper is based on data available as of September 18, 2018 and includes comments from other IMF departments and some Executive Directors.

## Introduction and Main Findings

The digital revolution is underway. While digitalization and automation are not new, they have accelerated in recent years, and a new wave of innovation—triggered by advances in artificial intelligence, robotics, computing power, and cryptography, as well as the explosion of big data—is reshaping the global economy. More so than during past periods of innovation, including the spread of personal computers in the 1980s and the rise of the Internet in the 1990s, today’s technological advances are multiple and overlapping, creating synergies and accelerating outcomes. The digital revolution is affecting all sectors and activities of the economy, with a far-reaching social and economic impact. The new technologies are general-purpose in nature, with the potential to transform the global economy, boost productivity substantially, and fundamentally alter the way we live and work, much as the steam engine and electricity did. But in that process, these technologies may also cause substantial disruptions and dislocations.

This paper focuses on whether the digital revolution in Asia is a new driver of growth or a disruptor of it. Given the diversity of digital innovations, the lack of a generally agreed-upon definition of the digital economy, and the sparsity of data, the paper uses a multipronged approach to analyze the digital economy in Asia.

## Key Findings

First, Asia has been at the forefront of the digital revolution, though with heterogeneity across the region:

- There are Asian players in the lead in nearly every aspect of digitalization, while at the same time some economies lag significantly behind. In fact, the region’s economies have the highest dispersion in terms of the adoption of digital technologies—not surprising given that Asia covers the entire income spectrum. Nonetheless, at any given income level, Asian economies are at the frontier relative to their global peers, and moreover, digitalization is accelerating even for relatively poor Asian economies.
- Automation via industrial robots is one area in which Asia is clearly at the forefront, although it is limited to a few Asian economies. These robots are used almost exclusively in manufacturing, and with Asia being the “factory to the world,” it is perhaps to be expected that a full two-thirds of the world’s industrial robots are employed in the region. The use of these robots has accelerated since 2010. China is now the single biggest user (accounting for some 30 percent of the market), and in 2016 China, Japan, and Korea each employed more robots than the United States. But this is not just because production volumes are high in Asia. Robot density (the number of industrial robots per 1,000 workers) is high and rising fast in several Asian economies, attesting to their rapid and extensive adoption. Indeed, Korea and Singapore are the global leaders in robot density, followed by Germany and Japan. Finally, Asia is a leader not only in the use of robots, but also in their production—Japan and Korea are the world’s top two producers, with market shares of 52 and 12 percent, respectively.
- E-commerce and Fintech are other areas in which Asia leads. For instance, China accounted for less than 1 percent of global e-commerce retail transaction value about a decade ago, but that share has grown to more than 40 percent, and the penetration of e-commerce (as a percentage of total retail sales) now stands at 15 percent, compared to 10 percent in the United States. E-commerce penetration is lower in the rest of Asia, but it is growing fast, particularly in India, Indonesia, and Vietnam. In terms of Fintech, Asian economies have made significant progress, in many cases leapfrogging into new types of technology. For example, in 2016, mobile payments made by

individuals for consumption purchases totaled \$790 billion in China, 11 times the size of such payments in the United States. Asia has also been a leader in cryptoassets, including initial coin offerings. Before China tightened regulations, more than 90 percent of Bitcoin trading volumes were against the renminbi, and in Korea, prices of Bitcoin and other cryptoassets have been substantially more volatile than in other economies, reflecting speculative demand. Finally, some small states in the region have even been approached by private investors to adopt cryptoassets as the legal tender, raising serious legal and regulatory concerns.

A second key finding is that Asia has already benefited immensely from digitalization. This paper finds that the diffusion of technological innovation has been the key driver of growth in per capita GDP in Asia over the past two decades, with digital innovation alone accounting for nearly 30 percent. The digital component of GDP, proxied most narrowly by the share of the information and communication technology (ICT) sector, is relatively large in many Asian economies—Asia is home to seven of the world’s top 10 economies in terms of the ICT share of GDP. The sector has also been growing substantially faster than overall GDP—twice as fast in India and Thailand, and nearly four times as fast in Japan. Digitalization has also boosted the productivity of non-ICT sectors. The paper finds, for instance, that a 1 percent increase in the overall digitalization of the Chinese economy is associated with a 0.3 percent increase in GDP growth. Innovation in Asia is tilted toward the digital sector, further highlighting its potential to boost future growth.

Third, e-commerce has the potential to support growth and economic rebalancing. For consumers, e-commerce may translate into better access to a wider range of products and services at lower prices, ultimately boosting consumption. For firms, e-commerce could also provide new business opportunities and access to larger markets and may thus support investment. The econometric analysis shows that participation in online commerce is associated with a more than 30 percent increase in total factor productivity at the firm level in Asia. Innovation, human capital, and, to some extent, access to finance seem to be behind online firms’ stronger performance. Finally, the paper finds that firms engaged in e-commerce also export 50 percent more, relying on their skilled labor force and capacity to innovate. Interestingly, e-commerce seems to be especially beneficial for small firms in Asia.

Fourth, digitalization presents opportunities for improving public finance in Asia. Adoption of digitalization by governments can, by improving reporting of transactions, increase value-added tax (VAT), tariff, and other revenue. The analysis indicates that if Asian economies were to move halfway to the global frontier, import-VAT revenue could rise by 0.6 percent of GDP. For Asian small states, which are typically further from the frontier, estimated revenue gains are on the order of 2½ percent of GDP. Digitalization can also improve the efficiency of public spending, including via the targeting of social assistance, by reducing inclusion and exclusion errors. More generally, digitalization can improve public financial management systems.

Fifth, the paper finds the impact of robots on employment depends on country-specific conditions. Using an approach pioneered by Acemoglu and Restrepo (2017a), the paper analyzes the impact of robot usage on employment across a large sample of economies in Asia, Europe, and the Americas. Contrary to some observers, the paper finds no evidence that robots destroy jobs on net—that is, the productivity-enhancing (and thus job-creating) effects of industrial robots have offset the displacement effect (that is, the destruction of old jobs). Restricting attention to Asia, however, there is a slight negative impact on overall manufacturing employment, and particularly so in certain heavily automated sectors like electronics and automobiles. Furthermore, like others, the paper finds that workers with medium-level education are more vulnerable to displacement than those with either low or high education levels. Interestingly, in Japan, with

its aging population and declining labor force, increased robot density in manufacturing is associated not only with greater productivity, but also with local gains in employment and wages. Japan's experience suggests that other Asian economies facing similar demographic trends in the future, such as China, Korea, and Thailand, may also benefit from automation.

Finally, the paper finds that economies with a greater propensity for technological leapfrogging have also tended to see declining traditional financial infrastructure, particularly bank branches. Unlike US tech companies, Asian tech giants, especially in China, have become key providers of financial services, putting competitive pressures on traditional financial institutions.

Neither the opportunities nor the challenges related to digitalization have yet become fully apparent. Some economists have questioned the ability of technological progress to keep propelling the economy forward, arguing that the low-hanging fruit have mostly been picked, and further advances will become increasingly difficult (Gordon 2016). Others argue that the new technologies are not widely diffused, complementary innovations and production processes that will boost productivity have not been fully developed, occupations may need to be redesigned, and the capital investments required to implement new technologies have not yet been made. For example, once the technology for self-driving cars has been perfected, fleets of these new vehicles will be needed before economic effects are truly felt. It is worthwhile recalling that it took more than two decades for electricity to substantially increase productivity. A reorganization of jobs and a wave of investment in physical and regulatory infrastructure will likely determine the productivity gains from the digital revolution.

## Striking the Right Balance

While the digital revolution is inevitable, the outcome—utopian or dystopian—will depend on policies. To realize the potential of the digital revolution, comprehensive policies and fresh thinking are needed. For policymakers, the first hurdle is to accept that the digital revolution is inevitable. Policy responses will need to strike the right balance between enabling digital innovation and addressing digitalization-linked risks. Policy priorities differ across Asia (and the world), as economies' initial conditions are different. Policies to harness digital dividends include revamping education to meet the demand for more flexible skill sets and lifelong learning, as well as new training, especially for the most adversely affected workers; reducing skill mismatches between workers and jobs; investing in physical and regulatory infrastructure that spurs competition and innovation; and addressing labor market and social challenges, including income redistribution and safety nets. But considering the inherent global reach of these technologies, regional and international cooperation will be key to developing effective policy responses, and the IMF can play an important role in this regard.

Policies to soften the labor market impact of new technologies can improve welfare. The more willing society is to support the necessary transition and to provide support to those who are left behind, the faster the pace of innovation that society can accommodate, while still ensuring that the outcomes improve welfare, with all members of the society better off. With the right policies, the digital revolution could be a new engine of growth and prosperity for Asia and the world.

This paper first provides an overview of the digital Asia landscape. It then revisits the debate on the sources of growth in Asia, focusing on the role of digital innovation. The paper then turns to analyzing four specific topics: automation and the future of work; e-commerce as a new engine of growth; digitalization of financial services; and digitalization to strengthen public finance. The final section concludes with a discussion on policy challenges.



## Asia's Digital Landscape

Asia has made significant strides in the digitalization of consumption, production, and innovation. While China has been the global trendsetter in many aspects of digitalization, many economies in Asia have advanced significantly. Nonetheless a digital divide still exists, with only a select few economies adopting digitalization at the highest level of sophistication. The impact of digitalization has also been far-reaching, with Fintech already starting to impact traditional banking, e-commerce supplanting smaller businesses, and governments adopting digitalization to improve public finance.

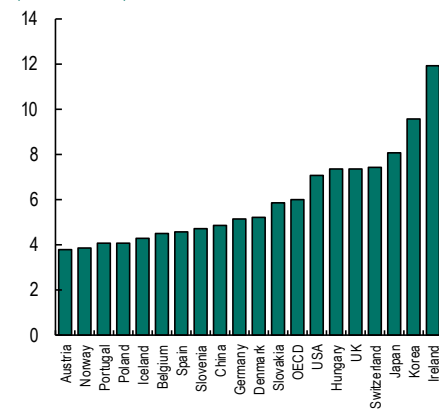
### Defining and Measuring the Digital Economy

The definition of the digital economy has evolved with the underlying technology. Over the past several decades, the ICT sector has undergone rapid development, from microelectronics in the 1940s to the birth of the computer in the 1960s, the introduction of the Internet in the 1990s, and most recently, blockchain, artificial intelligence, and robotics. Correspondingly, new sectors based on the evolving technologies have emerged, such as e-commerce, Fintech, and driverless cars.

The digital economy can be defined in a narrow or broad sense. The narrow definition refers to the ICT sector only or the “digital sector,” including telecommunications, the Internet, ICT services, hardware and software, etc. The broad definition includes both the ICT sector and parts of traditional sectors that have been integrated with digital technology, often called the “digital economy.” The G20 uses this broad concept and has defined the digital economy as “a broad range of economic activities that includes using digitized information and knowledge as the key factor of production, and modern information networks as the important activity space.”<sup>2</sup> The lack of a generally agreed-upon definition of the “digital economy” or “digital sector” is a hurdle to measuring the digital economy (see IMF 2018a). In the future, as digitalization penetrates an increasing number of activities and sectors, the boundaries between the digital and physical worlds will be blurred, and the entire world economy may be considered to be digital.

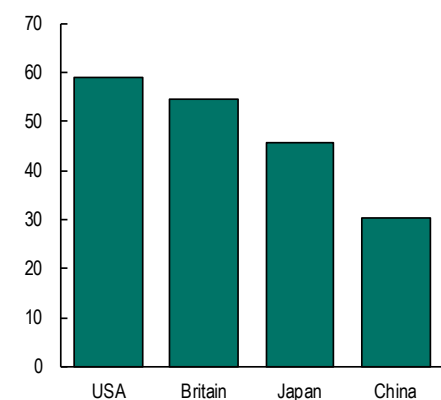
Reflecting different definitions, there are a range of measures of the digital economy. Unsurprisingly, these measures provide very different estimates of the size of the digital economy. For example, the narrow definition (based on the Organization for Economic Cooperation and Development framework) puts the size of China's digital economy at 6 percent of GDP, Japan's at 8 percent, and South Korea's at 10 percent (Figure 1). A broad definition by the China Academy of Information and Communication, based on national accounts data, suggests that the digital economy currently stands at 30 percent of GDP in China, 46 percent in Japan, and 59 percent in the United States (Figure 2). In addition, there are also many blended indices that include the enabling conditions for driving digitalization (such as ICT infrastructure and mobile

**Figure 1. Digital Economy: Narrow Definition**  
(Percent of GDP)



Sources: Organization for Economic Cooperation and Development, and Natixis.

**Figure 2. Digital Economy: Broad Definition**  
(Percent of GDP)



Source: China Academy of Information and Communication Technology.

<sup>2</sup> See the G20 Digital Economy Development and Cooperation Initiative.

penetration) and indicators for certain digital industries (such as e-commerce transactions).<sup>3</sup> For the purposes of this paper, the analysis mainly uses the narrow definition because of data availability. However, the paper also uses other measures to capture developments in specific areas such as robotics and e-commerce. A blended index has also been created for the purpose of the paper.

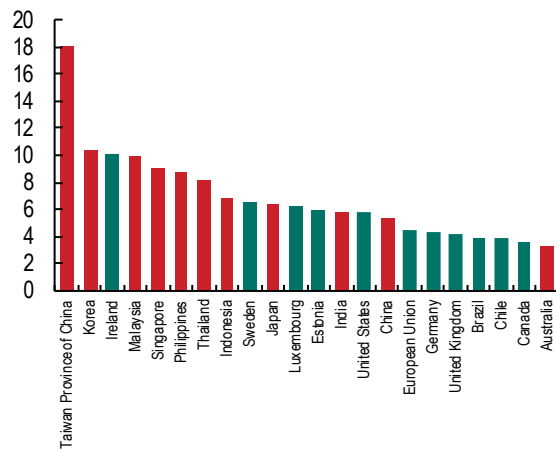
## Supply

### Digital Dividend: ICT Sector in GDP

Asia's digital sector is growing. In 2015, seven of the world's top 10 economies in terms of ICT share of GDP were from Asia (Figure 3). Not surprisingly, advanced economies such as Taiwan Province of China, Korea, and Japan have a large ICT sector. During 2005–15, the ICT/GDP ratio in the Taiwan Province of China almost doubled from 9.3 to about 18 percent of GDP, while Korea's increased from 7.5 to about 10 percent of GDP. Major economies that are members of the Association of Southeast Asian Nations (ASEAN), such as Malaysia, Singapore, Thailand, and the Philippines, are also among the global leaders in the ICT sector.

The ICT sector is growing faster than GDP in almost all Asian economies. During 2005–15, the ICT sector grew twice as fast as GDP in India and Thailand, about 40 percent faster in China, and nearly four times as fast in Japan (Figure 4).

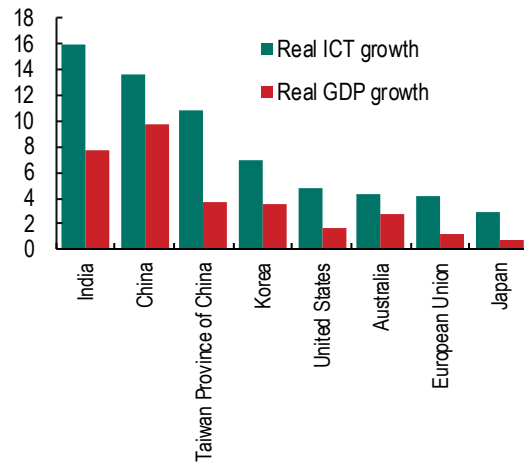
**Figure 3. ICT Sector as a Share of GDP, 2015**  
(Percent of GDP)



Sources: European Commission; CEIC Data Co. Ltd.; and IMF staff calculations.

Note: Canada and Ireland data are from 2014; ICT = Information and Communications Technology.

**Figure 4. ICT Sector and GDP Growth**  
(Year-over-year percent change, 2005-15)



Sources: European Commission; CEIC Data Co. Ltd.; and IMF staff calculations.

Note: ICT = Information and Communications Technology.

The components of ICT growth differ by economy. In economies such as Taiwan Province of China, Korea, and China, ICT growth is predominantly fueled by growth in ICT manufacturing, particularly of electronic components. In India, by contrast, computer-related services account for about 70 percent of ICT value added, with the traditional telecommunications sector also playing an important role.

<sup>3</sup> These indicators include the World Bank's Digital Adoption Index, the Fletcher School's Digital Evolution Index, and the World Economic Forum's Network Readiness Index.

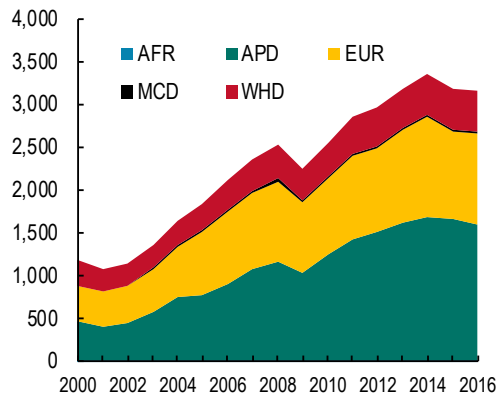
## Trade in Digitalization

Asia is the world's largest supplier of ICT goods<sup>4</sup> and services, accounting for about half of global ICT exports. Within Asia, China's contribution is about 60 percent (including Hong Kong SAR) and has contributed to more than half of ICT export growth over the past decade, followed by South Korea. Most of the contribution comes from goods exports, but services are starting to gain momentum (Figure 5).

### Trade Sector

*Asia contributes to more than half of global information and communications technology (ICT) exports ....*

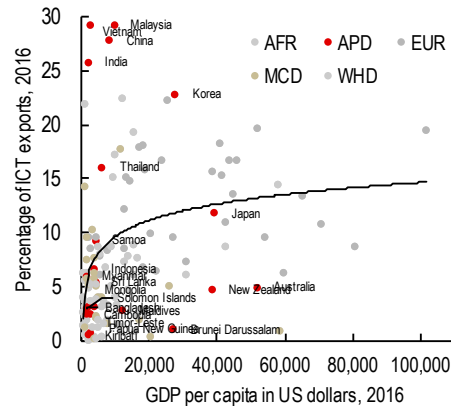
**Figure 5. Exports of ICT Goods and Services**  
(Billions of US dollars)



Note: AFR = Africa Department; APD = Asia & Pacific Department; EUR = European Department; MCD = Middle East & Central Asia Department; WHD = Western Hemisphere Department.  
Sources: World Bank, World Development Indicators; United Nations Conference on Trade and Development; and IMF staff calculations.

*....and ICT exports are not correlated with an economy's income level.*

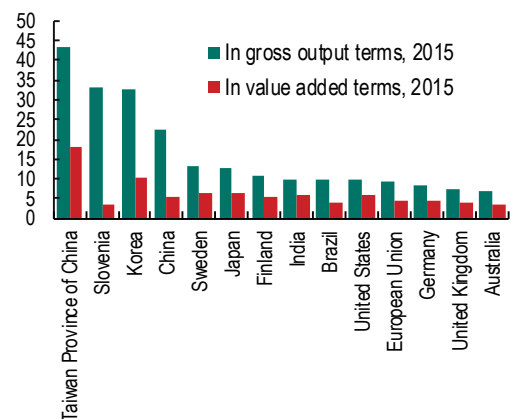
**Figure 6. GDP Per Capita and Percentage of ICT Exports**  
(Percent of total exports)



Note: AFR = Africa Department; APD = Asia & Pacific Department; EUR = European Department; MCD = Middle East & Central Asia Department; WHD = Western Hemisphere Department.  
Sources: IMF, *World Economic Outlook*; World Bank, World Development Indicators; and IMF staff calculations.

There appears to be little correlation between a country's income level and its exports of ICT goods and services (Figure 6). In India, for example, ICT services constitute almost 70 percent of total exports, the highest in Asia, despite the country having per capita income of below \$2,000, and India is closely followed by the Philippines. However, there is a large variation in sophistication of the types of goods and service that fall within ICT categories, ranging from computer peripherals to semiconductors. Interestingly, though China is the world's largest ICT exporter in gross terms, its domestic value added in ICT is only about the same as that in India or the United States, reflecting the country's position as an assembly hub in global value chains (Figure 7).

**Figure 7. Size of ICT Sector: Gross Output vs. Value Added**  
(Percent of GDP)



Sources: European Commission; CEIC Data Co. Ltd.; and IMF staff calculations.  
Note: ICT = Information and Communications Technology.

<sup>4</sup> ICT goods exports include computers and peripheral equipment, communication equipment, consumer electronic equipment, electronic components, and other information and technology goods.

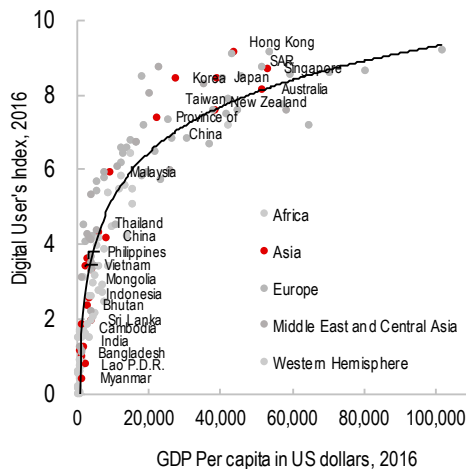
## Use of Digital Technologies

### ICT Sector: Digital Divide and Convergence

Asia has the highest dispersion of economies in terms of the adoption of digital technologies. Economies such as Korea and Japan are global trendsetters not only in the adoption of technology but also in its production. On the other side of the spectrum, there are economies such as Myanmar and Lao P.D.R, which rank low in digital adoption. Between these extremes lie Bangladesh and Cambodia, which are rapidly adopting certain aspects of digitalization. Nonetheless, at any given income level, Asian economies generally have adopted digitalization more than their global peers (Figure 8).<sup>5</sup>

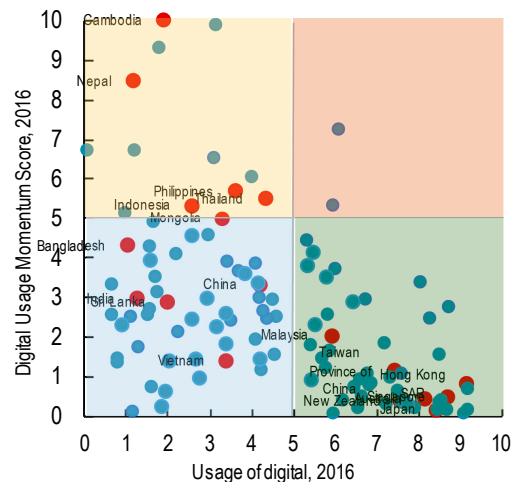
Less digitalized economies in Asia appear to be catching up. Digital convergence is likely given the accelerating speed of adoption by those at the lower end of the spectrum (Figure 9). Comparing the adoption of digital usage over 2012–16, the analysis in Figure 9 finds that the Asian advanced economies (Hong Kong SAR, Singapore, Japan, and Korea, for example) have relatively low levels of growth in this area, as they were already at high levels in the starting year (yellow quadrant). However, several ASEAN countries, as well as a few low-income developing countries with a lower level of ICT adoption, have gained significant momentum (green quadrant).

**Figure 8. GDP per Capita and Digital Usage**  
(Index 0–10)



Sources: IMF, World Economic Outlook; International Telecommunication Union; and IMF staff calculations.

**Figure 9. Digital Usage: Level and Momentum**  
(Index 0–10; Momentum change 2012–16)



Sources: IMF, World Economic Outlook; International Telecommunication Union; and IMF staff calculations.

### Use of Robotics

The use of higher-end digitalization products, such as robotic equipment,<sup>6</sup> is limited to a few select Asian

<sup>5</sup> Figures 8 and 9 are based on the Digital User's Index, which is a composite index created by IMF staff that consists of the average of six indicators: mobile phone subscriptions in terms of subscriptions per 100 population; percentage of individuals using the Internet; percentage of households with a personal computer; percentage of households with Internet access; fixed broadband Internet access in terms of subscriptions per 100 population; and mobile-broadband subscriptions in terms of subscriptions per 100 population.

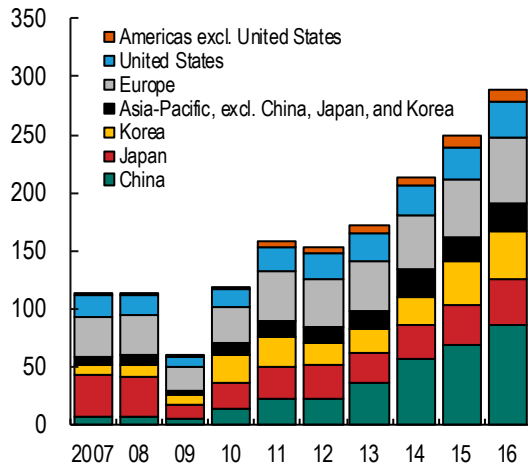
<sup>6</sup> Robotic equipment is classified as high-tech machinery and does not fall into the categories of ICT manufacturing and services. However, the International Federation of Robotics defines an industrial robot as an “automatically controlled, reprogrammable multipurpose manipulator programmable in three or more axes.” Industrial robots are stand-alone

economies. Over 60 percent of the world’s industrial robots are used in Asia, but China remains the dominant global player, with twice as many robots as the second largest consumer of robots, Korea (Figure 10). There were about 7.4 robots operating per 1,000 employees in manufacturing worldwide on average in 2016, but the comparable figures were 63 in Korea, 49 in Singapore, and 30 in Japan, far exceeding the global average (Figure 11). Nonetheless, a few emerging markets such as Thailand and India are also among the top users of industrial robots, illustrating that high-end digitalization goods are not restricted to high-income economies. Moreover, robot adoption in Asia continues to grow faster than in other regions.

### Use of Robotics

**Figure 10. Worldwide Destination of Industrial Robots by Region**

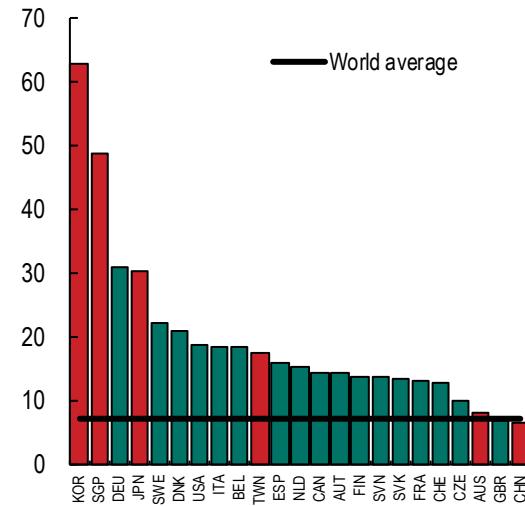
(Thousands of units)



Sources: International Federation of Robotics (2017); and IMF staff calculations.

**Figure 11. Robot Density in Manufacturing, 2016**

(Number of industrial robot stock, per 1,000 employees)



Source: International Federation of Robotics (2017).

### Fintech

Asia is second only to Europe in digital payments, with implications for traditional banking. Practices, however, vary across the region (Figure 12). For example, in Thailand, the launch of a government-backed electronic money transfer service forced banks to waive fees for retail e-transactions in April 2018, and mobile banking is replacing Internet banking (Figures 13 and 14). E-money is also gaining ground in Indonesia (Figure 15) and Malaysia, and in other economies, banks are reducing the number of physical branches and shifting toward digital banking.

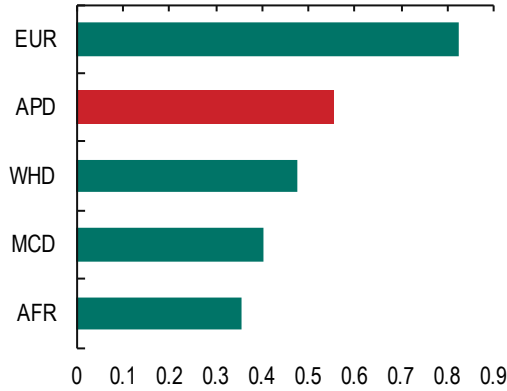
---

hybrid computer systems, thus, part of the broad definition of digitalization.

**Fintech**

*Asia's population is a strong user of digital payments...*

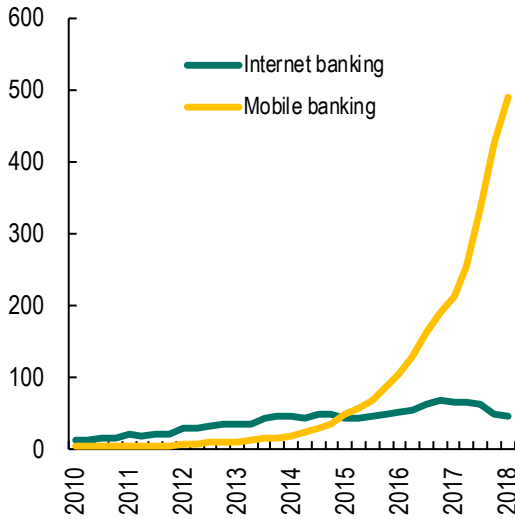
**Figure 12. Made or Received Digital Payments in 2016**  
(As a percentage of the population above 15 years of age)



Note: AFR = Africa Department; APD = Asia & Pacific Department; EUR = European Department; MCD = Middle East & Central Asia Department; WHD = Western Hemisphere Department.  
Source: World Bank, Global Findex database 2017.

*Mobile banking is overtaking Internet banking in Thailand...*

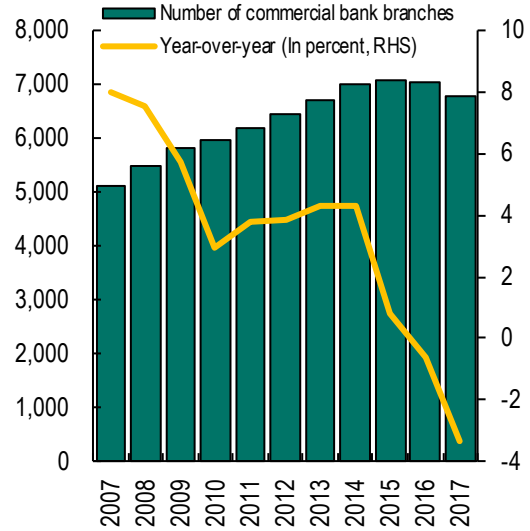
**Figure 14. Thailand: Transaction Volume**  
(In millions of units)



Sources: Haver Analytics; and IMF staff calculations.

*...and the rise of Fintech is having implications on traditional banking systems, with the number of bank branches declining.*

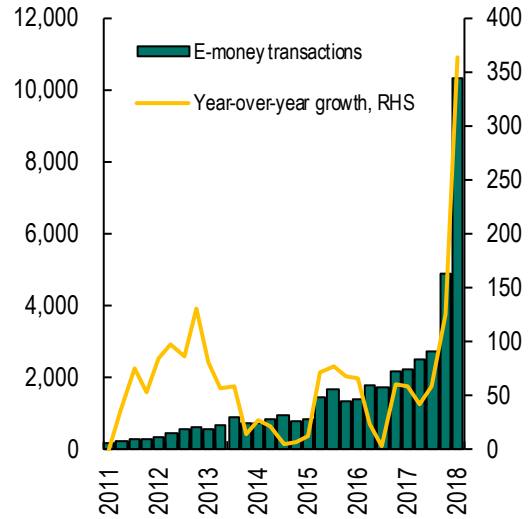
**Figure 13. Commercial Bank Branches in Thailand**  
(Unit)



Sources: Bank of Thailand; and IMF staff calculations.

*...and e-money transactions are gaining ground in Indonesia.*

**Figure 15. Indonesia: E-money Transactions**  
(Trillions Indonesian rupiahs)



Sources: Haver Analytics; and IMF staff calculations.

Although the Fintech revolution may not eliminate the need for traditional brokers and bankers, it has the potential to significantly reduce the costs and time involved in cross-border banking transactions, increasing banks' efficiency. Singapore's DBS, for example, reported that its digital customer businesses were 42 percent more profitable than traditional channels, with the highest margins of all on Internet-based services. Several other ASEAN banks are also launching full-digital banks, not only within their own country but also across borders. For example, Malaysia's CIMB group plans to launch its first full-fledged digital bank in Vietnam and the Philippines in 2018, while Singapore's DBS started India's first mobile-only bank in 2016 and launched Digibank in Indonesia in 2017.

## **E-commerce**

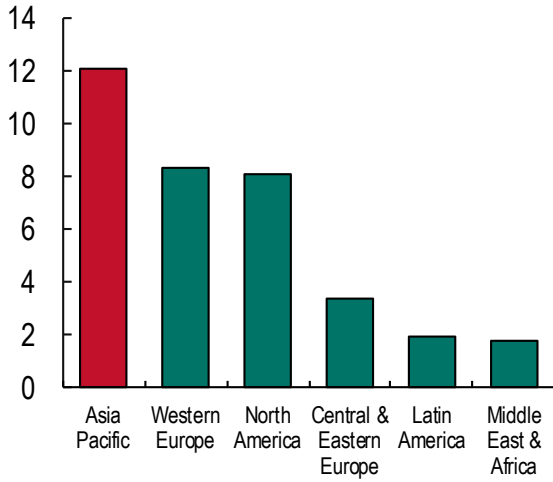
E-commerce is already large in Asia but has room to grow, given still low e-shopper penetration. Globally, Asia dominates other regions in terms of the share of retail sales that occurs via e-commerce (Figure 16). Internet connectivity and mass adoption of mobile technologies have made it easier for e-commerce companies to target consumers. For example, increasingly, online shoppers in China are buying via their mobile devices. However, this trend is not limited to China, as South Korea, Japan, and India are also among the top 10 economies in the world in terms of e-commerce sales (as a percentage of retail sales) (Figure 17). Economies that are not among the global trendsetters are also seeing rapid growth—Indonesia, for example, witnessed a fourfold increase in its e-commerce sales (as a percentage of retail sales) in a span of four years between 2014 and 2017 (Figure 18). Nonetheless, despite sound e-commerce developments over the years, Asia has considerable potential to grow its e-commerce. E-shopper penetration in Asia (the percentage of the online population that bought a product online) is the lowest globally, highlighting Asia's still untapped market (Figure 19).

**E-commerce**

*Asia has the largest e-commerce sale regionally...*

*...with China leading the way.*

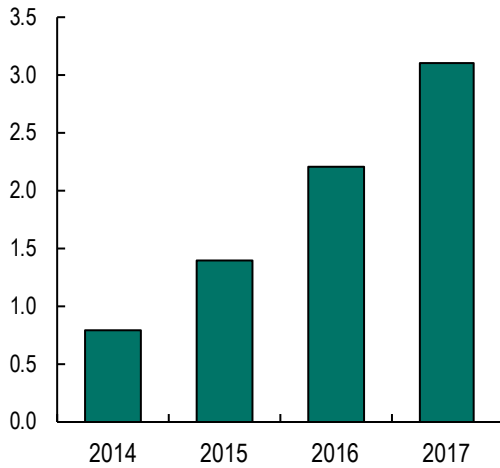
**Figure 16. E-commerce Sales**  
(In percent of total retail sales, 2016)



Sources: ystats.com; and IMF staff calculations.

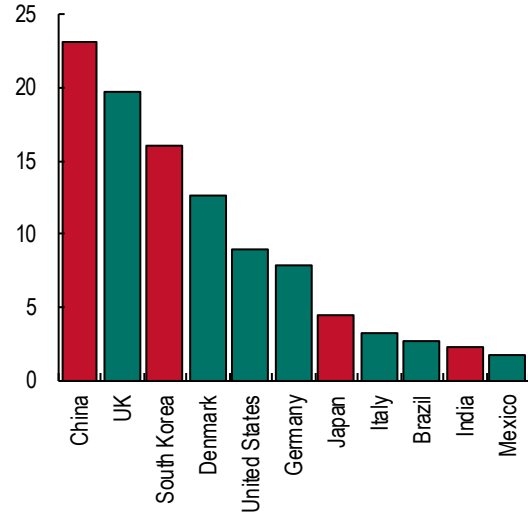
*But other emerging markets such as Indonesia are catching up...*

**Figure 18. Indonesia: E-commerce Sales**  
(Percent of total sales)



Sources: eMarketer; and IMF staff calculations.

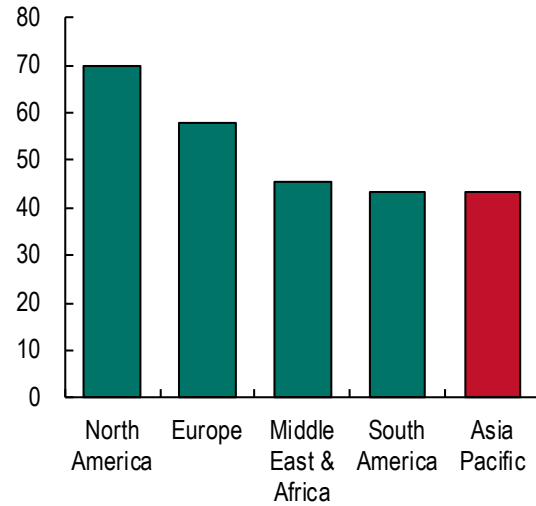
**Figure 17. E-commerce Sales: Selected Economies**  
(Percent of retail sales)



Sources: Statista; and IMF staff calculations.

*...and e-commerce has room to grow in Asia.*

**Figure 19. E-shopper Penetration**  
(In percent of total number of internet users)

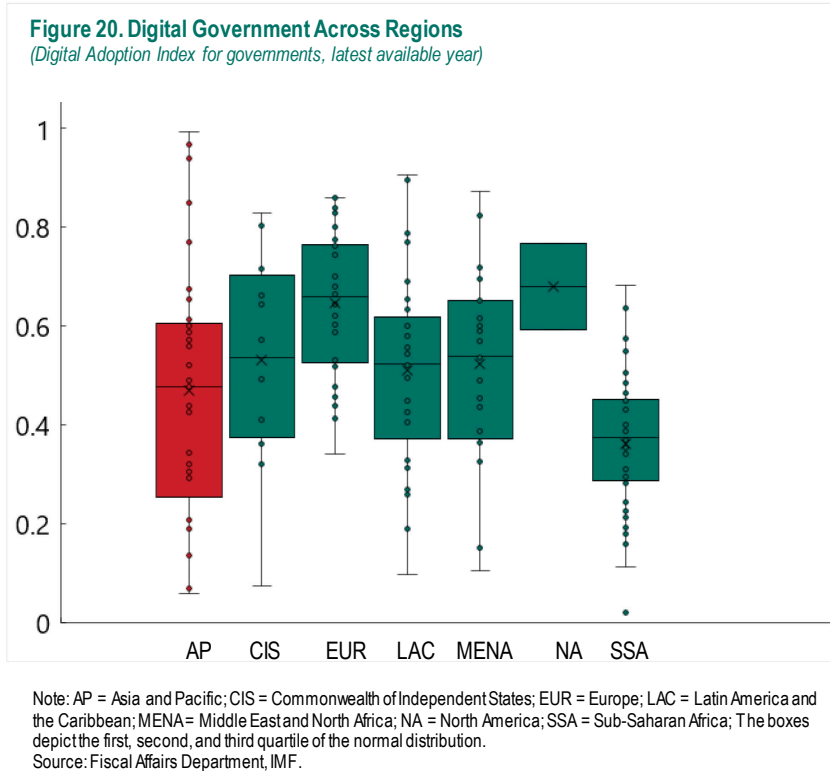


Sources: E-commerce Foundation; and IMF staff calculations.



## Public Finance

Some Asian economies are at the forefront of digital business and digital government, while others have room to do more. Overall, Asian economies span the gamut in terms of government adoption of digital technologies, but lag economies in North America and Europe (Figure 20).<sup>7</sup> Nonetheless, the top three global leaders in terms of digital adoption are from Asia: South Korea, Singapore, and Japan. Malaysia, India, and China also perform better than the European average.



## Innovation

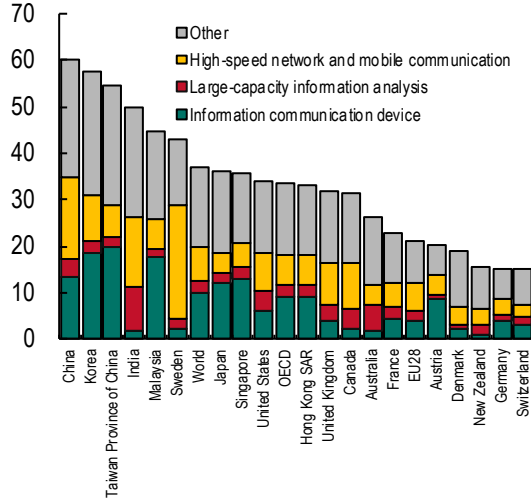
Innovation in Asia is tilted towards ICT. The top five economies in terms of the ICT share of patents are all Asian—China, Korea, Taiwan Province of China, India, and Malaysia. Japan and Singapore also outperform the United States and the OECD average (Figure 21). This is a promising indication that the ICT patents may ultimately develop into digitalization products that may propel growth, but this transition has yet to take place. Among the top 10 technology companies by market capitalization, only three are in Asia. The R&D expenditures of these companies are also below those of their competitors in other regions (Figure 22).

<sup>7</sup> The World Bank developed the Digital Adoption Index for its *World Development Report: Digital Dividends* (World Bank 2016).

**Innovation**

*Innovation in Asia is tilted towards information and communications technology (ICT)...*

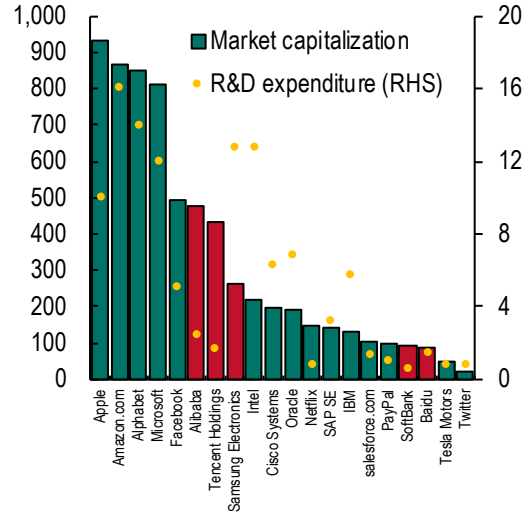
**Figure 21. Specialization in ICT-related patents, 2012-15**  
(Patents in ICT as a percentage of total IP5 patent families)



Sources: Organization for Economic Cooperation and Development Science Technology, and Innovation Micro-data Lab; Intellectual Property; and IMF staff calculations.

*...but Asian tech companies lag in terms of market size.*

**Figure 22. Tech Companies by Market Capitalization**  
(In billions of US dollars, as of July 31, 2018)

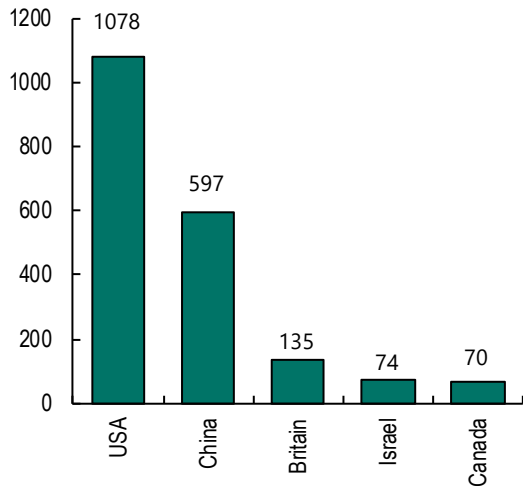


Sources: Bloomberg; and IMF staff calculations.

China is beginning to lead in computing power. As early as 2014, China overtook the United States in terms of terabytes processed in a minute. It is also catching up to the United States in terms of the number of supercomputers, as well as artificial-intelligence enterprises (Figures 23 and 24).

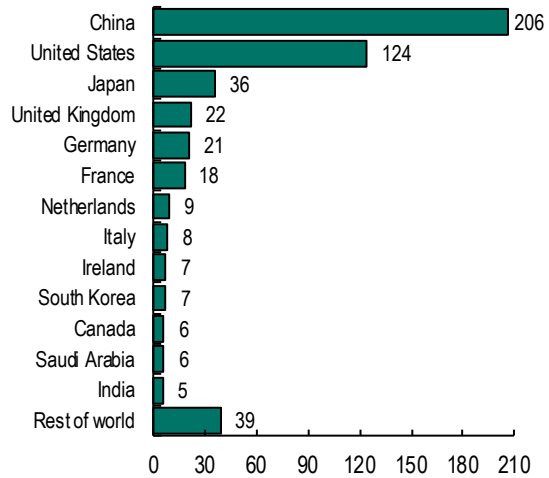
**Global Leaders in Artificial Intelligence and Computing Power**

**Figure 23. Number of AI Enterprises**  
(Units, 2016)



Sources: Statista; and IMF staff calculations.

**Figure 24. Distribution of Most Power Supercomputers**  
(Units, 2017)



Sources: Statista; and IMF staff calculations.

## Asia's Growth: From Perspiration to Digital Inspiration

A classic question in the literature is whether Asia's remarkable growth has been driven more by factor accumulation or by technological progress—in other words, by “perspiration or inspiration.” This section offers a new twist on this question by focusing on the role of digital technologies, in particular. The analysis finds that the diffusion of technological innovation has been the driver of growth in Asia since the 1990s, with innovation in the digital sector accounting for around 28 percent of growth in per capita GDP. Rapid accumulation of human capital has also contributed, but interestingly, and in contrast to the past, capital deepening has not, suggesting that Asia has transitioned to rely more on technological progress to drive economic growth.

Asia has maintained remarkably high growth rates, accounting for nearly two-thirds of global growth. Much of the debate on Asia's strong growth performance has centered on whether this growth reflects increases in total factor productivity (TFP) or factor accumulation (Young 1992, 1994, 1995; Kim and Lau 1994). Early research using data for 1965–90 found that most, and in some cases all, growth had come from factor accumulation, especially capital. Krugman (1994) popularized the zero TFP growth thesis and provocatively argued that Asian growth was mainly a matter of perspiration rather than inspiration—of working harder, not smarter. This section takes a fresh look at this debate, focusing on the role of digitalization.

To tackle this issue, the respective contributions of the various sources of growth are calculated using the accounting framework presented in Jones (2002), which allows estimation of the contribution of the digital sector using a (semi-) endogenous growth accounting framework.<sup>8</sup> In this framework, growth in labor productivity (that is, increases in output per worker,  $y^*$ )<sup>9</sup> is decomposed into (1) capital intensity ( $K/Y$ , or capital deepening); (2) rising labor quality ( $h$ , or human capital per worker); and (3) growing TFP, or the stock of ideas/knowledge. This last term is proxied by the frontier economies' contribution to research (Romer 1990; Aghion and Howitt [AH in Table 1] 1992; Grossman and Helpman [GH] 1991), measured by R&D intensity (the share of workers doing research) in both ICT and non-ICT sectors, and population growth (Jones [J] 1995; Kortum [K] 1997; Segerstrom [S] 1998) (Table 1).

**Table 1. United States: Growth Accounting 1950–2007**

$$y^* \approx \left(\frac{K}{Y}\right)^\beta * h * (R\&D \text{ intensity})^\gamma * L^\gamma$$

	Solow	Lucas	Romer/AH/GH	J/K/S
	2.0	0.0	1.2	0.4
	(100%)	(0%)	(58%)	(21%)

Note: Growth rates and shares of overall growth show the contribution of each term in the equation to growth in US GDP per hour from 1950 and 2007.

Source: John G. Fernald and Charles I. Jones (AER, 2014).

One of the main pillars of this framework is that growth in TFP depends on new ideas. Production of new ideas is related to the number of researchers, their efficiency, and the stock of existing ideas. Unlike physical

<sup>8</sup> This growth accounting/decomposition is valid across two points in time under general assumptions, but is not a steady-state relationship. The accounting exercise is in the same spirit as classic work in growth accounting by Solow (1957), but it differs in an important way. It is based on a complete growth model that endogenizes TFP growth (which is exogenous in the traditional Solow growth accounting framework) by appealing to the diffusion of new ideas produced by research labor at the global frontier (see Jones 2002, 227–29 for details).

<sup>9</sup> This can also be seen as growth in per capita GDP

and human capital, which are rival in use, ideas can be shared by all (that is, they are nonrival). While capital deepening and rising education attainment (measured by years of schooling as a proxy for human capital) have bounded effects on output per person, higher R&D intensity in employment can raise TFP and thus support GDP growth on a more sustained basis. For economies with still-low R&D intensity, such as China, the number of researchers can increase for a while even as population growth slows.

## Asia's Rising R&D Intensity

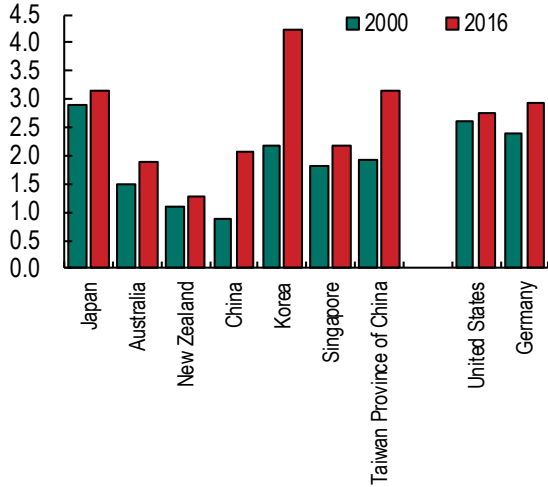
While technological developments have historically been concentrated in a few large industrialized economies, mainly the United States and Europe, Asia is increasingly contributing to the global stock of ideas, as the region's R&D intensity has increased significantly. Jones (2002) and Fernald and Jones (2014) focus on the United States and use G5 economies (France, Germany, Japan, the United Kingdom, and the United States) in constructing a measure of the global stock of R&D ideas. This section adds the evolving role of emerging market economies, particularly in Asia. Thus, China, Korea, and Taiwan Province of China have been added as contributors to global knowledge. Since size matters in the Jones (2002) and Fernald and Jones (2014) framework, and since the creation of new ideas is ultimately a function of population, it stands to reason that Asia, with its large and fast-growing population, should also increasingly contribute to global knowledge.

R&D efforts, whether measured in terms of expenditure or number of researchers, have risen globally in recent decades. Asian economies have seen especially rapid growth in R&D, particularly in China, Korea, and Taiwan Province of China. The R&D-expenditure-to-GDP ratio and the share of researchers in total employment (R&D intensity) are both higher in Japan, Korea, and Taiwan Province of China than in, for example, the United States (Figures 25 and 26). In addition, Asia's share of so-called "triadic" patent families (that is, patent applications filed in Japan, Europe, and the United States)<sup>10</sup> has increased to 43 percent, helped by a strong rise in China's and Korea's shares over the past 15 years (Figure 27). Asia, however, still has scope for growth—R&D intensity in China, for instance, has more than doubled since 2000 but is still at relatively low levels.

---

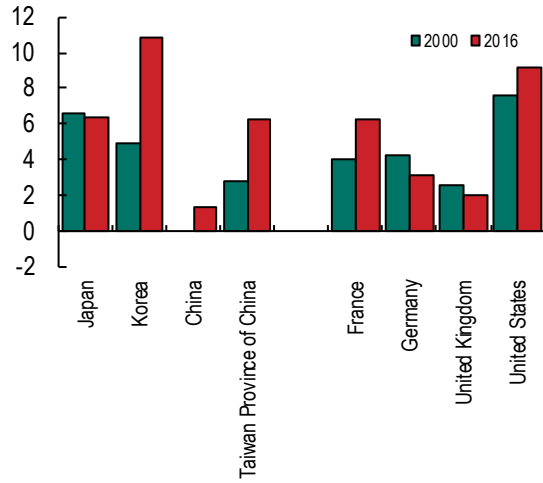
<sup>10</sup> Triadic patent families are a set of patents filed at these three major patent offices: the European Patent Office, the Japan Patent Office, and the United States Patent and Trademark Office.

**Figure 25. R&D Expenditure**  
(Percent of GDP)



Sources: OECD Statistics; and IMF staff calculations.  
Note: For some countries, available data could be as of 2001 or latest available.

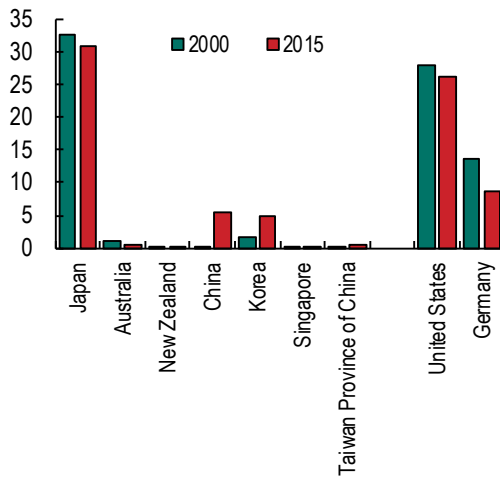
**Figure 26. R&D Intensity**  
(Percent of researchers in total employment)



Source: Organization for Economic Cooperation and Development; and IMF staff estimates.

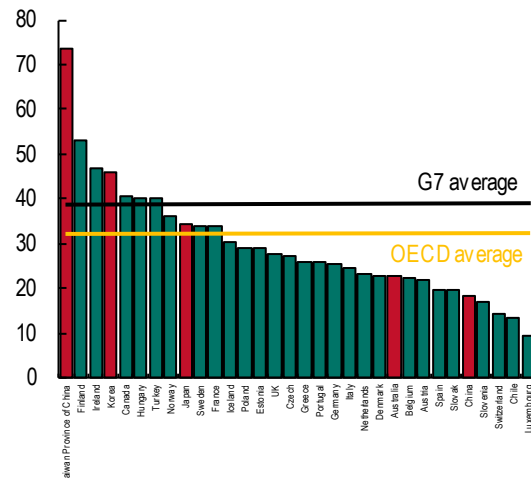
Asia's R&D intensity in the digital sector and patents in the digital sector have increased even faster, but important heterogeneity exists. The share of researchers working on the digital sector ranges from 18 percent in China to 23 percent in Australia, 34 percent in Japan, 46 percent in Korea, and 73 percent in Taiwan Province of China, as against an OECD average of 30 percent (Figure 28).

**Figure 27. Share of Countries in Triadic Patent Families**  
(Percent)



Source: Organization for Economic Cooperation and Development Statistics.

**Figure 28. Percentage of ICT Researchers**  
(Percent of total number of researchers)

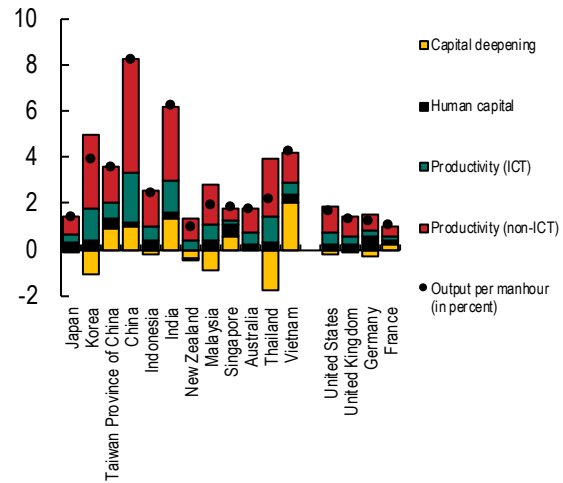


Sources: Organization for Economic Cooperation and Development, Research and Development Statistics: Business Enterprise R-D Expenditure by Industry - ISIC Rev. 4; and IMF staff calculations.  
Note: ICT = Information and Communications Technology.

## Results

While the earlier literature found that factor accumulation was the key driver of Asia’s growth in the 1960s, 1970s, and 1980s, this section finds that TFP growth (or technological progress) explains most of the economic growth over 1995–2016, though the results vary across countries. In advanced economies, which are closer to the global frontier and have older populations with greater human capital, factor accumulation played a more limited role than in emerging and developing economies. Increases in human capital contributed 11.9 percent to per capita income growth on average, with the contribution ranging from -0.5 percent in New Zealand to 27 percent in Singapore. For some economies in the region, especially those that were affected by the Asian financial crisis, the process of capital deepening made a negative contribution to per capita income growth, ranging from 78.6 percent in Thailand to 7.2 percent in Indonesia (Figure 29).

**Figure 29. Sources of Economic Growth, 1995–2016**  
(Percentage points)

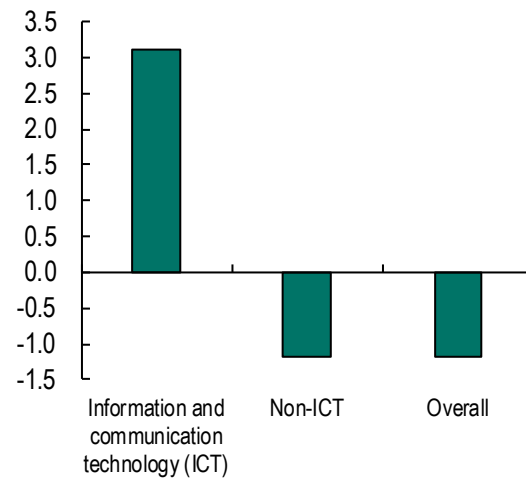


Sources: Organization for Economic Cooperation and Development; Fernald and Jones (2014); and IMF staff estimates. Note: ICT = Information Communication Technology.

More interestingly, the analysis for this section finds that innovation in the digital sector contributed to around 28 percent of per capita growth over 1995–2016, with contributions ranging between 12 percent (Singapore) and 49 percent (Thailand). Since the analysis uses the narrow definition (based on the OECD framework), the share of researchers working on the digital sector could be underestimated. Thus, the contribution of the digital sector to per capita growth could be higher if a broader definition of digitalization were used.

In addition, these estimates do not capture the overall contributions from the digital sector to growth, since the additional contributions from digital capital stock could not be estimated due to data availability issues across economies. Indeed, in some economies, where data are available (for example, Korea), there is evidence that the deepening of ICT capital is taking place at a faster pace than that of non-ICT capital, implying that the negative contribution from the capital deepening could have been even higher without the ICT capital (Figure 30). Similarly, in Japan, real fixed investment in computer software and ICT equipment grew at annual average growth rates of 4.2 percent and 5.2 percent, respectively, over 1995–2016, as compared to -0.1 percent for overall fixed investment. In Singapore, intellectual property product capital stock (9 percent of net capital stock as of 2017), which includes computer software and databases, grew twice as fast as the overall capital stock growth during 1995–2016, helping increase its share in real GDP to nearly 25 percent.

**Figure 30. Korea: Capital Deepening, 1995–2016**  
(Percent change; year-over-year average)



Sources: Bank of Korea; Haver Analytics; and IMF staff calculations.

Looking forward, the digital sector will likely be an even more important driver of growth in Asia. Indeed, assuming that current trends continue, innovation in the digital sector could account for 36 percent of Asia's economic growth within 15 years.

## Conclusion

This section has estimated the contribution of the digital sector to Asia's per capita growth over the past 25 years. Technological progress is found to have been the main driver of Asia's per capita growth, and digital technological progress is especially important, accounting for between 12 and 49 percent of per capita growth.

The next four sections dive down more deeply into specific aspects of the digital revolution, starting with automation and the future of work.

## Automation and the Future of Work in Asia

This section analyzes the impact of robot usage on employment across a large sample of economies in Asia, Europe, and the Americas. The analysis finds no evidence that robots destroy jobs on net. Restricting attention to Asia, however, there is a slight negative impact on overall manufacturing employment, and particularly so in certain heavily automated sectors. Furthermore, the analysis finds that workers with medium-level education are more vulnerable to displacement than those with either low or high education levels. Interestingly, in Japan, with its aging population and declining labor force, increased robot density in manufacturing is associated not only with greater productivity, but also with local gains in employment and wages.

Automation, like other technological changes, brings both opportunities and challenges.<sup>11</sup> By reducing costs and improving productivity, it may boost economic growth at a time of lackluster productivity growth and demographic headwinds. But the fear is that it may disrupt labor markets in transition as it takes over tasks and makes traditional jobs obsolete. One of the most notable and much discussed examples of automation technologies is the use of industrial robots. In 2016, there were about 1.8 million industrial robots—machines that are automatically controlled and reprogrammable to perform physical, production-related tasks—operating in the world, and their usage has been growing at double-digit rates in recent years (International Federation of Robotics 2017). More importantly, they are becoming more flexible, safer, and cheaper.

---

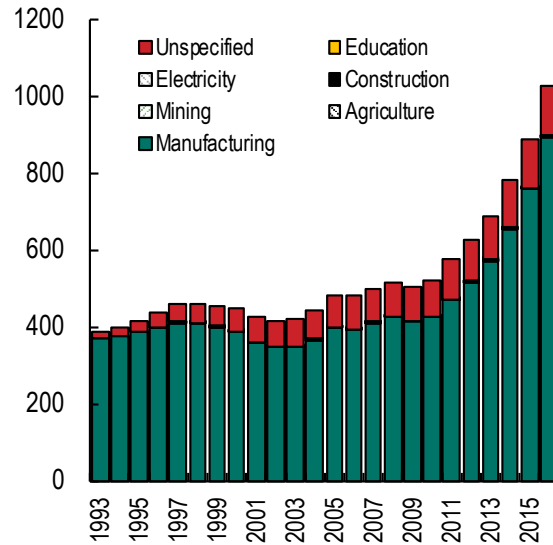
<sup>11</sup> Automation is undergoing a “Cambrian explosion” (Pratt 2015; McAfee and Brynjolfsson 2017), leading to a massive increase in the diversification and applicability of automation, ranging from artificial intelligence to robots, drones, self-driving cars, distributed ledger technologies, smart contracts, and decentralized autonomous organizations. This section focuses on industrial robots because of data availability.

Many economies in Asia have been at the forefront of automation using industrial robots. More than half of the estimated operational stock of industrial robots is in Asia (1 million units out of a total of 1.8 million units in 2016). These robots are used almost exclusively in manufacturing, with automotive manufacturing being by far the most automated subsector (Figure 31). In several Asian economies, the rise of industrial robots in recent years has also been driven by their use in the manufacturing of computers and electronics.

Automation can have two opposing effects on employment. On the one hand, robots may displace jobs, as they replace human labor and reduce labor demand directly. But on the other hand, they may also increase labor demand by boosting productivity and facilitating expanded production (Acemoglu and Restrepo 2017a). Furthermore, the employment impact of industrial robots may also indirectly reach across industries, as a productivity boost in one sector may have positive spillovers across supply chains, thus raising total production and income in the overall economy (Autor and Salomons 2018).

The analysis for this section finds a negative impact of robots on manufacturing employment in Asia, but not in the world overall (Figure 32).<sup>12</sup> Following the framework of Acemoglu and Restrepo (2017a), the analysis finds that robot penetration is not significantly associated with net employment losses in a sample of 14 manufacturing subsectors in 40 economies in Asia, Europe, and the Western Hemisphere for the period 2010–14. This suggests, contrary to some observers' worst fears, that the job-creating productivity effect of automation might have offset the displacement effect even at the industry level. When restricting attention to Asia, however, the analysis finds that the increased use of robots is associated with lower employment growth. One more robot per 1,000 employees is associated with a 0.26 percentage point decrease in employment growth in manufacturing sectors. The negative employment effect estimated for Asian economies is driven by highly automated sectors and economies, such as manufacturing of automotive components, plastic and rubber products, and electronics, where robot density was relatively high already in 2010 and has been increasing rapidly since then. This suggests that as automation intensifies, the job displacement effect may start to outweigh the productivity effect at least in the short run at the sectoral levels. This implies that a critical mass of robots may be needed before the impact becomes apparent. Also, it is important to note that employment data do not capture jobs created outside the sectors (for example, companies providing robotics repair and maintenance services).

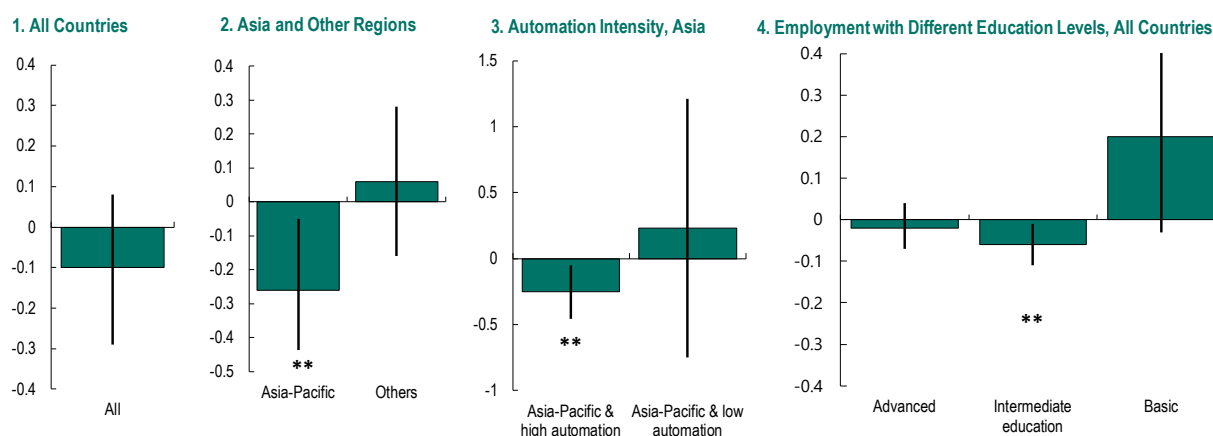
**Figure 31. Asia: Industrial Robots by Industry**  
(Thousands of robots)



Source: International Federation of Robotics (2017).

<sup>12</sup> The underlying regressions are available upon request. The results of this analysis do not capture potential spillover effects of manufacturing sector automation on employment of other sectors (for example, services).



**Figure 32. Estimated Effect of the Use of Robots on Employment Growth, 2010–14***(Percentage points, associated with one more robot per 1,000 workers)*

Sources: International Federation of Robotics; World Input-Output Database; International Labor Organization; and IMF staff calculations

Note: Figure is based on regressions of the changes in employment on the changes in robots per 1,000 employees during the period 2010–14. The left three charts are based on 14 manufacturing subsectors in 40 countries, and the right chart is based on countries for which education breakdown of employment data is available. Intermediate education refers workers with upper secondary and post-secondary non-tertiary education. Bars show the estimated total effects calculated based on the estimate coefficients for each specified group in the horizontal axis. Error bars refer to the 95 percent confidence interval. \*\* p&lt;0.05.

The impact of automation, however, depends on country-specific conditions. For example, in Japan, whose demographics dictate a declining labor force, increased robot density in manufacturing is associated not only with greater productivity, but also with local gains in employment and wages. Specifically, panel regressions using estimated prefecture-level robot density show that Japanese prefectures with higher exposure to robots had higher productivity and employment growth. The analysis for this section finds that the prefectures more exposed to robots have sizable positive effects on local labor market outcomes as well as productivity—an increase of robot density by 1 percent corresponds to a 15 percent increase in TFP growth for all samples, and of 6 percent in a manufacturing subsample. In addition, employment growth is also positively correlated—a 1 percent increase in robot density leads to a 0.2 percent increase in employment growth. Japan’s experience suggests that other Asian economies such as China, Korea, and Thailand facing similar demographic trends in the future may also benefit from automation (Box 1).

Automation has an uneven impact on employees with different skill levels (Figure 32, panel 4). Automation will render many jobs obsolete, and many will be created and changed. Jobs that are most susceptible to automation tend to involve routine and manual tasks, most prevalent in manufacturing. Those jobs have traditionally been performed by workers with mid-level skills or in the middle of the pay scale (Autor, Levy, and Murnane 2003; UNCTAD 2017). Several studies have documented that the use of industrial robots has a negative impact on middle- or low-skilled workers, with little effect on high-skilled jobs (Graetz and Michaels 2015; see also Chapter 2 of the October 2018 *World Economic Outlook*). The analysis here also finds supporting evidence of an uneven impact: penetration of industrial robots is negatively related to employment growth for workers with secondary education, while there is no significant relation for those with higher education. For workers with upper-secondary education (for example, high school), a one standard deviation increase in robot penetration at the economy level (equivalent to about 0.12 more robots per 1,000 employees in an economy over the period of 2010–14) is associated with a decrease in employment of about 0.24 standard deviations (or about a 0.01 percentage point decrease in employment in the sample) on average across the sample economies.

The challenge is how to manage the transition. Automation will help increase productivity (Graetz and Michaels 2015), and, as noted above, it may be necessary in the face of population aging. Acemoglu and Restrepo (2017b) find that economies with more pronounced demographic changes tend to invest more in automation technologies, and that helps mitigate the potential negative effect of aging on productivity and output. The challenges with automation, however, involve supporting those who are more vulnerable to changes and in need of a transition to new jobs. The analysis suggests that automation-induced labor market

changes may already be happening in some highly automated sectors in Asia. As automation intensifies, there will be a bigger transition necessary, and more workers may be in need of new jobs, especially those who are less skilled. It is thus imperative to provide training and re-training opportunities to help workers adapt and acquire skills that will be in demand. The October 2018 *World Economic Outlook* also finds that policies that help create more flexible labor markets, such as active labor market policies, can help absorb employment displacement related to automation.

Neither the opportunities nor the challenges have become fully apparent, as robots have not yet been widely used. As with past technologies, productivity effects await complementary innovations. For example, to boost productivity, firms need to redesign production processes and occupations. As these changes are slow, the impact of automation on productivity may even follow a “J-Curve,” that is, productivity may even decline before it ultimately increases (Brynjolfsson, Rock and Syverson 2017).

## E-commerce as a New Engine for Growth

E-commerce can support growth. The econometric analysis shows that participation in online commerce is associated with a more than 30 percent increase in TFP at the firm level in Asia. Innovation, human capital, and to some extent access to finance account for online firms’ better performance. Finally, the analysis for this paper finds that firms engaged in e-commerce also export 50 percent more, relying on their skilled labor force and capacity to innovate. Interestingly, e-commerce seems to be especially beneficial for small firms in Asia.

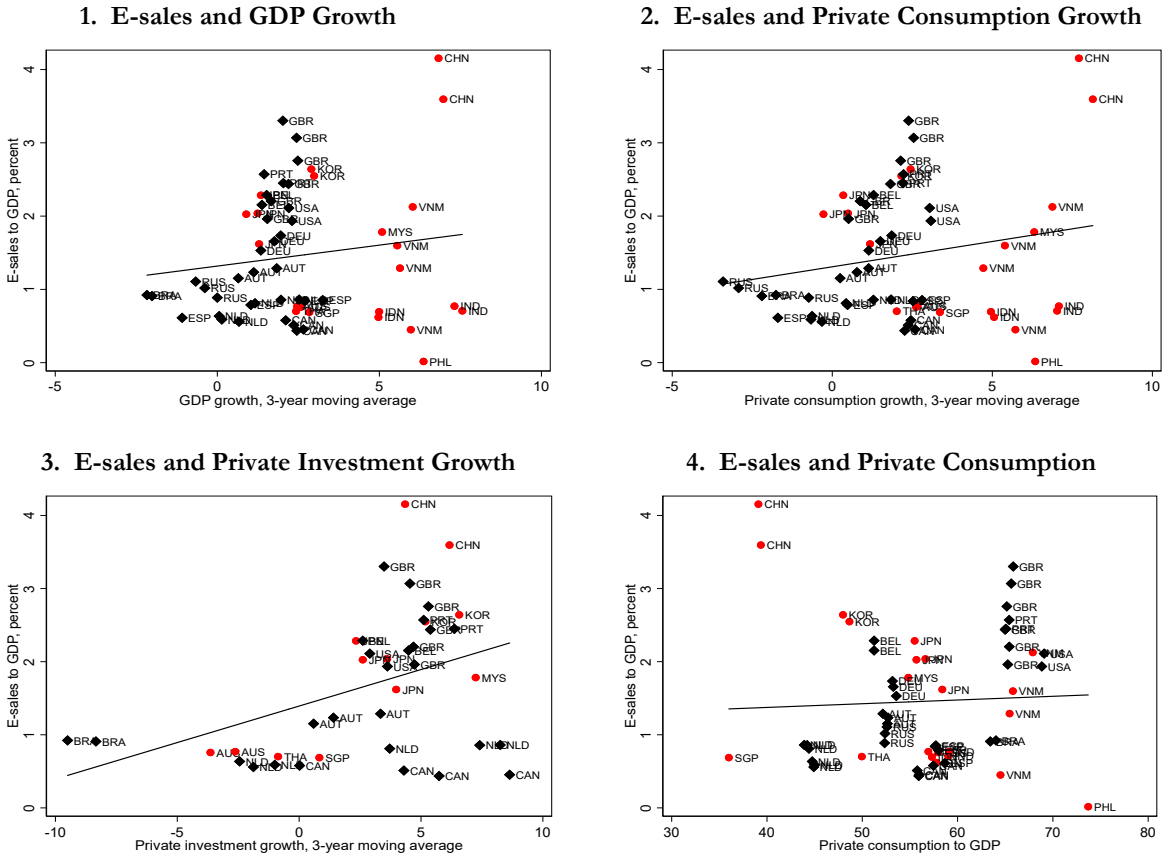
E-commerce can boost private consumption and investment. For consumers, e-commerce may translate into better access to a wide range of products and services at lower prices, ultimately boosting consumption (Figure 33).<sup>13</sup> Two studies by McKinsey in China and Indonesia highlight that e-commerce generates new consumption. In China, one study shows that out of \$100 in Internet spending, close to 40 percent represents incremental (new) consumption while the remaining 60 percent is diverted from traditional offline retail channels (Dobbs and others 2013). In Indonesia, about 30 percent of online commerce spending is new consumption, capturing previously untapped needs (Das and others 2018). For firms, e-commerce could also provide new business opportunities and access to larger markets, supporting investment.

E-commerce has great potential to improve labor and capital productivity, including for small and medium enterprises. Fast-growing cross-border e-commerce is also gaining traction, bringing greater potential to increase participation in regional and global value chains and support international trade. The empirical literature on the impact of e-commerce on firm activity is limited, but existing evidence suggests an overall positive effect on firm performance. Using firm-level data for 14 European economies covering 2002–10, Falk and Hagsten (2015) show that an increase in e-sales by 1 percentage point raises labor productivity growth by 0.3 percentage points, with a larger effect for small firms and those in the services sector. Yang, Shi, and Yan (2017) show that e-commerce participation has the potential to positively impact firms’ productivity in China. The World Bank (2016) shows that firms using e-commerce in Vietnam had on average 3.6 percentage points higher TFP growth than firms not using e-commerce.

---

<sup>13</sup> While e-sales seem to be associated with higher consumption growth, the analysis does not find evidence that economies with higher e-sales have a higher share of private consumption to GDP.

**Figure 33. E-sales and Macroeconomic Outcomes**



Source: IMF Staff Estimates.

## Evidence from Firm-Level Data Highlights the Benefits of E-commerce for Productivity

This section provides a novel analysis of performance differences between firms engaged in e-commerce and other firms. It relies on World Bank Enterprise Surveys (WBES) and uses a comprehensive sample of developing economies, including several Asian economies during 2006–12.<sup>14</sup> The WBES data include information on firms’ inputs and outputs as well as various characteristics of firms such as age, size, foreign ownership, and export status.

Firms with online activities differ on many fronts from other firms. Evidence from the WBES suggests that firms engaged in e-commerce activities tend to have a more educated labor force and better access to finance, and they innovate more than other firms (Table 2). For instance, a larger portion of online firms, relative to other firms, introduced new products or processes, used technology licensed from a foreign company, spent on R&D, or acquired internationally recognized quality certifications. Possibly reflecting the above factors, e-commerce firms tend to enjoy higher sales, value added, stock of capital, and exports than non-e-commerce firms.

<sup>14</sup> The sample includes 78 developing economies across all regions, including six Asian economies (China, Indonesia, Mongolia, Nepal, the Philippines, and Vietnam) that are pulled together to construct a cross-country dataset. Each survey is carried out between 2006 and 2012. E-commerce is a dummy variable taking one if a firm uses an Internet connection to order purchases from other establishments or to deliver products and services to clients.

**Table 2. Selected Characteristics of E-commerce Firms**

	All Countries		Asia	
	E-commerce	Other Firms	E-commerce	Other Firms
<b>Innovation</b>				
Firms owning a website (%)	70.9	53.6	76.0	57.4
Communicate by e-mail with clients and suppliers (%)	97.5	82.9	94.0	72.3
Use of technology licensed from a foreign company (%)	21.2	13.4	28.9	10.4
Internationally-recognized quality certification (%)	32.1	24.0	62.9	42.3
New products/services introduced during last 3 yrs (%)	59.1	45.0	51.2	36.5
Improved process introduced during last 3 yrs (%)	57.8	46.5	71.1	51.1
Did the firm spend on R&D during last fiscal year (%)	50.4	36.6	46.7	33.0
<b>Human capital</b>				
Workers with completed high school education (%)	73.0	63.7	61.8	56.1
Workers with high university degree (%)	10.4	9.8	10.3	9.8
Firms with formal training to employee last fiscal year (%)	65.8	59.9	88.1	77.6
<b>Finance</b>				
Firms with line of credit or loan (%)	53.9	42.8	36.8	23.9
Firms with overdraft facility (%)	59.4	47.6	33.9	27.2
<b>Other firm characteristics</b>				
Establishment part of a large firm (%)	21.2	18.1	13.8	11.6
Number of employees (median)	38.0	30.0	70.0	50.0
Foreign participation in capital (%)	10.7	7.8	4.5	2.0
Age (median)	16.0	14.0	11.0	11.0
<b>Perception on key investment climate factors</b>				
Telecommunication as an obstacle (% of firms)	40.4	30.2	6.5	4.8
Customs/trade regulations as an obstacle (% of firms)	34.9	24.0	6.6	3.5
Transport as an obstacle (% of firms)	41.3	32.3	14.1	8.5
<b>Performance</b>				
Annual sales (in thousands of US dollars, median)	1743	1157	2693	1553
Value added (in thousands of US dollars, median)	563	418	1095	619
Export in total sales (%)	6.7	4.2	7.4	3.8
Stock of capital (in thousands of US dollars, median)	537	348	1109	713
Purchase of fixed assets in last fiscal year (%)	60.5	52.4	53.9	45.1

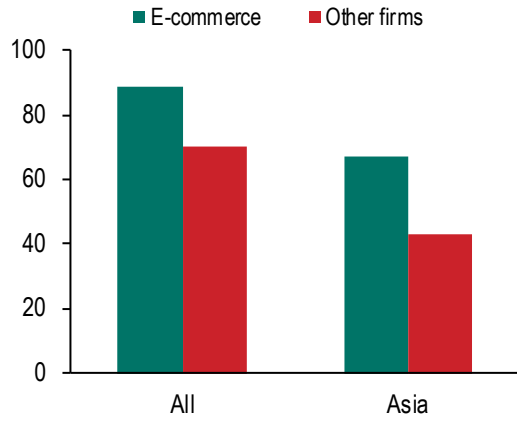
Source: World Bank, Enterprise Survey; and IMF staff calculations.

Firms with online activities have higher labor productivity. A first look at labor productivity, defined as the ratio of value added to the number of employees, highlights that firms with online activities (sales or purchases) have higher labor productivity (Figures 34 and 35). In Asia, firms engaged in online activities seem to have sizably higher labor productivity—on average 50 percent higher than other firms.<sup>15</sup>

<sup>15</sup> Potential outliers are excluded (top 1 percent and bottom 1 percent most/least productive firms) to avoid significant distortions of average figures.

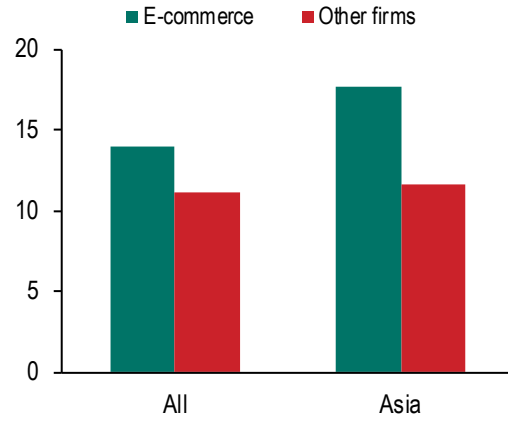
### Labor Productivity Differences between Online and Other Firms

**Figure 34. Labor Productivity**  
(Average, in thousands of US dollars)



Sources: World Bank, Enterprise Survey; and IMF staff calculations.  
Note: Labor productivity is the ratio of value added by the number of employees.

**Figure 35. Labor Productivity**  
(Median, in thousands of US dollars)

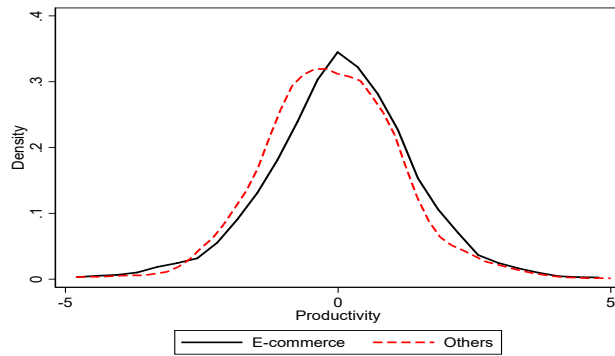


Sources: World Bank, Enterprise Survey; and IMF staff calculations.  
Note: Labor productivity is the ratio of value added by the number of employees.

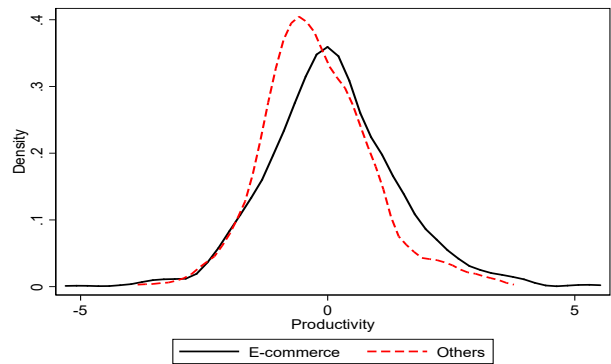
Firms with online activities, including small firms, also have higher TFP. To capture a more complete picture of the performance differential between firms with online activities and other firms, this section analyzes those differences in TFP.<sup>16</sup> Comparing the distribution of TFP between the two groups of firms confirms that firms with online activities have higher productivity, particularly in Asia. Interestingly, e-commerce seems to be especially beneficial for small firms in Asia (Figure 36).

**Figure 36. Distribution of Total Factor Productivity**

1. All Economies (All Firms)

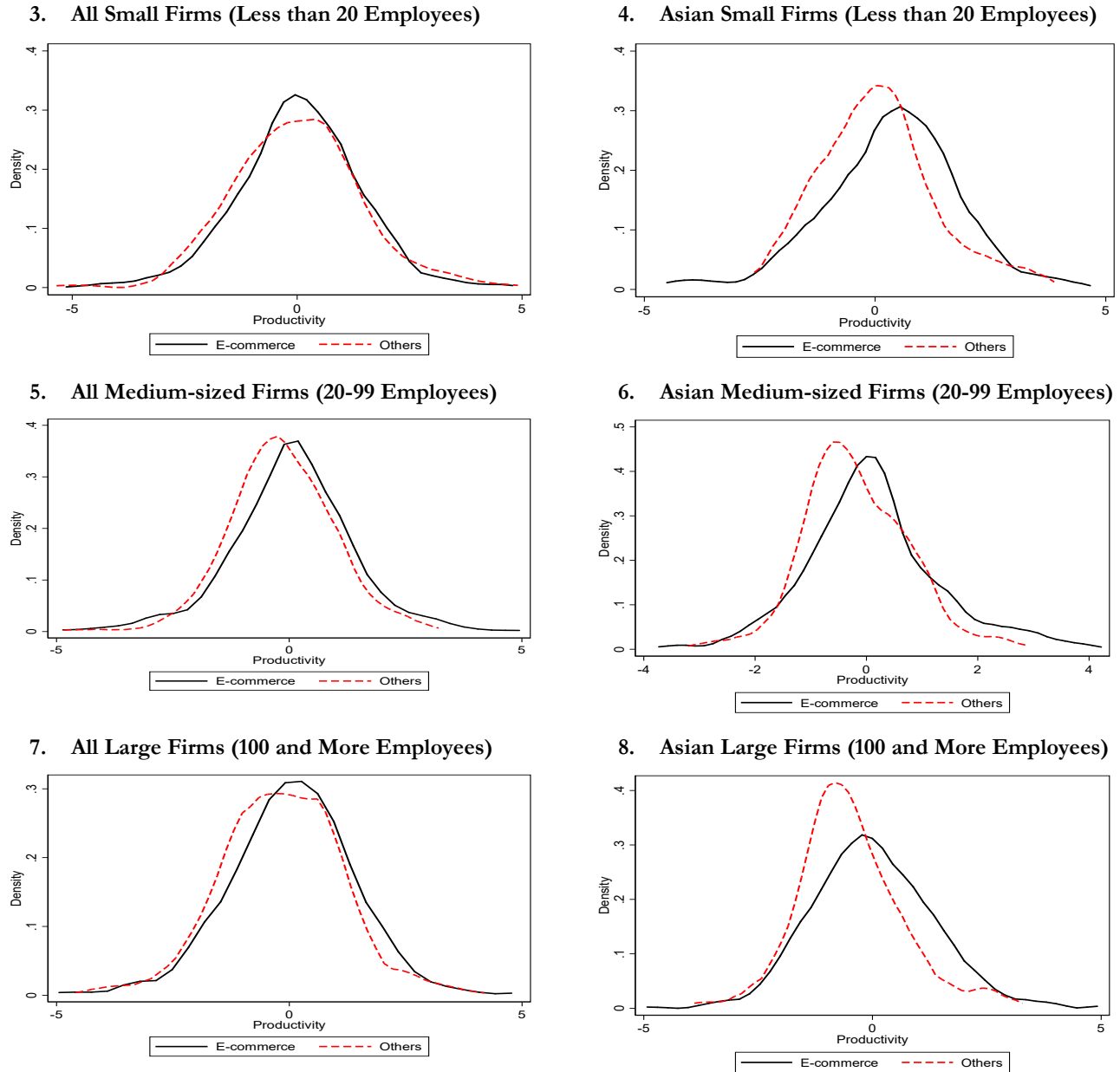


2. Asia (All Firms)



<sup>16</sup> This section estimates the TFP for each firm as a residual of an equation explaining the value added of each firm  $i$ , in country  $c$ , in sector  $s$ , at time  $t$  ( $V_{cst}$ ) by the number of total employees ( $L_{cst}$ ) and the level of capital stock ( $K_{cst}$ ). All variables are in logarithm terms and all regressions also include country and sectoral dummies.

Figure 36. Continued



Source: The World Bank Enterprises Surveys and IMF staff calculations.

Controlling for firms’ characteristics confirm the results presented in the analysis here (Figure 37, panel 1).<sup>17</sup> The suggestive evidence that firms (including small and medium ones) involved in e-commerce are more productive holds after controlling for a number of firm characteristics (age, size, foreign ownership, and export status) that are also known to affect performance. Consistent with the earlier evidence presented here, the potential impact of e-commerce on firm productivity seems to be greater in Asia than in other developing regions.

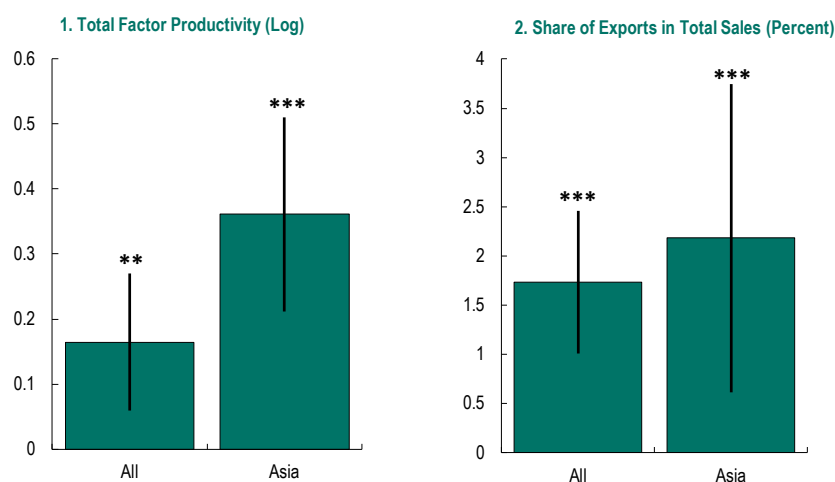
<sup>17</sup> The underlying regressions are available upon request.

Innovation, human capital, and to some extent access to finance seem to support online firms' greater performance. The higher productivity of firms with online activities seems to occur through their more highly skilled labor force, faster pace of innovation, and, to some extent, better access to finance, which allows these firms to deliver products and services with internationally recognized quality certification.

E-commerce firms also export more, relying on their skilled labor force and capacity to innovate (Figure 37, panel 2). Firms with e-commerce activities generate a larger share of sales revenues from export, particularly in Asia, highlighting the potential of e-commerce to promote cross-border trade. A better skilled labor force and a higher quality of products seem to support higher exports by firms with online activities. The role of skill premia in supporting export activities seems particularly important in Asia.

E-commerce, therefore, has the potential to support growth and economic rebalancing by boosting consumption and supporting new industries, especially smaller firms in Asia.

**Figure 37. Estimated Impacts of E-commerce Participation on Productivity and Export**



Sources: World Bank Enterprise Surveys; and IMF staff calculations.

Note: These figures illustrate coefficients and confidence intervals from two firm-level estimations: (a) the impact of e-commerce participation on total factor productivity controlling for firms' age, size, foreign ownership, and export status; and (b) the impact of e-commerce participation on the share of exports in total sales controlling for firms' size, age, and foreign ownership. The error bars refer to the 95 percent confidence intervals around the estimated coefficients. For Asia, the estimated coefficients imply that participation in e-commerce is associated with more than a 30 percent increase in total factor productivity and an increase in the share of exports to total sales by about 2 units, corresponding to a 50 percent rise. \*\* p<0.05; \*\*\* p<0.01.

## Platforms Can Magnify the Benefits of E-commerce, but Raise Competition Issues

Platforms can create positive externalities, including through network effects. Platforms have great potential to amplify the economic benefits of e-commerce. In addition to increased competition within the market and pressure to lower prices, including through reduced search costs, a broader geographical reach of suppliers, and savings in supply chain management, platforms bring about additional advantages through various network effects. As illustrated in the section above, firms with online activities also have better access to finance. For instance, Ant Financial Services Group, an affiliate company of the Chinese Alibaba group, collects information from Taobao, an e-commerce platform that is a subsidiary of Alibaba, to extend the credit frontier to firms not served by traditional banks. By enabling small and medium enterprises to access advanced ICT infrastructure, data centers, applications, and processes usually available to the most productive firms, platforms can further help firms boost their productivity. For example, Flipkart, a leading e-commerce platform in India, adopted several innovative initiatives to break barriers in e-commerce accessibility and affordability. Flipkart empowered its merchants through various types of training, including

on account management, marketing, and warehousing. The company also put in place a dedicated supply chain and last-mile infrastructure to facilitate delivery and developed a light e-commerce application that functions with limited Internet bandwidth or offline. A higher number of providers or customers using a platform tends to enhance its efficiency, including through the use of big data to better customize products and services, which in turn attract more providers and customers (same-side network effect).

Platforms can also raise competition issues. While e-commerce can provide various benefits, economies of scale and exclusive access to information of platforms pose anti-competitive concerns, particularly when e-commerce platforms become large. Network effects also make it challenging for retailers and vendors to switch platforms, reinforcing their market power and exacerbating the risk of anti-competitive practices.

Overall, the development of a platform economy has brought significant benefit to consumers, but it also poses many challenges as new issues emerge. Designing the proper policy response remains an open question, especially in the areas of taxation, competition, and data privacy. For example, the European Union has argued that platforms are too diverse for a one-size-fits-all solution and instead has urged a case-by-case application of antitrust law (Lougher and Kalmanowicz 2016). As a dynamic area of economic development, further research and regulatory experiments would be needed to establish a formal framework for the platform economy.

## Digitalization of Finance in Asia

Fintech can support growth and poverty reduction by strengthening financial development, inclusion, and efficiency. Fintech also poses risks to the financial sector, however. While the use of Fintech in Asia is heterogeneous, the analysis for this section finds evidence of convergence. It also finds that Fintech is positively associated with financial inclusion, yet demonstrates that it also has a potentially disruptive impact on traditional financial services.

In Asia, digitalization of finance has been growing faster than the global average. Three of the five economies identified as having the highest rate of Fintech adoption globally are in the region (China, India and Australia).<sup>18</sup> Fintech activities are widespread and have grown rapidly in frontier economies such as Mongolia and Bangladesh, as well as in emerging markets such as Malaysia and Thailand. The growth of Fintech activities in Asia has been fueled by a dramatic rise in funding. Since 2010, investments have picked up, led by China but also in Southeast Asia by Singapore, Malaysia and Thailand (IMF 2018b). Cumulative Fintech equity funding reached about \$28 billion in 2017, with two-thirds of that growth captured by China.

However, the development of Fintech has not been uniform. Economies have adopted a wide range of technologies based on consumer needs, level of development, regulatory stance, and existing financial and technological infrastructure. For example, while mobile payments have grown rapidly in China, Australia has instead experienced growth of contactless card payments, building on existing infrastructure and experience with the use of cards for secure payment. Similarly, several economies have not developed mobile money products that operate by monetizing pay-as-you-go phone credit, as “postpaid” monthly phone contracts have become standard (replacing prepaid phone credit).

The empirical work shows evidence of convergence (Figures 38.1 and 38.2). Using data on digital payments between 2014 and 2017, the analysis finds economies catching up to the frontier of universal access to digital payments. Economies with low levels of digital payment use in 2014 have significantly higher growth rates

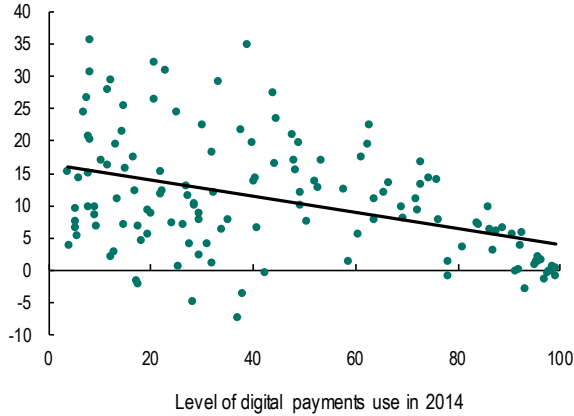
---

<sup>18</sup> Fintech is a catch-all term that represents a vast and growing array of technologies and applications. These include peer-to-peer lending, digital wallets, cryptoassets, roboadvisors, credit scoring algorithms using big data, branchless banking, e-money, mobile money, and digital payments. Much of the analysis in this section is focused on the last two of these products, due to data availability. For a wider discussion of some of these topics see IMF (2016, 2017a) and Chapter 1 of the April 2018 GFSR.



over 2014–17. This initial evidence of convergence is surprising given the wide underlying heterogeneity in the technologies and business models used.

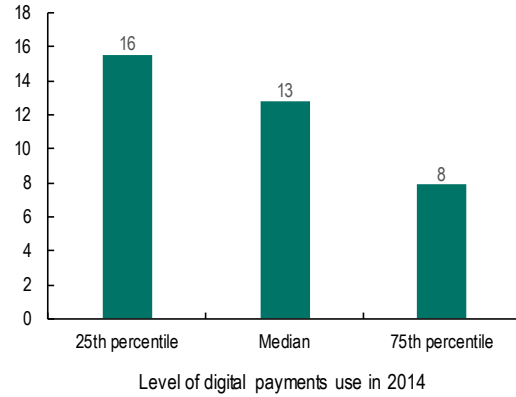
**Figure 38.1. Growth of Digital Payments Use, 2014-2017**  
(Change in share of population using digital payments, in percentage points)



Sources: World Bank, Global Findex database 2017; IMF, *World Economic Outlook*; and IMF staff calculations.

**Figure 38.2. Convergence in the Use of Digital Payments, 2014-2017**

(Growth in share of population using digital payments, after controlling for income growth)

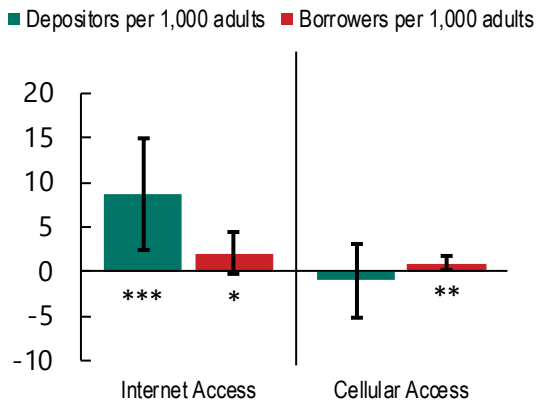


Sources: World Bank, Global Findex database 2017; IMF, *World Economic Outlook*; and IMF staff calculations.

The econometric evidence indicates that digital financial services can boost financial inclusion (Figure 39).<sup>19</sup> These results are particularly relevant for Asia, where nearly 30 percent of the population still lacks access to even a basic savings account. Furthermore, given the existing evidence that greater inclusion in the financial system has positive effects on growth, poverty, and inequality (Sahay and others 2015), there is potential for greater adoption of mobile technology for financial inclusion to translate into positive macroeconomic outcomes. In addition to direct benefits, Fintech has complementary benefits given its role in facilitating other digital activities such as e-commerce.

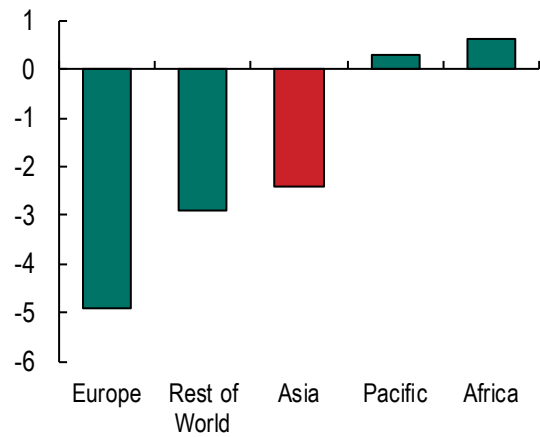
<sup>19</sup> The underlying regressions are available upon request.

**Figure 39. Technological Development and Financial Inclusion**  
(Marginal impact of increase, after controls, including country fixed effects)



Source: IMF staff calculations.

**Figure 40. Leapfrogging and Financial Infrastructure**  
(Marginal impact of increase in leapfrogging variable on bank branches per 100,000 adults by geographic region)



Sources: IMF, Financial Access Survey, World Bank, World Development Indicators; and IMF staff calculations.

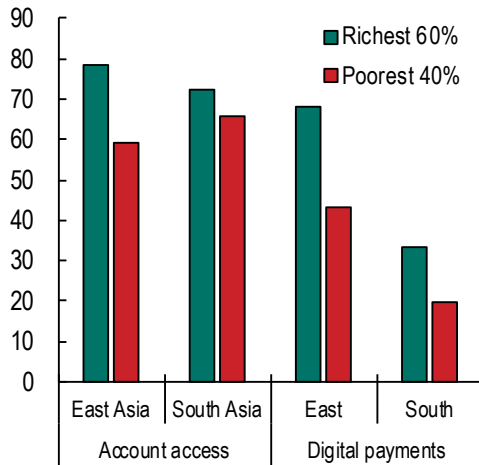
The econometric results also highlight the potentially disruptive nature of Fintech innovations (Figure 40). Specifically, they suggest that economies with a greater propensity for technological leapfrogging in moving to cellular technologies have also tended to see falling levels of traditional financial infrastructure, particularly bank branches. Specifically, there is a negative association between the adoption of new technology without widespread adoption of prior technology and traditional financial infrastructure. This is particularly pronounced in Europe and the Western Hemisphere. However, in Africa and also in the Pacific, the picture is more mixed, and technology may complement traditional means of financial service delivery, even after controlling for relatively lower levels of income and cellular access. The empirical results are supported by developments at the country level, where many economies in the region have seen an increase in digital banks and a corresponding decline in the physical presence of banks.

However, Fintech also faces challenges in promoting economic development or financial inclusion. Much of the use of Fintech has replicated patterns seen in the use of conventional financial products. For example, in Bangladesh while 20 percent of the population report having a mobile money account, this masks a large disparity between men (30 percent) and women (10 percent). There are gaps across Asia regarding use of Fintech based on both gender and position on the income distribution (Figures 41 and 42). This suggests that without attention from policymakers, there is a risk of a digital divide rather than a digital dividend from financial services, at least in the near term.

## Who Uses Digital Financial Services?

**Figure 41. Access to Traditional and Digital Financial Services**

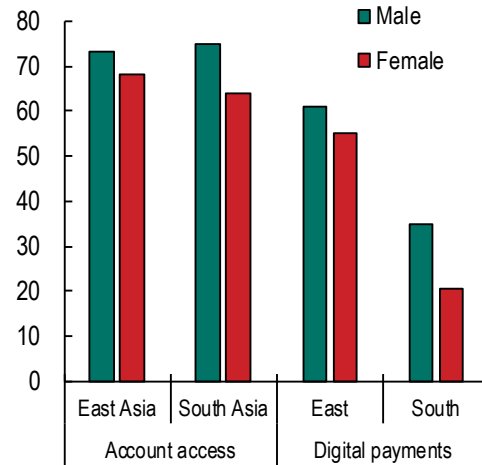
(Percent of total population)



Source: Global Findex Database, World Bank.

**Figure 42. Access to Traditional and Digital Financial Services**

(Percent of total population)



Source: Global Findex Database, World Bank.

Fintech may also pose risks to the financial sector if its applications undermine competition, monetary policy transmission, financial stability and integrity, and consumer and investor protection. The unique blend of large hybrid technology/financial companies that dominate service provision could have sizable spillover effects on the financial system. The development of financial services outside the boundaries of the supervisory and regulatory framework may lead to the emergence of new risks. Technologies, while accelerating the speed and volume of financial transactions, could also amplify the impact of spillovers. And to the extent that services are increasingly offered by specialized firms along the payments chain, as opposed to large, vertically integrated intermediaries, there may be fewer controls for the processing of data and the management of risks. Key risks include the following:

- Online payment service providers operate in the shadow banking system. They pool cash from banks and invest in interbank certificates of deposits or micro loans, resulting in credit and maturity transformation. Actual fund flows are difficult to monitor because these payment providers operate outside of the purview of regulatory supervision.
- Most Fintech companies that are engaged in consumer lending follow a capital-light model. Consumers could suffer large losses if these companies face a liquidity crunch. Credit risks could emerge when unsecured lending is provided to Fintech companies.
- “Know your customer” standards are weak, creating potential for embezzlement and fraud. Limited clarity on the size and nature of financial transactions, combined with opaque identities of many of the users, have raised concerns about anti-money laundering/combating the financing of terrorism (AML/CFT).
- Close integration across different segments of financial services could exacerbate risk spillovers across the financial services chain, amplifying losses in the event of a downturn.

## Digitalization to Strengthen Public Finance

Digitalization is transforming markets quickly and presents important opportunities and challenges for public finance, both in terms of revenue and expenditure. In taxation, more transactions could be subject to taxes, with more people taxed more fairly. On the other hand, digital platforms can erode tax bases by shifting transactions to sectors of lower taxation or compliance, and even abroad. In expenditure, digitalization can improve the effectiveness of public spending in Asia, particularly in improving the targeting of social safety nets, as long as robust design and legal and technological institutions address privacy and cybersecurity concerns.

### Taxation: Opportunities and Risks

Digitalization presents opportunities for improving tax collection in Asia. Digitalization can lead to better reporting of transactions in international trade, increasing VAT and tariff revenue. It can also lead to better reporting of financial account transactions and to improved cross-country collaboration, both of which could help increase income and wealth tax revenues through better reporting of offshore wealth and its related income.

#### Methodology

Using the estimates of the analysis developed in Chapter 2 of the April 2018 *Fiscal Monitor*, this section quantifies possible improvements in tax compliance and the likely increase in revenues associated with them. The model estimates the average gains of reducing the gap with the frontier in digitalization by 50 percent, measured by the UN Online Service Index. This variable assesses the scope and quality of public sector online services, including online services for tax submission and registration of businesses. Using bilateral trade data, the model estimates the impact of an improvement in digitalization in reducing the misreporting of prices of imports. Misreporting of prices is measured as the difference between the declared value of imports at destination and exports at origin.

First, the difference in price (misreporting) is regressed on a gravity model that takes into consideration country and time fixed effects, as well as other economic and institutional variables. The regression includes the variable that measures the level of digitalization (UN Online Service Index). After estimating that effect, the effect of higher digitalization on revenue related to international trade can be estimated. With that, and the appropriate tax rates, the increase in revenue is computed. The section uses the expected higher reported prices of imports to estimate the additional VAT revenue. Using tariff rates (instead of VAT rates), the model then estimates the increase in tariff revenue. Finally, the analysis uses another model that provides estimates of the increase in wealth and income taxes related to undeclared offshore wealth. Using tax rates on wealth, income and inheritance, it estimates country-specific revenue increases based on an estimate of financial returns and on the country's proportion of offshore deposits and an estimate of offshore wealth.

#### Results

Estimates of increased import-VAT revenue suggest benefits from technology adoption. According to the model, for Asian economies, the estimated increase in the VAT is 0.6 percent of GDP (Figure 43). It is much lower than in other regions, with several regions expected to benefit by more than 1 percent of GDP. It is higher, however, than for economies in the Western Hemisphere. For ASEAN, the gains are estimated at 1.2 percent of GDP, while for Pacific island countries they are estimated at 2.5 percent of GDP (Figures 43 and 44). Median gains are lower for advanced and emerging economies, at 0.1 and 0.7 respectively, and are lower in Asia than worldwide. However, for low-income countries the estimate is slightly higher at 1.8 percent of GDP.

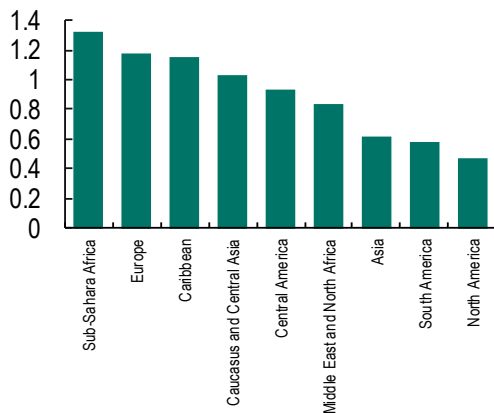
The results also suggest that digitalization can boost tariff revenues. Tariff revenue can be increased in Asia

by 0.2 percent of GDP on average (Figures 45 and 46). As with the VAT, most other regions are estimated to see higher increases, although Asia surpasses Europe and North America. Again, Pacific island countries are estimated to benefit more in the region, with a 0.7 percent of GDP estimated increase, followed by ASEAN countries, with 0.5 percent of GDP. The median gain for emerging markets is estimated at 0.2 percent of GDP, and at 1.1 percent of GDP for low-income countries. These values are about 0.1 percent of GDP lower than estimated for other regions.

Finally, increases in wealth and income tax revenue related to offshore wealth are estimated at 0.2 percent of GDP for Asia, also low when compared with other regions (Figures 47 and 48). Offshore wealth of Asian economies is estimated at 7.3 percent of GDP, lower than most other regions, except for North America. Among Asian economies, South Asia is the region with the highest estimates of tax increases, at 0.3 percent of GDP. Advanced economies in Asia have a slightly higher median of estimated gains, even when the proportion of wealth is lower than emerging markets and low-income countries.

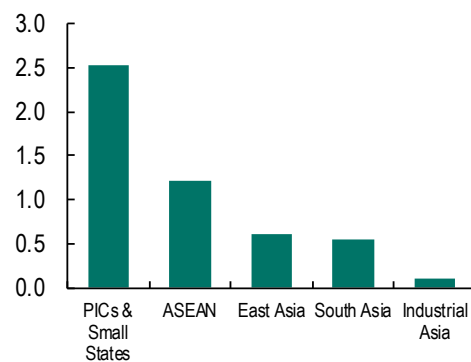
One caveat is in order for appropriate interpretation of the results. As previous sections of this paper have shown, digitalization is a function of GDP per capita, and for each income bracket Asian countries are at the frontier. Therefore, the fact that the estimated revenue increase for Asia is less than other regions may simply show that the distance to the frontier is smaller (indeed, zero for some), especially for Asian advanced economies.

**Figure 43. Potential Import-VAT Revenue Gains from Closing Half the Distance to the Digitalization Frontier, 2016**  
(Percent of GDP)



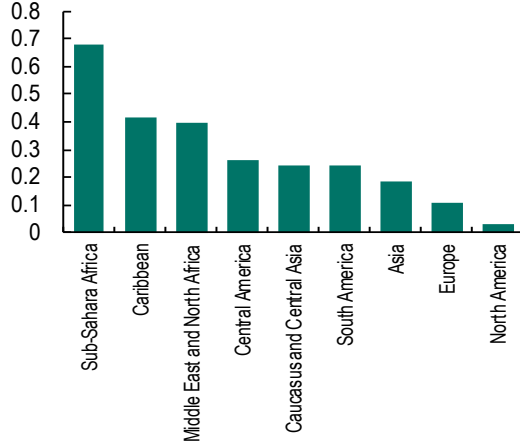
Sources: IMF April 2018 *Fiscal Monitor*; and IMF staff calculations.

**Figure 44. Potential Import-VAT Revenue Gains in Asia from Closing Half the Distance to the Digitalization Frontier, 2016**  
(Percent of GDP)



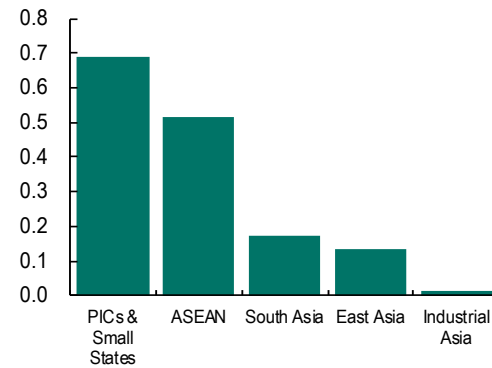
Sources: IMF April 2018 *Fiscal Monitor*; and IMF staff calculations.  
Note: VAT = Value-added Tax; ASEAN = Association of Southeast Asian Nations; PIC = Pacific island countries.

**Figure 45. Potential Tariff Revenue Gains from Closing Half the Distance to the Digitalization Frontier, 2016**  
(Percent of GDP)



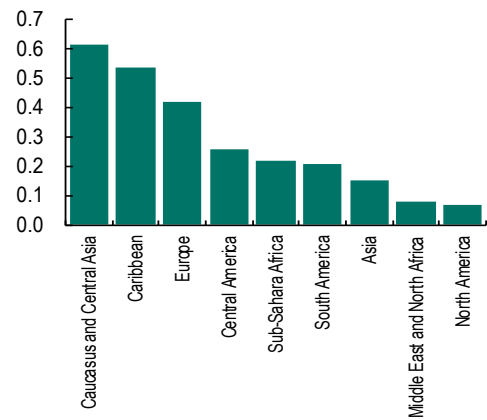
Sources: IMF April 2018 *Fiscal Monitor*; and IMF staff calculations.

**Figure 46. Potential Tariff Revenue Gains in Asia from Closing Half the Distance to the Digitalization Frontier, 2016**  
(Percent of GDP)



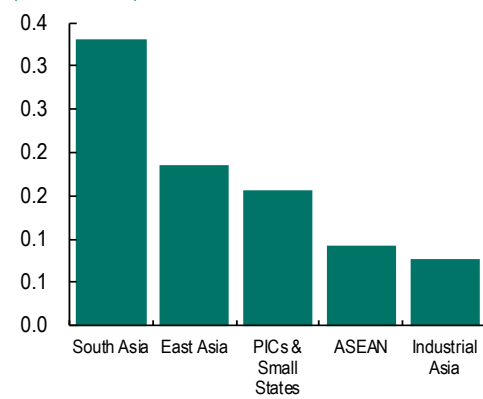
Sources: IMF April 2018 *Fiscal Monitor*; and IMF staff calculations. Note: ASEAN = Association of Southeast Asian Nations; PIC = Pacific island countries.

**Figure 47. Potential Revenue Gains from Offshore Wealth, 2016**  
(Percent of GDP)



Sources: IMF April 2018 *Fiscal Monitor*; and IMF staff calculations.

**Figure 48. Potential Revenue Gains in Asia from Offshore Wealth, 2016**  
(Percent of GDP)



Sources: IMF April 2018 *Fiscal Monitor*; and IMF staff calculations. Note: ASEAN = Association of Southeast Asian Nations; PIC = Pacific island countries.

One should caution against being too optimistic about revenue increases, as digital platforms raise the risk of base erosion from informality and internationalization. In recent years, the development of digital platforms has been quick and large, bringing a transformation in the way of conducting business in many markets. The transformation presents opportunities and risks for taxation. The main risks are base erosion by shifting transactions and profits from established formal commerce to informal ones or abroad. Transactions done in the formal sector of the economy can be shifted to other sectors with lower or fewer taxes or to the informal sector and paying no taxes at all. For example, Peer to Peer (P2P) platforms like Airbnb and Uber (or their regional competitors such as GO-JEK, Grab, and Tujia) allow transactions in highly taxed sectors, like taxi service or hotels, to be transacted with a lower effective level of taxation. P2P platforms allow also an increase in international transactions for agents that would otherwise make only domestic transactions. E-commerce transactions can shift transactions abroad, too, by replacing domestic retail.

Proper legislation can, however, enable digital platforms to share valuable data, formalize informal transactions, and withhold taxes. There are already many cases of P2P platforms withholding funds for tax purposes and reporting payments to tax authorities in several economies. For example, in India, digital platforms are required to charge and remit service taxes due on the income of sellers. In Australia, drive-sharing platforms are required to have their drivers registered as a business and charge a goods and services

tax. There are a variety of tax treatments of the P2P sector, and governments are making many changes as the sector is changing rapidly.<sup>20</sup>

Governments are taking multilateral action to address the issue of base erosion to international transactions on digital platforms. The OECD’s Base Erosion and Profit Shifting (BEPS) Project proposed a set of actions to help governments design domestic and international instruments to address tax avoidance, ensuring that profits are taxed where economic activities generating the profits are performed and where value is created. The digital economy is included in the project, and its implementation is still a work in progress.<sup>21</sup> India introduced an “equalization levy” that requires a 6 percent withholding from amounts paid to nonresident specified services that include online advertisement, any provision for digital advertising space, or any other facility or service for the purpose of online advertisement. Australia and the United Kingdom both introduced a “diverted profits tax” that taxes profits considered to have been diverted to low tax jurisdictions. These measures do not exclusively target digital companies, but the base erosion coming from digital transactions was certainly at the center of the motivation.

## Improving Social Safety Nets with Digitalization

Digitalization can help governments improve public financial management through various channels. For example, integrated beneficiary databases for social safety nets can facilitate inclusion of the previously unreached population, and digital identification for citizens can reduce benefit leakage. In addition, digital technologies allow governments to track and reduce absenteeism of teachers, doctors, and nurses, while removing “ghost” workers from government payrolls. E-procurement can also generate budgetary savings by promoting competition among contractors. While there would be more channels than listed here, this subsection focuses on the first one—improving social safety nets through digitalization—considering its critical role for inclusive growth in Asia.

There is scope to develop social safety nets in developing Asia. While income inequality has risen in the region since 1990 (Jain-Chandra and others 2016), Asia’s public spending on social safety nets has remained at 1.2 percent of GDP, a level lower than in developing Europe, Latin America and Caribbean, and Sub-Saharan Africa. The main objective of social safety net reforms is to reduce inclusion errors (leakage of benefits, that is, when individuals receive benefits to which they are not entitled) and exclusion errors (when eligible individuals do not receive benefits to which they are entitled). Digitalization can support this objective.

Developing digital social registries is a solution to reduce exclusion errors. Social registries are information systems that support outreach, intake, registration, and determination of potential eligibility for one or more social programs (Leite and others 2017). As a single gateway for various programs, they lower transaction costs for citizens and governments, thereby helping governments reach out to targeted groups. The Philippines’ registry (*Listahanan*), for example, serves as a registration gateway for as many as 52 social programs, ranging from cash transfers to emergency assistance, with 75 percent of the population registered. Social registries appear to have helped expand the coverage of conditional cash transfer programs in Indonesia and the Philippines. While social registries store information to determine potential eligibility such as income and other socioeconomic data, they rely largely on self-reported information from citizens. Thus, reducing inclusion errors would require data verification with other information systems such as civil and land registries. This function has yet to be developed for social registries in Indonesia and the Philippines.

Digital identification (ID) can help governments reduce inclusion errors. Digital ID systems store personal data in digital form and credentials that rely on digital, rather than physical, mechanisms to authenticate the identity of their holder (World Bank 2016). Digital ID can help governments eliminate duplicates and “ghost”

---

<sup>20</sup> For a recent comprehensive description see IMF (2017b).

<sup>21</sup> For an assessment of progress on BEPS and the digital economy see OECD (2018).



beneficiaries receiving social benefits. It can also serve as a necessary “key” to connect social registries with regulatory databases, thereby facilitating eligibility verification (Leite and others 2017). Digital ID also facilitates transition from in-kind to cash-based benefits by linking beneficiaries’ ID with their bank accounts for benefit payments, thereby reducing leakages. Developing Asia appears to be in a good position to advance on this front, as many economies already have operationalized digital ID systems.<sup>22</sup>

India’s experience with the *Aadhaar* identification system is a case in point.<sup>23</sup> *Aadhaar* is the world’s largest biometric identification system, providing a unique 12-digit ID number for 1.2 billion residents in India. It is linked to various social programs, providing authentication for eligible beneficiaries. Before 2015, the subsidy on liquefied petroleum gas in India was subject to substantial leakage, partly because of the government’s inability to authenticate beneficiaries. The government attempted to reduce leakages in two ways. First, starting in 2013, beneficiaries’ *Aadhaar* numbers were linked to the liquefied petroleum gas program to prevent claims from ghost beneficiaries or multiple claims. Second, the government made electronic transfers of the subsidy directly to the *Aadhaar*-linked bank account of beneficiaries, bypassing dealers. These reforms have reportedly reduced leakage and saved costs, although estimates vary.

## The Role of Policies

While the digital revolution is inevitable, the outcome—utopian or dystopian—will depend on policies. To realize the potential of the digital revolution, comprehensive policies and fresh thinking are needed. For policymakers, the first hurdle is to accept that the digital revolution is inevitable. Policy responses will need to strike the right balance between enabling digital innovation and addressing digitalization-linked risks.

### Policies to Facilitate Technological Advances

Policies should focus on further enhancing productivity; encouraging more R&D in digital and other sectors; promoting the diffusion of global knowledge by incentivizing new and dynamic firms; upgrading physical and soft infrastructure; and improving access to and the quality of education. Policies to increase R&D intensity and speed up the diffusion of innovation in Asia also include protection of intellectual property (patent policy), competition in research grants, and optimal government subsidies. Investment in R&D and human capital are essential not only to build innovation capacity but also to maximize the absorption of existing innovations.

### Fostering e-Commerce

There is room to improve enabling factors to further boost e-commerce in Asia. Existing digital divides and gaps in key infrastructures and e-commerce legislation are still preventing many Asian economies from fully reaping the potential benefits. Despite its rapid growth, e-commerce, including cross-border e-commerce, could expand faster if various barriers were removed, further supporting international trade, creating more opportunities for businesses, and increasing consumers’ welfare:

- *Economic factors and conditions.* A successful e-commerce transaction requires several critical elements, including, Internet access to allow the user to place an order, secure Internet servers to safeguard payments and personal information, a payment method such as a credit card, e-wallet, or mobile payment, and reliable delivery services for physical goods. While advanced economies, including in

<sup>22</sup> See the World Bank’s Identification for Development (ID4D) Global Dataset (<http://id4d.worldbank.org/global-dataset>).

<sup>23</sup> Discussions here draw on the India case study included in Chapter 1 of the April 2018 *Fiscal Monitor*.



Asia, have high readiness for e-commerce, emerging and developing economies in the region are not as ready, with many economies still having sizable gaps.

- *Legal and institutional environment.* The absence of laws to regulate the e-environment inhibits participation in e-commerce both for consumers and suppliers. For instance, e-transaction laws are essential to make electronic forms of exchange legally equivalent to paper-based transactions, a critical condition for most e-commerce transactions. A lack of consumer protection laws and legislation on privacy, data protection, and cybercrime may prevent potential customers from shopping online. While all advanced Asian economies and most emerging and developing economies in the region benefit from legislation covering electronic transactions, consumer protection, data protection, and cybercrime, this legislation is practically nonexistent in Pacific island countries. Enacting appropriate legislative and regulatory mechanisms can lower legal barriers to e-commerce use, raise consumer confidence, and expand domestic and particularly cross-border transactions. In addition to enacting laws, establishing enforcement mechanisms, including the capacity to address anticompetitive practices, is important to support the development of e-commerce.

## Policies to Manage the Transition and Reduce Inequality

Policies to harness digital dividends include revamping education to meet the demand for more flexible skill sets and lifelong learning, as well as new training, especially for the most adversely affected workers; reducing skill mismatches between workers and jobs; and addressing labor market and social challenges, including income redistribution and safety nets.

As automation intensifies, more workers will need to find new jobs, especially those who are less skilled. Rethinking education, particularly at secondary or lower levels, may have a far-reaching effect on managing the transition to the new age of automation. For instance, a stronger emphasis should be placed on promoting foundation skills, digital literacy, high-order thinking competencies, and social and emotional skills (OECD 2016). It is also imperative to provide training and re-training opportunities to help workers adapt and acquire skills that will be in demand. This should be preceded by the effort to more precisely identify emerging skills and examine how they can be translated into training programs. A good example is Singapore's SkillsFuture initiative, which provides a wide range of support for the labor force to maintain or acquire competitive skills.

As Korinek and Stiglitz 2018 show, policies to soften the labor market impact of new technologies can make a difference in terms of improving welfare. The more willing society is to support the necessary transition and provide support to those who are left behind, the faster the pace of innovation that society can accommodate while still ensuring that the outcomes are welfare improvements, with all members of the society better off.

## Digitalization of Finance<sup>24</sup>

Given the widespread adoption of Fintech, and the proliferation of different modes of delivery, there is a significant need for international collaboration to learn from and develop best practices. Fintech has implications for the role of market imperfections and cost structures in financial markets that will in turn have implications for financial stability and competition. This paper has pointed to the importance for policymakers to be aware of the likely impact of Fintech on both inclusion and inequality. Given uneven

---

<sup>24</sup> For more details see IMF (2017a) and the Bali Fintech Agenda.

access to technology and unequal patterns of technological literacy, policymakers should also be mindful of the potential for Fintech to create a digital divide.

Better data are needed for monitoring emerging developments, and greater agility may be needed from regulators and supervisors given the rapid rise of various Fintech products. This is particularly true in settings where regulation is unclear or outside traditional lines of reporting. For example, closed-loop platforms operate like gift cards and allow users to manage payments directly on mobile applications, while allowing credit to be created outside of the central bank's purview. Significant policy efforts have been made to address such loopholes. For example, China's money market fund Yuebao is now captured in the People's Bank of China's money supply statistics.

Meanwhile, promoting lower barriers to entry while maintaining a level playing field becomes a growing issue with the rising dominance of large firms. Regulations should allow for more competition and further reduce the costs of financial intermediation, while helping solve some problems of the current banking environment, such as the too-big-to-fail issue. In addition, regulation could encourage low leverage among new market participants from the beginning, which would allow for the sustainable growth of the industry and improve discipline, while addressing risks arising from AML/CFT and cybersecurity threats.

Harnessing digital dividends requires a strong cybersecurity framework. The global incidence of cybercrimes (against both public and private entities) is very high and increasing. As the economy goes digital, cyber risks will increase further. The global nature of Internet-based platforms raises issues regarding jurisdiction in cyberspace, particularly for ensuring effective law enforcement and judicial follow-up. Therefore, international cooperation is key for effective policy responses.

## Policies to Strengthen Public Finance

Policy actions can transform risks into opportunities. Digitalization also allows for an increased monitoring of business transactions that would otherwise be informal. This possibility of data collection is particularly evident in P2P platforms when they replace decentralized informal activities. Moreover, the development of P2P platforms can even present an opportunity for governments to pass legislation requiring the withholding of funds related to transactions. The withholding can be established for income, goods and services, or value-added taxes applicable to sellers. This withholding already seems straightforward for indirect taxes.

Governments are introducing legislative changes to limit base erosion. India introduced an "equalization levy" that requires a 6 percent withholding from amounts paid to nonresident specified services that include online advertisement, any provision for digital advertising space, or any other facility or service for the purpose of online advertisement. Australia and the United Kingdom both introduced a "diverted profits tax" that taxes profits considered to have been diverted to low tax jurisdictions. These measures do not exclusively target digital companies, but the base erosion coming from digital transactions was certainly at the center of the motivation behind their implementation.

Better data sharing is possible with the increased adoption of digital technologies. The OECD and the G20 have established an automatic exchange of information of nonresident financial accounts.<sup>25</sup> Other useful measures include the establishment of international registers of asset ownership and shareholders, which allows for taxation of capital income on a residence rather than a source basis. A combination of information on assets and capital incomes would allow for the introduction of dual income tax systems under which capital income and wealth would be linked and taxed under a single tax schedule, creating a synthetic capital

---

<sup>25</sup> See the April 2018 *Fiscal Monitor* for a thorough discussion about this exchange and other information-sharing mechanisms.

income tax.

Policymakers need to address significant risks surrounding the digital solutions. First, cybersecurity risks need to be mitigated. Second, large government-run databases with private information raise privacy concerns. Legal and technological frameworks are necessary to ensure that government agencies and third parties have access only to the minimal amount of information necessary for verifying identity records, with robust security measures to ensure data protection. Third, governments should ensure digital inclusion or fallback options to prevent the exclusion of genuine beneficiaries from social programs. This includes, for example, both the institutional and human capacity for Internet connectivity. These risks warrant careful design and planning of digital solutions for better social safety nets.

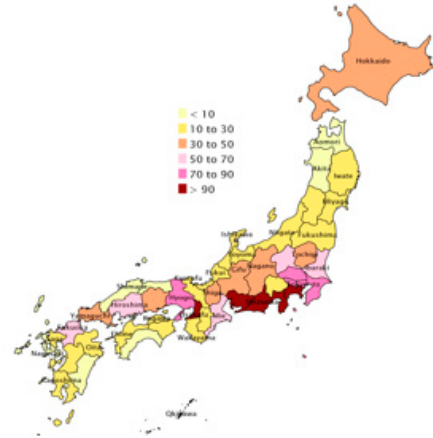
### Box 1. Macroeconomic Implications of Automation: The Case of Japan<sup>1</sup>

Using prefecture-level data, this box conducts empirical analysis to estimate Japan’s experience with industrial robots, focusing on its impact on productivity and labor. Following recent work by Acemoglu and Restrepo (2017a), the analysis first estimates prefecture-level robot density as a weighted sum of the share of robots used in each sector out of the total number of robots used in the economy, weighted by the share of a prefecture’s output contribution to a specific industry to the total output of the industry. That is, for each prefecture that has  $S_p$  number of industries, robot density of prefecture  $p$  at time  $t$ , *robot density* $_{p,t}$  is calculated as:

$$\text{robot density}_{p,t} = \sum_{s=1}^{S_p} \frac{y_{st}^p \text{robot stock}_{st}}{y_{st} \text{Hours worked}_{st}},$$

where  $y_{st}^p$  is the total output of industry  $s$  of prefecture  $p$  at time  $t$ ,  $y_{st}$  is the total output of industry  $s$  at time  $t$ , *Hours worked* $_{st}$  is the total hours worked, and *robot stock* $_t$  is the amount of operational stock of robots for industry  $s$  at time  $t$ . Based on this calculation, robot density varies across prefectures (Figure 1.1), depending on the industrial composition of the prefecture. Prefectures with the highest robot density are those that have large automotive and electronics manufacturing plants.<sup>2</sup>

Manufacturing Robot Density by Prefecture (2014)



Sources: International Federation of Robotics; Japan Statistical Federation; and IMF staff calculations.

Panel regression using the estimated prefecture-level robot density shows that Japanese prefectures with higher exposure to robots had higher productivity and employment growth. Using a panel regression with prefecture and industry group fixed effects, the analysis finds that prefectures more exposed to robots have sizable positive effects on local labor market outcomes as well as productivity. Controlling for the global financial crisis because the adoption of robots collapsed during that period due to weak global demand, the analysis finds that an increase of robot density by 1 percent corresponds to 6 percentage increase in total factor productivity (TFP) for the manufacturing sample. In addition, employment growth is also positively correlated—a 1 percent increase in robot density leads to 0.3 percentage point increase in employment growth.

Results are also indicative of potential spillover effects of automation in the manufacturing sector to service sectors. Higher robot density per prefecture is significantly correlated with higher TFP growth of the service sector. Table 1.1 shows that TFP for the service sector increases with higher adoption of robots. However, it also shows that higher automation in manufacturing is negatively correlated with some labor market outcomes in service sectors of that prefecture. Controlling for crisis and prefecture fixed effects, the analysis finds that an increase of robot density by 1 percent leads to a 1.2 percentage point decrease in employee growth in the service sector, while the impact on service sector wage growth is negative, but insignificant.

Automation technology and artificial intelligence can be a partial solution for Japan to deal with its declining labor force. Policies to highlight the positive sides of automation should be introduced to encourage automation technology in the areas that are in most need as a result of labor shortages due to demographic challenges (Schneider, Hong, and Lee 2018). Going forward, the advancement of technology to utilize automation technology in the non-manufacturing sector coincides with the increase in needs of automation in some age-related services sector.

<sup>1</sup> This box was prepared by Gee Hee Hong and Todd Schneider of the IMF’s Asia and Pacific Department.

<sup>2</sup> Aichi prefecture has several automobile manufacturing plants, including Toyota, and Kanagawa prefecture has Nissan’s headquarters and some of Nissan’s manufacturing plants. Examples of prefectures with the lowest robot density are some in the northwestern part of Honshu (such as Akita and Aomori prefectures), which is known for its agriculture, fishing, and forestry.

**Table 1.1. Impact of Robots on Manufacturing and Service Sector Productivity and the Labor Market at the Prefecture Level**

Variables	Manufacturing			Services		
	TFP	Wage Growth	Employee Growth	TFP	Wage Growth	Employee Growth
Robot density (prefecture)	6.308*** (2.657)	0.0912 (0.171)	0.275*** (0.078)	3.235*** (0.911)	-2.132 (1.905)	-1.208*** (0.433)
Crisis*Robot density	-14.28*** (0.996)	-0.533*** (0.064)	-0.173*** (0.029)	-1.159*** (0.353)	-3.687*** (0.737)	-1.136*** (0.167)
Constant	-22.63 (22.63)	-2.551* (1.456)	-3.681*** (0.666)	-1.789** (0.826)	2.739 (1.726)	2.159*** (0.392)
Prefecture fixed effects	Y	Y	Y	Y	Y	Y
Observations	940	940	940	940	940	940
R-squared	0.207	0.100	0.111	0.048	0.036	0.141

Source: IMF staff calculations.

Note: Standard errors in parentheses, \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ . TFP: total factor productivity.

However, automation may negatively affect female and low-skilled workers disproportionately. Existing studies tend to agree that industrial robots have contributed to an increase in inequality, as labor-saving technology has predominately replaced the jobs of middle- or low-skilled workers whose occupations are, thus far, more automatable (Autor, Levy, and Murname 2003; Berg, Buffie, and Zanna 2018; Goos and Manning 2007; Michaels, Natraj, and Van Reenen 2014). For Japan, Hamaguchi and Kondo (2017) estimate the “computerizability” of occupations based on the sophistication of tasks involved in each occupation, such as the use of creative intelligence, social intelligence, and cognitive perception and manipulation. In their study, female workers are exposed to higher risks to computerization than male workers, since female workers tend to be engaged in occupations with a high probability of computerization, such as receptionists, clerical workers, and sales workers.

Adequate training for the new generation of workers to improve skill quality and adaptability will be crucial, given the expected distributional consequences of automation technology. The need to educate and train the next generation of workers to adapt to such changes, and to have that education and training reflect the rising needs for these skills, are essential to minimize the negative effects that disproportionately hurt highly substitutable workers. To equip future workers with skills to more easily shift across occupations, general education may need to refocus on problem-solving and emphasize cognitive skills (IMF 2018c). To offset demographic challenges, policies are needed to encourage the untapped labor force, such as female workers, and to take into account the role of foreign workers.

## References

- Acemoglu, Daron, and Pascual Restrepo. 2017a. "Robots and Jobs: Evidence from US Labor Markets." NBER Working Paper No. 23285, National Bureau of Economic Research, Cambridge, MA.
- Acemoglu, Daron, and Pascual Restrepo. 2017b. "Demographics and Automation," NBER Working Paper No. 24421, National Bureau of Economic Research, Cambridge, MA.
- Aghion, Philippe, and Peter Howitt. 1992. "A Model of Growth through Creative Destruction." *Econometrica* 60 (2): 323–51.
- Autor, David, and Anna Salomons. 2018. "Is Automation Labor-Displacing? Productivity Growth, Employment, and the Labor Share." NBER Working Paper No. 24871, National Bureau of Economic Research, Cambridge, MA.
- Autor, David, Frank Levy, and Richard Murnane. 2003. "The Skill Content of Recent Technological Change: An Empirical Exploration." *Quarterly Journal of Economics* 118(4): 1279–333.
- Berg, Andrew, Edward F. Buffie and Luis F. Zanna. 2018. "Should We Fear the Robot Revolution? (The Correct Answer is Yes)," IMF Working Paper No. 18/116.
- Brynjolfsson, Erik, Daniel Rock and Chad Syverson. 2017. "Artificial Intelligence and the Modern Productivity Paradox: A Clash of Expectations and Statistics." NBER Working Paper No. 24001 November.
- Das Kaushik, Toshan Tamhane, Ben Vatterott, Phillia Wibowo, and Simon Wintels. 2018. "The Digital Archipelago: How Online Commerce Is Driving Indonesia's Economic Development." McKinsey & Company.
- Dobbs, Richard, Yougang Chen, Gordon Orr, James Manyika, Michael Chui, and Elsie Chang. 2013. "China's Retail Revolution: Online Shopping as a Catalyst for Growth." McKinsey Global Institute.
- Falk, Martin and Eva Hagsten, 2015, E-Commerce Trends and Impacts Across Europe, UNCTAD Discussion Paper No. 220.
- Fernald, John G., and Charles I. Jones. 2014. "The Future of US Economic Growth." *American Economic Review, AEA Papers & Proceedings* 104(5).
- Goos, Maarten and Alan Manning, 2007. "Lousy and Lovely Jobs: The Rising Polarization of Work in Britain," *Review of Economics and Statistics*, 89 (1), 118-133.
- Gordon, Robert J. 2016. *The Rise and Fall of American Growth*. Princeton, NJ: Princeton University Press.
- Graetz, Georg, and Guy Michaels. 2015. "Robots at Work." IZA Discussion Paper No. 8938, Institute for the Study of Labor, Bonn.
- Grossman, Gene M., and Elhanan Helpman. 1991. *Innovation and Growth in the Global Economy*. Cambridge, MA: MIT Press.

- Hamaguchi, Nobuyaki and Keisuke Kondo, 2017, “Regional Employment and Artificial Intelligence,” RIETI Discussion Paper, 17-K-023. Research Institute of Economy, Trade and Industry, Tokyo.
- International Federation of Robotics. 2017. “World Robotics, 2017.”
- International Monetary Fund (IMF). 2016. “Virtual Currencies and Beyond: Initial Considerations.” Staff Discussion Note No. 16/03, International Monetary Fund, Washington, DC.
- \_\_\_\_\_. 2017a. “Fintech and Financial Services: Initial Considerations.” IMF Staff Discussion Note No. 17/05, International Monetary Fund, Washington, DC.
- \_\_\_\_\_. 2017b. “Digital Revolutions in Public Finance.” Fiscal Affairs Department (Washington, DC).
- \_\_\_\_\_. 2018a. Measuring the Digital Economy, International Monetary Fund, Washington, DC.
- \_\_\_\_\_. 2018b. “Select Issues Paper on Fintech Opportunities and Challenges.” Staff Report of 2018 Article IV Consultation for Singapore (Washington, DC).
- \_\_\_\_\_. 2018c. “Technology and the Future of Work,” Group of Twenty Note, International Monetary Fund, Washington DC.
- Jain-Chandra, Tidiane Kinda, Kalpana Kochhar, Shi Piao, and Johanna Schauer. 2016. Sharing the Growth “Dividend: Analysis of Inequality in Asia.” IMF Working Paper, WP/16/48. Washington, DC.
- Jones, Charles I. 1995. “R&D-Based Models of Economic Growth.” *Journal of Political Economy* 103(4).
- \_\_\_\_\_. 2002. “Source of U.S. Economic Growth in a World of Ideas.” *American Economic Review* 92(1).
- Kim, Jong-Il, and Lawrence J. Lau. 1994. “The Sources of Economic Growth of the East Asian Newly Industrialized Countries.” *Journal of the Japanese and International Economies* 8 (3): 235–71.
- Korinek, Anton, and Joseph E. Stiglitz. 2018. “Artificial Intelligence and Its Implications for Income Distribution and Unemployment.” In *The Economics of Artificial Intelligence: An Agenda*, edited by Jay Agrawal, Joshua Gans, and Avi Goldfarb. Chicago: University of Chicago Press.
- Kortum, Samuel S. 1997. “Research, Patenting, and Technological Change.” *Econometrica* 65 (6): 1389–1419.
- Krugman, Paul. 1994. “The Myth of Asia’s Miracle.” *Foreign Affairs* 73 (6): 62–78.
- Leite, Phillippe, Tina George, Changqing Sun, Theresa Jones, and Kathy Lindert, 2017, “Social Registries for Social Assistance and Beyond: A Guidance Note & Assessment Tool.” World Bank Social Protection and Labor Discussion Paper No. 1704.
- Lougher, Guy, and Sammy Kalmanowicz. 2016. “EU Competition Law in the Sharing Economy.” *Journal of European Competition Law & Practice* 7(2): 87–102.
- McAfee, Andrew and Erik Brynjolfsson, 2017. “Machine, Platform, Crowd: Harnessing Our Digital Future.” New York: W.W. Norton and Company.

- Michaels, Guy, Ashwini Natraj, and John Van Reenen. 2014. "Has ICT Polarized Skill Demand? Evidence from Eleven Countries over Twenty-Five Years," *The Review of Economics and Statistics*, 96(1), 60–77.
- Organization for Economic Cooperation and Development (OECD). 2016. "Skills for a Digital World." Background Paper for Ministerial Panel 4.2. OECD, Paris.
- Pratt, Gill A. 2015. "Is a Cambrian Explosion Coming for Robotics?" *Journal of Economic Perspectives*, 29 (3):51-60.
- Romer, Paul M. 1990. "Endogenous Technological Change." *Journal of Political Economy* 98(5), Part 2.
- Sahay, Ratna, Martin Cihak, M. Papa N'Diaye, Adolfo Barajas, Srobona Mitra, J. Annette Kyobe, N. Yen Mooi, and Reza Yousefi. 2015. "Financial Inclusion: Can It Meet Multiple Macroeconomic Goals?" IMF Staff Discussion Note No. 1/17, International Monetary Fund, Washington, DC.
- Schneider, Todd., Gee H. Hong, and Anh V. Le. 2018. "Land of the Rising Robots." *Finance and Development* 55(2): 28–31.
- Segerstrom, Paul S. 1998. "Endogenous Growth Without Scale Effects." *American Economic Review* 88 (5): 1290–1310.
- Solow, Robert M. 1957. "Technical Change and the Aggregate Production Function." *Review of Economics*.
- United Nations Conference on Trade and Development (UNCTAD). 2017. "Robots, Industrialization and Inclusive Growth, Beyond Austerity: Toward Global New Deal." UNCTAD, Geneva.
- Young, Alwyn. 1992. "A Tale of Two Cities: Factor Accumulation and Technical Change in Hong Kong SAR and Singapore." *NBER Macroeconomics Annual* 7: 13–54.
- . 1995. "The Tyranny of the Numbers: Confronting the Statistical Realities of the East Asian Growth Experience." *The Quarterly Journal of Economics* 110 (3): 641–80.
- Yang, Zhuofan, Yong Shi, and Hong Yan. 2017. "Analysis on Pure E-commerce Congestion Effect, Productivity Effect, and Profitability in China." *Socio-Economic Planning Sciences*. 57. pp. 35–49.
- . 1994. "Lessons from the East Asian NICs: A Contrarian View." *European Economic Review* 38 (3–4): 964–73.
- World Bank. 2016. *World Development Report: Digital Dividends*. Washington, DC: World Bank.