

## Special Feature A

# The Impact Of Foreign Demand Shocks On The Singapore Economy: A Disaggregated Analysis

## Introduction

Previous issues of the *Review* have carried Special Features examining the impact of foreign GDP shocks on domestic macroeconomic variables, using the Monetary Model of Singapore (MMS) and the Satellite Model of Singapore (SMS).<sup>1</sup> In these earlier studies, a shock to foreign GDP was introduced through a change in the composite foreign GDP index, which served as a proxy for external demand. The simulation results from the models suggested that Singapore's GDP would fall by 1.2–1.3% points below baseline in the first year in response to a 1% fall in external demand, and recover after four to six quarters. CPI inflation would similarly decline relative to baseline, and reach its trough in the second year.

While an understanding of the impact of overall foreign demand shocks is crucial for monetary policymaking, the country composition of such shocks is likely to matter as well. Over the past two decades, China and Asia, in general, have become increasingly significant sources of intermediate and final demand for Singapore. This has resulted in a progressive reorientation of domestic exports towards the region, with the consequence that shocks originating thereof could have larger effects on Singapore's trade and output.

An indication of the relevance of country and region-specific shocks can be seen in their correlations with the growth of the Singapore economy. This association is depicted in Chart 1, which shows the dynamic correlations between Singapore's GDP growth rate and the growth rates in the US and China from 2000 to 2014.<sup>2</sup> Throughout the early to mid-2000s, the US' and China's GDP growth was about equally strongly correlated with Singapore's. However, after the Global Financial Crisis (GFC), Singapore's growth rate appears more highly correlated with China than the US, with a discernible downshift in the latter's correlation.

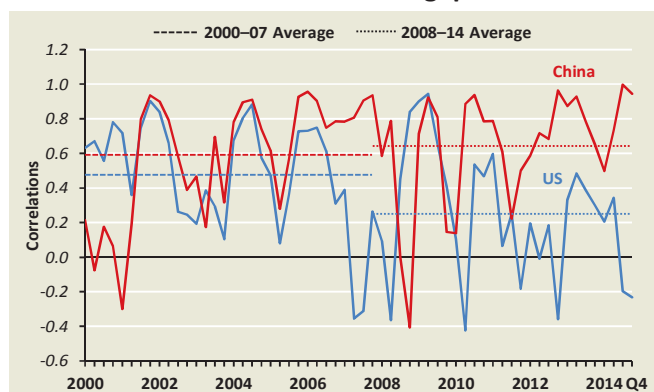
This Special Feature undertakes a disaggregated analysis of the impact of changes in Singapore's external demand on domestic growth and inflation outcomes. Such an analysis is necessary when growth in Singapore's major trading partners is uneven. In these instances, a composite foreign GDP variable may fail to fully capture the varying effects of changes in final demand in different export markets. Accordingly, this Feature will focus on country/region-specific shocks emanating from the large US, China and ASEAN-4 economies. However, before undertaking the analysis using the MMS, the next section provides an overview of how foreign GDP, from the perspective of Singapore, has evolved over the last 50 years.

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<sup>1</sup> See MAS (2007) and MAS (2011).

<sup>2</sup> The correlations are obtained using the Baba-Engle-Kraft-Kroner (BEKK) GARCH model applied to GDP growth rates.

**Chart 1**  
Dynamic Correlations of US and China  
GDP Growth with Singapore



## Historical Evolution Of Foreign Demand

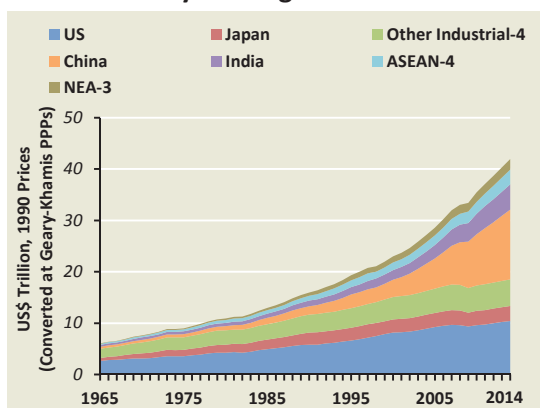
Over the past 50 years, Singapore's key trading partners saw robust GDP growth averaging 4.1% p.a. (on a GDP-weighted, PPP-adjusted basis), with their aggregate economic output rising by close to seven times between 1965 and 2014. (Chart 2) The expansion in external demand, however, was punctuated by several downturns—the oil price shocks in the mid- and late 1970s, the early 1980s recession in the developed countries, the Asian Financial Crisis (AFC) in 1997–98, and the GFC in 2008–09.

Alongside robust growth, the pattern of Singapore's trade flows has also evolved significantly over the years, reflecting changes in the relative importance of different markets and,

on the supply side, shifts in the composition of exports. In particular, Singapore transitioned from being an entrepôt port in the 1960s to a manufacturing base in the 1980s to 2000s, before increasingly taking on the role of a regional hub for modern services over the past decade.

At the time of Singapore's independence in 1965, the country's external demand was largely dependent on the trading activities of its ASEAN neighbours, given its role as an entrepôt. Over the next two decades, as Singapore rapidly industrialised and moved up the value-added ladder, it benefited from rising final demand in the advanced economies. (Chart 3) However, Singapore's exports were hit in the mid-1970s and

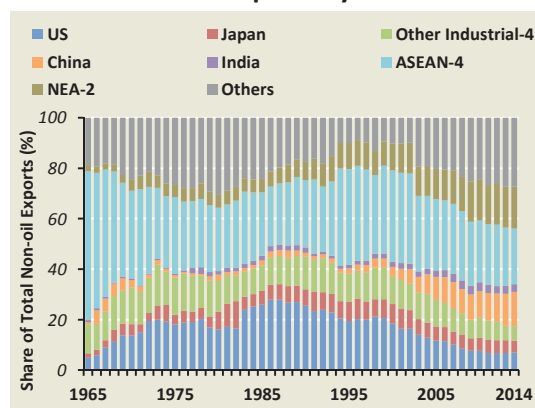
**Chart 2**  
Real GDP of Singapore's  
Key Trading Partners



Source: The Conference Board and EPG, MAS estimates

Note: "Other Industrial-4" refers to France, Germany, Netherlands and the UK; ASEAN-4 includes Indonesia, Malaysia, Thailand and the Philippines; and NEA-3 refers to Hong Kong, Korea and Taiwan.

**Chart 3**  
Composition of Singapore's  
Total Non-oil Exports by Destination



Source: UN Comtrade and EPG, MAS estimates

Note: NEA-2 refers to Hong Kong and Korea as data for Taiwan is unavailable for the full period.

again in the early 1980s when major trading partners such as the US and the UK went into recession, in part due to oil price shocks.

In the late 1980s and the first half of the 1990s, the ASEAN-4 countries started to boom, as they increasingly welcomed foreign investment and industrialised rapidly. Concurrently, Singapore moved into the production of higher value-added intermediate products, particularly electronics parts and components such as disk drives, as well as financial and other exportable services. Unfortunately, the region's growth came to a grinding halt when the AFC broke out in 1997. By 1999, however, confidence was largely restored and economic conditions had recovered.

In the new millennium, the economic centre of gravity veered sharply towards Asia, spurred by China's rise as a manufacturing base for global

firms, following its WTO accession in 2001. This gave rise to the build-up of extensive cross-border production networks that were centred on China as a final assembly centre. At the same time, Asia as a whole became an increasingly significant source of final demand for Singapore, as economic development engendered a virtuous cycle of rising employment and growing incomes.

Meanwhile, over the past two decades, growth in the advanced economies has slowed, reflecting Japan's 'lost decade' in the 1990s and sluggish growth in the 2000s, the 2008–09 GFC originating in the US, and the ongoing economic challenges in the Eurozone. Nonetheless, the progressive reorientation of Singapore's exports towards Asian demand has helped to maintain foreign GDP growth at close to the historical average of 4% p.a., except during the GFC period.

## The Impact Of Country And Regional Shocks

### Analytical Framework

The first part of this section develops a simple model that shows how a country's GDP growth is related to foreign GDP growth. This derivation uses the framework in Forbes and Abeysinghe (2005), in which a shock in one country affects other countries' GDP through trade linkages. The total output of an individual country can then be expressed as the sum of exports to its trading partners and domestic production:

$$Y_i = \sum_{j=1}^n X_{i,j} + A_i \quad (1)$$

where  $j \neq i$  indexes the country's export destinations. Writing this equation in terms of growth rates yields:

$$\frac{dY_i}{Y_i} = \frac{1}{Y_i} \left[ \sum_{j=1}^n dX_{i,j} + dA_i \right] \quad (2)$$

Next, exports from country  $i$  to country  $j$  can be represented as a reduced-form function of the output in country  $j$ :

$$X_{i,j} = X_{i,j}(Y_j) \quad (3)$$

Differentiating equation (3) and inserting the result into equation (2) yields:

$$\frac{dY_i}{Y_i} = \frac{X_i}{Y_i} \sum_{j=1}^n \left[ \eta_j \left( \frac{X_{i,j}}{X_i} \right) \left( \frac{dY_j}{Y_j} \right) \right] + \frac{dA_i}{Y_i} \quad (4)$$

where  $\eta_j = \left( \frac{\partial X_{i,j}}{\partial Y_j} \right) \left( \frac{Y_j}{X_{i,j}} \right)$  is the elasticity of country  $i$ 's exports to country  $j$ , with respect to country  $j$ 's income. Assuming that income elasticities are equal across countries, that is,  $\eta_j = \eta$ , the growth rate of output in country  $i$  is:

$$y_{i,t} = \alpha_i y_{i,t}^f + u_{i,t} \quad (5)$$

where  $\alpha_i = \eta \frac{X_i}{Y_i}$ ,  $y_{i,t}^f = \sum_{j=1}^n \left( \frac{X_{i,j,t}}{X_{i,t}} \right) y_{j,t}$  and  $u_{i,t}$  captures domestic demand and omitted influences. In equation (5), the variable  $y_{i,t}^f$  is an export-share weighted average of output growth in country  $i$ 's trading partners. By allowing the export shares to vary over time, the use of  $y_{i,t}^f$  accounts for changes in the relative importance of different markets and introduces a changing parameter structure into the model, thus stabilising estimates of the  $\alpha_i$  coefficients during times of major shocks.

### Recent Changes in Trade Elasticities

The practice of using an export-weighted foreign GDP variable to proxy for changes in a country's external demand has been adopted in macroeconomic models at many central banks. In the MMS, the  $y_{i,t}^f$  variable defined in equation (5) is allowed to enter into the equation describing manufacturing exports. Movements in this variable will, in turn, have an impact on domestic GDP growth and inflation, as discussed in the next section. The behavioural equation for manufacturing exports is given by:

$$\ln(EX_t) = \alpha + \beta_1 D_1 + \beta_2 D_2 + \beta_3 D_3 + \beta_4 TF + \sum_{i=0}^3 \phi_i y_{t-i}^f + \sum_{j=0}^1 \gamma_j \ln(RBB_{t-j}) + \varepsilon_t \quad (6)$$

where  $EX_t$  represents the gap between actual and short-run equilibrium exports, with the latter capturing, among other things, the effects of changes in relative trade prices.  $D_1, D_2$  and  $D_3$  are seasonal dummy variables;  $TF$  is a time trend;  $y_t^f$  is the quarterly real growth rate in composite foreign GDP; and  $RBB_t$  is the US book-to-bill ratio for semiconductors, included to account for the short-term effects of the global electronics cycle on Singapore's export volumes. The export weights in  $y_t^f$  are updated every year, and then converted into quarterly weights through interpolation.

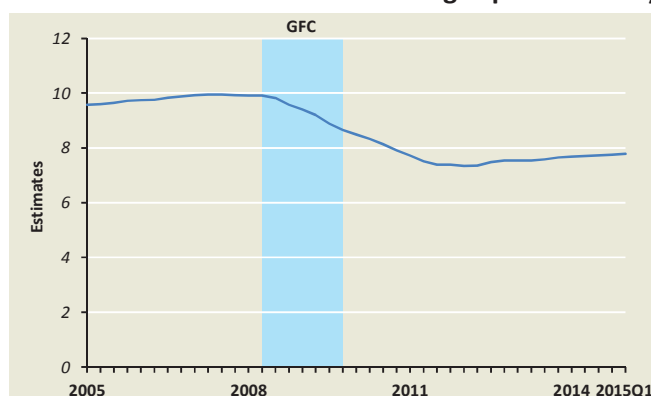
Chart 4 presents the recursive estimates of the sum of the coefficients on the  $y_t^f$  variable in equation (6), which can be interpreted as the elasticity of Singapore's manufacturing exports with respect to foreign GDP growth. This elasticity has been relatively stable in the pre-GFC period, and only experienced a downshift after the crisis. While not marked, the decline in the elasticity estimate and its subsequent levelling-off indicates that allowing for time-varying export shares in the computation of the composite foreign GDP index is insufficient to stabilise the estimated coefficients, thus hinting at a possible structural break in Singapore's trade relationships with the rest of the world.

To shed further light on the underlying causes of the decline in Singapore's export elasticity which could have stemmed from country/region-specific effects, a disaggregated specification of equation (6) is estimated, whereby external demand changes arising from Singapore's three major trading partners are considered separately<sup>3</sup>:

$$\begin{aligned} \ln(EX_t) = & \alpha + \beta_1 D_1 + \beta_2 D_2 + \beta_3 D_3 \\ & + \beta_4 TF + \sum_{i_1=0}^1 \phi_{i_1} US_{t-i_1} + \sum_{i_2=0}^1 \phi_{i_2} Chn_{t-i_2} \\ & + \sum_{i_3=0}^1 \phi_{i_3} ASEAN_{t-i_3} + \sum_{j=0}^1 \gamma_j \ln(RBB_{t-j}) + \varepsilon_t \end{aligned} \quad (7)$$

In the equation,  $US_t$ ,  $Chn_t$  and  $ASEAN_t$  represent the quarterly real GDP growth rates of the US, China and ASEAN-4 economies, respectively.

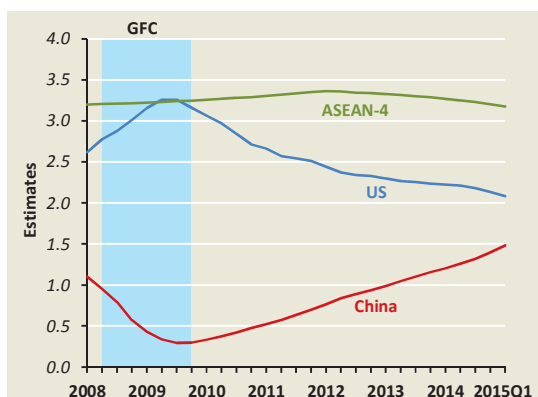
**Chart 4**  
Recursive Estimates of Manufacturing Export Elasticity\*



\* Equation estimation starts from Q1 1991. The estimate shown is a 12-quarter moving average of the total elasticity, i.e., the sum of the  $\phi_i$  coefficients in equation (6).

<sup>3</sup> Altogether, the US, China and ASEAN-4 countries contributed around two-thirds of overall foreign GDP growth over the period 1991–2014. The inclusion of more countries and regions is constrained by the presence of multicollinearity amongst foreign GDP variables.

**Chart 5**  
Recursive Estimates of Export Elasticities for Major Trading Partners\*

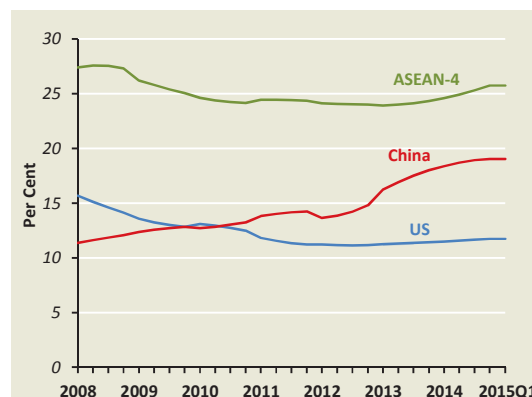


\* Equation estimation starts from Q1 1991. The estimated coefficients shown are the 12-quarter moving averages of the sum of the  $\phi_i$  coefficients in equation (7).

Chart 5 shows the recursive export elasticities by country/region, obtained by estimating equation (7) over Q1 1991 – Q1 2015. Putting aside the GFC period, the export elasticity for the US has declined steadily while that of China has risen sharply in recent years.<sup>4</sup> These trends appear to mirror shifts in the respective countries' non-oil domestic export (NODX) shares in Singapore's export basket. (Chart 6) Notably, China's share in Singapore's NODX rose substantially following the GFC, which more than offset the gentler decline in the US share. In comparison, the estimated elasticity of exports for ASEAN-4 has been broadly unchanged since 2008, consistent with the relative stability of their collective weight in Singapore's export basket.

Nonetheless, as demonstrated earlier, changes in export shares would be captured by corresponding movements in the  $y_t^f$  variable. The fall in the overall export elasticity in Chart 4 therefore suggests that, beyond changes in trade patterns, the export elasticity for the US could have undergone a structural downshift in the post-GFC period, while the corresponding

**Chart 6**  
Shares in Singapore's Non-oil Domestic Exports



Source: IE Singapore and EPG, MAS estimates

elasticity for China increased. In other words, the income elasticity  $\eta_j$  in equation (4) might well have differed across countries and over time, resulting in changes in the  $\alpha_i$  coefficients, even after shifts in export shares have been accounted for.

### Model Simulation Results

In this final section, an attempt is made to quantify the impact of a fall-off in external demand in the three countries/regions on the Singapore economy, by embedding the estimates of equation (7) into the MMS. In this scenario, a set of negative foreign demand shocks, in the form of a 1% fall in US, China and ASEAN-4 GDP levels, are individually simulated in the MMS.<sup>5</sup>

At the outset, it should be pointed out that these simulation exercises only account for the impact of external demand shocks on manufacturing exports and do not consider other transmission channels, such as financial links or trade in services. In the MMS, the initial shock causes an immediate decline in manufacturing export orders. In response, producers in the various

<sup>4</sup> During the GFC, Singapore's manufacturing exports actually became more elastic with respect to US income. This could have reflected the severe trade and financial dislocations caused by the initial GFC shock, which reverberated across the global economy rapidly and could not be fully explained by GDP changes alone. In particular, the synchronised downturn in the industrial countries and their collective impact on Singapore's exports could have been indirectly captured by the decline in US growth. Since these countries were not included in the estimation, this would have had the effect of boosting the US elasticity.

<sup>5</sup> The GDP for each region is assumed to fall 1% below baseline for four quarters, before recovering by 0.25% in each of the subsequent four quarters, and then reverting to the baseline by the end of the second year. When a demand shock is applied to any one country or region, GDP in the other two is kept unchanged.

sectors adjust their profit-maximising production and pricing decisions. As they reduce demand for domestic and imported intermediate inputs, further negative spillovers to the rest of the economy occur.

Table 1 shows the model simulation results, expressed as deviations from baseline outcomes. The first-year impact on Singapore's GDP from a US-specific external demand shock is around

−0.4%, compared to −0.3% from a China-specific shock. In contrast, a 1% downturn in the ASEAN-4 region would lead to a 0.6% drag on Singapore's GDP, the largest among the three regions examined. The effects of these foreign demand shocks on inflation would mostly materialise in the second year due to lags in the transmission mechanisms, and are more significant in the case of ASEAN-4.

**Table 1**  
**Impact of Foreign Demand Shocks on the Singapore Economy**  
**(via the Manufacturing Exports Channel)**  
(% Deviation in Levels)

Source of Shock	GDP Impact		CPI Impact	
	Year 1	Year 2	Year 1	Year 2
US	−0.4	−0.2	0.0	−0.3
China	−0.3	−0.1	0.0	−0.2
ASEAN-4	−0.6	−0.1	0.0	−0.5

## Conclusion

While the use of a composite foreign GDP variable facilitates the monitoring of global economic conditions on an aggregated basis, potentially divergent growth paths among Singapore's main trading partners highlight the need for a more disaggregated analysis of foreign demand shocks.

This Feature provides such an analysis by simulating the macroeconomic impact on Singapore of a downshift in demand in the US, China and ASEAN-4, using the MMS. The results provide some evidence to suggest that compositional effects at the country/region level have evolved over time.

The findings from this Feature also reaffirm Singapore's increasing dependence on China as an engine of growth. China's centrality within Asia's production network has grown significantly since the turn of the century, transforming it from a supplier of components and parts into a core production hub. Alongside this transition, Singapore's comparative advantage in intermediate goods exports has enabled the country to position itself favourably within regional supply chains, with China as the key node. Conversely, this development could also increase Singapore's vulnerability to an external demand shock from China.

## References

Forbes, K and Abeysinghe, T (2005), "Trade Linkages and Output-multiplier Effects: a Structural VAR Approach with a Focus on Asia", *Review of International Economics*, Vol. 13(2), pp. 356–375.

Monetary Authority of Singapore (2007), "Impact of a Foreign Demand Shock on the Singapore Economy—Perspectives from Two Macroeconometric Models", *Macroeconomic Review*, Vol. VI(2), pp. 58–71.

Monetary Authority of Singapore (2011), "An Overview of the Satellite Model of Singapore", *Macroeconomic Review*, Vol. X(2), pp. 68–76.