STRUCTURAL CHANGE AND MODERATING GROWTH IN THE PEOPLE'S REPUBLIC OF CHINA: IMPLICATIONS FOR DEVELOPING ASIA AND BEYOND

ASIAN DEVELOPMENT BANK

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Notes:
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Contents

Tables, Figures, and Boxes

Box Figures

Acknowledgments

Highlights

- **The People's Republic of China (PRC) is currently undergoing a number of important changes, which have wide-ranging implications for activity in the PRC, the rest of developing Asia, and the world.** First, demographic shifts are underway. The growth of the working age population has turned negative, and the sex ratio also peaked in 2011; declines in these key demographic indicators are associated with falling savings and growth rates. Second, there is the ongoing structural shift from industry toward services on the supply side, and from investment to consumption on the demand side. The decline in the growth contribution from industry and investment is already underway, but services and consumption growth, while reasonably robust, has not—and may not be able to—fully offset the decline. Third, the natural process of convergence implies that growth will slow as per capita income rises, labor costs rise, and returns on investment diminish. Fourth, external factors also play a role. Weaker-than-expected external demand—the lackluster recovery in advanced economies since the global financial crisis (GFC), and more recently weakness in other emerging markets—has been a drag on PRC exports, and this external weakness may have both cyclical and structural elements. Finally, following the GFC, efforts to maintain high growth through credit-supported investment contributed to widening macroeconomic imbalances; the growth moderation over the past 2 years partly reflects working out overcapacity in some sectors , efforts to restrain rapid credit growth, and the authorities' desire to contain real and financial vulnerabilities.

- **As a result of these shifts, growth in the PRC has been moderating, and we assume—in line with the *Asian Development Outlook*—that this will continue to slow over the medium term.** The PRC grew 6.9% in 2015—almost half a percentage point below 2014, and the first time in a quarter-century annual growth was below 7%. Growth is projected to slow to 6.6% this year, and moderate further in the future.

- **The structural shift and gradual growth moderation has real effects on the rest of Asia, but only modest impact on the United States (US) and Europe.** The effects of the current PRC growth moderation are assessed using the Global Projection Model—a multiregion macroeconomic model with real and financial linkages. The model simulations suggest that the ongoing structural shifts and gradual growth moderation would have real effects on the rest of Asia but only modest impact on the United States and Europe. A decline of 1 percentage point in PRC growth shaves about a third of a percentage point off developing Asia's growth each year, and reduces Japan's growth by a fifth of a percentage point. This reflects the PRC's strong intraregional trade and production linkages. The effect on commodity-exporting countries will also be significant. In contrast, the impact on the US and Europe will be negligible, as their relatively small trade exposure to the PRC will be offset by a boost from lower oil prices induced by lower PRC growth. Overall, global growth is about a third of a percentage point below what it would have been had the PRC economy not slowed.

- **A sharp drop in PRC growth—emanating from a disorderly unwinding of economic imbalances—is highly unlikely and not foreseen in the near term; and is a low-probability risk even over the medium term.** Although, we do not factor a sharp growth decline into our baseline analysis, it is nevertheless useful to analyze how such spillovers might differ under such a scenario. A sharp slowdown is not factored into our baseline analysis because the PRC authorities

still maintain substantial policy buffers to respond to adverse shocks. Nonetheless, in historical episodes of credit boom-busts, housing downturns, and financial crises elsewhere, investment growth has tended to slow sharply. The typical decline in GDP growth during a disorderly slowdown is about 2–3 percentage points. With investment a much larger share of GDP in the PRC, a decline in investment and consumption growth similar to past episodes could result in a sharper fall, reducing GDP growth by 4½ percentage points. The unlikely event of a sharp fall in PRC growth would have larger effects on all regions, but it is not simply a scaling up. The bigger reduction in PRC demand would amplify effects on trade and commodity prices. The effects on Asia would be proportionately larger. And an additional negative shock from tightening global financial conditions would contribute to lower growth in the US and Europe.

- **The estimated impact of a change in PRC activity on commodity prices is significant, but varies by commodity.** Econometric analysis finds that a 1 percentage point reduction in PRC growth lowers prices of coal and metals by 7%–22%, and oil and natural gas prices by 5%–7%. These suggest that the fall in PRC growth since 2011 can explain a significant portion of the decline in coal and metals prices over the same period, but only a small portion of the decline in oil and natural gas prices. The decline in commodity prices from PRC's growth moderation will act as a terms-of-trade shock for Asia's commodity exporters, but will benefit Asia's commodity importers.

- **Asia's commodity exporters would also be impacted through reduced export volumes.** For many Asian commodity exporters, the PRC is a major customer for their dominant export commodities such as coal, copper, and oil. The impact of a PRC growth moderation works indirectly through prices as well as through direct channels—commodity exporters that sell more to the PRC find a significantly larger impact on growth from fluctuations in PRC economic activity. These findings drive home how important diversification is for Asia's commodity exporters, across products as well as trading partners. It also highlights the need

to build fiscal buffers during good times to help cushion the blow when commodity prices fall.

- **More generally, the econometric analysis suggests that the more economies export to the PRC, the more vulnerable they are to a slowdown in demand.** Countries that have stronger trade linkages with the PRC experience significantly larger spillovers from changes in PRC growth. So economies such as Taipei,China; the Republic of Korea; Hong Kong, China; and Malaysia—whose value-added exports to the PRC in both final and intermediate goods and services are relatively high—are more likely to feel the pinch of the PRC growth moderation. Analysis using world input–output tables, which accounts for both trade and production linkages and allow tracing effects on individual economies and specific sectors, finds that spillovers through trade and production linkages are largest for several Asian economies. Mongolia; Taipei,China; the Republic of Korea; Malaysia; and Viet Nam are among those most affected by moderating PRC growth. For most economies, the impact is primarily in manufacturing. For Mongolia, Viet Nam, and Indonesia, however, a substantial part of the impact is through mining and quarrying.

- **The PRC's structural shift and growth moderation presents a challenge, but also opportunities for developing Asia.** Well-positioned developing Asian economies can benefit from the PRC's shrinking labor force, rising labor costs, and shift to consumption-based growth. There are three main opportunities. The first is for economies that primarily compete with the PRC in third markets. Bangladesh, for example, is already gaining market share as the PRC withdraws from the low-end segment of garment manufacturing—it is now the second-largest garment exporter behind the PRC.

- **The second opportunity is for those able to replace the PRC in segments of global production chains.** Global demand for products the PRC produces in quantity—ranging from low-cost T-shirts to high-tech smartphones and computers—continues to rise. But with

the PRC's rising labor costs, this production will increasingly move to lower cost economies. Viet Nam, for example, has already become a favored location for producing mobile phones and consumer electronics—partly by attracting more foreign direct investment. The opportunities are great for both large countries like India (that aim to become new export giants), and for smaller economies like Cambodia and Myanmar (with lower labor costs and starting the process of entering global markets and production chains). Low wages alone do not guarantee success, however. Countries need to invest in the necessary infrastructure and undertake needed policy reforms to become attractive investment destinations.

- **Finally, the PRC's trading partners can exploit the fact that not all exports will be affected equally.** As PRC consumption remains relatively robust and the growth decline is mostly from investment, economies that export to satisfy PRC consumer demand—both in goods as well as services (such as education and tourism)—will be better positioned than those catering to PRC investment demand.

1 The World's Economic Engine is Changing and Slowing

Fundamental changes are underway in the People's Republic of China

The People's Republic of China (PRC) is currently undergoing a number of important changes, both structural and cyclical, which have wide-ranging implications—for economic activity in the PRC, the rest of developing Asia, and the world. First, major demographic shifts are underway in the PRC. The growth of the working age population (between ages 15 and 59) turned negative in 2012, while the population between ages 15 and 64 peaked in 2014 (Figure 1). As the working age population shrinks, falling labor inputs will increasingly become a drag on growth. Shifting demographics will also impact the PRC's savings patterns. The United Nations (UN) estimates that, by 2035, there will be approximately 4 elderly PRC citizens for every 10 working age people. This will more than double the country's old-age dependency ratio over the next 2 decades. An increasing ratio tends to lower private savings rates, and will also raise government spending on pensions, health care, and other social programs for the elderly.

Shifting demographics largely reflects the sharp decline in the fertility rate, which has fallen to 1.5-1.6 from 5.9 in the 1970s—partly the result of the government's One Child Per Couple Policy. Even with the recent abolition of the One Child Per Couple Policy, the current fertility rate remains below the two births per woman replacement rate required for a stable population. The gender ratio is also an important demographic driver. According to Wei and Zhang (2015), an important driver of the high household savings rate is gender imbalance. Using the competitive savings motive as its framework, the authors show that high gender imbalances can motivate higher savings by individuals or families to improve their relative economic status and bolster competitiveness in the dating or marriage market. Comparing savings across regions between households with sons versus those with daughters, the authors found that not only did households with sons save more than households with daughters, but households with sons living in a region with a more skewed

Figure 1: Working age population growth and old-age dependency, PRC

Working age population growth

15–59 years old   15–64 years old

% change

Turned negative in 2012

Old-age dependency ratio
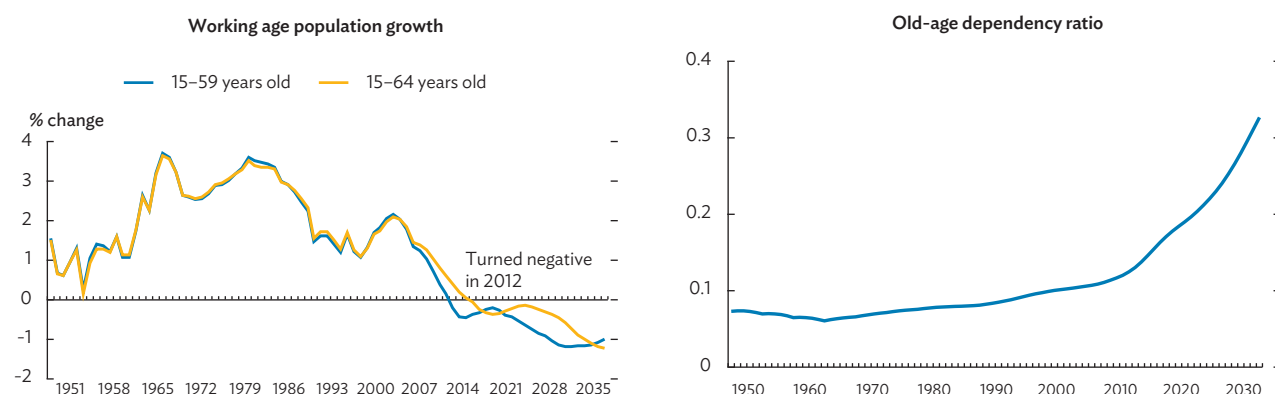
PRC = People's Republic of China.
Note: Old-age dependency ratio is the ratio of 65 years old and above to the working age population (15–64 years old).
Source: Population Division, Department of Economic and Social Affairs; United Nations Secretariat. *World Population Prospects: The 2015 Revision*. http:/esa.un.org/unpd/wpp/DVD

sex ratio tended to save more. Thus, a more balanced sex ratio could lower the country's strong propensity to save—roughly 50% at present.

Second, there is the ongoing shift in the PRC's economic structure, from industry toward services on the supply side, and from investment to consumption on the demand side (Figure 2). The shift is largely an attempt to make growth more sustainable and to correct economic imbalances generated following years of high investment growth. The shift toward services—more labor-intensive relative to manufacturing—creates employment and should boost domestic demand, thus reducing reliance on external demand to support growth. The contribution to growth

from industry and investment has begun to decline (Figure 3). But services and consumption growth, while reasonably robust, have not—and may not be able to—fully offset the drop. As industry and investment tend to be more import-intensive than services and consumption, these sectoral shifts also suggest that trade spillovers from the current growth moderation could be larger than in the past.

Third, the natural process of convergence implies that growth will slow as per capita income rises. The PRC has indeed been catching up quickly over the past 25 years, with real per capita gross domestic product (GDP) rising nine-fold since 1990. This has pushed wages higher—with current wages in the PRC already much higher relative to

Figure 2: Shares in nominal GDP, PRC
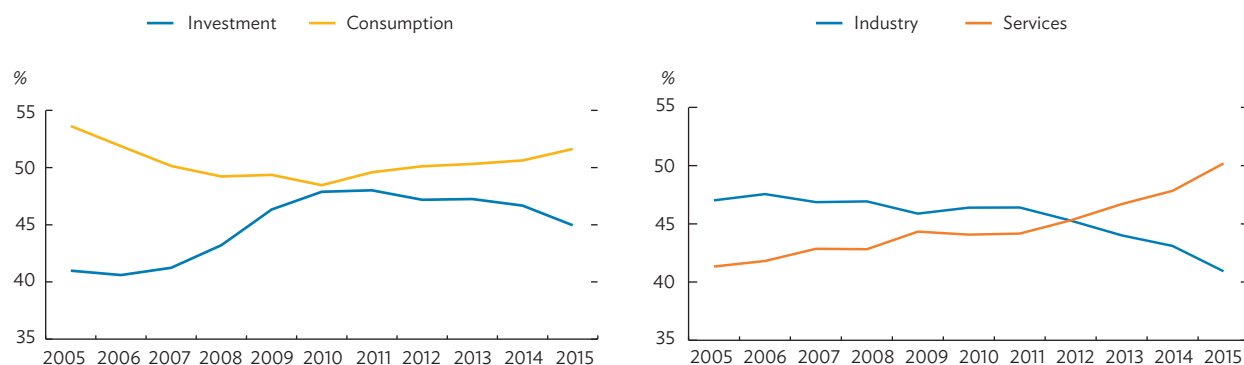
GDP = gross domestic product, PRC = People's Republic of China.
Source: CEIC Data Company (accessed 2 November 2016).

Figure 3: Contributions to GDP growth, PRC
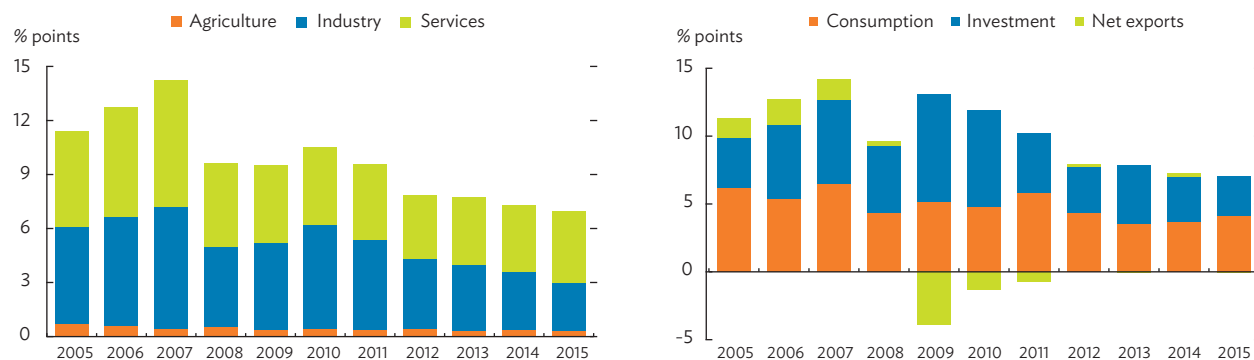
GDP = gross domestic product, PRC = People's Republic of China.
Source: CEIC Data Company (accessed 2 November 2016).

other countries in developing Asia.[1] For example, wage costs are almost four times those in Bangladesh, the Lao People's Democratic Republic (Lao PDR), Cambodia, and Myanmar (Figure 4). However, wages remain low in the PRC's poorer regions, and the PRC still holds opportunities for economies of scale: it remains a competitive location for production, as overall costs can remain lower due to networks of suppliers and established distribution channels.

Fourth, there has been a persistent drag on exports—due to weaker-than-expected external demand from the lackluster recovery in advanced economies since the global financial crisis and, more recently, from other emerging markets. Exports have contributed strongly to growth in the years since the PRC joined the World Trade Organization (WTO) in 2001. Since the global financial crisis, however, sluggish exports have not been a net contributor to growth.

Since 2011, growth in major industrial economies has remained below 2%, and the persistence of the weakness suggests a combination of cyclical and structural factors. In the euro area, investment remains low, and many countries remain hobbled by high unemployment, low inflation, and high debt. In the past year, the massive refugee influx and uncertainty over the future of the European Union (EU)—following the United Kingdom's (UK) "Brexit" decision—increased strains. The Japanese economy continues to operate below potential, as monetary and fiscal stimulus has failed to sustainably raise domestic demand and inflation. And the United States (US) economy remains fragile with persistent worries over lower levels of potential growth. These advanced economies account for some 40% of the PRC's total exports.

Even emerging markets are in a bind (Figure 5). The general slowdown in advanced economies, low commodity prices, geopolitical tensions, and the PRC's own rebalancing continue to exert downward pressure on emerging market growth (International Monetary Fund [IMF] 2016). And with the PRC largely interconnected to these economies through trade, their own weakness can easily spill over to the PRC economy. Nevertheless, it is clear that a substantial portion of the PRC's slowdown is due to domestic factors.

Figure 4: Average monthly factory worker wage, 2014
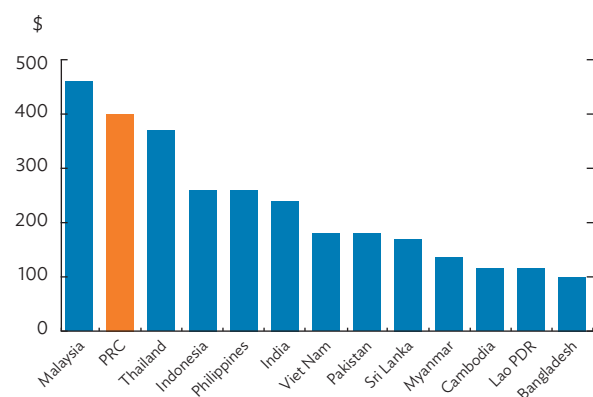
Lao PDR = Lao People's Democratic Republic, PRC = People's Republic of China.
Source: Capital Economics. 2016. *Emerging Asia Economics Weekly* (8 February).

Figure 5: Volume of trade in goods and services
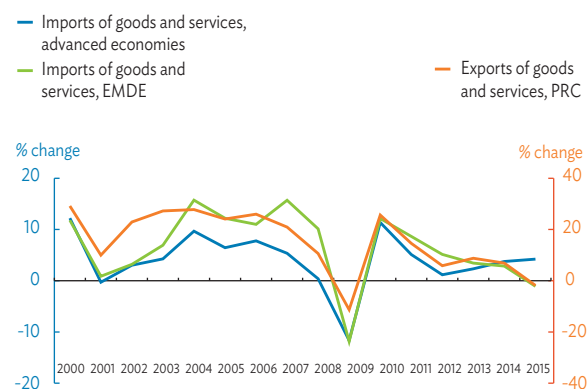
EMDE = emerging and developing economies, PRC = People's Republic of China.
Sources: International Monetary Fund, *World Economic Outlook* October 2016 online database (accessed 18 November 2016) and ADB estimates.

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[1]   The substantial increase in wages in the PRC has led to research into whether the PRC has passed the "Lewis Turning Point," where the supply of low-cost surplus labor is exhausted and labor shortages lead to a sharp rise in wages (Lewis, 1954). Several studies, including Cai and Wang (2008); Cai (2010); Chan (2010); Zhang, Yang, and Wang (2010); and Knight, Peng, and Li (2011) argue that the PRC has already passed the Lewis Turning Point, as evidenced by a substantial rise in real wages both in the peak and slack seasons, indicating a nationwide labor shortage. In contrast, other studies find that the PRC still has a large pool of underutilized rural labor (see Kwan 2009, Ercolani and Zheng 2010, and Golley and Meng 2011). Das and N'Diaye (2013) estimate that the PRC's surplus labor peaked in 2010 and that the PRC will reach the Lewis Turning Point between 2020 and 2025. Even with uncertainty surrounding the precise timing, the general consensus is that the PRC has either recently crossed or will soon cross the Lewis Turning Point. With rising labor costs, the PRC must improve the productivity of its industry and services sector through innovation and upgrading in order to continue growing (Zhuang, Vandenberg, and Huang 2012).

These changes have substantial implications for growth

As a result of these fundamental shifts, growth in the PRC has been moderating, and is expected to slow further over the medium term. The country's growth peaked at 14.2% in 2007, then fell sharply below 10% in 2008 and 2009 in response to the global financial crisis. A recovery in the global economy and strong countercyclical policies by PRC authorities resulted in growth rising to 10.6% in 2010, but in the years since growth has steadily declined. The PRC grew 6.9% in 2015—almost half a percentage point below 2014, and the first time in a quarter-century it fell below 7%. This growth moderation was no surprise: a slowdown was widely expected. But its extent was unforeseen, as evidenced by the continuous downward revisions to Consensus Forecasts (Figure 6). ADB expects growth to slow to 6.6% this year, and to moderate even further in the future.

Historically, this is not the sharpest PRC economic slowdown. The country saw a continuous decline in growth in the 1990s. After reaching 14.3% in 1992, growth in gross domestic product (GDP) declined steadily to 7.6% in 1999 (Figure 7). That slowdown was primarily domestic in nature: the result of policy tightening following a period of overheating and high inflation, and the subsequent need to clear the financial system of bad loans to failed

state-owned enterprises. But the significance of the PRC's current growth moderation is far greater, given the country's greater regional and global economic importance. The PRC's share of global GDP has grown from 1.5% in 1990 to 15% in 2015, and its share of global exports rose from 0.5% to 11%. As a result, today the PRC is the world's largest exporter and second largest economy (Figure 8). Indeed, the PRC now affects the global economy as much as it is affected by it (Summers 2015). By sheer economic size and influence, its slowdown will have significant spillovers—on its Asian neighbors and the rest of the world.

Figure 7: GDP growth performance, PRC
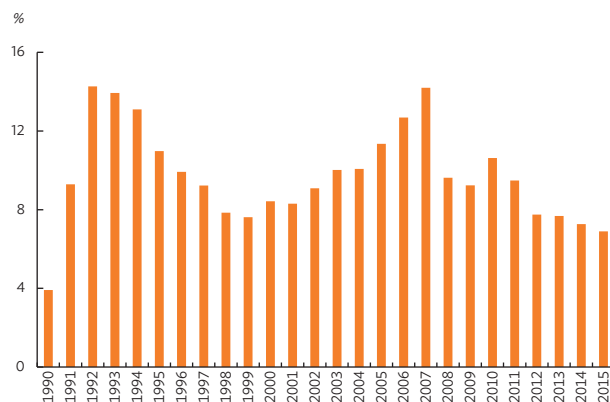
GDP = gross domestic product, PRC = People's Republic of China.
Source: World Bank, *World Development Indicators* online database (accessed 21 October 2016).

Figure 6: PRC's growth and Asia Pacific Consensus Forecasts

APCF = Asia Pacific Consensus Forecast, GDP = gross domestic product PRC = People's Republic of China.
Sources: International Monetary Fund, *World Economic Outlook,* October 2016 online database; and Consensus Economics, *Asia Pacific Consensus Forecast,* various issues.

Figure 8: Share of global GDP (in current $), PRC
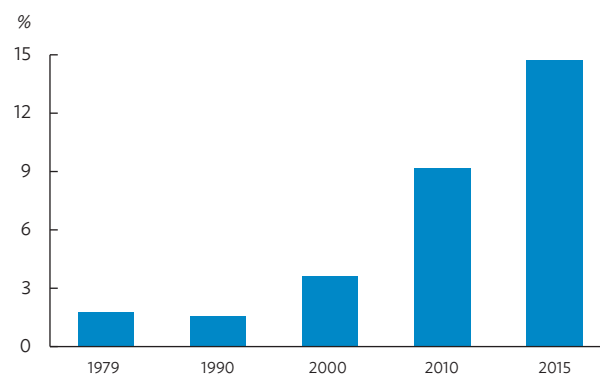
GDP = gross domestic product, PRC = People's Republic of China.
Source: World Bank, *World Development Indicators* online database (accessed 21 October 2016).

There is a low-probability risk of a sharper slowdown

Following the global financial crisis, efforts to maintain high growth contributed to rising vulnerabilities. In response to the collapse in external demand, the PRC employed expansionary policies that included a substantial easing of credit conditions and subsequent increases in debt-financed residential and infrastructure investment. These helped support growth, but also raised vulnerability to

a credit boom-bust cycle. The estimated stock of total social financing (a broad measure of credit) expanded continuously, with its stock exceeding 200% of GDP by 2016 (Figures 9 and 10). Debt helped fuel overinvestment and excess capacity in cement, steel, and aluminum, among others, and led to sharp increases in several asset markets as well. To mitigate financial risks, the central bank and other regulators constrained credit growth outside the banking sector since mid-2013, through stricter regulatory requirements and tighter controls on local government financing vehicles (Figure 11).

Figure 9: Total social financing, PRC
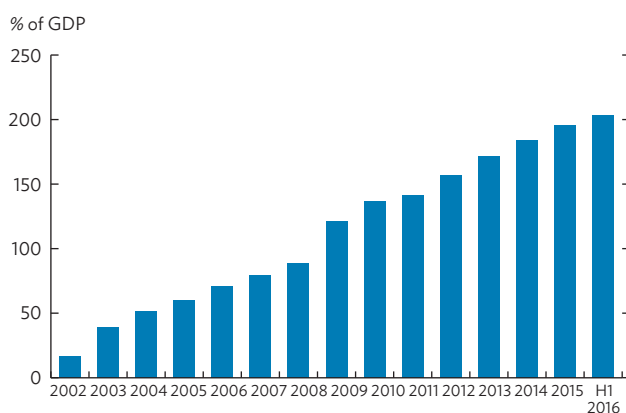
GDP = gross domestic product, PRC = People's Republic of China.
Sources: ADB 2015a; CEIC Data Company (accessed 10 November 2016); and ADB estimates.

Figure 10: Total debt, PRC
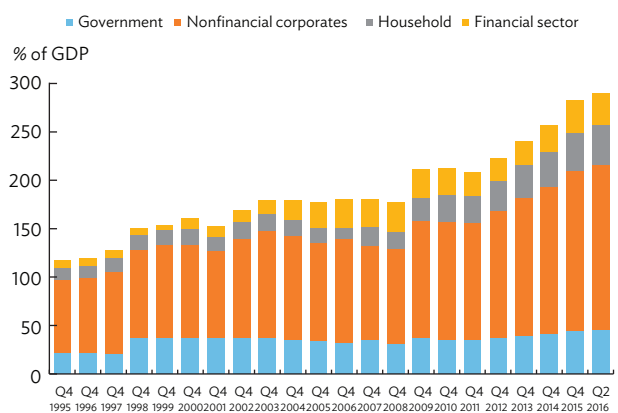
GDP = gross domestic product, PRC = People's Republic of China.
Note: Q2 2016 data is an estimate.
Source: Institute for International Finance, Emerging Markets Debt Monitor Data (accessed 23 November 2016).

Figure 11: Loans from shadow banks, PRC
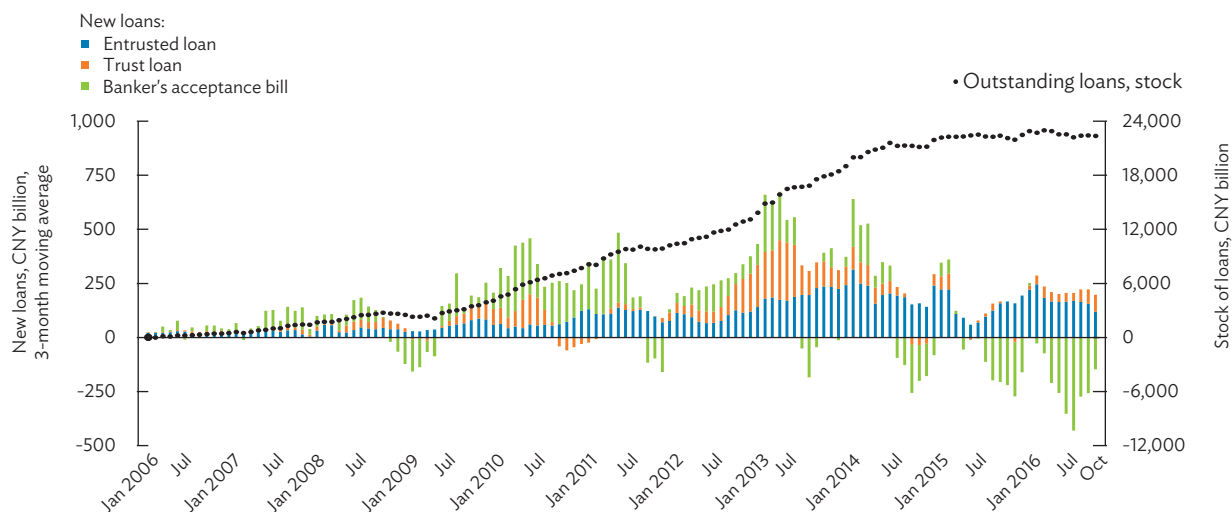
GDP = gross domestic product, PRC = People's Republic of China.
Sources: ADB 2016; CEIC Data Company (accessed 10 November 2016); and ADB estimates.

A sharp drop in PRC growth—emanating from a disorderly unwinding of economic imbalances—is not expected in the near term, and not a high-probability risk even over the medium term. The government holds substantial policy buffers to respond to adverse shocks. General government debt (measured as central government plus "on-budget" local government debt) remains relatively low, below the average for developing economies in the region (Figure 12). The People's Bank of China has sufficient ability to adjust capital controls and limit potentially destabilizing short-term capital flows. And foreign exchange reserves remain sizeable at just under $3.2 trillion as of end-September 2016 (Figure 13), almost double the reserve adequacy metric used by the IMF and covering almost 25 months of imports. Even with the slowdown, macroeconomic conditions remain favorable: growth is among the highest globally, inflation is low, and the current account remains in surplus. Perhaps most important, the authorities are cognizant of the potential risks and have already shown willingness to step in as needed to rein in credit growth, for example.

This report assesses the spillover effects of the PRC's structural shifts and the implied growth moderation on the rest of the region and the world. It complements the existing literature on international spillovers by considering the three main channels of transmission—commodity prices, trade, and production—both jointly in a global macroeconomic model, and individually in greater detail using a variety of analytical approaches. Another

Figure 12: General government gross debt (2015), selected developing Asian economies
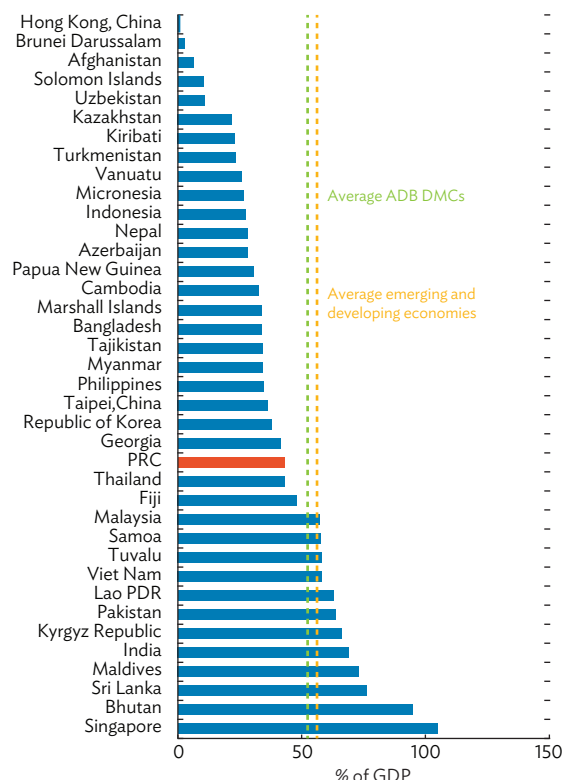
DMC = developing member country, GDP = gross domestic product, Lao PDR = Lao People's Democratic Republic, PRC = People's Republic of China.
Source: International Monetary Fund, *World Economic Outlook* October 2016 online database.

Figure 13: Foreign exchange reserves, PRC
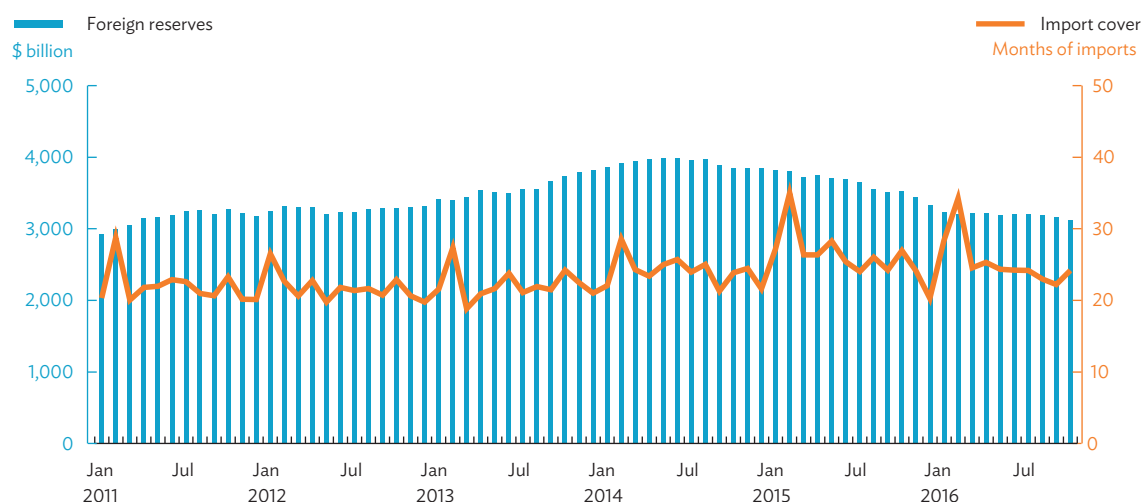
PRC = People's Republic of China.
Source: CEIC Data Company (accessed 10 November 2016).

differentiating factor is the emphasis on implications for the rest of developing Asia (and on individual countries in the region), although implications for the rest of the world are also discussed briefly.

Section 2 examines the effects on the global economy under a baseline scenario of gradual growth moderation; and under the unlikely scenario that growth declines more sharply than currently expected due to a disorderly unwinding of imbalances. The third section uses a vector autoregression framework to examine how the moderation could affect global commodity prices and developing Asia's commodity exporters. The analysis there explicitly addresses the structural breaks that are pervasive in commodity price behavior. The fourth section uses both panel regressions and sectoral analysis using the World Input-Output Database to examine how trade and production linkages shape the effects of a PRC slowdown on the region. These provide a more granular analysis of the impact of the PRC's structural shifts, on individual economies and specific sectors in developing Asia. The final section concludes and discusses how developing Asia's policymakers can respond to the challenges and opportunities that the PRC's structural changes present.

2 Implications of the People's Republic of China's Growth Moderation for the Rest of the World and Developing Asia

Understanding the global spillovers of the PRC growth moderation is important even if the focus here is on its impact on the rest of Asia. If slower PRC growth creates a drag on major economies such as the US and EU, then there are greater worries for Asia's policymakers than just direct spillovers from the PRC. The analysis here uses the seven-region version of the Global Projection Model (GPM7)—a quarterly, multiregion model currently used by many central banks and international organizations for forecasting and policy analysis.[2] The seven regional blocks covered by the GPM7 together account for 85% of global GDP: the US, euro area, Japan, the PRC, Latin America, emerging Asia (excluding the PRC), and a "Remaining Countries" block. The emerging Asia (excluding PRC) block consists of Hong Kong, China; India; Indonesia; the Republic of Korea; Malaysia; the Philippines; Singapore; Taipei,China; and Thailand. Combined with the PRC, these emerging Asia economies account for over 90% of developing Asia's GDP in purchasing power parity terms. GPM7 focuses on a few key variables of most interest to policymakers—output, inflation, interest and exchange rates, plus global commodity prices.

Each region is described by four behavioral equations, which are familiar and interpretable to policymakers. There is an output gap equation that measures the difference between actual and potential GDP, a Philips curve that shows the inverse relationship between the level of unemployment and inflation rate, a Taylor rule that stipulates how much a monetary authority should change the nominal interest rate in response to changes in inflation and output, and an uncovered interest-parity condition with risk premiums, which links real interest rates

with real exchange rates. For the G3 economies—the US, EU, and Japan—the model also incorporates financial–real linkages by including indicators of bank lending tightness, which affect economic activity. These can also proxy for global financial shocks as they can be correlated across regions and have spillovers beyond the G3. The PRC is modeled somewhat differently from other regions because it is a market economy that is still subject to substantial state control. In particular, it has a reserve–requirement ratio as an additional monetary policy variable, and the exchange rate regime is a weighted average of floating and fixed rates, with the latter getting two-thirds of the weight. GPM7 (and various Global Projection Model versions more generally) is often described as a "gap model," as it uses deviations from equilibrium values (potential output, nonaccelerating inflation rate of unemployment, the equilibrium real interest rate, and the equilibrium real exchange rate) in the behavioral equations mentioned above. Equilibrium values are unobserved, and are specified as stochastic processes, with lead–lag structures and stochastic shocks to both levels and growth rates. GPM7 is estimated using Bayesian estimation to ensure that simulation properties are sensible and consistent with priors and data. This also allows for estimation even with short samples. Finally, GPM7 also includes world commodity prices (oil, food, and metals), which are a function of the world output gap, and which, in turn, affect inflation and output across different regions.

There are advantages and limitations when taking a GPM-based approach to estimate spillovers. One advantage is that shocks to the variables of interest and causal effects can be easily identified and isolated. It also provides a

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more comprehensive global picture, examining multiple regions and variables of interest. Finally, spillover effects can be traced through multiple channels—as mentioned, all major transmission channels are present in GPM7, including trade, financial, exchange rate, and commodity price channels. However, being an aggregated regional model, GPM7 cannot fully tease out the implications for individual economies. In addition, it does not capture production linkages very precisely. Lastly, oil is the only individual commodity price that really matters in the model, and other commodities only enter as composites. For these reasons, it provides a useful starting point and complement to the more granular analysis (of individual economies and commodities) that is done in subsequent sections.

Spillovers from gradual growth moderation

A gradual growth moderation scenario can be modeled as policy-induced tightening—a reduction in demand—as authorities seek to reduce vulnerabilities from having the economy grow at a rate higher than what is sustainable. The PRC remains a heavily managed economy. In recent years, authorities were able to maintain actual GDP growth above the 7% growth target, but this was done in part by using an unsustainable mix of easy credit and investment. Authorities were cognizant of the rising risks, and also raised concerns about evidence of increased environmental pressures. In weighing achieving target growth against reining in vulnerabilities, the government began emphasizing the latter in 2014—evident from policies to better control credit growth, particularly in shadow banking. To model this scenario in GPM7, the authorities are assumed to have realized that potential growth rates of 7% or higher were overoptimistic. The realization that the pace of economic growth was unsustainable led to a shift in policy—a withdrawal of the stimulus that acted as a negative demand shock equal to the shift in their view of potential growth.

Using the GPM7 global general equilibrium framework, the model is first recalibrated to reflect baseline conditions assumed in the *Asian Development Outlook 2016* (ADO 2016)—including G3 GDP growth and inflation assumptions in 2016 and 2017. The forecasts in the ADO

2016, which see PRC growth slowing to 6.3% in 2017, incorporate the effects of the structural changes occurring in the PRC which are described in Section 1. The GPM7 assumptions for the other regional blocks—Emerging Asia excluding PRC (EA ex. PRC), Latin America (LA), and Remaining Countries—are left unchanged from GPM7 network assumptions. The ADO 2016 oil price assumptions in the forecast period are used as proxy for world commodity prices (Figure 14).

Figure 14: Oil price assumptions
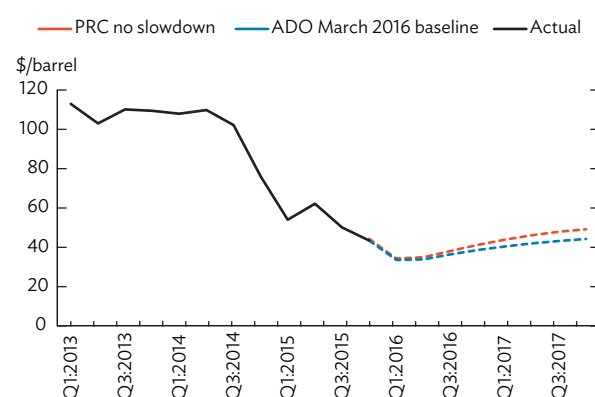
ADO = Asian Development Outlook, PRC = People's Republic of China.
Sources: Haver Analytics and ADB estimates.

Figure 15 shows the impact of a 1 percentage point negative shock to PRC GDP growth rates on other regional groups in the model.[3] The blue bars represent the trade and policy effects, the red bars the effect of commodity prices, and the yellow dots show the overall impact—the net effect on GDP growth through trade, policies, and commodity prices.

The simulations suggest that the effects on the rest of emerging Asia and on Japan are nontrivial. Asia (including the PRC) benefits from lower commodity prices—oil prices are 7%–10% lower than otherwise, due to weaker PRC and global economic activity. But the benefits to Japan and emerging Asia from lower commodity prices are more than offset by the negative impact from their strong intraregional trade and production linkages with the PRC. For Japan, these negative external effects are exacerbated because the adverse shock to demand and lower commodity prices both reduce inflation. In the

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[3]   A unit shock facilitates easy recalculation of spillover effects if one believes the actual shock to PRC growth is higher or lower than 1 percentage point. As it happens, 1 percentage point is the size of the "growth disappointment" in 2016–2017 relative to the forecasts in *Asian Development Outlook 2014,* assuming growth remained unchanged at 7.4% in those years.

Figure 15: Effects of a gradual growth moderation in the PRC
(deviations in GDP growth from baseline)
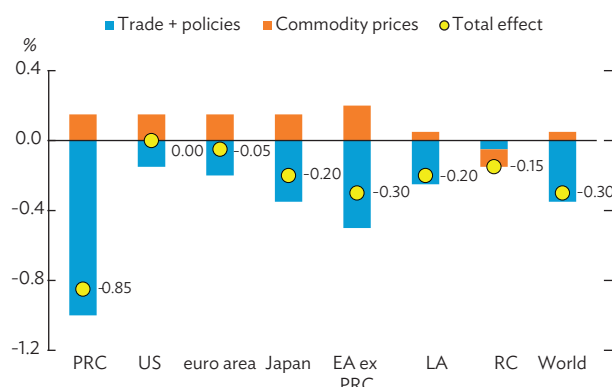
EA = Emerging Asia (Hong Kong, China, India; the Republic of Korea; Indonesia; Malaysia; the Philippines; Singapore; Taipei,China; Thailand); GDP = gross domestic product; LA = Latin America (Brazil, Chile, Colombia, Mexico, and Peru), PRC = People's Republic of China; RC = remaining countries (Argentina, Australia, Bulgaria, Canada, Czech Republic, Denmark, Estonia, Israel, New Zealand, Norway, the Russian Federation, South Africa, Sweden, Switzerland, Turkey, the United Kingdom, and Venezuela); US = United States.
Sources: *Asian Development Outlook* database and ADB forecasts.

presence of the zero lower bound, this implies a rise in real interest rates, which dampens domestic demand, compounding the negative external shock. As a result, weaker PRC growth shaves about a third of a percentage point off Emerging Asia's (excluding PRC) growth and a fifth of a percentage point off Japan's.

In contrast, the effects of a gradual growth moderation in the PRC on the US and Europe are negligible, while commodity-exporting regions are negatively affected through both trade and lower commodity prices. The effects on these regions via trade are much smaller, as final demand from the PRC is less important than it is for Asian countries. In the US and Europe, the adverse trade effects are almost fully offset by the boost from lower commodity prices. For oil-exporting regions (included in the Remaining Countries block), lower commodity prices act as a negative terms-of-trade shock, which compounds the adverse trade effects. Latin America, a significant supplier of commodities to the PRC, will be hit by a reduction in GDP growth by 0.2 percentage points due to the slowdown in demand from the PRC for their commodity exports. A small gain to Latin America from lower oil prices is offset by the more dominating trade and policy effects. The Remaining Countries block—which, as mentioned, contains several oil-producing economies—

sees growth decline by 0.15 percentage points, mostly due to lower oil prices. Overall, world GDP growth is almost a third of a percentage point below what it would have been had the PRC economy not slowed.

These estimates are broadly consistent with the results of other studies. Ahuja and Nabar (2012) find that a 1 percentage point slowdown in investment in the PRC reduces global growth by less than 10th of a percentage point, with growth in developing Asian countries falling between 0.2 percentage points and 0.9 percentage points. Ahuja and Myrvoda (2012) find that a 1% decline in PRC's real estate investment would shave 0.05% off global output, with Japan, the Republic of Korea, and Germany among the hardest-hit countries. Duval and others (2014) shows a 1 percentage point decline in PRC growth lowers GDP growth of the median Asian economy by 0.3 percentage point after the first year, and growth of the median non-Asian economy by 0.15 percentage points. IMF (2014) estimates that, on average, a 1 percentage point decline in PRC growth will result in a 0.15% slowdown in the growth of advanced economies (0.2% for Japan) but less than 0.1% for other emerging markets. More recently, Cashin, Mohaddes, and Raissi (2016) estimate that a 1 percentage point reduction in PRC growth results in a 0.23–0.35 percentage point reduction in the growth of ASEAN 5 countries. For other countries in the Asia and Pacific region, except for India, the fall in GDP growth ranges from 0.06–0.17 percentage points. The negative spillover effects for advanced economies are smaller, and global GDP growth falls by 0.23 percentage points in the short run. Zhai and Morgan (2016) use computable general equilibrium analysis and find that a 1.6 percentage point growth decline in the PRC would result in a growth deceleration of 0.26 percentage points in the rest of developing Asia.

What a sharp slowdown could look like: An event study analysis

Although a sharp decline in growth is not seen as a high-probability risk, it is not impossible. It is, therefore, informative to assess the likely consequences should this low-probability event materialize. A sharper growth slowdown than currently expected could result from a disorderly unwinding of existing imbalances. A credit boom could turn into a bust. Sharp increases in asset prices are subject to large corrections. And financial institutions—both regulated banks and unregulated shadow banks—might have to confront a sudden slew of bad loans, precipitating a financial crisis. These events could occur

simultaneously, exacerbating the economic effect.[4] The effects of a disorderly unwinding could also be amplified by a rise in capital outflows and exchange rate pressures. While policy buffers are substantial, there is a chance that they might not be deployed in a timely manner; for example, in response to subnational risks that materialize. Finally, new engines of growth may prove to be vulnerable to shocks such as e-commerce or to more standard financial system shocks.

Event study analysis can be used to examine the behavior of real GDP and its demand components during historical episodes of a disorderly unwinding of imbalances. An obvious caveat is that economies, and episodes themselves, can exhibit substantial heterogeneity. The hope is that looking at the average effects across a large number of episodes and economies can still be informative. The alternative of examining similar events out of the PRC's past is hindered by the dearth of such episodes, and the fact that the PRC in the past was very different from the PRC at present.

Three types of episodes are considered: credit boom-busts, banking crises, and housing downturns. Information on credit boom events is taken from Mendoza and Terrones (2012), which identified a total of 70 credit boom episodes in 61 economies over the period 1960–2010.[5] Data on banking crises is taken from Laeven and Valencia (2012). A banking crisis episode is said to be systemic when, in a given year, the banking system experiences financial distress—bank runs, losses, and/or liquidation of distressed banks—and, in response, major banking policy interventions are put in place. A total of 147 banking crises in 116 economies during 1970–2011 are identified in the paper. Finally, information on housing cycles is obtained from Igan and Loungani (2012). Using quarterly data of housing prices in 55 economies, they identify 138 housing cycles during 1970–2010.[6]

Eleven-year event windows of the macro aggregates centered at the start of the crisis episodes (t=0) are constructed. The event windows show the cross-country median growth rates of real output, private and public consumption, investment, exports, and imports (Figure 16).[7]

The variables show a well-defined pattern around the beginning of crisis episodes: high growth rates before the crisis event and then a decline. The decline in real output growth usually lasts about 2 years, and then growth reverts to previous rates. Among domestic demand components, investment shows sharper pre-crisis growth and subsequent contraction than private and government consumption. The same holds true for external demand: exports and imports rise and fall more than consumption. Between private and public consumption, the latter exhibits smaller fluctuations. As growth rates do not overshoot during recoveries, this suggests there are permanent effects on the level of real output.

In historical episodes of credit boom-busts, housing downturns, and financial crises, investment growth tends to slow sharply (Table 1). The typical decline in GDP growth during these disorderly slowdowns is about 2–3 percentage points (column 1). Private consumption growth declines by a similar magnitude. Among GDP components, the biggest decline in growth is in investment (column 3), which slows by about 10 percentage points. As the PRC's current economic structure is currently skewed strongly toward investment, a disorderly adjustment with the same impact on consumption and investment growth as in past episodes would result in a larger decline in GDP growth than the sample's 2-3 percentage points. Using the growth decelerations in Table 2 applied to current shares of investment and consumption in the PRC suggests that a disorderly adjustment could result in a decline of 4½ percentage points in PRC growth.

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[4]   There are several channels through which a disorderly unwinding of these types of economic imbalances can affect the real economy. Financial crises hurt international trade through demand-side shocks (see for example, Levchenko, Lewis, and Tesar, 2010; Bems, Johnson, and Yi, 2010) or supply-side shocks (see for example, Amiti and Weinstein, 2011; Chor and Manova, 2012). The link between housing prices and the real economy runs via the wealth and collateral effects on credit demand and supply (Goodhart and Hoffman 2008). Uncertainty in returns on capital may also affect a financial institution's decision to invest or lend, which can lead to a contraction in real economic activity (Claessens et al, 2014).

[5]   Using credit extended by the banking system to the private sector, Mendoza and Terrones (2012), defined a credit boom as a period when the difference between the logarithm of real credit per capita and its long-run trend exceeds the standard deviation of the cyclical component by a threshold factor.

[6]   Four or more consecutive quarters of decline (rise) in housing prices indicate a downturn (upturn). As all previous episodes are on an annual basis, quarterly data of housing peaks and troughs is converted to annual data by classifying the beginning year of the housing bust to be the same year if it starts in quarters 1 or 2. If it begins in quarters 3 or 4, the start of the housing bust will be the following year.

[7]   Event windows for the mean of the macro aggregates were also constructed, but these were not as well-behaved as the medians, as extreme values were affecting the average results. Median GDP growth does not fall below zero, but a substantial number of these episodes are associated with contractions in economic activity.

Figure 16: Median growth rates of GDP demand components following disorderly slowdowns

Credit boom-bust

— Real GDP   — Government consumption   — Investment
— Private consumption   — Imports   — Exports

Banking crisis

— Real GDP   — Government consumption   — Investment
— Private consumption   — Imports   — Exports

Housing downturn

— Real GDP   — Government consumption   — Investment
— Private consumption   — Imports   — Exports
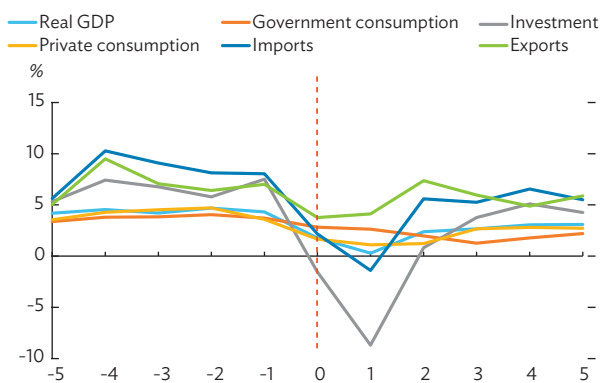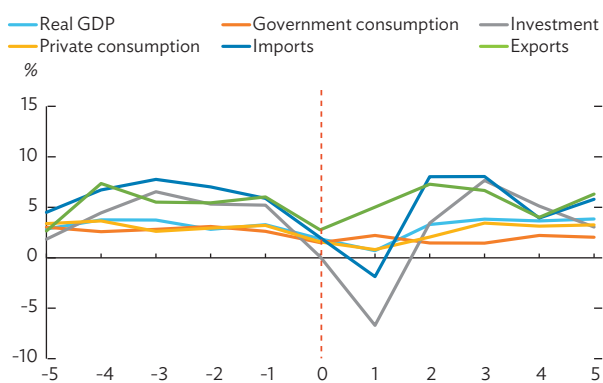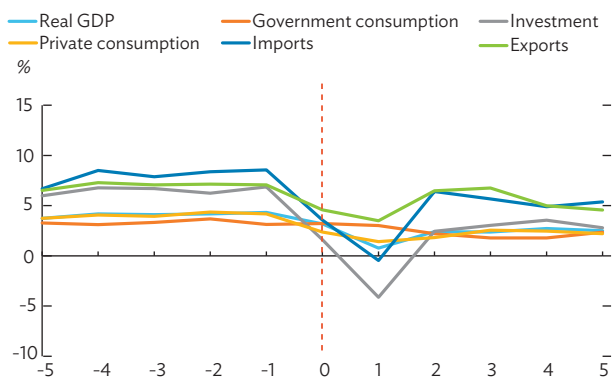
GDP = gross domestic product.
Source: ADB estimates.

Table 1: Magnitudes of growth decelerations during disorderly slowdowns
(growth in first 2 years after the event relative to previous 5 year growth, percentage points)

	Real GDP	Private consumption	Investment	Government consumption	Exports	Imports
Credit boom-bust	-3.4	-2.8	-11.7	-1.0	-3.1	-7.9
Banking crisis	-2.0	-2.0	-8.0	-1.0	-1.5	-6.3
Housing downturn	-2.1	-2.2	-7.8	-0.2	-3.0	-6.4

GDP = gross domestic product.
Note: Averages based on 70 credit boom-bust episodes in 61 economies during 1960–2010 (Mendoza and Terrones 2012, Appendix I); 147 banking crises in 116 economies during 1970–2011 (Laeven and Valencia, 2012, Table A1); and 138 housing cycles in 55 economies during 1970–2010 (Igan and Loungani 2010, Table 1).
Source: ADB estimates.

The Global Projection Model can then be used to examine the effects on the rest of the world of a PRC growth slowdown of this magnitude—involving both demand and supply elements. The financial sector typically becomes impaired following a financial crisis—for example, reducing demand via a credit crunch affecting both consumption and investment. In addition, it will also result in a supply shock through higher costs of capital for producers. More generally, on the supply side, capital growth may slow during these episodes, or some capital may become obsolete, impairing output longer term. There may be some skills obsolescence as well, if people become unemployed for protracted periods. Productivity may suffer if research and development investment is curtailed, as can happen during crises. On the demand side, lower wage growth reduces consumption growth, and diminished economic prospects can lead to lower investment growth.

To operationalize the sharp slowdown scenario in the GPM7, a negative shock to the baseline is imposed in the form of a 4.5% reduction in demand alongside a shock that lowers the path of potential growth in the PRC. Similar to the case of gradual growth moderation, PRC growth spillovers in this scenario are assumed to work through trade and commodity price channels, but this time it also works through the financial sector. Given the PRC's size and contribution to global growth, a disorderly slowdown at this level could potentially result in substantial tightening of global financial conditions.

A global financial shock like that in 2008/09—when the Chicago Board Options Exchange Volatility Index (VIX) spiked above 80 and remained elevated for several quarters—would unlikely result from a sharp slowdown in the PRC, as the PRC is neither a global financial center like the US nor as financially integrated as the euro area. But a sharp downturn in PRC growth can still have a large impact on financial markets. A preview of this was on display in August 2015, when a stock market swoon and concerns about PRC growth prospects led to the VIX spiking above 40 for the first time since the euro area crisis (Figure 17). Should a disorderly slowdown in the PRC materialize, one would expect a spike in the VIX of at least that magnitude, but with greater persistence.[8]

Figure 18 presents the results of simulations under the PRC sharp slowdown scenario. The red-shaded bars are the effects from a PRC-induced fall in world commodity prices. The US, euro area, Japan, and other Emerging Asia economies all benefit as a consequence, as these economies find production inputs more affordable. However, the situation differs in Latin America and Remaining Countries as the fall in commodity prices is a drag on growth.

On top of a sharper growth slowdown in the PRC, an exacerbating event—a negative global financial shock—is added to show that the underlying growth slowdown may precipitate financial turbulence due to loss of market confidence. The effects in Figure 18 are in the light green-shaded bars. The results show that the direct effects in the US and euro area cut as much as 0.6 and 0.4 percentage points off growth, respectively, as they have limited monetary space for easing. The PRC, Latin America, and Remaining Countries pull growth further down by 0.3 percentage points. On the whole, global growth would be lower by 1.75 percentage points, with the bulk of the effect coming from trade effects. The financial shock is seen to reduce growth by 0.4 percentage points on average over the forecast horizon. Commodity prices are primarily

Figure 17: US Chicago Board Options Exchange volatility index, 2004–present
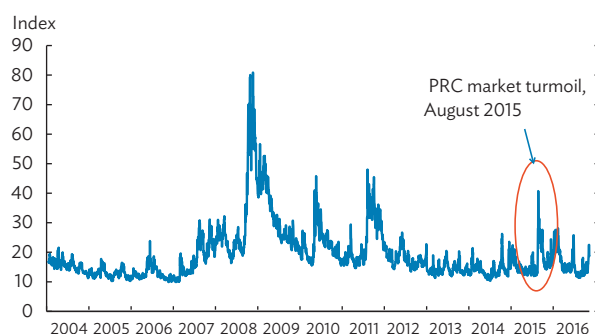
PRC = People's Republic of China, US = United States.
Source: Bloomberg (accessed 10 November 2016).

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8   This effect is operationalized in GPM7 via much tighter bank lending conditions in both the US and euro area, as the model uses bank lending tightening (BLT) to proxy financial effects; increased risk aversion leads to an increase in tightening conditions and represents a reduction in credit. More specifically, it is assumed that US banks experience a shock to their BLT at around 2/3 of the magnitude observed during the Lehman collapse in 2008. The European banks experience half of the US BLT shock as credit conditions there are already tighter as a result of euro area's existing slow growth momentum. In addition to a rise in global financial volatility and risk aversion, one could also imagine the PRC country risk premium rising in response to a sharp slowdown, leading to yuan depreciation.

redistributive, boosting commodity importers while pulling down commodity exporters, but the net effect on global growth is slightly positive—as many commodity exporters could use existing buffers to soften the impact.

In sum, a disorderly PRC slowdown would have significant adverse effects on all regions, and pull global growth down by 1.75 percentage points. The sharper slowdown in PRC demand implies that trade effects would be correspondingly larger, as would effects on commodity prices—oil prices fall by 10%–25% relative to the baseline. These two forces, once again, will tend to offset each other in both the US and euro area. But the additional negative shock from tightening global financial conditions would lower growth in these two regions by about 0.65 of a percentage point relative to the baseline. The effects on Asia would be larger—Japan's growth would drop by about 1.5 percentage points with Emerging Asia's by about 1.8 percentage points. And an additional negative shock from tightening global financial conditions would contribute to lower growth in the US and Europe.

Figure 18: Effects of a sharp growth decline in the PRC (deviations of GDP growth from baseline, 2016–2017 average)
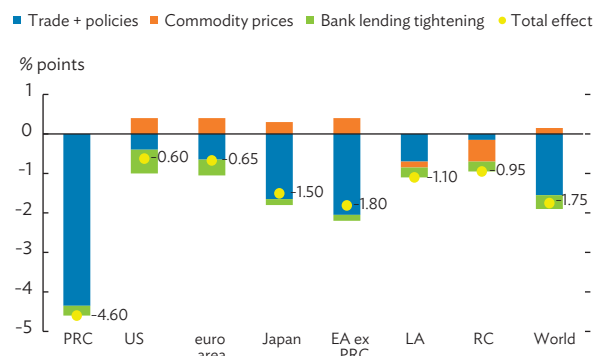
EA = Emerging Asia (Hong Kong, China, India; the Republic of Korea; Indonesia; Malaysia; the Philippines; Singapore; Taipei,China; Thailand); GDP = gross domestic product; LA = Latin America (Brazil, Chile, Colombia, Mexico, and Peru), PRC = People's Republic of China; RC = remaining countries (Argentina, Australia, Bulgaria, Canada, Czech Republic, Denmark, Estonia, Israel, New Zealand, Norway, the Russian Federation, South Africa, Sweden, Switzerland, Turkey, the United Kingdom, and Venezuela); US = United States.
Sources: *Asian Development Outlook* database and ADB forecasts.

3 The Impact on Commodity Prices and Commodity Exporters

Introduction

Over the past 15 years, rapidly growing commodity intensity in the PRC reflects its rapid expansion in tradable exports and large-scale fixed-asset investment, including construction. These are all commodity intensive—particularly in energy and base metals—and, as a result, the PRC now plays a dominant role in a variety of global commodity markets (Table 2).

The PRC's rapid, resource-intensive growth acceleration raises the question of just how much PRC demand drives commodity price trends. Commodity prices have shown significant volatility since 2000. For example, from 2000 to 2006, both metal and energy prices generally drifted upward, with frequent fluctuations around this rising trend. Commodity prices first peaked, and then fell sharply during the global financial crisis and its aftermath. Prices stabilized with most showing some signs of recovery from 2011. But since mid-2014, they again experienced a sustained drop, most noticeably in energy prices. While

economic growth of the PRC averaged around 10% since 2000, the recent gradual, steady drop to around 7% and perceived uncertainty over future growth have increased. This could be one of the contributing factors to the drop in commodity prices since mid-2014. The high volatility and changing persistence over time may have negative effects on developing economies heavily dependent for their exports on commodities.

Only a fraction of the huge PRC demand for energy and metal commodities can be met by domestic production. Thus, the PRC depends, to a large extent, on commodity imports from natural resource exporters. Its role in international commodity trade is also significant and changes in economic activity affects its trading partners. The PRC will continue to play an important role in world commodity trade as long as it affects the relative distribution of supply and demand of different commodities across countries (Roache 2012). Accordingly, a fall in commodity demand due to lower investment would potentially affect those exporting commodities to

Table 2: Share of selected global commodities, PRC

	Consumption as a share of world consumption, %			Imports as a share of world imports, %		
	2000	2010	2014	2000	2010	2014
Coal	29.5	48.2	50.6	0.3	15.2	18.6
Tin	17.7	41.9	50.8	5.2	8.3	5.9
Zinc	15.8	42.7	46.8	3.6	10.2	12.6
Copper	12.4	38.2	50.0	11.6	28.9	33.5
Aluminium	13.4	41.2	47.9	5.7	6.0	6.1
Nickel	5.1	34.3	44.9	2.0	25.4	24.7
Oil	6.2	11.0	12.0	3.5	9.0	11.4
Natural gas	1.0	3.5	5.4	1.9	2.1	7.2

PRC = People's Republic of China.
Sources: BP Statistical Review, United Nations *Commodity Trade Statistics* (UN Comtrade) database (both accessed 7 December 2015), and World Bureau of Metal Statistics.

the PRC directly through reduced trade, and all exporters indirectly through commodity price effects. Both can impact GDP growth in these economies based on the extent to which their economy depends on commodity trade.

The major exporters of energy and metal commodities in Asia—with large direct trade links with the PRC—include Azerbaijan, Brunei Darussalam, Indonesia, Kazakhstan, Malaysia, and Mongolia (Table 3). These economies are particularly vulnerable to changes in demand for their commodity exports and will be affected by changes in commodity prices as well.

This section analyzes the effects of a PRC slowdown on commodity prices. It assesses whether growth in commodity-dependent developing Asian economies reliant on the PRC for commodity exports responds asymmetrically to commodity price shocks. The analysis is carried out in two parts. The next section assesses the impact of PRC growth on commodity prices. Then, the effects a PRC slowdown would have on commodity-exporting Asian economies is estimated.

The People's Republic of China's impact on commodity prices

There have been several studies examining the impact of the PRC on commodity prices. Elekdag et al (2007) examine the increase in demand for oil from emerging Asia using a dynamic stochastic general equilibrium model, and find that an exogenous shock to PRC oil demand could

lead to an increase in oil prices by about 20% on impact and a subsequent rise by as much as 60%. Cheung and Morin (2007) use a regression-based approach, finding that oil and metal prices are becoming increasingly aligned with Emerging Asia's economic activity. They find that a 1% increase in Emerging Asian industrial production leads to a 5.8% increase in real oil prices. Adopting a similar econometric framework, Arbatli and Vasishtha (2012) find that surprise forecasts in the US and Emerging Asia— the PRC and India—are important for explaining price movements in most commodities in their sample. But they also find that growth in Emerging Asia's economies does not go far in explaining oil prices—a 1 percentage point revision in growth in Emerging Asia is associated with a 5.5% increase in the price of copper, a 3.6% increase in aluminum and 3% increase in zinc.

Roache (2012) makes use of a vector autoregression (VAR) model and finds that economic shocks in the PRC have a small impact on the price of oil and some base metals. Roache and Roussett (2015) build on this by allowing credit shocks to be included in the VAR model. They find a 1 percentage point shock in industrial production growth leads to a cumulative response in aluminum prices of 6.4% after 4 quarters, and 7.0% for copper, 6.7% for tin, and 2.3% for zinc. The oil price response is 8.8%. These are statistically significant and considerably higher compared with Roache (2012). Klotz et al (2014) find a causal relationship between PRC economic activity and prices for global energy and industrial metals. The impact of a 1 standard deviation shock to economic activity in the PRC has a 17-month effect on energy prices, with the effect on industrial metal prices relatively lower at about 7 months. Gauvin and

Table 3: Selected developing Asian economies and their main primary exports, 2013

Developing Asian economies	Exports of primary commodities to PRC/ Total exports to PRC (%)	Net export of primary commodities to World/GDP (%)	Major primary export commodities to World
Azerbaijan	57.8	28.1	Oil, natural gas
Indonesia	79.4	3.6	Coal, tin, natural gas
Kazakhstan	89.5	26.9	Oil, iron, copper
Malaysia	34.7	7.1	Natural gas, oil, tin
Mongolia	98.7	11.1	Copper, coal, oil

GDP = gross domestic product, PRC = People's Republic of China.
Note: Country i's net export of primary commodities to world = (exports to world $_{primary\ commodities}$ – imports from world $_{primary\ commodities}$/ GDP$_{Country\ i}$)*100
Primary commodities cover SITC codes 01 (beverage and tobacco), 02 (crude materials, inedible), 03 (mineral fuels), 04 (animal and vegetable oils), 67 (iron and steel), and 68 (nonferrous metals).
Sources: United Nations *Commodity Trade Statistics* (UN Comtrade) database (accessed 28 October 2016) and *Asian Development Outlook* database.

Rebillard (2015) employ a global VAR model and find that a sharp PRC shock would cause metal prices to fall by 66% and oil prices by 41% over a 5-year period. This contrasts with the gradual growth moderation scenario, where metal prices decline by a more modest 12% and oil prices by 13%.

All of these analyses, however, ignore the presence of abrupt and unexpected "structural" breaks in commodity prices (Technical Appendix). A body of literature[9] has shown that commodity prices are plagued by such structural breaks. All commodity prices in the analysis contain at least two structural breaks. The results of the structural break test due to Bai and Perron (2003) and graphs demarcating the structural break points and

corresponding regimes that demarcate the breaks are in Table A.1 and Figure A.1 in the Technical Appendix.

In this analysis, the PRC impact on commodity prices is examined by adopting a Flexible Fourier Form VAR framework that allows for smooth breaks. This increases the power and size properties of the model. The Flexible Fourier Form can mimic the nature of the breaks by being agnostic of the number of breaks, break dates, and size of the breaks. Rather than controlling for the breaks, the appropriate frequencies are chosen in the model— Enders and Jones (2016) show it is possible to mimic the breaks with a small number of low-frequency trigonometric components. The approximations of possible break dates are in commodity price data in Figure 19.

Figure 19: Commodity prices approximated by Flexible Fourier Form
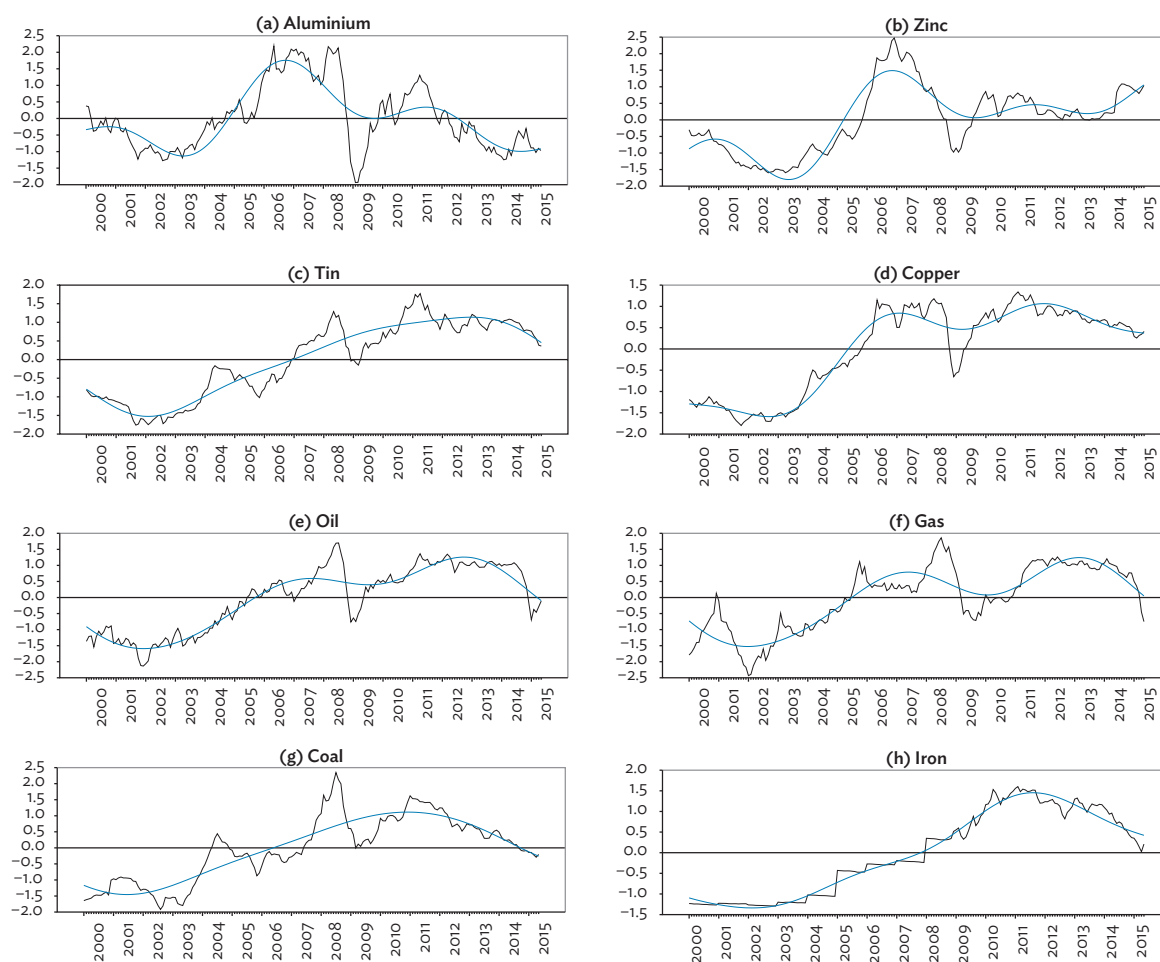
Source: Ghoshray and Pundit 2016.

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9   For example, Zivot and Andrews (1992), Zanias (2005), Kellard and Wohar (2006), Harvey et al (2010) Ghoshray (2011), Ghoshray et al (2014), and Sun and Shi (2015).

Besides economic activity, exchange rates are included as an important determinant of commodity demand. Since global commodity prices are priced in US dollars, a fall in dollar value is a shift in relative prices that would lead to increased demand for commodities, leading to an increase in commodity prices. Another important determinant included here is interest rates. An increase in interest rates leads to an increase in storage costs, which leads to a reduction in commodity demand and, thereby, lowers commodity prices. However, it is also possible that investment in extraction falls after an increase in interest rates, leading to a decrease in future supply that, in turn, exerts upward pressure on commodity prices.[10]

Given the importance of structural breaks in commodity prices, unit root tests that allow for Flexible Fourier Form are carried out. The results of the test statistics show that the null hypothesis of a unit root for all variables, except nickel, can be rejected. In addition, using a model selection criterion (i.e., Akaike Information Criterion), in all cases the Flexible Fourier Form VAR model outperforms the linear VAR, which motivates this methodology.

How a shock on People's Republic of China activity impacts commodity prices

The cumulative response of a shock to real activity in the PRC affects commodity prices (Table 4). The effect of a 1 percentage point decline in industrial production growth has a significant effect on prices of most metals. For copper, the initial impact of the shock in the first quarter, lowers the price by 4.2%. By the second quarter the accumulated response depresses copper prices by about 7%. Into the third and fourth quarters, while the effect of the shock continues to lower prices, the responses are no longer significant. A higher effect is found for other metals such as aluminum and tin. In the first 3 quarters, we find that the responses to a shock to real PRC economic activity is significant, lowering prices cumulatively by 11.9% for aluminum and 20.8% for tin. After the third quarter, responses become insignificant. In the case of iron, the response sizes are much smaller from the first quarter to the third quarter, cumulatively bringing prices down 4.5%. For zinc, the response is small and significant in magnitude in the first quarter, and becomes insignificant in subsequent quarters.

In energy, coal has a relatively higher response following a 1 percentage point decrease in industrial production growth, with prices dropping 11.5% cumulatively in 3 quarters. For oil and natural gas, the responses are smaller—7.0% for oil and 4.4% for gas over 3 quarters. The cumulative response in the fourth quarter for oil, natural gas, and coal become insignificant.

The sustained decline in commodity prices following a negative shock in real activity in the PRC is not surprising as the shocks should persist, given the nature of commodity prices. While accounting for Flexible Fourier Form, prices are stationary—which follows economic theory (Deaton and Laroque 2003, Wang and Tomek 2007). However, in empirical studies, it is widely accepted that commodity prices tend to be highly persistent. As a result, a shock in commodity prices should dissipate. Yet the rate of decline is expected to be slow. In the case of copper, oil, and zinc the magnitude of these results are somewhat similar to Roache and Roussett (2015).

Table 4: Impulse response function of a shock to PRC industrial production

	Aluminum	Copper	Iron	Zinc	Tin	Oil	Gas	Coal
1 QTR	–5.969*	–4.200*	–2.546*	–2.563*	–9.379*	–3.27*	–1.942	–4.152
2 QTR	–9.962*	–6.985*	–3.885*	–4.115	–16.71*	–5.98*	–3.49*	–8.429*
3 QTR	–11.86*	–7.441	–4.461*	–3.271	–20.78*	–7.004*	–4.39*	–11.45*
4 QTR	–12.377	–6.685	–4.586	–1.542	–22.141	–6.909	–4.675	–12.841

PRC = People's Republic of China, QTR = quarter.
Note: * denotes significance at the 10% level.
Source: Ghoshray and Pundit 2016.

[10] For this analysis, growth of PRC industrial production comes from the CEIC Data Company; commodity prices—aluminum, copper, iron, gas, coal, oil, tin, and zinc—are from IMF International Financial Statistics via Haver Analytics, Real Effective Exchange Rate Index: Based on Consumer Price Index, 2010 = 100 from the CEIC Data Company, and US Federal Funds interest rate and US consumer price index sourced from the Haver Analytics and Federal Reserve Bank of St. Louis. The frequency of the data is monthly from January 2000 to June 2015.

The large declines produced from the impulse response function analysis, particularly for metals, seem to reflect the price declines seen since the PRC economic slowdown. The results suggest the steep decline in commodity prices from the PRC slowdown will likely continue during the first 3 quarters after the shock, but the effect of the shock should dissipate over time.

The upshot is that, in general, the impact and responses of commodity prices to a shock in economic activity in the PRC are mixed. While there seems to be considerable evidence that a shock to the PRC has a significant impact on all commodity prices, the impact on most metals and coal is higher than on oil and natural gas. The response due to a shock in interest rates is much smaller and, in some cases, insignificant, at least over selected quarters. The response of commodity prices to a shock in real exchange rates is relatively higher for energy prices compared with metal prices, zinc being an outlier.

The analysis of PRC economic activity on commodity prices was further evaluated by testing whether commodity prices respond asymmetrically to an increase or decrease in the PRC's economic growth in a structural nonlinear dynamic model. The results show no evidence of asymmetric price responses.

The Impact of People's Republic of China moderation on commodity-exporting countries in developing Asia

Weaker PRC demand also hurts Asia's commodity exporters through reduced export volumes. For many Asian commodity exporters, the PRC is a major customer for dominant export commodities such as coal, copper, and oil (Figure 20). This is particularly true for Mongolia, whose exports of commodities are close to 30% of GDP, and where close to 90% of exports go to the PRC.

To analyze the impact of a PRC slowdown on developing Asia's commodity-exporting countries, the analysis in Section 3.2 is supplemented with panel regression-based analysis. The analysis focuses on Azerbaijan, Brunei Darussalam, Indonesia, Kazakhstan, Mongolia, and Malaysia, the six developing Asian economies with the largest share of net primary exports to the world relative to GDP, and for whom the PRC is a major export market. The focus is on natural gas, oil, copper, and coal—the bulk of these countries' exports to the PRC.[11]

Figure 20: Commodity exports to the PRC, selected developing Asian countries, 2013
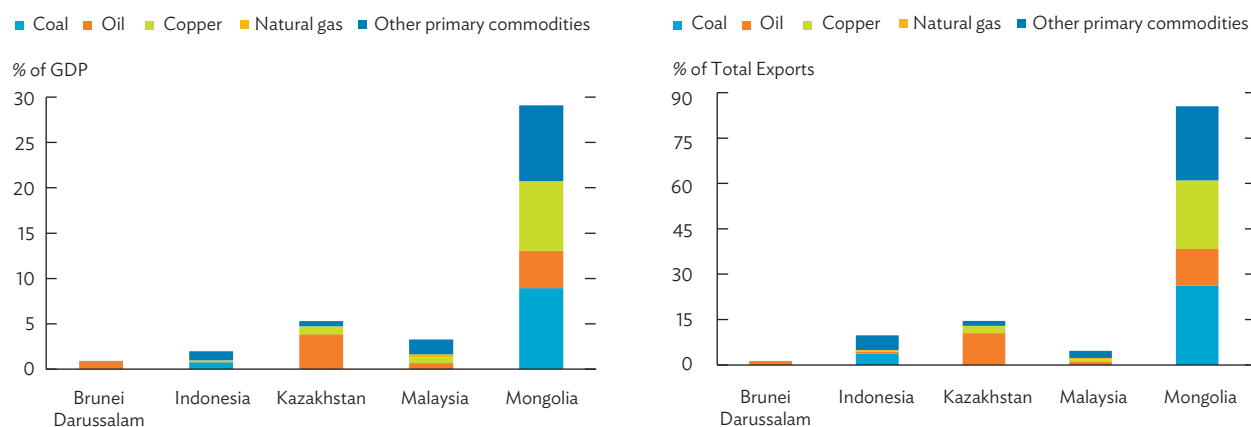
PRC = People's Republic of China.
Source: ADB estimates.

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[11]   The UN *Commodity Trade Statistics* database (UN Comtrade), SITC Revision 3 version is used for import and export data, covering 2000–2014. The information on total terms-of-trade (base year = 2010) and the current GDP in US dollars come from the World Bank's *World Development Indicators* online database. Prices of commodities were sourced from Haver Analytics.

The analysis proceeds in two steps. First the impact of commodity price movements on these countries' terms of trade (TOT) is estimated, as this will determine how the commodity price effects of a PRC growth slowdown estimated in the previous section will affect the TOT of individual countries (Table 5). It shows how the terms of trade of these economies are strongly correlated with just a few key commodity prices. Then a panel growth regression is used, drawn from the *Asian Development Outlook 2015 Update,* which helps quantify how PRC growth affects commodity-exporting countries both via TOT effects as well as through their direct trade linkages with the PRC.

The panel growth regression is constructed as follows. For commodity exporters with strong trade linkages to the PRC, a reduction in PRC demand for a particular primary commodity as consequence of slower growth can affect growth in these economies via adverse TOT effects, and also via reduced exports to the PRC:

$$GDP_{ECO}^{gr} = \alpha + \beta_1\left(TOT_{ECO}^{gr}\right) + \beta_2\left(\frac{Nonprimary\ export\ to\ the\ PRC_{ECO}}{GDP_{ECO}} \times GDP_{PRC}^{gr}\right)$$
$$+ B_2\left(\frac{Primary\ commodity\ export\ to\ the\ PRC_{ECO}}{GDP_{ECO}} \times GDP_{PRC}^{gr}\right) + \varepsilon_t$$

Where, GDP_{ECO}^{gr} is the GDP growth in the primary commodity exporting economy; GDP_{ECO} is GDP of commodity exporting economy; GDP_{PRC}^{gr} is GDP growth of the PRC; and TOT_{ECO}^{gr} is the change in the TOT in a primary exporting economy. For this particular estimation, annual trade data from UN Comtrade is again used, and only those countries with a share greater than 1% of total exports to the PRC to GDP is considered—leaving 40 economies in the estimation sample (Table 6).

TOT growth is positively and significantly related to GDP growth for the commodity-exporting countries in the sample, consistent with the literature. The interactions of the share of coal to GDP and share of copper to GDP with PRC GDP growth show a positive and significant coefficient, indicating that economies with higher coal and copper exports to the PRC are likely to see a bigger decline in GDP growth in response to a PRC slowdown. In contrast, the interactions of natural gas and oil exports as a share of GDP with PRC GDP growth are not significant, consistent with the PRC's smaller role in these commodity markets. The coefficient of the share of nonprimary exports to GDP interacted with the PRC GDP growth

Table 5: Terms of trade estimation results

	Dependent variable: Terms of Trade $_{ECO}$					
	(1)	(2)	(3)	(4)	(5)	(6)
Independent variables	Azerbaijan	Brunei Darussalam	Indonesia	Kazakhstan	Mongolia	Malaysia
Natural gas	0.307**	0.486***	0.002			0.090***
	(0.049)	(0.0019)	(0.952)			(0.007)
Oil	0.320***	0.286***		0.570***		-0.055**
	(0.00656)	(0.00659)		(0.000)		(0.012)
Coal			0.164***		0.191***	
			(0.000)		(0.001)	
Copper				0.0607**	0.284***	
				(0.0253)	(0.000)	
Constant	1.219***	0.454	3.885***	1.462***	2.616***	4.388***
	(0.003)	(0.146)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	14	14	14	14	14	14
R-squared	0.984	0.977	0.948	0.998	0.970	0.524
F test	0.003	0.003	0.003	0.003	0.003	0.003

Notes: Robust probability values in parentheses. Significance at 1%, 5%, and 10% levels are denoted respectively by ***, ** and *. Level estimations in log format.
Source: ADB estimates.

Table 6: Growth panel regression results

Independent variables:	Dependent variable: GDP growth $_{ECO}$					
	(1)	(2)	(3)	(4)	(5)	(6)
Terms of trade growth ECO	0.0379**	0.0341*	0.0363*	0.0355*	0.0369*	0.0363*
	(2.068)	(1.862)	(1.874)	(1.937)	(1.854)	(1.968)
Nonprimary exports to PRC/GDP$_{ECO}$ x GDP$^{gr}_{PRC}$	0.540**	0.505**	0.524**	0.518**	0.521**	0.524**
	(2.575)	(2.532)	(2.612)	(2.634)	(2.498)	(2.496)
Coal exports to PRC/GDP$_{ECO}$ x GDP$^{gr}_{PRC}$	9.595***				9.177***	9.228***
	(11.65)				(7.849)	(10.12)
Copper exports to PRC/GDP$_{ECO}$ x GDP$^{gr}_{PRC}$		1.612**			1.434**	1.430**
		(2.651)			(2.083)	(2.114)
Oil exports to PRC/GDP$_{ECO}$ x GDP$^{gr}_{PRC}$			−0.115		−0.274	
			(−0.173)		(−0.370)	
Natural gas exports to PRC/GDP$_{ECO}$ x GDP$^{gr}_{PRC}$				−25.22	−24.26	
				(−0.745)	(−0.677)	
Constant	3.634***	3.630***	3.711***	3.743***	3.640***	3.574***
	(44.11)	(45.36)	(42.19)	(38.15)	(30.39)	(44.28)
Number of observations	500	500	500	500	500	500
Number of countries	40	40	40	40	40	40
R-squared	0.020	0.016	0.013	0.015	0.024	0.022

GDP = gross domestic product, PRC = People's Republic of China.
Note: Robust t-statistics in parentheses. Significance at 1%, 5% and 10% levels are denoted respectively by ***, ** and *.
Source: ADB estimates.

rate is also positive and significant, suggesting that economies with larger nonprimary exports to the PRC tend to see larger declines in GDP growth as PRC GDP growth slows. The preferred specification is to include all primary commodities of interest in one specification (column 5).

The various results from the VAR analysis and the regression analyses conducted in previous sections are used to compute the combined total effects of growth and TOT. To determine the impact of reduced commodity demand from the PRC on Asia's commodity exporters, the cumulative (4-quarter) impact from the impulse response

functions of the VAR analysis are used (Table 7), which provide the impact of a 1 percentage point negative shock in PRC industrial production. This is then multiplied by the significant TOT coefficients from Table 6 for the six Asian economies to obtain the impact on overall TOT, and by the coefficient obtained from the growth regression equation (0.0369, from column 5 in Table 7) to derive the TOT effects on GDP growth. To obtain the overall growth effects, coefficients from the growth regressions are used and multiplied by the commodity shares for each of the economy share, then multiplied by –1 to simulate a 1 percentage point drop in PRC growth. Table 8 summarizes the primary commodity and nonprimary commodity effects on the five Asian economies. Among developing Asia's commodity exporters, Mongolia is most affected, with a 0.93 percentage fall in GDP emanating just from the primary commodity effect.

Figure 21 shows the overall growth effects on commodity exporters of a 1 percentage point decline in PRC growth. The growth effects are further decomposed by commodity. The fall in the price of commodities have Brunei Darussalam, Indonesia, Kazakhstan, and Mongolia via lower TOT. This shaves off about 0.2 percentage points from the GDP growth in Brunei Darussalam

Figure 21: Effect on commodity-exporting DMCs of a 1 percentage point decline in the PRC growth
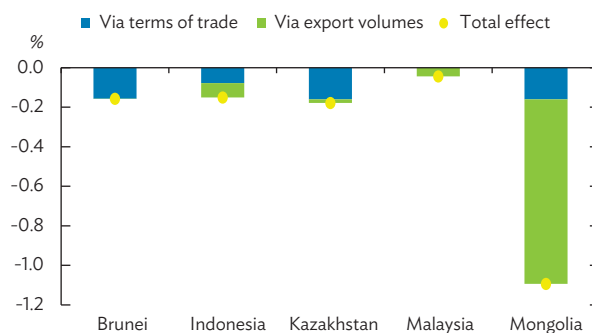
PRC = People's Republic of China.
Source: ADB estimates.

and Kazakhstan. As noted earlier, Mongolia stands to suffer most from the decline in PRC growth as the PRC is its major market for coal and copper. These findings drive home the importance of diversification for Asia's commodity exporters, across products as well as trading partners.

Discussion and conclusions

The PRC's role in the sharp fall in commodity prices since 2014—which has had a significant impact on once-dynamic emerging commodity exporters—is actually more limited than commonly assumed. In fact, the gradual, needed, and partially managed slowdown in the PRC is just part of the commodity-price story. And that may mean that commodity prices can rebound even as the PRC continues to pursue its structural shift toward more sustainable growth.

Table 7: Change in the total terms of trade and TOT effects, selected developing Asian economies

Economy	Change in TOT	TOT effect
Brunei Darussalam	-4.248	-0.157
Indonesia	-2.106	-0.078
Kazakhstan	-4.344	-0.160
Mongolia	-4.351	-0.160
Malaysia	-0.037	-0.001

TOT = terms of trade.
Source: ADB estimates.

Table 8: Growth effects via exports to the PRC, selected developing Asian economies

Economy	Primary commodity effect	Nonprimary commodity effect	Growth effects via exports to PRC
Brunei Darussalam	0.0000	-0.0004	-0.0004
Indonesia	-0.0706	-0.0027	-0.0732
Kazakhstan	-0.0136	-0.0046	-0.0182
Mongolia	-0.9312	-0.0020	-0.9333
Malaysia	-0.0098	-0.0325	-0.0423

PRC = People's Republic of China.
Source: ADB estimates.

To be sure, there is a clear correlation between GDP growth in the PRC and commodity prices. In the early 2000s, when PRC growth accelerated, commodity prices rose sharply. And since the slowdown began in 2011, energy prices have fallen by 70%, metals prices by 50%, and agricultural commodity prices by 35%. But the view that the PRC slowdown was the main driver behind the collapse in commodity prices is incomplete, at best.

As this section shows, while the PRC does play a significant role in commodity markets—accounting for about half of global consumption of metals, coal, and pork, for example—it is not nearly as dominant as widely believed. It accounts for less than one-fifth of world consumption of sugar, wheat, poultry, and beef; 12% of crude oil; and 5% of natural gas. In fact, some of the commodities with the largest price declines—most notably oil (down 73%) and natural gas (down 55%)—are way down the PRC list.

As is well-known, cross-border production chains are increasingly important. And by pulling their impact out of the equation, the conventional measure of PRC commodity consumption is actually biased upward. PRC actual commodity consumption is even lower than the figures suggest. Conventional measures take the sum of a country's production and net commodity imports to determine how much it consumes. But a sizeable portion of the commodities the PRC "consumes" actually goes into production of goods later exported across the world. Indeed, almost one-third of PRC metal demand goes into exports. Subtracting the commodities embedded in these exported manufactured goods would substantially reduce the PRC's apparent role in these markets.

A look at the commodity-price fluctuations themselves reinforces this view. Consider copper: from 2001 to 2006, when prices gyrated wildly—price declines of 30% some years and increases of 150% in others—all while growth in

PRC industrial production remained relatively steady at 15% and copper demand at 20%. Clearly, other factors—ranging from supply-side factors and global demand to speculative demand and inventory adjustment—have also played a major role in driving prices.[12]

So what does the PRC's continuing moderation in growth imply for commodity prices? Even since the slowdown began in 2011, the PRC consumption of commodities continues to grow faster than the rest of the world. As a result, its share in global commodity consumption continues to rise. This should not be surprising with its GDP growth still above 6%. While the shift from an investment-led to a consumption-driven growth model will dampen growth in PRC demand for metals and energy, it will also bring an increase in demand for food products and services, and thus agricultural commodities.

The conclusion is clear: the PRC's gradually shifting economic structure does not spell disaster for commodity exporters. On the contrary, even if, as many fear, PRC economic growth slows further, it will not dent commodity prices by much.

For commodity prices, the prospects lie in the promise of growing demand from other emerging giants—such as India and Indonesia, for example. The rest of developing Asia's economy is currently about 4% larger than the PRC's, and twice as large as it was in 2000, when growth in the PRC commodity demand began to accelerate. If solid growth in Asia's other emerging economies continues over the next decade and a half, it will generate commodity demand at least as large as the PRC boom years.

The drag on commodity prices from the PRC growth moderation is real. But with PRC commodity import volumes still going strong—and the rest of developing Asia set to generate a new surge in demand—the prospects for a commodity-price rebound look a bit brighter.

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[12]   One interpretation is that the PRC's strong growth and role as the marginal buyer of commodities supported the commodity boom, and the resultant surge in commodity prices fueled an investment boom that was premised on extrapolation of rising marginal demand from the PRC. The subsequent slowdown in PRC demand prompted a reevaluation of the demand–supply trajectories in non-oil commodity markets, as it became clear to market participants that these trajectories had become fundamentally misaligned. These markets consequently entered a period of adjustment as markets responded to the prospect of excess structural supply. The trajectory of prices during this phase depends largely on market perception on how supply is adjusting to a more realistic assessment for the outlook for demand. Once that supply adjustment is complete, demand factors will start to play a bigger role. At that point, even slower but still reasonable growth in the PRC and (India) demand could well start to provide support for commodity prices.

4 Spillovers through Trade and Production Linkages

Introduction

The rise of the PRC as a global economic heavyweight closely parallels its rise as a global trading power. The PRC is increasingly important in developing Asia's trading system, not only as an exporter but also as importer. In particular, since joining the WTO in 2001, the PRC has emerged as an important destination for exports from other Asian economies, especially those in East and Southeast Asia. The value of developing Asia's exports of machinery, metals, chemicals, and minerals to the PRC have steadily increased—to $469 billion in 2015 from $72 billion in 2000 (Figure 22). Chemicals are imported mostly from Hong Kong, China; the Republic of Korea; Singapore; and Taipei,China; and machinery imports come mainly from Taipei,China. Machinery, metals, chemicals, and minerals collectively account for about 75% of developing Asia's total exports to the PRC (Figure 23).

The share of developing Asia's exports going to the PRC rose from 12% in 2000 to 25% in 2015 (Figure 24). As a share of GDP, exports to the PRC rose from 6% to 11% over the same period (Figure 25). The four newly industrialized economies—Hong Kong, China; the Republic of Korea; Singapore; and Taipei,China—are potentially vulnerable to a sharp PRC slowdown, as they are all major exporters of capital goods to the PRC. And as the previous section shows, slower growth in the PRC will dampen demand for key commodities such as copper, iron, and other minerals, putting downward pressure on prices. Asia's net commodity exporters, such as Indonesia, Kazakhstan, Malaysia, and Mongolia, will thus be adversely affected. A sizable portion of PRC imports from its neighbors are parts and components for assembly and reexport to the US and other world markets. But a large and growing share is final goods (Park and Shin 2010). Therefore, the PRC slowdown will have a more direct impact on imports from the region.

Figure 22: Composition of developing Asia's exports to the PRC
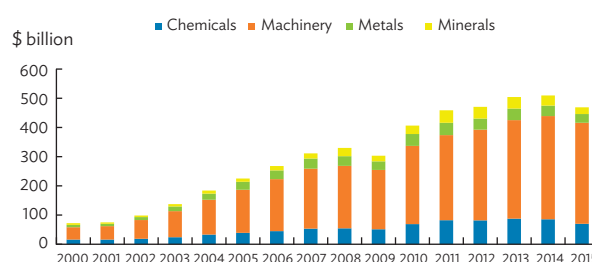
PRC = People's Republic of China.
Note: Chemicals cover SITC code 5; Machinery cover SITC codes 71–77; Metals cover SITC codes 28, 67,68,69; Minerals cover SITC codes 33 and 66.
Source: United Nations *Commodity Trade Statistics* (UN Comtrade) database (accessed 28 October 2016).

Figure 23: Composition of developing Asia's exports to the PRC
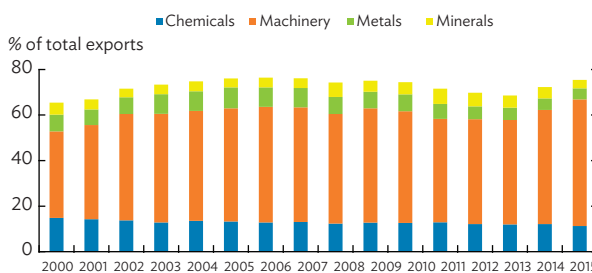
PRC = People's Republic of China.
Note: Chemicals cover SITC code 5; machinery cover SITC codes 71–77; metals cover SITC codes 28, 67, 68, 69; and minerals cover SITC codes 33 and 66.
Source: United Nations *Commodity Trade Statistics* (UN Comtrade) database (accessed 28 October 2016).

Figure 24: Developing Asia's exports to the PRC
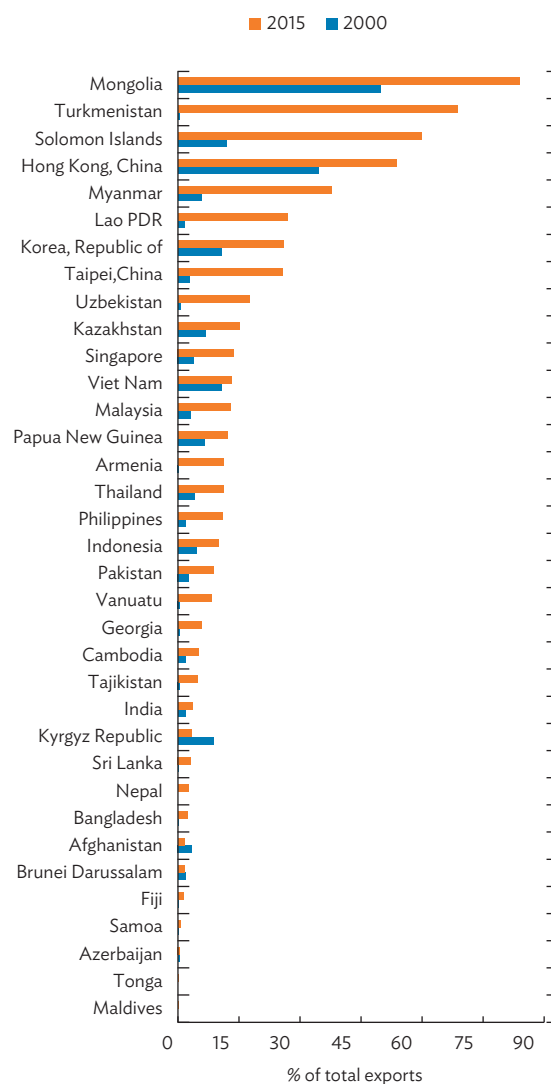
PRC = People's Republic of China.
Source: International Monetary Fund, *Direction of Trade Statistics* online database, *World Economic Outlook* database; World Bank, *World Development Indicators* online database; and CEIC Data Company (all accessed 27 October 2016).

Figure 25: Developing Asia's exports to the PRC
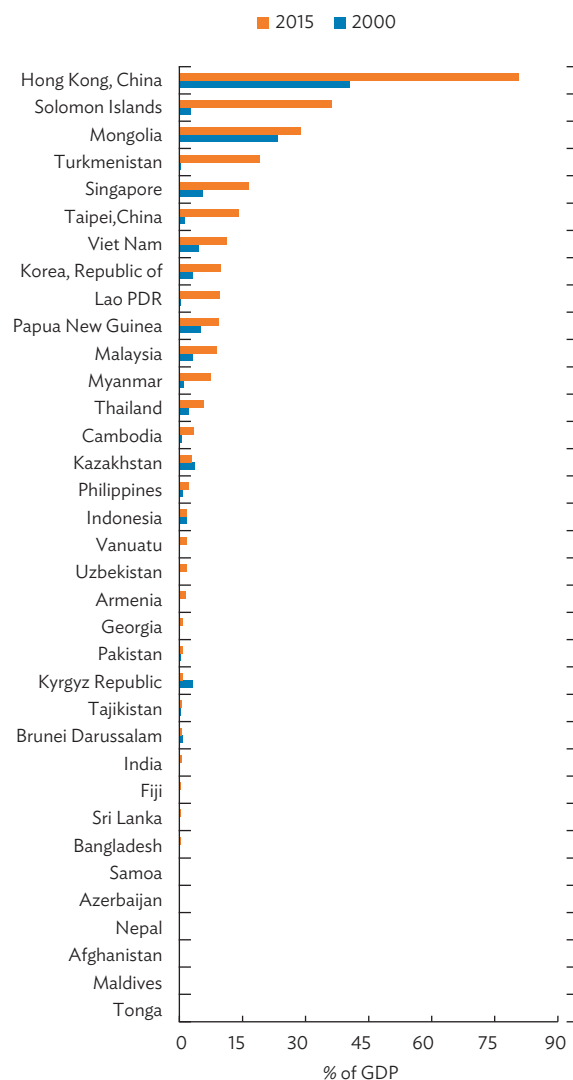
PRC = People's Republic of China.
Sources: International Monetary Fund, *Direction of Trade Statistics* online database, *World Economic Outlook* database; World Bank, *World Development Indicators* online database; and CEIC Data Company (all accessed 27 October 2016).

The trade channel approach: A panel regression approach

As noted above, trade is likely to be the primary channel of spillover effects from the PRC slowdown on the rest of Asia. How GDP growth in the PRC spills over to affect trade is examined through panel data analysis using the methodology in Ahuja and Nabar (2012). Spillover from the PRC to a trading partner is measured as the product of the partner's exports to the PRC as a share of its GDP and the PRC GDP growth rate. The trading partner's TOT growth rate, its lagged GDP growth rate, and an index for macroeconomic volatility are included in the analysis to control for changes in trade prices, and to capture dynamic macroeconomic instability since the onset of the global financial crisis. The pane regression specification is as follows:

$$GDP_{it}^{gr} = \alpha + \beta SP_{it}^{C} + \gamma ToT_{it} + \delta VT_{it} + \eta_i + \epsilon_t + v_{it}$$

where

GDP_{it}^{gr}: GDP growth rate of i at t
$SP_{it}^{C} = \left| \left(\frac{Total\ exports\ to\ PRC_{it}}{GDP_{it}} \right) * PRC_{i}^{gr} \right|$
PRC_{i}^{gr}: PRC GDP growth rate at t
ToT_{it}: Annual percentage change in terms of trade of i at t
VT_{it}: Volatility of i at t, standard deviation of GDP over moving 5-year windows

The estimated spillover impact of a PRC slowdown on the rest of developing Asia is significant, and its impact became more substantial after the global financial crisis (Table 4.1).[13] In 2012, a 1 percentage point decline in PRC growth slows growth in Asia by 0.128 percentage point. By comparison, a 1 percentage point decline in US growth slows growth in Asia, including the PRC, by 0.31 percentage points. However, the PRC impact becomes considerably greater in the post-global financial crisis period (2007–2012). More specifically, growth in Asia falls by 0.25 percentage points. Healthy growth in exports to a robust PRC helped the region cope with advanced economies recession (Figure 26). By the same token, however, the PRC slowdown is a negative shock for the rest of developing Asia.

Table 9: Panel analysis with a fixed effect model: The effect of a PRC slowdown

Variables	(1)	(2)
	2002–2012	2007–2012
SP	0.0128***	0.0250***
	(0.00448)	(0.00790)
ToT	0.0264	0.00133
	(0.0254)	(0.0331)
VT	-0.303**	-0.476**
	(0.137)	(0.231)
Constant	5.438***	4.259***
	(0.619)	(1.122)
Observations	297	162
R-squared	0.061	0.112
Number of countries	27	27

GDP = gross domestic product, SP = Spillover from the PRC to a trading partner, ToT = annual percentage change in terms of trade, VT = volatility (standard deviation of GDP over 5-year windows)

Note: Standard of error of the estimates in parenthesis. Significance of 1%, 5%, and 10% levels are denoted respectively by ***, **, and *.

Source: Lee, Park, and Ramayandi 2016.

Figure 26: Exports of developing Asia to advanced economies and the PRC
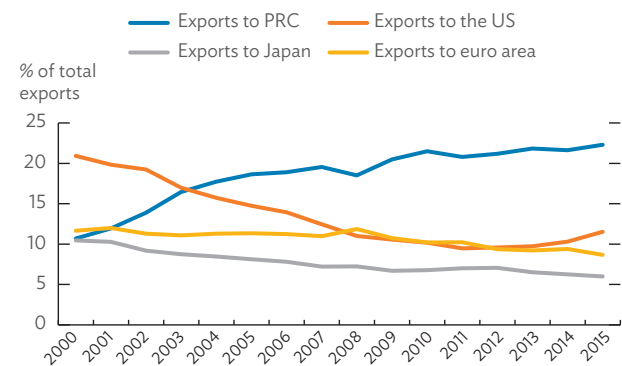
PRC = People's Republic of China, US = United States.
Sources: International Monetary Fund, *Direction of Trade Statistics* online database; and CEIC Data Company (both accessed 10 November 2016).

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[13]   Because the growth slowdown in the PRC started in 2011–2012, the empirical analysis uses data up to those years to gauge the immediate impact of slower PRC growth on the region. However, the results reported in Table 4.1 are robust to extending the sample to the latest available year, and also to extending the sample of countries from developing Asia to a global sample.

While spillovers are significant for developing Asia as a whole, the magnitude varies substantially across subregions (Figure 27). It is biggest in East Asia: Hong Kong, China; the Republic of Korea; Mongolia; and Taipei,China have rapidly expanded trade with the PRC over the past decade. The growth in trade between the PRC and Southeast Asia has been powered not only by the PRC's economic expansion, but also from the free trade agreement concluded in 2010. Total trade between the PRC and Southeast Asia grew more than thirtyfold in the past 10 years, and the PRC has become Southeast Asia's largest trading partner. A 1 percentage point reduction in PRC growth pulls down the weighted average growth rates of East, Southeast, and Central Asia by 0.63, 0.17, and 0.14 percentage points, respectively. The effect is more limited in the Pacific, and more limited still in South Asia. (for further discussion of how the PRC slowdown affects economies in the Pacific, see Box). The results in this section are consistent with the observation that East and Southeast Asia have much closer economic links with the PRC than does South Asia.

Figure 27: Impact of 1 percentage point growth slowdown in the PRC on the rest of developing Asia, 2007–2012

Source: Lee, Park, Ramayandi 2016.

Box: Impact on Pacific economies: Distinct characteristics lead to different expected effects

The PRC is increasingly important to the Pacific. Total merchandise trade ballooned from $264 million in 2000 to $4.2 billion in 2015.Growth in Pacific imports far outpaced exports. Resource-exporting economies like Papua New Guinea, Solomon Islands, and Timor-Leste dominate—with energy, mineral, and forestry products accounting for most merchandise exports, while imports are almost wholly production inputs (industrial supplies and fuel/lubricants).

Box Figure 1: Pacific trade with the PRC ($ million)
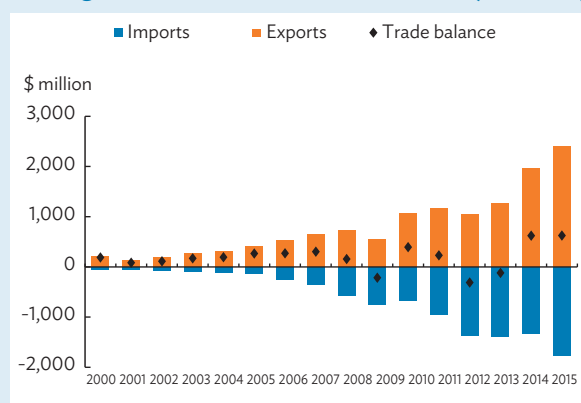
PRC = People's Republic of China.
Sources: International Monetary Fund, *Direction of Trade Statistics* online database; CEIC Data Company (both accessed 10 November 2016).

Tourism has also increased, with PRC visitors to the Pacific—particularly Fiji, Palau, and Vanuatu—rising steadily in recent years. In Palau, PRC visitor arrivals grew by an average annual 213.6% in 2012–2015—now totaling over half of tourists. Over the same period, arrivals from the PRC to Fiji grew at annual average rates of 17.2% and to Vanuatu 52.5%—though the PRC accounts for only a small share of total visitors. Cook Islands has also increased arrivals from the PRC. Investment and development assistance have picked up slowly—for example, in 2006–2013, official development assistance from the PRC to the Pacific equaled 15.5% of Australian assistance.

Box Table: Visitor arrivals from the PRC to selected Pacific destinations

	Fiji		Palau		Vanuatu	
	% of total visitors	% growth, y-o-y	% of total visitors	% growth, y-o-y	% of total visitors	% growth, y-o-y
2012	4.0		2.7		0.6	
2013	3.6	-11.3	9.0	202.2	1.0	70.5
2014	4.1	21.0	28.0	317.6	1.4	47.2
2015	5.3	41.8	53.8	121.1	2.4	39.9

( ) = negative, PRC = People's Republic of China, y-o-y = year on year.
Notes: For Palau, the PRC includes Hong Kong, China and Macau, China.
Sources: Asian Development Bank and Asian Development Bank Institute. 2015. *Pacific Opportunities: Leveraging Asia's Growth.* Manila; Fiji Bureau of Statistics; Palau Office of Planning and Statistics; and Vanuatu National Statistics Office.

Box continued

Impact of PRC rebalancing and slowdown

The PRC's structural rebalancing and slowing growth affects most if not all Pacific economies through their close ties with Australia. Any impact of the slowdown there could, in turn, reduce Australian demand for goods and services from the Pacific.

Weaker PRC demand also affects Pacific resource exporters (both by volume and value). Solomon Islands, which shipped 62.9% of its exports (mostly timber) to the PRC in 2014, has been affected most. And while Papua New Guinea and Timor-Leste do not export much to the PRC, lower commodity prices related to the PRC slowdown dampened overall exports (Box Figures 2, 3).

Box Figure 2: Papua New Guinea: export price indexes
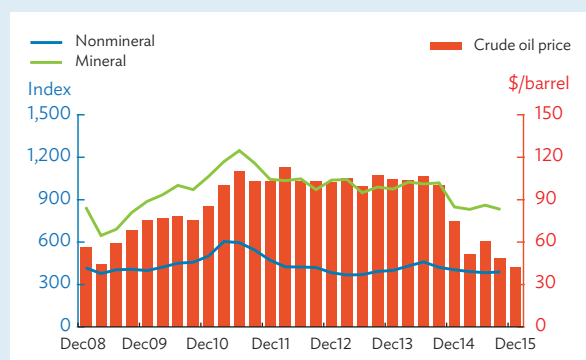
Source: Bank of Papua New Guinea.

Box Figure 3: Timor-Leste: petroleum revenues
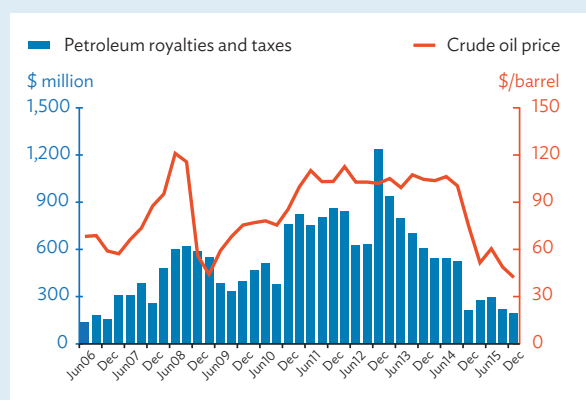
Source: Central Bank of Timor-Leste.

In contrast, there seems to be little impact on the Pacific's tourism-driven economies. The PRC's growing middle class and rising propensity for overseas travel will likely continue. Visiting "exotic" destinations with clean environments, group tourist visas from travel hubs in Hong Kong, China and Macau, China, and the relatively low cost of Pacific destinations (compared with Europe or North America) should keep the outlook for PRC visitors bright.

Box Figure 4: Visitor arrivals in Palau by source
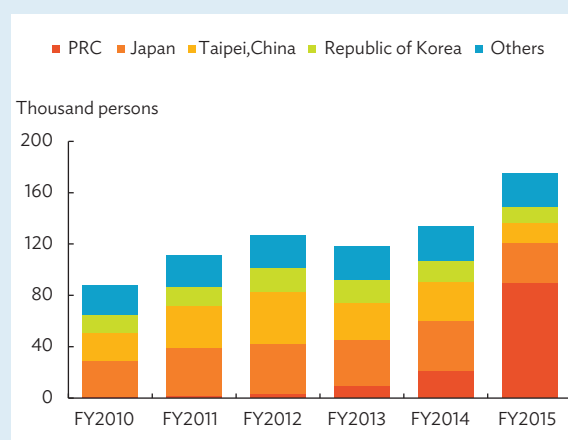
FY = fiscal year, PRC = People's Republic of China.
Note: Years are fiscal years, ending on 30 September of the same calendar year.
Source: Asian Development Bank. 2016. *Asian Development Outlook 2016.* Manila.

Palau has seen capacity constraints in tourist facilities, market saturation among PRC visitors, and maintenance issues with some of the aircraft used for charter flights. Most of the factors currently affecting visitor arrivals appear to be temporary.

The Pacific may also see opportunities for light manufacturing in some of its larger economies, with some Pacific-based manufacturers able to supply goods previously imported from the PRC. For example, Fiji is growing its garment industry as local producers take advantage of rising costs of PRC imports in supplying higher-quality garments to national and, in cases such as uniforms, for export.

For individual economies, the most heavily exposed economy is Hong Kong, China. Its trade with the PRC exceeded 90% of its GDP in 2011 and 2012. A 1 percentage point slowdown in the PRC may slow growth in Hong Kong, China by more than 2 percentage points. The adverse effect will also be large for Mongolia; the Republic of Korea; Singapore; and Taipei,China, which all depend heavily on exports to the PRC (Figure 28). On the other hand, the impact on Southeast Asia's largest economy, Indonesia, is much more muted. This is despite its large natural resource exports to the PRC including coal, tin, rubber, cocoa, and palm oil. The likely reason is that domestic demand plays a relatively large role in Indonesia's growth, which also helps to explain the limited effect on the Philippines.

Figure 28: Impact of 1 percentage point growth slowdown in the PRC on selected developing Asian economies, 2007–2012
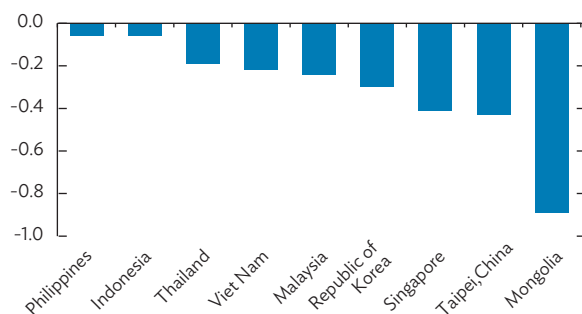
PRC = People's Republic of China.
Source: Lee, Park, Ramayandi 2016.

Understanding sectoral effects: Analysis using world input-output data

In the current global environment where the speed, depth, and breath of global production have been rising, a tool that integrates the production system and international trade is increasingly needed to provide a more complete analysis of changing trade patterns, production and technology flows, and the environmental impact of human activity. The analysis in this section uses the World Input-Output Database (WIOD). The WIOD provides world input-output tables for 35 industries in current prices ($ million) for 27 EU countries and 13 other major countries in the world for 1995–2011.

The framework of the WIOD, which is described in more detail in Timmer et al (2012) and ADB (2015b), provides an ideal system for depicting and analyzing productive and trading activities—so integrated in the globalized world that studying one in isolation from the rest would be suboptimal. The system of input–output tables (IOTs) in the WIOD is based on Wassily Leontief's economic input–output model. The IOTs detail the transactional linkages among various industrial and institutional sectors of an economy. They are derived from an economy's supply and use tables (SUTs), which integrate all relevant production, expenditure, and income data of the economy into a two-dimensional sector-commodity space. The SUTs are transformed into IOTs by employing well-established and standard methods and are combined into a single symmetric table (matrix with equal number of rows and columns) in the sector–sector or commodity–commodity space.

As the WIOD provides disaggregated information for only 6 Asian economies,[14] ADB embarked on a project to augment the WIOD database known as the ADB Multi-Region Input-Output Database (ADB MRIO). To date, six ADB developing member countries have been included in the initial list—Bangladesh, Malaysia, Mongolia, the Philippines, Thailand, and Viet Nam—covering 2000, 2005–2008, 2011, and 2015. In order to preserve the complementarity with the WIOD, the tables in the ADB MRIO database are structured the same way as the WIOD. The WIOD allows one to directly calculate the contributions of each sector of each country to satisfy one additional unit of final demand in a country, in this case the PRC. By using the relative size of the declines in PRC investment and consumption from Section 2, the effect this will have on each sector in each country can be calculated (using the so-called "Leontief inverse" or total requirements matrix).[15]

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[14]   The PRC, India, Japan, the Republic of Korea, Indonesia, and Taipei,China.
[15]   While use of the WIOD has the advantage of providing more granular analysis of the impact on specific countries and sectors, it also has its limitations. Specifically, it is a static analysis, and does not take into consideration any effects that work through prices (e.g., falls in the TOT that were analyzed in Section 3), or through behavioral responses to the shock (e.g., declines in consumption and especially investment). For these reasons, the estimated magnitudes of the impact will tend to understate the size of spillover effects.

By sector, developing Asia is most vulnerable to a PRC slowdown. Among the 45 economies included in the analysis, spillovers through trade and production linkages are largest for several Asian economies (Figure 29). Most affected is Mongolia, via the effects a PRC slowdown would have on its extractive sector, a result very much consistent with the analysis in Section 3. The other economies most affected would be Taipei,China; the Republic of Korea; Malaysia; and Viet Nam. For most economies, the impact is primarily in manufacturing. For Mongolia, Viet Nam, and Indonesia, the impact is also in mining and quarrying.

Figure 29: Sectoral impact of a PRC slowdown for selected developing Asian countries
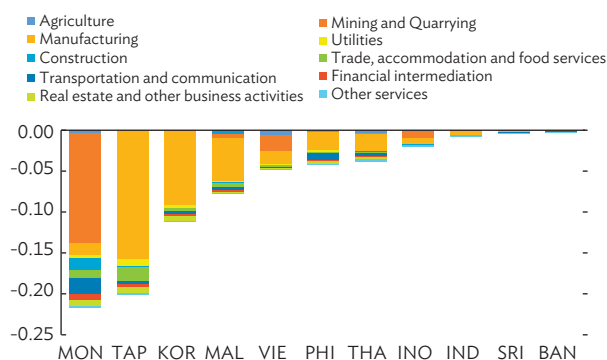
BAN = Bangladesh; IND = India; INO = Indonesia; KOR = Republic of Korea; MAL = Malaysia; MON = Mongolia; PHI = Philippines; PRC = People's Republic of China; SRI = Sri Lanka; TAP = Taipei,China; THA = Thailand; VIE= Viet Nam.
Source: ADB estimates.

Looking forward: shifting patterns of trade from the People's Republic of China's Belt and Road Initiative

In 2013, the PRC's President Xi Jinping proposed the establishment of a network of railways, roads, pipelines, and utility grids across Asia, Europe, and Africa. Known as the Belt and Road Initiative (BRI), this initiative is not only about connecting countries physically. It seeks to promote economic cooperation, including policy coordination, trade and financing collaboration, and social and cultural exchanges (The State Council 2015). Thus, it has the potential for profoundly reshaping the PRC's trading patterns and production linkages.

According to the framework issued by the State Council, the BRI has two main components: the Silk Road Economic Belt, which will connect the PRC to Europe (via Central Asia), to the Persian Gulf and the Mediterranean Sea (through Central and West Asia), and to the Indian Ocean (via South Asia); and the 21st Century Maritime Silk Road, which is a sea route from the PRC's coast to Europe and to the South Pacific. To facilitate this initiative, the PRC has set up a US $40 billion Silk Road Fund.

To date, more than 60 economies have been identified along the "belt and road." These countries (including the PRC) account for almost a third of global GDP in current US dollars, more than a third of global merchandise exports, and over half of the world's population. For most of the countries on the "belt and road" the PRC is already one of their major trading partners, their largest export market and the main source of investment (Nataraj and Sekhani 2016), and the BRI will only strengthen these linkages further. Indeed, the PRC has been encouraging more enterprises to do business in these countries. In fact, the PRC's foreign direct investment (FDI) outflows to BRI countries soared to US$18.9 billion in 2015 from about US$382 million in 2004, or an average annual growth rate between 2004 and 2015 of 43% (Table 10). For 2015 alone, the PRC's investment in the BRI countries increased by 39% year-on-year, more than twice the annual growth rate of its total outward FDIs. The share of its outward FDI flows to the BRI countries in its total outward FDI almost doubled, from 7% in 2004 to 13% in 2015.

For 2016, PRC companies made a nonfinancial direct investment of US$11.12 billion in 51 countries along the belt and road in January-September (Ministry of Commerce, PRC 2016). The main destinations were Singapore, Indonesia, Thailand, Malaysia, the Lao PDR, and the Russian Federation. It is expected that by promoting these investments, new opportunities and markets will be created for firms both in the PRC and in other BRI countries, which will have a multiplier effect on production, trade, and employment.

Table 10: Top BRI country destinations of PRC's outward FDI

	Outward FDI in 2015 (US$ million)		Outward FDI stock at end-2015 (US$ million)	
	2004	2015	2004	2015
Total	382.30	18,874.69	1,933.98	115,200.65
Singapore	47.98	10,452.48	233.09	31,984.91
The Russian Federation	77.31	2,960.86	123.48	14,019.63
Indonesia	61.96	1,450.57	121.75	8,125.14
United Arab Emirates	8.31	1,268.68	46.56	4,602.84
India	0.35	705.25	4.55	3,770.47
Turkey	1.58	628.31	2.89	1,328.84
Viet Nam	16.85	560.17	160.32	3,373.56
Lao PDR	3.56	517.21	15.42	4,841.71
Malaysia	8.12	488.91	123.24	2,231.37
Cambodia	29.52	419.68	89.89	3,675.86

BRI = belt and road initiative, FDI = foreign direct investment, Lao PDR = People's Democratic Republic, PRC = People's Republic of China.
Source: CEIC Data Company (accessed 28 November 2016).

5 Challenges and Opportunities for Developing Asia

The slowdown underway in the PRC presents both challenges and opportunities to the rest of developing Asia. Many of the challenges have been identified and quantified in this report. For commodity exporters, diversifying existing markets will be coupled by the challenge of diversifying economic activity more generally. And for those who trade heavily with the PRC and are integrated with the PRC through global value chains, expanding markets by exporting components to emerging global value chain bases developing elsewhere—and deepening domestic or subregional value chains—are continuing challenges.

By doing this, well-positioned developing Asian economies can also benefit from the PRC's shrinking labor force, rising labor costs, and shift to consumption-based growth. There are three main opportunities. The first is for economies that primarily compete with the PRC in third markets (Figure 30). They can increase market share as the PRC withdraws. Bangladesh, for example, is already gaining market share from the low-end segment of garment manufacturing; it is now the world's second largest garment exporter after the PRC.

The second is for those able to replace the PRC in segments of global production chains. Global demand for products the PRC produces in quantity—ranging from low-cost T-shirts to high-tech smartphones and computers—continues to rise. But with the PRC's rising labor costs, this production will increasingly move to lower cost economies. Viet Nam, for example, is already a favored location for producing mobile phones and consumer electronics, partly by attracting more FDI. The opportunities are great for both large countries like India (that aim to become new export giants) and for smaller economies like Cambodia and Myanmar (which have lower labor costs and are starting the process of entering global markets and production chains). Low wages will not guarantee success, however. Countries need to invest in the necessary infrastructure and undertake needed policy reforms to become attractive investment destinations.

Finally, the PRC's trading partners can exploit the shift toward greater PRC consumption. With the growth decline mostly from investment, economies that export to satisfy growing PRC consumer demand—both in goods and services (such as education and tourism)—will be better positioned to take advantage of the PRC's ongoing structural change and accompanying growth moderation.

Figure 30: Developing Asia: Index of competition with the PRC, 2014
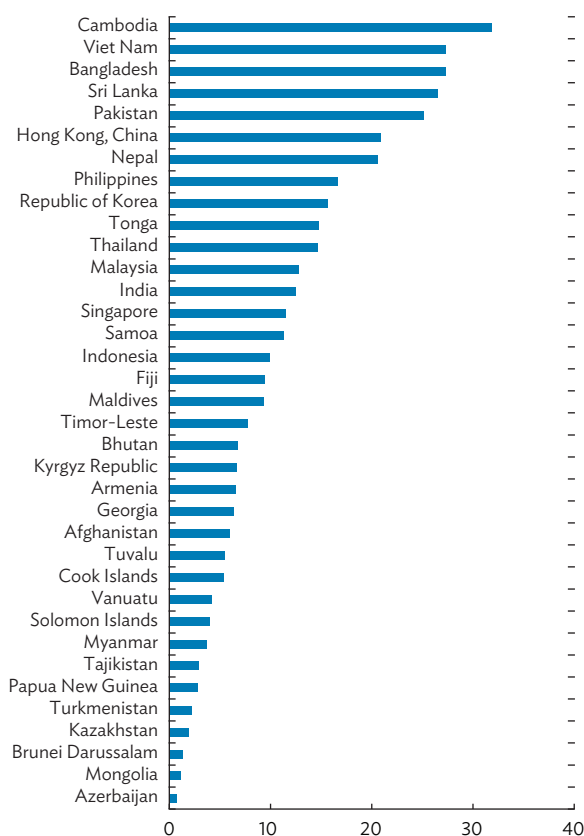
PRC = People's Republic of China.
Note: The index of competition measures the importance of the People's Republic of China in a country's export markets (weighted by product), with 100 indicating total dominance and 0 indicating complete absence. The latest available data for selected countries are Tajikistan, Turkmenistan: 2000; Tuvalu: 2005; Myanmar: 2010; Cook Islands, Vanuatu: 2011; Bhutan, Papua New Guinea: 2012; Cambodia, the Kyrgyz Republic, Timor-Leste: 2013.
Source: ADB estimates.

Technical Appendix

Table A.1: Structural break tests

	Break date 1	Break date 2
Aluminum	October 2002	August 2008
Tin	July 2003	October 2010
Copper	October 2002	March 2006
Zinc	May 2003	September 2009
Oil	October 2008	January 2012
Gas	June 2001	January 2009
Iron	December 2004	February 2010
Coal	January 2007	December 2009

Source: Ghoshray and Pundit 2016.

Figure A.1: Commodity prices demarcating structural breaks

(a) Aluminium

(b) Zinc

(c) Tin

(d) Copper

Figure A1 *continued*

Source: Ghoshray and Pundit 2016.
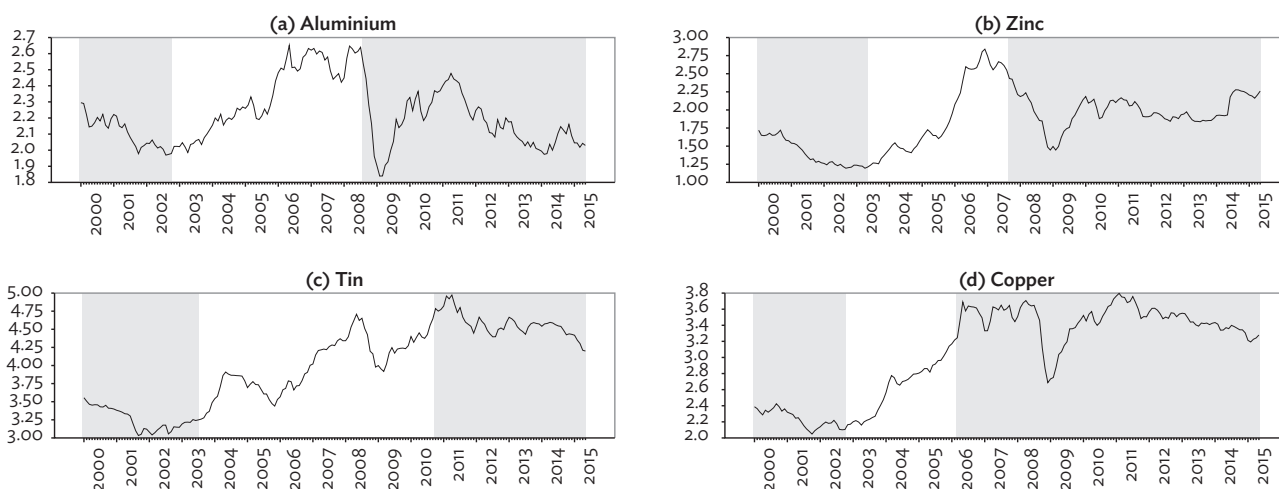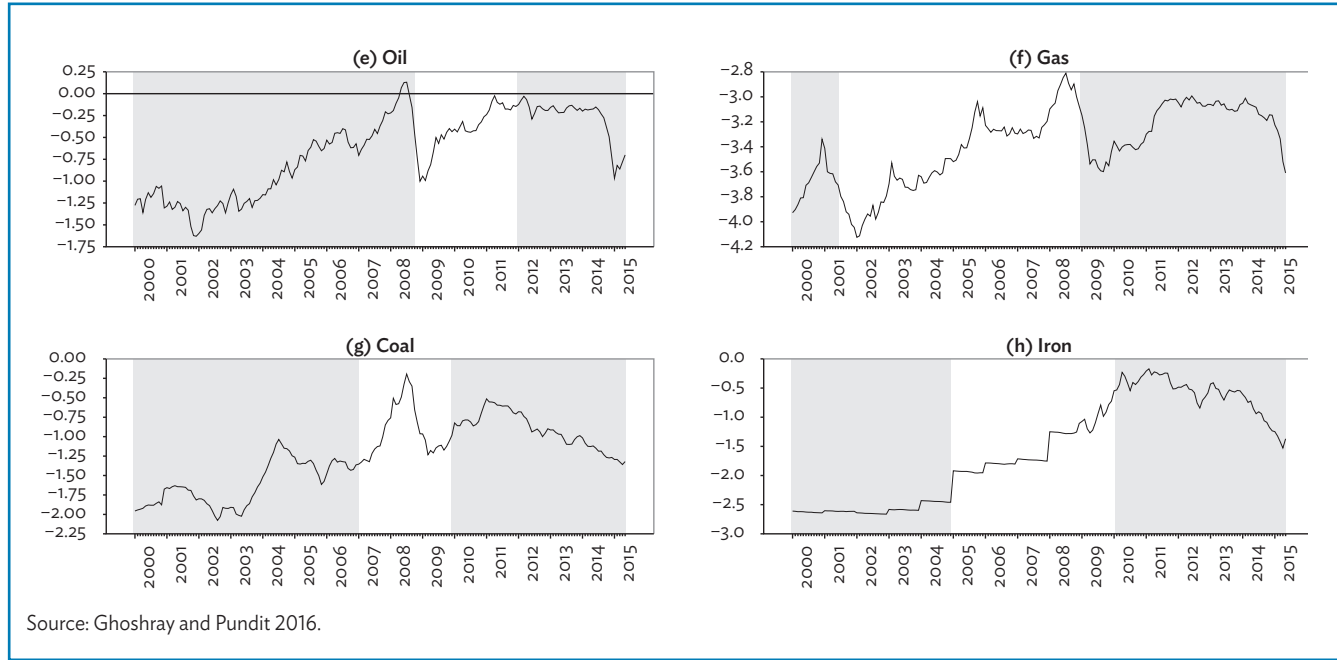
To address the problem of structural breaks in commodity price data, this study follows Enders and Jones (2016) who build on the VAR model by allowing for the Flexible Fourier Form to capture the multiple smooth shifts in the data that are likely to be present in the VAR model. Full details can be found in Ghoshray and Pundit (2016), which is the full working paper version of this section.

Structural breaks may be present in the deterministic or the stochastic part of a VAR model. In order to control for the number of breaks when the number of breaks and the form of such breaks are unknown, Enders and Lee (2015) employ a variant of the Flexible Fourier Form due to Gallant (1981). They consider a VAR where the deterministic part (d_t) of the equation for the variable (y_t) to be included in the VAR is given by:

$$d_{it} = \delta_{i0} + \delta_{i1}d_{1t} + \delta_{i2}d_{2t} + \cdots + \delta_{im}d_{mt} \quad (1)$$

Where the d_{it} represents potentially smooth functions over time, the parameters $\delta_{ij}(j = 1,2,\ldots,m)$ indicates the magnitude of the effect of break j on variable i; and m denotes the number of breaks in variable .

Since the number of breaks is large and they tend to be smooth, a methodology is necessary that allows δ_{ij} to be a smooth function over time. To this end Enders and Jones

(2016) use a simplified version of the Flexible Fourier Form to represent the deterministic portion (d_t) of the variable (y_t) given by:

$$d_{it} = a_{i0} + \sum_{k=1}^n a_{ik}sin(2\pi kt/T) + \sum_{k=1}^n a_{ik}cos(2\pi kt/T) \quad (2)$$

This formulation enables a small number of low frequency components from a Fourier approximation to capture the essential characteristics of a series containing structural breaks as demonstrated in recent studies put forward by Astill et al (2015) and Rodriguez and Taylor (2012) among others. The issue of controlling for the breaks is transformed into the choice of the appropriate frequencies to include into the model. As stated by Enders and Jones (2016), we set the frequency of the trigonometric components to $n \leq 3$.

As a prelude to testing the VAR with Flexible Fourier, we test for stationarity of the data series included in the VAR model using an appropriate Lagrange Multiplier based unit root test that includes trigonometric components and carried out using the following steps as stated in Enders and Lee (2012):

First estimate the following regression:

$$\Delta y_t = a_0 + \sum_{k=1}^n a_k sin(2\pi kt/T) + \sum_{k=1}^n b_k cos(2\pi kt/T) + v_t \quad (3)$$

Next, using the estimates from the above equation, construct the detrended series $\tilde{S}_t$ by estimating the following regression:

$$\tilde{S}_t = y_t - \hat{a}_0 t - \sum_{k=1}^n \hat{a}_k sin(2\pi kt/T) + \sum_{k=1}^n \hat{b}_k cos(2\pi kt/T) \quad (4)$$

Then implement the unit root test by estimating the following regression:

$$\Delta y_t = \phi \tilde{S}_t + d_0 + \sum_{k=1}^n d_{1i}\Delta sin(2\pi kt/T) + \sum_{k=1}^n d_{2i}\Delta cos(2\pi kt/T) + \varepsilon_t \quad (5)$$

A completely agnostic approach to the problem of detecting breaks is to select k using purely statistical means. A grid-search method is then used such that the value $k = \hat{k}$ minimizes the sum of squared residuals from (5). Specifically, for each integer value of k in the interval $1 \leq k \leq k_{max}$ (5) is estimated and the regression yielding the best fit is selected.[1] As established in Becker, Enders, and Hurn (2004), the presence of high frequency components could be due to various forms of stochastic parameter instability.

The null hypothesis of interest is $H_0: (\phi = 0)$. If the null is rejected we can conclude that the data series is stationary. In the case of serially correlated errors, the equation is augmented by adding lagged values of $\Delta \tilde{S}_t$.

Below are the results:

Table A.2: Unit root tests with Flexible Fourier Form

Commodity			lag
Aluminum	3	−5.43*	4
Coal	1	−5.03*	11
Copper	3	−4.90*	11
Iron	3	−4.77*	1
Gas	3	−5.26*	11
Nickel	1	−2.74	1
Oil	2	−5.72*	11
Tin	1	−3.95*	11
Zinc	3	−4.05*	10
Macroeconomic variables			
Real Exchange Rate	2	−3.61*	7
Interest rate	3	−6.24*	10

Notes: *denotes significance at the 10% level. Lag length selected according to the General to specific methodology. k denotes the frequency.

The choice of variables in this study is stacked in a vector $\mathbf{z}'_t = [IPCH_t, REER_t, IR_{t_t}, PCOM_t,]$ where $IPCH_t$ denotes the industrial production growth of PRC, $PCOM_t$ is the price of the primary commodity, $REER_t$ is the real exchange rate and IR_t is the interest rate. The lag length l was chosen according to the Akaike Information Criterion (AIC). The linear VAR would take the following form:

$$\mathbf{z}_t = \mathbf{A}_0 + \sum_{i=1}^l \mathbf{A}_i \mathbf{z}_{t-i} + \mathbf{e}_t \quad (6)$$

Where $\mathbf{A}_0$ is a vector of intercepts, $\mathbf{A}_i$ sis coefficient matrix while $\mathbf{e}_t$ is a vector of error terms. The error vector is ordered with industrial production growth of PRC causally prior exchange rates, interest rates, and commodity prices similar to the study by Roache (2012).

In the case of the Flexible Fourier Form, the VAR model is estimated as:

$$\mathbf{z}_t = \mathbf{A}_0(t) + \sum_{i=1}^l \mathbf{A}_i \mathbf{z}_{t-i} + \mathbf{e}_t \quad (7)$$

$$\mathbf{A}_0(t) = [\delta_1(t), \delta_2(t), \delta_3(t), \delta_4(t), \delta_5(t)]'$$

And each intercept $\delta_i(t)$ depends on the n Fourier frequencies such that:

$$\delta_i(t) = a_i + b_i t + \sum_{k=1}^n a_{ik} sin(2\pi kt/T) + \sum_{k=1}^n a_{ik} cos(2\pi kt/T) \quad (8)$$

The VAR model with Fourier frequencies is estimated beginning with a trigonometric frequency set to. The power and size properties of this model are good when testing for smooth structural change in a VAR. Not accounting for structural breaks results in a mis-specified model. A model selection test is then carried out using the AIC to determine model performance.

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[1]   Enders and Lee (2012) suggests the use of the integer values 1 through 5 since low frequencies are associated with breaks.

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Structural Change and Moderating Growth in the People's Republic of China: Implications for Developing Asia and Beyond

The People's Republic of China (PRC) is currently undergoing a number of structural and cyclical changes, which have wide-ranging implications for economic activity in the PRC, the rest of developing Asia, and the world. This report assesses the effects of these changes on the rest of the region and the world, looking closely at various channels of transmission including commodity prices, trade, and production. The continued moderation of growth in the PRC could knock off a third of a percentage point a year in growth for the rest of developing Asia over the next 2 years. Changes in PRC economic activity significantly affect commodity prices, but the estimated impact varies by commodity. This report discusses how developing Asia's policy-makers can respond to the challenges and opportunities presented by these changes.

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ASIAN DEVELOPMENT BANK
6 ADB Avenue, Mandaluyong City
1550 Metro Manila, Philippines
www.adb.org

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