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Stylised facts on business cycles in Hong Kong

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Abstract

This article explores the stylised facts of Hong Kong's business cycles. Cyclical components of the economic time series are obtained through X13-ARIMA deseasonalisation and HP filter detrending and are analysed in terms of their cyclicality and lead-lag relationship with the cyclical components of real GDP. The Hang Seng Index, hotel occupancy rate, number of S&P agreements for residential building units, effective exchange rate index, air cargo throughput, and number of average daily cross-boundary vehicle movements are identified as leading economic indicators in Hong Kong. Generally speaking, the business cycles in Hong Kong share similar properties as those in the United States.

香港經濟周期的典型事實

摘要

本文探討香港經濟周期的典型事實。通過 X13-ARIMA 消除季節性因素和 HP 濾器剔除趨勢得出經濟時間序列的循環波動成分，並分析與實質本地生產總值的循環波動成分的周期性和超前滯後關係。恆生指數、酒店入住率、住宅物業買賣合約總數、港匯指數、空運貨物吞吐量及平均每日跨境車輛流量均被確定為香港經濟的領先指標。整體而言，香港的經濟周期與美國的經濟周期具有相似的特性。

I. INTRODUCTION

1. This article aims to establish the stylised facts of Hong Kong's business cycles. Based on the United States' data, Nobel laureate Robert E. Lucas, Jr. has strongly made the point that "business cycles are all alike".[1] What he meant is that co-movements among economic variables have many common features over the business cycle. For example, when real income rises, real consumption usually also rises, and vice versa. These are known as **Business Cycle Facts**. Knowing these facts is useful for interpreting economic data and predicting movements of economic variables.

2. Two features of the cyclical behaviour of economic variables are important for understanding business cycles. First is the direction of movement of the economic variables relative to the direction of aggregate economic activity, i.e. the cyclicality of the economic variables. If a variable moves in the same direction as aggregate economic activity, it is **procyclical**. If the variable moves in the opposite direction, it is **countercyclical**. If the variable displays no clear pattern over the business cycle, it is **acyclical**. Second is the timing of the economic variables' turning points (peaks and toughs) relative to the turning points of aggregate economic activity, i.e. the lead-lag relationship of the economic variables. If a variable tends to move in advance of aggregate economic activity, it is a **leading** variable. If the variable moves in tandem with aggregate economic activity, it is a **coincident** variable. If the variable moves after aggregate economic activity, it is a **lagging** variable.

3. Standard economics textbooks usually describe the cyclical behaviour of macroeconomic variables based on the United States' data.[2] In comparison, this research aims to establish Business Cycle Facts for Hong Kong using the most updated economic data from Hong Kong.

II. DATA AND METHODOLOGY

4. The quarterly time series for 30 economic variables (expenditure, labour market, price, property market, financial market, tourism, and logistics and transport variables; see the data definitions listed after ***Table 1***) in Hong Kong from 1973Q1 to 2018Q4 have been assembled.[3]

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[1] Lucas, R.E. (1995). "Understanding business cycles." In *Essential readings in economics*. Palgrave: London, 306-327. Also see Moore (1961) for some early work on this field. Moore, G.H. (1961). "Leading and Confirming Indicators of General Business Changes." *Business Cycle Indicators*, Vol. 1. NBER Book Series Studies in Business Cycles.

[2] Abel, A.B., Bernanke, B.S., and Croushore, D. (2008). *Macroeconomics*, 6th ed. Pearson: Hong Kong.

[3] Hong Kong GDP and its component data are available starting from 1973Q1. For other variables, data starting from their earliest available dates are used.

Table 1 : Cyclical Behaviour of Hong Kong's Economy: Deviations from Trend of Key Variables, 1973:I - 2018:IV (HP-filtered, X13-ARIMA deseasonalised)

	Relative standard deviation *	Cross-correlation with GDP (Lead: +; Lag: -)											Auto-correlation
		GDP(-5)	GDP(-4)	GDP(-3)	GDP(-2)	GDP(-1)	GDP(0)	GDP(1)	GDP(2)	GDP(3)	GDP(4)	GDP(5)	
Expenditure													
Real GDP	1.00	-0.12	0.06	0.35	0.56	0.78	1.00	0.79	0.55	0.35	0.06	-0.16	0.78
Real consumption	0.98	0.12	0.27	0.46	0.54	0.65	0.66	0.59	0.44	0.23	0.05	-0.18	0.69
Real gross domestic fixed capital formation	2.00	0.16	0.38	0.52	0.55	0.63	0.59	0.45	0.23	0.06	-0.12	-0.19	0.71
Change in real inventories	0.78	-0.18	-0.25	-0.20	-0.08	0.09	0.22	0.21	0.13	0.11	0.06	0.00	0.45
Real government expenditure	0.90	-0.01	-0.09	-0.03	0.00	-0.07	-0.04	-0.06	-0.10	-0.05	-0.09	-0.19	0.33
Real exports of goods	2.03	-0.18	-0.01	0.27	0.47	0.63	0.78	0.67	0.51	0.31	0.10	-0.11	0.76
Real exports of services	1.53	-0.24	-0.15	0.02	0.21	0.45	0.70	0.64	0.59	0.47	0.29	0.09	0.64
Real imports of goods	2.18	-0.12	0.06	0.29	0.48	0.64	0.71	0.65	0.51	0.29	0.14	-0.08	0.79
Real imports of services	1.60	0.02	0.11	0.27	0.40	0.50	0.58	0.53	0.40	0.24	0.09	-0.13	0.64
Labour market													
Nominal wages	0.62	0.33	0.33	0.33	0.28	0.23	0.12	-0.04	-0.22	-0.32	-0.39	-0.38	0.71
Unemployment rate		-0.07	-0.29	-0.52	-0.67	-0.75	-0.71	-0.48	-0.26	-0.04	0.14	0.30	0.84
Underemployment rate		-0.16	-0.33	-0.50	-0.63	-0.69	-0.64	-0.43	-0.19	0.07	0.30	0.45	0.72
Prices													
Consumer price index	0.59	0.32	0.33	0.29	0.23	0.14	-0.01	-0.16	-0.29	-0.38	-0.41	-0.37	0.88
Inflation		-0.04	0.08	0.13	0.22	0.34	0.36	0.30	0.24	0.08	-0.04	-0.13	0.00
Effective exchange rate index	1.25	0.09	0.12	0.13	0.03	-0.11	-0.23	-0.32	-0.32	-0.25	-0.16	0.01	0.77
Property market													
Residential property price index	3.70	0.05	0.14	0.26	0.38	0.45	0.49	0.43	0.29	0.14	-0.02	-0.12	0.88
Residential property rental index	2.26	0.03	0.21	0.43	0.68	0.82	0.79	0.57	0.22	-0.10	-0.36	-0.51	0.82
Residential property transaction	10.13	-0.07	-0.16	-0.19	-0.11	0.04	0.28	0.36	0.32	0.18	-0.04	-0.19	0.59
Financial market													
Hang Seng Index	5.84	-0.36	-0.30	-0.14	0.08	0.34	0.64	0.74	0.67	0.53	0.33	0.12	0.67
1-month HIBOR		0.01	0.17	0.33	0.48	0.50	0.51	0.48	0.33	0.30	0.20	0.07	0.66
M1	2.54	-0.37	-0.49	-0.49	-0.43	-0.20	-0.02	0.17	0.27	0.24	0.11	-0.04	0.73
M2	1.19	0.25	0.33	0.40	0.40	0.43	0.43	0.41	0.33	0.19	0.00	-0.19	0.86
Tourism													
Overnight visitor arrivals	4.87	-0.44	-0.30	-0.09	0.22	0.42	0.55	0.26	0.26	0.12	0.05	0.06	0.09
Same-day-in-town (SDIT) arrivals	4.17	-0.16	-0.10	0.02	0.19	0.25	0.51	0.21	0.19	0.04	-0.04	-0.03	0.22
Hotel occupancy rate		-0.22	-0.18	-0.12	0.13	0.51	0.77	0.78	0.63	0.34	0.01	-0.22	0.66
Average achieved hotel room rate	2.86	0.23	0.43	0.63	0.76	0.83	0.78	0.57	0.36	0.17	0.01	-0.10	0.85
Logistics and Transport													
Total container throughput	3.49	-0.17	-0.17	-0.08	0.08	0.22	0.23	0.14	-0.15	0.02	-0.01	0.05	0.09
Air cargo throughput	2.10	-0.69	-0.76	-0.75	-0.50	-0.08	0.45	0.75	0.85	0.67	0.29	-0.13	0.73
Air passenger	4.82	0.10	0.11	0.15	0.23	0.33	0.52	0.25	0.22	0.08	0.02	0.01	0.12
Average daily cross-boundary vehicles	0.63	-0.74	-0.75	-0.56	-0.19	0.05	0.43	0.53	0.56	0.55	0.52	0.47	0.68

Data definition:

Real GDP	Gross domestic product (in chained (2016) dollars)
Real consumption	Private consumption expenditure (in chained (2016) dollars)
Real gross domestic fixed capital formation	Gross domestic fixed capital formation (in chained (2016) dollars)
Change in real inventories	Changes in inventories (in chained (2016) dollars)
Real government expenditure	Government consumption expenditure (in chained (2016) dollars)
Real exports of goods	Exports of goods (in chained (2016) dollars)
Real exports of services	Exports of services (in chained (2016) dollars)
Real imports of goods	Imports of goods (in chained (2016) dollars)
Real imports of services	Imports of services (in chained (2016) dollars)
Nominal wages	Nominal payroll indices per person engaged (1999Q1 = 100)
Unemployment rate	Unemployment rate (not seasonally adjusted) (%)
Underemployment rate	Underemployment rate (%)
Consumer price index	Composite consumer price index (October 2014 - September 2015 = 100)
Inflation	Quarter-to-quarter change in composite consumer price index (October 2014 - September 2015 = 100)
Effective exchange rate index	Effective exchange rate indices for Hong Kong Dollar (January 2010=100)
Residential property price index	RVD's residential property price index (nominal) (1999=100)
Residential property rental index	RVD's residential property rental indices (nominal) (1999=100)
Residential property transaction	Number of S&P agreements for residential building units (Land Registry)
Hang Seng Index	Hang Seng Index (period end)
1-month HIBOR	1-month HIBOR (percent per annum)
M1	M1 (HK$Mn)
M2	M2 (HK$Mn)
Overnight visitor arrivals	Number of overnight visitor arrivals ('000)
Same-day-in-town (SDIT) arrivals	Number of same-day-in-town arrivals ('000)
Hotel occupancy rate	Hotel occupancy rate (%)
Average achieved hotel room rate	Average achieved hotel room rate (HK$)
Total container throughput	Total container throughput ('000 TEU's)
Air cargo throughput	Air cargo throughput ('000 Tonnes)
Air passenger	Air passenger ('000)
Average daily cross-boundary vehicles	Average daily cross-boundary vehicle movements

Note : (*) GDP volatility is used as the base to calculate the relative standard deviation.

5. Every economic time series variable can be decomposed into seasonal, trending (growth), and cyclical (business cycle) components. To investigate the business cycle properties of various economic variables, they first need to be deseasonalised and detrended to obtain the cyclical components for analysis.

- For deseasonalisation, the U.S. Census Bureau's X13-ARIMA model is employed to obtain the seasonally adjusted time series for the economic variables. This adjustment involves the following multiplicative seasonal ARIMA regression model:[4]

$$\phi(B)\Phi(B^s)(1-B)^d(1-B^s)^D(y_t - \sum_i \beta_i x_{it}) = \theta(B)\Theta(B^s)a_t$$

  where y_t is the time series, ϕ and θ are the nonseasonal autoregressive and moving average operators, Φ and Θ are their seasonal counterparts, $(1-B)^d$ and $(1-B^s)^D$ are nonseasonal differencing of order d and seasonal differencing of order D, x_{it} are regression variables (such as trading day effects, outliers, leap years, Easter Holiday, etc.), and a_t is i.i.d. white noise. The seasonally adjusted time series is obtained by removing the estimated seasonal components identified from the above regression.

  Chart 1 illustrates this process using Hong Kong's real GDP time series. The original real GDP time series (in blue) displays obvious up-and-down seasonal patterns, which are removed after applying the X13-ARIMA seasonal adjustment (the adjusted series is in red).

- For detrending, the Hodrick-Prescott filter (HP filter), the standard method to remove trend movements in the business cycle literature, is applied to the X13-ARIMA-adjusted time series to obtain the detrended and deseasonsalised time series of the economic variables. By defining y_t as the economic variable, τ_t as the trend component, $(y_t - \tau_t)$ as the detrended component, and λ as the smoothing parameter (usually set at 1 600 for quarterly data), the HP filter involves solving the following minimization problem:

$$\min_{\{\tau_t\}} \sum_{t=1}^{T}(y_t - \tau_t)^2 + \lambda \sum_{t=1}^{T-1}(y_t - \tau_t)^2[(\tau_{t+1} - \tau_t) - (\tau_t - \tau_{t-1})]^2$$

[4] U.S. Census Bureau (2018). *X-13ARIMA-SEATS Reference Manual*. Available online at https://www.census.gov/ts/x13as/docX13AS.pdf .

6. As depicted in ***Chart 2*** (the green line), the HP filter is applied to construct a trending component that replicates the time-varying growth trend of the X13-ARIMA-adjusted real GDP series (the red line). Taking the difference between the two series yields a series of the HP-filtered residuals (displayed in ***Chart 3***), which is the cyclical component to be used in business cycle analysis.

7. The quarterly time series for 30 economic variables in Hong Kong are deseasonalised by X13-ARIMA and then detrended by the HP filter to obtain the cyclical components.[5] For each economic variable, the cross-correlation between its cyclical component and the cyclical component of real GDP are computed. This exercise is repeated by leading and lagging the cyclical component of the economic variable by up to five quarters, that is,

$$Corr(X_i,\ real\ GDP_t), \text{ where } i = integer[t-5, t+5]$$

is calculated where X_i is the cyclical component of the economic variable at time i and $real\ GDP_t$ is the cyclical component of the log of real GDP at time t.

8. ***Table 1*** depicts the cross-correlation results for identifying the cyclicality and lead-lag relationship of the economic variables. A variable is identified as procyclical if $Corr(X_t,\ real\ GDP_t) > 0.1$, countercyclical if $Corr(X_t,\ real\ GDP_t) < -0.1$, and acyclical otherwise. Procyclical and countercyclical variables are identified as leading if the largest cross-correlation occurs at $[t-5, t-1]$, coincident if it occurs at t, and lagging if it occurs at $[t+1, t+5]$.[6] The second column and the last column of *Table 1* depict the volatility of the cyclical component of the economic variable with respect to real GDP and the autocorrelation of the cyclical component respectively.

[5] For variables stated in level terms (except changes in inventories which periodically take on negative values), the natural logarithm of the time series is used.

[6] The methodology follows Kydland and Prescott (1990), except they did not state the exact thresholds for categorising the variables as cyclical or acyclical. In this article, the thresholds are set at ± 0.1 so that nominal wages would not be categorised as acyclical. Kydland, F.E. and Prescott, E.C. (1990). "Business Cycles: Real Facts and a Monetary Myth." *U.S. Federal Reserve Bank of Minneapolis Quarterly Review*, Spring, 3-18.

Chart 1 : Real GDP, Hong Kong, original and X13-ARIMA-ajusted series, 1973Q1-2018Q4

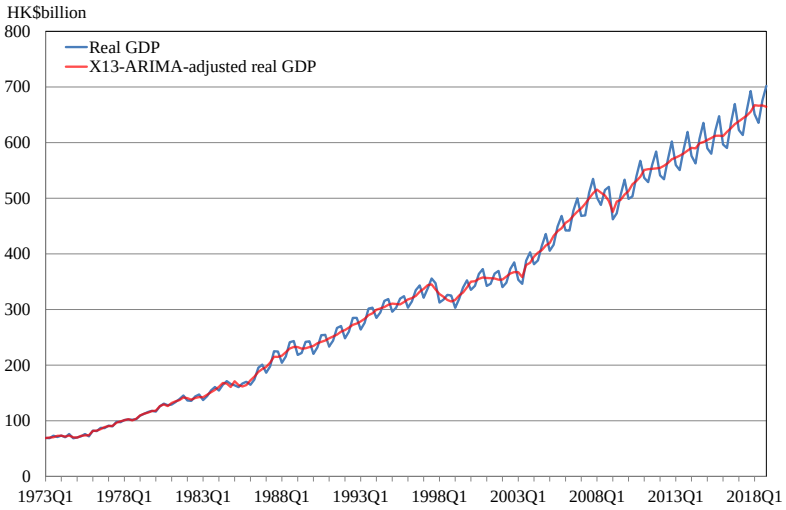


Chart 2 : Log(X13-ARIMA-adjusted real GDP, Hong Kong), original and HP-filtered series, 1973Q1-2018Q4

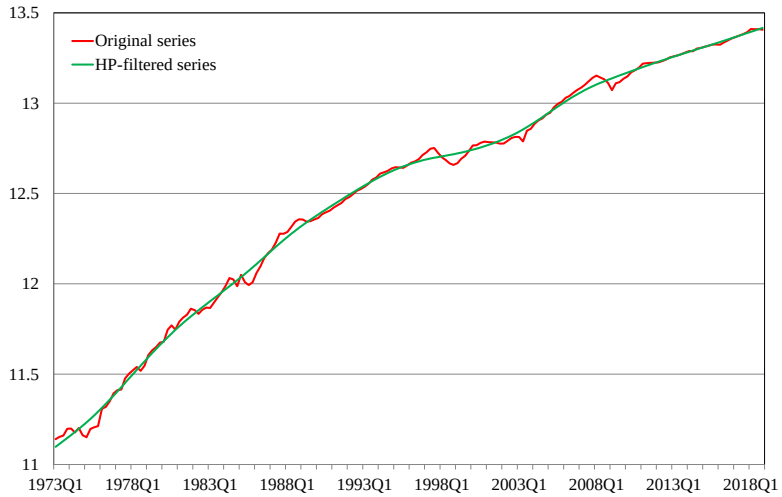
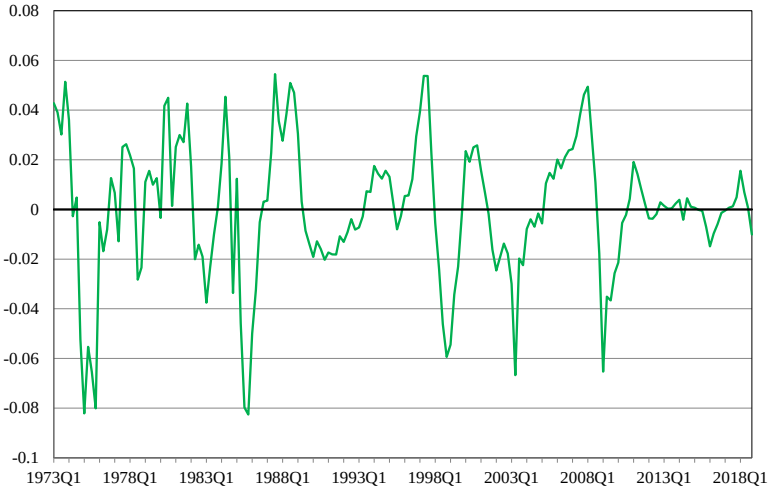


Chart 3 : Log(X13-ARIMA-adjusted real GDP, Hong Kong), HP-filtered residuals, 1973Q1-2018Q4



III. BUSINESS CYCLE FACTS OF HONG KONG

9. ***Table 2*** summarises the Business Cycle Facts of Hong Kong.

Table 2: Hong Kong Business Cycle Facts
(*HP filter detrending, X13-ARIMA deseasonalisation***)**

Variable	*Direction*	*Timing*
Expenditure		
Real consumption	Procyclical	Coincident
Real gross domestic fixed capital formation	Procyclical	Lagging
Change in real inventories	Procyclical	Coincident
Real government expenditure	Acyclical	-
Real exports of goods	Procyclical	Coincident
Real exports of services	Procyclical	Coincident
Real imports of goods	Procyclical	Coincident
Real imports of services	Procyclical	Coincident
Labour market		
Nominal wages	Procyclical	Lagging
Unemployment rate	Countercyclical	Lagging
Underemployment rate	Countercyclical	Lagging
Prices		
Consumer price index	Acyclical	-
Inflation	Procyclical	Coincident
Effective exchange rate index	Countercyclical	Leading
Property market		
Residential property price index	Procyclical	Coincident
Residential property rental index	Procyclical	Lagging
Residential property transaction	Procyclical	Leading
Financial market		
Hang Seng Index	Procyclical	Leading
1-month HIBOR	Procyclical	Coincident
M1	Acyclical	-
M2	Procyclical	Coincident
Tourism		
Overnight visitor arrivals	Procyclical	Coincident
Same-day-in-town (SDIT) arrivals	Procyclical	Coincident
Hotel occupancy rate	Procyclical	Leading
Average achieved hotel room rate	Procyclical	Lagging
Logistics and Transport		
Total container throughput	Procyclical	Coincident
Air cargo throughput	Procyclical	Leading
Air passenger traffic	Procyclical	Coincident
Average daily cross-boundary vehicles	Procyclical	Leading

10. For expenditure components, real consumption, real gross domestic fixed capital formation, changes in real inventories, real exports and real imports are generally procyclical. Among them, changes in real inventories show smoother behaviour across business cycles when compared to the other expenditure components. With respect to timing, all these components are coincident indicators, except for real gross domestic fixed capital formation which is a lagging indicator. Real government expenditures are acyclical. As expected, the components of GDP (except discretionary government spending) generally follow the ups and downs of aggregate economic activities.[7]

11. For labour market variables, in a recession, employment grows slowly or falls below its trend. The unemployment rate and underemployment rate are thus strongly countercyclical and lag the business cycle by around one quarter. On the other hand, nominal wages show smoother procyclical behaviour and lag real GDP by around three to five quarters. The reason for such lags is possibly because employers and employees usually enter into wage contracts which would be effective for a fixed period of time. For example, the employer cannot easily lay off an employee and/or lower his/her wage in face of a recession. It takes time for the existing contracts to expire and employers and employees to negotiate for new contracts with new wage terms. Therefore wages, unemployment rate and underemployment rate tend to lag aggregate economic activities.

12. For price variables, while the consumer price index shows acyclical behaviour, the inflation rate is procyclical and coincident with the business cycle. This might be due to inflation expectations reflecting the economic environment: when the economy is booming, people might expect prices to go up and result in a rise in actual inflation rate (this relationship is captured by the expectations-augmented Phillips curve). On the other hand, the effective exchange rate index, which measures the overall strength of the Hong Kong dollar relative to selected currencies, tends to fall one to two quarters before a rise in real GDP. When the effective exchange rate index decreases, the Hong Kong dollar turns weaker and will increase the competitiveness of Hong Kong's exports, thereby contributing to a rise in real GDP.

13. For property market variables, the residential property price index, the rental index, and the number of S&P agreements for residential building units are all procyclical. Among them, the rental index is strongly procyclical. With respect to timing, the number of S&P agreements leads real GDP by around one quarter, while the residential property price index is coincident with real GDP and the rental index

[7] In this article, we explain the cyclical and lead-lag behaviours of the selected economic variables by economic intuition. These intuitions are not part of the formal modelling framework.

lags real GDP by around one quarter. The procyclicality might be explained because a rise in real GDP indicates a better economic environment, and would improve the sentiment of the property market and thereby raise transactions, sales prices, and rental prices.

14. For financial market variables, the Hang Seng Index is procyclical (stock prices generally rise in good economic times) and leads real GDP by around one quarter (stock prices generally fall in advance of a recession). The reason might be that, expecting an imminent decline in real GDP and a deteriorating investment environment, people might begin to sell stocks. This would result in a drop in stock prices before the actual decline in real GDP. The 1-month HIBOR is procyclical and coincident with real GDP. Different definitions of money supply have differential cyclicality and lead-lag behaviours—while M1 is acyclical, M2 is procyclical and coincident with real GDP. Because of the fixed exchange rate system, Hong Kong does not have an independent monetary policy and largely imports its monetary policy from the United States, so there is no well-established theory to explain the cyclical behaviours of the monetary variables in Hong Kong.

15. For tourism variables, the numbers of overnight visitors and same-day in-town visitors, the hotel occupancy rate and the average achieved hotel room rate are all procyclical. Among them, the latter two are strongly procyclical. This phenomenon shows that tourism, as one of the four pillar industries in Hong Kong, is an important impetus for economic growth in Hong Kong. With respect to timing, the hotel occupancy rate leads real GDP by around one quarter, while the numbers of overnight visitors and same-day in-town visitors are coincident with real GDP and the average achieved hotel room rate lags real GDP by around one quarter.

16. For logistics and transport variables, total container throughput, air cargo throughput, and the numbers of air passengers and average daily cross-boundary vehicle movements are all procyclical. Similar to tourism, as logistics is another pillar industry in Hong Kong, its component sector show procyclical behaviour with respect to real GDP. With respect to timing, air cargo throughput and average daily cross-boundary vehicles generally lead real GDP by two or three quarters, while total container throughput and the number of air passengers are coincident with real GDP.

17. In sum, the Hang Seng Index, the hotel occupancy rate, the number of S&P agreements for residential building units, the effective exchange rate index, air cargo throughput and the number of average daily cross-boundary vehicle movements are identified as leading economic variables that move in advance of aggregate economic activity in Hong Kong.

18. Real gross domestic fixed capital formation, nominal wages, the unemployment and underemployment rates, the residential property rental index, and the average achieved hotel room rate are identified as lagging economic variables in Hong Kong.

IV. COMPARISON WITH BUSINESS CYCLES IN THE UNITED STATES

19. To put these findings in the context of business cycle research, it is useful to examine whether business cycles in Hong Kong share similar properties as those in the United States.[8] Quarterly time series for 22 economic variables in the United States from 1947Q1 to 2018Q4 have been sourced from the Federal Reserve Bank of St. Louis (see the data definitions listed after ***Table 3***).[9]

20. Using X13-ARIMA deseasonalisation and HP filter detrending, ***Table 4*** summarises the Business Cycle Facts in the United States. Generally speaking, for the identified economic variables, the Business Cycle Facts are broadly similar across Hong Kong and the United States as summarised below:

- For expenditure components, in both Hong Kong and the U.S., all except real government expenditures are procyclical and most are coincident with real GDP (in Hong Kong, real domestic fixed capital formation lags real GDP, while in the U.S. real exports of goods and services lag real GDP).

- For labour market variables, in both Hong Kong and the U.S., nominal wages are procyclical and the unemployment rate is countercyclical. Both variables lag real GDP movements.

- For price variables, in both Hong Kong and the U.S., inflation is procyclical and coincident with real GDP, while the exchange rate is countercyclical and leads real GDP movements. The countercyclical price and procyclical inflation behaviour have been documented in G-7 countries including the U.S.[10] While the countercyclical price behaviour might be explained by the supply-determined models (e.g. technological shocks), the procyclical inflation behaviour is

[8] See for example Kydland and Prescott (1990), Serletis and Krause (1996). Kydland, F.E. and Prescott, E.C. (1990). "Business Cycles: Real Facts and a Monetary Myth." *U.S. Federal Reserve Bank of Minneapolis Quarterly Review*, Spring, 3-18. Serletis, A. and Krause, D. (1996). "Nominal stylized facts of US business cycles." *Federal Reserve Bank of St. Louis Review*, 78(4), 49.

[9] The U.S. GDP and its component data are available starting from 1947Q1. For others, data starting from their earliest available date are used.

[10] Chadha, Bankim, and Prasad, Eswar. (1994). "Are prices countercyclical? Evidence from the G-7". *Journal of Monetary Economics*, 34, 239-257.

consistent with the demand-determined models (e.g. monetary shocks), i.e. U.S.'s price and inflation behaviour needs to be explained by both the demand- and supply-determined models.[11] This finding also suggests that, the procyclical price and inflation behaviours in Hong Kong indicate that demand-determined models might be sufficient in explaining this portion of business cycle facts in Hong Kong.

- For property market variables, in both Hong Kong and the U.S., the number of S&P agreements for residential building units / new one-family houses sold are leading and procyclical. However, while the residential property price index and the residential property rental indices for Hong Kong and the all-transactions house price index for the U.S. are procyclical, the former are coincident with or lagging real GDP movements, while the latter is a lagging indicator.

- For financial market variables, in both Hong Kong and the U.S., stock prices are leading and procyclical. The multiple interest rates in the U.S. display different cyclical behaviours: while the Federal Fund rate, interbank rate and 3-month T-bill rates are procyclical and lag real GDP, the Aaa and Baa bond yields are countercyclical and lead real GDP. In the U.S., M1 and M2 are both acyclical. In Hong Kong, while M1 is aycylical, M2 is procyclial and coincident with real GDP. In general, the above results suggest that interest rates show more cyclical movements with real GDP than monetary aggregates do. This can perhaps be explained by the monetary transmission mechanism – in particular, as interest rates occupy a later position in affecting the real output than the monetary aggregates, it might be not surprising to observe the interest rates showing more cyclical movements with real GDP.[12] On diverse interest rate movements in the U.S., it is observed that the policy rates (or the operating targets), including the Federal Fund rate and the interbank rate, lag and move in the same direction with real GDP, perhaps indicating the Federal Reserve Bank adjusting its policy rate to stabilise output with a lag. On the other hand, the corporate interest rates, including the Aaa and Baa bond yields, lead and move in opposite directions with real GDP, perhaps indicating that these interest rates can provide part of causal explanations that boost real GDP by simulating consumption and investments.

[11] Haslag, Joseph H., and Li, Xue. (2017). "On Phase Shifts in a New Keynesian Model Economy," *Working Papers 2017-02*, Department of Economics, University of Missouri.

[12] Mishkin, F.S. (1996). "The channels of monetary transmission: lessons for monetary policy" (No. w5464). *National Bureau of Economic Research*.

Table 3 : Cyclical Behaviour of the U.S. Economy: Deviations from Trend of Key Variables, 1947:I - 2018:IV (HP-filtered, X13-ARIMA deseasonalised)

	Relative standard deviation *	Cross-correlation with GDP (Lead: +; Lag: -)											Auto-correlation
		GDP(-5)	GDP(-4)	GDP(-3)	GDP(-2)	GDP(-1)	GDP(0)	GDP(1)	GDP(2)	GDP(3)	GDP(4)	GDP(5)	
Expenditure													
Real GDP	1.00	0.18	0.34	0.53	0.72	0.89	1.00	0.89	0.71	0.51	0.31	0.12	0.88
Real consumption	0.79	0.12	0.28	0.45	0.61	0.76	0.87	0.87	0.77	0.63	0.48	0.31	0.88
Real gross private domestic investment	4.79	-0.06	0.14	0.38	0.61	0.81	0.92	0.81	0.65	0.49	0.33	0.19	0.86
Change in real private inventory	0.36	-0.38	-0.28	-0.08	0.15	0.37	0.52	0.44	0.38	0.33	0.26	0.22	0.56
Real government expenditure	0.84	0.22	0.13	0.01	-0.07	-0.09	-0.09	-0.15	-0.15	-0.15	-0.12	-0.05	0.82
Real exports of goods and services	2.78	0.34	0.40	0.47	0.53	0.57	0.52	0.34	0.14	-0.05	-0.20	-0.33	0.86
Real imports of goods and services	3.50	-0.10	0.14	0.37	0.60	0.79	0.86	0.80	0.66	0.52	0.41	0.33	0.88
Labour market													
Nominal wages	1.16	0.47	0.58	0.67	0.73	0.76	0.68	0.50	0.26	0.04	-0.13	-0.27	0.89
Unemployment rate		-0.38	-0.55	-0.72	-0.85	-0.90	-0.86	-0.70	-0.50	-0.30	-0.12	0.03	0.92
Prices													
Consumer price index	0.86	0.22	0.14	0.03	-0.09	-0.20	-0.34	-0.48	-0.58	-0.63	-0.64	-0.58	0.91
Inflation		0.19	0.28	0.30	0.29	0.35	0.39	0.25	0.12	0.01	-0.13	-0.19	0.31
Trade-weighted US dollar index	3.60	-0.14	-0.12	-0.12	-0.15	-0.16	-0.18	-0.18	-0.15	-0.09	-0.05	0.03	0.81
Property market													
Housing price index	1.52	0.47	0.51	0.55	0.56	0.52	0.47	0.41	0.32	0.20	0.08	-0.06	0.94
New 1-family houses sold	10.00	-0.18	-0.13	-0.04	0.12	0.27	0.51	0.67	0.73	0.68	0.63	0.54	0.66
Financial market													
S&P 500 Index	7.40	0.06	0.08	0.14	0.26	0.38	0.47	0.51	0.46	0.34	0.19	0.05	0.76
Fed Fund rate		0.41	0.44	0.47	0.48	0.49	0.38	0.16	-0.04	-0.20	-0.36	-0.43	0.70
Interbank rates		0.40	0.44	0.49	0.52	0.52	0.46	0.26	0.00	-0.18	-0.31	-0.42	0.83
Aaa corporate bond yield		0.06	0.09	0.08	0.04	-0.02	-0.17	-0.32	-0.44	-0.49	-0.51	-0.49	0.80
Baa corporate bond yield		0.17	0.14	0.07	-0.05	-0.17	-0.36	-0.52	-0.60	-0.60	-0.57	-0.50	0.83
3-month Treasury Bill yield		0.34	0.41	0.46	0.47	0.48	0.39	0.20	0.03	-0.13	-0.30	-0.38	0.79
M1	2.05	-0.14	-0.14	-0.14	-0.12	-0.07	0.02	0.10	0.15	0.18	0.21	0.22	0.92
M2	0.84	0.00	-0.03	-0.07	-0.12	-0.10	0.01	0.11	0.17	0.20	0.22	0.24	0.84

Data definition:

Real GDP	Real gross domestic product, billions of chained 2012 dollars, quarterly, seasonally adjusted annual rate
Real consumption	Real personal consumption expenditures, billions of chained 2012 dollars, quarterly, seasonally adjusted annual rate
Real gross private domestic investment	Real gross private domestic investment, billions of chained 2012 dollars, quarterly, seasonally adjusted annual rate
Change in real private inventory	Change in real private inventories, billions of chained 2012 dollars, quarterly, seasonally adjusted annual rate
Real government expenditure	Real government consumption expenditures and gross investment, billions of chained 2012 dollars, quarterly, seasonally adjusted annual rate
Real exports of goods and services	Real exports of goods and services, billions of chained 2012 dollars, quarterly, seasonally adjusted annual rate
Real imports of goods and services	Real imports of goods and services, billions of chained 2012 dollars, quarterly, seasonally adjusted annual rate
Nominal wages	Gross domestic income: compensation of employees, paid: wages and salaries, billions of dollars, quarterly, seasonally adjusted annual rate
Unemployment rate	Civilian unemployment rate, percent, monthly, seasonally adjusted
Consumer price index	Consumer price index: total all items for the United States, index 2010=100, quarterly, seasonally adjusted
Inflation	Quarter-to-quarter change in consumer price index: total all items for the United States, index 2010=100, quarterly, seasonally adjusted
Trade-weighted US dollar index	Trade weighted U.S. Dollar index: Major currencies, index mar 1973=100, monthly, not seasonally adjusted
Housing price index	All-transactions house price index for the United States, index 1980:Q1=100, quarterly, not seasonally adjusted
New 1-family houses sold	New one family houses sold: United States, thousands, monthly, seasonally adjusted annual rate
S&P 500 Index	S&P 500, index, daily, not seasonally adjusted
Fed fund rate	Effective federal funds rate, percent, monthly, not seasonally adjusted
Interbank rates	3-month or 90-day rates and yields: Interbank rates for the United States, percent, quarterly, not seasonally adjusted
Aaa corporate bond yield	Moody's seasoned Aaa corporate bond yield, percent, monthly, not seasonally adjusted
Baa corporate bond yield	Moody's seasoned Baa corporate bond yield, percent, monthly, not seasonally adjusted
3-month Treasury bill yield	3-month treasury bill: secondary market rate, percent, monthly, not seasonally adjusted
M1	M1 money stock, billions of dollars, monthly, seasonally adjusted
M2	M2 money stock, billions of dollars, monthly, seasonally adjusted

Note : (*) GDP volatility is used as the base to calculate the relative standard deviation.

Table 4: United States Business Cycle Facts

(*HP filter detrending, X13-ARIMA deseasonalisation*)

Variable	*Direction*	*Timing*
Expenditure		
Real consumption	Procyclical	Coincident
Real gross private domestic investment	Procyclical	Coincident
Change in real private inventory	Procyclical	Coincident
Real government expenditure	Acyclical	-
Real exports of goods and services	Procyclical	Lagging
Real imports of goods and services	Procyclical	Coincident
Labour market		
Nominal wages	Procyclical	Lagging
Unemployment rate	Countercyclical	Lagging
Prices		
Consumer price index	Countercyclical	Leading
Inflation	Procyclical	Coincident
Trade-weighted US dollar index	Countercyclical	Leading
Property market		
Housing price index	Procyclical	Lagging
New 1-family houses sold	Procyclical	Leading
Financial market		
S&P 500 Index	Procyclical	Leading
Fed Fund rate	Procyclical	Lagging
Interbank rates	Procyclical	Lagging
Aaa corporate bond yield	Countercyclical	Leading
Baa corporate bond yield	Countercyclical	Leading
3-month Treasury Bill yield	Procyclical	Lagging
M1	Acyclical	-
M2	Acyclical	-

V. CONCLUSION

21. This article explores the stylised facts of Hong Kong's business cycles. Cyclical components of 30 economic time series (expenditure, labour market, price, property market, financial market, tourism, logistics and transport variables) in Hong Kong are obtained through X13-ARIMA deseasonalisation and HP filter detrending and are analysed in terms of their cyclicality and lead-lag relationship against the cyclical components of real GDP. The Hang Seng Index, hotel occupancy rate, number of S&P agreements for residential building units, effective exchange rate index, air cargo throughput, and number of average daily cross-boundary vehicle movements are identified as leading economic indicators in Hong Kong. Also, the comparison between the business cycles in Hong Kong and the United States broadly supports Robert Lucas's statement that "business cycles are all alike". In particular, the cyclical behaviours of expenditure components, price and labour market variables are broadly similar across Hong Kong and the United States, but some property market and financial market variables (e.g. residential property price index, interest rates) show different cyclical behaviour across the two economies.[13]

[13] It should be noted that the business cycle facts documented in this article indicate the "average" behaviour of economic variables over different business cycles. Some variables, like the money supply, could behave differently in different business cycles (e.g. before and after the global financial crisis).