HONG KONG MONETARY AUTHORITY

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# *FINANCIAL CONDITIONS INDEXES FOR HONG KONG*

***Key points:***

- *We construct financial conditions indexes (FCIs) for Hong Kong, so as to track and draw macro-financial implications from Hong Kong's overall financial conditions. Two compilation approaches are used to cross check the robustness of the estimated financial conditions.*

- *The FCIs tightened materially during the Asian Financial Crisis and the Global Financial Crisis, and loosened subsequent to the implementation of quantitative easing in the US. Due to heightened global financial volatility, the FCIs tightened again during the second half of 2015 and the first half of 2016.*

- *Decomposition analysis shows that the sharp plunges of the FCIs during crisis periods were mainly driven by movements in domestic asset prices and volatilities, reflecting the ability of the asset markets to signal sharp changes in future economic activity. During tranquil periods, the dynamics of the FCIs were driven mainly by domestic property prices, reflecting the strong influence of the property market on the real economy.*

- *Statistical tests show that the FCIs can forecast economic activity well. In particular, pseudo-out-of-sample tests indicate that the FCIs can forecast real GDP growth up to two quarters ahead. Hence, the FCIs can complement our macro-financial surveillance toolkits and aid future research involving macro-financial interactions.*

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## I. INTRODUCTION

Many financial variables are known to influence and have predictive power on economic activities. For example, asset prices can exert collateral and wealth effects on consumption, while yield spreads were found to have some predictive power on future economic activity (Estrella (2005)). Given the importance of the financial sector in the Hong Kong economy, it would be useful to assess and draw economic implications from Hong Kong's overall financial conditions. In this research memorandum, we compile the financial condition indexes (FCIs) for Hong Kong, which take into account a broader set of financial variables (e.g. Osorio et al. (2011), IMF (2015)) than traditional monetary condition indexes that comprise interest rate and exchange rate only.

The literature has proposed a few econometric techniques to compile FCIs. Among these, most studies use the weighted-sum approach and/or the principal component (PC) approach, with the former weighing the financial variables by its impact on real activity, while the latter weighs through finding the common component (i.e. principal component) of the selected set of financial variables. Given that different techniques have their pros and cons, we follow IMF (2015) and Osorio et al. (2011) in using both techniques to construct the FCIs for Hong Kong, so as to cross check the robustness of the estimated financial conditions indexes.

We find that the FCIs with both approaches broadly share the same pattern, tightening materially during the Asian Financial Crisis (AFC) and the Global Financial Crisis (GFC), and loosening after the implementation of the quantitative easing in the US. In the face of heightened global financial market volatility, the FCIs tightened again during 2015H2–2016H1. Decomposition analysis shows that the sharp plunges of the FCIs during crisis periods were mainly driven by property prices, stock prices and stock market volatilities. This probably reflects the ability of the asset markets to signal sharp changes in future economic activity. During tranquil periods, the dynamics of the FCIs were driven mainly by property prices, manifesting the strong influence of the property market on the real economy.

Both in-sample and pseudo-out-of-sample tests show that the FCIs can track and forecast real GDP growth well. In particular, pseudo-out-of-sample forecasting power tests indicate that the FCIs can perform better than simple statistical models in forecasting Hong Kong's real GDP growth up to two quarters

ahead. Thus, the FCIs could aid our macro-financial surveillance of the Hong Kong economy, by providing a quick assessment of the impact of major financial disturbances on the real economy.

The rest of the paper is organised as follows. Section II describes the methodology used to compile the FCIs for Hong Kong. Section III analyses and compares the dynamics of the FCIs. Section IV assesses the forecasting power of the FCIs on real GDP growth. The final section concludes.

## II. METHODOLOGY

Following IMF (2015) and Osorio et al. (2011), we use both the weighted-sum approach based on vector auto-regression (VAR) and the PC approach to construct the FCIs for Hong Kong. These two alternative approaches allow us to cross check the robustness and reliability of the estimate for the development of Hong Kong's financial conditions over time.

On the weighted sum approach, we first estimate a VAR:

$$X_t = A_0 + \sum_{i=1}^{2} A_i X_{t-i} + \sum_{i=1}^{2} B_i Y_{t-i}^{*} + \varepsilon_t$$

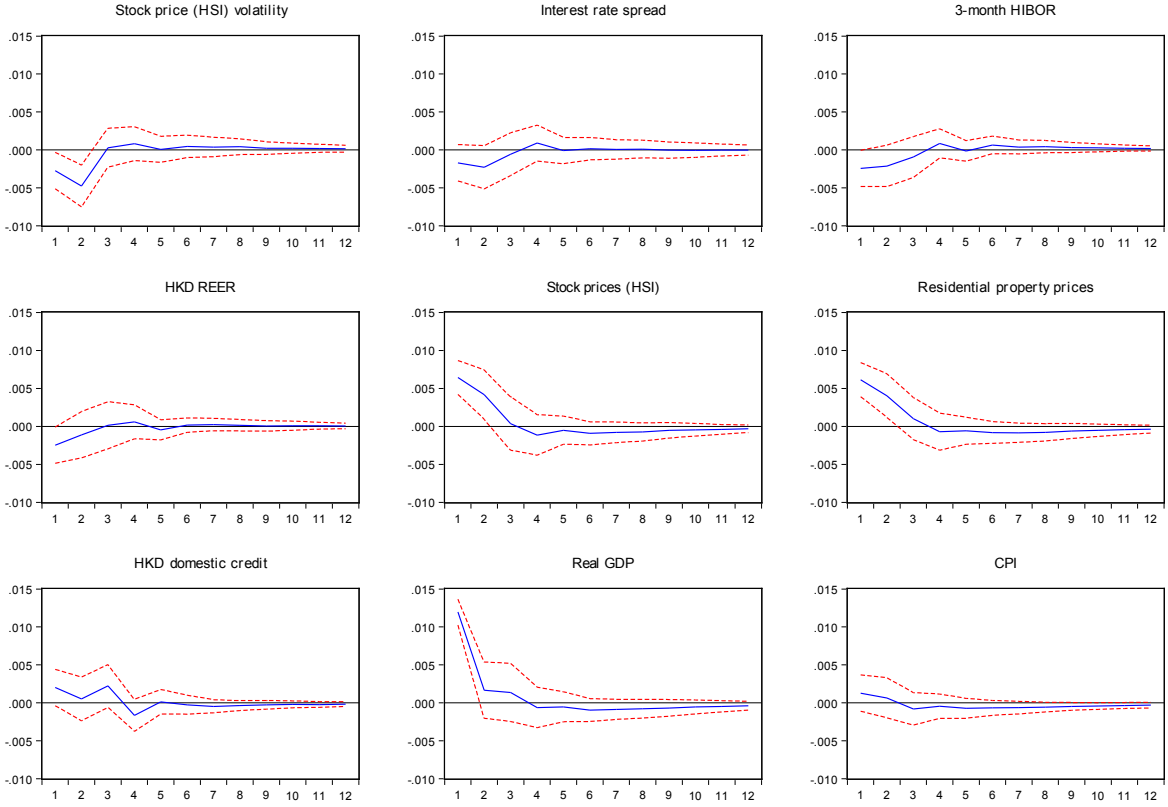
where $X_t$ is a vector of endogenous variables, $A_0$ and $A_i$ are vectors of coefficients, and $\varepsilon_t$ is a vector of error terms. The list of endogenous variables include Hong Kong's quarter-on-quarter real GDP growth, CPI inflation, and the following financial variables which are broadly representative of the major aspects of Hong Kong's financial environment: 3-month HIBOR (in quarterly changes), residential property prices (in quarter-on-quarter growth rate), the Hang Seng Index (HSI) (in quarter-on-quarter growth rate), volatility of the Hang Seng Index (in level), Hong Kong Dollar real effective exchange rate (REER) (in quarter-on-quarter growth rate), Hong Kong Dollar domestic loans (in quarter-on-quarter growth rate), and the spread of the 3-month HIBOR over the yield of the 3-month Exchange Fund Bill (i.e. measure of credit risk similar to the US TED spread, expressed in level). $Y_t^*$, which is the weighted GDP of Hong Kong's trading partners (in quarter-on-quarter growth rate), is also included as an exogenous variable in the VAR. Using a sample period of 1992Q1–2016Q2 to estimate the VAR, we construct the financial conditions index as follows:

$$FCI_t^{WS} = \sum_{j=1}^{n} w_j (x_{j,t} - \bar{x}_j)$$

where $w_j$ is the weight of the financial variable $x_{j,t}$ in the financial conditions index $FCI_t^{WS}$, and $\bar{x}_j$ is the sample average of the financial variable $x_{j,t}$. The weight $w_j$ is set as the accumulated responses of real GDP growth within four quarters to a one-unit shock to the financial variable $x_{j,t}$. To avoid any dependence of the estimated weight on the ordering of the variables in the VAR, the generalised impulse response scheme (Pesaran and Shin 1998) is used to measure the impact on real GDP growth from each financial variables.

Chart 1 illustrates the impulse responses of real GDP growth to individual variables, all of which have the expected signs. For example, a positive shock to the interest rate spread or stock price volatility (as indicators of risk) would dampen real GDP growth, while a positive shock to stock prices or residential property prices would support real GDP growth.

**Chart 1: Impulse responses of real GDP growth**




Source: HKMA staff estimates.

On the PC approach, given its ability in extracting information from a large set of variables, we expand the list of the component financial variables to include also indicators such as term spreads, credit spreads, and asset quality (see the full list of financial variables in the Appendix), so as to broaden the scope of information captured.

We follow Hatzius et al. (2010) and Wacker et al. (2014) by first transforming the component financial variables to ensure stationarity, followed by standardisation of the resulting series. We then purge the financial variables from the influences of Hong Kong's real GDP growth and CPI inflation, such that the extracted principal component collects only exogenous information from the financial variables and not endogenous feedback from the real economy. In particular, we set up the following regression:

$$X_{i,t} = B_i(L)Y_t + \epsilon_{i,t}$$

where $X_{i,t}$ is a financial variable, $Y_t$ is a vector of Hong Kong's real GDP growth and CPI inflation, and $\epsilon_{i,t}$ is the purged financial variable. $L$ denotes time lags and is set to be two quarters. We then decompose $\epsilon_{i,t}$ as follows:

$$\epsilon_{i,t} = \lambda_i' FCI_t^{PC} + u_{i,t}$$

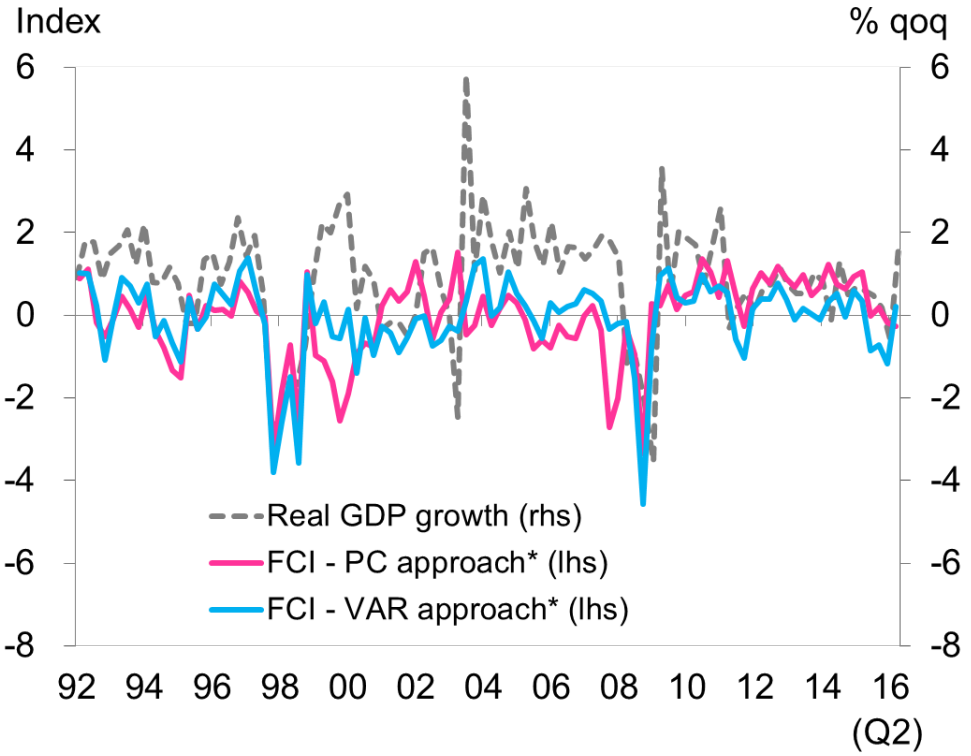
where $FCI_t^{PC}$ is the constructed financial condition index, $\lambda_i'$ is the factor loading of the financial variables in the index, and $u_{i,t}$ is the idiosyncratic component of $\epsilon_{i,t}$ which is assumed to be uncorrelated across the financial variables. Similar to Hatzius et al. (2010), Wacker et al. (2014), and Osorio et al. (2011), we estimate $FCI_t^{PC}$ by taking the first principal component of $\epsilon_{i,t}$.

## III. ANALYSIS OF THE INDEXES

In this section, we examine the dynamics of the estimated FCIs and the contribution of the underlying component variables to the changes in the FCIs. Chart 2 shows the constructed FCIs under the two approaches, with a higher value of the FCI representing a loosening of financial conditions, while a lower value indicates a tightening of financial conditions. To facilitate comparison, the FCIs are normalised with its standard deviation being equal to one. Hong Kong's real GDP growth is also shown in the chart for reference.

From the chart, it can be seen that $FCI_t^{WS}$ and $FCI_t^{PC}$ broadly share the same pattern. In particular, both indexes indicate, as expected, a material tightening of financial conditions during the AFC and the GFC, with the magnitude of the tightening being broadly similar in both crises. Both FCIs also show that financial conditions loosened after the implementation of quantitative easing in the US in 2009Q1, before tightening momentarily in late 2011 amid the deepening of the European sovereign debt crisis. Financial conditions then became loose again in the following years until 2015Q3, when global financial volatilities picked up amid concerns about the US rate hike and the change to the RMB fixing mechanism.

**Chart 2: FCIs and real GDP growth**




Note: FCI is in units of standard error.
Sources: C&SD, HKMA staff estimates.

Having said that, the $FCI_t^{WS}$ and $FCI_t^{PC}$ did diverge from each other occasionally, reflecting the differences in the underlying methodology and the selected component financial variables. For instance, after the rebound in 1998Q4, $FCI_t^{PC}$ plunged again to low levels reached at the height of the AFC, before continuing to pick up sharply and peak in 2002Q1. Meanwhile, $FCI_t^{WS}$ also dropped initially, but the magnitude of the decline as well as the subsequent fluctuations was comparatively moderate. As shown later in the section, the

divergence in this episode can be partly attributed to the dynamics of variables including swap spread, mortgage rate spread, office and retail property prices, all of which were components of $FCI_t^{PC}$ but not $FCI_t^{WS}$.

Table 1 shows that the sharp plunges of $FCI_t^{WS}$ during crisis periods were mainly driven by stock prices, residential property prices and stock market volatility, reflecting the ability of the asset markets to signal sharp changes in economic activity. During tranquil periods, the fluctuation of $FCI_t^{WS}$ could mainly be attributed to the dynamics of property prices, reflecting the strong influence of Hong Kong's property market on the real economy (Wu et al. (2016), BIS (2016)).

**Table 1: Contribution to changes in $FCI_t^{WS}$**

| Period | Average contributions to changes in FCI per quarter | | | | | | |
|---|---|---|---|---|---|---|---|
| | 3-month HIBOR | HKD domestic loans | HKD REER | Residential property prices | Stock prices | Stock market volatilities | Interest rate spreads |
| **Pre-AFC (1991Q3 - 1997Q2)** | -0.01 | 0.05 | -0.04 | 0.20 | 0.09 | 0.07 | -0.01 |
| **AFC (1997Q3 - 1998Q4)** | -0.02 | -0.10 | -0.04 | -0.78 | -0.21 | -0.49 | -0.15 |
| **Pre-GFC (1999Q1 - 2008Q2)** | 0.00 | -0.08 | 0.05 | -0.10 | 0.00 | 0.06 | 0.01 |
| **GFC (2008Q3 - 2009Q1)** | 0.06 | -0.12 | -0.12 | -0.52 | -0.63 | -0.63 | -0.33 |
| **Post-GFC (2009Q2 - 2016Q2)** | -0.02 | -0.03 | -0.01 | 0.10 | -0.02 | 0.11 | 0.06 |

Source: HKMA staff estimates.

The contribution of individual components to $FCI_t^{PC}$ are grouped according to its nature and the results are shown in Table 2. The sharp plunges of the $FCI_t^{PC}$ during crisis periods were mainly driven by stock market volatilities and interest rate spreads, reflecting worsened market sentiments or heightened risks. Interest rate spreads play a more important role in driving $FCI_t^{PC}$ than $FCI_t^{WS}$ as the former included a large number of interest rate spreads components. As mentioned previously, such spreads were also responsible for the plunge of the $FCI_t^{PC}$ after 1998Q4 and therefore the divergence between $FCI_t^{PC}$ and $FCI_t^{WS}$ during the period. Meanwhile, property prices still remained important to the dynamics of $FCI_t^{PC}$ throughout the sample period, while measures of money and credit were also important contributors.

**Table 2: Contribution to changes in $FCI_t^{PC}$**

| Period | Average contributions to changes in FCI per quarter | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Interest rates | Money and Credit | Delinquency | Property prices | Stock market | Stock market volatilities | Interest rate spreads | Others |
| **Pre-AFC (1991Q3 - 1997Q2)** | 0.02 | 0.08 | 0.00 | -0.12 | 0.02 | 0.02 | -0.03 | -0.01 |
| **AFC (1997Q3 - 1998Q4)** | -0.06 | -0.18 | -0.01 | -0.23 | 0.09 | -0.27 | -0.60 | 0.00 |
| **Pre-GFC (1998Q4 - 2008Q2)** | -0.01 | -0.08 | 0.02 | -0.04 | -0.02 | 0.00 | -0.20 | -0.02 |
| **GFC (2008Q3 - 2009Q1)** | -0.03 | -0.09 | 0.01 | 0.02 | -0.17 | -0.43 | -0.63 | -0.04 |
| **Post-GFC (2009Q2 - 2016Q2)** | 0.00 | 0.04 | 0.00 | 0.12 | -0.01 | 0.10 | 0.38 | 0.01 |

Source: HKMA staff estimates.

## IV. EVALUATION OF THE INDEXES

To assess the performance of the FCIs in tracking and forecasting real GDP growth on both quarter on quarter and year on year basis, we conduct both in-sample and pseudo-out-of-sample tests using the following growth forecasting model similar to Osorio et al. (2011) and Wacker et al. (2014):

$$g_{t+h} = \alpha + \sum_{i=1}^{p} \beta_i g_{t+1-i} + \gamma FCI_t^X + \omega_t$$

Where $g_{t+h}$ is either the quarter-on-quarter or year-on-year growth of real GDP at $h \leq 2$ quarters ahead, and $X \in WS, PC$. Based on Schwarz Information Criteria (SIC), $p$ is set to be equal to one for the quarter-on-quarter growth case and four for the year-on-year growth case. For the year-on-year case, given that the FCIs are constructed with reference to the quarter-on-quarter real GDP growth, we take the four-quarter moving average of the FCIs as the predictors so that everything is on a year-on-year basis.

For the in-sample test, we measure the performance of the FCIs based on the adjusted R-squared and the t-statistics of the FCIs' coefficients in the growth forecasting model. The AR(1) and AR(4) models, where $\gamma$ is set to be equal to zero, are used as benchmarks respectively for the quarter-on-quarter and year-on-year cases.

For the quarter-on-quarter case, Table 3 shows that both the models with $FCI_t^{ws}$ and $FCI_t^{PC}$ yield much higher adjusted R-squared compared to the AR(1) model in the one-quarter ahead horizon, with $FCI_t^{ws}$ outperforming all other models. The coefficient of both $FCI_t^{WS}$ and $FCI_t^{PC}$ are also statistically significant at the 5% confidence level. Moving to the two-quarter ahead horizon,

however, both $FCI_t^{WS}$ and $FCI_t^{PC}$ do not perform well.

**Table 3: In-sample tests: qoq real GDP growth**

| *Model* | $h = 1$ | | $h = 2$ | |
|---|---|---|---|---|
| | Adjusted R-squared | t-statistics of the FCI's coefficients | Adjusted R-squared | t-statistics of the FCI's coefficients |
| 1. AR(1) | 0.090 | n.a. | 0.072 | n.a. |
| 2. $FCI_t^{WS}$ | **0.261** | **4.871**** | 0.072 | 1.123 |
| 3. $FCI_t^{PC}$ | **0.170** | **3.238**** | 0.075 | 1.340 |

** indicates that the coefficient is statistically significant at 5% confidence level.
Source: HKMA staff estimates.

Table 4 shows that $FCI_t^{WS}$ and $FCI_t^{PC}$ also improve the goodness of fit of the model in the year-on-year case, with both $FCI_t^{WS}$ and $FCI_t^{PC}$ yielding higher adjusted R-squared comparing to the AR(4) model in both one- and two-quarter ahead horizons. Nevertheless, except for $FCI_t^{WS}$ in the one-quarter ahead horizon, the coefficients of the FCIs are not statistically significant.

**Table 4: In-sample tests: yoy real GDP growth**

| *Model* | $h = 1$ | | $h = 2$ | |
|---|---|---|---|---|
| | Adjusted R-squared | t-statistics of the FCIs' coefficients | Adjusted R-squared | t-statistics of the FCIs' coefficients |
| 1. AR(4) | 0.735 | n.a. | 0.467 | n.a. |
| 2. $FCI_t^{WS}$ | **0.777** | **2.236**** | **0.543** | 1.056 |
| 3. $FCI_t^{PC}$ | **0.769** | 1.543 | **0.542** | 1.179 |

** indicates that the coefficient on the FCI is statistically significant at 5% level.
Source: HKMA staff estimates.

As for the pseudo-out-of-sample test, we assess the forecasting performance of the above growth forecasting model using the root mean squared errors (RMSEs) calculated over the forecasting period of 2008Q1–2016Q2. As benchmarks, we compare the forecasting performance of the FCIs with: (1) the AR(1) model for the quarter-on-quarter case and the AR(4) model for the year-on-year case and, (2) the random walk model, where $p$ and $\beta_1$ are set to be equal to one while $\alpha$ and $\gamma$ are set to be equal to zero, for both the quarter-on-quarter and year-on-year cases. To facilitate comparison, the RMSEs of each model are expressed relative to that of the AR model. The results are shown in Table 5.

For the quarter-on-quarter case, the random walk model is the worst performing model, with its RMSEs being higher than that of the AR(1) model as well as the FCIs over all forecasting horizons considered. Both $FCI_t^{WS}$ and $FCI_t^{PC}$ can outperform the AR(1) model in the one-year ahead horizon but not in the two-year ahead horizon, with $FCI_t^{WS}$ performing better than $FCI_t^{PC}$ in the one-year ahead horizon and vice versa in the two-year horizon.

**Table 5: Pseudo-out-of-sample tests: qoq real GDP growth**

| *Model* | $h = 1$ | $h = 2$ |
|---|---|---|
| 1. AR(1) | 1.00 | 1.00 |
| 2. Random Walk | 1.22 | 1.24 |
| 3. $FCI_t^{WS}$ | **0.83** | 1.15 |
| 4. $FCI_t^{PC}$ | **0.97** | 1.09 |

Source: HKMA staff estimates.

For the year-on-year case, both $FCI_t^{WS}$ and $FCI_t^{PC}$ can outperform the AR and the random walk model in the one- and two-year ahead horizons (Table 6). Again, $FCI_t^{ws}$ performs better than $FCI_t^{PC}$ in the one-year ahead horizon and vice versa in the two-year, although the difference in the RMSEs becomes smaller than those for the quarter-on-quarter case.

**Table 6: Pseudo-out-of-sample tests: yoy real GDP growth**

| *Model* | $h = 1$ | $h = 2$ |
|---|---|---|
| 1. AR(4) | 1.00 | 1.00 |
| 2. Random Walk | 1.13 | 1.23 |
| 3. $FCI_t^{WS}$ | **0.94** | **0.96** |
| 4. $FCI_t^{PC}$ | **0.98** | **0.94** |

Source: HKMA staff estimates.

Altogether, the in-sample and the pseudo-out-of-sample forecasting power tests indicate that the FCIs are stronger than simple statistical models in forecasting real GDP growth in at least the one-quarter ahead horizon. This, together with the FCIs' usefulness in tracking the overall domestic financial conditions, means that the indexes could provide much value-added to our existing macro-financial surveillance toolkits.

## V. CONCLUSION

Given the role of financial variables in affecting economic activity and transmitting shocks, we construct FCIs for Hong Kong so as to provide a summary measure for assessing the overall financial conditions and their implications for future economic activity. We find that the FCIs constructed under two different approaches broadly share the same pattern, tightening materially during the AFC and the GFC, and loosening after the implementation of quantitative easing in the US. In the face of heightened global financial market volatility, the FCIs tightened again during 2015H2–2016H1. Decomposition analysis shows that the sharp plunges of the FCIs during crisis periods were mainly driven by domestic asset prices and volatilities, reflecting the ability of the asset markets to signal sharp changes in future economic activity. During tranquil periods, the dynamics of the FCIs were driven mainly by domestic property prices, reflecting the strong influence of the property market on the real economy. Our statistical tests indicate that the FCIs can forecast real GDP growth better than simple statistical models up to two quarters ahead. The FCIs are therefore useful tools for macro-financial surveillance of Hong Kong.

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# APPENDIX: COMPONENT VARIABLES OF THE FCI USING PC APPROACH

## Table A1: Component variables of $FCI_t^{PC}$

| Variables | Classification | Starting date | Transformation |
|---|---|---|---|
| 10-year EFN/HKGB yield | Interest rates | 1996Q4 | Level difference |
| 3-month HIBOR | Interest rates | 1982Q1 | Level difference |
| Base rate/3-month EFB yield spread | Interest rate spreads | 1998Q2 | Level |
| 2-year EFN/3-month EFB yield spread | Interest rate spreads | 1991Q3 | Level |
| 10-year EFN/HKGB /2-year EFN yield spread | Interest rate spreads | 1996Q3 | Level |
| Average mortgage interest rate/ 10-year EFN/HKGB yield spread | Interest rate spreads | 1996Q3 | Level |
| 3-month HIBOR/3-month EFB yield spread | Interest rate spreads | 1991Q2 | Level |
| 2-year HKD interest rate swap/2-year EFN yield spread | Interest rate spreads | 1992Q2 | Level |
| 1-year HIBOR/1-month HIBOR spread | Interest rate spreads | 1990Q4 | Level |
| HKD REER | Others | 1985Q1 | Log 1st difference |
| Residential property price index | Property prices | 1980Q1 | Log 1st difference |
| Office space price index | Property prices | 1980Q1 | Log 1st difference |
| Retail space price index | Property prices | 1980Q1 | Log 1st difference |
| Flatted factory space price index | Property prices | 1980Q1 | Log 1st difference |
| Hang Seng Index | Stock market | 1980Q1 | Log 1st difference |
| Realised volatility of HSI | Stock market voliatilities | 1980Q1 | Level |
| Realised volatility of D-SIBs' stock prices | Stock market voliatilities | 1986Q1 | Level |
| Seasonally adjusted HKD M1 | Money and Credit | 1984Q4 | Log 1st difference |
| HKD domestic credit | Money and Credit | 1980Q3 | Log 1st difference |
| Credit card receivables | Money and Credit | 1990Q4 | Log 1st difference |
| Household loans | Money and Credit | 1990Q4 | Log 1st difference |
| Household loans/bank assets | Money and Credit | 1990Q4 | Log 1st difference |
| Property related loans/bank assets | Money and Credit | 1990Q4 | Log 1st difference |
| Outstanding amount of HKD debt instruments, other than EFBN: Less Than 3 Years | Money and Credit | 1995Q3 | Log 1st difference |
| New issues of HKD debt instruments, other than EFBN: Less Than 3 Years | Money and Credit | 1995Q3 | Log 1st difference |
| HKEX Market Capitalization | Stock market | 1995Q2 | Log 1st difference |
| HKEX Market Capitalization/GDP | Stock market | 1995Q2 | Log 1st difference |
| Price of crude oil relative to 2 years moving average ratio | Others | 1984Q3 | Level |
| HSI Finance/HSI Index (relative to 2-year moving average) | Stock market | 1994Q1 | Level |
| Mortgage loans delinquency ratio | Delinquency | 1998Q3 | Level difference |
| Credit card loans delinquency ratio | Delinquency | 1996Q1 | Level difference |

Sources: C&SD, HKMA, CEIC, HKMA staff estimates.