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Spillovers from China's Growth Slowdown to the Singapore Economy

Singapore

Kodjovi Eklou, Shujaat Khan, and Margaux MacDonald

SIP/2024/041

IMF Selected Issues Papers are prepared by IMF staff as background documentation for periodic consultations with member countries. It is based on the information available at the time it was completed on July 1, 2024. This paper is also published separately as IMF Country Report No 24/256.

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Spillovers from China's Growth Slowdown to the Singapore Economy

Prepared by Kodjovi Eklou, Shujaat Khan, and Margaux MacDonald *

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ABSTRACT: This paper examines the impact of China's economic deceleration on Singapore, highlighting how the deepening trade integration and China's pivotal role in Global Value Chains (GVCs) amplify these spillover effects. Utilizing multi-region input-output tables, empirical estimates, and the IMF's Global Integrated Monetary and Fiscal model, it identifies significant sectoral and aggregate impacts, particularly in electrical and machinery manufacturing, petrochemicals, and financial services. The analysis underscores the vulnerability of Singapore's economy to shifts in Chinese demand and productivity, emphasizing the need for vigilant monitoring and strategic adaptation to mitigate potential risks associated with China's slowdown.

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Singapore

Prepared by Kodjovi Eklou, Shujaat Khan, and Margaux MacDonald [1]

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Asia and Pacific Department

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CONTENTS

SPILLOVERS FROM CHINA'S GROWTH SLOWDOWN TO THE SINGAPORE ECONOMY

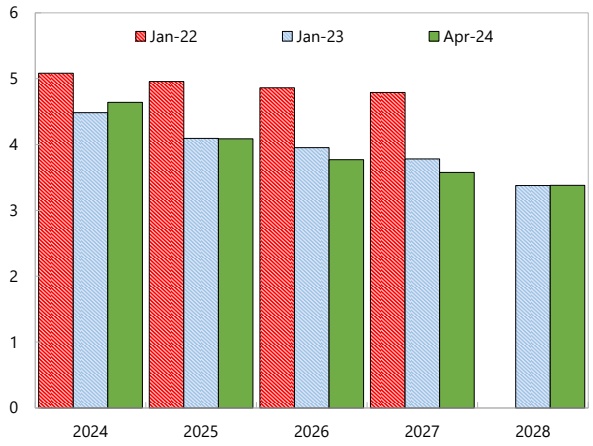
China's economy is facing significant headwinds, including an ageing population and slowing productivity growth. As a result, growth is projected to moderate in the medium term. This moderation is expected to weigh on growth in ASEAN trading partner countries over the medium term due to the complexity of production processes via global value chains, in which China is a key player and ASEAN countries are increasingly linked. We examine the impact of this transition on Singapore from three perspectives. First, using global input-output tables we show that there are select sectors in Singapore that are important contributors to domestic value added but are particularly exposed to a slowdown in China. We then use empirical methods and estimate that a 1 percentage point decline in Chinese domestic growth is expected to reduce trend growth in ASEAN countries cumulatively by about 1 percentage point over the medium term (five years), mainly through a decline in the growth of capital stock—suggesting important impacts on investment in ASEAN countries from a slowdown in China. Finally, a general equilibrium model suggests that growth spillovers from China to ASEAN are significant and the spillovers are further amplified by the region's deep integration in global value chains.

A. China's Growing Influence in Asia

1. GDP growth is expected to slow in China over the medium term amid longstanding headwinds. As its population ages and productivity growth remains low, growth in China is expected to slow to just over 3 percent in the medium term. In recent years, IMF staff have revised growth projections to suggest that this transition will happen earlier than previously expected (Figure 1). This moderation in GDP growth is projected to be broad-based, with consumption and investment growth slowing.

Figure 1. Singapore: IMF China Growth Projection

(percent)



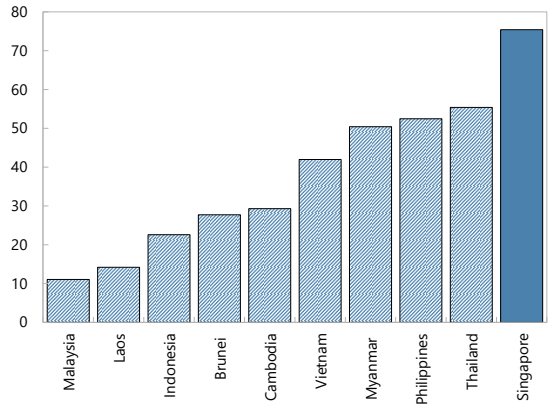
Source: IMF World Economic Outlook.
Note: Legend dates indicate WEO vintage.

2. The decline in trend growth in China will likely impact other countries in the Asia-Pacific region, including Singapore. As documented in the IMF's *October 2023 Regional Economic Outlook for Asia and the Pacific*, China's importance in the global economy has increased significantly over the past three decades and it has been a crucial driver of trade integration in Asia. Much of this can be attributed to China's insertion in global value chains (GVCs), which are defined as such when the location of different stages of the production process is across multiple countries. This fragmentation of the production process means that intermediate

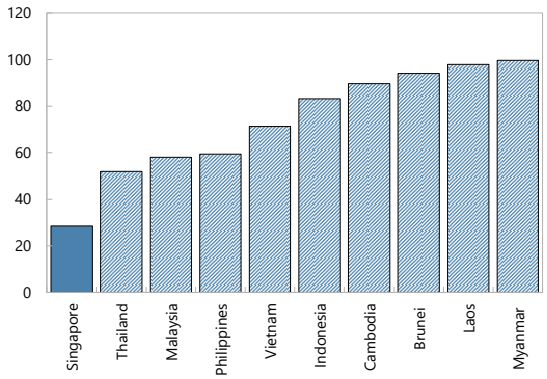
goods pass the border of multiple countries, and sometimes of the same country, more than once. For China, insertion into GVCs initially involved mainly assembly of foreign inputs in China but has more recently transformed, with China now being a key supplier of production inputs to many Asian countries. This integration has allowed China's unprecedented growth over the last three decades to help lift all countries in the region. As China's final demand moderates, however, it may leave countries or sectors exposed to a decline in demand. In the case of Singapore, data shows that there were significant bilateral exports of GVC goods to China (Figure 2A) in 2022—equal to over 75 percent of Singapore's aggregate exports to China. At the same time, only 29 percent of Singapore's aggregate bilateral exports to China contains value-added that originates in Singapore (meaning the remainder of aggregate exports is content which is created in other countries, imported into Singapore, and either re-exported or used as intermediates to create Singapore's exports) (Figure 2B). This highlights the complicated task of understanding global spillovers in the context of complex GVCs.

Figure 2. Singapore: Bilateral GVC Exports to China, 2022

A. Bilateral GVC Exports to China
(percent of country's total bilateral exports to China)



B. Domestic Value Added Absorbed Abroad of Bilateral Exports to China
(percent of country's total bilateral exports to China)



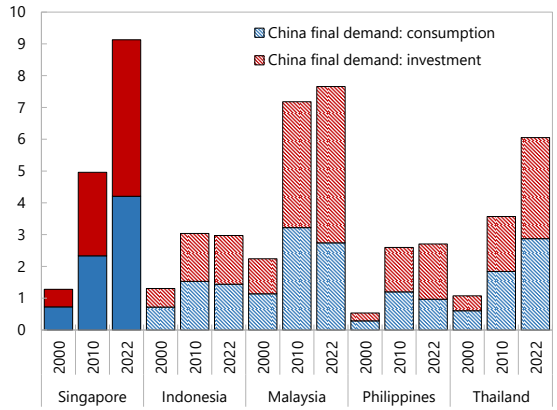
Source: Eora Global Supply Chain Database; Belotti and others (2020); and IMF staff calculations.

3. Given the domestic nature of China's structural transformation, final demand is expected to decline, leaving Singapore vulnerable. Both China's slowing productivity growth and its aging population are primarily domestic factors that will likely play out in a decline in final demand. Though trade in intermediate goods is a key aspect of regional flows, many countries in the region—and in particularly Singapore—have played an increasingly important role in serving Chinese final consumption and investment demand in the last two decades (Figure 3). Specifically, over 9 percent of Singapore's value-added in 2022 was ultimately absorbed by China, suggesting there is some value-added at risk in the face of China's structural transformation.

4. This paper seeks to estimate a range for the potential impact of a growth moderation in China on Singapore's economy. Several approaches are taken which give a range of estimates and various perspectives of the possible magnitude and direction of spillovers. First, we look at the potential implications of a decline in growth in China on the value-added output of specific sectors in Singapore using global input-output tables. Here we identify the sectors in China which account for the largest share of Chinese final demand for Singaporean goods, and the sectors in Singapore which are the largest exporters of goods that are consumed as final demand in China. Then we turn to empirical analysis to estimate the expected spillovers. Using local projections methods, we estimate the impact of a decline in the Chinese GDP growth attributed to domestic factors on trend GDP growth in ASEAN countries, including Singapore. We then decompose Singapore's trend GDP into its capital, labor, and total factor productivity (TFP) components and estimate the impact of a decline in Chinese growth on the growth of each component in Singapore. Lastly, we employ the IMF's Global Integrated Monetary and Fiscal model (GIMF) augmented with GVCs to analyze the sensitivity of growth in Southeast Asia to growth shocks in China.

Figure 3. Singapore: Value Added Embedded in Chinese Final Demand

(percentage points, share of gross value added)



Source: EORA Global Supply chain Database; Aslan and others (2017); and IMF staff calculations.

B. Sectoral Impact of China's Slowdown

5. Multi-region input-output tables can provide insights into a country's exposure to Chinese final demand at the sectoral level. We employ multi-region input-output tables from the Eora Global Supply Chain database to study the sectoral linkages between China and Singapore. The table covers c=189 countries, s=26 intermediate good sectors, and f=6 final demand components over the years 1990-2022.[1] Several indicators, such as trade in intermediates or in final demand goods by origin, are extracted directly from the raw database, which is structured as

$$\boldsymbol{AX} + \boldsymbol{Y} = \boldsymbol{X} \qquad (1)$$

Where $\boldsymbol{X}$ is a matrix of gross output for each country, $\boldsymbol{Y}$ is the matrix of goods used for final demand, and $\boldsymbol{A}$ is the matrix of input-output coefficients, describing the units of intermediate goods needed to produce one unit of gross output. The Eora database provides data directly on $\boldsymbol{X}, \boldsymbol{Y}$ and $\boldsymbol{T}$ where $\boldsymbol{T} = \boldsymbol{AX}$. Value-added indicators, including value added content of final demand (as well as

[1] The 6 final demand components are private consumption, public consumption, non-profit institutions serving households, gross fixed capital formation, changes in inventories, and acquisitions less disposals of valuables. See Lenzen and others (2012) and Lenzen and others (2013) for detailed description of the 26 sectors and their construction.

other measures such as backward and forward GVC trade) are constructed by recovering the $\boldsymbol{A}$ matrix from the raw data. We follow the steps laid out by Aslam and others (2015) and used in IMF (2023) for this procedure. Specifically, we first rearrange equation (1) such that $\boldsymbol{X} = \boldsymbol{BY}$, where

$$\boldsymbol{B} = (\boldsymbol{I} - \boldsymbol{A})^{-1}$$

is the Leontief inverse matrix. Each element of the B matrix shows the total output required directly and indirectly to produce one unit of goods for final demand, $\boldsymbol{Y}$. Then $\boldsymbol{A}$ is recovered by using the $\boldsymbol{T}$ matrix of intermediate goods demand and the $\boldsymbol{X}$ matrix of gross output using the definition of $\boldsymbol{T} = \boldsymbol{AX}$ and element by element division of the $\boldsymbol{T}$ and $\boldsymbol{X}$ matrices:

$$\boldsymbol{A} = \boldsymbol{T} \oslash \begin{bmatrix} \boldsymbol{X}' \\ \dots \\ \boldsymbol{X}' \end{bmatrix}_{cs \times 1}$$

Finally, we calculate the foreign value added and domestic value added by recovering the matrix of value-added shares, $\widehat{\boldsymbol{V}}$, with our $\boldsymbol{A}$ matrix, as follows:

$$\widehat{\boldsymbol{V}} = \boldsymbol{I}_{cs \times cs} - diag\left(\sum_{i}^{cs} A_{i1} \dots \sum_{i}^{cs} A_{iCS}\right)$$

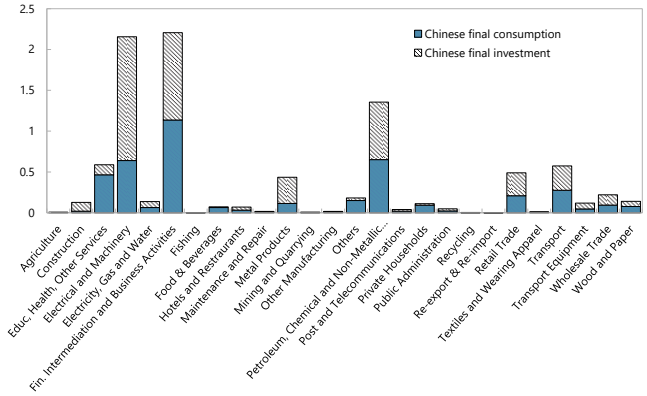
where $\boldsymbol{I}$ is an identity matrix. See Aslam and others (2017) for more details on this derivation. Together, the $\widehat{\boldsymbol{V}}\boldsymbol{B}$ matrix is the value-added shares matrix, meaning it contains all the information of value-added production by source that is embedded in the input-output table. Thus, to recover the value-added content from a source country in the final demand of a destination country we simply multiply $\widehat{\boldsymbol{V}}\boldsymbol{B}$ matrix with final demand matrix, $\boldsymbol{Y}$:

$$\textbf{Total value added} = \widehat{\boldsymbol{V}}\boldsymbol{BY} = \widehat{\boldsymbol{V}}(\boldsymbol{1} - \boldsymbol{A})^{-1}\boldsymbol{Y} \qquad (2)$$

Because we are interested in final consumption and investment demand in China, we assume all other blocks of the $\boldsymbol{Y}$ matrix except those corresponding to columns for China are equal to zero, and in the final $\widehat{\boldsymbol{V}}\boldsymbol{BY}$ matrix in (2) we extract the rows that correspond to goods whose value added originates in Singapore. This gives us Singapore's value added that is ultimately absorbed by China (even if it also passes through third countries).

Figure 4. Singapore: VA Embedded in Chinese Final Demand

(percentage points, share of Singapore total value added)



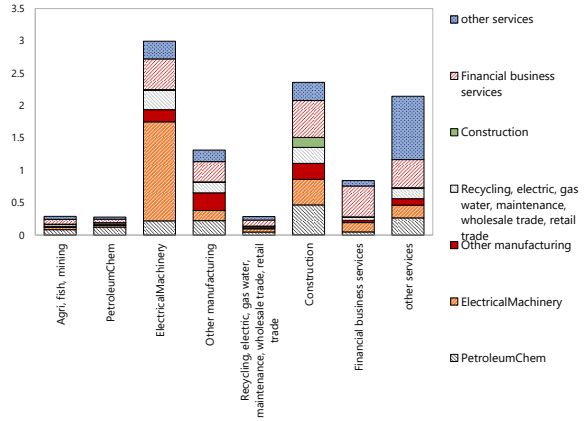
Source: Eora Global Supply Chain Database; Aslam and others (2017); and IMF staff calculations.

6. We find that Singapore's value added that is ultimately absorbed in China is highly concentrated in a few industries. Our analysis shows that Singapore's value added that is ultimately absorbed in China as final consumption and investment significantly increased over time to 9 percent of Singapore's total value added (see paragraph 3 and Figure 3).[2] We then decompose this value across the 26 origin sectors in Singapore and find that the financial intermediation and business services, electrical and machinery manufacturing, and petroleum and chemicals industries account for about 60 percent of Singapore's value added that is ultimately absorbed by China (Figure 4, or 5.7 percentage points of the 9 percent of value added absorbed by China). In the business and financial services and in the petroleum, chemical and non-metallic mineral sectors, approximately half the value added goes to Chinese final consumption (both private and public) and half comes from Chinese final investment demand. In the electrical and machinery manufacturing sector, this demand comes primarily from Chinese final investment demand.

7. Chinese demand for Singaporean goods and services is also highly concentrated. Singapore's exports to China are absorbed in three main sectors in China—electrical and machinery equipment, construction, and financial and business services (Figure 5). Except for construction, a large share of the value added from Singapore absorbed in China remains within the same sector.

Figure 5. Singapore: China's Sectoral Absorption of Singapore's Value Added

(percent of Singapore value added)



Source: EORA Global Supply Chain Database, Aslam and others (2017), and IMF staff calculations.

Note: The sectors on the x-axis represents destination sectors in China, the columns as indicated by the legend represent the origin sectors in Singapore. The 26 sectors shown in Figure 11 are aggregated for easier exposition. The "other services" category includes hotels and restaurants, transport, post and telecommunications, public administration, education and health, private households, other services, and the re-export and re-import sectors. All other sector groups are as labelled.

8. We construct a hypothetical scenario where Chinese final consumption and investment demand decline by 10 percent and examine the sectoral impact in Singapore. Since the global input-output tables allow us to examine both the flow of value added across countries and where value added created in one country is ultimately absorbed, we can also use the data to see how a decline in demand would be allocated across countries and sectors. We construct a hypothetical scenario where there is a 10 percent reduction in both Chinese final consumption and final investment demand across all country-sectors origins, and look separately at the impact of each decline. We use an approach similar to Los and others (2016), but

[2] Note that while total value added in the global input-output tables is theoretically equivalent to GDP, in practice there is a degree of error in aggregating data to generate the tables and thus the two measures do not match exactly. In the case of Singapore, value added calculated from the EORA input-output tables ranges from 61 to 128 percent of actual GDP over the 1990-2022 period, with an average value of 91 percent of actual GDP. The correlation between the two series is 94 percent. We use the ratio of value added absorbed by China to total value added reported in the input-output table, rather than actual GDP, for consistency purposes.

rather than assigning the entire Chinese intermediate and final demand blocks of the $\boldsymbol{Y}$ and $\boldsymbol{T}$ matrices values of zero (as the authors do), we instead decrease their value by 10 percent. We call the intermediate goods demand and final demand matrices with these hypothetical values $\boldsymbol{Y}^*$ and $\boldsymbol{T}^*$, respectively. We then calculate the corresponding hypothetical value added originating in Singapore that is absorbed in China in a similar way to equation (2):

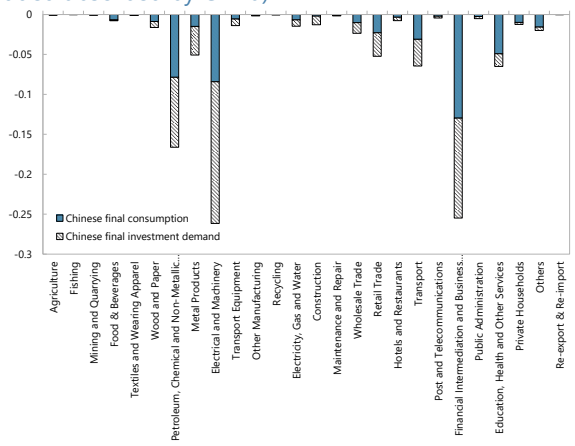
$$\boldsymbol{Total\ value\ added}^* = \hat{\boldsymbol{V}}(\mathbf{1} - \boldsymbol{A}^*)^{-1}\boldsymbol{Y}^* \qquad (3)$$

Because we are still only interested in final consumption and investment demand in China, we assume all other blocks of the $\boldsymbol{Y}$ matrix except those corresponding columns for China are equal to zero, and in the final $\hat{\boldsymbol{V}}\boldsymbol{B}\boldsymbol{Y}$ matrix in (3) we extract the rows that correspond to goods whose value added originates in Singapore—as we did in equation (2). The difference between equations (3) and (2) is then the changes in value added originating from Singapore that is absorbed in Chinese final demand.

9. Results show that the source of the slowdown in China is important for spillover effects. Figure 6 shows the results of this exercise, separately for the decline in Chinese consumption and investment.

Figure 6. Singapore: Impact of a 10 Percent Decline in Chinese Final Demand

(percent point difference in share of Singapore's value added absorbed by China)



Source: EORA Global Supply Chain Database; Aslam and others (2017); and IMF staff calculations.

- The main sectors impacted—both by the decline in consumption and investment—are those who are initially most exposed to Chinese demand, that is the petroleum, electrical and machinery, and financial intermediation sectors. We calculate that the value added absorbed by Chinese final consumption and investment demand would decline by 0.15, 0.25, and 0.25 percentage points in each of these three sectors, respectively. The total decline across all sectors is equal to 1.1 percentage points.

- The source of the slowdown in China is also important. If it is a slowdown in final consumption, then those sectors in Singapore likely to see a bigger impact relative to an investment decline are services and household goods (food, clothing, textiles, education etc.). At the same time, these sectors represent less than half of Singapore's value added exported to China.

- Note that this exercise does not consider any behavioral response to the slowdown in China. On the upside, there would likely be some reorienting of exports to alternative destination that would offset the calculated decline. On the downside, the slowdown in China would translate into greater fragmentation in GVCs and lower demand for other goods and services that cannot be captured by the static input-output tables.

C. Aggregate Impact of China Growth Shock

10. This section analyzes the spillovers from China's growth slowdown to ASEAN economies using aggregate cross-country data. After analyzing the sectoral linkages and their implication for spillovers, we now turn to provide an empirical estimate of the potential magnitude of these spillovers at the aggregate level, exploring also potential heterogeneity across ASEAN economies based on the intensity of trade ties with China.

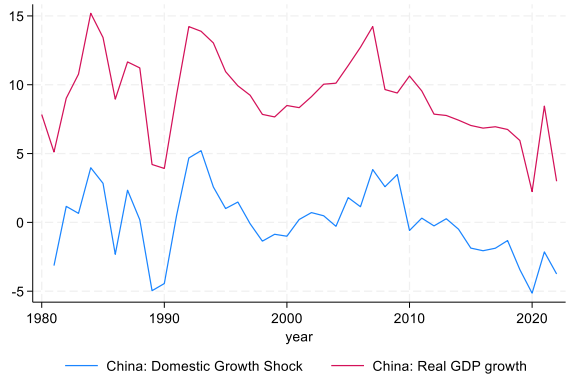
11. In order to estimate the impact of Chinese growth on Singapore, exogenous domestic growth surprises must be first identified. Isolating exogenous domestic growth shocks in China ensures that in the second step of the analysis, where spillovers from these shocks are estimated, we are not capturing confounding effects (for instance global factors that would affect all countries simultaneously) but rather the change in China's domestic growth alone. The methodology to identify domestically originated growth shocks in China follows Ahmed et al. (2022) by estimating the following regression:

$$\Delta \log Y_t = \beta_0 + \beta_1 X_t + \vartheta_t^{CHN} \qquad (4)$$

where $\Delta \log Y$ is the first difference of the logarithm of China's real GDP, sourced from the World Development Indicators (WDI). *X* is a vector of global factors including the change in the logarithm of global oil price, global metal price, the US long term bond yield and the real GDP growth of the G7 economies. These control variables are included contemporaneously following Ahmed et al. (2022). The US long term (10 years) bond yield is taken from the Federal Reserve Bank while the rest of the control variables are sourced from the IMF World Economic Outlook (WEO). ϑ_t^{CHN}—the residual of the regression—is then the China domestically originated growth shock. The intuition is that equation (4) purges the changes in Chinese real GDP that are driven by global factors, and isolates changes in Chinese GDP that depend only on domestic factors. This approach is also similar to Furceri et al (2017), although we focus on some specific global factors here.[3] The approach, while simple, could over-estimate the growth shock if the specification (4) omits key global variables that are uncorrelated with the ones included. This is, however, unlikely given that growth for G7 countries is included among our controls. On the other hand, this could

Figure 7. Singapore: China Growth Shock

(percentage point)



Source: World Economic Outlook and IMF staff calculations.
Notes: The Domestic growth shock (in blue) is obtained from Equation (1).

[3] Ahmed et al. (2022) also include in their VAR analysis the VIX, Emerging Market Bond Index, and growth of global imports excluding Asian EMs. We do not include these variables given limited data availability, which would severely reduce our sample size as we use annual data. We obtained similar shock series in robustness checks using a sample excluding the pandemic period.

underestimate the domestic component if changes in China's real GDP are also a driver of our control variables. With that caveat, the China-domestic growth shocks estimated by equation (4) are presented in Figure 7.

12. The impact of China's growth shock on ASEAN countries' trend growth is then estimated using the local projection framework. Our empirical approach includes the 10 ASEAN economies over the period 1990-2019 and estimates the following two models, based on the local projection framework developed by Jordà (2005):

$$Y_{ct+h} - Y_{ct-1} = \beta^h \vartheta_t^{CHN} + \sum_{j=0}^{5} \theta_j^h Z_{ct-j} + \alpha_c + \xi_{ct+h} \quad (5)$$

$$Y_{ct+h} - Y_{ct-1} = \beta^h \vartheta_t^{CHN} + \gamma^h (\vartheta_t^{CHN} \times G_{ct}) + \sum_{j=0}^{5} \theta_j^h Z_{ct-j} + \alpha_c + \xi_{ct+h} \quad (6)$$

where Y_{ct} is the logarithm of the trend GDP of country *c* in year *t*, ϑ_t^{CHN} is the China-specific or China-domestic growth shock, Z_{ct} is a set of control variables including lags of China-specific growth shocks, G_{ct} , lags of trend GDP and lags of trade openness.[4] α_c represents country fixed effects that control for unobserved country characteristics which do not vary over time. G_{ct} in equation (6) captures whether a country belongs to the high or low trade linkage group based on the sample median value. Countries with high (low) trade linkage are above (below) the sample median. Our specification in equation (6) follows the semi-parametric approach of Cloyne et al. (2023), providing a flexible way to estimate the impact of the China growth shock without any assumption about the functional form. The horizon, *h,* is up to five years. Equation (5) estimates the magnitude of the average growth spillovers to ASEAN country's trend growth. Equation (6) estimates the same spillover but conditioning on the exposure to China through trade linkages. The variable of interest is trend growth, rather than actual growth, in order to capture the structural or long-term impact of a slowdown in China on ASEAN countries.[5] The local projection approach offers several advantages, including robustness to misspecifications. Montiel Olea and Plagborg-Møller (2021) show that local projection inference is both simpler and more robust than standard autoregressive inference, whose validity is known to depend sensitively on the persistence of the data and on the length of the horizon.[6]

13. We find a statistically significant spillover from a shock to China's domestic growth on average trend growth in ASEAN economies. Figure 8 shows that a 1 percentage point decline in China's domestic growth could lead to an equal cumulative decline (about 1 percentage point) of

[4] We obtain the trend GDP series based on HP filter applied to real GDP series. Trade openness data defined as total trade as share of GDP is taken from the World Development Indicators.

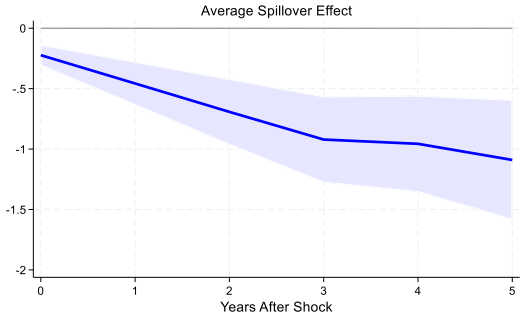
[5] Note however that our idiosyncratic growth shocks from China potentially capture both structural and short-term dynamics. Using trend growth and a dynamic framework allows nevertheless to provide an assessment of the impact of these shocks on medium to long-term growth in ASEAN economies.

[6] Note however that given our relatively short time dimension (with 30 years), the impulse responses could be biased especially over the longer horizon (Herbst and Johannsen, 2024). The issue could be mitigated by our short horizon of projection.

trend growth on average in ASEAN countries after five years, this is equivalent to about 0.2 percent per year. This estimate is within the range estimated by Dizioli et al (2016), who estimated an elasticity of Chinese growth on ASEAN-5 countries of about 0.2 percent over the period 1981Q1 to 2013Q1 using a GVAR model.

Figure 8. Singapore: Average Spillover of China's Growth on ASEAN Countries Trend Growth

(percentage point)

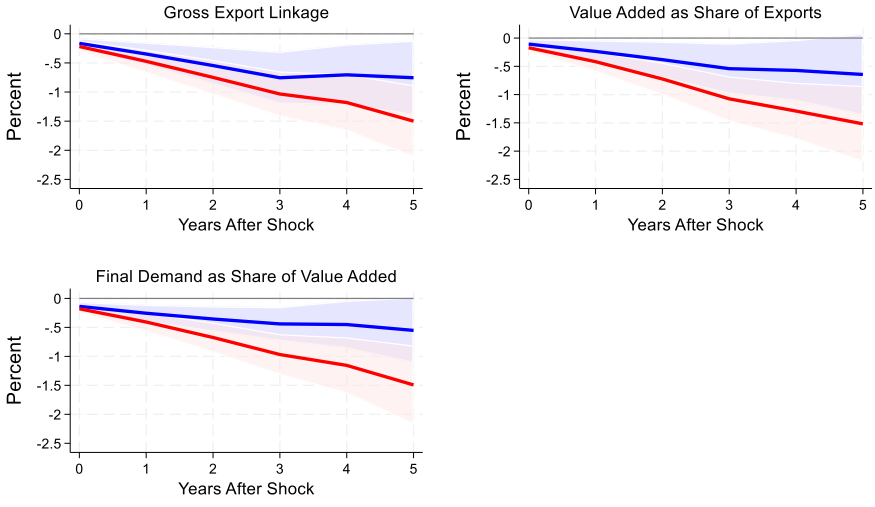


Source: IMF staff calculations.

Note: This chat shows the average impact of a 1 percent reduction in Chinese GDP shock on trend output growth in ASEAN countries. 90 percent confidence interval from Kraay and Driscoll standard errors in shaded areas. Marginal Impact is in percent. China shock is identified based on equation (1).

14. Our results also show that the magnitude of the spillovers is driven by strong trade linkages. Figure 9 shows larger spillovers for countries with stronger trade ties with China, either measured through gross trade or in value added terms. More specifically, the results show that the spillover is twice as large for countries with a stronger trade linkage with China. This is consistent with previous studies which have shown that the trade channel is the main channel of transmission of growth spillovers from China (Duval et al., 2014; Furceri et al, 2017, Copestake et al, 2023). However, for Singapore, the more relevant channel appears to be related to its relative dependence on final demand from China in value-added terms (as implied in Figure 3). More specifically, the estimates imply a cumulative impact of 2.1 percentage points over five years in Singapore, compared to 1.4 percentage points for the average ASEAN country in the sample over the period, given its dependence on Chinese final demand (Figure 10).

Figure 9. Singapore: The Trade Channel of Growth Spillovers from China to ASEAN Countries



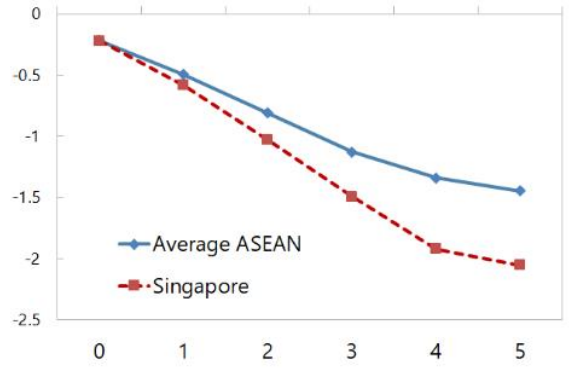
Source: IMF staff calculations.

Notes: This chart shows the impact of 1 percent reduction in Chinese GDP domestic growth shock on trend output growth in ASEAN countries. The red (blue) lines show the marginal impact for ASEAN countries with high (low) gross trade of value-added linkage with China. Gross export linkage is obtained as exports to China in share of total Exports. We calculate value added linkage in two ways, i) as the share of value-added exports to China in total exports and ii) the share of final demand from China in total value added. 90 percent confidence interval from Kraay and Driscoll standard errors in shaded areas. Marginal Impact is in percent.

Figure 10. Singapore: Dependence on Final Demand from China and Growth Spillovers

(Percentage point, marginal effect on trend output)

Sources: Eora Global Supply Chain Database; and IMF staff calculations.



urces: Eora Global Supply Chain Database IMF Staff Calculations

Notes: The coefficient estimates are obtained from a specification similar to Equation (6), however we interact the China growth shock with the level of final demand from China in ASEAN countries. We then calculate Singapore-specific marginal impact by multiplying the coefficient by the average final demand in value added over the period (1990-2019).

15. We find that growth spillovers from China to ASEAN countries is likely to be driven by the impact on investment and to some extent employment. In a simplified Cobb-Douglas production function approach, output growth can be written as:

$$g_y = g_{TFP} + (1-\alpha)g_K + \alpha g_L$$

where, g_{TFP} is total factor productivity (TFP) growth, g_K is capital growth, g_L is labor growth, and α is labor income share. We take data on TFP, capital stock, and employment (both number of persons employed, and average number of hours worked) from the Penn World Tables and estimate how growth spillovers from China affect these determinants of output. Our estimates, using a specification similar to the one in equation (5), but instead using labor, capital, and TFP as dependent variables, are shown in Figure 11. The results show that domestic growth shocks from China are likely to impact trend output in ASEAN economies first through their impact on capital stock and, in a more moderate way, through their impact on employment. We find that a 1 percent decline in the China domestic growth shock could decrease capital stock in ASEAN economies cumulatively by 1 percentage point over 4 years before moderating to about 0.8 percentage points in the fifth year. The impact is about 0.5 percentage points cumulatively over five years for employment. We find no meaningful impact on hours worked and on TFP. Overall, our results imply that growth spillovers from China to trend output in ASEAN economies are likely to be particularly strong through the impact on investment. Indeed, expectations about the growth prospects of an important trade partner such as China is likely to affect firms' decision to invest in their productive capacity, which would ultimately translate into trend output. Macroeconomic model simulation in the next section looks in more detail at this channel.

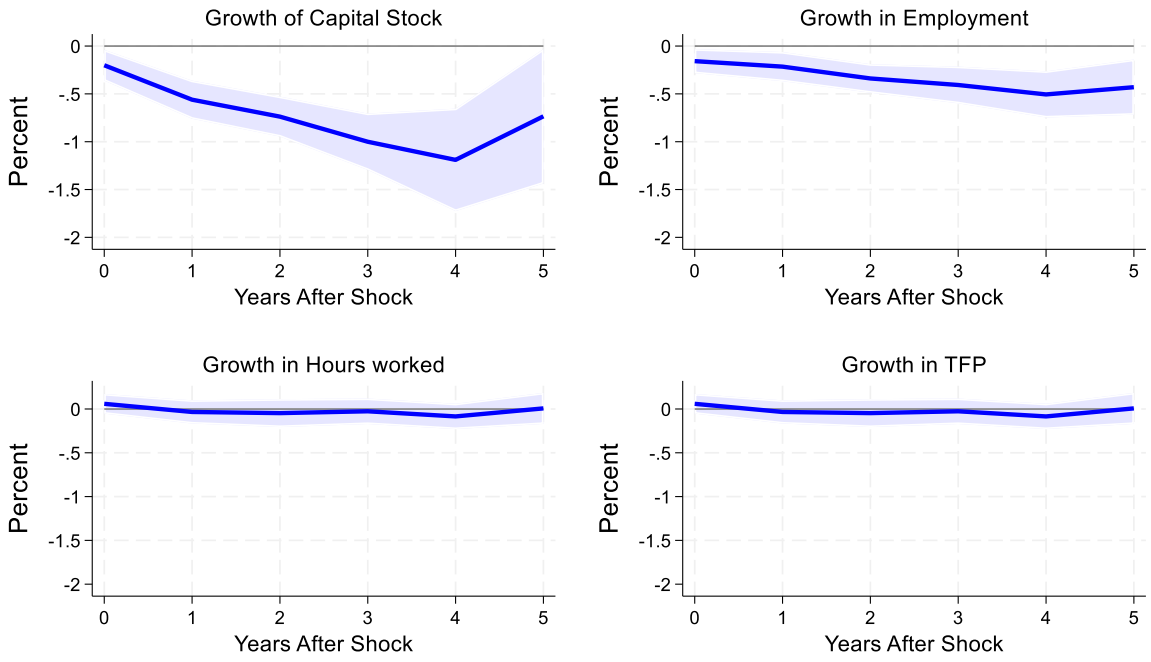
16. Our finding on the size of the spillovers is robust to using an alternative measure of the size of the China-specific growth shock. In an alternative approach, we estimate the China-specific growth shock, following Furceri et al. (2017) as follows:

$$\Delta \log Y_{Ct} = \beta_C + \tau_t + \varepsilon_{ct} \qquad (7)$$

where $\Delta \log Y_{Ct}$ is the change in the log of real GDP in country *c* at time *t*; β_C are country fixed effects; and τ_t are time fixed effects. We estimate this panel specification for China and all ASEAN countries in the sample and obtain ε_{ct} for *c*=China, as the China-specific growth shock. While Figure 12 shows that the baseline shocks were potentially under-estimating China specific growth, the results from the estimated spillovers reported in Figure 13 are very similar to our baseline results. Specifically, we find that, on average, a 1 percent increase in China's growth could lead to persistent spillovers to growth in ASEAN, resulting in a cumulative increase of about 0.8 percentage points over five years. This translates to an average annual growth impact of 0.16 percent (close to the 0.2 percent in our baseline estimation).

Figure 11. Singapore: Average Growth Spillover from China on ASEAN Economies Production Inputs

(Percentage point marginal effect)



Source: IMF staff calculations.

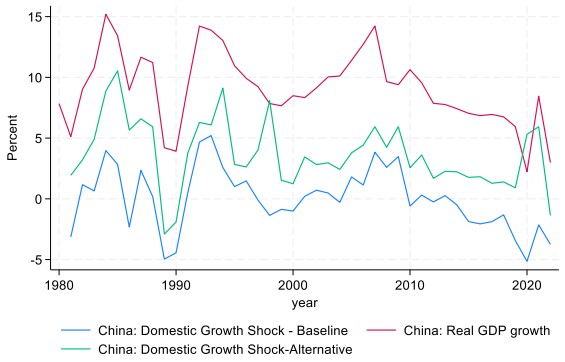
Notes: This chart shows the impact of 1 percentage point reduction in Chinese GDP domestic growth shock on inputs (capital, labor and TFP) in ASEAN countries. 90 percent confidence interval from Kraay and Driscoll standard errors in shaded areas. Marginal Impact is in percent.

D. A General Equilibrium Analysis of Spillovers from China's Growth to Southeast Asia

17. A general equilibrium framework can facilitate studying the spillovers from shocks in an interconnected world. This section uses the IMF's Global Integrated Monetary and Fiscal model (GIMF) augmented with GVCs to analyze the sensitivity of growth in Southeast Asia to growth shocks in China.[7] GIMF is IMF's multi-regional micro-founded dynamic stochastic general equilibrium (DSGE) model. In the model, firms produce two types of intermediate goods, tradeable or non-tradable, with the former consumed domestically and exported. Final goods are an inelastic combination of tradeable and non-tradeable goods. The model has 10 regions, including the United States, EU and Switzerland, other advanced economies, China, India, Indonesia, Japan, South Korea, other Southeast Asia (which includes Singapore), and the rest of the world.[8] Bilateral trade between each region is tracked.

Figure 12. Singapore: Alternative China Growth Shock

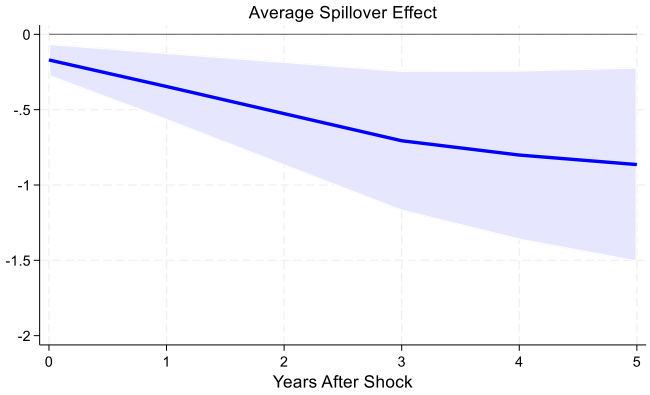
(percentage point)



Source: IMF World Economic Outlook; and IMF staff calculations.

Figure 13. Singapore: Robustness Check – Average Spillover from China Growth on ASEAN Trend Growth

(percentage point)



Source: IMF staff calculations.
Notes: This chat shows the average impact of a 1 percent increase in Chinese GDP shock on trend output growth in ASEAN countries. 90 percent confidence interval from Kraay and Driscoll standard errors in shaded areas. Marginal Impact is in percent. China shock is identified based on equation (4).

18. GVCs lead to a greater complexity in the trade linkages between countries and are accounted for in the GIMF model. To account for the complex trade interlinkages, as detailed in Carton and Muir (forthcoming), the GIMF model is augmented with GVCs. This extension disaggregates the tradeable goods into non-GVC tradable goods and GVC tradable goods. GVC goods can be used domestically as intermediate goods to produce other GVC goods, or they can be exported. Domestically produced GVC goods can also be combined with non-GVC tradeable goods to form an aggregate tradable intermediate goods bundle. The final goods produced domestically are a combination of non-tradeable and tradeable intermediate goods. If traded, the GVC goods can

[7] The exercise draws on IMF (2023) and Cerdeiro et al. (forthcoming).

[8] Other Southeast Asia comprises Brunei, Cambodia, Hong Kong SAR, Lao PDR, Malaysia, Myanmar, Philippines, Singapore, Thailand, and Vietnam. The version of the model used for this study does not disaggregate these countries, consequently masking the heterogeneity in their direct and indirect linkages to China.

again be used as intermediates to produce additional GVC goods or as final products. Thus, the extended GIMF model with GVCs can capture the complex linkages of non-tradable, non-GVC tradable, and GVC tradable production sectors, within and across countries, including through round-about trade.

19. The model is calibrated to match data that shows Southeast Asia is one of the most open regions in the world. Each region in the model is calibrated using OECD Inter-Country Input-Output Database of 2018. The model's steady-state calibration implies that Southeast Asia, excluding Indonesia, is one of the most open regions in the world, with exports and imports accounting for about 60 percent of GDP. Moreover, the region is also highly integrated in GVCs, with GVC tradable exports accounting for about 40 percent of aggregate exports and GVC tradable imports accounting for about 50 percent of aggregate imports. This implies that the region is very sensitive to shocks on GVC tradable sectors. While the model is calibrated to the broader Southeast Asia region, relative to the region, Singapore is more open and more deeply integrated in GVCs (recall Figure 2), including due to the large share of electrical and electronic products in its trade. This suggests that the simulated impact on the region from a downside scenario may underestimate the possible impact of the shock on Singapore. The calibration also assumes a relatively inelastic demand for goods in the GVC tradable sector, based on an assumption that the cross-sector and cross-region chains are more difficult to reconfigure. This means that for regions more dependent on GVC goods, shocks will lead to larger movements in prices.

20. Simulations suggest significant growth spillovers to Southeast Asia from productivity shocks in China. We consider a scenario in which China's aggregate annual productivity grows by about 1 percentage point higher relative to the baseline for 15 years.[9] Moreover, it is assumed that in China's GVC sector, productivity grows twice as fast as the productivity growth in the non-tradables sector to account for the large productivity gaps relative to the frontier in the GVC sector (IMF, 2023). The model can capture both the direct spillovers from trade linkages and productivity spillovers from China to other regions, with the latter accounting for both direct technological spillovers from the technology content in imports and indirect spillovers from dissemination of technological advances. Estimates are presented in Figure 14, which suggest that in this scenario where China's GDP level in the long-run increases by over 20 percent, GDP level in Southeast Asia (excluding Indonesia) increases by over 4 percent, relative to baseline. The increase in productivity in China results in greater investment (Figure 14, panel B) and capital stock, as the higher productivity implies a larger return to capital. Labor demand also increases, resulting in an increase in labor income and consumption (Figure 14, panel C), which supports a stronger growth in China. As China and Southeast Asia (excl. Indonesia) have strong trade ties, this leads to greater external demand that bolsters growth in the region.

21. Strong spillovers to growth in Southeast Asia can also be explained through indirect technological spillovers and the region's strong integration in GVCs. Indirect technological

[9] We show the impact from a positive shock in line with IMF (2023), Cerdeiro and others (forthcoming) , and Carton and Muir (forthcoming). One can imagine the impact of the equivalent negative shock to Chinese productivity as having results of the opposite sign, though due to the nature of the model they would not be exactly symmetric.

spillovers lead to an increase in productivity in Southeast Asia (excl. Indonesia), causing private investment and consumption in the region to grow as well. Such technological spillovers are larger for regions that have stronger trade ties with China and that are further away from the technological frontier, as is the case for Southeast Asia (excl. Indonesia) (see IMF, 2023). Additionally, increased productivity in the GVC sector in China leads to a decline in prices of GVC goods and an increase in their demand both domestically and abroad (Figure 14, panel E). Since Southeast Asia is also strongly integrated in GVCs, particularly with China, the region benefits from greater demand for GVC goods.

E. Summary

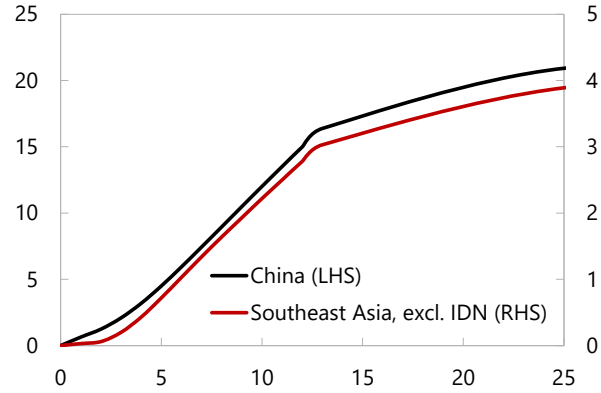
22. Growth in China is expected to moderate over the medium term. According to IMF staff projections, ageing population and slowing productivity growth are projected to lower China's GDP growth to around 3.5 percent by 2028. This is expected to happen from a moderation in both investment and consumption.

23. We find that this slowdown will likely have important spillovers to ASEAN countries, including Singapore. We first take a detailed look at the sectoral exposure of Singapore's value added to China and find that those sectors most exposed to China (electrical and machinery, petrochemical, and financial intermediation) will likely account for much of the decline in production in the face of moderating Chinese growth. Using a local projection method to capture the dynamic impact of such a domestic growth shock, we estimate that a 1 percentage point decline in Chinese domestic growth will result in a cumulative decline of about 1 percentage point of trend growth on average in ASEAN countries after five years, which is equivalent to about 0.2 percentage points per year. Accounting for the particularly large exposure of Singapore to Chinese final demand (relative to other ASEAN countries) suggests the cumulative decline in Singapore's output could be as high as 2.1 percentage points over five years. The decline will come primarily from a drop in the growth of capital stock, and to a lesser extent from a decline in employment growth, while TFP growth is not expected to be significantly affected. A general equilibrium model analysis provides further evidence of the spillover channels from China to Singapore and ASEAN peers, showing that productivity driven growth shocks in China may have a significant impact on the region's growth due to trade linkages and that these spillovers are amplified by the region's deep integration in GVCs.

Figure 14. Singapore: Spillovers from China's Growth to Southeast Asia

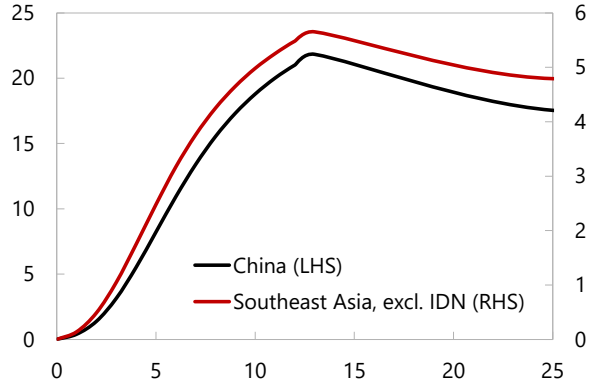
A. Real GDP

(percent deviation)



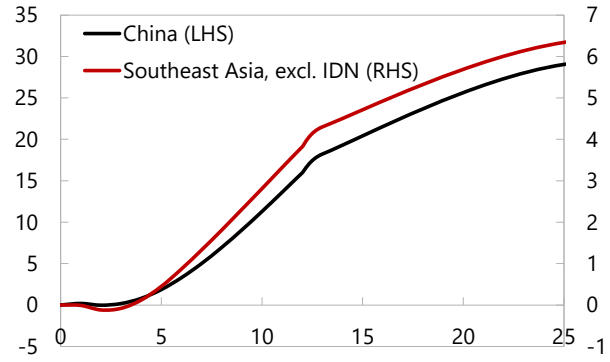
B. Real Private Investment

(percent deviation)



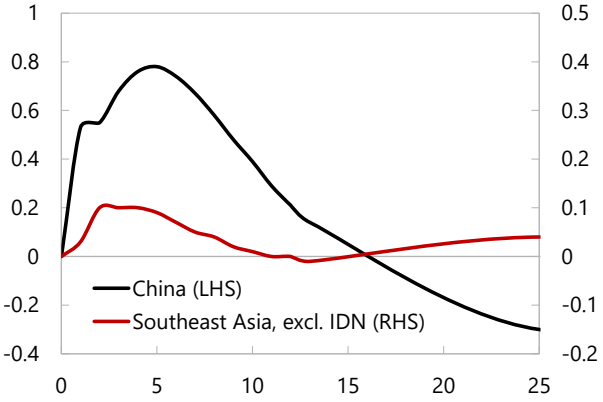
C. Real Household Consumption

(percent deviation)



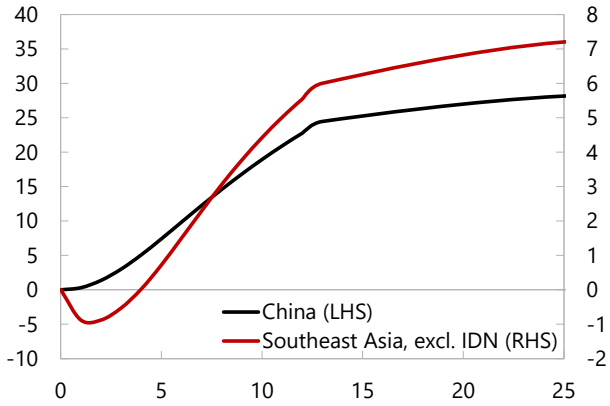
D. Trade Balance/GDP

(absolute deviation)



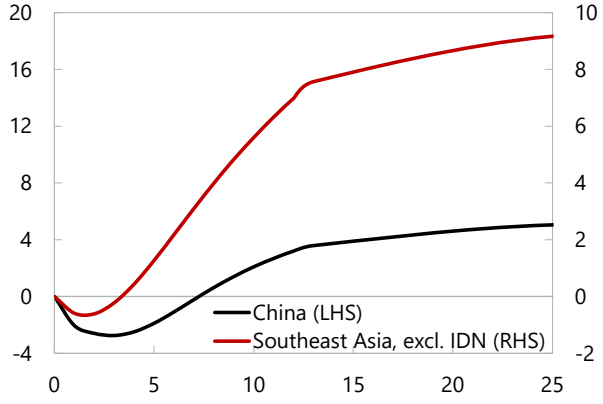
E. Real Exports of GVC Goods

(percent deviation)



F. Real Imports of GVC Goods

(percent deviation)



Source: IMF (2023) and IMF staff calculations.

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