

International reserve holdings – Are financial centres different?

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Since the Asian financial crisis, a number of Asian economies have accumulated sizeable reserves. This has led to a debate about the appropriate size of international reserves and associated macroeconomic policies, particularly the exchange rate policy. This paper examines the demand for international reserves by considering the financial centre status of an economy as well as factors often cited in literature, such as the size of an economy, trade openness, and the exchange rate regime. In particular international financial centres, which are often confronted with substantial and volatile international capital flows, may seek to hold a higher level of foreign reserves.

The results confirm that the openness and size of the financial sector are important determinants of the level of reserve holdings. After controlling for the size of the economy, trade openness and financial centre status, the level of reserves in Hong Kong does not appear to be unusually high by international standards.

I. Introduction

The adequacy of foreign exchange reserves has attracted renewed interest with the accumulation of sizeable reserves by a number of Asian economies. It is generally regarded that the demand for reserves depends on the size of the economy (perhaps measured by the level of imports), trade openness, and the exchange rate regime. Nevertheless, for an international financial centre (IFC), the size of the financial sector and the openness to capital flows are other potentially important factors that are often overlooked in existing studies. In particular, IFCs may find it desirable to hold more reserves to help ensure financial stability as the openness of these economies is likely to expose them to volatile capital flows. Using a sample of over 140 economies, this article examines the empirical evidence for the relationship between reserve holdings and financial sector development, and considers how the level of foreign exchange reserves held by Hong Kong compares with the other economies considered.

The IFC status of an economy can be gauged by a number of variables, including financial openness, the scale of the financial sector, the size of the stock market, and external banking assets. Financial openness can be captured by the ratio of capital flows to GDP and the size of the financial sector by the ratio of liquid liabilities to GDP. Interestingly, the analysis shows that the reserve holdings of Hong Kong do not differ significantly from the pattern observed from other economies. The relatively high level of reserves reflects mainly the openness of the economy and the well-developed financial sector.

The paper is organised as follows. Section II provides some stylised facts on the relationship between reserve holdings and a number of potential determinants, such as GDP, imports, external debt, liquid liabilities, stock market capitalisation, external banking assets, financial openness, and exchange rate flexibility. Reserves are strongly correlated with indicators of financial sector development, which suggests that the reserves of Hong Kong are not

¹ The paper was written when Kitty Lai was working in the Research Department.

unusually large by international standards. Section III examines the importance of different variables in determining the reserve holdings across economies based on regression results. The outcome provides evidence that financial openness and financial sector development are important factors determining the size of reserves. After taking these factors into account, the level of reserves held by Hong Kong does not appear significantly different from others. Section IV concludes.

II. Reserve holdings and economic characteristics

Using data from the IMF and the World Bank, data on foreign exchange reserves and other economic variables are collected from 140 economies (see Appendices I and II). Most of the data refer to the end of 2002, except external debt, liquid liabilities and stock market capitalisation for which only data for the end of 2001 are available. Industrial economies, based on the IMF classification, are excluded since studies have generally found that the pattern of reserve holdings of non-industrial economies differs significantly from the industrial economies.²

The scatterplots in Chart 1 show that reserves are, as expected, strongly correlated with GDP, imports, and external debt (see the first row in the chart). By contrast, there is no clear relationship between reserves and the ratio of imports to GDP. However, the significance of trade openness may be difficult to establish without controlling for other variables. The scatterplot of reserves against the ratio of external debt to GDP, a measure of an economy's indebtedness or debt-servicing ability, suggests that Hong Kong is an outlier. In Hong Kong's case, the external debt comprises mainly external liabilities of the banking sector, reflecting the international business of the sector, rather than a reliance on external financing. This differs from most non-industrial economies that borrow more (relative to their income) and tend to have lower reserves.

More importantly, reserves are strongly correlated with indicators of financial sector development, including the shares of liquid liabilities and the stock market capitalisation in GDP (see the third row in Chart 1 and Appendix III). There is, however, no clear relationship between reserves and external banking assets, the latter being interpreted as an indicator of IFC status.

Given the potential role of financial factors, it is helpful to consider financial openness and measures of the degree to which exchange rates are flexible. In the analysis below, financial openness is captured by the sum of capital inflows and outflows as a ratio to GDP, and is intended to provide a measure of the intensity of international capital flows. Furthermore, exchange rate flexibility is measured by the standard deviation of the monthly changes of the nominal effective exchange rate (NEER) within a 24-month or a 60-month time frame. These variables do not demonstrate a clear relationship with reserves (last row of Chart 1). Thus, controlling of the other factors is, at a minimum, required in order to accurately explore the effects of these variables on the level of reserves.

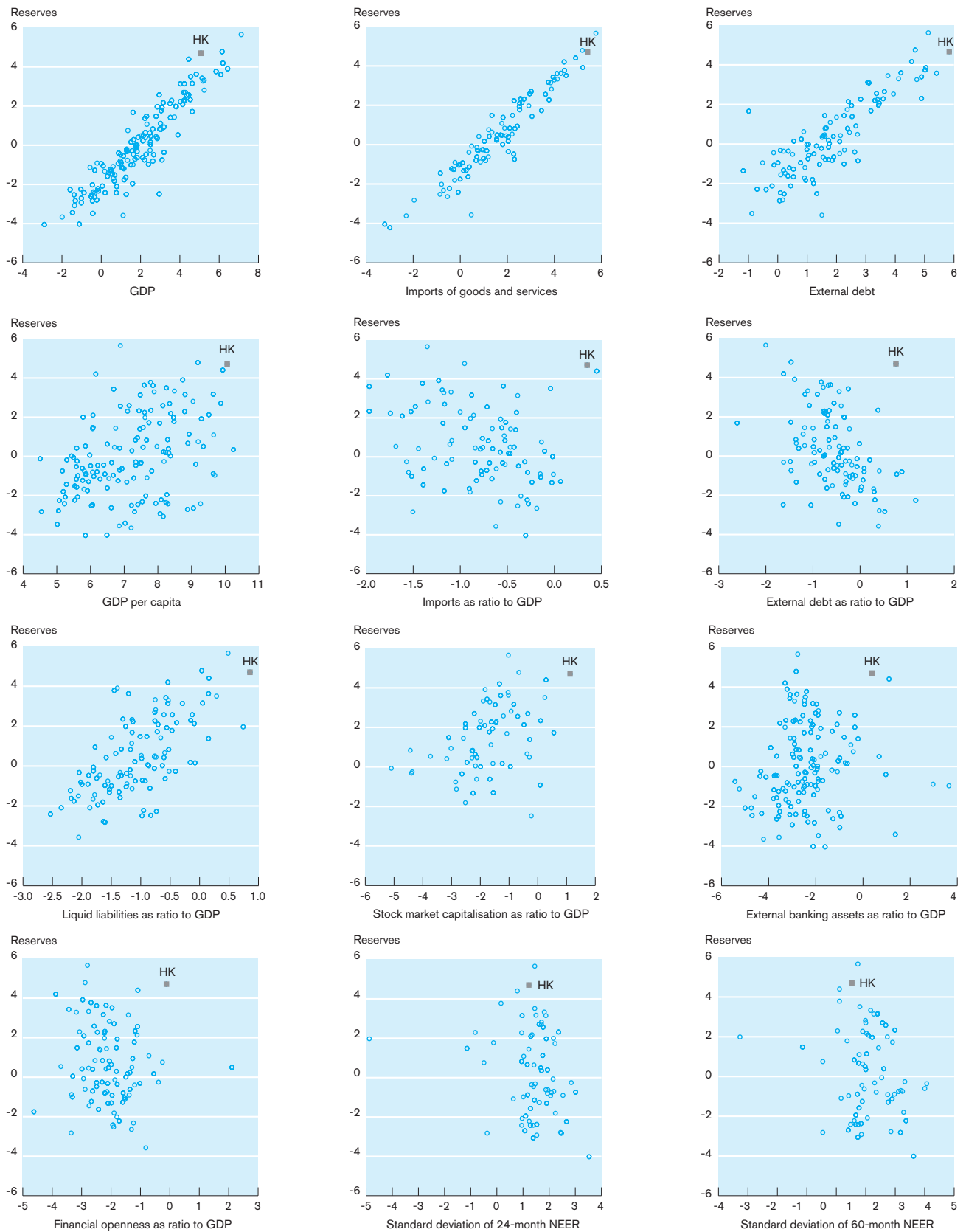
To summarise the analysis so far, these charts do not provide any indication that the level of reserves held by Hong Kong is unusually large by international standards. In fact, the sizeable reserves of Hong Kong may, to a large extent, reflect the fact that the economy is highly open to trade and has an advanced financial sector.

As well (and as noted above), the scatterplots are bivariate while the true relationship between the different variables presumably is multivariate. Thus, these graphs are, at most, suggestive of the factors that determine the demand for reserves. The next section applies more formal statistical techniques to obtain a fuller view of the demand for foreign exchange reserves in the sampled economies.

² See Wijnholds and Kapteyn (2001) for a survey of reserve adequacy literature. See also Aizenman and Marion (2004), Clark (1970), Flood and Marion (2002), Frenkel (1974), Grubel (1971) and Rogoff et al. (2003).

CHART 1

Foreign exchange reserve holdings



Note: All series are expressed in US\$ terms (except for the ratios and the two exchange rate flexibility variables) and are in logs. Figures are end-2002 positions, except for external debt, liquid liabilities and stock market capitalisation, which refer to end-2001. Reserves are foreign exchange reserves. Industrial economies (based on the IMF classification) are excluded.

III. Empirical analysis

The analysis in this section starts from the generally accepted theory on factors determining the demand for reserves and estimates the demand for reserves using the data described above. More specifically, foreign exchange reserves are regressed on GDP, GDP per capita, exchange rate flexibility, imports, external debt, liquid liabilities, external banking assets, stock market capitalisation and financial openness, with the last six variables all expressed as ratios to GDP. All variables are in US dollar nominal terms (except the ratios and the standard deviations of monthly changes of NEER) and are in logarithms. In order to test if the reserve holding pattern of Hong Kong is similar to or different from other economies, a dummy variable for Hong Kong is also introduced. If Hong Kong's reserve holdings are similar to the pattern of the other economies studied, the coefficient for the dummy variable should be numerically small and statistically insignificant.

Theoretical considerations suggest that foreign exchange reserves increase with the size of GDP, or GDP per capita. Reserves are also likely to rise with trade openness (as captured by the ratio of imports to GDP), which raises the vulnerability to external shocks. By contrast, there is no clear a priori relationship between external indebtedness and reserves. A more indebted economy (a higher external debt-to-GDP ratio) may be more vulnerable to external shocks in that it is more reliant on access to international capital markets, and may therefore demand more reserves. Turning to the role of exchange rate flexibility, it is plausible that economies with a fixed-rate regime (official or de facto) demand more reserves compared to economies with a more flexible exchange rate regime.

It also seems likely that economies with more developed and internationalised financial sectors may hold more reserves to cope with the potential volatility of capital flows. This can be captured by the scale of liquid liabilities, stock market capitalisation, external banking assets relative to GDP and financial openness. Reserves are thus expected to vary positively with these ratios.

The estimation results are shown in Tables 1, 2 and 3. The size of an economy, captured by GDP, and the Hong Kong dummy variable are found to be significant in all specifications and are therefore included in all regressions. Table 1 adds sequentially the other explanatory variables. The specification with the ratio of imports to GDP is found to have the largest explanatory power, and the regressions in Table 2, therefore, incorporate this variable in all specifications. The results in that table show that liquid liabilities are strongly significant and are included in all specifications in Table 3.³ While the dummy variable for Hong Kong is no longer significant in most specifications in Table 2, it is retained in Table 3 to test whether Hong Kong is significantly different from other economies in various specifications. This exercise of adding explanatory variables on a sequential basis helps to explore their relative explanatory power. It should be emphasised, however, that the results need to be interpreted with caution, as the sample size varies across the different specifications due to data restrictions.

³ Table 2 shows that the 60-month standard deviation of monthly change in NEER is also statistically significant and the corresponding 'goodness-of-fit statistic' is higher. However, the latter involves a much smaller sample, and the t-ratio is in fact smaller than that of liquid liabilities.

TABLE 1
Estimation results

Dependent variable: Reserves (log)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
GDP	0.983 (0.028) ***	1.089 (0.035) ***	0.870 (0.034) ***	0.942 (0.050) ***	0.984 (0.030) ***	1.021 (0.035) ***	1.014 (0.036) ***	1.013 (0.035) ***
Imports/GDP		0.765 (0.133) ***						
Liquid liabilities/GDP			0.715 (0.102) ***					
Stock market capitalisation/GDP				0.159 (0.111)				
External banking assets/GDP					0.147 (0.064) **			
Financial openness/GDP						0.152 (0.087) *		
24-month standard deviation of monthly change of NEER							-2.744 (0.791) ***	
60-month standard deviation of monthly change of NEER								-5.453 (2.060) **
Dummy for HK	1.651 (0.115) ***	0.474 (0.218) **	0.613 (0.186) ***	1.151 (0.334) ***	1.245 (0.208) ***	1.239 (0.231) ***	1.466 (0.148) ***	1.423 (0.144) ***
Constant	-1.932 (0.084) ***	-1.562 (0.129) ***	-0.937 (0.186) ***	-1.404 (0.376) ***	-1.588 (0.168) ***	-1.696 (0.228) ***	-1.879 (0.109) ***	-1.808 (0.116) ***
Adjusted R ²	0.857	0.903	0.854	0.811	0.860	0.873	0.902	0.906
SE of regression	0.809	0.640	0.760	0.768	0.793	0.711	0.698	0.685
Sample size	145	94	111	68	142	94	70	70
Adjusted R ² for dependent variable: log(Reserves/GDP)	0.015	0.239	0.227	0.062	0.068	0.054	0.075	0.109

Notes: All variables are in logarithms, except for the dummy variable for Hong Kong.

The sample size varies for each regression depending on data availability.

Figures in parentheses are standard errors. Standard errors are corrected for heteroskedasticity and autocorrelation by White's covariance estimator.

*, ** and *** denote statistical significance at the 10%, 5% and 1% levels respectively.

TABLE 2
Estimation results

Dependent variable: Reserves (log)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
GDP	1.089 (0.035) ***	0.976 (0.041) ***	1.086 (0.048) ***	1.088 (0.033) ***	1.107 (0.034) ***	1.076 (0.047) ***	1.055 (0.045) ***
Imports/GDP	0.765 (0.133) ***	0.471 (0.152) ***	0.707 (0.149) ***	0.660 (0.126) ***	0.769 (0.142) ***	0.827 (0.232) ***	0.682 (0.205) ***
Liquid liabilities/GDP		0.521 (0.127) ***					
Stock market capitalisation/GDP			0.097 (0.078)				
External banking assets/GDP				0.162 (0.072) **			
Financial openness/GDP					0.011 (0.078)		
24-month standard deviation of monthly change of NEER						-8.050 (9.222)	
60-month standard deviation of monthly change of NEER							-19.078 (6.760) ***
Dummy for HK	0.474 (0.218) **	0.149 (0.225)	0.212 (0.246)	0.171 (0.238)	0.410 (0.234) *	0.327 (0.284)	0.374 (0.265)
Constant	-1.562 (0.129) ***	-1.009 (0.190) ***	-1.376 (0.225) ***	-1.283 (0.168) ***	-1.593 (0.193) ***	-1.297 (0.202) ***	-1.091 (0.195) ***
Adjusted R ²	0.903	0.906	0.927	0.910	0.899	0.914	0.929
SE of regression	0.640	0.608	0.479	0.616	0.639	0.590	0.535
Sample size	94	79	56	94	93	43	43
Adjusted R ² for dependent variable: log(Reserves/GDP)	0.239	0.356	0.433	0.295	0.240	0.401	0.507

Notes: All variables are in logarithms, except for the dummy variable for Hong Kong.

The sample size varies for each regression depending on data availability.

Figures in parentheses are standard errors. Standard errors are corrected for heteroskedasticity and autocorrelation by White's covariance estimator.

*, ** and *** denote statistical significance at the 10%, 5% and 1% levels respectively.

TABLE 3
Estimation results

Dependent variable: Reserves (log)

	(1)	(2)	(3)	(4)	(5)	(6)
GDP	0.976 (0.041) ***	1.044 (0.046) ***	1.007 (0.043) ***	0.968 (0.040) ***	0.980 (0.088) ***	0.985 (0.072) ***
Imports/GDP	0.471 (0.152) ***	0.597 (0.156) ***	0.476 (0.140) ***	0.528 (0.157) ***	0.629 (0.269) **	0.600 (0.224) **
Liquid liabilities/GDP	0.521 (0.127) ***	0.298 (0.120) **	0.380 (0.127) ***	0.542 (0.130) ***	0.370 (0.204) *	0.222 (0.156)
Stock market capitalisation/GDP		0.049 (0.081)				
External banking assets/GDP			0.145 (0.099)			
Financial openness/GDP				-0.112 (0.117)		
24-month standard deviation of monthly change of NEER					-9.361 (10.821)	
60-month standard deviation of monthly change of NEER						-19.361 (6.969) ***
Dummy for HK	0.149 (0.225)	0.069 (0.255)	-0.069 (0.266)	0.291 (0.266)	0.112 (0.327)	0.221 (0.320)
Constant	-1.009 (0.190) ***	-1.184 (0.220) ***	-0.883 (0.219) ***	-1.163 (0.248) ***	-0.831 (0.480) *	-0.740 (0.402) *
Adjusted R ²	0.906	0.932	0.907	0.906	0.910	0.925
SE of regression	0.608	0.463	0.603	0.606	0.615	0.560
Sample size	79	56	79	79	35	35
Adjusted R ² for dependent variable: log(Reserves/GDP)	0.356	0.472	0.365	0.358	0.397	0.500

Notes: All variables are in logarithms, except for the dummy variable for Hong Kong.

The sample size varies for each regression depending on data availability.

Figures in parentheses are standard errors. Standard errors are corrected for heteroskedasticity and autocorrelation by White's covariance estimator.

*, ** and *** denote statistical significance at the 10%, 5% and 1% levels respectively.

The results suggest a number of conclusions.

- The size of Hong Kong's reserves is fully explained by the main features of the economy, once measures capturing trade openness and IFC status are included.⁴
- Financial sector development is an important determinant of reserve holdings. The ratio of liquid liabilities to GDP is highly significant, with a positive coefficient for all regressions.⁵ The ratio of external banking assets to GDP has strong explanatory power for reserves, although it becomes less significant when imports and liquid liabilities are incorporated in the analysis. The explanatory power of stock market capitalisation is limited. It is marginally insignificant in equation (4) in Table 1, and becomes even more so when imports and liquid liabilities are included in the regression (see equations (3) in Table 2 and (2) in Table 3). Nevertheless, the three variables are

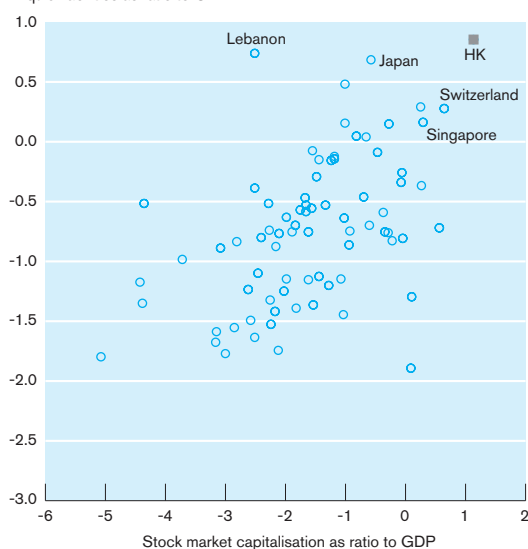
related closely with each other. Economies with larger shares of liquid liabilities in GDP tend to be major financial centres (such as Switzerland, Singapore, and Lebanon), with a large stock market and an international banking sector (see Chart 2 below).⁶

- Financial openness is a significant explanatory variable (see equation (6) in Table 1). This suggests that the magnitude of international capital flows is an important determinant of the level of foreign reserves, which is consistent with the view that policy makers of IFC economies prefer a higher level of foreign reserves. Nevertheless, when imports and liquid liabilities are included among the "core" regressors in Table 3, the variable is statistically insignificant. This is likely due to the strong correlation between this variable and the other regressors (see Appendix III).

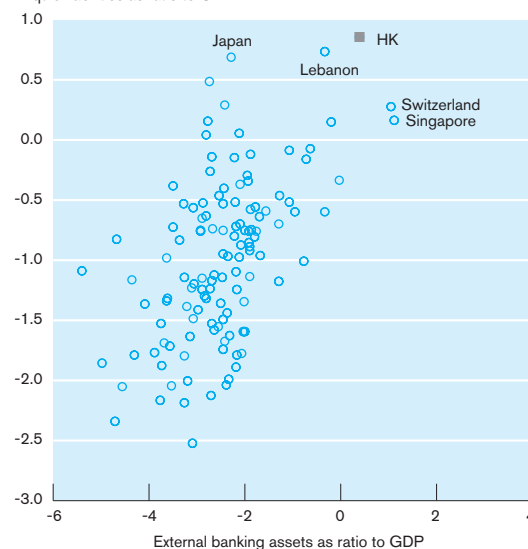
CHART 2

Liquid liabilities and financial centre characteristics

Liquid liabilities as ratio to GDP



Liquid liabilities as ratio to GDP



⁴ This follows from the fact that the dummy variable for Hong Kong is significant in all equations in Table 1 and some equations in Table 2, but no longer so once imports and liquid liabilities are used as regressors.

⁵ The ratio of domestic credit to GDP is another measure of the size of the banking sector. This is also statistically significant (at 1% level) in explaining reserve holdings among the sampled economies.

⁶ Lebanon has historically served as a major financial centre in the Middle East.

- Trade openness is an important factor in determining reserves, as evidenced by the fact that the imports-to-GDP ratio is highly significant in all regressions.
- The exchange rate flexibility variables, especially the 60-month standard deviation of monthly change in NEER, are significant in most specifications. This finding, which is also obtained in other studies⁷, is consistent with the view that economies with fixed-rate regimes (de jure or de facto) demand more reserves compared to those with more flexible exchange rates. Although the coefficient on liquid liabilities becomes insignificant after including the exchange rate flexibility variable in equation (6) of Table 3, this is likely due to the reduction in sample size resulting from data restrictions.⁸

IV. Conclusion

The evidence presented above supports the notion that trade openness and financial depth are major determinants of reserve holdings, in addition to the size of the economy. In other words, the reserve holdings are larger when the share of imports and liquid liabilities in GDP is larger. Moreover, the findings also show that the magnitude of capital inflows and outflows plays an important role in determining the level of foreign reserves. Hong Kong does not appear to differ significantly from other non-industrial economies. The larger reserves reflect the status of Hong Kong as an international financial and trading centre, and thus the need to hold a safety cushion to cope with potential volatility in fund flows and external trade payments. There is also some evidence suggesting that the exchange rate regime plays a role in determining the reserve holdings.

⁷ For example, Aizenman and Marion (2003). However, a potential caveat to this approach is that, while the variability of NEER may be a proxy for exchange rate regime, the causality may also run the other direction. In particular, a high NEER variability may reflect the lack of reserves (or perhaps a depletion of reserves after significant exchange rate depreciation).

⁸ Moreover, liquid liabilities are found to have a negative correlation with 60-month standard deviation of the monthly change in NEER (see Appendix III). This probably reduces the statistical significance of the former variable.

APPENDIX I

Data

Variables	Description	Sources
Reserves	Foreign exchange reserves, US dollar billion in 2002	International Financial Statistics (IMF), series "1D.DZF".
GDP	Gross domestic product, current US dollar billion in 2002	World Economic Outlook Database (IMF), http://www.imf.org/external/pubs/ft/weo/2003/02/data/index.htm .
Imports	Imports of goods and services, US dollar billion in 2002	International Financial Statistics (IMF), sum of the values of series "78ABDZF" (Imports of goods, f.o.b.) and "78AEDZF" (Debit of services).
External debt	Total external debt, US dollar billion at end-2001	2003 World Development Indicators (The World Bank), Table 4.16.
Liquid liabilities	Liquid liabilities, US dollar billion in 2001	2003 World Development Indicators (The World Bank), Table 5.5.
Stock market capitalisation	Stock market capitalisation, US dollar billion in 2001	2003 World Development Indicators (The World Bank), Table 5.4.
External banking assets	External assets of banking sector, US dollar billion at end-2002	BIS International Banking Statistics, December 2003, Table 6A. http://www.bis.org/statistics/bankstats.htm . Figures refer to gross international liabilities of BIS reporting banks vis-à-vis banks in individual economies.
Capital inflows	Capital inflows, US dollar billion in 2002	Sum of absolute values of series "78BEDZF" (Direct investment in reporting economy, n.i.e.), "78BGDZF" (Portfolio investment liabilities, n.i.e.) and "78BIDZF" (Other investment liabilities, n.i.e.).
Capital outflows	Capital outflows, US dollar billion in 2002	Sum of absolute values of series "78BDDZF" (Direct investment Abroad), "78BFDZF" (Portfolio investment assets), "78BHDZF" (Other investment assets) and "78CADZF" (Net errors and omissions).
Financial openness	Sum of capital inflows and capital outflows, US dollar billion in 2002	
24-month standard deviation of monthly change of NEER	24-month standard deviation of monthly (log) change of average Nominal effective exchange rate index. (Jan 2002-Dec 2003)	International Financial Statistics (IMF), series "NECZF".
60-month standard deviation of monthly change of NEER	60-month standard deviation of monthly (log) change of average Nominal effective exchange rate index. (Jan 1999-Dec 2003)	International Financial Statistics (IMF), series "NECZF".

APPENDIX II

Summary Statistics

	Reserves	GDP	Imports	Liquid liabilities	Stock market capitalisation	External banking assets	Financial openness	24-month standard deviation of monthly change of NEER	60-month standard deviation of monthly change of NEER
	as ratio to GDP								
Mean	-0.07	2.01	-0.79	-1.04	-1.78	-2.36	-2.06	0.03	0.03
Median	-0.33	1.86	-0.72	-1.09	-1.68	-2.47	-2.09	0.01	0.01
Maximum	5.66	7.14	0.46	0.86	1.14	3.68	2.12	0.47	0.30
Minimum	-5.73	-2.92	-1.97	-2.54	-5.27	-5.43	-4.63	0.00	0.00
Std. Dev.	2.19	2.02	0.53	0.68	1.27	1.39	0.92	0.06	0.04
Skewness	0.22	0.07	-0.19	0.30	-0.43	1.09	0.81	7.34	6.04
Kurtosis	2.56	2.65	2.49	2.87	3.52	6.17	6.54	59.16	44.96
Jarque-Bera Probability	2.48 0.29	0.91 0.64	1.58 0.45	1.82 0.40	3.04 0.22	91.97 0.00	60.55 0.00	10109.28 0.00	5719.26 0.00
Sum	-10.56	309.32	-75.14	-119.15	-126.03	-351.18	-197.57	1.81	1.82
Sum Sq. Dev.	731.04	623.84	26.07	52.60	113.79	286.89	80.72	0.22	0.10
Observations	153	154	95	115	71	149	96	72	72

Notes: All variables are in logarithms.

APPENDIX III

Correlation Matrix

	Reserves	GDP	Imports	Liquid liabilities	Stock market capitalisation	External banking assets	Financial openness	24-month standard deviation of monthly change of NEER	60-month standard deviation of monthly change of NEER
	as ratio to GDP								
Reserves	1.00								
GDP	0.93	1.00							
Imports/GDP	0.19	-0.08	1.00						
Liquid liabilities/GDP	0.72	0.60	0.36	1.00					
Stock market capitalisation/GDP	0.65	0.60	0.38	0.63	1.00				
External banking assets/GDP	0.33	0.13	0.50	0.55	0.32	1.00			
Financial openness/GDP	0.02	-0.10	0.42	0.39	0.15	0.60	1.00		
24-month standard deviation of monthly change of NEER	-0.20	-0.08	-0.45	-0.16	-0.18	-0.18	0.12	1.00	
60-month standard deviation of monthly change of NEER	-0.46	-0.23	-0.38	-0.43	-0.24	-0.33	-0.03	0.59	1.00

Notes: All variables are in logarithms.

REFERENCES

Aizenman, Joshua and Nancy Marion (2003), "The High Demand for International Reserves in the Far East: What is Going on?", *Journal of the Japanese and International Economies*, 17(3): 370-400.

Aizenman, Joshua and Nancy Marion (2004), "International Reserve Holdings with Sovereign Risk and Costly Tax Collection", *Economic Journal*, 114(127): 569-91.

Clark, Peter (1970), "Demand for International Reserves: A Cross-Country Analysis", *The Canadian Journal of Economics*, 3(4): 577-94.

Flood, Robert and Nancy Marion (2002), "Holding International Reserves in an Era of High Capital Mobility", IMF Working Paper WP/02/62, International Monetary Fund.

Frenkel, Jacob (1974), "The Demand for International Reserves by Developed and Less-Developed Countries", *Economica*, 14(161): 14-24.

Grubel, Herbert (1971), "The Demand for International Reserves: A Critical Review of the Literature", *Journal of Economic Literature*, 9(4): 1148-66.

Rogoff, Kenneth et al. (2003), "Evolution and Performance of Exchange Rate Regimes", IMF Working Paper WP/03/243, International Monetary Fund.

Wijnholds, Onno and Arend Kapteyn (2001), "Reserves Adequacy in Emerging Market Economies", IMF Working Paper WP/01/143, International Monetary Fund.