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Hong Kong's Growth Synchronisation with China and the U.S.: A Trend and Cycle Analysis*

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Abstract

This paper investigates the synchronisation of Hong Kong's economic growth with mainland China and the US. We identify trends of economic growth based on the permanent income hypothesis. Specifically, we first confirm whether real consumption in Hong Kong and mainland China satisfies the permanent income hypothesis, at least in a weak form. We then identify the permanent and transitory components of income of each economy using a simple state-space model. We use structural vector autoregression models to analyse how permanent and transitory shocks originating from mainland China and the US affect the Hong Kong economy, and how such influences evolve over time. Our main findings suggest that transitory shocks from the US remain a major driving force behind Hong Kong's business cycle fluctuations. On the other hand, permanent shocks from mainland China have a larger impact on Hong Kong's trend growth.

Keywords: Business Cycle Synchronisation, Permanent Income Hypothesis, Stochastic Trend, Structural Vector Autoregression

JEL Classification: C32, E21, E32, F44

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1. Introduction

Hong Kong has become increasingly integrated with the economy of mainland China. Headline numbers of trade and financial flows seem to suggest that mainland China is now playing a dominant role in driving Hong Kong's economic cycles. Yet, these headline figures, particularly of trade data, have masked the underlying driving forces behind the cross-border flows in goods and services. Indeed, given the Mainland's status as the "world's factory", a good chunk of production goes to serving final demand from foreign countries rather than domestic demand on the Mainland itself. And fluctuations in final demand from foreign economies have been very much driven by fluctuations of the US economy, reflecting its status as the largest economy in the world. Given Hong Kong's linked exchange rate system (LERS), with the Hong Kong dollar pegging to the US dollar, and its unique geographic location as a gateway between mainland China and the rest of the world, an interesting and important question naturally arises: Are Hong Kong's business cycles more synchronised with those of the Mainland economy or the US?

This paper studies the relative importance of mainland China and the US in driving Hong Kong's economic cycles. Economic integration can be expected to intensify trade and financial linkages between Hong Kong and the Mainland, which can lead to a higher degree of the output co-movement. On the other hand, the US remains an important source of influence for Hong Kong, particularly from the perspective of final demand, while the linked exchange rate regime reinforces the transmission of shocks from the US to the Hong Kong economy. Although there has been some conjecture that the Hong Kong economy might have become more closely linked with the Mainland than that of the US, only a few studies such as Genberg et al (2006) have analysed this issue in a rigorous manner.

From a supply side perspective, the Hong Kong economy has successfully transformed itself from a manufacturing-focused economy into a service-based economy in the past twenty years. Most of its manufacturing activity migrated north to Guangdong province in mainland China. By contrast, financial and business services have flourished, and Hong Kong has become a major international financial centre. At the same time, export and import related trade services have become the largest source of value-added and employment. This process of transformation toward a service-based economy with higher productivity has coincided and been very much driven by the rise of mainland China as a major trading nation and one of the most important destinations of foreign direct investment in the global economy.

From a demand perspective, Hong Kong has primarily served as a gateway for trade and financial flows between the Mainland and the rest of the world, and Hong Kong's cyclical conditions are very much tied to fluctuations in the volume of flows of goods, services and capital between the Mainland and its major trading partners. Such a "bridge" role is likely to remain important for Hong Kong's economic future, even though trade and financial flows that are more closely linked to developments in domestic demand on the Mainland will gain increasing significance (Genberg and He, 2008).

These two different perspectives point to the possibility that, in principle, the trend and cyclical components of Hong Kong's output growth may be driven by different external forces. We hypothesize that mainland China has been a more important force in driving Hong Kong's trend growth, but the US has maintained its position as a dominant force in driving Hong Kong's cyclical fluctuations. This would be consistent with the observation by He and Liao (2012) that synchronised supply shocks have contributed more to the observed synchronisation in output fluctuations among the Asian economies than demand shocks.

We investigate the co-movement of output of Hong Kong, mainland China and the US in terms of both stochastic trends and the transitory cycles of income. Stochastic economic growth theory suggests that shocks to trend income are a result of fluctuations in the stochastic trend of productivity, which have a permanent impact on an economy. In contrast, transitory productivity shocks and demand shocks only cause temporary fluctuations of the economy in a cyclical manner. To decompose output movements into trend and cycle, we take a theory-guided method and use real GDP data along with consumption data to estimate the stochastic income trend of the economy of Hong Kong, mainland China and the US respectively. This identification strategy is built on Fama (1992), Cochrane (1994), Kim and Piger (2000), and Aguiar and Gopinath (2007), in which real income and consumption data are used together to identify permanent income. In particular, Aguiar and Gopinath (2007) show that using trends and cycles of income that are identified based on the permanent income hypothesis in a business cycle model can well fit the stylised facts of business cycles in emerging markets. We do not use conventional filtering techniques such as the HP filter to detrend the GDP time series because, as discussed in Cogley and Nason (2000) and Estrella (2007), filters can yield inferior results and might artificially generate business cycle dynamics even when there are none in the original data.

We first confirm whether real consumption in Hong Kong and mainland China satisfies the permanent income hypothesis. Next, we derive the permanent and transitory component of income for Hong Kong, mainland China and the US by applying a simple state-space model on consumption and output data. We then make use of a hierarchical, structural vector autoregression model to analyse how the permanent and transitory shocks originating from mainland China and the US affect the Hong Kong economy, and how such influences evolve over time.

Our main findings suggest that the transitory shocks from the US remain a major driving force behind Hong Kong's business cycle fluctuations. On the other hand, our results show that Hong Kong and mainland China share a strong co-movement in terms of long-run trend growth. Permanent shocks originating from the Mainland have a substantial influence on Hong Kong's trend growth, likely reflecting the on-going progress of economic and social integration between the two economies.

This paper is organised as follows. In section 2, we provide some stylised facts on economic integration between Hong Kong, mainland China and the US. In Section 3, we estimate the stochastic income trend for each economy. Section 4 analyses how permanent and transitory shocks from the Mainland and US affect the Hong Kong economy, and section 5 concludes.

2. Stylised Facts on Economic Integration

Commentary in the popular press has often argued that the influence of mainland China on the Hong Kong economy has become dominant, especially over the past decade, as trade and financial linkages have become increasingly tighter. However, the headline figures are only informative about export destinations, rather than the origin of final demand for exports. It is noteworthy that a significant proportion of the goods that are exported to the Mainland are re-exported to serve the final demand from advanced economies.

To illustrate the point, headline trade figures suggest that the share of Hong Kong's merchandise and services exports to the Mainland increased to 51% in 2012, while the US share declined to 21% compared to a much larger share from a decade ago. However, the picture looks very different if we exclude the import content and only account for the value-added of exports. Appendix A describes how to compute value-added exports. As shown in Figure 1, the share of merchandise exports to the Mainland in value-added terms was about 22% in 2012. The US share, though having declined from a decade ago, was still around 25% in 2012. The US share would be even larger if we took into account its influence on other export markets of Hong Kong, such as the euro area. These observations suggest that the impact of US final demand shocks could still be the dominating force that drives fluctuations in the external demand for goods in Hong Kong. Meanwhile, the US share in Hong Kong's services exports excluding tourism services remained larger than the Mainland's share as shown in Figure 2. This implies that the final demand from the US in non-tourism services exports remained larger than the demand from mainland China.

A point worth mentioning is that, within the category of Hong Kong's financial services export, US demand accounted for 33% of the total in 2012, whereas the Mainland's share was merely 4%, as shown in Figure 3. This fact is in contrast to the general misconception that the demand for financial services in Hong Kong is largely Mainland-driven. Indeed, Hong Kong has been transforming into an international financial centre by providing intermediation services between users of funds and global investors. On the one hand, Hong Kong financial sector has become more productive in expanding the supply of financial products, including initial public offerings (IPOs) and renminbi bonds, to raise funds for Mainland corporations. On the other hand, Hong Kong has been targeting overseas investors who are trying to gain exposure to Mainland-related financial assets. In other words, overseas investors have been driving the demand for Mainland-related financial products supplied through Hong Kong, while the on-going financial integration between Hong Kong and Mainland can be considered a supply-side factor that contributes to rising productivity of the Hong Kong economy.

Reflecting the on-going financial integration between Hong Kong and mainland China, Figures 4 and 5 show that the importance of the Mainland as a source of inward foreign direct investment (FDI) and as a destination of outward foreign direct investment (ODI) has been increasing; in comparison, the US shares have been stable or declining in recent years. Meanwhile, the stock market capitalisation of Mainland companies in Hong Kong has increased since 2005, as shown in Figure 6. The issuance

of offshore renminbi bonds has increased substantially since 2010 as Hong Kong has evolved into a major offshore renminbi centre, as illustrated in Figure 7.

At the same time, mainland China plays a dominant role as a tourism services export destination. Stripping out import content, tourism services exports to the Mainland rose from 28% of total tourism services exports in 2000 to over 66% in 2012, whereas the US share dropped from 11% to 4% over the same period, as illustrated in Figure 8. The secular trend in tourism services exports to mainland China not only reflects the Mainland's demand for Hong Kong's tourism services, but has also contributed to Hong Kong's transformation toward a service-based economy over the past decade from a supply-side perspective.

In sum, the size of Hong Kong's service sector has been rising along with the increase in labour productivity as shown in Figure 9. This rise in labour productivity has been underpinned by strong total factor productivity (TFP) growth as a result of the expansion of the service export sector. As suggested by Leung et al. (2009), a large part of TFP growth might have been boosted by the increasing financial linkages between Hong Kong and the Mainland given the high value-added content of financial services. These facts together point to the possibility that mainland China has been a major force affecting Hong Kong's trend growth.

3. Estimating Trends and Cycles

3.1 Model Motivation

We adopt a theory-based method to identify trends and cycles in output data. A standard stochastic growth model can help illustrate this point. In a basic one-sector growth model, output (Y_t) is produced by capital (K_t) and labour (L_t), and is subject to exogenous growth in labour-augmenting technology, or trend productivity growth (A_t):

$$Y_t = e^{z_t} K_t^{1-\alpha} (A_t L_t)^{\alpha}$$

where α is the labour share, z_t is a transitory productivity shock which has zero mean, and:

$$A_t = e^{g_t} A_{t-1} = \prod_{s=0}^{t} e^{g_s}$$

where the productivity trend A_t follows a random walk and g_t is the shock to the stochastic trend. The realisation of g_t affects A_t permanently, so output is a nonstationary process containing a

stochastic trend.

The representative agent maximises a standard lifetime utility function by choosing consumption (C_t) and labour (L_t):

$$U = \sum_{t=0}^{\infty} \beta^t u(C_t, \varepsilon_t, 1 - L_t)$$

where ε_t denotes consumption shocks, which is a demand shock with a temporary effect. Agents optimally respond to productivity and demand shocks by smoothing their consumption over time, and their response can be different when facing a permanent or transitory shock. This comes to the permanent income hypothesis. The strict form of the hypothesis suggests that consumption only responds to permanent shocks, conditional on the agents' information on the type of shock. If a balanced growth path exists in the above model, output and consumption will grow at a rate determined by trend growth (g_t). In other words, output and consumption will share a common stochastic trend.

Guidance from this theoretical model can help to identify permanent and transitory shocks to output that are indistinguishable in the raw data. Specifically, we can treat the common stochastic trend shared by output and consumption as a measure of permanent income. Previous studies have used consumption and output data to identify a trend component (A_t) of output using the permanent income hypothesis as an identification scheme, see for example Fama (1992), Cochrane (1994), Kim and Piger (2000), and Aguiar and Gopinath (2007). Following this literature, we make use of a simple state-space model to identify the common stochastic trend between output and consumption, namely "permanent income". The difference between actual output and its stochastic trend is "transitory income". As a robustness check, we follow Kim and Piger (2000) who use consumption as a proxy for the stochastic trend of output, and decompose output into its trend and cycle accordingly as shown in Appendix C.

Next, we investigate whether consumption data in Hong Kong and mainland China is consistent with the permanent income hypothesis. We then introduce a state-space model that we use to decompose output into trend and cycle.

3.2 Test for Permanent Income Hypothesis

The data we use are real GDP and real consumption for Hong Kong, mainland China and the US at quarterly frequency. The sample period ends in the second quarter of 2013. Seasonally-adjusted real GDP data for Hong Kong starts from the first quarter of 1973, and the series for the US starts from the

first quarter of 1947.[1] The quarterly real GDP series for mainland China is constructed based on several GDP and deflator series, and requires our own seasonal adjustment. The constructed series begins from the first quarter of 1978.[2]

As for real consumption data, we use headline real personal consumption expenditure (PCE) for Hong Kong and the US. Since quarterly real consumption data for mainland China is not available, we use the interpolation procedures described in Chow and Lin (1971) and Bloem, Dippelsman and Maehle (2001) to estimate the quarterly real consumption based on real retail sales and annual real consumption data. The real retail sales series starts from the first quarter of 1985.[3]

The use of US consumption and output data to construct permanent income has been well studied in the literature. We therefore assume that the permanent income hypothesis holds for US consumption. To test whether the hypothesis holds for consumption in Hong Kong and mainland China, we investigate whether a common stochastic trend between output and consumption exists by (1) testing the stationarity of the gap between output and consumption, (2) conducting the Johnasen cointegration tests, and (3) estimating a vector error correction model (VECM) to test if consumption is not predictable by anticipated transitory income change and follows a random walk as suggested by Hall (1978).

The simplest way of testing whether output and consumption are cointegrated is to test whether the gap between the two is stationary. The gap is given by $\hat{z}_t = y_t - \hat{\alpha} - \hat{\beta} c_t$, where y_t and c_t are the logarithm of real GDP and consumption respectively, and $\hat{\alpha}$ and $\hat{\beta}$ are the OLS estimates from a simple regression of output on consumption, both in logarithmic terms.

Table 1 shows unit root test results on the log of real GDP, log consumption, and the gap between the two for Hong Kong and mainland China respectively.[4] We cannot reject a unit root for output and consumption data for Hong Kong and mainland China at the 5% level. But as one might suspect, we can confidently reject a unit root in the first difference of output and consumption for both economies

[1] Seasonally-adjusted real GDP data for Hong Kong only goes back to the first quarter of 1990, so we use X12-ARIMA to perform seasonal adjustment on Hong Kong real GDP data between 1973 and 1989.

[2] The series used for constructing the real GDP series for mainland China includes quarterly real GDP growth data which is not available until after the fourth quarter of 2010, year-on-year real GDP growth which goes back to the fourth quarter of 1999, year-to-date year-on-year growth which goes back to the fourth quarter of 1991, quarterly nominal GDP data which starts from 1978, and annual nominal and real GDP growth which helps to generate a proxy for the GDP deflator for the period between 1978 and 1991.

[3] Real retail sales data are constructed using the nominal retail sales data deflated by the consumer price inflation. An index of annual real consumption is constructed using annual real consumption growth with 2002 as the base year. Note that even though real retail sales is cointegrated with real GDP according to cointegration tests that we conduct, the series does not represent value-added consumption, unlike the PCE series used for Hong Kong and the US. The resulting estimate of the stochastic trend may not necessarily capture real permanent income in terms of value-added. The use of estimated real consumption data, however, can circumvent this problem.

[4] The output-consumption gap for Hong Kong is $\hat{z}_t = y_t + 0.07 - 0.97 c_t$. The gap for mainland China is $\hat{z}_t = y_t - 1.7 - 1.18 c_t$.

at the 1% level, meaning that these series are integrated of order one, or I(1). We also reject a unit root for the output-consumption gap at the 5% level, implying cointegration, or the existence of a stochastic trend, between output and consumption for both economies.

Next, we conduct a Johansen cointegration test and show that there exists a cointegrating vector in each pair of output and consumption data. The results are reported in Table 2. The null hypothesis of no cointegrating vector between output and consumption is rejected at the 5% level in the case of Hong Kong, and at the 5% and 10% level in the case of mainland China according to different test statistics. The null hypothesis of one cointegrating vector is not rejected in all tests. This again confirms that output and consumption share a common stochastic trend in both economies.

The permanent income hypothesis suggests that consumption responds to changes in permanent income, but has minimal response to changes in transitory income. In other words, consumption cannot be predicted by short-term income flucutations if the permanent income hypothesis holds. To find out whether the hypothesis holds, we estimate a VECM of consumption and output, where the long-run relationship between the two variables is controlled for. Given that consumption and output in Hong Kong and mainland China are I(1) processes, and that the two series are cointegrated in each economy, the theoretic cointegration vector is (1, -1). We make use of this fact and run a VECM by restricting the long-run equation coefficient on output following Cochrane (1994). We also estimate an unrestricted version of a VECM for comparison.

Tables 3 and 4 show the VECM results for Hong Kong and mainland China. The error correction coefficients suggest that at quarterly frequency, Hong Kong's consumption adjusts by 7% to 8% of the deviation from its long-run level, whereas the speed of adjustment is 9% to 10% in mainland China. The speed of adjustment is much faster than those found in Cochrane (1994) and Morley (2007). Next, we focus on testing if consumption responds to anticipated transitory income changes. We expect no response if the permanent income hypothesis holds, as in Hall (1978). Our results, however, suggest that consumption does respond to changes in transitory income. The coefficient on the first lag of output growth in the consumption growth equation is positive and significant at the 5% level under the restricted VECM in the case of Hong Kong, and is positive and significant in both VECMs in the case of mainland China. The results suggest that after controlling for the long-term relationship between consumption and output, a 1 percentage point increase in lagged transitory output can still predict a 0.2 percentage point increase in Hong Kong's consumption, and a 0.16 to 0.18 percentage point increase in the Mainland's consumption.

Even though our results suggest that consumption in Hong Kong and mainland China does not strictly follow the permanent income hypothesis, we should not simply accept the failure of this hypothesis in explaining the consumption data. First, the cointegration tests above suggest that a common stochastic trend exists between output and consumption in both economies. Recall from the stochastic growth model that the common stochastic trend represents the underlying permanent productivity trend and hence the permanent income trend of an economy. Second, although the

coefficient on lagged output growth is positive and significant, a magnitude of 0.2 or less is not particularly big. We can compare these to, for example, an estimate of 0.5 in Campbell and Mankiw (1989) based on the US data, which implies that half of the US consumers are the so-called "rule-of-thumb" consumers who consume their current rather than permanent income.

A plausible explanation behind the positive impact of anticipated transitory income changes on consumption is that there are two types of consumers: liquidity-constrained consumers who respond to temporary income shocks, and unconstrained ones who respond to changes in permanent income only. Recent studies by Benito and and Mumtaz (2012) and Faruqui and Torchani (2012) use British and Canadian household data respectively, to identify the proportion of households who face liquidity constraints based on a life-cycle/permanent income hypothesis framework. Both studies find that after controlling for the grouping of unconstrained and constrained (20-40% of total) households, consumption of the constrained households responds positively to lagged income growth, while consumption of the unconstrained households does not. Following this logic, our small coefficients on lagged income growth can be interpreted as capturing the consumption behavior of liquidity-constrained households, while the rest behave as predicted by the permanent income hypothesis.

3.3 Trends Versus Cycles: A Structural Identification

In this section we describe how we estimate permanent income for Hong Kong, mainland China and the US using quarterly data. Following the literature, we estimate permanent income using an unobserved component (UC) model which has a modeling structure resembling a stochastic growth model framework for decomposing output into its permanent and transitory components.

We decompose real output into its trend and transitory component by estimating the following UC model:

$$y_t^i = \tau_t^i + u_{yt}^i$$

$$c_t^i = \bar{c}^i + \gamma_c^i \tau_t^i + u_{ct}^i$$

$$\tau_t^i = \mu^i + \tau_{t-1}^i + v_t^i$$

where y_t^i is the logarithm of real GDP of economy $i \in \{HK, CN, US\}$, c_t^i is the logarithm of consumption. τ_t^i is the economy-specific stochastic trend. u_{yt}^i and u_{ct}^i are the transitory components of y_t^i and c_t^i respectively. $\bar{c}^i$ reflects the long-run impact of taxes and private saving on consumption as suggested by Morley (2007), and γ_c^i is the marginal propensity to consume out of permanent income. The stochastic trend τ_t^i follows a random walk process with an economy-specific drift μ^i,

and v_t^i is the shock to the stochastic trend. The transitory components of income and consumption follow unobservable finite-order autoregressive (AR) processes:

$$\phi_y^i(L)u_{yt}^i = \varepsilon_{yt}^i$$

$$\phi_c^i(L)u_{ct}^i = \varepsilon_{ct}^i$$

where ε_{yt}^i and ε_{ct}^i are shocks to temporary income and consumption respectively. The lag polynomials are normalised by setting $\phi_{j,0}^i = 1$ for $j \in \{y, c\}$. We define $\Theta = \{v_t^i, \varepsilon_{yt}^i, \varepsilon_{ct}^i\}$ and assume that $\Theta \sim \text{iid } \mathrm{N}(0, \Omega)$, where shocks can be correlated with each other. In our estimation, we assume AR(1) processes for the transitory component of income and consumption.

The estimation results from the UC model for Hong Kong, mainland China and the US can be found in Appendix B. Figures 10 to 12 plot the quarter-on-quarter growth of output, consumption and our estimates of permanent income for Hong Kong, mainland China and the US respectively. As illustrated in these figures, the growth rate of consumption and permanent income can be quite different. To derive our measure of transitory income, we subtract our estimated permanent income from the real output data for each economy.

4. Transmission of Permanent and Transitory Shocks

4.1 The Transmission of Transitory Shocks

In this section, we analyse how transitory shocks are transmitted between Hong Kong, mainland China and the US. We estimate a hierarchical structural vector autoregression (SVAR) model following Genberg (2005) and Genberg et al. (2006), which is given by:

$$\begin{pmatrix} A_0^{HH} & A_0^{HC} & A_0^{HU} \\ 0 & A_0^{CC} & A_0^{CU} \\ 0 & A_0^{UC} & A_0^{UU} \end{pmatrix} \begin{pmatrix} X_t^{HK} \\ X_t^{CN} \\ X_t^{US} \end{pmatrix} = \begin{pmatrix} A^{HH}(L) & A^{HC}(L) & A^{HU}(L) \\ 0 & A^{CC}(L) & A^{CU}(L) \\ 0 & A^{UC}(L) & A^{UU}(L) \end{pmatrix} \begin{pmatrix} X_{t-1}^{HK} \\ X_{t-1}^{CN} \\ X_{t-1}^{US} \end{pmatrix} + \begin{pmatrix} u_t^{HK} \\ u_t^{CN} \\ u_t^{US} \end{pmatrix}$$

where A_0 and $A(L)$ are structural coefficients, and X_t^i for $i \in \{HK, CN, US\}$ is a block of macroeconomic variables for Hong Kong, mainland China or the US. Each block includes transitory output and inflation of the respective economy, while the US block also includes the 3-month US Treasury bill rates. u_t^i is a corresponding vector of shocks. The SVAR system ranks the variables in such an order so that it can capture the increasing importance of mainland China in the global economy in the past two decades. Specifically, not only can shocks from the US affect mainland

China and Hong Kong, but shocks from mainland China can also affect the US. Since Hong Kong is a small open economy, it is affected by shocks from both mainland China and the US, but not vice versa.

We take into account the handover of Hong Kong to Chinese sovereignty in July 1997 and assess how the economic linkages among the three economies have evolved. We estimate the SVAR model in two sub-periods: between 1985Q1 and 1997Q2, and between 2003Q4 and 2013Q2 where we skipped the period between Asian financial crisis and the SARS outbreak when the Hong Kong economy went through a prolonged period of deflation.

The results on variance decomposition of the forecast errors on Hong Kong's output and inflation are shown in Table 5. Shocks originating from Hong Kong dominate the impact on its own output and inflation variations over a short-term horizon during both sample periods.[5] However, US shocks exert a much larger impact on the Hong Kong economy in the longer run. For instance, when we look at a 20-quarter horizon, US shocks can explain about 57% of Hong Kong's output fluctuations in the earlier period, and about 48% in the latter period, both of which are larger than the contribution from shocks originating from mainland China and Hong Kong. The long-run influence of Mainland shocks on Hong Kong's inflation becomes larger in the latter period, explaining 36% of the variations in inflation, while the US influence still accounts for about 37% after dominating in the earlier period.

4.2 The Transmission of Permanent Shocks

As shown in the previous section, we find that the Mainland plays a smaller role in driving Hong Kong's business cycle fluctuations than the US. However, given the continuing economic and financial integration between Hong Kong and the Mainland, the Mainland's influence on Hong Kong may have become more important at the trend cycle frequency. As discussed in Section 2, Hong Kong and the Mainland are bonded through financial integration and FDI flows. In particular, a large part of TFP growth has been boosted by increasing financial linkages, for instance, through the expansion in the supply of Mainland-related financial products in Hong Kong's financial markets. This might have caused trend growth in Hong Kong and mainland China to become more synchronised.

To formally study the transmission of permanent shocks across borders, we estimate the following SVAR model:

$$\begin{pmatrix} b_0^{HH} & b_0^{HC} & b_0^{HU} \\ 0 & b_0^{CC} & b_0^{CU} \\ 0 & b_0^{UC} & b_0^{UU} \end{pmatrix} \begin{pmatrix} \hat{\tau}_t^{HK} \\ \hat{\tau}_t^{CN} \\ \hat{\tau}_t^{US} \end{pmatrix} = \begin{pmatrix} b^{HH}(L) & b^{HC}(L) & b^{HU}(L) \\ 0 & b^{CC}(L) & b^{CU}(L) \\ 0 & b^{UC}(L) & b^{UU}(L) \end{pmatrix} \begin{pmatrix} \hat{\tau}_{t-1}^{HK} \\ \hat{\tau}_{t-1}^{CN} \\ \hat{\tau}_{t-1}^{US} \end{pmatrix} + \begin{pmatrix} \varepsilon_t^{HK} \\ \varepsilon_t^{CN} \\ \varepsilon_t^{US} \end{pmatrix}$$

[5] Impulse responses suggest that the output shocks are demand shocks rather than temporary supply shocks since the impulse responses of an economy's transitory output and inflation move in the same direction in the face of a shock to its own transitory output for all three economies in the sample.

where $\hat{\tau}_t^i$ for $i \in \{HK, CN, US\}$ denotes the permanent income series estimated using the state-space models discussed in Section 3.3.

Table 6 reports the results of variance decompositions of the forecast errors of Hong Kong's permanent income. In contrast to the results relating to transitory shocks, the Mainland is more important than the US in explaining variations in Hong Kong's trend growth. The long-run influence of US permanent shocks on Hong Kong declined from about 36% between 1985Q1 and 1997Q2 to 30% during the 2003Q4-2013Q2 period. On the other hand, the long-run impact of the Mainland's permanent shocks on Hong Kong's trend growth variations increased significantly from about 15% to about 65% in the latter period. Appendix C shows the results of variance decompositions of the forecast errors of Hong Kong's transitory and permanent income based on an alternative SVAR model, which uses a different measure of permanent income. The results presented in Appendix C are largely consistent with the key results discussed here.

In sum, while the US influence remains a dominant force behind Hong Kong's short-term business cycle variations, mainland China has become a more dominant influence driving Hong Kong's trend growth.

5. Conclusions

In this paper we use structural models to disentangle the stochastic trend and the transitory component of output in Hong Kong, mainland China and the US, and to investigate the interaction between these economies in terms of common trends and cycles. We find that US transitory shocks have remained a dominant force in driving Hong Kong's business cycle fluctuations, and that transitory shocks from mainland China have played a less important role. However, when it comes to the permanent shocks, the picture is the opposite: permanent shocks from the Mainland explain a much larger portion of the volatility in Hong Kong's trend output than those from the US.

Our findings suggest that, at the business cycle frequency, Hong Kong remains more synchronised with the US than with mainland China. Since it is the similarity of cyclical shocks that matters most for the choice of exchange rate regime, the LERS, which links the Hong Kong dollar to the US dollar, continues to be appropriate for the foreseeable future. On the other hand, Hong Kong has benefited from the rise of mainland China as a major trading nation and a prime destination of FDI by transforming itself from a manufacturing economy to a service economy characterised by higher productivity. Active exchange of human capital and knowledge has been propagating longer-term productivity progress across the border.

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Table 1. Unit Root and Cointegrations Test for Hong Kong Output and Consumption

	Hong Kong		Mainland China	
	Lags of differences [a]	p-value [b]	Lags of differences	p-value
y_t	8	0.3648	7	0.0851
c_t	3	0.7817	2	0.4361
$\hat{z}_t$	11	0.0147	13	0.0022
Δy_t	-	0.0000	-	0.0000
Δc_t	-	0.0000	-	0.0000

Note: a) Chosen by a general-to-specifc rule, starting with a maximum of 14 lags and reducing if the last lag is not significant at the 10% level for a standard *t*-test. b) Test regressions for y_t and c_t include a constant and a time trend, and the statistics is MacKinnon p-values. The test regression for $\hat{z}_t$ only includes a constant, and the reported statistics is Phillips and Ouliaris p-value.

Table 2. Johansen Cointegration Tests for Output and Consumption

Trace statistics	**Hong Kong**	**Mainland China**
Null hypothesis	p-value [a]	p-value
No cointegrating vectors	0.0281	0.0591
At most one cointegrating vector	0.9009	0.7054
Maximum Eigenvalue statistics		
Null hypothesis		
No cointegrating vectors	0.0081	0.0416
At most one cointegrating vector	0.9009	0.7054

Note: a) MacKinnon-Haug-Michelis p-value.

Table 3. VECM of Output and Consumption for Hong Kong

	Restricted		Unrestricted	
	Δc_t	Δy_t	Δc_t	Δy_t
Error correction coefficient	-0.082	-0.073	-0.071	-0.012
	(0.051)	(0.047)	(0.028)	(0.026)
Δy_{t-1}	0.198	-0.023	0.143	-0.022
	(0.094)	(0.085)	(0.096)	(0.089)
Δy_{t-2}	0.046	-0.098	0.003	-0.097
	(0.095)	(0.086)	(0.096)	(0.088)
Δy_{t-3}	0.122	0.195	0.089	0.200
	(0.091)	(0.083)	(0.091)	(0.085)
Δc_{t-1}	-0.321	0.217	-0.282	0.233
	(0.082)	(0.074)	(0.081)	(0.075)
Δc_{t-2}	0.120	0.134	0.142	0.149
	(0.090)	(0.082)	(0.088)	(0.082)
Δc_{t-3}	0.297	0.017	0.309	0.025
	(0.081)	(0.073)	(0.080)	(0.074)
Constant	-0.000	0.000	-0.001	0.005
	(.005)	(0.004)	(0.004)	(0.004)
R^2	0.4313	0.4028	0.4458	0.3940

Note: Standard errors reported in parentheses.

Table 4. VECM of Output and Consumption for Mainland China

	Restricted		Unrestricted	
	Δc_t	Δy_t	Δc_t	Δy_t
Error correction coefficient	-0.091	-0.094	-0.096	-0.076
	(0.030)	(0.049)	(0.029)	(0.048)
Δy_{t-1}	0.177	-0.174	0.155	-0.201
	(0.060)	(0.096)	(0.058)	(0.095)
Δy_{t-2}	0.105	-0.154	0.090	-0.174
	(0.055)	(0.088)	(0.054)	(0.088)
Δy_{t-3}	0.142	-0.402	0.131	-0.419
	(0.054)	(0.087)	(0.053)	(0.087)
Δy_{t-4}	0.167	0.114	0.164	0.105
	(0.059)	(0.095)	(0.058)	(0.096)
Δc_{t-1}	-0.145	0.140	-0.121	0.162
	(0.095)	(0.153)	(0.094)	(0.155)
Δc_{t-2}	0.204	0.268	0.228	0.287
	(0.095)	(0.154)	(0.095)	(0.156)
Δc_{t-3}	-0.024	0.314	0.002	0.327
	(0.096)	(0.156)	(0.097)	(0.159)
Δc_{t-4}	0.064	0.521	0.082	0.528
	(0.088)	(0.142)	(0.088)	(0.145)
Constant	-0.004	0.004	-0.005	0.006
	(0.006)	(0.009)	(0.006)	(0.009)
R^2	0.7805	0.6875	0.7839	0.6841

Note: Standard errors reported in parentheses.

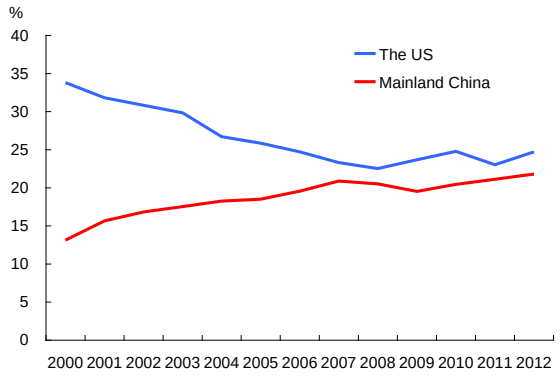
Table 5. Variance Decompositions of Transitory Shocks for Hong Kong

1985Q1 to 1997Q2	Output			Price		
Horizon (in quarters)	US	CN	HK	US	CN	HK
1	13.562	16.346	70.092	33.387	1.737	64.877
4	31.646	17.629	50.725	49.719	7.331	42.950
10	52.055	13.300	34.645	58.304	7.590	34.106
20	57.084	13.680	29.237	59.266	7.795	32.938
2003Q4 to 2013Q2						
1	16.500	8.574	74.926	36.998	9.709	53.293
4	37.856	18.007	44.137	34.778	36.291	28.931
10	52.416	18.104	29.481	36.855	35.910	27.234
20	47.622	28.657	23.721	37.012	35.992	26.996

Table 6. Variance Decomposition of Permanent Shocks for Hong Kong

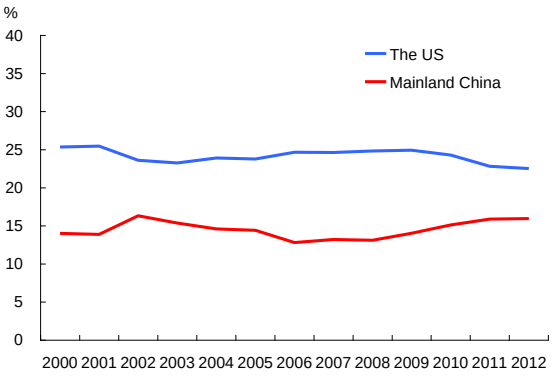
1985Q1-1997Q2	TREND_US	TREND_CN	TREND_HK
1	2.766	7.558	89.676
4	11.757	14.539	73.704
10	26.385	19.767	53.848
20	35.779	14.702	49.520
2003Q4-2013Q2			
1	4.935	4.735	90.330
4	15.650	42.683	41.667
10	31.818	58.990	9.192
20	29.808	65.270	4.922

Figure 1. Shares in Hong Kong Merchandise Exports (Value-Added)



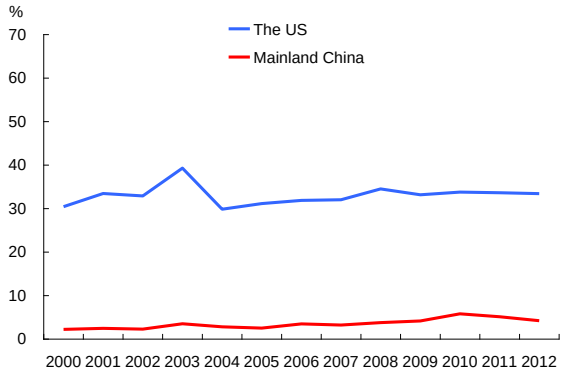
Sources: CEIC; C&SD and authors' estimates.

Figure 2. Shares in Hong Kong Services Exports Excluding Tourism (Value-Added)



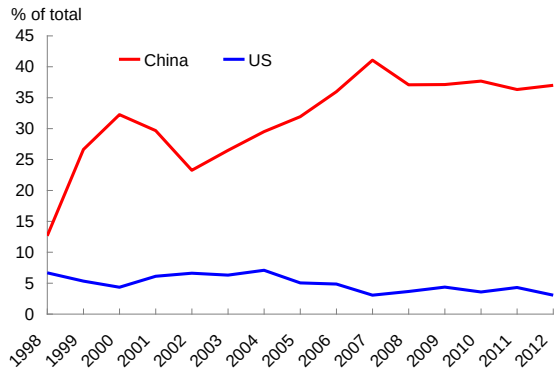
Sources: C&SD and authors' estimates.

Figure 3. Shares in Hong Kong Financial Services Exports (Value-Added)



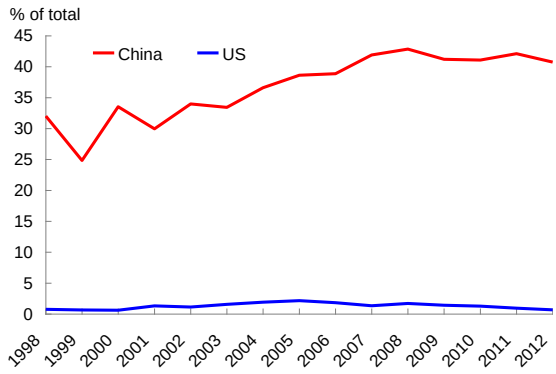
Sources: C&SD and authors' estimates.

Figure 4. Hong Kong's Inward FDI Positions by Origin



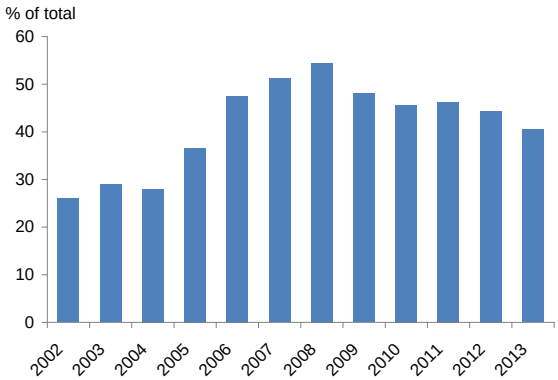
Sources: CEIC; C&SD and authors' estimates.

Figure 5. Hong Kong's Outward FDI Positions by Destination



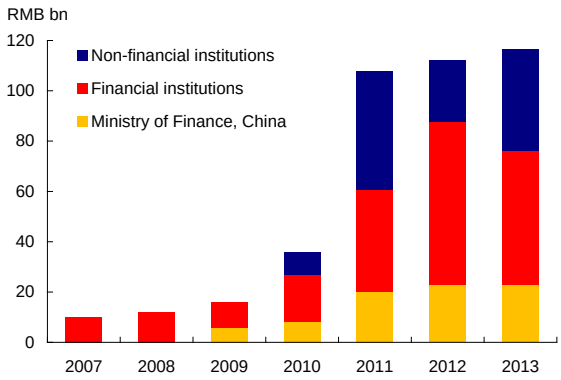
Sources: CEIC; C&SD and authors' estimates.

Figure 6. Share of Mainland Companies in Hong Kong Stock Market Capitalisation



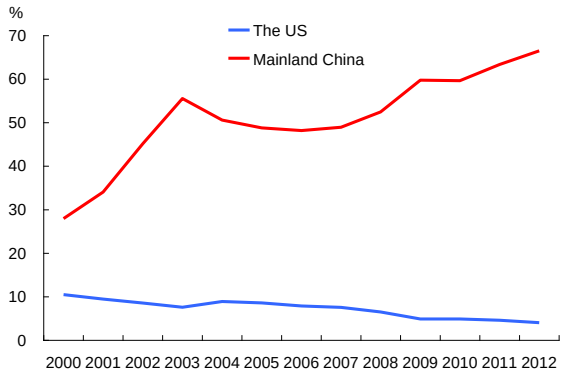
Sources: CEIC; HKEx and authors' estimates.

Figure 7. Issuance of Offshore Renminbi Bonds in Hong Kong



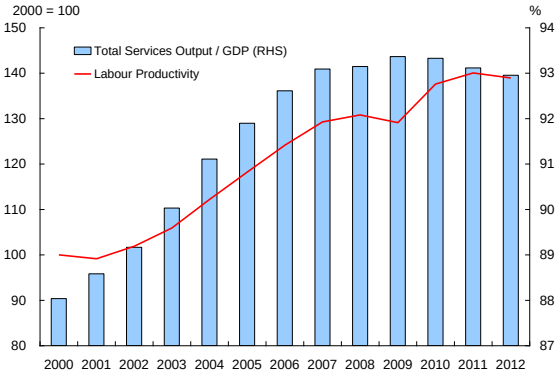
Sources: Newswires.

Figure 8. Shares in Hong Kong Tourism Services Exports (Value-Added)



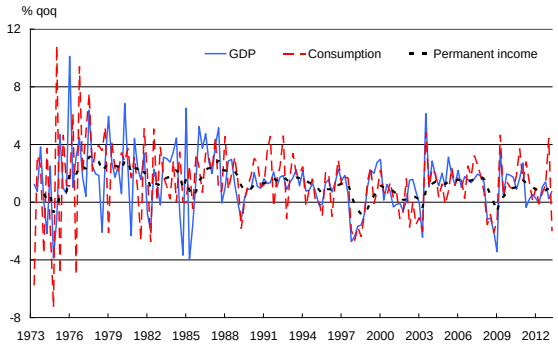
Sources: C&SD and authors' estimates.

Figure 9. Hong Kong's Labour Productivity and Service Sector Growth



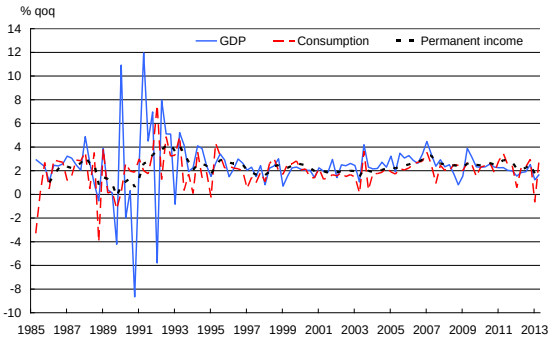
Sources: CEIC; C&SD and authors' estimates.

Figure 10. Growth of GDP, Consumption and Permanent Income for Hong Kong



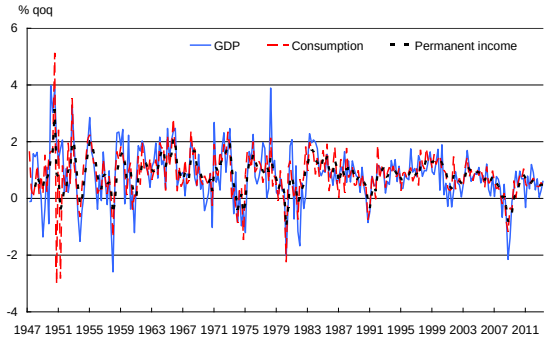
Sources: CEIC and authors' estimates.

Figure 11. Growth of GDP, Consumption and Permanent Income for Mainland China



Sources: CEIC and authors' estimates.

Figure 12. Growth of GDP, Consumption and Permanent Income for US



Sources: CEIC and authors' estimates.

Appendix A. The Construction of Value-Added Exports

A.1 Merchandise Exports

Merchandise exports to a destination in value-added terms is the sum of domestic exports and re-export margins to a destination, and commissions from offshore trade to the destination. We adjust all the components to value-added terms before computing merchandise exports by destination.

Domestic exports

To derive estimates of Hong Kong's domestic exports to mainland China in value-added terms, we subtract outward processing domestic exports from headline domestic exports using data from Hong Kong's Census and Statistics Department (C&SD), and then further strip out other types of processing trade that we have estimated using China Custom data from China's National Bureau of Statistics (NBS). We then subtract the proportion of sales that can be attributable to purchases of materials and supplies based on the data from C&SD.

For Hong Kong's domestic exports to the US in value-added terms, we add to the headline domestic exports to the US from C&SD data with our estimates of Hong Kong processing trade to mainland China that are re-exported to the US based on China Custom data. This captures total final demand for Hong Kong's domestic exports from the US that is missing from the headline figures. Again we subtract the proportion of sales attributable to purchases of materials and supplies based on the data from C&SD.

Total domestic exports in value-added terms is headline total domestic exports subtracting outward processing domestic exports and the proportion of sales attributable to purchases of materials and supplies based on C&SD data.

Re-exports

The adjustments to re-exports are similar to those made to domestic exports. Here we make use of the outward process re-exports data for consistency. To derive total re-exports and re-exports by destination in value-added terms, we estimate the rate of re-export margins based on offshore trade statistics from C&SD, and apply them to the adjusted re-export figures to proxy exporters' commissions earned from re-exports.

Commissions from offshore trade

Total offshore trade commission, and commission earned by destination, are from the data of gross margins from merchanting in C&SD's Offshore Trade in Goods tables.

A.2 Services Exports

We use headline services exports for all categories except for tourism services. This is because a large part of tourism services exports is expenditure on shopping which involves import content. We adjust tourism services exports by stripping out the import content in visitors' shopping expenditure based on data from the Hong Kong Tourism Board.

Table A1 below contains our estimates of mainland China and US shares in Hong Kong merchandise exports, services exports excluding tourism, tourism services exports and financial services exports, all in value-added terms.

Table A1. Mainland China and US Shares in Hong Kong Exports in Value-Added Terms

% of total	Merchandise		Services (excluding tourism)		Tourism services		Financial services	
Year	Mainland China	US	Mainland China	US	Mainland China	US	Mainland China	US
2000	13.1	33.8	14.0	25.3	28.0	10.5	2.2	30.4
2001	15.7	31.8	13.9	25.5	34.1	9.5	2.5	33.5
2002	16.8	30.8	16.3	23.6	45.2	8.6	2.3	32.9
2003	17.5	29.8	15.4	23.2	55.6	7.6	3.5	39.3
2004	18.2	26.7	14.6	23.9	50.6	8.9	2.8	29.8
2005	18.5	25.9	14.4	23.8	48.8	8.6	2.5	31.1
2006	19.6	24.7	12.8	24.7	48.2	7.9	3.5	31.9
2007	20.9	23.3	13.2	24.6	49.0	7.6	3.2	32.0
2008	20.5	22.5	13.1	24.8	52.5	6.5	3.8	34.5
2009	19.5	23.7	14.0	24.9	59.8	4.9	4.2	33.2
2010	20.4	24.8	15.1	24.3	59.7	4.9	5.8	33.8
2011	21.1	23.0	15.9	22.8	63.4	4.6	5.1	33.6
2012	21.8	24.7	16.0	22.5	66.5	4.0	4.2	33.4

Sources: C&SD and authors' estimates.

Appendix B. Coefficient Estimates of State-Space Models

This section of the appendix shows the coefficient estimates from the unobserved component (UC) model using output and consumption data for Hong Kong, mainland China and the US.

Table B1. Coefficient Estimates of State-Space Models

	Hong Kong	Mainland China	US
γ_c^i	1.075	0.869	0.993
	(0.100)	(0.074)	(0.050)
$\phi_{y,1}^i$	-0.023	-0.184	0.068
	(0.086)	(0.095)	(0.064)
$\phi_{c,1}^i$	-0.456	-0.331	-0.439
	(0.080)	(0.124)	(0.085)
σ_v^i	0.365	0.415	0.377
	(0.000)	(0.000)	(0.000)
$\sigma_{\varepsilon y}^i$	1.822	2.114	0.700
	(0.007)	(0.005)	(0.000)
$\sigma_{\varepsilon c}^i$	2.079	1.107	0.479
	(0.008)	(0.001)	(0.000)
$\rho_{v,\varepsilon y}^i$	0.194	0.175	0.266
	(0.015)	(0.069)	(0.000)
$\rho_{v,\varepsilon c}^i$	0.264	0.299	0.447
	(0.001)	(0.002)	(0.000)
$\rho_{\varepsilon y,\varepsilon c}^i$	0.439	0.118	0.562
	(0.000)	(0.222)	(0.000)

Note: Standard errors of shocks (σ_v^i , $\sigma_{\varepsilon y}^i$, $\sigma_{\varepsilon c}^i$) are multiplied by 100. ρ^i denotes correlation between shocks.

Appendix C. Variance Decompositions based on an Alternative Model

As a robustness check, we construct an alternative measure of stochastic permanent income trend and re-estimate the SVAR models. Specifically, Mainland data have relatively short time series. This makes identifying the stochastic trend using an unobserved component model statistically less reliable. To check the robustness of our results, we assume that consumption *itself* is the stochastic trend for an economy. Specifically, based on the consumption function $c_t^i = \bar{c}^i + \gamma_c^i \tau_t^i + u_{ct}^i$ for $i \in (HK, CN, US)$, we estimate the loading of the output γ_c^i on the trend τ_t^i. Note that consumption for mainland China throughout this Appendix is proxied by real retail sales. For simplicity, the shocks from the US can affect Mainland China, but not vice-versa, following Genberg (2005). In other words, we set A_0^{UC} and $A^{UC}(L)$ to 0 in the SVAR system shown in Section 4.1.

Table C1. Estimating the Cointegration Relation

	Mainland China	US	Hong Kong
OLS	1.0473	0.9057	1.0327
	(0.9956, 6.79 6.84)	(0.9978, 2.93, 2.98)	(0.9718, 6.28, 6.33)
DOLS with 1 lag/lead	1.0578	**0.9113**	1.0473
	(0.9960, 6.66 6.78)	(0.9980, 2.84, 2.97)	(0.9725, 6.27, 6.39)
DOLS with 2 lags/leads	1.0626	0.9127	1.0567
	(0.9962,6.61 6.78)	(0.9982, 2.84, 3.01)	(0.9728, 6.26, 6.43)
DOLS with 3 lags/leads	1.0664	0.9140	**1.0691**
	(0.9963, 6.56, 6.79)	(0.9980, 2.85, 3.08)	(0.9732, 6.24, 6.47)
DOLS with 4 lags/leads	1.0699	0.9159	1.0805
	(0.9964, 6.50, 6.79)	(0.9981, 2.86, 3.13)	(0.9733, 6.24, 6.52)
DOLS with 5 lags/leads	**1.0751**	0.9177	1.0917
	(0.9968, 6.39, 6.73)	(0.9981, 2.87, 3.19)	(0.9734, 6.24, 6.57)
DOLS with 6 lags/leads	1.0790		
	(0.9969, 6.34, 6.74)		
DOLS with 7 lags/leads	1.0828		
	(0.9970, 6.29, 6.75)		

We estimate the cointegrating coefficients using the Stock-Watson Dynamic OLS (DOLS) method. The estimates of the cointegrating coefficient are reported in Table C1. The numbers in parenthesis below each estimate are adjusted R^2, the Akaike Information Criterion (AIC) and the Schwarz Information Criterion (BIC) respectively. In general, we prefer a high R^2, and low AIC and BIC. We select the best model based on AIC and BIC criteria, as well as likelihood ratio test. Indeed, the

cointegration vectors for all the three economies are close to the theory-implied value (1, -1).[6] We use the selected estimates for the factor loadings on trends to compute the transitory components as shown in Table C2.

Table C2. Transitory Components of Outputs

$$\tilde{y}_t^{CN} = y_t^{CN} - 1.0751 * c_t^{CN}$$

$$\tilde{y}_t^{HK} = y_t^{HK} - 1.0691 * c_t^{HK}$$

$$\tilde{y}_t^{US} = y_t^{US} - 0.9113 * c_t^{US}$$

We re-estimate the SVAR model described in Section 4.1 using the alternative measure of transitory outputs, inflation rates of the three economies, as well as the 3-month US Treasury bill rates, at quarterly frequency. We also re-estimate the SVAR model described in Section 4.2 to study the transmission of permanent shocks across economies using the alternative measure of permanent income. Table C3 reports the variance decomposition of the forecast errors on Hong Kong's output and inflation equation. US transitory shocks had a large impact on Hong Kong before 1997, explaining more than 50% of Hong Kong's output fluctuations in a 4-quarter horizon, and even larger over a longer horizon. In the latter sample period, US shocks are still important in explaining Hong Kong's business cycles, but the magnitude of their impact is smaller at all horizons. The effect of Mainland shocks on Hong Kong's real economy also drops, implying that Hong Kong's economic integration with the Mainland did not increase output co-movement between the two economies at the business cycle frequency. Nevertheless, consistent with our previous results where we used transitory income generated from state-space models, US transitory shocks remain a dominant force in driving Hong Kong's business cycle.

Table C3. Variance Decompositions of Transitory Shocks for Hong Kong

1985Q1 to 1997Q2	Output			Price		
Horizon (in quarters)	US	CN	HK	US	CN	HK
1	17.919	3.258	78.823	24.251	11.864	63.885
4	53.869	10.413	35.718	30.291	31.424	38.285
20	83.846	12.712	3.442	64.344	21.104	14.552
1999Q1 to 2012Q4						
1	15.582	1.688	82.730	14.063	0.325	85.612
4	34.619	6.450	58.931	20.447	16.486	63.067
20	51.925	5.750	42.325	13.229	26.790	59.981

[6] Since the parameter estimates from the above DOLS is super-consistent, with the rate of convergence given by the sample size instead of its square root, it will not have the generated-regressors problem and will not affect our inference when we study how the transitory shocks are transmitted across borders in our VECM estimation.

Table C4 reports the variance decompositions of the forecast errors on Hong Kong's permanent income equation. In contrast to the results of transitory shocks, permanent shocks from mainland China were more important than the US in determining Hong Kong's trend growth, similar to our previous analysis. A permanent shock to the Mainland leads to a notable shift in Hong Kong's output trend.

Table C4. Variance Decomposition of Permanent Shocks for Hong Kong

1985Q1 to 1997Q2	Output		
Horizon (in quarters)	Trend_US	Trend_CN	Trend_HK
1	8.303	35.371	56.326
4	12.921	39.359	47.719
20	13.543	39.141	47.315
1997Q3 to 2003Q4			
1	2.413	2.494	95.093
4	9.028	15.498	75.474
20	9.379	18.791	71.831
2004Q1 to 2013Q2			
1	11.015	23.924	65.061
4	13.183	32.967	53.851
20	11.606	42.724	45.670