HONG KONG MONETARY AUTHORITY

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REVISED SMALL FORECASTING MODEL FOR HONG KONG

Key points:

- *This paper presents revisions to the small forecasting model for the Hong Kong economy. In particular, the model is extended to better capture Hong Kong's economic integration with Mainland China. In addition, private consumption and investment are modelled separately to account for sectoral dynamics and an explicit interest rate channel of shock transmission.*

- *The modified model consists of 8 behavioural equations and 15 identities. Most of the behavioural equations are estimated using quarterly data from 1990 Q1 to 2004 Q2. The model converges to a long-run equilibrium consistent with economic theory, at a plausible pace reflecting the flexibility of the economy.*

- *The model is useful for short-term macroeconomic forecasting and analysing the impact of external shocks on the local economy. Simulations based on the model suggest that the Mainland has become increasingly important for the Hong Kong economy. In particular,*

  - *Mainland growth has been the main factor supporting the recovery in Hong Kong since the second half of 2003. Specifically, growth on the Mainland is estimated to have contributed to growth in Hong Kong by 2½ percentage points in the second half of 2003 and 3½ percentage points in the first half of 2004, out of an actual growth of 4½% and 9½% during the corresponding periods.*

  - *A one-percentage point permanent reduction in Mainland growth could reduce Hong Kong's real GDP growth by ½ percentage points in the first year on account of reduced trade activities. Indirect effects through financial channels could add another half of a percentage point. However, the impact will decline over time as the depreciation of the real effective exchange rate brought about by lower consumer prices improves Hong Kong's competitiveness and brings output growth back to a new steady state.*

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INTRODUCTION

A number of modifications have recently been made to the small forecasting model (SFM). The SFM was constructed in 2002 to produce short-term macroeconomic forecast and to provide a framework for analysing the impact on the main macroeconomic aggregates in Hong Kong of hypothetical shocks.[1] Due to changes in the Hong Kong economy and the global environment, the forecasting model needs to be updated continuously. Furthermore, a main shortcoming has been that the links between the Hong Kong and Mainland economies are not explicitly modelled. This has made it difficult to use the model to study the potential impact of developments on the Mainland on Hong Kong. In updating the model, a modification has been made to explicitly account for the impact of Mainland growth on Hong Kong, which was treated as part of the general external factors in the earlier model. Another revision is to provide a better account of private domestic demand determination by estimating consumption and investment separately, with the interest rate transmission channel explicitly added.[2]

This paper summarises the re-estimation of key equations of the SFM and analyses the impact on Hong Kong of developments on the Mainland. The rest of the paper is organised as follows. Section II discusses estimates of key equations. Compared with the earlier model, the revisions improve the fit of the behavioural equations. Section III presents two simulations to assess the contribution of Mainland growth to the recent economic recovery in Hong Kong and the impact on Hong Kong of a hypothetical slowdown of Mainland growth. The results suggest that developments in the Mainland economy exert significant influence on the Hong Kong economy. Section IV provides concluding remarks. Appendices A and B list all equations and variables.

II. THE NEW MODEL SPECIFICATION

As with other macroeconomic models, the SFM needs to be modified constantly to reflect developments such as new data series or deeper analysis of particular sectors of the economy. In this round of revision, the SFM is modified to include measures of Mainland growth and inflation in the specification to capture

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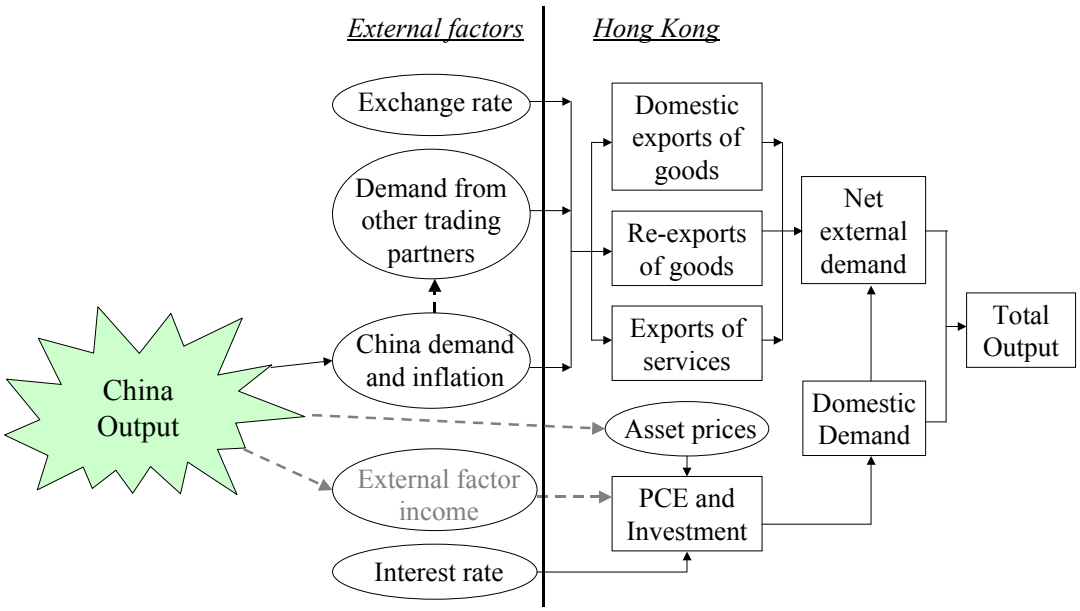
1 The SFM is detailed in Ha, Leung and Shu (2002).

2 The model was revised to reflect the direct impact of interest rate changes on consumption and investment. However, the impacts on asset prices of movements in interest rates are not explicitly modelled, as asset prices are inherently difficult to forecast, especially in the short run. This may be an area for future work.

the impact of developments in the Mainland economy via trade channels (Chart 1). In addition, private consumption and investment equations are modified to reflect the interest rate transmission mechanism.

Chart 1. Transmission Mechanisms of External Shocks to Mainland Output



Note: Transmission channels represented by the solid lines are modelled in the SFM, while those of the dashed lines have not been incorporated in the new model yet.

Compared with the earlier version of the model, the modifications improve the fit of the behavioural equations. The estimation of the behavioural equations yields plausible results, with all parameters being statistically significant and having expected signs. The model is well behaved as it converges at a plausible pace to a long-run equilibrium consistent with economic theory, and exhibits short-run dynamics reflecting the flexibility of the economy.

These revisions have not affected the basic structure of the model, which consists of three parts. The first part contains equations for forecasting output and its major components, with government expenditure treated as exogenous. The second part characterises the dynamics of inflation using a Phillips curve, with import prices being exogenous. In addition, asset prices, including property prices, are also exogenous to the model, as they are inherently difficult to forecast. The third part relates the unemployment rate to the output gap by Okun's law. Most of the equations are specified in error-correction form and estimated using quarterly data from 1990 Q1 to 2004 Q2. Each equation is estimated with the Newey-West estimator that provides consistent estimates of standard errors in the presence of heteroskedasticity and autocorrelation. The "general-to-specific"

method is used to determine the number of lags of the explanatory variables. All variables are in logarithms, except the inflation rate, interest rates, the unemployment rate, and the time trend. Specification and estimation of key equations are discussed below. A complete list of equations and statistical tests is provided in Appendix A. Data descriptions appear in Appendix B.

A. Output

Output is disaggregated into several major components according to the expenditure approach. The key expenditure components of gross domestic output (*y*) include private domestic demand (*dd*), public expenditure (*g*), total export earnings (*x*), and imports for domestic uses less changes in inventory (*m*). Private domestic demand is further decomposed into consumption (*pce*) and investment (*inv*); and total export earnings into domestic exports (*dx*), re-export earnings (*rxm*), and exports of services (*xs*). A behavioural equation is estimated for each component.

$$y_t = \log\left(e^{dd_t} + e^{x_t} - e^{m_t} + e^{g_t}\right) \tag{1}$$

$$dd_t = \log\left(e^{pce_t} + e^{inv_t}\right) \tag{2}$$

$$x_t = \log\left(e^{rxm_t} + e^{dx_t} + e^{xs_t}\right) \tag{3}$$

Private Domestic Demand

In the earlier model, private domestic demand—the sum of private consumption and investment—is estimated as a function of income and wealth, using real gross domestic product and real asset prices[3] as proxies. It is modified in the new model by estimating behavioural equations for the two components separately, allowing for different explanatory variables and elasticities for each component. This modification promotes an understanding of developments in different sectors of the economy.

[3] As there are no good statistical measures available on labour income and household wealth, for simplicity and ease for forecasting, real income is used as the proxy for labour income, and real property prices and the Hang Sang Index are used as proxies for household wealth.

- *Private Consumption*

In the long run, private consumption expenditure is estimated as a function of income, wealth and real interest rates. Real property prices (*rpp*) and the Hang Seng Index (*rhs*) are used as proxies for wealth, while real gross domestic product (*y*) is used as a measure of income. The real interest rate (*reali*) is defined as the best lending rate minus the headline inflation rate. For the short-run dynamics, a measure of the nominal interest rate (*i*) was included to capture the substitution effects of changes in interest rates.[4] Changes in the unemployment rate (*u*) are also included to capture influences of precautionary saving.

$$\begin{aligned}\Delta pce_t &= \alpha_0 - \alpha_1\left(pce_{t-1} - \alpha_2 rpp_{t-1} - \alpha_3 rhs_{t-1} - \alpha_4 y_{t-1} - \alpha_5 reali_{t-1}\right) \\ &\quad + \alpha_6 \Delta y_t + \alpha_7 \Delta i_t + \alpha_8 \Delta u_t\end{aligned} \tag{4}$$

The estimation of the equation for private consumption yields plausible results, with all parameters being statistically significant and having the expected sign. The long-term income elasticity is estimated to be 0.8 (Table 1). A 10% increase in real property prices or equity prices is estimated to raise private consumption by close to 1% in the long run. An increase of one percentage point in real interest rates will lower consumption by about ½% in the long run. In the short run, an increase of 1 percentage point in unemployment rate and nominal interest rates will reduce consumption by 1½% and 3% respectively.

[4] This practice follows that of the Bank of England (2000).

Table 1. Estimation of Private Domestic Demand Equations

	Dependent variables				
	Δpce			Δinv	
α_1	0.87**	(6.4)	β_1	0.44**	(4.1)
α_2	0.10**	(3.2)	β_2	0.27**	(5.1)
α_3	0.09**	(2.3)	β_3	0.10**	(2.9)
α_4	0.80**	(12.7)	β_4	0.89**	(453)
α_5	-0.38*	(1.7)	β_5	0.18*	(1.9)
α_6	0.51**	(8.7)	β_6	0.71**	(7.9)
α_7	-3.05**	(3.4)	β_7	-1.38	(1.5)
α_8	-1.50**	(2.3)			
R^2	0.68			0.62	
Durbin-Waston Statistics	1.84			1.91	
White test for heteroskedasticity	1.48 [0.20]			2.03 [0.03]	

Note: Numbers in parentheses are t-statistics, and those in squared brackets are p-values.
* and ** indicate significance at the 10 and 5 percent level respectively.
Source: Staff estimates.

- *Private Investment*

Private investment, including property-related investment and purchases of equipment, machinery and software, is specified as a function of income, real asset prices and real interest rates. Real interest rates were initially included in the long run specification, but were dropped subsequently because the sign of the estimated parameter was not as expected by theory.[5] This suggests that interest rate changes affect private investment through asset price movements in the long run. Asset prices affect private investment mainly through two channels. First, the value of assets, particularly the value of real-estate property, affects companies' borrowing costs because assets are commonly used as collateral for bank credit. Second, equity prices determine the cost at which firms raise capital through the equity market and thereby affect the cost of investment. In the short-run dynamics, changes in real interest rates are found to affect investment.

[5] A measure of long-term real interest rate should have been used here, as investment decisions are ultimately driven by the movements in the real long rates. However, having a short rate and a long rate in the model simultaneously necessitates the modelling of the term structure, which is an area for future work.

$$\Delta inv_t = \beta_0 - \beta_1\left(inv_{t-1} - \beta_2 rpp_{t-1} - \beta_3 rhs_{t-1} - \beta_4 y_{t-1}\right) + \beta_5 \Delta rpp_t + \beta_6 \Delta y_t + \beta_7 \Delta reali_t \quad (5)$$

The results suggest that a 10% increase in real property prices and equity prices are estimated to raise private investment by 2¾% and 1% respectively in the long run (Table 1). In the short run, an increase of 1 percentage point in real interest rates will reduce investment by 1½%.

Export Earnings

Hong Kong's export earnings include re-export earnings, domestic exports of goods, and exports of services. Since re-export values (*rx*) are directly observed and easier to model than export earnings, we estimate a behavioural equation for re-export values. Then re-export earnings are defined as the product of the re-export values and the re-export margin, which is exogenously determined. Equations for the three components of exports are estimated separately, allowing for different explanatory variables and elasticities. All three behavioural equations have been modified to incorporate factors capturing economic developments in the Mainland.

- *Domestic exports*

The previous equation includes a measure of Hong Kong's trade-weighted foreign demand (y^W), real effective exchange rate (*reerxc*), and a trend variable (*T*). The new equation attempts to capture the demand of Mainland economy by disaggregating y^W into two variables – real GDP of the Mainland economy (y^{CN}) and Hong Kong's foreign demand excluding Mainland China (y^{WexCN}). The estimation suggests that a 1% increase in the Mainland output would raise domestic exports of goods by about ½% in the long run. The estimated negative value for the coefficient of the trend variable reflects the relocation of Hong Kong's manufacturing sector to the Mainland, where costs of production are much lower (Table 2).

$$\Delta dx_t = \lambda_0 - \lambda_1(dx_{t-1} - \lambda_2 reerxc_{t-1} - \lambda_3 y^{WexCN}_{t-1} - \lambda_4 y^{CN}_{t-1}) + \lambda_5 T \quad (6)$$

- *Re-exports*

In the earlier model, re-exports are estimated as a function of the Mainland's real effective exchange rate ($reer^{CN}$) and its trade-weighted foreign demand (y^{WCN}). The latter measures world demand for Mainland products, some of which are exported through Hong Kong. However, an emerging trend is a rapid increase of Chinese imports passing through Hong Kong. In order to capture this development, the new re-export function incorporates Mainland real output (y^{CN}), which measures demand on the Mainland for goods produced by the rest of the world channelled through Hong Kong. In addition, to provide a better measure of the demand for Chinese goods from the rest of the world, Hong Kong was removed from the measures of the Mainland's real effective exchange rate ($reer^{CNexHK}$) and its trade-weighted foreign demand ($y^{WCNexHK}$). The results suggest that Hong Kong's re-exports would rise by ½% in the long run in response to a 1% rise in the Mainland output (Table 2).

$$\Delta rx_t = \alpha_0 - \alpha_1\left(rx_{t-1} - \alpha_2 reerxhk_{t-1}^{CN} - \alpha_3 y_{t-1}^{WCNexHK} - \alpha_4 y_{t-1}^{CN}\right) + \alpha_5 \Delta y_t^{WCNexHK} + \alpha_6 \Delta y_t^{CN} \quad (7)$$

- *Exports of services*

Similar to the equation for domestic exports of goods, a major change of the exports of services equation is segregating the overall foreign demand into the Mainland demand and foreign demand excluding Mainland China. The new specification also tries to capture the impact of Severe Acute Respiratory Syndrome (SARS) by including a dummy variable (*DSARS*) taking the value of 1 in 2003 Q2 and 0 otherwise.[6] In addition, reflecting the complimentarity between increasing re-exports and trade-related exports of services, a new variable given by the time trend interacted with changes in re-exports is included.

$$\Delta xs_t = \beta_0 - \beta_1(xs_{t-1} - \beta_2 reerxc_{t-1} - \beta_3 y_{t-1}^{WexCN} - \beta_4 y_{t-1}^{CN}) + \beta_5 \Delta y_t^{CN} + \beta_6 DSARS + \beta_7 (T * \Delta rx_t) \quad (8)$$

[6] The dummy variable also captures any possible impact on the long-run relation in the equation, given the model is linear in variables.

The modification improved the fitness of the equation significantly. The estimation suggests that a 1% increase in the Mainland output and aggregate output of Hong Kong's other major trading partners would raise exports of services by about ¾% and ½% respectively in the long run (Table 2). The estimated value for the coefficient of the SARS dummy variable indicates that the outbreak of SARS lowered exports of services significantly by 20% in the second quarter of last year (quarter-on-quarter and seasonally-adjusted). The estimated positive value of the coefficient of the *T*Δrx* reflects the increasing importance of offshore trade.

Table 2. Estimation of Export Earnings Equations

	Dependent variables							
	Δrx			*Δdx*			*Δxs*	
α_1	0.24**	(4.1)	λ_1	0.60**	(5.2)	β_1	0.91**	(5.2)
α_2	-1.05**	(4.4)	λ_2	-0.10	(1.1)	β_2	-0.54**	(7.9)
α_3	2.21**	(5.8)	λ_3	3.08**	(4.9)	β_3	0.55**	(2.4)
α_4	0.49**	(3.2)	λ_4	0.52**	(2.2)	β_4	0.63**	(8.1)
α_5	2.42**	(1.9)	λ_5	-0.03*	(4.4)	β_5	0.93**	(3.6)
α_6	0.65**	(1.9)				β_6	-0.20**	(9.0)
						β_7	0.003**	(1.9)
R^2	0.92			0.94			0.80	
Durbin-Waston Statistics	2.19			2.05			1.68	
White test for heteroskedasticity	0.59 [0.85]			0.45 [0.92]			1.85 [0.05]	

Note: Numbers in parentheses are t-statistics, and those in square brackets are p-values.
* and ** indicate significance at the 10 and 5 percent level, respectively.

Retained Imports

Total imports, including goods and services for local consumption and production, are specified as a function of the real effective exchange rate (*reer*) and total final demand (*tfd*). In the earlier model, total final demand was defined as the sum of total domestic demand and total exports. The replacement of total exports by total export earnings improved the fit of the equation, because it is the income derived from exports, rather than the value of exported goods, that affects the domestic demand for imports.

$$\Delta m_t = \varphi_0 - \varphi_1(m_{t-1} - \varphi_2 tfd_{t-1}) + \varphi_3 \Delta tfd_t + \varphi_4 \sum_{i=1}^{4} \Delta reer_{t-i} \qquad (9)$$

A dummy variable was initially included in the specification in an attempt to capture the impact of SARS but was dropped since it was insignificant. Likewise, the *reer* was also found to be statistically insignificant in the long run specification and was thus dropped. This suggests that in the long run retained imports depend solely on the final demand and the effective exchange rate affects only its dynamics. A 1% increase in total final demand would raise retained imports by 1¼% in the long run (Table 3).

Table 3. Estimation of Retained Import Equation

Dependent variables: Δm		
φ_1	0.43**	(2.9)
φ_2	1.27**	(36.9)
φ_3	1.65**	(11.0)
φ_4	0.25**	(2.3)
$R^2 = 0.92$		
Durbin-Waston Statistics = 2.18		
White test for heteroskedasticity = 0.67 [0.84]		

Note: Numbers in parentheses are t-statistics, and those in square brackets are p-values.
* and ** indicate significance at the 10 and 5 percent level respectively.
Source : Staff estimates.

B. Prices

Domestic prices (p) are determined by import prices (p^W) and property prices (p^P) in the long run. In the short run, inflation (π) is influenced by the output gap (*gap*) and changes in import prices and property prices. The inclusion of property prices reflects their lagged effect on consumer prices through rental prices, which are sticky due to lease contracts. The import prices are measured as the trade-weighted average of consumer prices of Hong Kong's major trading partners deflated by nominal effective exchange rate of Hong Kong dollar. The new model attempts to capture the impact of Mainland inflation by disaggregating p^W into two variables – consumer prices of the Mainland economy (p^{CN}) and import prices without the Mainland prices (p^{WexCN}). Both prices are deflated by the respective exchange rate indices. The new specification also includes a dummy variable capturing the impact of SARS.

$$\pi_t = \sigma_0 - \sigma_1\left(p_{t-1} - \sigma_2 p_{t-1}^{WexCN} - \sigma_3 p_{t-1}^{CN} - \sigma_4 p_{t-1}^{P}\right) + \sigma_5 \sum_{i=0}^{n} \Delta p_{t-i}^{P} + \sigma_6 \sum_{i=0}^{l} \Delta p_{t-i}^{CN} + \sigma_7 \sum_{i=1}^{k} gap_{t-i} + \sigma_8 DSARS \quad (10)$$

where $p_t^{WexCN} = wcpi_t^{exCN} - neer_t^{exCN}$, and

$$p_t^{CN} = cpi_t^{CN} + hkdrmb_t$$

With the new specification, long-run homogeneity still holds as the null hypothesis that $\sigma_2+\sigma_3+\sigma_4=1$ cannot be rejected (Table 4, regression 1)[7]. Moreover, the sum of estimates for parameters σ_2 and σ_3 is fairly close to the coefficient of p^W in the previous model. Estimates of the restricted model (Table 4 regression 2) show that property prices, Mainland consumer prices, and import prices excluding Mainland determine 19%, 28% and 53% of the movement of domestic prices respectively in the long run. The estimates indicate that the output gap influences inflation dynamics with a lag of 2-3 quarters.

[7] The adjustment to deviations from the long-run equilibrium is about 10% per quarter, which is higher than alternative estimates on Hong Kong by Ha and Leung (2001) but fairly close to those estimates for other open economies, such as the UK, Australia, and Thailand.

Table 4. Estimation of Phillips Curve

Dependent variables: π

	Regression 1		Regression 2	
σ_1	0.09**	(11.8)	0.10**	(14.0)
σ_2	0.38**	(3.4)	0.53**	(13.9)
σ_3	0.23**	(4.1)	0.28**	(7.6)
σ_4	0.21**	(10.5)	0.19	--
σ_5	0.51**	(4.3)	0.68**	(5.3)
σ_6	0.03**	(2.6)	0.02**	(2.2)
σ_7	0.06**	(8.0)	0.06**	(7.3)
σ_8	-0.00**	(3.7)	-0.01**	(8.8)
R^2	0.95		0.94	
Durbin-Waston Statistics	1.77		2.16	
White test for heteroskedasticity	1.82 [0.08]		0.47 [0.87]	

Wald test ($\sigma_2 + \sigma_3 + \sigma_4$=1): F-statistics = 2.19 [0.15]

Note: Numbers in parentheses are t-statistics, and those in squared brackets are p-values.
** indicates significance at the 5 percent level.
Source: Staff estimates.

C. Unemployment

The unemployment rate is related to the output gap by Okun's law. The deviation of the unemployment rate from the natural rate (u^*), the unemployment gap, is estimated in a partial adjustment form. The natural rate of unemployment is estimated as in Peng, Cheung and Fan (2001). In the earlier model, both the level and change of the output gap affect unemployment contemporaneously. In the new model, the fit of equation is improved by adding one-period lag of the change of output gap. The result indicates that changes in output gap have greater impact than the level of the output gap on the unemployment rate (Table 5). This implies that the growth momentum, as measured by the changes in the output gap, plays a more important role in reducing unemployment than the current stage of economic growth does.

$$u_t - u_t^* = \theta_0 + \theta_1\left(u_{t-1} - u_{t-1}^*\right) + \theta_2 gap_t + \theta_3 \Delta gap_{t-1} + \theta_4 \Delta gap_t \qquad (11)$$

Table 5. Estimation of Unemployment Rate Equation

Dependent variables: u		
θ_1	0.96**	(36.2)
θ_2	-0.06**	(3.0)
θ_3	-0.13**	(3.6)
θ_4	-0.08**	(3.3)
$R^2 = 0.96$		
Durbin-Waston Statistics = 2.16		
White test for heteroskedasticity = 0.47 [0.87]		

Note: Numbers in parentheses are t-statistics, and those in squared brackets are p-values.
** indicate significance at the 5 percent level.
Source: Staff estimates.

III. SIMULATING THE IMPACT OF MAINLAND ECONOMY ON HONG KONG

Two simulations are conducted to investigate macroeconomic responses of the Hong Kong economy to shocks to Mainland growth. One is a counterfactual scenario, to quantify the contribution of Mainland growth to the recent economic recovery in Hong Kong. The other is a simulation of the impact on Hong Kong of a hypothetical slowdown in Mainland growth. The simulation results are summarised below. Given the nature of macroeconomic forecasting, which are based on many modelling simplifications and assumptions, these results should be interpreted with caution. Nevertheless, they provide a useful starting point for macroeconomic monitoring and policy analysis.

A. The Contribution of Mainland Growth to Hong Kong's Recent Recovery

Since 1997, economic growth in Hong Kong has been interrupted by a string of external shocks, including the Asian Financial Crisis in 1998, the global economic downturn in 2001, and the outbreak of SARS in the second quarter of 2003. The economy started to recover since the latter part of 2003. Real GDP grew by 12.1% in 2004 Q2 on a year-on-year comparison, while deflation in CCPI on a month-on-month comparison has largely disappeared since August 2003.

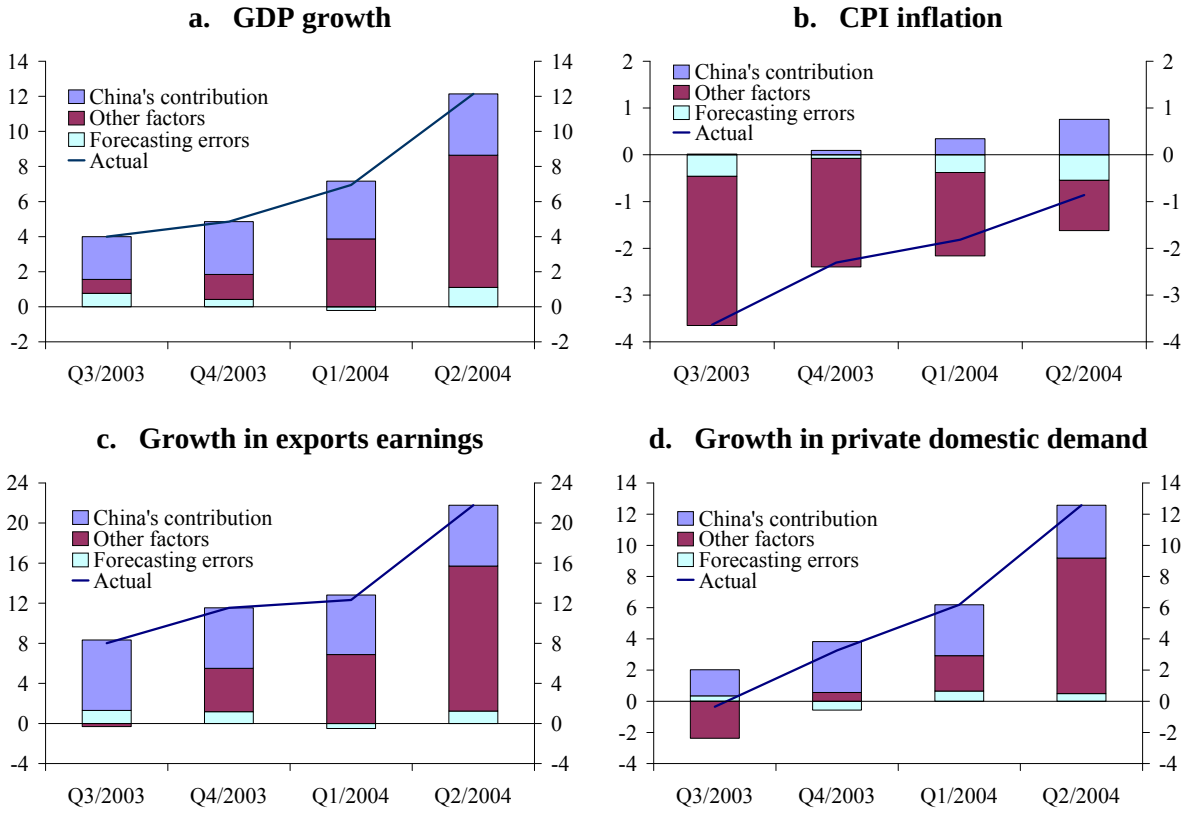
The analysis suggests that the recovery was largely supported by the strength in the Mainland economy, which partly benefited from the global recovery. Real GDP growth on the Mainland accelerated from early 2003 notwithstanding a

temporary slowdown in the second quarter of 2003 due to the impact of SARS, with inflation picking up, and the trade account recording a significant deficit in 2004 Q1. To quantify the contribution of Mainland growth to the recovery in Hong Kong, the revised SFM was used to generate a counterfactual simulation, in which Mainland output and consumer prices are assumed to remain flat during 2003 H2 and 2004 H1. This generates a scenario in which the Hong Kong economy is not supported by any economic stimulus from the Mainland. The set of macroeconomic aggregates resulting from the counterfactual simulations are compared against those under a benchmark scenario, which is produced by a set of dynamic "in-sample" forecasts using actual values of all exogenous variables for the same period. Thus the difference which measures the contribution of Mainland growth – is not subject to any model based forecasting errors.

The simulation suggests that the economic recovery in the second half of 2003 was mainly driven by Mainland growth via the trade channel. As the recovery becomes more broad-based, the relative contribution from the Mainland to overall growth in Hong Kong has gradually declined. Mainland growth is estimated to have raised Hong Kong's growth by 2½ percentage points in the third quarter of 2003, compared with the actual output growth of 4% (Chart 2). On the other hand, of the 12.1% increase in Hong Kong output in the second quarter of 2004, Mainland contributed only 3½ percentage points.

These simulations are subject to several qualifications. First, the results may underestimate the significance of economic developments on the Mainland as they do not include the impact of external factor income derived from the Mainland. Second, since asset prices are treated as exogenous and not determined by the model, the impact of higher asset prices brought about by the strengthening of Hong Kong's economic relationship with the Mainland is not reflected.

Chart 2. The Mainland's Contribution to Hong Kong Output Growth



Source : Staff estimates.

B. Impact of a Hypothetical Slowdown on the Mainland

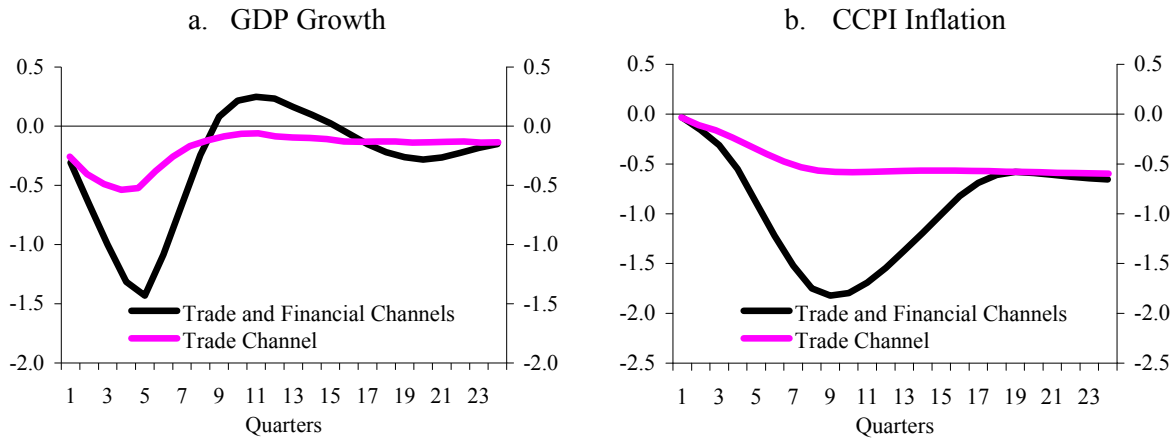
Recent developments present challenges to the macroeconomic management in Mainland China. The latest data point to a sharp slowdown in the growth of broad money and credit, which raises the concern of whether the administrative measures adopted so far are too strong to generate a soft landing. To quantify the impact of a hypothetical slowdown in Mainland growth on Hong Kong, simulations are conducted using the revised SFM.

The simulations are in the nature of "shock-minus-control" experiments, as they represent the effects of shocks relative to a baseline case. The responses of endogenous variables to shocks are measured as deviations in percentage points from the baseline. To carry out the simulations, the model is shocked by a permanent reduction of one percentage point in Mainland growth.[8] Mainland inflation is assumed to decline by about 2 percentage points accordingly, following the historical experience.

[8] The choice of the magnitude of the shock does not affect the analysis.

Chart 3 presents the responses of key endogenous variables to the shock. Real output growth and consumer price inflation would fall by about ½ and 0.1 percentage points respectively relative to the baseline in the first year of the shock (Table 6). This reflects in part lower external demand for Hong Kong's goods and services due to slower growth on the Mainland. Furthermore, as a narrowing output gap depresses prices and thus inflation falls, real interest rates rise. Domestic demand declines as higher real interest rates discourage consumption and investment.

Chart 3. A Hypothetical Slowdown in Mainland Growth
(Percentage point deviation from baseline)



Source : Staff estimates.

Table 6. The 1-year Impact of a Hypothetical Slowdown in Mainland Growth
(Percentage point deviation from baseline)

	Trade channel[1]	Financial channel[2]
Real GDP	-0.4	-0.4
Domestic demand	-0.4	-1.3
Export earnings	-0.6	0.0
Domestic exports	-0.2	0.0
Re-exports of goods	-0.6	0.0
Exports of services	-0.7	0.0
Inflation rate	-0.1	-0.1
Unemployment rate	0.1	0.1

[1] Assume one percentage point decline in real output growth and about two percentage decline in consumer price inflation on the Mainland.
[2] Assume a change in investors' sentiment leads to a 10% decline in equity and property prices.

Source : Staff estimates.

However, asset price adjustments resulting from a deterioration of investors' sentiments towards the Mainland and Hong Kong could affect growth further. Our estimates suggest that every 10% decline in the Hang Seng Index and property prices could reduce real output growth by another half of a percentage point. Therefore, while the direct impact from a shock to Mainland growth appears not large, the total effect after accounting for potential adverse asset price movements could be more significant.

In the long run, growth would slowly recover to a permanently lower level, due to the permanently lower Mainland growth. This recovery mainly reflects the decline in the domestic price level that leads to a depreciation of the real effective exchange rate hence improves Hong Kong's competitiveness. Gradually, the negative impact of the shocks is offset by the improvement in the balance of payment. Inflation will also return to a new steady-state level that is permanently lower than the baseline .

IV. CONCLUDING REMARKS

This paper presents recent revisions to the Small Forecasting Model. Compared to the earlier work, the model takes account explicitly the importance of the Mainland economy to Hong Kong, particularly by reflecting the trade channels of shock transmission between the two economies. In addition, private domestic demand is divided into private consumption and private investment to capture better sectoral dynamics. The direct impact of interest rate movements on consumption and investment are also analysed. A number of technical modifications are made to improve the fit of the model and account for the SARS episode in 2003 Q2.

The changes improve the model's explanatory power while preserving its forecasting performance. Simulations based on the model provide useful tools for analysing the transmission of external shocks and its impact on the local economy. In addition, it continues to serve as a good base for short-term macroeconomic forecasting.

Appendix A

List of Equations

This appendix provides a full list of equations in the model. All variables are in logarithms, except the inflation rate, the unemployment rate, and the time trend. First difference operator is denoted by Δ. Absolute t-values are in brackets.

1. Real Output

(i) Output

$$y_t = \log\left(e^{tdd_t} + e^{x_t} - e^{m_t}\right)$$

(ii) Output gap

$$gap_t = y_t - y_t^*$$

2. Domestic Demand

(i) Total domestic demand

$$tdd_t = \log\left(e^{pce_t} + e^{inv_t} + e^{g_t}\right)$$

(ii) Private consumption

$$\Delta pce_t = \underset{(2.6)}{1.83} - \underset{(6.4)}{0.87}\left(pce_{t-1} - \underset{(3.2)}{0.10}rpp_{t-1} - \underset{(2.3)}{0.09}rhs_{t-1} - \underset{(12.7)}{0.80}y_{t-1} + \underset{(1.7)}{0.38}reali_{t-1}\right) + \underset{(8.7)}{0.51}\Delta y_t$$
$$- \underset{(3.4)}{3.05}\Delta blr_{t-1} - \underset{(2.3)}{1.50}\Delta u_t + seasonal\ dummies$$

where $reali_t = blr_t - (p_t - p_{t-4})$

Adjusted R^2: 0.68
Equation standard error: 0.0238
Jarque-Bera test for normality: χ^2-statistics = 3.65 [0.16]
White test for heteroskedasticity: F-statistics = 1.48 [0.20]
Durbin-Waston Statistics: 1.84
Sample period: 1990Q1 – 2004Q2

(iii) Private investment

$$\Delta inv_t = \underset{(5.9)}{-0.05} - \underset{(4.1)}{0.44}\left(inv_{t-1} - \underset{(5.1)}{0.27} rpp_{t-1} - \underset{(2.9)}{0.10} rhs_{t-1} - \underset{(453)}{0.89} y_{t-1}\right) + \underset{(1.9)}{0.18}\Delta rpp_t + \underset{(7.9)}{0.71}\Delta y_{t-1} - \underset{(1.5)}{1.38}\Delta reali_{t-1} + seasonal\ \ dummies$$

Adjusted R^2: 0.62
Equation standard error: 0.0642
Jarque-Bera test for normality: χ^2-statistics = 6.18 [0.05]
White test for heteroskedasticity: F-statistics = 2.03 [0.03]
Durbin-Waston Statistics: 1.91
Sample period: 1990Q1 – 2004Q2

3. External Trade

(i) Total export earnings

$$x_t = \log\left(e^{rx_t + rrxm_t} + e^{dx_t} + e^{xs_t}\right)$$

(ii) Domestic exports of goods

$$\Delta dx_t = \underset{(1.2)}{-2.20} - \underset{(5.2)}{0.60}\left(dx_{t-1} + \underset{(1.1)}{0.10} reerxc_{t-1} - \underset{(4.9)}{3.08} y_{t-1}^{WexCN} - \underset{(2.2)}{0.52} y_{t-1}^{CN}\right) - \underset{(4.4)}{0.03}T + seasonal\ \ dummies$$

Adjusted R^2: 0.94
Equation standard error: 0.0383
Jarque-Bera test for normality: χ^2-statistics = 12.6 [0.00]
White test for heteroskedasticity: F-statistics = 0.45 [0.92]
Durbin-Waston Statistics: 2.05
Sample period: 1990Q1 – 2004Q2

(iii) Re-exports of goods

$$\Delta rx_t = \underset{(4.1)}{-0.24}\left(rx_{t-1} + \underset{(4.4)}{1.05}reerxhk_{t-1}^{CN} - \underset{(5.8)}{2.21}y_{t-1}^{WCNecHK} - \underset{(3.2)}{0.49}y_{t-1}^{CN}\right) + \underset{(1.9)}{2.42}\Delta y_t^{WCNexHK} + \underset{(1.9)}{0.65}\Delta y_t^{CN} + seasonal\ \ dummies$$

Adjusted R^2: 0.92
Equation standard error: 0.0292
Jarque-Bera test for normality: χ^2-statistics = 1.3 [0.53]
White test for heteroskedasticity: F-statistics = 0.59 [0.85]
Durbin-Waston Statistics: 2.19
Sample period: 1995Q1 – 2004Q2

(iv) Exports of services

$$\Delta xs_t = \underset{(3.8)}{3.19} - \underset{(5.2)}{0.91}\left(xs_{t-1} + \underset{(7.9)}{0.54}reerxc_{t-1} - \underset{(2.4)}{0.55}y_{t-1}^{WexCN} - \underset{(8.1)}{0.63}y_{t-1}^{CN}\right) + \underset{(3.6)}{0.93}\Delta y_t^{CN} - \underset{(9.0)}{0.20}DSARS + \underset{(1.9)}{0.003}\left(T * \Delta rx_t\right) + seasonal\ dummies$$

Adjusted R^2: 0.80
Equation standard error: 0.0347
Jarque-Bera test for normality: χ^2-statistics = 1.14 [0.56]
White test for heteroskedasticity: F-statistics = 1.85 [0.05]
Durbin-Waston Statistics: 1.68
Sample period: 1988Q1 – 2004Q2

(v) Imports less imports for re-exports and change in inventories

$$\Delta m_t = \underset{(2.8)}{-1.93} - \underset{(2.9)}{0.43}\left(m_{t-1} - \underset{(36.9)}{1.27}tfd_{t-1}\right) + \underset{(11.0)}{1.65}\Delta tfd_t + \underset{(2.3)}{0.25}\sum_{i=1}^{4}\Delta reer_{t-i} + seasonal\ \ dummies$$

where $tfd_t = \log\left(e^{x_t} + e^{tdd_t}\right)$

Adjusted R^2: 0.92
Equation standard error: 0.0203
Jarque-Bera test for normality: χ^2-statistics = 0.52 [0.77]
White test for heteroskedasticity: F-statistics = 0.67 [0.84]
Durbin-Waston Statistics: 2.18
Sample period: 1990Q1 – 2004Q2

4. Prices

(i) Inflation

$$\pi_t = -0.36 - 0.10\left(p_{t-1} - 0.53\,p^{WexCN}_{t-1} - 0.28\,p^{CN}_{t-1} - 0.19\,p^{P}_{t-1}\right) + 0.68\sum_{i=4}^{11}\Delta p^{P}_{t-i} + 0.02\sum_{i=0}^{1}\Delta p^{CN}_{t-i}$$
(13.9) (14.0) (13.9) (7.6) (13.9) (5.3) (2.2)

$$+ 0.06\sum_{i=2}^{3} gap_{t-i} - 0.01\,DSARS + seasonal\ \ dummies$$
(7.3) (8.8)

Adjusted R^2: 0.94
Equation standard error: 0.00.5
Jarque-Bera test for normality: χ^2-statistics = 12.7 [0.00]
White test for heteroskedasticity: F-statistics = 1.77 [0.09]
Durbin-Waston Statistics: 1.69
Sample period: 1990Q1 – 2004Q2

(ii) Import prices

$$p^{WexCN}_t = wcpi^{exCN}_t - neer^{exCN}_t,$$

$$p^{CN}_t = cpi^{CN}_t + hkdrmb_t$$

$$wcpi_t = (1-0.42)wcpi^{exCN}_t + 0.42cpi^{CN}_t$$

(iii) Asset prices

$$rpp_t = \frac{p^p_t}{cpi_t}$$

$$rhs_t = \frac{hs_t}{cpi_t}$$

5. Unemployment rate

$$u_t - u^*_t = 0.96\left(u_{t-1} - u^*_{t-1}\right) - 0.06\,gap_t - 0.13\Delta gap_{t-1} - 0.08\Delta gap_t$$
(36.2) (3.0) (3.6) (3.3)

Adjusted R^2: 0.96
Equation standard error: 0.0034
Jarque-Bera test for normality: χ^2-statistics = 4.26 [0.12]

White test for heteroskedasticity: F-statistics = 0.47 [0.87]
Durbin-Waston Statistics: 2.16
Sample period: 1990Q1 – 2004Q2

6. Exchange rates

(i) Real effective exchange rate

$reer_t = p_t - p_t^W$,
where $p_t^W = wcpi_t - neer_t$

(ii) Real effective exchange rate with declining weight for RMB

$reerxc_t = p_t - p_t^{WexCN}$

(iii) Normal effective exchange rate

$neer_t = (1 - 0.42) neer_t^{exCN} + 0.42 \, {}^{1}\!/\!_{hkdrmb_t}$

Appendix B

Variable and Data Descriptions

I. Endogenous variables

dd	real private domestic demand
dx	real domestic exports of goods
inv	real private investment
m	real retained imports of goods and services less inventories
neer	nominal effective exchange rate index of HKD
p	consumer price index
pce	real private consumption
p^{CN}	China's consumer price in HKD terms
p^{W}	trade-weighted foreign consumer price in HKD terms
p^{WexCN}	trade-weighted foreign consumer price in HKD terms (excluding China)
reali	real interest rate
π	CPI quarter-on-quarter inflation
reer	CPI-based real effective exchange rate of HKD
reerxc	CPI-based real effective exchange rate of HKD with declining weight for RMB
rhs	eight-quarter moving average of real Hang Seng index
rpp	real property price
rx	real re-exports of goods
tdd	real total domestic demand
tfd	real total final demand
u	unemployment rate
wcpi	trade-weighted consumer price of Hong Kong's major trading partners
x	real total export earnings
xs	real exports of services
y	real GDP

II. Exogenous variables

blr	best lending rate
cpi^{CN}	China's consumer price index
g	real public spending
hkdrmb	HKD per RMB
hs	eight-quarter moving average of nominal Hang Seng Index
$neer^{exCN}$	nominal effective exchange rate index of HKD (excluding China)
p^{P}	nominal property price
$reer^{CN}$	China's real effective exchange rate index
$reerxhk^{CN}$	China's real effective exchange rate index (excluding Hong Kong)
rrxm	rate of re-export margin in base year
*u**	natural rate of unemployment
$wcpi^{exCN}$	trade-weighted consumer price of Hong Kong's major trading partners (excluding China)
y^{CN}	China's real GDP

y^{WexCN}	trade-weighted output of Hong Kong's major trading partners (excluding China)
y^{WCN}	China's trade-weighted foreign output
$y^{WCNexHK}$	China's trade-weighted foreign output (excluding Hong Kong)
y^*	output at potential

III. Other variables

seasonal dummies	quarterly dummy variables
T	time trend
DSARS	dummy for Severe Acute Respiratory Syndrome

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