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CHINA SPILLOVERS

New Evidence from Time-Varying Estimates

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CHINA SPILLOVERS: NEW EVIDENCE FROM TIME-VARYING ESTIMATES

Introduction

The role of China in the world economy has steadily increased since the launch of its "reforms and opening-up" strategies in 1978. China has become the second-largest economy after the United States, increasing its share in the world's GDP (in market exchange rates) from about 3 percent in 1980 to about 15 percent in 2015 (Figure 1). Linkages between China and the rest of the world have been growing as well, with China's imports from the rest of the world increasing from about 1 percent to 14 percent over the same period.

Until recently, China has been the leading contributor to global economic growth and—since the recent global financial crisis—a stabilizing driver of its evolution. GDP growth in China has averaged about 9½ percent since 2000—fueled by a sharp increase in investment as the economy built infrastructure—and remained strong in 2009 and 2010 as the response to the global financial crisis prompted a fiscal stimulus. However, as China recently began to rebalance its economy away from investment and exports and toward consumption, its GDP growth slowed significantly from about 7.8 percent in 2013 to 6.9 percent in 2015 (Figure 2)—partly reversing the country's contribution to global output and trade growth—and is expected to continue to decline gradually over the medium term (IMF 2016b).

There is little consensus regarding the consequences of a China's growth slowdown for the rest of the world. Some argue that a significant slowdown in China may have large implications and possibly lead to a worldwide recession if the "rebalancing" process is not well managed (for example, Buiter 2015). Others suggest that even a significant slowdown in China is unlikely to have large global effects, as its role in the world economy is still limited. For instance, according to Krugman "a 5 percent slump in [China's] own GDP; given an income elasticity of 2, which is reasonable, this would mean a 10 percent fall in imports—but that's a shock to the rest of the world of just 0.3 percent of GDP. Not nothing, but not that big deal."

Previous empirical evidence suggests that historically the size of growth spillovers from China to the rest of the world has been quite limited (see IMF 2016aand references cited therein).[1] However, the magnitude of spillovers through trade linkages could have increased over time, and other channels may amplify the effect of a growth slowdown in China on other countries.[2] For instance, a lower growth in China—given the size of its commodity imports in the world—may directly impact commodity prices, therefore providing positive income effects for net commodity importers and adverse effects for net commodity exporters (Kolerus and others 2016).[3] Moreover, the steady increase in China's demand for commodities over the last two decades suggests that spillovers through commodity prices may also have increased.[4] Also, while direct

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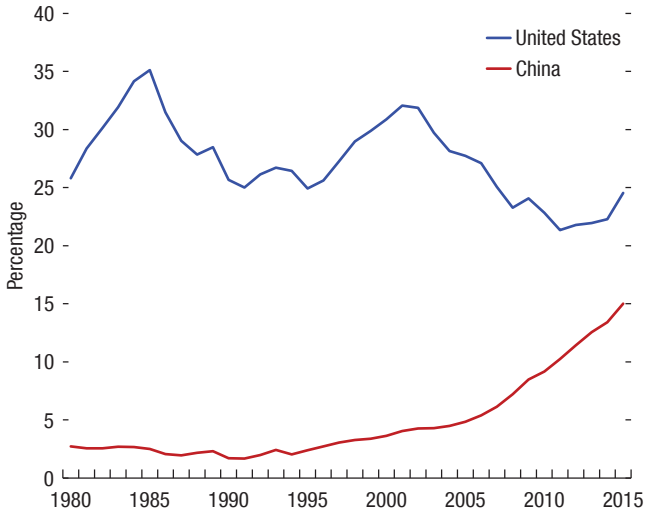
[1] Arora and Vamvakidis (2010) find, based on VAR estimates, that a 1 percent shock to economic activity in China is associated with a short-term output effect in other countries of about 0.08 percent. Ahuja and Nabar (2012) find that a 1 percentage point slowdown in investment in China is associated with a reduction of global growth of 0.1 percentage point. Duval and others (2014) estimate the growth spillover effect of China of about 0.15 percentage point in non-Asian economies and about 0.3 percentage point in Asian economies. Cashin and others (2016), based on a global vector autoregression model for 26 countries, find that median spillover for the median economy is about 0.1 percent.

[2] Blagrave and Esperoni (2016) estimate the effect of China demand shocks on export growth in advanced and emerging market economies. Using a panel vector autoregression framework, they find that a 1 percentage point shock to China's final demand reduce export growth in other countries by 0.1–02 percentage point, on average, with the effect being larger for emerging Asia economies.

[3] Kolerus and others (2016) find that China shocks have a significant effect on commodity prices. In particular, they find that a 1 percent increase in China's industrial production leads to an increase in metal prices by about 5-7 percent and fuel prices by 7 percent.

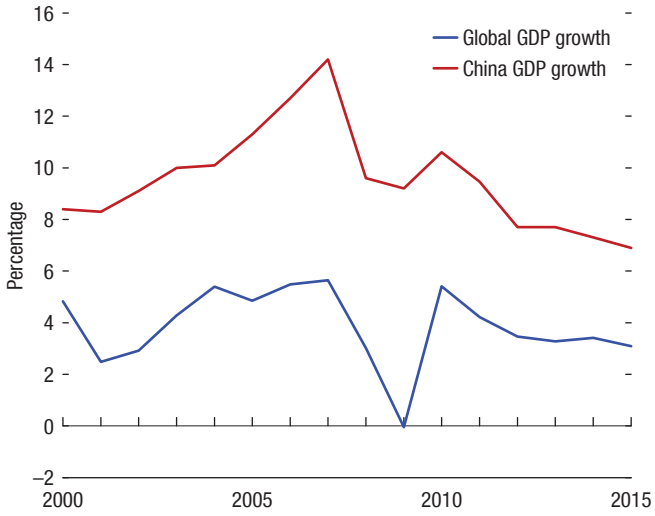
[4] China's share of global demand for metals—such as iron ore, copper, and nickel—has increased from about 3 percent in the mid-1990s to about 40 in 2015. Similarly, China's share of global demand for oil has increased from about 1 to 11 percent in the same period. Estimates presented in Kolerus and others (2016) suggest that the effect of China's shock on oil and metal prices has increased over time, especially since the early 2000s.

Figure 1. U.S. and China Share in World GDP, 1980–2015



Note: Estimates based on equations (4) and (5). Short-term denotes the effect one year after shock.

Figure 2. China's and Global GDP Growth, 2000–2015



Note: Estimates based on equations (4) and (5). Median of countries within each group is reported. Short-term denotes the effect one year after shock.

spillovers through financial channels remain limited—given the remaining restrictions on cross-border financial transitions, investment, and banking activities in China—a larger-than-expected slowdown in China could affect market sentiment and increase global risk aversion, therefore amplifying the effect of real shocks (Mwase and others 2016). Indeed, financial markets in many advanced and emerging market economies have experienced high volatility following negative news regarding the Chinese economy and its equity market turmoil in July/August.[5]

This note contributes to the ongoing debate by analyzing how growth shocks in China affect particular regions and country groups and how the impact and key transmission channels of these growth shocks have increased over time. For this purpose, it uses novel empirical approaches to identify growth shocks in China and, then, to estimate time-varying measures of spillovers for a large set of 148 advanced and emerging market economies from 1990 to 2014.

The main results can be summarized as follows:

- Historically, an average impact of growth shocks in China on global output has been statistically significant but limited. In particular, a 1 percent negative growth shock in China has decreased output in other economies by about 0.06 percent one year after the shock. Spillovers have been typically larger in neighboring (Asian) countries as well as in low-income and emerging economies.
- Since the early 2000s, the magnitude of spillovers has significantly increased. In particular, a 1 percent negative growth shock in China in the most recent years has lowered, on average, output in other economies by about 0.25 percent one year after the shock.
- Trade linkages remain the main transmission channels with larger effects for net commodity exporters and countries mostly exporting manufacturing goods. Also, spillover effects tend to be larger during periods of high global uncertainty and have been positively associated with an increase in the share of industry in total value in China, which suggests an important role of "rebalancing" process.

The remainder of the note is organized as follows: The second section describes the methodological framework, and the third section presents the results. The final section summarizes and discusses policy implications.

Methodological Framework

In general, one could assume that economic growth in each country is driven by shocks common to many or all countries, shocks specific to this country, and shocks

[5] Mwase and others (2016) find that recent economic and financial development in China had a significant impact on global financial markets. They find that the degree of comovements between asset prices in China and elsewhere has increased since mid-2015, and is larger in countries with stronger trade linkages with China.

specific to foreign countries—such as China. Shocks in a foreign country can spill over to others in many ways, including through conventional linkages such as finance and trade.[6] Following Doyle and Faust (2005), growth drivers in each country can be formalized as follows:

$$\Delta y_{it} = \varepsilon_t + \varepsilon_{it} + \rho_{ict}\varepsilon_{ct} + \Sigma_j \rho_{ijt}\varepsilon_{jt}, \quad (1)$$

where Δy_{it} denotes real GDP growth in country i at time t, ε_t denotes shocks common to all countries, ε_{it} are domestic idiosyncratic shocks, are China's idiosyncratic shocks, ε_{ct} (for $j \neq i$ *and* c) are other countries' idiosyncratic shocks, and ρ_{ict} measures the linkages between country i and China in time t. In the analysis below, we focus on trade linkages (ρ^2_{ict}), as well as time-unvarying country-specific characteristics in other countries (ρ^0_i)—such as being a net commodity exporter—and time-varying factors in China (ρ^1_i):[7]

$$\rho_{ict} = \rho^0_i + \rho^1_{ct} + \rho^2_{ict} Trade_{ict}. \quad (2)$$

Identification of China's Idiosyncratic Shocks

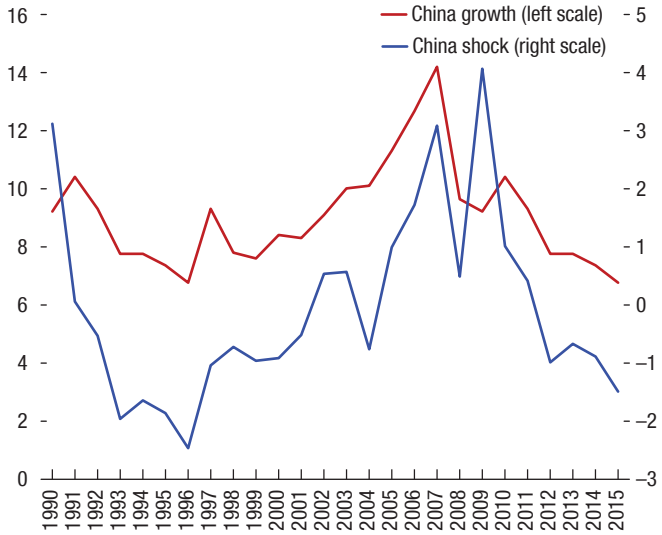
We follow Morgan and others (2004) and IMF (2013) to identify China's idiosyncratic shocks, for a given year, as the deviation from the average growth for China over the entire period and from average growth for all countries in the sample in that year:

$$\Delta y_{it} = \alpha_t + \gamma_t + \varepsilon_{it}, \quad (3)$$

where Δy_{it} is real GDP growth in country i at time t; α_t and γ_t are country and time fixed effects, respectively; and ε_{it} for i equal to China, represents China's idiosyncratic shocks. The main advantage of this approach is that it isolates the spillover effect of country-specific shocks from shocks that can affect all countries simultaneously—which in contrast is a shortcoming of global vector autoregression approaches. Its main limitation is that it is impossible to definitively distinguish between pure China's shocks and shocks in China that are quickly transmitted to other economies and that are captured by the time fixed effects. As a result, the magnitude of the spillovers estimated with the shocks identified with this approach should be considered as a lower-bound estimate.

Figure 3 shows the evolution of China's idiosyncratic shocks and real GDP growth during the period 1990–-2015. These two variables are strongly correlated over the entire period. A notable exception is 2009—the year of the Chinese economic stimulus program and the drop in GDP in many advanced and emerging market and developing economies. In particular, while the measure of idiosyncratic shocks increases in 2009, real GDP growth fell somewhat. The different behavior of these two variables during periods of significant global shocks highlights the importance of identifying China's shock to assess their spillover affects correctly.

Figure 3. Evolution of China's Idiosyncratic Shocks and Real GDP Growth



Note: Estimates based on equations (4) and (5). Median of countries within each group is reported. Short-term denotes the effect one year after shock.

Statics and Time-Varying Estimations

To assess the impact of China's growth shocks on other countries' output, we follow the statistical

[6] Theoretically, the linkages depend on the nature of the shocks. While real shocks are mostly transmitted through trade linkages, financial ones are mostly transmitted through financial linkages (see, for example, IMF 2016b). Regarding the role of linkages, economic theory has ambiguous predictions about the impact of changing financial and trade linkages on output comovements. For example, an increase in financial linkages can lead to lower output comovements in the case of real shocks, but higher output comovements in the case of financial shocks. For a more detailed discussion, see Kalemli-Ozcan and others (2013) and the references therein.

[7] Because of limited time series data of bilateral financial flows of each country with China, this framework does not allow to test for the role of financial linkages in transmitting shocks and how the transmission through financial linkages has changed over time. While the direct transmission of spillovers through financial channels is likely to be limited—given, for instance, the remaining restrictions on cross-border financial transitions, investment, and banking activities in China—recent empirical evidence points to an increase in the comovement between asset prices in China and elsewhere since mid-2015 (Mwase and others 2016).

approaches proposed by Jordà (2005) and Aghion and Marinescu (2008). In particular, we apply three econometric specifications.

Static Framework

The first specification consists of estimating equation (1) under the assumption that the spillover coefficients do not vary over time (that is, $\rho_{ict} = \rho_{ic}$ for each t), using the local projection method:

$$y_{i,t+k} - y_{i,t-1} = \alpha_i + \rho^k_{ic}\varepsilon_{C,t} + \delta(L)\Delta y_{it} + u_{it}, \qquad (4)$$

where y is the log of real GDP; and ε_C are the China growth shocks identified in equation (3). The coefficient ρ^k_i measures the spillover effect of a 1 percent change in China's growth at each time horizon $k = 0, \ldots, 4$ for each country i. Two lags of GDP growth are included to account for the normal dynamics of output and, since determinants of output growth are typically serially correlated, to control for various factors that may influence output growth in the short term, as well as possible feedback effects of lagged GDP growth on China's idiosyncratic shocks.[8] Equation (4) is estimated in a panel framework as well as country-by-country.

Time-Varying Estimates

The second specification allows the spillover coefficients to vary over time:

$$\rho^k_{ict} = \rho^k_{ict-1} + v^k_{it}. \qquad (5)$$

To obtain the coefficients ρ^k_{ict}, equations (4) and (5) are estimated jointly using a varying-coefficient model proposed by Schlicht (1985, 1988). In this approach, the variances σ^2_i are calculated by a method-of-moments estimator that coincides with the maximum-likelihood estimator for large samples. The time-varying model generalizes the static regression model, which is obtained as a special case when the variance of the disturbances (v^k_{it}) in the coefficients approaches zero.

As discussed by Aghion and Marinescu (2008), this method has several advantages compared to other methods to compute time-varying coefficients such as rolling windows and Gaussian methods. First, it allows using all observations in the sample to estimate the magnitude of spillover in each year—which by construction is not possible in the rolling windows approach. Second, changes in the size of spillovers in a given year come from innovations in the same year, rather than from shocks occurring in neighboring years.

Transmission Channels

The third specification examines the channels through which growth shocks in China are transmitted to other countries:

$$\rho^k_{ict} = \rho^0_i + \rho^1_{ct} + \rho^2_{ict} Trade_{ict} + \in_{it}, \qquad (6)$$

where ρ^0_i are country fixed effects to capture unobserved heterogeneity across countries and time-unvarying factors such as geographical variables; ρ^1_{ct} are time fixed effects to control for China's specific time-varying factor, and $Trade_{ict}$ is defined as the share of each country's exports to China in domestic GDP ((*Export to China*)/*GDP*). Two variants of equation (6) are estimated. The first one excludes country fixed effects to assess the effect of observable time-unvarying country-specific factors, such as whether a country is a commodity exporter. The second variant excludes time fixed effects to examine the effect of observable time-varying factors that are common across countries, such as the share of China's value added in industry—a proxy for "rebalancing."

Since the dependent variable in equation (6) is based on estimates, the regression residuals can be thought of as having two components. The first component is sampling error (the difference between the true value of the dependent variable and its estimated value). The second component is the random shock that would have been obtained even if the dependent variable were observed directly as opposed to estimated. This would lead to an increase in the standard deviation of the estimates, which would lower the t-statistics. This means that any correction to the presence of this unmeasurable error term will increase the significance of our estimates. To address this issue, equation (6) is estimated using weighted least squares. Specifically, the weighted-least-squares estimator assumes that the errors $\in_{it}$ in equation (6) are distributed as $\in_{it} \sim N(0,\sigma^2/s_i)$, where s_{it} are the estimated standard deviations of the spillover coefficient for each country i, and σ^2 is an unknown parameter that is estimated in the second-stage regression.

The three specifications are estimated using annual data for an unbalanced panel of 148 countries over the period 1990–2014.

[8] The results—available upon request—are robust to different lag-parametrizations.

Results

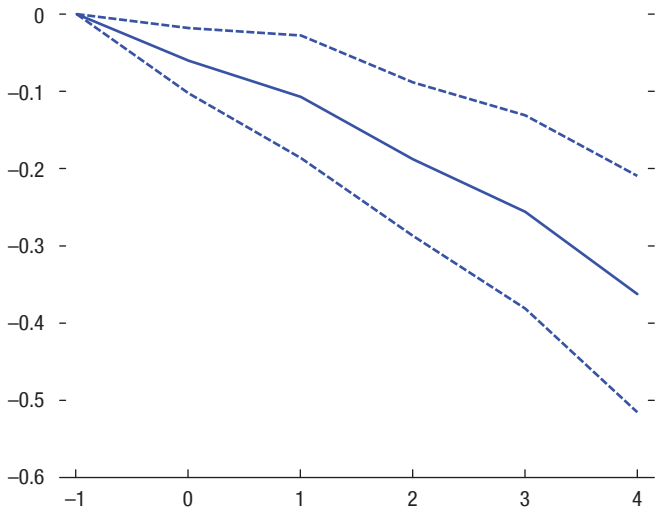
Historical Spillovers: Static Framework

The results obtained by estimating the impact of China's shocks on output in other countries using equation (4) are presented in Figure 4 (see also Table 1). The figure shows the panel-based estimated effect of China's idiosyncratic shocks and the associated confidence bands (dotted lines). The results show that China's shocks have long-lasting effects on output in other countries. In particular, the estimates suggest that a 1 percent negative shock in China's growth decreases output in other countries by 0.06 in the very short term—one year after the shock—and by about 0.35 percent in the medium term—four years after the shock. The effect eventually levels off and starts declining after year 6.[9]

As discussed in the previous section, the magnitude of the spillover effects estimated using the idiosyncratic shocks identified in equation (3) should be interpreted as a lower-bound estimate. To gauge a possible range of estimates for the short- and medium-term effects of China shocks, we reestimate equation (4) using China's real GDP growth. The results presented in Figure 5 show, as expected, that the declines in output in other countries associated with reductions in China's GDP growth are larger than those for China's idiosyncratic shocks. In particular

[9] The results—available upon request—also suggest that the effect becomes statistically nonsignificant by the 10th year. This result, however, has to be treated with caution given the large uncertainty surrounding the estimates over the long term.

Figure 4. Effect of a 1 Percent Negative Shock in China to Output in Other Countries



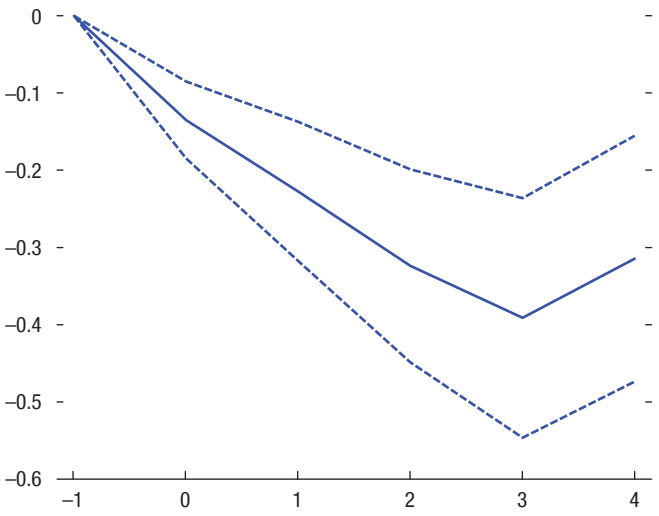
Note: $t = 0$ is the year of the shock. Solid lines denote the response, and dashed lines denote 90 percent confidence bands. Estimates based on equation (4).

Table 1. The Effect of China's Shocks on Output in Other Countries: Static Framework

	Idiosyncratic Shocks	GDP Growth
$K = 0$	0.060**	0.135***
	(2.30)	(4.47)
$K = 1$	0.107**	0.227***
	(2.22)	(4.15)
$K = 2$	0.188***	0.188***
	(3.11)	(3.11)
$K = 3$	0.766***	0.766***
	(3.12)	(3.12)
$K = 4$	0.256***	0.256***
	(3.37)	(3.37)
$K = 5$	0.362***	0.362***
	(3.90)	(3.90)

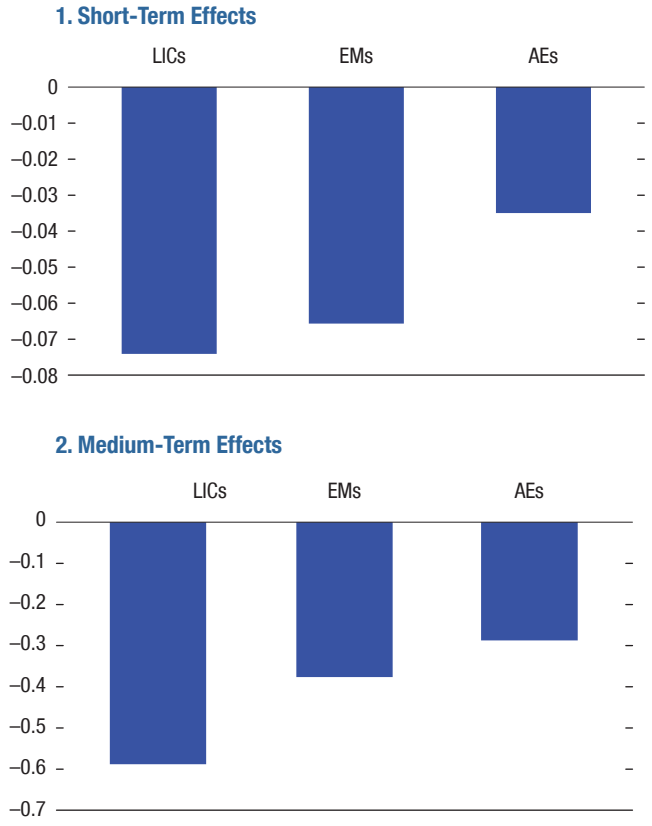
Note: *t*-statistics based on robust clustered standard errors in parentheses. China's idiosyncratic shocks are identified as in equation (3). Estimates based on equation (4). Two lags of GDP growth included as controls but not reported.
*$p < .01$; **$p < .05$; ***$p < .01$.

Figure 5. Effect of a 1 Percent Reduction in China GDP Growth to Output in Other Countries



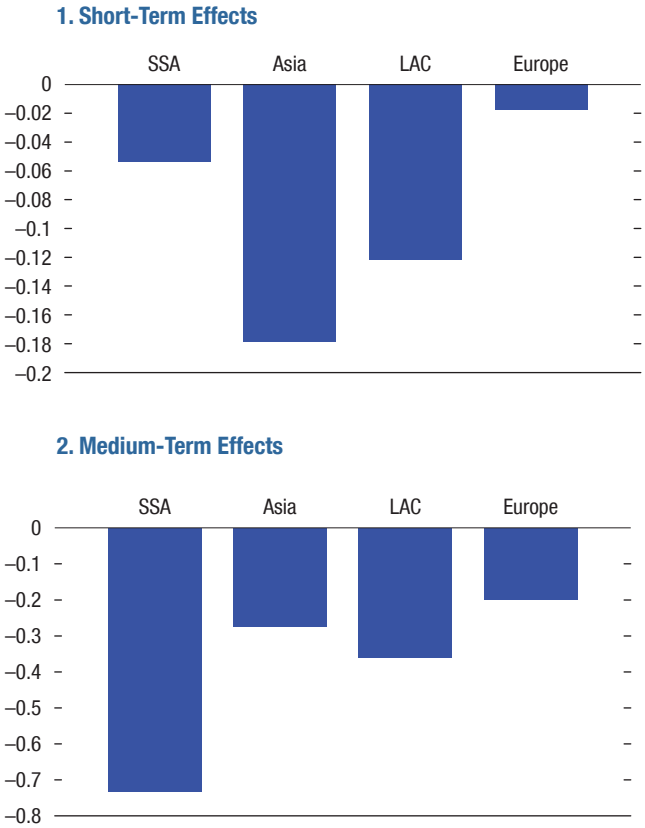
Note: $t = 0$ is the year of the shock. Solid lines denote the response, and dashed lines denote 90 percent confidence bands. Estimates based on equation (4).

Figure 6. Effect of a 1 Percent Negative Shock in China to Output across Income Groups



Note: Estimates based on equation (4). Short-term (medium-term) denotes the effect one (three) year(s) after shock. AEs = advanced economies; EMs = emerging markets; LICs = low-income countries.

Figure 7. Effect of a 1 Percent Negative Shock in China to Output across Regions



Note: Estimates based on equation (4). Short-term (medium-term) denotes the effect one (three) year(s) after shock. LAC = Latin America and the Caribbean; SSA = sub-Saharan Africa.

ular, the estimates suggest that a 1 percent reduction in China's growth decreases output in other countries by 0.13 in the very short term—one year after the shock—and by about 0.4 percent in the medium term—three years after the shock.

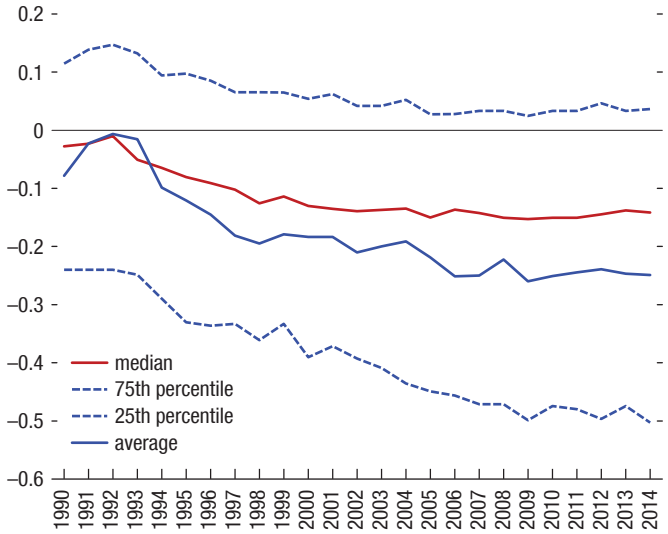
To assess possible heterogeneity across countries, equation (4) is reestimated for various country groups and regions. The results (Figure 6) suggest that both short- and medium-term effects are typically larger in low-income countries than in emerging markets and advanced economies—possibly reflecting the large share of China's trade and foreign direct investment in many of these economies (Arora and Vamvakidis 2010; IMF 2016a). In particular, a 1 percent negative shock in China's growth is associated with a short-term (medium-term) reduction in output of 0.075 (0.588) percent in low-income countries, 0.065 (0.377) in emerging markets, and 0.035 (0.288) in advanced economies, respectively.[10]

The effects of China's idiosyncratic shocks also vary substantially across regions (Figure 7) and are typically larger in Asian and sub-Saharan African countries. In particular, the short-term (that is, one year after) output effect of a 1 percent negative shock to China's economic activity ranges from –0.17 percent in Asian economies to –0.02 percent in European countries, while the medium-term (that is, three years after) effect ranges from about –0.73 in sub-Saharan African countries to –0.2 percent in Europe.[11]

[10] The effects are statistically significantly different from zero. The only exception is the short-term effect for advanced economies.

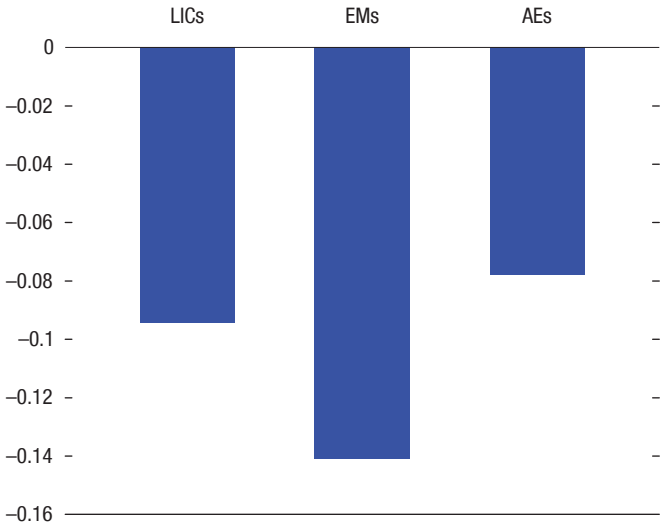
[11] The effect is negative but not statistically significant in the Middle East, North Africa, Afghanistan, and Pakistan and the Commonwealth of Independent States.

Figure 8. Evolution of (Short-Term) Spillover Effect of 1 Percent Negative Shock in China



Note: Estimates based on equations (4) and (5). Short-term denotes the effect one year after shock.

Figure 9. Increase in the (Short-Term) Effect of a 1 Percent Negative Shock in China to Output across Income Groups during 1990–2014



Note: Estimates based on equations (4) and (5). Median of countries within each group is reported. Short-term denotes the effect one year after shock.

How Have Spillovers Changed over Time?

The results obtained by estimating the evolution of the impact of China's idiosyncratic shocks on output in other countries using equations (4) and (5) are presented in Figure 8. The figure shows the average, median, and interquartile ranges of the short-term spillover effects (that is, the effect one year after the shock) across countries. The results show that the effect of China's shocks on output in other economies has increased over time. In particular, the estimates for the median economy suggest that the effect of a 1 percent negative shock in China's growth on output in other countries has increased from about –0.02 percent in 1990 to about –0.15 percent in 2014. The average effect has also steadily increased since the 1990s and is now at about –0.25. Also, the evolution of the interquartile range suggests that the increase in spillover effects has been broad-based across countries.[12]

The magnitude of the increase in spillover effects, however, varies across regions and income groups (Figures 9 and 10). In particular, the effect has increased more for the median emerging and developing economy than for the median advanced economy, and more in Asia and sub-Saharan African economies than in Latin American and Caribbean and European economies.[13]

Determinants of Spillovers

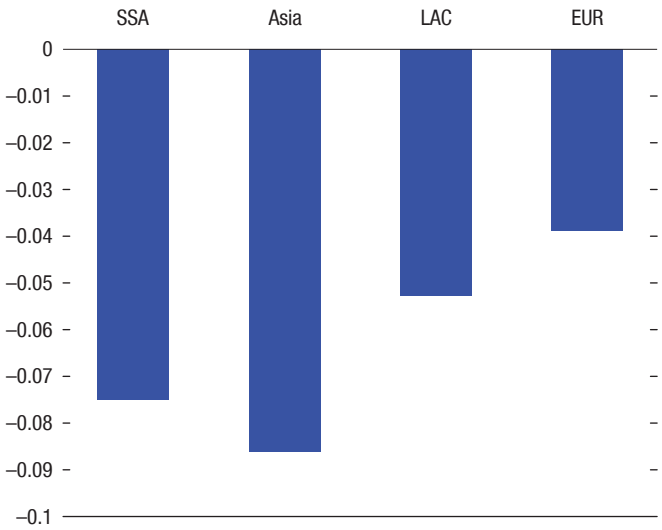
This section examines the channels through which spillovers from China are transmitted to other countries. The analysis focuses on short-term spillovers, for which the identification of transmission channels is less prone to omitted variable bias. Indeed, the medium-term response of output in each country to shocks in China does not depend only on the strength of the transmission channels but also on the country-specific policy response to these shocks as well as country-specific factors (such as the degree of product and labor market regulation), which influences each economy's resilience to shocks.

Table 2 presents the results obtained by estimating equation (6) using different econometric specifications. The coefficients associated with the various determi-

[12] The results—available upon request—suggests that medium-term effect of China's idiosyncratic shocks on output in other countries has also increased, even though the increase has been more modest than for the short-term effects.

[13] Due to the presence of outliers, the average of the effect for each country group tends to differ from the median effect. For example, the average effect for each country group suggests that spillovers have increased more for advanced and emerging market economies than for low-income countries.

Figure 10. Increase in the (Short-Term) Effect of a 1 Percent Negative Shock in China to Output across Regions during 1990–2014



Note: Estimates based on equations (4) and (5). Median of countries within each group is reported. Short-term denotes the effect one year after shock.

nants typically exhibit the expected sign. Starting with trade linkages, we find that spillovers are robustly and positively associated with the degree of trade linkages of each country with China. In particular, we find that an increase of 10 percent in exports to China is associated with an increase in the magnitude of spillovers of about 0.01.

The results also suggest that spillovers from China's growth shocks are larger for countries in which GDP growth is positively associated with changes in commodity prices (net commodity exporters). In particular, a 1 percent negative shock in China has marginal positive effects in net commodity importers while these effects are negative for net commodity exporters.[14] The differential spillover effects from an increase in output sensitivity to commodity prices from the 25th to the 75th percentile of the distribution of sensitivity (approximately one standard deviation) are about 0.14 percent.[15] The results also suggest larger spillover effects for countries whose exports to China consist mostly of manufactures. In particular, in these countries, the average spillover effect is about 0.1.[16] In contrast, the effect of the Chicago Board Options Exchange Volatility Index (VIX) and the share of

[14] The sensitivity is assessed estimating a bivariate regression of GDP growth to changes in commodity prices for each country. The results are available upon request.

[15] The magnitude of this result should be treated with caution given that is not possible to separate between unobservable country-specific factors and the sensitivity of GDP growth in each country to changes in commodity prices.

[16] Computed as the average spillover effect (about 0.06) plus the dummy coefficient (0.04). Also, in this case, the magnitude of this result should be treated with caution given that it is not possible to separate the effect of this variable from unobserved country-specific characteristics.

Table 2. Transmission Channels

Specification Regressors	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)
Exports to China (% of GDP), log	0.133***	0.119***	0.205***	0.111***	0.135***	0.0930**	0.098**
	(0.028)	(0.026)	(0.027)	(0.027)	(0.032)	(0.040)	(0.045)
Commodity sensitivity		0.022***		0.022***			
		(0.001)		(0.001)			
Manufacturing exporters			0.044**	0.043**			
			(0.019)	(0.018)			
Industry's share of total valued					–0.033		–0.136
					(0.294)		(0.516)
VIX (log)						0.002	0.000
						(0.013)	(0.015)
Country fixed effects	Yes	No	No	No	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes	No	No	No
Number of observations	3,236	3,213	3,236	3,213	3,236	1,846	1,846
R^2	0.604	0.091	0.027	0.092	0.604	0.788	0.788

Note: Robust clustered standard errors in parentheses. Estimates based on equation (6). VIX = Chicago Board Options Exchange Volatility Index.
*$p < .01$; **$p < .05$; ***$p < .01$.

Table 3. Transmission Channels—Alternative Measure of Trade Linkages

Specification Regressors	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)
Value added exports to China (% of GDP), log	0.062***	0.090*	0.168***	0.133**	0.119***	0.084***	0.077***
	(0.019)	(0.052)	(0.054)	(0.052)	(0.017)	(0.014)	(0.014)
Commodity sensitivity		0.024***		0.023***			
		(0.002)		(0.002)			
Manufacturing exporters			0.146***	0.125***			
			(0.024)	(0.023)			
Industry's share of total valued added					–0.069		0.745***
					(0.232)		(0.185)
VIX (log)						0.004	0.014**
						(0.005)	(0.006)
Country fixed effect	Yes	No	No	No	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes	No	No	No
Number of observations	918	918	918	918	918	663	663
R^2	0.962	0.116	0.048	0.144	0.959	0.984	0.984

Note: Robust clustered standard errors in parentheses. Estimates based on equation (6). VIX = Chicago Board Options Exchange Volatility Index.
*$p < .01$; **$p < .05$; ***$p < .01$.

industry in total value added in China are not statistically significant.

As a robustness check, we reestimate equation (6) using the value added of individual country's exports to China instead of total exports (Table 3). Despite the smaller time sample, the results for trade linkages, the sensitivity to commodity prices, and the dummy for manufacturing exporters are robust and similar to those presented in Table 2. Also, the effect of VIX and the share of industry in total value added in China turn out to be statistically significant when these variables are jointly considered (column VII). This result provides suggestive evidence that spillovers are positively associated with the increase in the share of industry in total value added in China—possibly suggesting an important role of rebalancing—and that they are amplified during periods of high global uncertainty.

Conclusions

The recent "rebalancing" of China's economy has opened discussions on the effects of its growth slowdown on the rest of the world. This note tries to contribute to this debate using a novel empirical strategy to estimating time-varying spillovers for a large set of advanced and emerging market economies.

Our analysis suggests that the magnitude of China's spillovers has steadily increased across countries during the last two decades, but remains limited. In particular, the short-term effect of a 1 percent negative growth shock in China on output in other countries has increased, on average, from about –0.06 percent in 1990 to about –0.25 percent in 2015.

The size of spillover effects varies across income groups and regions. In particular, the effects are larger in emerging markets than in advanced economies, and in Asian and sub-Saharan African countries than in the rest of the world. Trade links remain key transmission channels. Spillovers are larger for countries that export mostly manufacturing goods and for net commodity exporters. The results also suggest that a negative shock in China has marginal positive effects for net commodity importers.

Overall, while the results presented in this note tend to suggest that the consequences of a growth slowdown in China may be limited for the rest of the world, there is uncertainty regarding the implications of China's transition for global output. On the one hand, several factors suggest that spillovers may be larger than currently estimated. First, since it is not possible to definitively distinguish between China's idiosyncratic shocks and shocks to China that are quickly transmitted to other economies (and therefore captured by global factors), the magnitude of the spillovers estimated with the shock identified in the analysis should be treated as a lower-bound

estimate. Second, investment and exports growth fell much more than output growth, possibly suggesting higher spillovers through trade linkages. Third, as financial linkages of China with the rest of the word increase—as China eases restrictions on capital accounts—financial spillovers are likely to become more relevant. Fourth, an increase in policy uncertainty regarding the transition process could increase market volatility and amplify the magnitude of spillovers—as pointed out by some evidence presented in the note. On the other hand, a well-managed transition delivering a more efficient allocation of resources and higher sustainable growth in China would benefit the global economy in the long run.

Annex 1. Data Issues

Annex Table 1.1. Summary Statistics

Variables	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Exports to China (% of GDP), log	3496	0.049	0.034	–0.066	0.128
Commodity sensitivity	3504	5.083	6.559	–30.226	24.195
Manufacturing exporters	4512	0.074	0.262	0	1
Industry's share of total valued added	4324	0.459	0.016	0.413	0.479
VIX (log)	2632	3.018	0.298	2.529	3.459

Note: Robust clustered standard errors in parentheses. Estimates based on equation (6). VIX = Chicago Board Options Exchange Volatility Index.
*$p < .01$; **$p < .05$; ***$p < .01$.

Annex Table 1.2. Data Description and Sources

Variables	Source
Exports from China to other countries	IMF, *Direction of Trade Statistics*
Commodity sensitivity	IMF, *World Economic Outlook* and estimates
Export earnings from manufacturing	IMF, *World Economic Outlook*
Export earnings from diversified sectors	IMF, *World Economic Outlook*
Industry value added in percent of GDP	IMF, *Direction of Trade Statistics*
Chicago Board Options Exchange Volatility Index (VIX)	Bloomberg

Note: Robust clustered standard errors in parentheses. Estimates based on equation (6). VIX = Chicago Board Options Exchange Volatility Index.
*$p < .01$; **$p < .05$; ***$p < .01$.

Annex Table 1.3. Manufacturing Exporters

Bangladesh	Poland
Botswana	Romania
Cambodia	Swaziland
Hungary	Thailand
Malaysia	Tunisia
Mexico	Turkey
Philippines	Vietnam

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