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

Dong He, Wei Liao, and Tommy Wu

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Hong Kong's Growth Synchronization with China and the U.S.: A Trend and Cycle Analysis[1]

Prepared by Dong He, Wei Liao, and Tommy Wu

Authorized for distribution by Steven Barnett

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Abstract

This paper investigates the synchronization of Hong Kong SAR's economic growth with mainland China and the United States. This paper identifies trends of economic growth based on the permanent income hypothesis. Specifically, the paper confirms whether real consumption in Hong Kong SAR and mainland China satisfy the permanent income hypothesis, at least in a weak form. It then identifies the permanent and transitory components of income of each economy using a simple state-space model. It uses structural vector autoregression models to analyze how permanent and transitory shocks originating from mainland China and the United States affect the Hong Kong economy, and how such influences evolve over time. The paper's main findings suggest that transitory shocks from the United States remain a major driving force behind Hong Kong SAR's business cycle fluctuations. On the other hand, permanent shocks from mainland China have a larger impact on Hong Kong SAR's trend growth.

Contents   Page

I. INTRODUCTION

Hong Kong SAR 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 SAR'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 of such final demand from foreign economies have been very much driven by fluctuations of the U.S. economy, reflecting its status as the largest economy in the world. Given Hong Kong SAR's linked exchange rate system (LERS) with the Hong Kong dollar pegging to the U.S. 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 SAR's business cycles more synchronized with those of the mainland economy or the United States?

This paper studies the relative importance of mainland China and the United States in driving Hong Kong SAR's economic cycles. Economic integration intensifies both trade and financial linkages between Hong Kong SAR and the mainland, which can lead to a higher degree of the output co-movement. On the other hand, the United States remains as an important source of influence for Hong Kong SAR, particularly from the perspective of final demand, while the linked exchange rate regime enforces the transmission of shocks from the United States 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 with the United States, only a few studies such as Genberg, Liu, and Jin (2006) have analyzed 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 the manufacturing activities migrated north to Guangdong province on the mainland. Instead, financial and business services have flourished, and Hong Kong SAR has now 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 SAR has primarily served as a gateway of trade and financial flows between the mainland and the rest of the world, and Hong Kong SAR'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 SAR'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 SAR'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 SAR's trend growth, but the United States has maintained its position as a dominant force in driving Hong Kong SAR's cyclical fluctuations. This would be consistent with the observation by He and Liao (2012) that synchronized supply shocks contributed more to the observed synchronization in output fluctuations among the Asian economies than demand shocks.

We investigate the co-movement of output of Hong Kong SAR, mainland China and the United States in terms of both the stochastic trend and the transitory cycle of income. Stochastic economic growth theory suggests that shocks to trend income are results 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 movement into trends and cycles, we take a theory-guided method and use real GDP data along with consumption data to estimate the stochastic income trends of the economies of Hong Kong SAR, mainland China and the United States 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 applying trends and cycles of income that are identified based on the permanent income hypothesis in a business cycle model can well fit the stylized facts of business cycles in emerging market. We do not use the 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 is none in the original data.

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

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

This paper is organized as follows. In section II, we provide some stylized facts on economic integration among Hong Kong SAR, mainland China and the United States. In Section III, we

estimate the stochastic trend in each economy. Section IV analyzes how permanent and transitory shocks from the mainland and United States affect the Hong Kong economy. Section V concludes.

II. STYLIZED 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 in the past decade, as trade and financial linkages become increasingly tighter. However, the headline figures are only informative about the export destinations, which are not necessarily the same as where the final demand of export is coming from. This is especially true for goods export to the mainland where a significant proportion of the goods are then re-exported to serve the final demand from advanced economies.

To illustrate the point, headline trade figures suggest that the share of Hong Kong SAR's merchandise and service exports to the mainland increased to 51 percent in 2012, while the U.S. share declined to 21 percent compared to a much larger share from a decade ago. 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 percent in 2012. The U.S. share, although having declined from a decade ago, remained at about 25 percent in 2012. The U.S. share would be even more significant if we take into account its influence on other export markets of Hong Kong SAR, such as the euro area. These observations suggest that the impact of U.S. final demand shocks could still be the dominating force that drives the fluctuations in the external demand for goods in Hong Kong SAR. Meanwhile, the U.S. share in Hong Kong SAR's services export excluding tourism services continued to be larger than mainland's share as shown in Figure 2. This implies that the final demand from the United States in nontourism services exports remained larger than the demand from mainland China.

Figure 1. Shares in Hong Kong SAR Merchandise Exports (value-added)
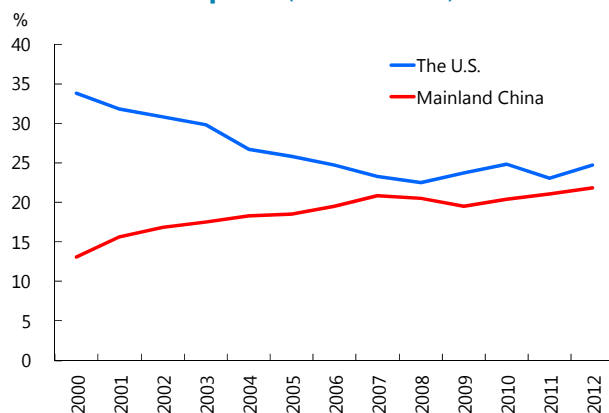
Figure 2. Shares in Hong Kong SAR Services Exports Excluding Tourism (value-added)
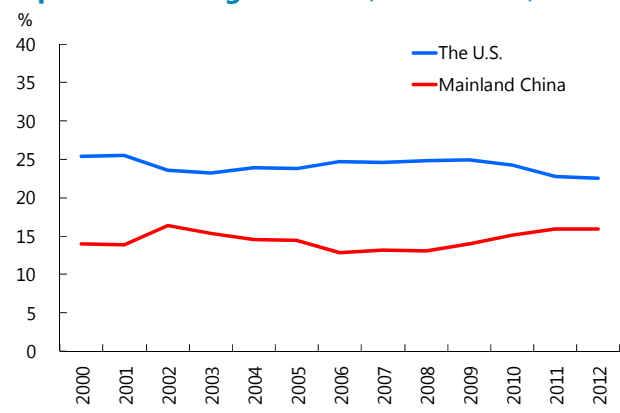
Sources: CEIC; C&SD and authors' estimates.

A point worth mentioning is that, within the category of Hong Kong SAR's financial services export, the U.S. demand accounted for 33 percent of the total in 2012, whereas the mainland share was merely 4 percent, as shown in Figure 3. This fact is in contrast to the general misconception that the demand for financial services in Hong Kong SAR is largely mainland-driven. Indeed, Hong Kong SAR 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 SAR financial sector has become more productive at 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 SAR has been targeting overseas investors who are trying to gain exposures to mainland-related financial assets. In other words, overseas investors have been driving the demand for mainland-related financial products supplied through Hong Kong SAR, while the ongoing financial integration between Hong Kong SAR and mainland would be a supply-side factor that contributes to rising productivity of the Hong Kong SAR economy.

**Figure 3. Shares in Hong Kong SAR
Financial Services Exports** (value-added)
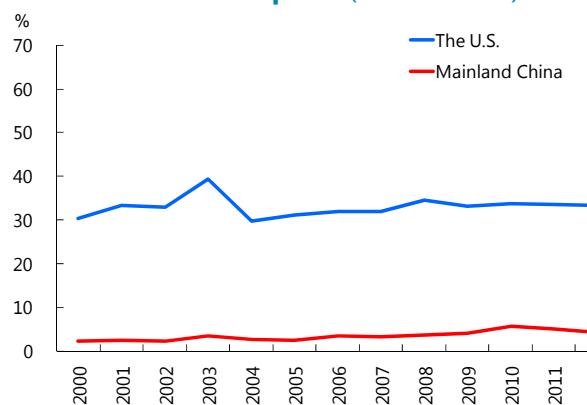
Sources: C&SD and authors' estimates.

Reflecting the ongoing financial integration between Hong Kong SAR 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 U.S. shares have been stable or declining in recent years. Meanwhile, stock market capitalization of mainland companies in Hong Kong SAR has become larger since 2005, as shown in Figure 6. The issuance of offshore renminbi bonds has also increased substantially since 2010 as Hong Kong SAR is developing into a major offshore renminbi centre (Figure 7).

6

Figure 4. Hong Kong SAR's Inward FDI Positions By Origin

% of total
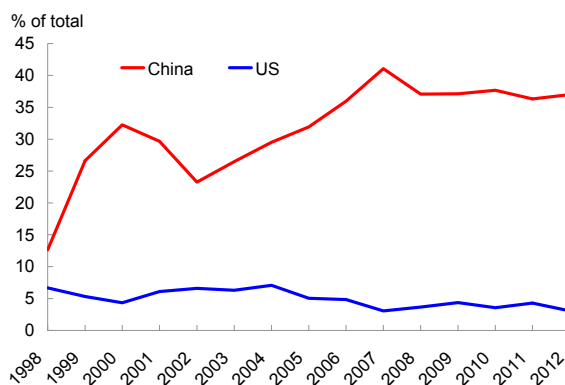
Figure 5. Hong Kong SAR's Outward FDI Positions By Destination

% of total
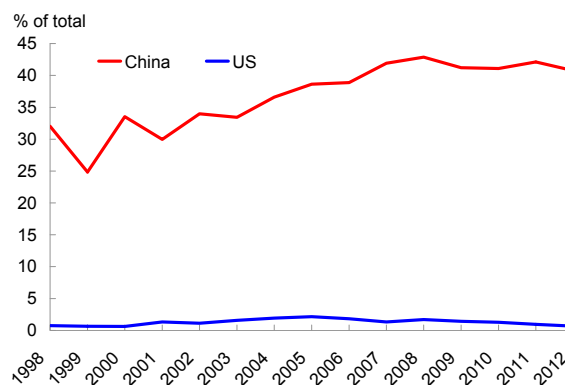
Figure 6. Share of Mainland Companies in Hong Kong Stock Market Capitalization

% of total
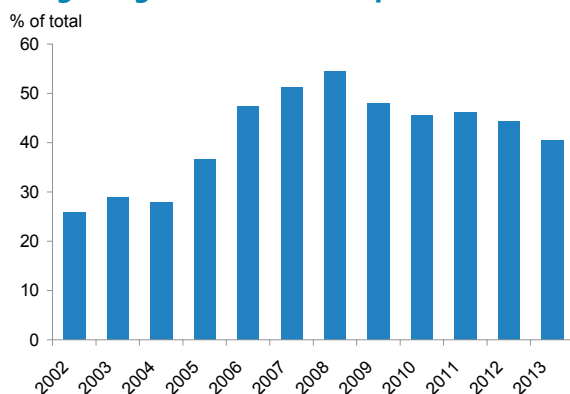
Figure 7. Issuance of Offshore Renminbi Bonds in Hong Kong SAR

RMB bn
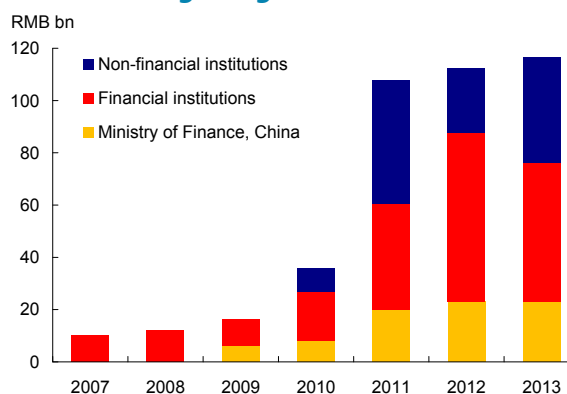
Sources: CEIC; C&SD; Hong Kong Stock Exchange, Newswires; and authors' estimates.

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 percent of total tourism services exports in 2000 to over 66 percent in 2012, whereas the U.S. share dropped from 11 percent to 4 percent over the same period, as illustrated in Figure 8. The secular trend in tourism services exports to mainland China not only reflects mainland's demand for Hong Kong's tourism services, but has also contributed to Hong Kong's transformation toward a service-based economy in 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 labor productivity as shown in Figure 9. Such rise in labor productivity has been underpinned by strong total factor productivity (TFP) growth as a result of the expansion of services export sector as suggested by Leung, Han, and Chow (2009), whereby a large part of TFP growth might have been boosted by the increasing financial linkages between Hong Kong SAR and the mainland, especially 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 SAR's trend growth.

Figure 8. Shares in Hong Kong SAR Tourism Services Exports (value-added)
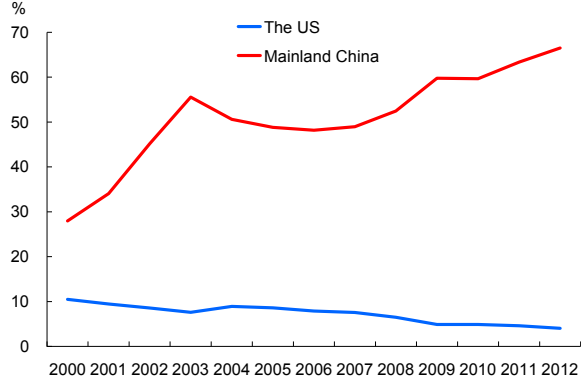
Figure 9. Hong Kong SAR's Labor Productivity and Service Sector Growth

Sources: CEIC; C&SD and authors' estimates.
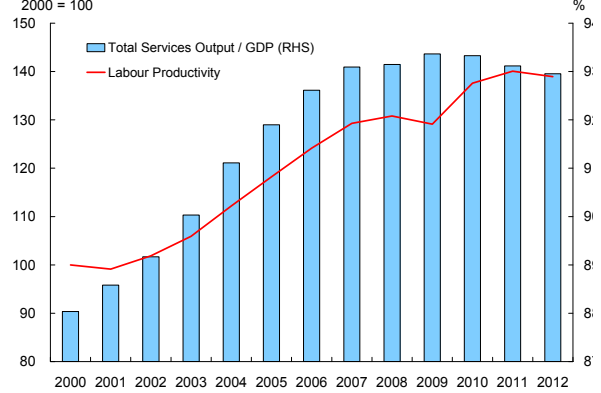
III.   ESTIMATING TRENDS AND CYCLES

A.   Model Motivation

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

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

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

$$A_t = e^{g_t} A_{t-1} = \prod_{s=0}^{t} e^{g_s} \tag{2}$$

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

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

$$U = \sum_{t=0}^{\infty} \beta^t u(C_t, \varepsilon_t, 1 - L_t) \tag{3}$$

where ε_t denotes consumption shock, a demand shock that has temporary effect. Agents optimally respond to productivity and demand shocks by smoothing their consumption over

8

time, and their responses 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 would only respond to permanent shocks, conditional on the agents' information on the types of shock. If a balanced growth path exists in the above model, output and consumption will grow at a rate determined by the trend growth (g_t). In other words, output and consumption share a common stochastic trend.

Guidance from the 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 literature have used consumption and output data to identify the trend component (A_t) of output using the permanent income hypothesis as an identification scheme. Some of the studies in the extensive literature include 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, or namely the "permanent income." The difference between the actual output and the stochastic trend is the "transitory income." As a robustness check, we follow Kim and Piger (2000) which use consumption as a proxy to the stochastic trend of output, and decompose output into trends and cycles accordingly as shown in Appendix C.

Next, we establish the fact that consumption in Hong Kong SAR and mainland China do follow the permanent income hypothesis. We then introduce the state-space models that we use to decompose output trend and cycle.

B. Test for Permanent Income Hypothesis

The data we use are real GDP and real consumption of Hong Kong SAR, mainland China and the United States in quarterly frequencies, and all data end on the second quarter of 2013. The seasonally adjusted real GDP data for Hong Kong starts from the first quarter of 1973, and the series for the United States starts from the first quarter of 1947.[2] The construction of quarterly real GDP series for mainland China requires our own seasonal adjustment and calculations based on several series, and the constructed series begins from the first quarter of 1978.[3]

As for real consumption data, we use headline real personal consumption expenditure (PCE) for Hong Kong SAR and the United States. Since quarterly real consumption data for

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

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.[4]

The use of U.S. consumption and output data to construct permanent income has well been studied in the literature. We therefore assume that the permanent income hypothesis holds for U.S. consumption. To test whether the hypothesis holds for consumption in Hong Kong SAR 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 random walk consumption 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 the unit root tests results on log real GDP, log consumption, and the gap between the two for Hong Kong SAR and mainland China respectively.[5] We cannot reject the unit root for output and consumption for both Hong Kong SAR and mainland China at the 5 percent level, but as one might suspect, we can confidently reject unit root for the first difference of output and consumption for both economies at the 1 percent level, meaning that these series are integrated of order one, or I(1). We also reject unit root for the output-consumption gaps at the 5 percent level, implying cointegration, or the existence of a stochastic trend, between output and consumption for both economies.

Next, we conduct the Johansen cointegration test and show that there exists a cointegrating vector in each pair of output and consumption. The results are reported in Table 2. The null hypothesis of no cointegrating vectors between output and consumption is rejected at the 5 percent level for the case of Hong Kong SAR, and at 5 and 10 percent levels for the case of

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[4] Real retail sales are constructed using nominal retail sales data deflated by 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 the cointegration test we have conducted, the series does not represent value-added consumption, unlike the PCE series used for Hong Kong and the United States. The resulting estimate of stochastic trend may not necessarily capture the real permanent income in terms of value-added. The use of the estimated real consumption data, however, can circumvent this problem.

[5] 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 $\hat{z}_t = y_t - 1.7 - 1.18 c_t$.

mainland China according to the different test statistics. The null hypothesis of having one cointegrating vector is not rejected among all tests. This again confirms that the output and consumption do share a common stochastic trend in both economies.

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

| | Hong Kong SAR | | Mainland China | |
	Lags of differences 1/	p-value 2/	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	...	0.0	...	0.0
Δc_t	...	0.0	...	0.0

1/ 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 percent level for a standard t-test.

2/ 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 SAR	Mainland China
Null hypothesis	p-value 1/	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

1/ MacKinnon-Haug-Michelis p-value.

The permanent income hypothesis suggests that consumption responds to changes in permanent income, but with minimal response to changes in transitory income. In other words, consumption cannot be predicted by short-term income flucutations should 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 being controlled for. Given that consumption and output in Hong Kong SAR and mainland China are I(1) processes, and that the two series are cointegrated for the respective economies, the theoretic cointegration vector is (1, -1). We make use of this fact and run a

VECM by restricting the long-run equation coefficient of output following Cochrane (1994). We also estimate an unrestricted version of VECM for comparison.

Tables 3 and 4 show the VECM results for Hong Kong SAR and mainland China. The error correction coefficients suggest Hong Kong SAR's consumption adjusts at a quarterly frequency that is equivalent to 7 to 8 percent of the deviation from the long-run consumption, and at a speed of adjustment of 9 to 10 percent of the consumption deviation in mainland China. The speeds are much faster than those found in Cochrane (1994) and Morley (2007). Next, we focus on testing if consumption does not respond to anticipated transitory income change, following the form of permanent income hypothesis in Hall (1978). Our results, however, suggest that consumption does exhibit some responses to changes in transitory income. The coefficient on the first lagged output growth in the consumption growth equation is positive and significant at the 5 percent level under the restricted VECM for the case of Hong Kong SAR, and is positive and significant in both VECMs for the case of mainland China. The results suggest that after controlling for the long-term relationship between consumption and output, 1 percentage point increase in lagged transitory output can still predict about 0.2 percentage point increase in Hong Kong SAR's consumption and about 0.16 to 0.18 percentage point increase in mainland's consumption.

Even though our results suggest that consumption of Hong Kong SAR and mainland China do not strictly follow the permanent income hypothesis, we should not readily 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 U.S. data, which implies that half of the U.S. consumers are the so-called rule-of-thumb consumers who consume their current income rather than permanent income.

Table 3. VECM of Output and Consumption for Hong Kong SAR 1/				
	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	0.2
	(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}	0.12	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	0.0	0.0	-0.001	0.005
	(0.005)	(0.004)	(0.004)	(0.004)
R^2	0.4313	0.4028	0.4458	0.394

1/ Standard errors reported in parentheses.

A plausible explanation behind the positive impact of anticipated transitory income change on consumption is that there are two types of consumers: one type with liquidity constraint who will respond to a temporary income shock, and another type who only respond to changes in permanent income. 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 percent of total) households, the constrained household consumption responds positively to lagged income growth, while the unconstrained group 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 would still behave as predicted by the permanent income hypothesis.

Table 4. VECM of Output and Consumption for Mainland China 1/

	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	0.09	-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	0.14	-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

1/ Standard errors reported in parentheses.

C. Trends Versus Cycles: A Structural Identification

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

We decompose the real output into their respective trends and transitory components by estimating the following UC model:

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

$$c_t^i = \bar{c}^i + \gamma_c^i \tau_t^i + u_{ct}^i \tag{4}$$

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

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:

$$\phi_y^i(L)u_{yt}^i = \varepsilon_{yt}^i \tag{5}$$

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

where ε_{yt}^i and ε_{ct}^i are shocks to temporary income and consumption respectively. The lag polynomials are normalized 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 $\Theta \sim \text{iid } N(0, \Omega)$, where shocks can be correlated with each other. In our estimation, we assume AR (1) processes for the transitory income and consumption.

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

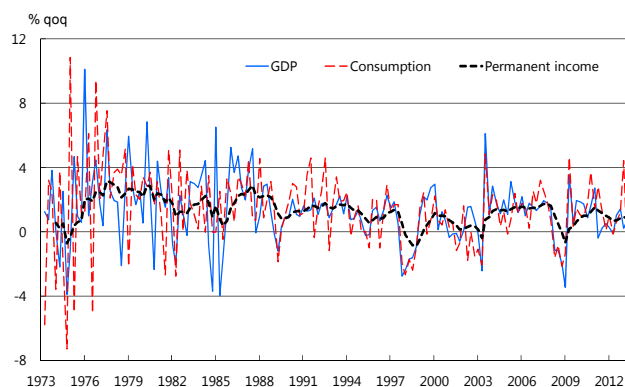**Figure 10. Growth of GDP, Consumption, and Permanent Income for Hong Kong SAR**

Figure 11. Growth of GDP, Consumption, and Permanent Income for Mainland China
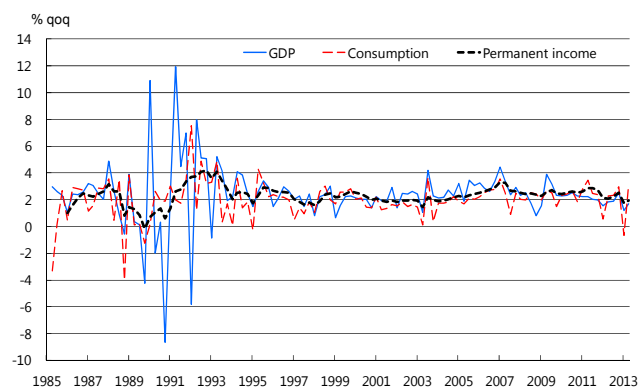
Figure 12. Growth of GDP, Consumption, and Permanent Income for United States
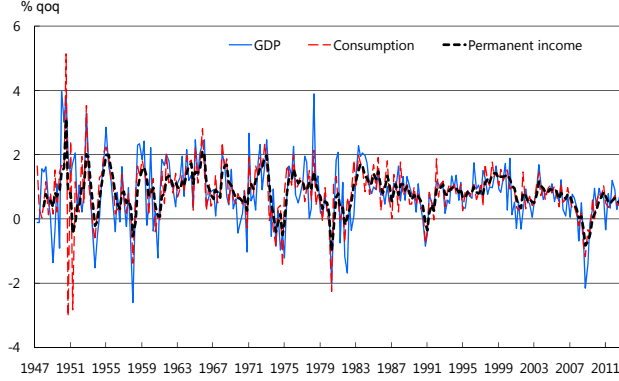
IV. TRANSMISSION OF PERMANENT AND TRANSITORY SHOCKS

A. The Transmission of Transitory Shocks

In this section, we analyze how transitory shocks are transmitted across Hong Kong SAR, mainland China and the United States. We estimate a hierarchical structural vector autoregression (SVAR) model following Genberg (2005) and Genberg, Liu, and Jin (2006), which is given by:

$$
\begin{pmatrix} A_0^{HH} & A_0^{HC} & A_0^{HU} \\ 0 & A_0^{CC} & A_0^{CU} \\ 0 & A_0^{UC} & A_0^{UU} \end{pmatrix} \begin{pmatrix} X_t^{HK} \\ X_t^{CN} \\ X_t^{US} \end{pmatrix} = \begin{pmatrix} A^{HH}(L) & A^{HC}(L) & A^{HU}(L) \\ 0 & A^{CC}(L) & A^{CU}(L) \\ 0 & A^{UC}(L) & A^{UU}(L) \end{pmatrix} \begin{pmatrix} X_{t-1}^{HK} \\ X_{t-1}^{CN} \\ X_{t-1}^{US} \end{pmatrix} + \begin{pmatrix} u_t^{HK} \\ u_t^{CN} \\ u_t^{US} \end{pmatrix} \quad (6)
$$

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 SAR, mainland China or the United States. The mainland and U.S. blocks include U.S. transitory output, U.S. inflation, the three-month U.S. Treasury bill rates, and mainland's transitory output and inflation. The Hong Kong block includes those variables in the mainland and U.S. blocks, with the addition of Hong Kong SAR transitory output and inflation. u_t^i is the 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 shocks from the United States can affect mainland China and Hong Kong SAR, but also shocks from mainland China can affect the United States as well. Since Hong Kong SAR is a small open economy, it is affected by the mainland and U.S. transitory output and inflation shocks, and U.S. interest rate shocks, but not vice versa.

We take into account the handover of Hong Kong SAR 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 subperiods: between 1985:Q1 and 1997:Q2, and between 2003:Q4 and 2013:Q2 where we skipped the period between Asian financial crisis

and the SARS outbreak when the Hong Kong economy had gone through a prolonged period of deflation.

The results on variance decompositions of forecast errors of Hong Kong SAR's output and inflation are shown in Table 5. Shocks originating from Hong Kong SAR dominate the impact on its own output and inflation variations in the short-term horizons during both sample periods.[6] However, the U.S. shocks exert much larger impact on the Hong Kong economy in the longer term. For instance, when we look at the 20-quarter horizon, the U.S. shocks can explain about 57 percent of Hong Kong SAR's output fluctuations in the earlier period, and about 48 percent in the latter period, both of which are larger than the contributions from shocks originating from mainland China and Hong Kong SAR. The long-run influence of the mainland shocks on Hong Kong SAR's inflation had become larger at about 36 percent of inflation variations in the latter period, while the U.S. influence still accounts for about 37 percent of Hong Kong SAR's inflation variations after dominating in the earlier period.

Table 5. Variance Decompositions of Transitory Shocks for Hong Kong SAR						
1985:Q1 to 1997:Q2	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	42.95
10	52.055	13.3	34.645	58.304	7.59	34.106
20	57.084	13.68	29.237	59.266	7.795	32.938
2003:Q4 to 2013:Q2						
1	16.5	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	35.91	27.234
20	47.622	28.657	23.721	37.012	35.992	26.996

B.   The Transmission of Permanent Shocks

As shown in the previous section, we find that the mainland played a smaller role in driving Hong Kong SAR's business cycle fluctuations compared to the United States. However, given the continuing economic and financial integration between Hong Kong SAR and the mainland, the mainland's influence on Hong Kong SAR might have become more pronounced at the trend cycle freqency instead. As we discussed in Section II, Hong Kong SAR and the mainland are bonded through financial integration and FDI flows. In particular, a large part of TFP growth boosted by increasing financial linkages, for instance, through the expansion in supply of mainland-related financial products in the Hong Kong SAR financial market, might have been driving the trend

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[6] 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.

growth of Hong Kong SAR and mainland China to become more synchronized.

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

$$
\begin{pmatrix} b_0^{HH} & b_0^{HC} & b_0^{HU} \\ 0 & b_0^{CC} & b_0^{CU} \\ 0 & b_0^{UC} & b_0^{UU} \end{pmatrix} \begin{pmatrix} \hat{\tau}_t^{HK} \\ \hat{\tau}_t^{CN} \\ \hat{\tau}_t^{US} \end{pmatrix} = \begin{pmatrix} b^{HH}(L) & b^{HC}(L) & b^{HU}(L) \\ 0 & b^{CC}(L) & b^{CU}(L) \\ 0 & b^{UC}(L) & b^{UU}(L) \end{pmatrix} \begin{pmatrix} \hat{\tau}_{t-1}^{HK} \\ \hat{\tau}_{t-1}^{CN} \\ \hat{\tau}_{t-1}^{US} \end{pmatrix} + \begin{pmatrix} \varepsilon_t^{HK} \\ \varepsilon_t^{CN} \\ \varepsilon_t^{US} \end{pmatrix} \tag{7}
$$

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

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

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

Table 6. Variance Decomposition of Permanent Shocks for Hong Kong SAR			
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	49.52
2003Q4—2013Q2			
1	4.935	4.735	90.33
4	15.6	42.683	41.667
10	31.818	58.99	9.192
20	29.808	65.27	4.922

V. CONCLUSIONS

In this paper we have used structural models to disentangle the stochastic trend and the transitory components of output in Hong Kong SAR, mainland China and the United States, and to investigate the interactions among these economies in trends and in cycles. We have found that the U.S. transitory shocks have remained the dominant forces driving Hong Kong SAR's business cycle fluctuations, and transitory shocks from mainland China have played a less important role. However, when it comes to the permanent shocks, the picture turns into the opposite: the permanent shocks from the mainland explained a much larger portion of Hong Kong SAR's trend volatility in output that those from the United States.

Our findings suggest that at the business cycle frequencies, Hong Kong SAR is still more synchronized with the United States than with mainland China. Since it is the similarity of cyclical shocks that matter the most for the choice of exchange rate regime, the LERS, which links the Hong Kong dollar to the U.S. dollar, would continue to be appropriate for the foreseeable future. On the other hand, Hong Kong SAR 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 characterized by higher productivity. Active exchange of human capital and knowledge has been propagating the longer-term productivity progress across the border.

Appendix A: The Construction of Value-Added Exports

A. 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 into value-added terms before computing merchandise exports by destination.

Domestic exports

To arrive at the estimates of Hong Kong SAR's domestic export to mainland China in value-added terms, we subtract outward processing domestic exports from headline domestic export using data from Hong Kong SAR'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 SAR's domestic export to the United States in value-added terms, we add to the headline domestic exports to United States from C&SD data with our estimates of Hong Kong SAR processing trade to mainland China which are then re-export to the United States based on China Custom data. This attempts to capture the total final demand of Hong Kong SAR domestic exports from the United States 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 export in value-added terms is the headline total domestic exports subtracted by outward processing domestic exports, and further strip out the proportion of sales attributable to purchases of materials and supplies based on the data from C&SD.

Re-exports

The adjustments on re-exports are similar to those being made on domestic exports, except that we make use of the outward process re-exports data for consistency. To arrive at the total re-exports and re-exports by destinations in value-added terms, we estimate the rates 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 destinations are from the data of gross margin from merchanting in C&SD's Offshore Trade in Goods tables.

B. 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 U.S. shares in Hong Kong SAR merchandise exports, services exports excluding tourism, tourism services exports and financial services exports, all in value-added terms.

Percent of Total	Merchandise		Services (excluding tourism)		Tourism Services		Financial Services	
	Mainland China	U.S.	Mainland China	U.S.	Mainland China	U.S.	Mainland China	U.S.
Year								
2000	13.1	33.8	14	25.3	28	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	7.6	3.2	32
2008	20.5	22.5	13.1	24.8	52.5	6.5	3.8	34.5
2009	19.5	23.7	14	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	15.9	22.8	63.4	4.6	5.1	33.6
2012	21.8	24.7	16	22.5	66.5	4	4.2	33.4

Table A1. Mainland China and U.S. Shares in Hong Kong SAR Exports in Value-Added Terms

Sources: C&SD; and authors' estimates.

Appendix B: Coefficient Estimates of State-Space Models

This section of the appendix shows the coefficient estimates of unobserved component (UC) model using Hong Kong SAR and U.S. output and consumption data, and the coefficient estimates of the dynamic factor model using data from mainland China.

Table A1. Coefficient Estimates of State-Space Models

	Hong Kong SAR	Mainland China	U.S.
γ_c^i	1.075	0.869	0.993
	(0.10)	(0.07)	(0.05)
$\phi_{y,1}^i$	-0.023	-0.184	0.068
	(0.09)	(0.10)	(0.06)
$\phi_{c,1}^i$	-0.456	-0.331	-0.439
	(0.080)	(0.124)	(0.085)
σ_v^i	0.365	0.415	0.377
	(0.0)	(0.0)	(0.0)
$\sigma_{\varepsilon y}^i$	1.822	2.114	0.7
	(0.007)	(0.005)	(0.0)
$\sigma_{\varepsilon c}^i$	2.079	1.107	0.479
	(0.008)	(0.001)	(0.0)
$\rho_{v,\varepsilon y}^i$	0.194	0.175	0.266
	(0.015)	(0.069)	(0.0)
$\rho_{v,\varepsilon c}^i$	0.264	0.299	0.447
	(0.001)	(0.002)	(0.0)
$\rho_{\varepsilon y,\varepsilon c}^i$	0.439	0.118	0.562
	(0.0)	(0.222)	(0.0)

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 United States 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 IV.A.

We estimate the cointegrating coefficients using the Stock-Watson Dynamic OLS (DOLS) method. We select the preferred cointegration relation by looking at both the Akaike Information Criterion (AIC) and the Schwarz Information Criterion (BIC).

We report the estimates of the cointegrating coefficient in Table C1. The numbers in parenthesis below each estimate are adjusted R^2, AIC and BIC respectively. In general, we prefer a high R^2, and low AIC and BIC. We select model based on AIC and BIC criteria, as well as likelihood ratio test.

Table C1. Estimating the Cointegration Relation			
	Mainland China	U.S.	Hong Kong SAR
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)
	1.0626	0.9127	1.0567
DOLS with 2 lags/leads	(0.9962,6.61 6.78)	(0.9982, 2.84, 3.01)	(0.9728, 6.26, 6.43)
	1.0664	0.9140	**1.0691**
DOLS with 3 lags/leads	(0.9963, 6.56, 6.79)	(0.9980, 2.85, 3.08)	(0.9732, 6.24, 6.47)
	1.0699	0.9159	1.0805
DOLS with 4 lags/leads	(0.9964, 6.50, 6.79)	(0.9981, 2.86, 3.13)	(0.9733, 6.24, 6.52)
	1.0751	0.9177	1.0917
DOLS with 5 lags/leads	(0.9968, 6.39, 6.73)	(0.9981, 2.87, 3.19)	(0.9734, 6.24, 6.57)
	1.079		
DOLS with 6 lags/leads	(0.9969, 6.34, 6.74)		
	1.0828		
DOLS with 7 lags/leads	(0.9970, 6.29, 6.75)		

The cointegration vectors for all the three economies are close to the theory-implied value (1, -1).[7] We use the following estimates for the factor loadings on trends to compute the transitory components as shown in Table C2:

We estimate the SVAR model described in Section IV.A using the alternative measures of transitory outputs, inflation rates of the three

Table C2. Transitory Components of Outputs
$\widetilde{y}_t^{CN} = y_t^{CN} - 1.0751 * c_t^{CN}$
$\widetilde{y}_t^{HK} = y_t^{HK} - 1.0691 * c_t^{HK}$
$\widetilde{y}_t^{US} = y_t^{US} - 0.9113 * c_t^{US}$

economies, as well as the three-month U.S. Treasury bill rates, at quarterly frequency. We also estimate the alternative model described in Section IV.B. Table C3 reports the variance decompositions of forecast errors of Hong Kong SAR's output and inflation. The U.S. transitory shocks had a large impact on Hong Kong SAR before 1997, explaining more than 50 percent of Hong Kong SAR's output fluctuation in the 4-quarter horizon, and even larger in the longer horizons. In the latter sample period, the U.S. shocks were still important behind Hong Kong

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[7] 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.

SAR's business cycles, but the magnitude of their impact decreased at all frequencies. The mainland shocks' effect on Hong Kong SAR's real economy also dropped, implying that Hong Kong SAR's economic integration with the mainland did not increase output co-movement between the two economies at the business cycle frequencies. Nevertheless, consistent with our previous results where we used transitory income generated from state-space models, the U.S. transitory shocks remained a dominant force behind Hong Kong SAR's business cycle.

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

Table C3. Variance Decompositions of Transitory Shocks for Hong Kong SAR

1985:Q1 to 1997:Q2	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
1999:Q1 to 2012:Q4						
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

Table C4. Variance Decomposition of Permanent Shocks for Hong Kong SAR

1985:Q1 to 1997:Q2	Output		
Horizon (in quarters)	Trend_US	Trend_CN	Trend_HK
1	17.919	3.258	78.823
4	53.869	10.413	35.718
20	83.846	12.712	3.442
1997:Q3 to 2003:Q4			
1	15.582	1.688	82.730
4	34.619	6.450	58.931
20	51.925	5.750	42.325
2004:Q1 to 2013:Q2			
1	11.015	23.924	65.061
4	13.183	32.967	53.581
20	11.606	42.724	46.67

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