HONG KONG MONETARY AUTHORITY

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ESTIMATING DEMAND FOR NARROW MONEY AND BROAD MONEY

Key points:

- *Under the Linked Exchange Rate system, both Hong Kong dollar (HKD) narrow money (M1) and broad money (M2 and M3) are endogenously determined by factors such as economic activity and capital flows. Although these monetary aggregates do not provide any indication of the policy stance of the Hong Kong Monetary Authority (HKMA), they do contain leading information about output growth and inflation.*

- *This paper provides an updated analysis of the determinants of the demand for HKD M1 and M3 with three main objectives. First is to build a framework to better understand and interpret the behaviour of key HKD monetary aggregates. Second is to offer an explanation of the recent movements in M1 and M3. Third is to make use of the information content contained in these monetary aggregates to explain inflation and output.*

- *The significant decline in HKD M1 since the beginning of 2005 could be well-explained by our model. Specifically, the model suggests that demand for M1 tends to become increasingly sensitive to interest rates when they are approaching zero. This non-linear feature of the demand for M1 helps explain the sharp increase in M1 between 2002 and 2004, and the subsequent, rapid decline in M1 since the beginning of 2005.*

- *As for the broad money demand model, it can be used to construct a money gap indicator, which is found to be useful in explaining CPI inflation and output gap. This money gap indicator can be used to gauge the impact of an autonomous increase in the stock of broad money (due to capital inflows, for example) on inflation and output.*

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I. INTRODUCTION

This paper studies the demand for money in Hong Kong, with a view to building a framework to better understand and interpret the behaviour of the key monetary aggregates. Under the Linked Exchange Rate system, money supply is endogenously determined by the level of economic activity and capital flows. Although these monetary aggregates do not provide any indication of the policy stance of the Hong Kong Monetary Authority (HKMA) so to speak, they do contain leading information about output growth and inflation.

In this paper, money demand models are estimated for Hong Kong dollar (HKD) narrow money (M1) and broad money (M3). Based on the narrow money demand model, we offer some explanations to the somewhat abrupt movements in M1 during the recent years when deposit rates were close to zero. Moreover, based on the broad money demand model, a money gap indicator is constructed to explore whether this indicator can help explain inflation and output gap. The rest of the paper is organised as follows. The next section reviews the related literature. Section III provides some stylised facts, and highlights the key factors that may influence the demand for money in Hong Kong. Section IV reports empirical estimates of the demand functions for various monetary aggregates, and discusses the key findings and applications. The final section concludes.

II. LITERATURE REVIEW

For the purpose of modelling money demand, a typical log-linear form money demand function such as the one below can be used.

$$(m^d - p) = \gamma_0 + \gamma_1 y + \gamma_2 (R_{out} - R_{own}) + \gamma_3 \Delta p$$

where $(m^d - p)$ is the logarithm of the quantity of real money demanded, y is a scale variable such as real income (also expressed in logarithm), R_{out} and R_{own} are rates of return on assets outside of money and on money itself, and Δp represents expected inflation rate. The rate differential $(R_{out} - R_{own})$ is a measure of the opportunity cost of holding money, while the inflation rate is the "return" of holding goods. The coefficient γ_1 is expected to be positive and can be interpreted as the income elasticity of money demand. The expected signs of γ_2 and γ_3 are negative.

Empirical literature suggests that the income elasticity of the demand for narrow money tends to be less than one, while the income elasticity of demand for broad money is usually found to be higher than that for narrow money, and is sometimes greater than unity (Handa (2000)). Most variables relevant to the money demand function are proven non-stationary. Therefore, co-integration analysis with an error-correction model is usually employed. Ericsson (1998) provides a summary of technical issues related to the modelling of money demand.

There are only a handful of empirical studies on the money demand in Hong Kong. Among those, Hawkins and Leung (1997) contains a comprehensive coverage of the subject. In Hawkins' paper, estimations were based on monthly data, and the error-correction models were estimated by a two-step, Engle-and-Granger approach. Lai and Shi (2002) estimated HKD M3 demand using an error correction model, and it incorporated a real property price variable to capture wealth effects and potentially the effect of capital flows. Bahmani-Oskooee and Ng (2002) estimated broad money demand by using the autoregressive distributed lag co-integration procedure. The long-run income elasticity of broad money was estimated to be about 1.7% in all of the above studies.

III. STYLISED FACTS AND RECENT DEVELOPMENTS

a. Narrow money

Narrow money M1 is defined as the sum of cash in circulation and demand deposit held at licensed banks, both are non-interest bearing. In the long-run, demand for narrow money is likely to be driven by the level of overall economic activity. Chart 1 shows that narrow money as a percentage of GDP was largely within a range between 13% and 21% from 1985 to 2000, but was almost doubled from 2001 to 2004. This increase was associated with the historically low level of interest rates, which substantially reduced the opportunity costs of holding narrow money. Indeed, the increase in M1 was especially sharp when deposit rates were close to zero in 2003 and 2004 (Chart 2). This suggests that M1 becomes increasingly sensitive to interest rates when the latter is approaching zero. As interest rates began to climb in the second quarter of 2005, narrow money has contracted as a result. Such a contraction largely continued throughout the rest of 2005.

Narrow money growth can also be affected by various short-term factors. Specifically, stock market and property market activities may lead to short-term fluctuations in M1. Chart 3 illustrates that M1 growth appears to be correlated with stock market turnover, suggesting that the latter may play a role in driving the short-term movements of narrow money.

Chart 1: Narrow money M1 as percentage of GDP and 3-month time deposit rate (Quarterly)

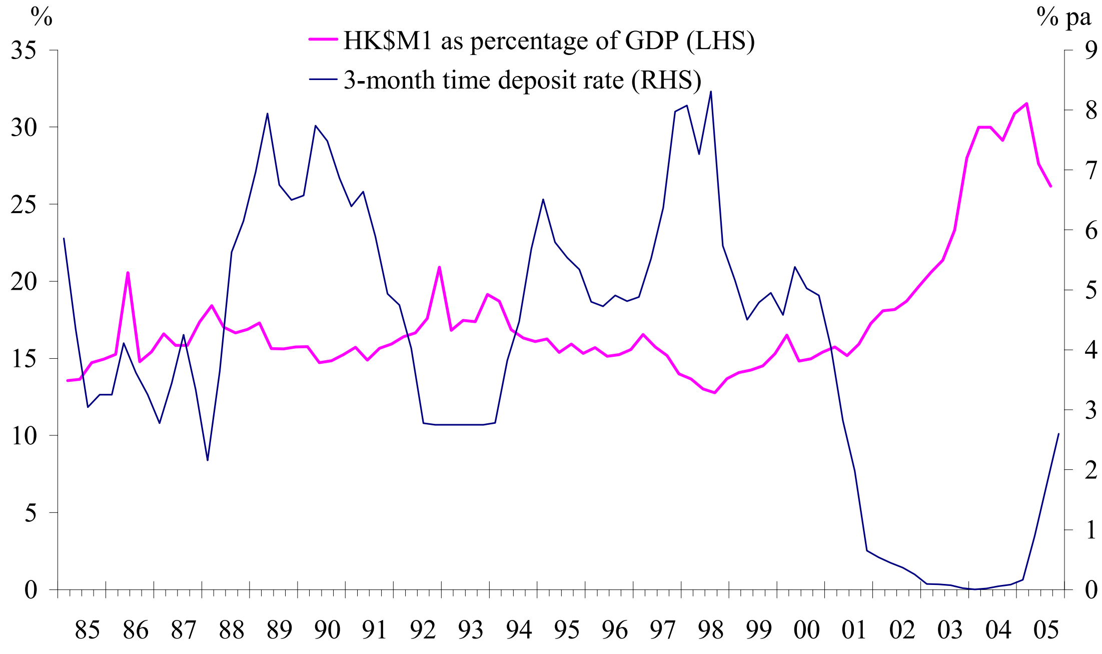


Chart 2: Cash in circulation and demand deposits as percentage of GDP (Quarterly)

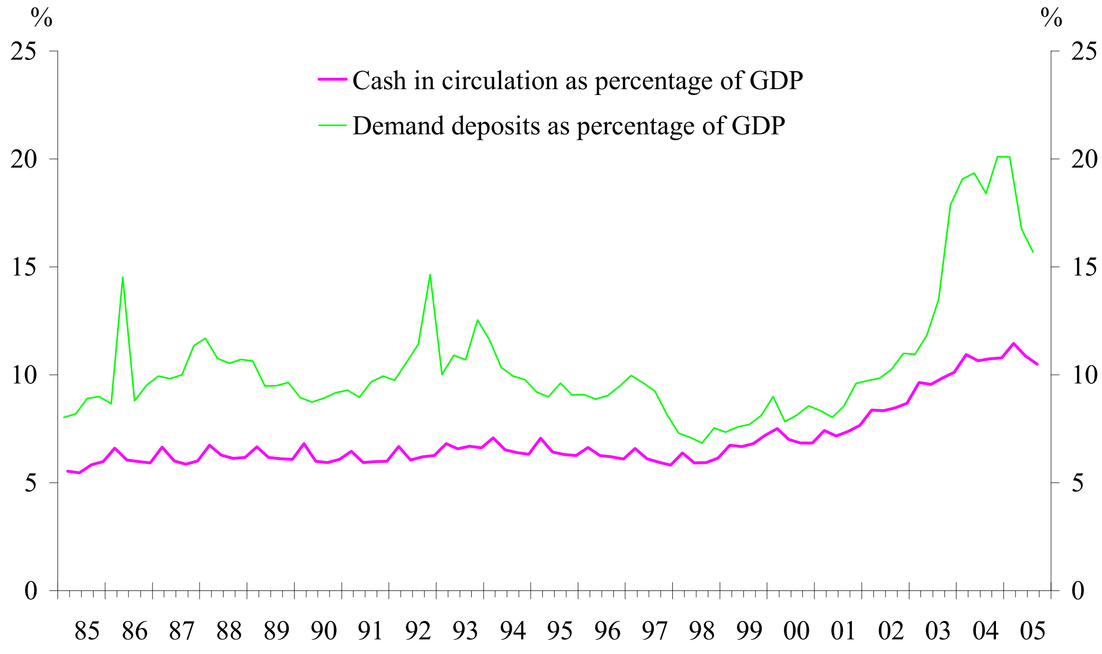
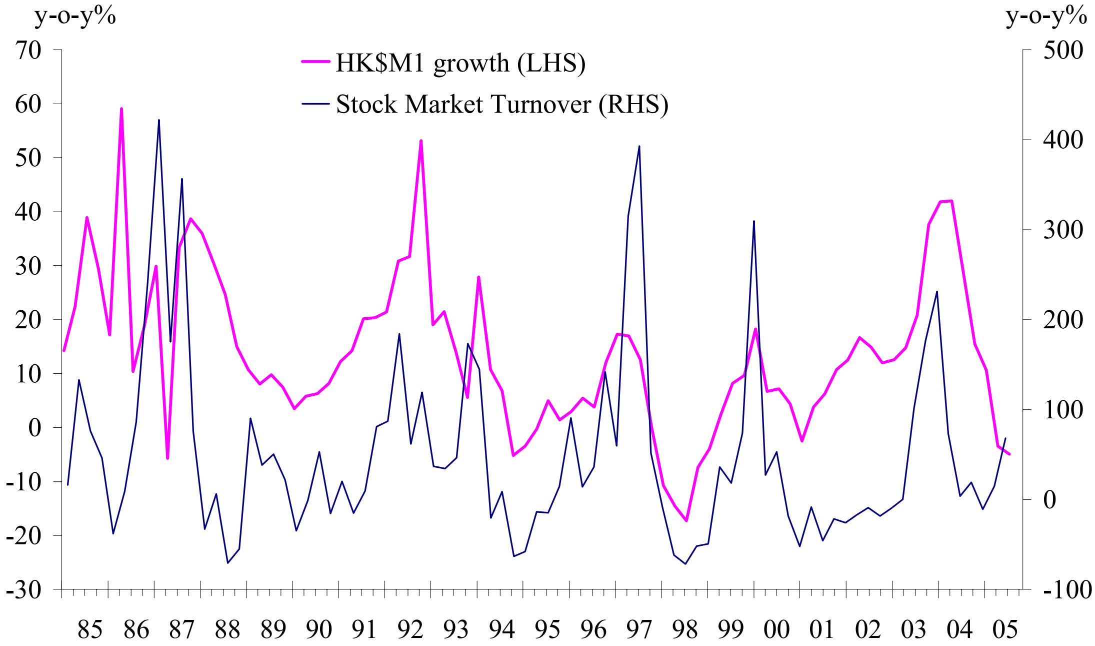


Chart 3: M1 Growth and Stock Market Turnover (Quarterly)



b. Broad money

Broad money M3 is defined as the sum of M1 and all other bank deposits (including savings and time deposits) as well as negotiable certificates of deposits (NCDs) held by the public. Over the long term, the growth in broad money appears to be in line with overall economic growth. In the more recent periods, given that deflation ended and recovery began in the second half of 2003, broad money growth has picked up somewhat from the recent trough that was reached in 2002 (Chart 4). In addition to this, given the introduction of the three refinements to the operations of the Linked Exchange Rate system in May 2005, HKD interest rates started to catch up with their USD counterparts (Chart 5).[1] This has reduced the opportunity cost of holding broad money, and can be conducive to M3 growth going forward.

[1] With the introduction of three refinements to the operation of the Linked Exchange Rate system, the negative interest rate spread between 12-month HIBOR and LIBOR was significantly narrowed since May 2005. In particular, Hong Kong dollar interest rates were largely in line with their US dollar counterparts in the second half of 2005, reflecting the effectiveness of the three refinements.

Chart 4: Hong Kong dollar M3 and Nominal GDP
(Quarterly, year-on-year % change)

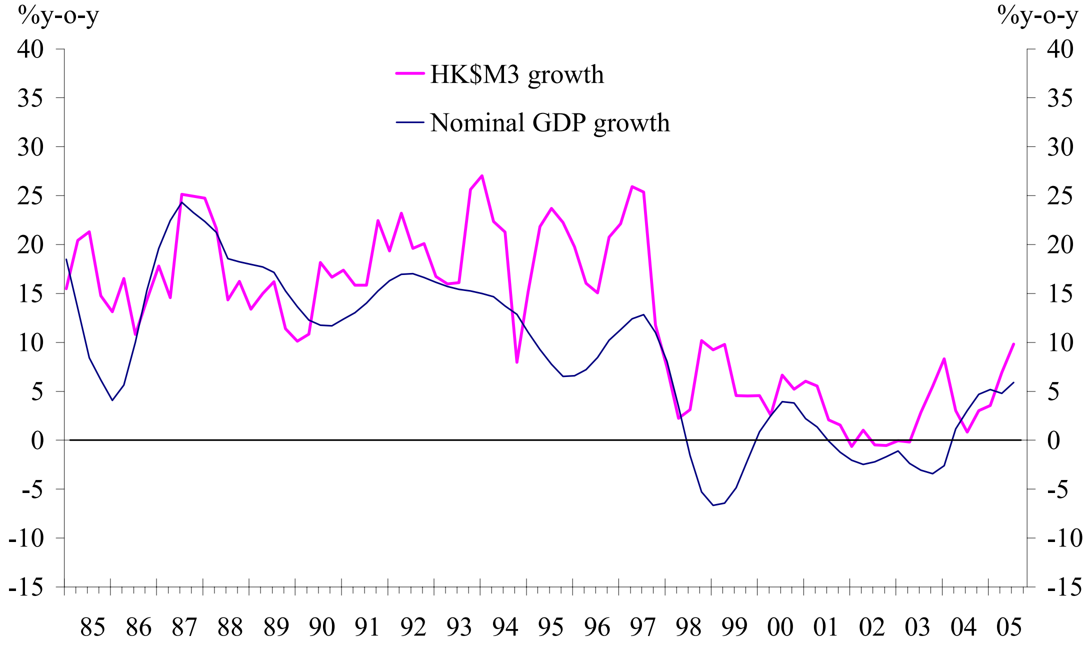
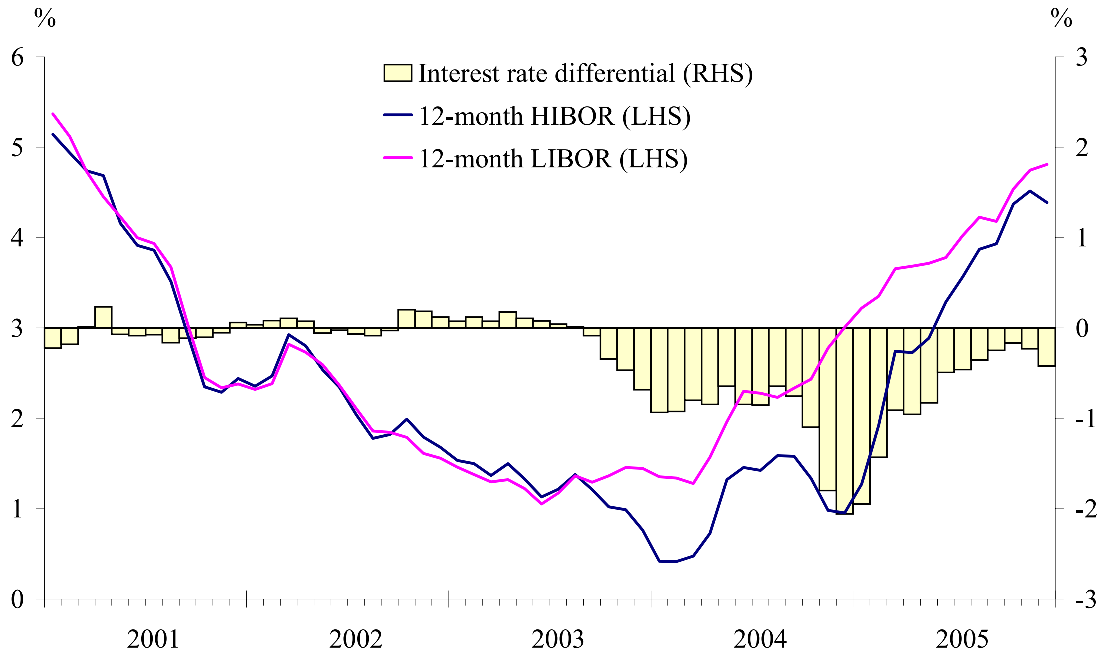


Chart 5: Interest rate differential between HKD and USD
(HIBOR – LIBOR, 12 month)



IV. EMPIRICAL ANALYSIS

The form of money demand functions to be estimated for M1 and M3 is based on the log-linear model as stated in Section II. The scale variables and the opportunity cost variables used in the estimation may vary across different monetary aggregates. Estimation is performed by using Johansen co-integration analysis with an error-correction model, which requires all the variables to be stationary in the first difference. Stationarity tests have confirmed these pre-requisites. The details of the results are presented and discussed below.

a. Narrow money

The demand for narrow money (m_1) is modelled as a function of real GDP (gdp) and the logarithm of three-month time deposit rate $ln(i_T)$, which is used to measure the opportunity cost of holding narrow money. The co-integrating equation, which represents the long-run demand for narrow money, is shown below in Equation (1). The short-run model is summarised in Table 1, where the term ecm_{t-1} represents the error-correction term, i.e. the deviation of m_1 from the long-run equilibrium value implied by the co-integrating equation. In addition to the lagged terms of the variables used in Equation (1), an additional variable TO, the real value of stock market turnover expressed in logarithm, is added to the short-run model in order to capture the effect of stock market activity on the demand for M1.

$$m_{1t} = 4.5 + \underset{(4.83)***}{0.6116}\, gdp_t - \underset{(-2.57)***}{0.0723}\, ln(i_{Tt}) \qquad (1)$$

Sampling period: 1984 Q4 to 2005 Q1

Table 1: Error-correction model for HKD narrow money

(dependent variable = Δm_{1t})		
	Coefficients	t-statistics
C	0.0116***	[2.34]
Ecm_{t-1}	-0.0759**	[-1.95]
$\Delta m_{1\ t-1}$	-0.2128***	[-2.32]
$\Delta m_{1\ t-2}$	-0.1840***	[-2.42]
$\Delta m_{1\ t-3}$	-0.0979**	[-1.72]
Δgdp_{t-1}	0.5239***	[5.77]
$\Delta ln(i_{T\ t-1})$	-0.0726***	[-4.94]
$\Delta ln(i_{T\ t-3})$	-0.0461***	[-2.83]
$\Delta ln(i_{T\ t-4})$	-0.0660***	[-2.85]
ΔTO_t	0.0439***	[2.17]

Adj R^2	0.69	
Equation standard error	0.05	
LM test for serial correlation	2.32	[0.31]
Jarque-Bera test for normality	8.49	[0.01]
White test for heteroskedasticity	24.53	[0.65]

All the estimated coefficients are of correct signs. The long-run elasticity of narrow money demand with respect to real income is less than unity at 0.61, roughly in line with the estimate by Hawkins and Leung (1997). However, compared with previous studies, one distinct feature of our model is the way interest rates are incorporated. In Equation (1), the logarithm, rather than the level itself, of time deposit rate is used in estimation. The rationale is as follows. As discussed in Section III, when interest rates were near zero, depositors were quite indifferent between holding demand deposits and holding savings and time deposits. (In fact, M1 increased by almost 60% between end-2002 and end-2004, with bulk of the increase coming from demand deposits). In order to capture such non-linear effect in the demand for narrow money, the logarithm of time deposit rate is used in the estimation. This implies that the semi-elasticity of i_T depends on the level of i_T. According to Equation (1), if i_T was raised by 1 percentage point from 5% to 6%, narrow money would be reduced by only 1.3% in the long run. However, if the increase was from 0.1% to 1.1%, narrow money would be reduced by as much as 17%. The helps explain the rapid decline in M1 (particularly, demand deposits) in 2005.

As for short-run dynamics, stock market turnover has a positive but temporary effect on the demand for narrow money. This turnover variable was also tested in the long-run equation but was found to be statistically insignificant. This suggests that stock market activity only has a short-term impact on the demand for narrow money.

b. Broad money

The demand for broad money M3 (m_3) is modelled as a function of real GDP (*gdp*), an opportunity cost variable *r*, which is defined as the yield of five-year US treasury bond less the HKD three-month time deposit rate, and the expected inflation rate (π_e) . Equation (2) shows the co-integrating equation that represents the long-run demand for broad money, and Table 3 summarises the short-run model. An additional variable *mvp*, the estimated real market value of housing stock (expressed in logarithm), is added to the short-run model in order to capture the wealth effect arising from rising property prices.[2]

$$m_{3_t} = -3.33 + \underset{(16.01)^{***}}{1.3992}\, gdp_t - \underset{(-2.55)^{***}}{0.0259}\, r_t - \underset{(-11.09)^{***}}{0.0422}\, \pi_{e_t} \qquad (2)$$

Sampling period: 1984 Q4 to 2005 Q1

Table 2: Error-correction model for HKD broad money

(dependent variable = Δm_{3t})		
	Coefficients	t-statistics
C	0.0380***	[6.94]
ecm_{t-1}	-0.1377***	[-4.25]
Δm_{3t-1}	-0.3080***	[-3.22]
Δm_{3t-2}	-0.3280***	[-3.85]
Δm_{3t-3}	-0.3790***	[-4.10]
Δgdp_t	0.1096*	[1.49]
$\Delta \pi_{e\,t}$	-0.0118***	[-2.68]
Δmvp_t	0.2033***	[3.71]

Adj R^2	0.44	
Equation standard error	0.03	
LM test for serial correlation	5.91	[0.05]
Jarque-Bera test for normality	3.09	[0.21]
White test for heteroskedasticity	23.50	[0.37]

The estimated coefficients are of correct signs. The long-run elasticity of broad money demand with respect to real income is found to be 1.4, which is consistent with the estimates by Lai and Shi (2002) and Bahmani-Oskooee and Ng (2002). The long-run coefficient of the opportunity cost variable is 0.03, suggesting that a 1 percentage point increase in the opportunity cost of holding M3 would result in a 3 percent reduction in broad money. As for the short-run dynamics, market value of housing stock has a positive effect on the demand for broad money, suggesting that there is a positive wealth effect on the demand for money.

[2] In Lai and Shi (2002), a real property price variable is used in the short-run dynamics. It was argued that rising asset prices in the first half of 1990s could be attributed to significant capital inflows. Thus, the effect of property value might also reflect the impact of capital flows on money demand. This variable is found to be statistically significant only in the short-run equation but not in the long-run relationship.

The above results can be used to compute the "money gap", which is defined as the difference between the actual stock of money and that implied by the long-run relationship represented by Equation (2). Chart 6 illustrates the actual value of M3 (m_3), the value of M3 implied by the long-run relationship (m_3^*), and money gap ($m_3 - m_3^*$).

Chart 6: Money Gap

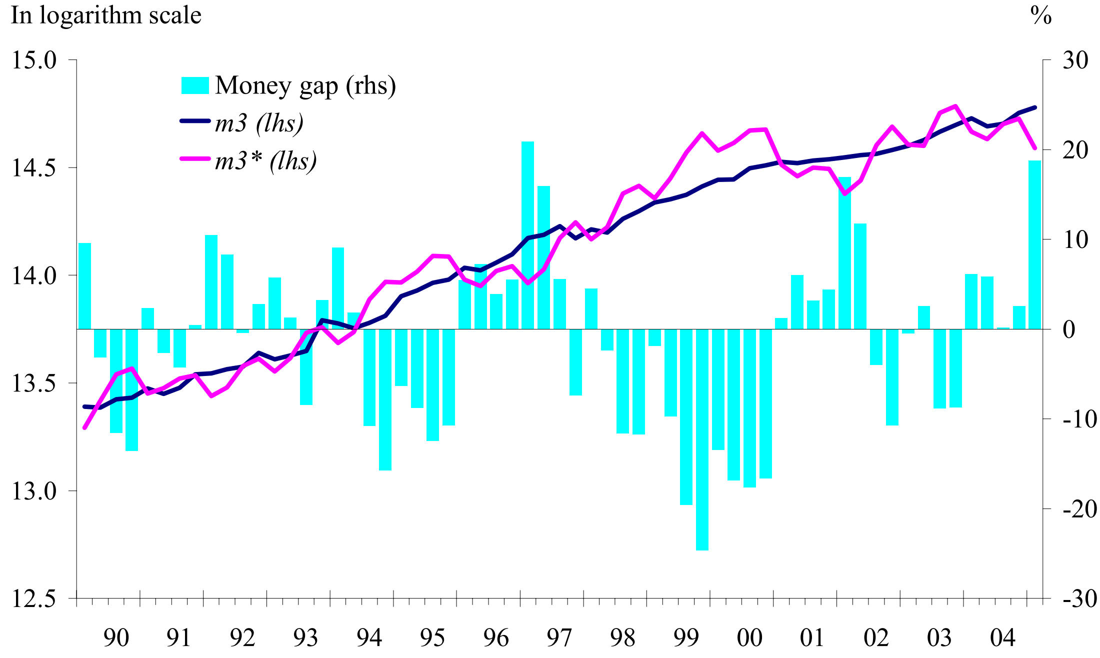
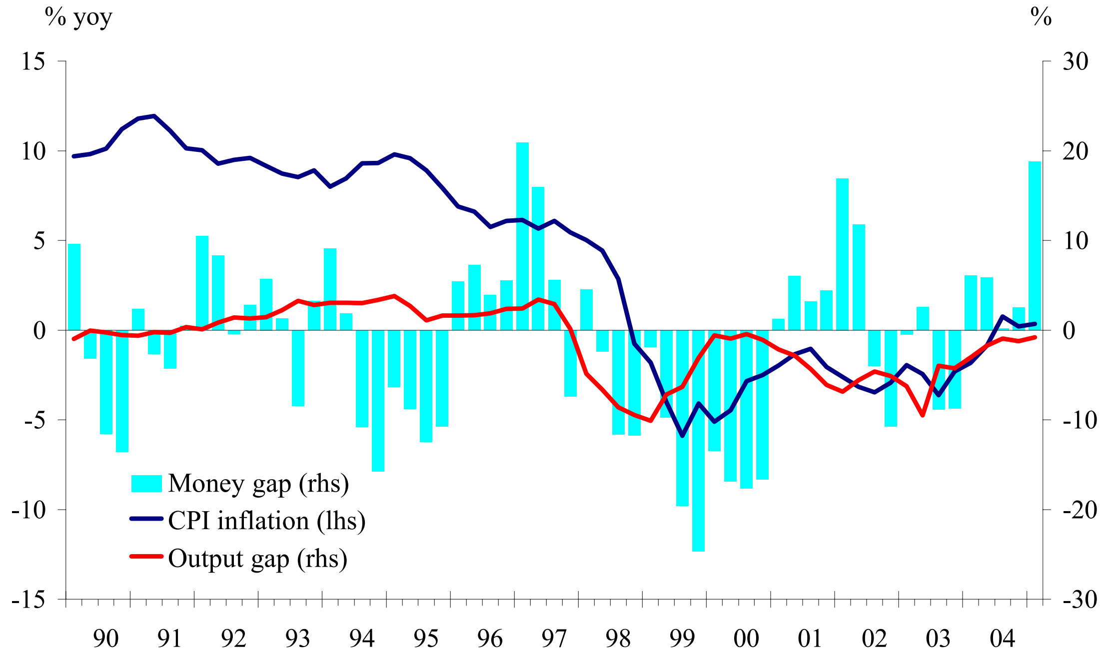


Chart 7: Money Gap, CPI Inflation and Output Gap



Money gap is potentially useful in explaining inflation and output. Nonetheless, casual observation seems to suggest that neither inflation rate nor output gap have a strong relationship with money gap (Chart 7). In order to assess whether money gap can help explain inflation and output, an inflation equation and an output gap equation are estimated by incorporating money gap as an explanatory variable as follows.

The specification below is based on the inflation equation of our in-house forecast model (Kong and Leung (2004)) but augmented by the money gap variable, with *mgap* representing the money gap, p^{WexCN} price level of major trade partners in HKD terms (excluding China), p^{CN} price level in the Mainland China in HKD terms, *gap* output gap, and *pp* property prices.

$$\pi_t = \underset{(5.5)}{-0.17} - \underset{(5.8)}{0.07}\left(p_{t-1} - \underset{(6.2)}{0.55}p_{t-1}^{WexCN} - \underset{(3.5)}{0.29}p_{t-1}^{CN} - \underset{(6.2)}{0.16}p_{t-1}^{P}\right) + \underset{(6.5)}{1.09}\sum_{i=4}^{9}\Delta p_{t-i}^{P} + \underset{(3.2)}{0.04}\sum_{i=0}^{1}\Delta p_{t-i}^{CN}$$
$$+ \underset{(4.5)}{0.11}gap_{t-i} + \underset{(2.5)}{0.01}mgap_{t-1} - \underset{(10.0)}{0.01}DSARS + seasonal\ dummies \quad (3)$$

$$where \quad p_t^{WexCN} = wcpi_t^{exCN} - neer_t^{exCN}, \quad p_t^{CN} = cpi_t^{CN} + hkdrmb_t \quad and \quad gap_t = y_t - y_t^*$$

Sampling period: 1990 Q1 to 2005 Q1

Adj R^2	0.92	
Equation standard error	0.00	
LM test for serial correlation	12.02	[0.02]
Jarque-Bera test for normality	3.09	[0.21]
White test for heteroskedasticity	45.56	[0.07]

The estimated coefficient of *mgap* is positive and statistically significant, suggesting an autonomous increase in the stock of broad money (due to, for example, capital inflows) can have a positive impact on inflation. Comparing with output gap, a one-standard-deviation increase in the money gap indicates that inflation would rise by about 0.5 percentage point on an annualised basis, while a respective increase in the output gap would raise inflation by 1.7 percentage points.[3] This indicates that the money gap plays only a secondary role in explaining the variation in inflation as compared to the output gap.[4]

[3] These are sample standard deviations.
[4] A similar money gap indicator is constructed by using the narrow money demand function. However, this indicator is found to be insignificant and of incorrect signs in the inflation equation.

Likewise, we re-estimate the output gap equation in Peng, Fan and Leung (2005), which is a reduced-form aggregate demand equation, augmented by *mgap*.[5] The results are shown in equation (4), where *gap* is the output gap in logarithm, $reer^{HKD}$ and $reer^{RMB}$ are the logarithms of the HKD and RMB real effective exchange rates respectively, *INTR* is the real interest rate, gap^{W} is foreign output gap, *HSIY* is the ratio of Hang Seng Index to nominal GDP, *PROPY* is the ratio of the private residential property price index to nominal GDP, and Δ denotes the four-quarter difference of a variable.

$$
\begin{aligned}
gap_t = {} & \underset{(5.2)}{0.60 gap_{t-1}} - \underset{(3.0)}{0.11 \Delta reer_t^{HKD}} - \underset{(2.2)}{0.19 \Delta reer_t^{RMB}} - \underset{(1.4)}{0.03 INTR_{t-1}} \\
& + \underset{(3.2)}{1.17 gap_t^{W}} + \underset{(1.8)}{0.03 HSIY_t} + \underset{(1.3)}{0.01 PROPY_t} + \underset{(1.5)}{0.02 mgap_t}
\end{aligned}
\tag{4}
$$

Sample period : 1990Q1 – 2005Q1

Adj R^2	0.82	
Equation standard error	0.03	
Jarque-Bera test for normality	9.61	[0.01]
White test for heteroskedasticity	44.28	[0.02]

The coefficient of the money gap variable is estimated to be positive and marginally significant, suggesting that the money gap indicator is useful in explaining the output gap.[6] However, the magnitude of this coefficient is quite small. A one-standard-deviation increase in the money gap will only raise the output gap by less than 0.2 percentage point, indicating only limited impact of money gap on output.

V. CONCLUDING REMARKS

The money demand functions presented in this paper can enhance our understanding of the behaviour of key monetary aggregates. A specific application of our narrow money demand model is to explain the relatively abrupt movements in narrow money during the past several years. Our findings suggest that the sharp increase in M1 between 2002 and 2004 was associated with the non-linear effects of near-zero interest rates, which brought about a significant shift from term deposits towards demand deposits during this period. With interest rates rising since the beginning of 2005, there has been a reversal of the above process, or a rapid shift from liquid deposits back to the less liquid deposits. This implies the cost of funds for banks has been boosted not only by the rise in deposit rates, but also by the shifting of deposits towards the less liquid.

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[5] The regression is conducted using the generalised method of moments. The instrument variables include lags of the dependent and independent variables, as in Peng, Fan and Leung (2005).

[6] The money gap indicator based on the narrow money demand function is also tested in the output gap equation, and is found to be statistically insignificant.

Separately, the broad money demand function presented in this paper is consistent with previous similar studies, showing that the money demand relationship is quite stable over time. The model can be used to construct a money gap indicator, which is found to be useful in explaining inflation and output. This can be useful to the understanding of how an autonomous increase in broad money (caused by capital inflows, for instance) may affect inflation and output growth.

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