# Development Growth Models for Singapore and Malaysia: A Geweke Causality Analysis

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## Abstract

**Purpose** – Nearly five decades after undergoing a structural transformation and navigating several external shocks, both Singapore and Malaysia are now grappling with some crucial policy challenges that necessitate a course-correction in order to sustain their growth momentum, going forward. In light of the renewed interest in understanding the growth constraints faced by the two countries, this paper aims to empirically explore the drivers of economic growth in both Singapore and Malaysia, using data from 1975 to 2012.

**Design/Methodology/Approach –** The paper employs a novel empirical approach—the Geweke causality analysis—to investigate the causal drivers of economic growth in Singapore and Malaysia. Intuitively, the Geweke causality analysis helps us understand and measure the linear dependence and feedback between multiple time series variables. To that effect, we perform both a bi-variate as well as a multi-variate causality analysis.

**Findings –** The empirical results established using Geweke causality analysis suggest that Malaysia's new development trajectory should lie in rebalancing the economy toward greater domestic demand and building a robust services sector. The results also suggest that Singapore, on the other hand, should embrace a growth model that goes beyond relying heavily on foreign direct investment (FDI) as a source of economic growth as the linear dependence between FDI and real GDP growth appears to be weaker compared to the linear dependence between the remaining variables and the real GDP growth.

**Originality/Value –** While the traditional growth accounting framework provides useful insights at the aggregate level, there is a growing literature that discusses the importance of sectoral analysis to understand structural transformations in the economies which become important to sustain productivity growth in the long-run. This is immensely relevant in the case of Malaysia and Singapore, as well, especially with the changing policy focus in these countries to overcome structural growth issues. In light of this growing discussion on the importance of understanding the growth dynamics at the sectoral level, this paper presents new empirical evidence on the growth drivers in Singapore and Malaysia with a sectoral focus.

**Keywords:** Geweke causality, economic growth, Singapore, Malaysia, structural transformation.

**Paper type:** Research paper

*JEL Classification codes*: E2, O40, P5

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Both Malaysia and Singapore have been viewed as success stories in economic development and are widely hailed as role models for other developing countries to follow. While Singapore, with a Gross Domestic Product (GDP) per capita of US$55,182 in 2013, has moved to high income status, Malaysia, with a GDP per capita of US$10,538 (in 2013), has become a *bona fide* upper middle income country. A comparison of the macroeconomic performance of both the countries in terms of growth trajectories and inflationary environment since the mid–1960s reveals that Singapore has visibly outpaced Malaysia in both dimensions ever since it obtained its independence from Malaysia in 1965 (Figure 1).

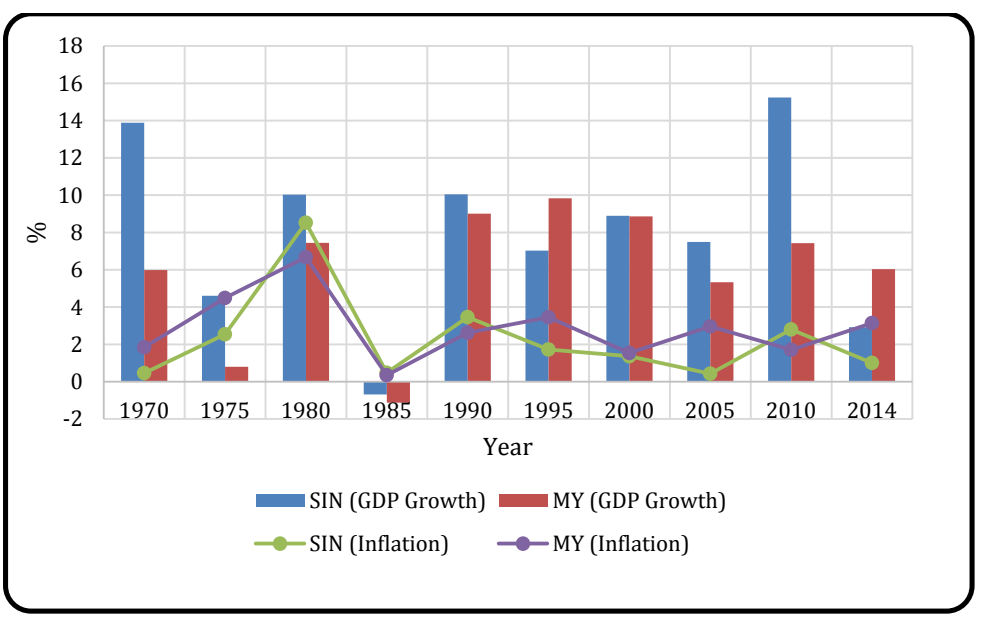


*Figure 1.* Growth and inflation in Singapore and Malaysia (1970–2014). Retrieved from the World Development Indicators, The World Bank (2015).

If there is one common denominator between the two countries, it is the fact that both of them have focused on developing world-class infrastructure and sound macroeconomic management on the one hand, while being plugged into the regional production networks, on the other. In particular, the two countries have benefitted from being part of the regional "flying geese pattern" of comparative advantage, whereby countries developed industries consistent with their comparative advantage based on their endowment structure (Akamatsu, 1962).[1] The model, which can essentially be understood as an international division of labor

based on a dynamic comparative advantage, has in fact remained one of the striking features of the broader East Asian growth and economic transformation story, as well. As the comparative advantages of the "lead goose" (Japan) cause the leader to shift away from labor-intensive production to more capital-intensive activities, the leader passes its low-productivity production to other follower countries aligned behind in the hierarchy, resembling a pattern of flying geese (Figure 2).[2] More generally, developed countries or regions move up the production value chain or industrial ladder towards high value-added activities.[3] The relocation of labor-intensive and low value-added manufacturing industries, as a phenomenon, stems from Adam Smith's theory of international division of labor and specialization, supplemented by foreign direct investment (FDI) (Tan, Yuan, Yoong, & Yang, 2015).

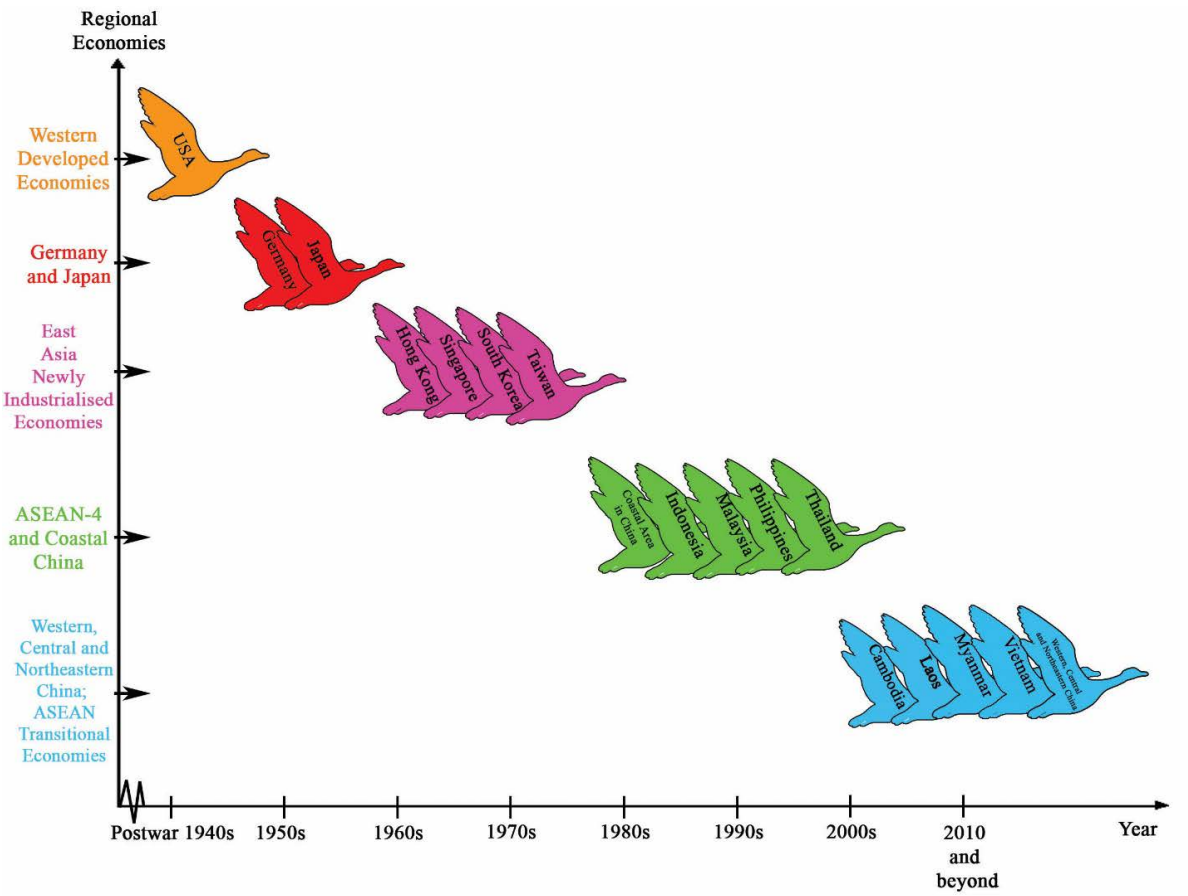


*Figure 2.* Flying geese model. Developed by the Asia Competitiveness Institute.

Nearly five decades after undergoing a structural transformation and navigating several external shocks like the Asian financial crisis in 1997–1998 and the global financial crisis in 2008–2009, both Singapore and Malaysia are now grappling with some crucial policy challenges that necessitate a course-correction in order to sustain their growth momentum, going forward. In particular, there is a growing recognition that Malaysia is now struggling to avoid falling into the much talked about "middle income trap" (Flaaen, Ghani, & Mishra, 2013; and Woo, 2011). For its part, Singapore is finding it somewhat difficult to ramp up stagnating labor productivity, especially among small and medium enterprises

(SMEs) along with concerns of growing income inequality (Tan, 2014; Tan & Tan, 2012; and Tan & Tan, 2014). In fact, the policy discourse in Singapore has been drifting towards the need for the city-state to adopt a holistic approach to economic growth and development. Such an approach must go beyond relying heavily on FDI as a key source of economic growth and instead focus on policies that aim at reviving internal demand. Enhancing investments in industrial, technological capabilities and, human resources in the country would be the key to enact such policies (Tan, 2014). Similarly, in Malaysia, the policy discussions have been focused on how to help the country with the development of a robust and strong services sector, alongside its manufacturing, which would facilitate the country's transition to a high-income status.

In light of the renewed interest in understanding the growth constraints faced by the two countries and the subsequent policy interest that the issue has generated, this paper aims to revisit the issue of drivers of economic growth in both Singapore and Malaysia. Specifically, the paper attempts to provide an empirical explanation for the sources of growth in Singapore and Malaysia at the sectoral level by identifying the key variables that ought to be the focus of policy in order to sustain the growth momentum. To do this, the paper employs a novel empirical approach—the Geweke causality analysis—to investigate the causal drivers of economic growth in both countries. Intuitively, Geweke causality analysis helps us to understand and measure the linear dependence and feedback between multiple time series variables. To that effect we perform both a bi-variate as well as multi-variate causality analysis.

The remainder of the paper is organized as follows. The next section presents an overview of the literature concerning the growth experiences and structural transformation of both Singapore and Malaysia, as well as some of the contemporary policy challenges faced by each of them. This discussion will be followed by the section that will inform the hypotheses to be tested in the paper. The following section will then outline a detailed exposition of the empirical methodology and the data used for the analysis. Then, the empirical results are discussed and, finally, the paper concludes with a brief discussion of the policy implications emanating from the analysis.

## Literature Review

The "state capitalist" nature of the East Asian growth model has been a topic of extensive discussion in the literature.[4] Characterized by a fine balance between an active state intervention and market dynamics, the region maintained a consistent and prolonged period of robust growth for the most part of the last four decades. The major phases in the sustained high growth era of East Asian economies was marked by the rise of Japan from the 1950s to the 1970s, with the next two decades witnessing the emergence of East Asia's four Newly Industrializing Economies (NIEs)—comprising Singapore, Hong Kong, South Korea, and Taiwan – on the back of robust manufacturing base. The NIEs were followed later by the near NIEs of Malaysia, Indonesia, and Thailand, as well as the Philippines.[5]

There is an established body of literature that tries to understand the Asian growth miracle and has remained a subject of intense discussion – see Felipe (1997, 2006) for a comprehensive review. As Gopalan and Rajan (2014) noted, the origins of this debate regarding the sources of economic growth in East Asia gained a lot of attention in the early 1990s with the much cited work of Young (1992) and Kim and Lau (1994). These papers provided empirical evidence that factor inputs (mainly capital) drove economic growth in some East Asian countries like Singapore and Hong Kong, as opposed to the growth being

driven by total factor productivity (TFP) that captures technological progress. This opened the floodgates for a plethora of research about whether growth in the region was driven by factor accumulation or by productivity and learning during the three decades beginning 1965.

Within Asia, Singapore and Malaysia have been the focus of several growth studies. Hu (2010), for instance, offers a comparison of the growth dynamics in Singapore and Malaysia by assessing the role of TFP in their economic growth between 1960 and 1990. The paper finds that the conventional arguments in the literature about the relative non-importance of TFP are rejected and that TFP has played a crucial role in the catching-up process.[6]

While the traditional growth accounting framework provides useful insights at the aggregate level, there is a growing literature that discusses the importance of sectoral analysis to understand structural transformations in the economies which become important to sustain productivity growth in the long-run (ADB, 2013; Cantore, Clara, & Saore, 2013; Memedovic & Lapadre, 2009; and Rodrik, 2013). This is immensely relevant in the case of Malaysia and Singapore, as well, especially with the changing policy focus in these countries to overcome structural growth issues. The most recent policy initiative in Malaysia, for instance, comes from the announcement of the new "Eleventh Malaysia Plan", which envisions achieving the "developed country" status by 2020, through various structural reforms, including the revitalization of the services sector's contribution to the economy's economic output.[7]

There is a small but growing empirical literature that has attempted to focus on understanding the importance of services and manufacturing sectors in driving the growth momentum in both Singapore and Malaysia, as well as the broader Asian region as a whole (Chandran & Krishnan, 2008; Clemes, Arifa, & Gani, 2003; Kamaruddin & Masron, 2010; Li, Michael, Clemes, & Gani, 2015; and Park & Shin, 2013). In general, as emphasized by Park and Shin (2012), the services sector in the Asia region remains largely underdeveloped but has immense potential to become a new engine of economic growth for developing Asia as a whole, which has traditionally banked on an export-oriented manufacturing model to propel growth. Empirically analyzing the prospects for the services sector as a growth driver, the paper finds that the services sector was already a significant contributor to the region's growth in the past (between 1970 and 1989) and that the prospects of the services sector propelling the future growth of the region are quite optimistic.

In light of this growing discussion on the importance of understanding the growth dynamics at the sectoral level, this paper will undertake an empirical investigation of the growth drivers in Singapore and Malaysia with a sectoral focus. In what follows, we will specifically focus on the structural transformation that Singapore and Malaysia underwent since the mid–1960s to date, and also highlight some of the policy challenges that the countries and the policymakers are confronting today. This would lead us to develop some testable hypotheses for our empirical analysis in the next section.

## *Growth Transformation of Singapore*

As Figure 1 clearly shows, Singapore grew at a growth rate of about 10 percent on average for the period between 1970 and 2010, with three significant exceptions that severely dented the economy owing to external shocks occurring in 1985 (oil shock), 1998 (Asian financial crisis), and 2009 (global financial crisis).

The initial two decades were largely the time that Singapore channeled its efforts to employ export-led industrialization and rapid capital accumulation as a primary economic strategy to foster its economic growth. The government's foremost policy objective was to promote growth by attracting FDI which was expected in turn to create employment, as well as to enhance the productive capacity of the economy (Vu, 2011).

There were two key strategic decisions that were the hallmark of Singapore's growth strategy. The first was to shift away from import-substitution policies in favor of export-led industrialization post-independence from Malaysia, and the second was to go after specific global multinational corporations (MNCs) to attract the much-needed FDI which would translate into the growth of its industrial sector. The growth transformation of Singapore really began when the government started seeing the fruits of these two key strategies, which in many ways defined the country's development approach for a long time. The world witnessed the rise of Singapore through the development of industrial land, infrastructure facilities, reformed and conducive labor laws, as well as investments in basic technical education relevant to industrialization (Menon, 2015; Rajan, 2003).

It is important to highlight that, by 1975, Singapore had established a substantial industrial base, with its manufacturing sector's share in GDP climbing to about 22 percent from around 14 percent or so in 1965. Singapore was compelled to move up the value chain towards more capital-intensive and skill-intensive activities. The restructuring and structural transformation occurred in the early 1980s when the focus shifted towards high-tech manufacturing and higher value-added services. Economic restructuring through the "New Industrial Revolution" helped the country to develop more capital- and skill-intensive industries (Saner, Yiu, & Gopinathan, 2014). The structural transformation that occurred during this phase was considered a development success as it helped in the creation of higher value-added sectors and jobs.

The final turnaround in Singapore's growth transformation occurred in 1985 when the country was hit by a severe economic downturn, which paved the way for a series of structural reforms in the 1990s. As Menon (2015) pointed out:

> In fact, the 1985 recession was a significant milestone in Singapore's development history… The most important outcomes from that period of review, which continued into the 1990s, were the structural reforms to: enhance wage flexibility in the labor market; tap more decisively into regional markets for trade and outward investment; step up the pace of industrial upgrading; promote innovation, enterprise, and entrepreneurship in the economy; and liberalize various services sectors such as finance, telecommunications, and utilities… In fact, the key story post-1985 recession up till the Global Financial Crisis of 2008 was the rise of modern services as a twin engine of growth alongside manufacturing.

Indeed, one of the highlights of Singapore's growth performance since the 1990s has been the dynamism of its services sector, as also reflected in the growing importance of the share of modern services in Singapore's GDP. Modern services (financial, business, communications, and entertainment services) had almost doubled from 16 percent in 1965 to just less than 30 percent in 2010 as a share of Singapore's output (Menon, 2015).[8]

While Singapore has rebounded from the global financial crisis and posted impressive growth rates in 2010 and 2011, since then there appears to have been a dip in the average

growth rates. Between 2011 and 2014, the average annual growth rate has been hovering around 4 percent, much less than the average 10 percent growth that it posted in 2010 and 2011. Among the various cyclical factors that one may associate with this slowdown, there are also structural concerns like lagging productivity, that Singapore appears to be facing, which need closer attention. Further, it has become imperative to recognize that as Singapore moves up the technological ladder the skill sets possessed by the local population need upgrading to suit the demands of higher value-added jobs. This implies that those with secondary or lower education may be becoming increasingly trapped in an 'economic underclass', underlining the importance of investments in education to strengthen human capital required for a knowledge-intensive economy, as well as to promote upward mobility and incomes (Tan, 2012).

## *Growth Transformation of Malaysia*

Malaysia, on the other hand, also witnessed strong sustained growth between 1970 and 2014, growing at an average annual rate of over 6 percent (Figure 1). Very similar to the case of Singapore – with the oil shocks in the mid-1980s, the Asian financial crisis, and the global financial crisis being the exceptions – the country has had a sustained growth performance overall through this period.

The Malaysian economy has also witnessed notable structural shifts during the last few decades that allowed the economy to transition into a middle-income country from a low-income country (Flaaen et al., 2013). From a country that was known to be a producer of primary products, its transformation into an economy with a robust industrial base occurred in the 1970s, which also happened to be the tipping point in the economic history of Malaysia. It was at this juncture that the country started actively promoting export-oriented manufacturing and FDI inflows into export-oriented firms (Yusof & Bhattasali, 2008).

In a nutshell, the Malaysian economic growth story can be understood as a classic structural transformation story of a largely agricultural economy to a more industrialized economy, supported by export-orientation and FDI inflows and now stuck in its attempt to migrate from its middle-income status. As Flaaen et al. (2013) noted:

> Like many other middle income economies, it is squeezed by the competition from low-wage economies on the one hand, and more innovative advanced economies on the other… (There is a) need for broad structural transformation; that is, moving to higher productivity production in both goods and services. (p. 23)

While Malaysia still remains a highly-open economy dependent on external demand, it is pertinent to note that domestic demand has increasingly become an important driver of economic growth in recent years (Bank Negara Malaysia, 2012). This has in turn triggered structural changes within the economy, enhancing stronger economic growth and employment creation in the domestic-oriented industries. As emphasized by Bank Negara Malaysia (2012), strong private consumption and resilient total investments have been enabling the economy to expand despite the weak export performance after the global financial crisis. Hence, the policy makers must pay more attention towards harnessing the internal demand by strengthening local manufacturing and services sectors.

It is important here to recognize that, although Malaysia has long relied on an outward-oriented model with FDI inflows providing the necessary technology and skills for the country to effectively participate in the global value chains, scaling up those value chains requires investments in strong local capacity building and investments in human capital. This underlines the need for the country to focus on enhancing high productivity and competitiveness.

Finally, it is important to recognize that although Malaysia managed to expand its tradable sector over the last few decades – which allowed it to become a sophisticated manufacturing exporter – it has lagged in terms of the development of its services sector. The empirical results furnished by Flaaen et al. (2013) further revealed that there are large gaps in the productivity between manufacturing and services in Malaysia, which have accelerated significantly in the recent years. This highlights the urgency for Malaysia to engage in another round of structural transformation, but one that is much broader that will allow them to reap higher productivity in both the goods and services sectors.

The foregoing discussion leaves us with some important points that can be the basis for developing some testable hypotheses. While there are a number of factors that could have driven economic growth at different stages, it is pivotal to recognize the structural constraints faced by these economies now. The policy priorities of the countries have to change accordingly, factoring in their respective growth constraints.

Given this background we attempt to identify empirically the key variables that Singapore and Malaysia should focus on that will help relieve their growth constraints, moving forward. We take into consideration the need for a balanced growth between manufacturing and services on the supply side, as well as the need to focus on promoting domestic consumption on the demand side and outline our hypotheses accordingly for both the countries in the next section.

## Hypotheses and Data

Based on the above discussion regarding the structural transformation of Singapore and Malaysia, we come up with the following set of hypotheses for both the countries, underscoring the importance of a particular set of variables that will be pivotal for both countries to sustain their growth momentum, moving forward.

### *Hypothesis for Singapore*

With regard to Singapore, we propose the following hypothesis: Private consumption, net FDI inflows, enhancement in services value added, and investment in education are the key driving forces for Singapore's trajectory towards an advanced, knowledge-based economy.

### *Variables and Data*

We will test the above hypothesis for Singapore with annual data between 1975 and 2012. FDI net inflows in current US$ and services value added in constant 2005 US$ were obtained from the World Bank's World Development Indicators database. Private consumption expenditure and government expenditure on education in local currency are from the Singapore Department of Statistics. All data were transformed to meet the stationary

requirement of the Geweke analysis. The list of variables, their notations and definitions are presented in Table 1.

Table 1
*Variables Used in Geweke Causality Analysis for Singapore*

| Variable | Notation | Definition |
|---|---|---|
| X | GGDP | Growth rate of real GDP (2005 US$) |
| Y1 | ΔPCE | Change in private consumption expenditure (local currency, 2010 market prices) |
| Y2 | ΔFDI | Change in FDI net inflows (current US$) |
| Y3 | ΔSVA | Change in real services value added (2005 US$) |
| Y4 | ΔGEE | Change in government expenditure on education (current local currency) |

*Note.* Authors' compilation.

### *Hypothesis for Malaysia*

For Malaysia to escape the middle income trap, we propose the following hypothesis: An expansion of household consumption and deepening of both manufacturing and services sector as reflected in increases in the domestic value added in both sectors would enhance the country's real GDP growth, thereby propelling it to the rank of high-income industrialized economies.

### *Variables and Data*

We will test the above hypothesis for Malaysia with annual data between 1975 and 2012. The data were obtained from the World Bank's World Development Indicators database and transformed to meet the stationary requirement of the Geweke analysis. The list of variables, their notations and definitions are presented in Table 2.

Table 2
*Variables Used in Geweke Causality Analysis for Malaysia*

| Variable | Notation | Definition |
|---|---|---|
| X | GGDP | Growth rate of real GDP (2005 US$) |
| Y1 | ΔHFC | Change in household final consumption (current local currency) |
| Y2 | ΔMVA | Change in real manufacturing value added (2005 US$) |
| Y3 | ΔSVA | Change in real services value added (2005 US$) |

*Note.* Authors' compilation.

## Research Methodology

The unidirectional causality analysis that is popularly employed in the literature does not investigate the degree of dependence or the extent of various kinds of feedback between different time series variables (Calderón & Liu, 2003). However, the method suggested by Geweke (1982) overcame this problem and helps to measure the linear dependence and feedback between multiple time series variables. In essence, the linear dependence is defined as "the sum of the measure of linear feedback from the first series to the second, linear feedback from the second to the first and instantaneous linear feedback" (Geweke, 1982). The direction of causality and the interplay of the variables can be examined in a more

detailed manner with a reduced form quantitative framework under the Geweke causality analysis.[9]

Even though Geweke causality analysis is used predominantly as a tool to identify causal relationships in the field of neuroscience, there have been some prominent applications of Geweke causality to macroeconomic issues, as well, in the literature. Some examples include Aizenman and Noy (2006), Calderón and Liu (2003), and Tan and Cheng (1995). Tan and Cheng (1995), for instance, employed Geweke's approach to examine the causal nexus of money, output, and prices in Malaysia. Calderón and Liu (2003) explored the direction of causality between financial development and economic growth. Aizenman and Noy (2006) investigated the two-way linkages between FDI and trade. It is worth emphasising that applying such a decomposition method a la Geweke, for understanding sectoral growth dynamics, is novel in the related literature.

Like Granger (1969) and Sims (1972), Geweke's causality analysis focused the attention on a wide-sense stationary, purely non-deterministic multiple time series $Z = \{z_t, t \text{ real}\}$. Therefore, the vector $z_t$ can be expressed under the following autoregressive representation:

$$z_t = \sum_{s=1}^{\infty} B_s z_{t-s} + e_t$$

where $e_t$ is white noise and $z_t$ can be partitioned into $k$×1 and $l$×1 sub-vectors $x_t$ and $y_t$.

Geweke also showed that a canonical form for the wide-sense stationary time series $z_t = (x_t, y_t)$ is of the form:

$$x_t = \sum_{s=1}^{\infty} E_{1s} x_{t-s} + u_{1t} \qquad var(u_{1t}) = \Sigma_1 \qquad (1)$$

$$x_t = \sum_{s=1}^{\infty} E_{2s} x_{t-s} + \sum_{s=1}^{\infty} F_{2s} y_{t-s} + u_{2t} \qquad var(u_{2t}) = \Sigma_2 \qquad (2)$$

$$x_t = \sum_{s=1}^{\infty} E_{3s} x_{t-s} + \sum_{s=0}^{\infty} F_{3s} y_{t-s} + u_{3t} \qquad var(u_{3t}) = \Sigma_3 \qquad (3)$$

$$x_t = \sum_{s=1}^{\infty} E_{4s} x_{t-s} + \sum_{s=-\infty}^{\infty} F_{4s} y_{t-s} + u_{4t} \qquad var(u_{4t}) = \Sigma_4 \qquad (4)$$

$$y_t = \sum_{s=1}^{\infty} G_{1s} y_{t-s} + v_{1t} \qquad var(v_{1t}) = \mathrm{T}_1 \qquad (5)$$

$$y_t = \sum_{s=1}^{\infty} G_{2s} y_{t-s} + \sum_{s=1}^{\infty} H_{2s} x_{t-s} + v_{2t} \qquad var(v_{2t}) = \mathrm{T}_2 \qquad (6)$$

$$y_t = \sum_{s=1}^{\infty} G_{3s} y_{t-s} + \sum_{s=0}^{\infty} H_{3s} x_{t-s} + v_{3t} \qquad var(v_{3t}) = \mathrm{T}_3 \qquad (7)$$

$$y_t = \sum_{s=1}^{\infty} G_{4s} y_{t-s} + \sum_{s=-\infty}^{\infty} H_{4s} x_{t-s} + v_{4t} \qquad var(v_{4t}) = \mathrm{T}_4 \qquad (8)$$

The measure of linear feedback from *Y* to *X* is defined as:

$$F_{Y \to X} = \ln(|\Sigma_1| / |\Sigma_2|) \qquad (9)$$

The measure $F_{Y \to X}$ is always non-negative and takes the value of zero only if the linear feedback running from *Y* to *X* is absent. Symmetrically, the measure of linear feedback from *X* to *Y* is defined as:

$$F_{X \to Y} = \ln(|\mathrm{T}_1| / |\mathrm{T}_2|) \qquad (10)$$

The instantaneous feedback is defined as:

$$F_{X \cdot Y} = \ln(|\mathrm{T}_2| \times |\Sigma_2| / |\Upsilon|) \tag{11}$$

where:

$$\Upsilon = \mathrm{var}\begin{pmatrix} u_{2t} \\ v_{2t} \end{pmatrix} = \begin{bmatrix} \Sigma_2 & C \\ C' & \mathrm{T}_2 \end{bmatrix}$$

Thus, the measure of linear feedback between two vectors *X* and *Y* can be decomposed into the sum of measure of linear feedback from *X* to *Y*, the measure of linear feedback from *Y* to *X*, and the instantaneous linear feedback between the two vectors. That is:

$$F_{X,Y} = F_{X \to Y} + F_{Y \to X} + F_{X \cdot Y} \tag{12}$$

It is useful to note that the absence of a particular causal ordering implies that one of these feedback measures is equal to zero.

Geweke also proved that the equations in the following set are equivalent:

$$F_{X,Y} = \ln(|\Sigma_1| \times |\mathrm{T}_1| / |\Upsilon|) = \ln(|\Sigma_1| / |\Sigma_4|) = \ln(|\mathrm{T}_1| / |\mathrm{T}_4| \tag{13}$$

$$F_{X \to Y} = \ln(|\mathrm{T}_1| / |\mathrm{T}_2|) = \ln(|\Sigma_3| / |\Sigma_4|) \tag{14}$$

$$F_{Y \to X} = \ln(|\Sigma_1| / |\Sigma_2|) = \ln(|\mathrm{T}_3| / |\mathrm{T}_4|) \tag{15}$$

$$F_{X \cdot Y} = \ln(|\mathrm{T}_2| \times |\Sigma_2| / |\Upsilon|) = \ln(|\Sigma_2| / |\Sigma_3|) = \ln(|\mathrm{T}_2| / |\mathrm{T}_3|) \tag{16}$$

The distribution of statistics and the calculation of their respective confidence intervals can be found in Appendix A.

## Empirical Results

Our empirical results reveal some important findings. As noted earlier, we performed two different kinds of analysis, with the first one focusing on bi-variate causality analysis (Table 3) and the second one focusing on a multi-variate approach to causality analysis (Table 4). Similar exercises are carried out for Malaysia which will be the subject of discussion in the next sub-section.

### *Geweke Causality Analysis for Singapore*

The empirical results for Singapore are summarized in Tables 3 and 4. We performed two different kinds of estimation, with the first one focusing on bi-variate causality analysis (Table 3) and the other one throwing light on causal factors affecting Singapore's growth story using a multi-variate approach (Table 4).

Table 3

*Estimated Measures of Bi-directional Causality between Growth Rate of Real GDP (GGDP), Change in Private Consumption Expenditure (ΔPCE), Change in FDI Net Inflows (ΔFDI),*

*Change in Real Services Value Added (ΔSVA), and Change in Government Expenditure on Education (ΔGEE) for Singapore, 1975-2012.*

| Economic aggregates | | $H_0(F_{x,y} = F_{x\to y} + F_{y\to x} + F_{x\cdot y})$ | | | |
|---|---|---|---|---|---|
| $x$ | $y$ | $F_{x,y}$ | $F_{x\to y}$ | $F_{y\to x}$ | $F_{x\cdot y}$ |
| GGDP | ΔPCE | 0.9325*** (0.0000) | 0.0537 (0.1702) | 0.2459*** (0.0033) | 0.6329*** (0.0000) |
| ΔPCE | GGDP | 0.9967*** (0.0000) | 0.3070*** (0.0010) | 0.0569 (0.1584) | 0.6329*** (0.0000) |
| GGDP | ΔFDI | 0.4290** (0.0147) | 0.0024 (0.9611) | 0.3339*** (0.0040) | 0.0927* (0.0804) |
| ΔFDI | GGDP | 0.5074*** (0.0050) | 0.4108*** (0.0011) | 0.0040 (0.9367) | 0.0927* (0.0804) |
| GGDP | ΔSVA | 1.1500*** (0.0000) | 0.0004 (0.9098) | 0.1355** (0.0294) | 1.0142*** (0.0000) |
| ΔSVA | GGDP | 1.2859*** (0.0000) | 0.1836** (0.0112) | 0.0881* (0.0790) | 1.0142*** (0.0000) |
| GGDP | ΔGEE | 0.3947*** (0.0032) | 0.0396 (0.2391) | 0.2604*** (0.0025) | 0.0948* (0.0686) |
| ΔGEE | GGDP | 0.3324*** (0.0087) | 0.2317*** (0.0044) | 0.0060 (0.6467) | 0.0948* (0.0686) |

*Note.* *, **, and *** denote 10%, 5%, and 1% level of significance, respectively. Confidence interval would be provided upon request. Authors' compilation.

Based on the hypothesis set out earlier for Singapore, we are interested in probing the importance of the following set of variables comprising private consumption expenditure (PCE), net foreign direct investment (FDI) inflows, real services value added (SVA), and government expenditure on education (GEE) in causally driving growth rates of real GDP in Singapore over 1975-2012.

The results for the bi-variate causality analysis for Growth Rates of Real GDP (GGDP) and changes in Private Consumption Expenditure (ΔPCE) are presented in the first two rows of Table 3. We can clearly observe that the causality runs from ΔPCE to GGDP and the results are visibly symmetric. To elaborate, as the measure of linear dependence between GGDP and ΔPCE ($\boldsymbol{F_{x,y}}$) shows, we find that the causality runs from ΔPCE to GGDP implying that changes in private consumption expenditure has strongly driven growth in real GDP in Singapore over the years, as captured by its high statistical significance. This is also evident from the second row when we interchange the x and y variables as we find that the causality is strictly unidirectional, with ΔPCE causally influencing GGDP. It is also notable that in both cases, the instantaneous feedback between GGDP and ΔPCE ($\boldsymbol{F_{x\cdot y}}$) is not just highly significant at the 1 percent level but also accounts for over 60 percent of the total linear dependence between GGDP and ΔPCE.

Next, we consider the bi-variate analysis for GGDP and change in net FDI inflows (ΔFDI). The third and fourth rows from Table 3 yet again are consistent with our hypothesis. The third row suggests that FDI flows appear to have a significant unidirectional causal impact on Singapore's GGDP although it is relatively weaker compared to private consumption expenditure. The aggregate measure of linear dependence between GGDP and

ΔFDI ($\boldsymbol{F_{x,y}}$) is significant only at the 5 percent level. Interestingly, the instantaneous feedback ($\boldsymbol{F_{x \cdot y}}$) between the two variables is also only weakly significant at the 10 percent level, which implies that over 80 percent of the aggregate linear dependence is accounted for by linear feedback from *y* to *x* ($\boldsymbol{F_{y \to x}}$). On a similar note, as the fourth row from Table 3 points out, when we test for the causal direction from ΔFDI to GGDP, we find clear evidence consistent with what was mentioned earlier, *viz*., the linear dependence between ΔFDI and GGDP is driven by linear feedback from *x* to *y* ($\boldsymbol{F_{x \to y}}$).

When we examine the importance of services value added (captured in the fifth and sixth rows of Table 3), the results are yet again consistent with our priors, with services value added exerting a strong causal influence on Singapore's economic growth. When we decompose the aggregate linear dependence between GGDP and ΔSVA, we find that about 90 percent of that dependence is accounted for by the instantaneous feedback ($\boldsymbol{F_{x \cdot y}}$) between the two variables although there is a relatively strong unidirectional relationship that can be observed from ΔSVA to GGDP ($\boldsymbol{F_{y \to x}}$). The results are consistent in the next row, when we interchange the *x* and *y* variables, and we still find the direction of causality running from ΔSVA to GGDP, in line with economic intuition that greater orientation towards services value added would enhance the economic growth.

Comparable results can be observed for the relationship between GGDP and changes in Government Expenditures on Education (ΔGEE). We can observe that the aggregate measure of linear dependence between the two variables is not only highly significant (at the 1 percent level), but a decomposition of the linear dependence between the two variables reveals that about 70 percent of it is driven by the linear feedback from ΔGEE to GGDP.

Extending this bilateral setting to a multi-directional setting, we test the causal importance of the vector of all the above variables in explaining economic growth in Singapore. The results are shown in Table 4.

Table 4

*Estimated Measures of Multi-directional Causality between the GGDP, Change in ΔPCE, Change in FDI, Change in ΔSVA, and Change in ΔGEE for Singapore, 1975-2012.*

| Economic aggregates | | $\boldsymbol{H_0(F_{x,y} = F_{x \to y} + F_{y \to x} + F_{x \cdot y})}$ | | | |
|---|---|---|---|---|---|
| $\boldsymbol{x}$ | $y$ | $F_{x,y}$ | $F_{x \to y}$ | $F_{y \to x}$ | $F_{x \cdot y}$ |
| GGDP | ΔPCE<br>ΔFDI<br>ΔSVA<br>ΔGEE | 1.9012***<br>(0.0000) | 0.2593<br>(0.3811) | 0.8736***<br>(0.0003) | 0.7683***<br>(0.0000) |

*Note.* *, **, and *** denote 10%, 5%, and 1% level of significance, respectively. Confidence interval would be provided upon request. Authors' compilation.

We can observe that there is a strong association between the *x* variable, GGDP, and the *y* vector consisting of the four variables we discussed above. The results are strongly consistent with that of what we found earlier in the bilateral causality framework, with the measure of linear dependence between *x* and *y* ($\boldsymbol{F_{x,y}}$) and the instantaneous feedback between

*x* and *y* ($\boldsymbol{F_{x \cdot y}}$) highly significant at the 1 percent level. Further, the linear feedback from *y* to *x* ($\boldsymbol{F_{y \to x}}$) continues to be highly significant at the 1 percent level and also accounts for about 45 percent of the linear dependence between *x* and *y*.

These results reiterate the strong causal importance of variables such as private consumption expenditure, services value added as well as government expenditures on education in driving Singapore's economic growth. They have not only contributed to Singapore's impressive growth transformation since 1975 but are also crucial variables to pay attention to from a policy point of view, moving forward to sustain the growth momentum. It is also pertinent to underline that despite the significance of FDI inflows in generating a significant and causal impact on Singapore's economic growth, in relative terms, other variables exert a more decisive influence than FDI inflows, underscoring the need to look beyond FDI as a source of growth.

## *Geweke Causality Results for Malaysia*

Like in the case of Singapore, we perform two different kinds of estimation, with the first one focusing on bi-variate causality analysis (Table 5) and the other one throwing light on causal factors affecting Singapore's growth story using a multi-variate approach (Table 6).

Table 5

*Estimated Measures of Bi-directional Causality between GGDP, Change in Household Final Consumption (ΔHFC), Change in Real Manufacturing Value Added (ΔMVA), and Change in ΔSVA for Malaysia, 1975-2012.*

| Economic aggregates | | $H_0(F_{x,y} = F_{x \to y} + F_{y \to x} + F_{x \cdot y})$ | | | |
|---|---|---|---|---|---|
| $x$ | $y$ | $F_{x,y}$ | $F_{x \to y}$ | $F_{y \to x}$ | $F_{x \cdot y}$ |
| GGDP | ΔHFC | 0.8485*** | 0.1357 | 0.2467** | 0.4661*** |
| | | (0.0000) | (0.1065) | (0.0171) | (0.0001) |
| ΔHFC | GGDP | 0.9828*** | 0.1648* | 0.3519*** | 0.4661*** |
| | | (0.0000) | (0.0659) | (0.0030) | (0.0001) |
| GGDP | ΔMVA | 1.1181*** | 0.0001 | 0.0873* | 1.0307*** |
| | | (0.0000) | (0.9618) | (0.0805) | (0.0000) |
| ΔMVA | GGDP | 1.1507*** | 0.0991* | 0.0208 | 1.0307*** |
| | | (0.0000) | (0.0625) | (0.3935) | (0.0000) |
| GGDP | ΔSVA | 0.8591*** | 0.0033 | 0.0873* | 0.7684*** |
| | | (0.0000) | (0.7322) | (0.0804) | (0.0000) |
| ΔSVA | GGDP | 0.9586*** | 0.1237** | 0.0665 | 0.7684*** |
| | | (0.0000) | (0.0375) | (0.1270) | (0.0000) |

*Note.* *, **, and *** denote 10%, 5%, and 1% level of significance, respectively. Confidence interval would be provided upon request. Authors' compilation.

The results for the bi-variate causality analysis for GGDP and change in Household Final Consumption (ΔHFC) are presented in the first two rows of Table 5. We can clearly see that there is a strong bi-directional association between GGDP and ΔHFC. In both cases, the measures of linear dependence between GGDP and ΔHFC ($\boldsymbol{F_{x,y}}$) are highly statistically significant at the 1 percent level. Similarly, in both cases, the instantaneous feedback between

GGDP and ΔHFC ($\boldsymbol{F_{x \cdot y}}$) is also highly significant at the 1 percent level. Furthermore, it is notable that the instantaneous feedback accounts for almost half of the total linear dependence between GGDP and ΔHFC, which implies that the current as well as the past values of ΔHFC possess significant explanatory power to predict GGDP.

Next, we consider the bi-variate analysis for the Growth Rate of Real GDP (GGDP) and change in Real Manufacturing Value Added (ΔMVA). The third and fourth rows of Table 3 show the relevant results and we find yet again that the aggregate measure of linear dependence between GGDP and ΔMVA ($\boldsymbol{F_{x,y}}$) is highly significant, indicating the strong bi-directional association between the two variables. While we can observe a similar result for the instantaneous feedback ($\boldsymbol{F_{x \cdot y}}$) between the two variables which is also significant at the 1 percent level, interestingly, we find different results in the bi-variate analysis. When we decompose the linear feedback between GGDP and ΔMVA, we find that there is only a weak unidirectional relationship that can be observed from ΔMVA to GGDP, in line with the economic intuition that changes in manufacturing value added exerts a notable influence on enhancing economic growth. Very similar results can be observed for the relationship between GGDP and change in Real Services Value Added (ΔSVA). We can observe that the aggregate measure of linear dependence, as well as the instantaneous feedback between the two variables, is highly significant (at the 1 percent level). While we decompose the linear feedback between the two variables, we find that the causality is unidirectional, running from ΔSVA to GGDP. On the whole, the bi-variate analysis empirical results for Malaysia imply that an enhancement in manufacturing and services value added would help the country reap considerable growth benefits.

We extend this bilateral framework to estimate the multi-directional causality between GGDP and the vector of variables including changes in Household Final Consumption (ΔHFC), changes in Real Manufacturing Value Added (ΔMVA), and changes in Real Services Value Added (ΔSVA). The results are shown in Table 6.

Table 6

*Estimated Measures of Multi-directional Causality between GGDP, Change in ΔHFC, Change in ΔMVA, and Change in ΔSVA for Malaysia, 1975-2012.*

| Economic aggregates | | $\boldsymbol{H_0(F_{x,y} = F_{x \to y} + F_{y \to x} + F_{x \cdot y})}$ | | | |
|---|---|---|---|---|---|
| $\boldsymbol{x}$ | $y$ | $F_{x,y}$ | $F_{x \to y}$ | $F_{y \to x}$ | $F_{x \cdot y}$ |
| GGDP | ΔHFC<br>ΔMVA<br>ΔSVA | 1.4196***<br>(0.0000) | 0.0862<br>(0.3890) | 0.1940*<br>(0.0789) | 1.1394***<br>(0.0000) |

*Note.* *, **, and *** denote 10%, 5%, and 1% level of significance, respectively. Confidence interval would be provided upon request. Authors' compilation.

As shown in Table 6, there is a strong association between the *x* variable, GGDP, and the *y* vector. The story appears to be consistent with the results of bilateral causality that we observed earlier. To be sure, the results show that the measure of linear dependence between *x* and *y* ($\boldsymbol{F_{x,y}}$) and the instantaneous feedback between *x* and *y* ($\boldsymbol{F_{x \cdot y}}$) are all highly significant

at the 1 percent level, while the linear feedback from *y* to *x* ($\boldsymbol{F_{y\to x}}$) is marginally significant at the 10 percent level. The multi-variate analysis results further indicate that the linear feedback from *y* to *x* ($\boldsymbol{F_{y\to x}}$) accounts for around 14 percent of the total linear dependence between the two vectors, and the instantaneous feedback between *x* and *y* ($\boldsymbol{F_{x\cdot y}}$) accounts for over 80 percent of the total linear dependence. These two measures put together contribute to roughly 95 percent of the total linear dependence.

These results conform to our stated conjectures of the paper that changes in household final consumption, changes in real manufacturing value added, as well as services value added are equally important in driving Malaysia's economic growth.

It is important to underline that even though we acknowledge that both are broad components of GDP per se, the issue at stake is not just one of mechanical causality, but the fact that both these sectors are equally important in sustaining growth momentum moving forward. This is consistent with the policy focus in Malaysia where the importance of services has been emphasized by a growing literature as a way out of the middle income trap. Further, as our multivariate Geweke analysis shows, there is a strong instantaneous causality between the vector of variables and growth; it supports our conjectures about the need to focus on sectoral growth as a means of structural transformation.

## Conclusions and Policy Implications

This paper has made an attempt to shed some light on understanding the structural transformation in Singapore and Malaysia and its importance in sustaining economic growth in the long run. Both countries are again in an interesting phase of history, experiencing a change in policy discourse about the need to reorient their economies away from the growth model they have been reliant on so far. While in both countries the need to focus more on domestic demand has been emphasized, in Malaysia particularly, the importance of paying equal attention to developing a robust services sector (to the same extent as manufacturing) has been reiterated, especially given the growing concerns of Malaysia being stuck in a middle income trap. In this context, this paper attempted to analyze the growth drivers in both the countries by focusing largely on sectors driving the growth dynamics in Singapore and Malaysia.

The empirical results that the paper arrives at using Geweke causality analysis leave some important policy implications that have to be emphasized. Firstly, for Malaysia, it is important to recognize that while the country has been reliant on exports and foreign direct investment (FDI) as the primary engines of growth since its independence, the transition from a middle income to high income requires a substantial boost in domestic consumption. The shift from external demand to internal demand as a driver of economic growth has been observed in practically all high-income industrialized economies. Therefore, for Malaysia, the thrust of its new development trajectory should lie in rebalancing the economy toward greater domestic demand. Measures to stimulate private consumption may include:

- Reduction of consumption taxes, import tariffs, and non-tariff barriers.
- Maintaining low interest rates.
- Provision of social services, including health care and education to facilitate upward mobility and thus incomes.
- Fiscal transfers to poor and lower-middle-class households.

Secondly, strengthening local manufacturing and services sectors is paramount for Malaysia to sustain the growth momentum. While FDI provides the necessary technology and skills for the country to effectively participate in the global value chains, climbing up the value chains necessitates strong local capability. Furthermore, as competition for FDI has intensified with the emergence of numerous low-cost labor-abundant countries, Malaysia has to compete on the basis of high productivity and more value added. Policies for boosting local industries may comprise:

- Improving the quality of education with an emphasis on technology and innovation.
- Implementing programs for skill development in collaboration with the private sector, particularly foreign firms.
- Facilitating technological transfer from multinational corporations to local firms.
- Providing incentives for firms to innovate and capitalize on new inventions.

For the case of Singapore, as illustrated through the Geweke causality analysis, there is a need for the city-state to adopt a holistic approach to economic growth and development, a model that goes beyond relying heavily on FDI as a source of growth. As indicated earlier, the linear dependence between FDI and real GDP growth appears to be weaker than the linear dependence between the remaining variables and the real GDP growth. A conscious effort promotes such a holistic approach to economic growth; the Singapore policy makers must shift policy attention towards:

- Strong internal demand.
- Competitive local industries, as indicated by an increase in the domestic value added in the services sector, the leading sector in the Singapore's economy.
- Investment in education, both to strengthen the human capital required for a knowledge-intensive economy and to promote upward mobility and incomes.

The Geweke results for Singapore also shed important light on the dynamics between FDI, local sector, and economic development. While FDI remains vital in today's increasingly globalized world, it must be complemented by an equal, if not higher, amount of investment in industrial and technological capabilities, as well as human resources in the host country.

## Endnotes

1. According to the flying geese model, developed countries or regions tend to relocate their manufacturing and labor-intensive industries to developing countries or regions through international trade and international investment, resulting in industrial restructuring and technological upgrading (Akamatsu, 1962). For a specific discussion on the flying geese model and East Asian growth story, see Tan et al. (2014).
2. See Tan et al. (2014) and Kumagai (2015) for a discussion on the relevance and application of the flying geese model to the East Asian growth model.
3. The East Asian fragmentation of manufacturing production and exports was characterized by China, Japan, and Korea being the source countries for production networks and China increasingly serving as the prime "assembly base". Countries like Malaysia and Singapore absorbed new production technologies and became major exporters of parts and components. This was then passed on to countries like Indonesia, Cambodia, Laos, Myanmar, and Vietnam as they were able to absorb the relocation of labor intensive segments. Data highlights that the share of production

network exports in parts and components for Singapore grew from about 30 percent during 1992–1993 to 50 percent during 2006–2007, with the corresponding figure for Malaysia rising from around 28 percent to 54 percent during the same period. For a more elaborate discussion, see Chia (2013).

4. See Naughton and Tsai (2015) for a recent assessment; also, see Xing and Shaw (2013) and The Economist (2012).

5. The more recent phase from the early 1980s has largely been a China story, with China leading the third wave of the economic growth in terms of regional trade and investment.

6. For some recent assessments of the traditional growth decomposition in Singapore and Malaysia using growth accounting frameworks, see Economic Survey of Singapore (2014) and Bank Negara Malaysia (2012).

7. As the Government of Malaysia's strategy paper on transforming the services sector notes, "In the Eleventh Malaysia Plan, 2016–2020, the services sector will continue to be the primary driver of the economic growth. The strategies are formulated to enhance the competitiveness and resilience of the services sector and promote the migration into high-value and knowledge-intensive services activities" (Government of Malaysia, 2015, p.18-1). See also Astro Awani (2015) and Matsangou (2015).

8. Data has shown that well before 2010 – when the integrated resorts took-off – Singapore experienced a significant jump in its services sector FDI compared to manufacturing FDI. The share of financial and insurance services alone as a percentage of total stock of FDI into Singapore rose from 42 percent in 2007 to about 48 percent in 2013, while the corresponding share of manufacturing FDI dipped from around 25 percent to 17 percent during the same period (For more information, see Department of Statistics, Singapore accessible from: http://www.singstat.gov.sg/statistics/browse-by-theme/investment)

9. For a more detailed treatment and discussion of causality analysis, see Geweke (1984) and Granger (1988).

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# Appendix A

## *Distribution of Statistics*

Under the null hypothesis that there is no unidirectional causality running from Y to X:

i.e. if $F_{Y\to X} = 0$, then $n\,\hat{F}_{Y\to X} \sim \chi^2(klp)$ (A1)

If $F_{X\to Y} = 0$, then $n\,\hat{F}_{X\to Y} \sim \chi^2(klp)$ (A2)

If $F_{X \cdot Y} = 0$, then $n\,\hat{F}_{X \cdot Y} \sim \chi^2(kl)$ (A3)

Since these tests are tests of nested hypotheses, $\hat{F}_{Y \to X}$, $\hat{F}_{X \to Y}$, and $\hat{F}_{X \cdot Y}$ are asymptotically independent. The measure of linear feedback between $X$ and $Y$,$F_{X,Y}$, can be tested at once:

If $F_{X,Y} = 0$.

$$n\,\hat{F}_{X,Y} \sim \chi^2(kl(2p+1)) \quad \text{(A4)}$$

## *Confidence Interval*

The 95 percent confidence interval (CI) could be calculated approximately as follows:

For $\hat{F}_{Y \to X}$,

$$\left\{\left[\left(\hat{F}_{Y \to X} - \frac{klp-1}{3n}\right)^{1/2} - \frac{1.96}{\sqrt{n}}\right]^2 - \frac{2klp+1}{3n}, \left[\left(\hat{F}_{Y \to X} - \frac{klp-1}{3n}\right)^{1/2} + \frac{1.96}{\sqrt{n}}\right]^2 - \frac{2klp+1}{3n}\right\} \quad \text{(A5)}$$

For $\hat{F}_{X \to Y}$,

$$\left\{\left[\left(\hat{F}_{X \to Y} - \frac{klp-1}{3n}\right)^{1/2} - \frac{1.96}{\sqrt{n}}\right]^2 - \frac{2klp+1}{3n}, \left[\left(\hat{F}_{X \to Y} - \frac{klp-1}{3n}\right)^{1/2} + \frac{1.96}{\sqrt{n}}\right]^2 - \frac{2klp+1}{3n}\right\} \quad \text{(A6)}$$

For $\hat{F}_{X \cdot Y}$,

$$\left\{\left[\left(\hat{F}_{X \cdot Y} - \frac{kl-1}{3n}\right)^{1/2} - \frac{1.96}{\sqrt{n}}\right]^2 - \frac{2kl+1}{3n}, \left[\left(\hat{F}_{X \cdot Y} - \frac{kl-1}{3n}\right)^{1/2} + \frac{1.96}{\sqrt{n}}\right]^2 - \frac{2kl+1}{3n}\right\} \quad \text{(A7)}$$

For $\hat{F}_{X,Y}$,

$$\left\{\left[\left(\hat{F}_{X,Y} - \frac{kl(2p+1)-1}{3n}\right)^{\frac{1}{2}} - \frac{1.96}{\sqrt{n}}\right]^2 - \frac{2kl(2p+1)+1}{3n}, \left[\left(\hat{F}_{X \cdot Y} - \frac{kl(2p+1)-1}{3n}\right)^{\frac{1}{2}} + \frac{1.96}{\sqrt{n}}\right]^2 - \frac{2kl(2p+1)+1}{3n}\right\} \quad \text{(A8)}$$