



**ROLE OF CREDIT IN EQUITY MARKET BOOMS AND BUSTS**

Prepared by Lillian Cheung and Chi-Sang Tam<sup>1</sup>  
Research Department

**Abstract**

Widespread financial distress typically arises from the unwinding of financial imbalances that build up disguised by benign economic conditions. This paper studies whether credit is a pertinent indicator of future equity price booms, and thus provides a signal for potential financial instability. Our analysis shows that excess credit does increase the probability of an equity price boom ahead. We argue that a policy response worthy of consideration would be a strengthening of the system-wide focus of the prudential framework coupled with monetary policy rules that take into account occasional development of financial imbalances to prevent potentially significant financial strains from developing. To this end, greater co-operation between monetary and prudential authorities is important, not just in managing crises, but also in preventing their emergence.

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Keywords: financial stability; monetary stability; equity price booms and busts; excess credit

Author's E-Mail Address: [lcheung@hkma.gov.hk](mailto:lcheung@hkma.gov.hk); [cstam@hkma.gov.hk](mailto:cstam@hkma.gov.hk)

<p>The views and analysis expressed in this paper are those of the authors, and do not necessarily represent the views of the Hong Kong Monetary Authority.</p>
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***Executive Summary:***

- *The current financial crisis has demonstrated how financial imbalances can be built up in a low-inflation environment reflecting monetary stability, and how devastating the consequences on economic and financial stability can be with high-cost busts in asset prices and financial markets. While the rescue measures introduced by governments in various countries may allay the panic in the financial markets, they do not address the prevention of future financial crises.*
- *This paper studies the conditions pertaining to potential financial strains by focusing on the role of credit in equity price booms and busts, and the implications for monetary policy.*
- *Our analysis suggests that excess credit has been a leading indicator of the probability of an equity price boom, and points to the importance of studying rare episodes of large booms and busts rather than average historical relationships as in most studies.*
- *Our findings also suggest the importance of the macroeconomic environment in determining financial stability and provide valuable information for policy makers on potential booms that could lead to increased risk of financial instability.*
- *A policy response worthy of consideration would be a strengthening of the system-wide focus of the prudential framework coupled with monetary policy rules that take into account occasional development of financial imbalances to prevent potentially significant financial strains from developing.*
- *To this end, greater co-operation between monetary and prudential authorities is important, not just in managing crises, but also in preventing their emergence. While our analysis provides a first step in discerning factors pertaining to equity price booms, further analytical work will still be required in understanding the dynamics between financial and real economic factors.*

## I. INTRODUCTION

Widespread financial distress typically arises from the unwinding of financial imbalances that build up disguised by benign economic conditions. The current financial crisis has demonstrated how financial imbalances can be built up in a low-inflation environment reflecting monetary stability, and how devastating the consequences on economic and financial stability can be with high-cost busts in asset prices and financial markets. While the rescue measures introduced by governments in various countries may allay the panic in the financial markets, they do not address the prevention of future financial crises.

Although there is a combination of many symptoms which could lead to potential financial crisis, booms and busts in asset prices are one of a richer set of symptoms. Indeed, large swings in asset prices figure prominently in many historical accounts of financial instability. This is true for both industrial and emerging market countries alike. Typical examples in recent decades include Latin America in the late 1970s to early 1980s, the Nordic countries in the late 1980s, and East Asia in the mid to late 1990s. A study by Gochoco-Bautista (2008) provides evidence that asset prices booms raise the probability of extremely bad macroeconomic conditions (i.e. large excess supply and high inflation) in Asian economies. In particular, asset price bubbles that are associated with credit booms present particular challenges, as they often magnify the subsequent disruptions to financial instability and their damaging effects on the real economy.

However, the difficulties in identifying financial imbalances are artificially magnified when the question is put in terms of asset price bubbles. While it is almost impossible to reach a consensus about whether a particular asset price boom period should be considered a bubble or not, the question whether a boom is a bubble is for many practical purposes more semantic than of real importance. For policymakers, the important question is whether a combination of events in the financial and/or real sectors can be identified, which expose the financial system to a significantly higher level of risk. A financial crisis can make it very difficult to maintain price stability. This is demonstrated by the fact that all major deflationary episodes in the world have been related to substantial falls in asset prices. The identification difficulties look less daunting when the issue is analysed on this basis.

In this paper, we study the possibility of discerning the conditions pertaining to potential financial strains on the basis of *ex ante* information, and focus on the role of credit on equity price booms and busts, and the implications for monetary policy. The paper is structured as follows. The next section discusses the role of credit as a signal of equity price booms and hence future financial instability. Section III gives some case studies on selected episodes of equity price booms and busts over the past two decades, and examines the characteristics of credit and macroeconomic conditions during these periods. Section IV then presents our empirical testing of the hypothesis of whether credit booms increase the probability of equity price booms ahead based on experience from a number of advanced equity markets in Asia and the Nordic countries using a probit model. Finally, the last section discusses the role of monetary policy in maintaining financial stability and concludes.

## **II. CREDIT AS AN IMPORTANT FACTOR IN EQUITY PRICE BOOMS**

While not all asset price booms are dangerous, booms are likely to be costly if associated with high leverage. Historical experience suggests that developments in the monetary aggregates and credit play an important role in the development of asset price boom episodes. Although the issue of empirical causality between asset prices on the one hand and money and credit developments on the other is a complicated one, the potential role of credit in driving asset prices is straightforward.

A bubble is more likely to develop when investors can leverage their positions by investing borrowed funds. Indirectly, expenditures on goods and services tend to generate an upswing in economic activity, helping cash flows and brightening prospects for future income on assets, thereby buoying their valuation. In turn, higher asset values strengthen the net worth of borrowers and hence their borrowing capacity by increasing the value of collateral. A self-reinforcing process can easily develop. Further on, a high level of outstanding debt will increase the negative effects of asset price declines through the forced liquidation of leveraged positions and possible defaults, which in turn put additional pressure on asset prices. An interesting finding by Detken and Smets (2004) based on some stylised facts for financial, real and monetary policy developments during asset price booms in some OECD countries suggests that while booms followed by little real output loss (i.e. low-cost booms) have no significant relation with macroeconomic activities,

there is evidence that booms followed by large real output loss (i.e. high-cost booms) are associated with significantly looser monetary conditions over the boom period, and they seem to follow rapid growth in real money and credit.

Indeed, credit excesses appear to be the root cause of the current crisis. According to Shin and Adrian (2008), there is evidence pointing to procyclical leverage where financial intermediaries adjust their balance sheets actively, and doing so in such a way that leverage is high during booms and low during busts. During the boom, the intermediaries utilise surplus capital by expanding their balance sheets. In the US sub-prime mortgage market, when balance sheets were expanding fast enough, the urge to employ surplus capital was so intense that even borrowers that did not have the means to repay were granted credit. This sowed the seeds of the subsequent downturn in the credit cycle.

In this respect, it should not be surprising that credit variables have been found to be pertinent indicators to predict financial crises and identify costly asset price boom episodes. Booms and busts in asset prices, together with rapid credit expansion and, often, above-average capital accumulation, can jointly sow the seeds of future instability. As a result, the financial cycle can amplify, and be amplified by, the business cycle.

### **III. THE ROLE OF CREDIT IN PAST EQUITY MARKET BOOMS/BUSTS: SOME CASE STUDIES**

Some common characteristics of credit and macroeconomic conditions during equity price booms can be drawn through a review of selected major episodes of equity market booms/busts over the past two decades. Here, we look at the experience in Japan during the late 1980s, the Asian financial crisis in the late 1990s, and the Nordic banking crises in the late 1980s to early 1990s.

#### **a. Japan's asset price bubble (late 1980s)<sup>2</sup>**

During Japan's asset price boom in the late 1980s, equity and land prices soared under a long period of economic growth, stable inflation and low unemployment. The period between January 1986 and June 1987 recorded the

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<sup>2</sup> See Okina et.al (2001), Okina and Shiratsuka (2002) and Shiratsuka (2003) for detailed discussion of the lessons learnt from Japan's asset price bubble in the 1980s.

fastest stock price inflation, with the Tokyo Stock Price Index (TOPIX) jumping from 1040 to 2220 in 17 months, representing a 71% annual growth rate. The relatively low interest rate environment eased financing conditions for investment substantially. With the yen experiencing a rapid appreciation in the mid-1980s, the Bank of Japan (BOJ) eased monetary conditions by slashing short-term interest rate significantly. With inflation being close to zero at the time, it also did not justify a tightening in monetary policy by the BOJ. Therefore, low interest rate, fast growth in broad money supply, robust GDP growth and stock price boom co-existed for several years until the end of 1989. At the same time, banks' risk-taking behaviour also increased due to financial deregulation, as they channelled more funds to real-estate-related sectors and to small firms, accepting property as collateral. It appeared that while bank deregulation has led to risky lending, protracted monetary expansion has helped sustain the asset price bubble over a long period of time.

As asset prices continued to soar and inflation moved upward, the BOJ decided to start raising rates in 1989. As a result, the stock market collapsed at the beginning of 1990. However, as land prices continued to rise, monetary policy only gradually reversed its course in the summer of 1991 as growth declined and inflation and land prices started to move down. The subsequent decade has been termed 'the lost decade', during which Japan suffered from anaemic growth and repeated bouts of very low inflation and deflation.

Japan's experience re-emphasises the importance of regulatory policies that may prevent feedback loops between asset price bubbles and credit provision. Indeed, during the boom, Japanese regulations that allowed banks to count as capital unrealised gains from equities may have contributed to banks' appetite for equities during the stock market run-up and to financial instability as the stock market collapsed. After the bursting of the bubble, policymakers did not quickly resolve the fragility of the banking sector, thereby allowing conditions to worsen as banks kept lending to inefficient, debt-ridden firms.

#### **b. Asian financial crisis (late 1990s)<sup>3</sup>**

The Asian economies had experienced a period of rapid growth in income and savings since the late 1980s until the bubble burst in 1997. The crisis was triggered in Thailand by the collapse of the Thai baht following the decision of

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<sup>3</sup> See Wade (1998) and Ito (1999) for detailed discussion of the Asian financial crisis.

the Thai government to de-peg from the US dollar, after exhaustive efforts to support it in the face of a severe financial overextension. As the crisis spread, most of the Southeast Asia and Japan saw slumping currencies, devalued stock markets and other asset prices, and a precipitous rise in private debt. Indonesia, South Korea and Thailand were the countries most affected by the crisis.

The causes of the Asian financial crisis are many and disputed. Nonetheless, it is widely believed that unsustainable macroeconomic imbalances and poor economic policies in these countries were the root of the crisis, though once the crisis was ignited, market over-reaction caused individual financial systems to collapse to an extent and depth more severe than warranted by the initial weak fundamentals. General contributing fundamental factors include exchange rate misalignments, current account imbalances, excessive domestic investment in risky and low-profitability projects, the unsustainable surge in short-term external liabilities, and excessive borrowing and lending in a banking environment plagued with moral hazard problems and lax regulation and supervision.

A number of economies in the region developed into a bubble fueled by 'hot money' from massive short-term capital inflows, and the sudden reversal on the eve of the crisis was the key factor leading to the crisis. The huge private capital flows into the region were largely attracted by the impressive growth performance of many Asian economies enticed. With the expanding availability of foreign capital, the domestic banking system of every Asian economy was flooded with liquidity. Without careful macroeconomic management, as well as proper banking supervision and regulations, this situation contributed to excessive growth in domestic credit to the private sector, further fueling the investment boom and leading to over-investment in many of the Asian economies.

As a result, credit growth was much faster than real GDP growth in many of the Asian economies. Such rapid growth in the private sector indebtedness underlined the fragility of the banking system. The quality of bank loans was a vital issue because a large portion of the investment backed by those loans had been made in inflated property markets under overheated economies. Moreover, the investment boom was supported essentially by large-scale foreign borrowing. Thailand, Indonesia and South Korea had large private current account deficits and the maintenance of fixed exchange rates encouraged external borrowing and led to excessive external borrowings by banks and currency mismatches in their balance sheets, causing excessive exposure to foreign exchange risk in both the financial and corporate sectors.

With the highly-leveraged economic climate pushing up asset prices to an unsustainable level, the eventual collapse of asset prices caused individuals and companies to default on their debt obligations. The resulting panic among lenders led to a large withdrawal of credit from the crisis countries and massive foreign capital outflows, putting depreciative pressure on their exchange rates. In order to prevent a collapse of the currency values, these countries' governments were forced to raise domestic interest rates to exceedingly high levels to help diminish the capital flight and to intervene in the exchange market at the fixed exchange rate with foreign reserves. When it became clear that the tide of capital fleeing in these countries is unstoppable, the authorities ceased defending their fixed exchange rates and allowed their currencies to float. The resulting depreciated value of those currencies meant that foreign currency-denominated liabilities grew substantially in domestic currency terms, causing more bankruptcies and further deepening the crisis.

**c. The Nordic banking crisis (late 1980s to early 1990s)**

Three Nordic countries, Finland, Norway and Sweden, went through a banking crisis during the period between the 1980s and early 1990s, when their banking sectors suffered huge credit losses. The balance sheets of banks in these countries deteriorated sharply since the late 1980s while property and equity prices also dropped significantly.<sup>4</sup>

The Nordic crisis is generally regarded as the combined result of financial liberalisation without simultaneous and appropriate adjustments of regulation and the turn of the business cycle. The banking sectors in these countries were gradually liberalised in the 1980s, during which the profit shelter of banks was removed. Banks therefore offered credit to businesses and individuals aggressively in the face of increased competition, boosting the supply of credit. On the demand side, the need and willingness to borrow increased rapidly amid the expansion phase of the business cycle in these countries. Higher credit availability and favourable economic conditions thus boosted investment, while higher investment and the economic boom led to higher profit and boosted equity and property prices. With higher profits and collateral value (from property and shares), businesses could increase their borrowings from banks for further investment, boosting profit and asset prices further.

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<sup>4</sup> See Dress and Pazarbaşıoğlu (1995) for details.



The downturn began in the late 1980s, when investors and regulators realised that the upward trend in property and equity prices, which were driven by unrealistic profit expectation and high indebtedness, could not be sustained. Regulators began to reform tax policies and tighten the monetary policy in order to dampen credit growth. As a result, credit and business investment fell into a negative feedback loop, leading to asset price slumps and economic downturn afterwards.

#### **IV. EMPIRICAL ANALYSIS**

The above three episodes demonstrate the disruptive effects on the real economy as the financial imbalances unwound. One distinguishing characteristic of these episodes was the role played by credit in equity price booms as a result of the relaxation of credit constraints in the wake of liberalization and heightened competition in the financial industry. At the same time, during these episodes, financial imbalances built up in low inflation environments in many countries. Apart from close-to-zero inflation experienced in Japan in the late 1980s, inflation in South Korea was generally falling throughout the 1990s, and was also relatively low elsewhere in Asia prior to the crisis in 1997, but asset prices and credit were rising strongly. While the above episodes have illustrated the importance of credit in signalling equity price booms, such hypothesis is subject to more rigorous statistical tests in this section.

Many studies in the existing literature have derived evidence of correlation between asset prices (including equity prices) and credit and other real sector variables. As mentioned previously, Detken and Smets (2004) provide some interesting statistical evidence on the relation between credit growth, output growth and equity price boom. Bordo and Wheelock (2004) review the stock price booms in the US in the 19<sup>th</sup> and 20<sup>th</sup> centuries, and found in some stylised facts that most booms occurred during periods of relatively rapid economic growth and credit growth. Adalid and Detken (2007) also show that excess money growth during the asset price boom helps explain the depth of post-boom recessions in the OECD countries.

However, these studies involved only simple statistical analysis of the stylised facts, and any empirical testing is confined only to the movements between credit growth and asset or equity prices, rather than the dynamics between excess

credit and the booms/busts of equity markets. For example, the empirical results of Goodhart and Hofmann (2003) suggested that credit market shock has no significant impact on both real estate price and equity price. However, such results may reflect the design of the empirical work based on the relationship between credit growth and asset price movements in general, rather than between excess credit and asset price booms in particular, which reflects the phenomenon that excess leveraging often plays a major role in high-cost booms which increase the risk of financial stability. At the same time, the effects of credit growth over a relatively short period also do not take into account cumulative effects of the credit boom.

The objective of our analysis is to fill this gap in the literature by examining the relationship between excess credit and equity price booms/busts rather than general movements in credit and equity prices, by testing whether credit boom signifies higher probability of equity price boom ahead. In this study, we focus on the experience of a number of advanced equity markets, including those of the five industrialised Asian economies of Japan, Hong Kong, Singapore, South Korea, and Taiwan, as well as two Nordic economies, including Finland and Norway.<sup>5</sup> This selection is to avoid regional bias while attaining generality in the results for markets with a similar structure. Our empirical analysis involves two major steps. The first step is to identify the booms and the second is the estimation of the impact of excess credit on the probability of an equity price boom ahead using a probit model.

#### **a. Identifying the booms**

To begin with, we identify booms in the equity markets studied. Quarterly data of equity indices are used, and nominal indices are deflated by the consumer price indices to obtain equity indices in real terms. (Please refer to Annex I for details on data definition and sources.) We follow the method in Gochoco-Bautista (2008) to identify equity price booms, and the rule can be stated as follows:

$$B_t = 1 \text{ if } \frac{P_t - \bar{P}_t}{\bar{P}_t} > \text{threshold}, \text{ and}$$
$$B_t = 0 \text{ otherwise} \tag{1}$$

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<sup>5</sup> Sweden has been excluded from our sample for estimation as there are missing observations between January and November 2001 in the domestic credit series.

where  $B_t$  is a binary variable which equals 1 when there is an equity price boom at time  $t$  and 0 otherwise;  $p_t$  is the real equity price and  $\bar{p}_t$  is the long term trend of real stock price derived by the Hodrick Prescott filter<sup>6</sup>. The equation implies that when the real stock price is higher than its long term trend by more than the pre-specified threshold value, the period is identified as a booming period. Here, we set the threshold value at 10%, which is a value commonly used in the similar studies.<sup>7</sup>

Chart 1 shows real stock prices in various economies with the identified booms. Our assumption of booms being 10% above the long-term trend appears to give reasonable results, as many of the identified booms correspond to the widely recognised and remarkable episodes. Among them, there are two episodes which appear to affect most of the equity markets studied. The Asian financial crisis in the late 1990s affected all newly industrialised economies in Asia, while the technology bubble in the early 2000s affected all equity markets studied.

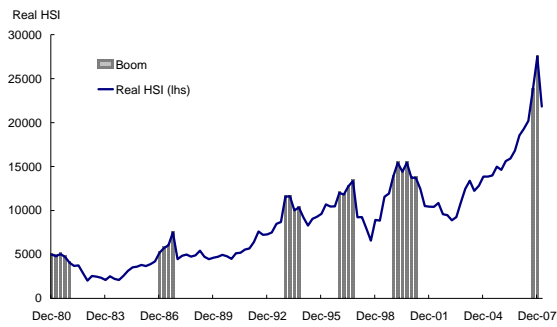
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<sup>6</sup> Here we use Hodrick Prescott filter with a smoothing factor ( $\lambda$ ) equals to 1,600.

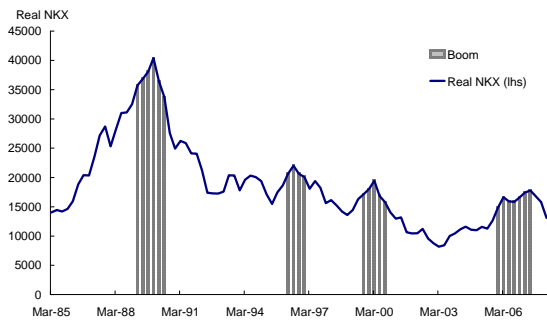
<sup>7</sup> Other threshold values (5%, 15% and 20%) have been used to check the sensitivity of our results, and they give no major qualitative difference.

Chart 1: Estimated equity price booms

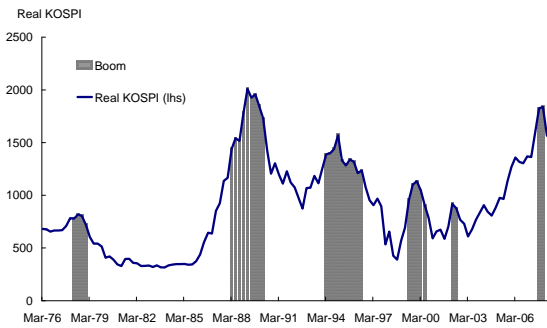
Hong Kong



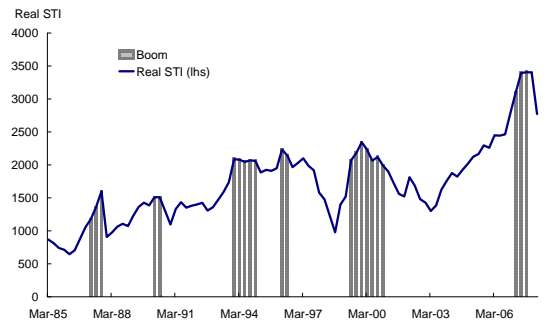
Japan



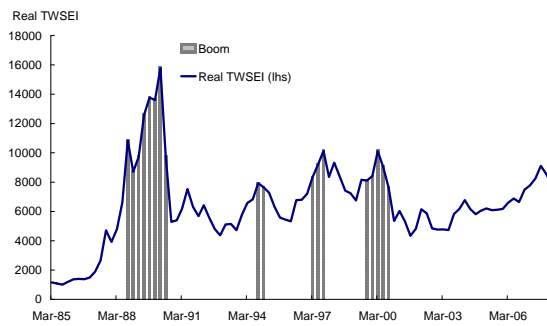
South Korea



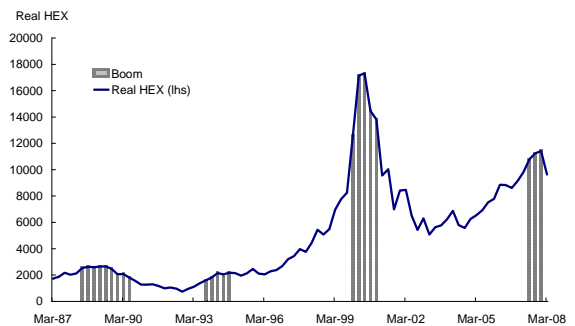
Singapore



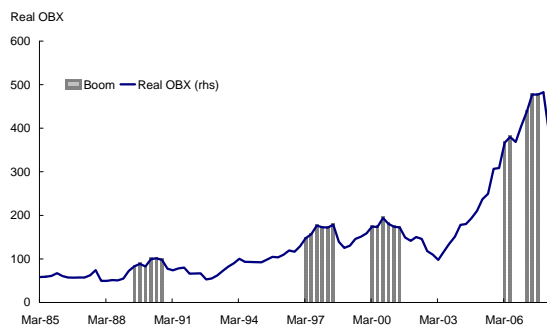
Taiwan



Finland



Norway



Sources: Bloomberg, CEIC, Ecwin, HKMA estimates.

**b. Probability of an equity price boom**

With the equity price booms identified, we can estimate the following probit model in the second stage to test whether credit boom is a signal of subsequent equity price boom. Our model is specified as follows:

$$\Pr(B_{k,t} = 1) = \alpha_0 + \sum_{i=1}^m \beta_i c_{k,t-i} + \sum_{i=1}^n \gamma_i g_{k,t-i} + e_{k,t} \quad (2)$$

where  $B_{k,t}$  is a binary variable equals 1 when there is a stock price boom at time  $t$  in country  $k$  and 0 otherwise, while  $\Pr(\cdot)$  is the probability operator;  $c_{k,t}$  is a credit variable, and  $g_{k,t}$  is the output gap which reflects the business cycle and is used here as a collective indicator of real economic activities. If the hypothesis that credit boom does lead to equity price boom is true, we will expect the sign of  $\beta$ s to be significant and positive. The expected sign of  $\gamma$ s is also positive, as asset market usually booms during the economic upturns as reflected in a widening of the output gap.

With regard to the credit variable, two commonly employed measures in the existing literature are credit growth rate and the discrepancy between credit and its equilibrium value, i.e. excess credit. Here, we use excess credit instead of credit growth, as the effects of a single year of rapid credit growth could not sufficiently reflect the financial vulnerabilities due to the accumulated imbalance in the credit market (Borio and Lowe (2002)). On the other hand, excess credit based on the outstanding credit stock may better reflect the accumulation. The key to estimating excess credit is to determine the equilibrium value of credit. To this end, we employ an error correction model to estimate the equilibrium value of credit:<sup>8</sup>

$$\Delta credit_{k,t} = \phi_0 + \phi_1 \Delta y_{k,t} + \tau (credit_{k,t-1} - \theta_0 - \theta_1 y_{k,t-1}) + c_{k,t} \quad (3)$$

where  $credit_{k,t}$  is the logarithm of real credit at time  $t$  in country  $k$  and  $y_t$  is the

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<sup>8</sup> The error correction model is based on the following auto-regressive distributed lag (ARDL) model which shows the dynamic relation between credit and GDP:

$$credit_{k,t} = \phi_0 + \phi_1 y_{k,t} + \phi_2 y_{k,t-1} + (\tau + 1) credit_{k,t-1} + c_{k,t} .$$

In the Engle-Granger two steps procedure, the unit root test shows that both real credit and real GDP are I(1) and their first differences are I(0), while the cointegration test indicates that these two series are cointegrated, hence justifying the specification of an error correction model.

logarithm of real GDP, while  $\Delta$  is the difference operator.<sup>9</sup> The fitted value of this model is the adjustment in credit towards the equilibrium level, and the residual  $c_{k,t}$  can be regarded as excess credit which cannot be explained by normal economic activity.

Table 1 shows the estimation results. All coefficients are significant at the 5% level and have the expected signs. The unit root test on the residuals rejects the existence of unit root at 1% significance level, and we can then use the residual series as a proxy for excess credit in the estimation of the probit model.

**Table 1: Estimation results of excess credit**

$$(\Delta credit_{k,t} = \phi_0 + \phi_1 \Delta y_{k,t} + \tau(credit_{k,t-1} - \theta_0 - \theta_1 y_{k,t-1}) + c_{k,t})$$

Variable	Coefficient	Estimate
---	$\phi_0$	0.01* (0.001)
---	$\theta_0$	-1.39* (0.26)
First difference of GDP	$\phi_1$	0.24* (0.05)
First lag of GDP (in the long-term relation equation)	$\theta_1$	1.34* (0.02)
Error correction term	$\tau$	-0.02* (0.01)

Notes: \* implies significance at the 5% level.  
Standard errors in the parentheses.

Table 2 shows the estimation results of the probit model. The number of lags of the explanatory variables are determined by the general-to-specific method.<sup>10</sup> All coefficients are significant at the 5% level and have the expected signs. The results indicate that a one–percentage–point increase in the excess credit raises the probability of a stock price boom to occur one quarter ahead by 8.7 percentage points, while the output gap increases the probability four quarters ahead. The impact of more recent output gaps are increasingly larger than that of past output gaps, with a quarterly impact of approximately 0.2 percentage points on average.

<sup>9</sup> Real credit is calculated by deflating nominal credit by the consumer price index, while real GDP is constant price GDP.

<sup>10</sup> We started from eight lags of both excess credit and output gap.

**Table 2: Estimation results of the panel probit model**

$$(\Pr(B_{k,t} = 1) = \alpha_0 + \sum_{i=1}^m \beta_i c_{k,t-i} + \sum_{i=1}^n \gamma_i g_{k,t-i} + e_{k,t})$$

Variable	Coefficient	Estimate
Constant	$\alpha_0$	-0.80* (0.06)
1 <sup>st</sup> lag of excess credit	$\beta_1$	8.73* (2.56)
1 <sup>st</sup> lag of output gap	$\gamma_1$	0.25* (0.05)
2 <sup>nd</sup> lag of output gap	$\gamma_2$	0.24* (0.05)
3 <sup>rd</sup> lag of output gap	$\gamma_3$	0.22* (0.05)
4 <sup>th</sup> lag of output gap	$\gamma_4$	0.12* (0.05)

McFadden R-squared: 0.11

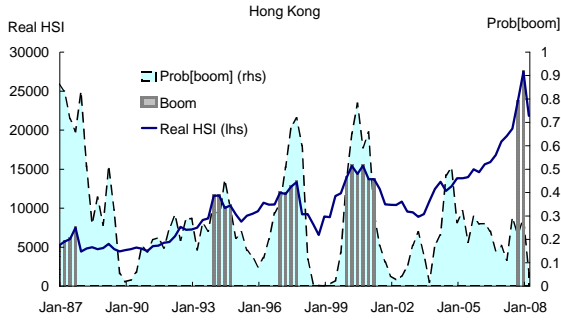
Notes: \* implies significance at 5% level.

Standard errors in the parentheses.

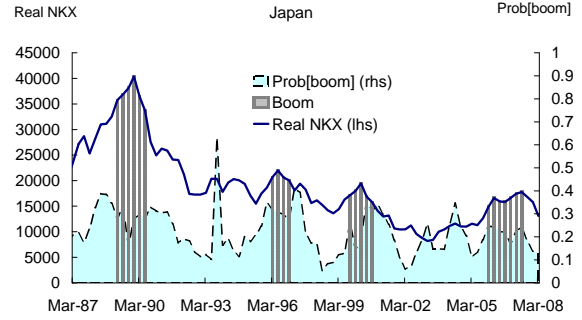
Chart 2 shows the fitted probability of equity price booms along with the equity indices and the booms identified at the first stage. In general, the estimated probability of equity price booms appears to track the extreme equity price movements closely, which goes up significantly during most of the identified boom periods.

**Chart 2: Estimated probability of equity price booms**

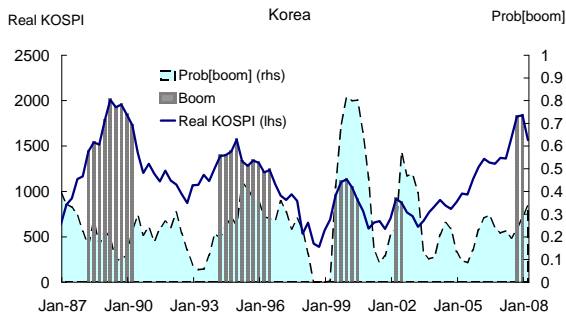
**Hong Kong**



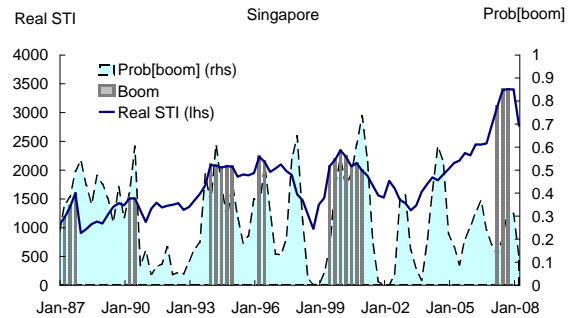
**Japan**



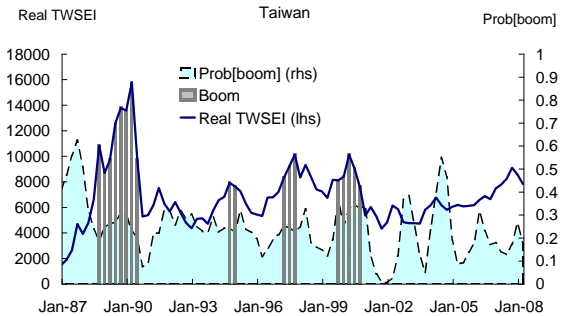
**South Korea**



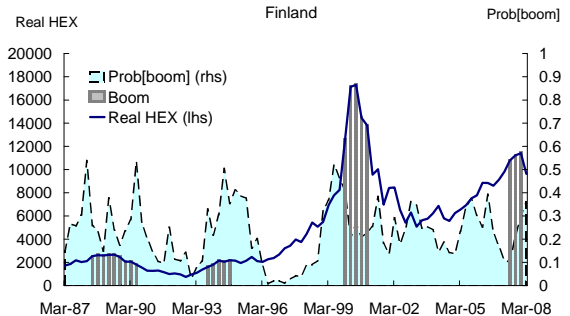
**Singapore**



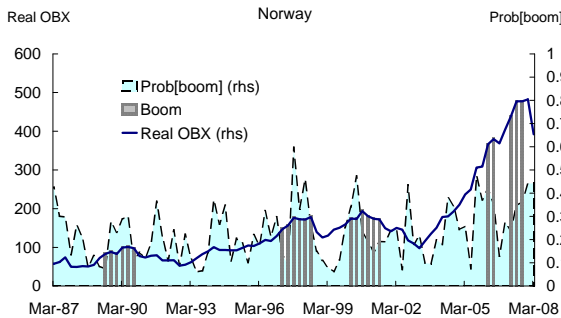
**Taiwan**



**Finland**



**Norway**



Sources: Bloomberg, CEIC, Ecwin, HKMA estimates.



Table 3 summarises the predictive ability of the model by measuring Type I and Type II errors of the in-sample prediction. The rule of prediction can be stated as:

$$\hat{B}_{k,t} = 1 \text{ if } \Pr(B_{k,t} = 1) > \textit{threshold}, \text{ and}$$

$$\hat{B}_{k,t} = 0 \text{ otherwise.} \tag{4}$$

The rule implies that when the estimated probability of a boom is larger than a pre-specified threshold value, then the estimated boom indicator ( $\hat{B}_{k,t}$ ) is equal to one. Here we set the threshold value by taking the occurrence ratio of the booming periods in the whole sample, which is about 0.25.<sup>11</sup> The rule correctly predicts 100 booming periods out of 155, implying that the Type I error (i.e. predicts a 0 state while the actual state is 1) ratio is about 35%. On the other hand, the model gives a similar Type II error (i.e. predicts state is 1 when the actual state is 0) ratio of 36%. The overall fitness, which considers all the hits and misses of the prediction by Rule (4), is about 65%, compared with 25% of the naïve predictor (i.e.  $B_{naive,k,t} = 1$  for all  $k$  and  $t$ ).

**Table 3: Summary statistics of model prediction**

		<b>Predicted</b>		
		<i>B=0</i>	<i>B=1</i>	<i>Total</i>
	<i>B=0</i>	<b>298</b>	165	463
<b>Actual</b>	<i>B=1</i>	55	<b>100</b>	155
	<i>Total</i>	353	265	<b>618</b>
<b>Type I error ratio (%)</b>		35.48		
<b>Type II error ratio (%)</b>		35.64		
<b>Overall fitness (%)</b>		64.40		

## V. CONCLUSION AND POLICY IMPLICATIONS

Our analysis suggests that excess credit has been a leading indicator of the probability of an equity price boom ahead, and points to the importance of studying rare episodes of large boom and busts rather than average historical relationships as in most studies. It is disasters that policy makers are truly

<sup>11</sup> There are 155 booming periods out of 618 periods in the whole sample. This ratio indicates that the sample is unbalanced, that is, there are many more non-booming periods than the booming periods. It is therefore more reasonable to take this ratio as the threshold value in the prediction rule (4) than using the commonly-used half-half ratio, 0.5, which assuming a balanced sample.

concerned about, and such asymmetry may not have been properly captured by the existing literature.

Our findings also suggest the importance of macroeconomic environment in determining financial stability and provide valuable information for policy makers on potential booms that could lead to increased risk of financial instability. Given the disruptive effects of the unwinding of financial imbalances on the real economy and historical experience pointing to the limits of price behaviour in providing sufficient signal for these distortions, these raise the question of whether monetary policy has a role to play in maintaining financial stability.

A policy response worthy of consideration would be a strengthening of the system-wide focus in the prudential framework coupled with monetary policy rules that take into account occasional development of financial imbalances to prevent potentially significant financial strains ahead. To this end, greater co-operation between monetary and prudential authorities is important, not just in the management of crises, but also in preventing their emergence. Prudential measures that generate counter-cyclical effects to dampen boom-bust cycles of asset prices may play a useful role in maintaining macroeconomic and financial stability, particularly in disastrous scenarios of large asset price swings. For example, in the case of Hong Kong where discretionary monetary policy for macroeconomic stabilisation is absent under the currency board system, the adoption of a forward-looking strategy by adjusting capital requirements according to property price misalignments may help stabilise housing prices.<sup>12</sup>

By the same token, a prompt response of monetary policy to financial imbalance before their further build up will be important. Monetary policy rules that do not take these imbalances into account may accommodate their further build up, and the consequences of failing to act early enough can be serious. In particular, there is a risk of greater amplitude in financial cycles leading to more disruptive booms and busts in the real economy. While it is always difficult and debatable to determine whether monetary policy causes booms/busts, or whether monetary policy should react to asset prices or act as a remedy in the aftermath of a financial crisis, it would be unwise to rule out the potential of monetary policy decisions to take into account any signs of an over-expansion in credit which could potentially lead to significant financial stress on the economy.

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<sup>12</sup> See Hong Kong Monetary Authority (2008).

Nonetheless, such policy adjustments will entail complex technical issues, and our analysis provides a first step in discerning factors pertaining to equity price booms. Further analytical work will still be required in understanding the dynamics between financial and real economic factors, in particular, the identification of the potential for an equity price boom today that will increase the threat of future financial instability.

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**Data Definition and Sources**

**Table A1: Stock price indices**

	<b>Stock index</b>	<b>Source</b>
<b>Hong Kong</b>	Hang Seng index	CEIC
<b>Korea</b>	KOSPI	CEIC
<b>Singapore</b>	Straits Times index	CEIC
<b>Taiwan</b>	Taiwan Stock Exchange index	CEIC
<b>Japan</b>	Nikkei 225 index	CEIC
<b>Finland</b>	OMX Helsinki index	Bloomberg
<b>Norway</b>	Oslo Stock Exchange index	Ecwin

**Table A2: Credit measures for estimating excess credit as a percentage of GDP**

	<b>Credit measure</b>	<b>Source</b>
<b>Hong Kong</b>	Loans for use in Hong Kong	CEIC
<b>Korea</b>	Loans of commercial and specialised banks, total	CEIC
<b>Singapore</b>	Loans and advances total to non-bank sector by domestic banking unit, including billing finance	CEIC
<b>Taiwan</b>	Loans (major financial institutions)	CEIC
<b>Japan</b>	Loans and discounts, domestically licensed banks, total	CEIC
<b>Finland</b>	Domestic credit	Ecwin
<b>Norway</b>	Credit indicator (C2)	Ecwin

**Table A3: Interest rates**

	<b>Interest rate</b>	<b>Source</b>
<b>Hong Kong</b>	Interbank offer rate (3 months)	CEIC
<b>Korea</b>	Money market rate (composite)	Ecwin
<b>Singapore</b>	Interbank rate (3 months)	CEIC
<b>Taiwan</b>	Interbank rate (overnight)	Ecwin
<b>Japan</b>	Collateralized Call rate (overnight)	CEIC
<b>Finland</b>	EURIBOR (3 months)	Ecwin
<b>Norway</b>	NIBOR (3 months)	Ecwin