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Asset Prices and Monetary Policy: Booms and Fat Tails in East Asia

Maria Socorro Gochoco-Bautista*

Abstract

Do housing and equity booms significantly raise the probability of extremely bad outcomes at the margin? This study addresses this question for a group of 8 East Asian countries. The main findings are the following: (i) Asset price booms in housing and equity markets, either separately or jointly but especially in housing, significantly raise the probability at the margin that (a) the real output gap will be in the left tail of its distribution, in which output is significantly below trend, and (b) the price-level gap will be in the right tail of its distribution, in which the price level is significantly above trend. At the margin, the risk of the occurrence of these particular tail events due to asset price booms is largely asymmetric and does not apply to the tails of good outcomes; and (ii) Expected real output and price level outcomes that are either obtained without conditioning on asset price booms or are obtained conditional on asset price booms using the normal approximation underestimate the risk of tail events and lead to less pessimistic but misleading inferences. One implication for monetary policy is that an approach that is *ex-ante* more compatible with risk management may be appropriate.

Keywords: asset price booms, tails, GDP-at-risk, CPI-at-risk, risk management
JEL Classification: E44, E52, E58

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1 Introduction

There is a general consensus among both central bankers and academics that asset prices are important. Asset prices affect the real economy through several known channels of transmission. These include effects on consumption via the wealth effect, and effects on investment via Tobin's Q and the financial accelerator effect.[1] Asset price booms and subsequent busts wreak havoc on financial stability. Unfortunately, the effects of financial instability are rarely confined to the financial sector alone. Instead, they tend to spill over to the real economy and cause great harm, as was experienced by countries in East Asia in 1997. Consequently, asset prices forecast inflation largely because output is influenced by asset prices. Asset prices may be indicators of macroeconomic conditions to which authorities can respond. This is intuitively appealing, as asset prices are inherently forward-looking and hence, contain information about market expectations.

There are other issues, however, on which there is less consensus. Even if asset prices are important, there is no consensus on the weight to attach to them. Depending on one's point of view, asset prices may or may not have a significant implication for the conduct of monetary policy, such as the need for pre-emptive measures. Furthermore, most of the literature as well as the practical implementation of monetary policy has focused on the possible effects of asset prices on the *means* of variables of interest to policymakers, such as inflation and output growth. The importance of asset prices in this framework, especially booms, depends largely or solely on whether such booms affect the mean values

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[1]The theoretical bases and empirical evidence for these traditional channels are not unambiguous. Changes in the interest rate have a direct effect on consumption apart from any effect via changes in asset prices and hence, wealth. Alchian and Klein [1973] first proposed the need for a broader price index in which the price of future consumption is included. However, it is unclear whether asset prices such as equity prices are good proxies for the price of future consumption since asset prices may change for reasons unrelated to future consumption. Tobin's Q performs poorly in regressions. A better measure of Q appears to be one constructed from profit forecasts rather than from equity prices. Some studies, such as Bernanke and Gertler [1989], also find that the net worth of entrepreneurs rather than the ratio of the stock price to the replacement cost of capital is a better indicator of a firm's investment incentives. Furthermore, they argue that the net worth of entrepreneurs may play an important role in shock propagation since the more investment is self-financed, the greater is the willingness to supply capital.

of these variables.[2] At the same time, the role of asset prices in directly affecting financial stability has largely been regarded as either a totally separate matter altogether from their effects on the *means* of variables of interest, or as a natural by-product of a successful strategy to contain inflation. In particular, the orthodox approach to monetary policy, so-called 'benign neglect', is premised on the assumption that a monetary regime focused on price stability will naturally promote financial stability as a by-product.[3] Hence, events occurring in financial markets, such as asset price booms, should not affect the conduct of monetary policy except insofar as inflation targets may be directly compromised within the usual policy horizon. Instead, central bankers should simply respond *ex-post* to problems created by the unwinding of financial imbalances or asset price busts.

Borio and Lowe [2002] and others have long emphasized that central banks should not set monetary policy by focusing on inflation alone. They reason that highly-leveraged asset acquisition fuelled by excessive credit creation and asset misallocation can happen even when inflation is low and stable. Excessive credit creation manifests first in financial imbalances and asset price booms, and only subsequently in output and goods price inflation. A central banker focused on the mean of inflation alone may thus miss seeing possible growing financial imbalances. The subsequent unwinding of these financial imbalances stresses bank and corporate balance sheets, increases the probability of episodes of financial instability and amplifies business cycles.[4]

The need for pre-emptive policy or any policy response in such a benign inflation environment, therefore, is not obvious. A pro-active and restrictive monetary policy stance, such as raising the interest rate to prevent large asset booms from developing or getting out of hand, will stress the financial system and is costly to

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[2] For the 8 East Asian countries included in this study, an earlier version of this study, available from the author upon request, finds evidence of significantly adverse effects of asset price booms on the conditional mean and volatility of the output- and price-level gaps. In the literature, evidence of a significant effect of asset prices on inflation is mixed. Stock and Watson [1999] find that equity prices do not perform well at forecasting US inflation at a one-year horizon compared with measures of real economic activity. Likewise, Cecchetti et al. [2000] and Filardo [2000] find that the inclusion of housing prices does not significantly improve the performance of inflation forecasts. Furthermore, as pointed out in Woodford [1994], if policymakers use the information in the inflation indicator and endogenously respond to it, the forecasting ability of the indicator will decrease. See Hördahl and Packer [2007] for an excellent summary of the literature on asset prices and monetary policy.

[3] See Trichet [2005] and Bordo and Jeanne [2002, p.141] for a discussion of this orthodox view. Exponents of orthodox policy include Schwartz [1995, 2002], Bernanke and Gertler [1999, 2001], Bordo, Dueker and Wheelock [2002, 2003] , Gilchrist and Leahy [2002], and Goodfriend [2003], while Bordo and Jeanne [2002], Cecchetti et al. [2000, 2003], Detken and Smets [2003], Dupor [2002] and BIS economists such as Borio [2006], Borio and Lowe [2002, 2004], Filardo [2000, 2004, 2005], Knight [2006], and White [2006] are regarded as exponents of what has been referred to as the 'BIS view' in Eichengreen and Mitchener [2003].

[4] Cecchetti, Genberg and Wadhwani [2003] likewise emphasize the point that such financial imbalances lead to unnecessarily large business cycle fluctuations, apart from having an impact on expected inflation.

the economy. It will almost certainly result in missed goals in the meantime. Hence, given such difficult but uncertain tradeoffs, it is understandable that the expressed preference of some central bankers and academics is for a policy of 'benign neglect'. Low and stable rates of inflation and robust growth rates in East Asia and in other countries worldwide have also perhaps engendered a sense of complacency about the need to rethink the way monetary policy is implemented, especially in view of its apparent success.

A recent study by Cecchetti [2006], however, provides a compelling rationale as to why asset prices ought to matter for monetary policy (and why central bankers ought to sleep less soundly at night), quite apart from any possible effects such asset prices may have on the mean values of variables of interest. The empirical evidence he provides is that housing and equity price booms raise the risk of particularly bad macroeconomic outcomes occurring in his sample of developed countries, whose price-level and output gaps are characterized by so-called 'fat tails'. A distribution characterized by such 'fat tails' is one in which the probability of being in the tail of bad outcomes, for example, is higher than if the distribution were normal. Hence, **if** asset price booms significantly raise the risk of extreme bad events occurring, i.e., being in the tail of bad outcomes of a distribution, the existence of 'fat tails' will worsen the expected losses from asset booms.

This may have potentially important implications for the conduct of monetary policy. It may be myopic and counterproductive for a central banker to focus exclusively on minimizing a quadratic loss function around the mean values of variables of interest to the neglect of the risk of extreme events occurring if asset booms make such tail events more likely. An approach that is *ex-ante* more actively compatible with risk management may be appropriate.

Specifically, this implies focusing on tail events concerned with the probability of the occurrence of very bad outcomes. If asset price booms affect the likelihood at the margin that output will be in the left tail of its distribution, in which output is significantly below trend, or that the price level will be in the right tail of its distribution, in which the price level is significantly above trend, then such information may relevant to central bankers concerned about managing risks. Hence, a risk-management approach that gives importance to such tail events may be seen as being additional to or quite apart from the usual way monetary policy is conducted.[5] Another implication of the existence of 'fat tails' is that statistical and econometric methods that typically assume the normal approximation will lead to misleading inferences and underestimate the likelihood of extreme events or bad outcomes.

[5] A middle way referred to 'flexible inflation targeting' is proposed by Bean [2003].

This study examines whether or not conditioning on asset price booms matters for the incidence and behavior of expected bad tail outcomes in the output gap and price-level gap for several East Asian countries. These include the following: Hong Kong SAR, Indonesia, Japan, Korea, Malaysia, the Philippines, Singapore and Thailand. Quarterly data are used. A description of the data, time period, and their sources is given in Appendix A.

The study is divided into the following sections: Section 2 describes the statistical characteristics of the data and examines the empirical distributions of both real output- and price-level gaps and identifies asset boom periods. Section 3 is the heart of the study, while the conclusions of the study and possible implications for the conduct of monetary policy are presented in Section 4.

In Section 3, tail events and behavior are examined in several ways: First, a simple panel probit regression is used to test whether asset price booms in housing and equity markets significantly raise the probability at the margin that the output gap will be in the left tail of its distribution, in which output is significantly below trend, or that the price-level gap will be in the right tail of its distribution, in which the price level is significantly above trend. The panel probit is also expanded to include other explanatory variables as a way to test the robustness of the results. The effect of simultaneous asset booms and housing and equity markets is also examined. The same analysis is applied to the opposite tails of both distributions to assess whether asset prices have a similar effect at the margin on the probability of good outcomes occurring. If so, then the risks are symmetric and the net effect of asset prices on output and the price level will tend to be neutral.

Second, given results in the previous section which imply that asset prices have a significant effect at the margin on the probability of bad outcomes, one can assess how incorrectly forecasts of output and price-level gaps would be estimated if such information in asset prices is ignored. Hence, a comparison of the forecasts of output- and price-level gaps conditioned on asset price booms versus unconditional forecasts, both at different threshold levels for asset booms, is made.

Third, a comparison is made between forecasts conditional on asset price booms using the empirical distribution versus the normal approximation. This would illustrate how misleading use of the normal distribution would be if the empirical distributions of the output and price-level gaps have non-normal distributions and / or fat tails.

Briefly, the results of the study show the following: (i) Asset price booms in housing and equity markets, whether separately or jointly but especially in housing, significantly raise the probability at the margin that the real output gap will be in the left tail of its distribution, in which output is significantly below trend, and that the price-level gap will be in the right tail of its distribution, in which the price level is significantly above trend. At the margin, the risk of the occurrence of tail events due to asset price booms is largely asymmetric and does not similarly raise the probability at the margin of the occurrence of good outcomes; and (ii) Expected real output and price level outcomes that are obtained without conditioning on asset price booms, or are obtained conditional on asset price booms using the normal approximation, both underestimate the risk of tail events and lead to less pessimistic but misleading inferences.

2 An Examination of the Data

2.1 Real Output and Price-Level Gaps

We begin by presenting some basic descriptive statistics of the data for the output and price-level gaps for each country in our sample. Quarterly data for the logs of real GDP and CPI are used for output and the price level, respectively. The GDP data are de-seasonalized using the Census X-12 procedure. The output and price-level gaps are then calculated as deviations from their Hodrick-Prescott (HP) trends using a smoothing parameter set to 1600 for the 8 countries.[6]

The descriptive statistics in Table 1 indicate that both the GDP- and price-level gaps have non-normal distributions. Based on the *p*-values for the Jarque-Bera test statistic, the null hypothesis of normality is rejected at the 5 percent level of significance for the CPI gap in all countries in the sample except Hong Kong, and for the GDP gap in Hong Kong, Indonesia, Korea, and Malaysia. The kurtosis statistic for both the price-level and GDP gaps in all countries exceeds 3, which is the level for the normal, and is indicative of heavy or 'fat tails.' The exception to this is the kurtosis statistic of 2.75 for Japan's real GDP gap, indicative of 'thin tails.' The skewness statistic also shows that both the GDP and CPI gaps are mostly skewed to the left, especially for the latter.

Another way to show non-normality in a distribution is through the use of a graphical technique called a QQ (quantile-quantile) plot.[7] This method compares the plots of the empirical quantiles of the series in question on the horizontal axis against those assuming a theoretical distribution, such as the normal, on the vertical axis. If the distributions are the same, the QQ plot will lie on a straight line. Any curvature in the QQ plot indicates that the two distributions being compared are not the same. 'Fat tails' is one reason why a distribution may be

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[6] When a smoothing parameter of 9600 is used, the results are relatively unchanged.

[7] The tails of a probability distribution may be demarcated at a certain level *p*, referred to as the *p*th-quantile of the probability distribution function.

non-normal, but is not the only one. Nevertheless, the QQ plot may also be used to detect the presence of fat tails. A QQ plot that falls on a straight line in the middle part but curves upward at the left end and downward at the right end, for example, is indicative of a leptokurtic distribution or one with a fatter tail than the normal distribution.[8] The QQ plots of the CPI gap and the GDP gap for the individual countries in the study are shown in Figures 1 and 2, respectively.

In Figure 1, the empirical quantiles of the price-level or CPI gap series for each of the eight countries are plotted against the normal distribution. It is apparent that none of the QQ plots lies on a straight line. The graphs of the CPI gap show relatively more curvature in the QQ plots of Indonesia and Korea, and to a lesser extent, the plots for the Philippines and Thailand.

Similarly, in Figure 2, the empirical quantiles of the GDP gap series for each of the eight countries are plotted against those from the normal distribution. The graphs for Indonesia and to a lesser extent, Malaysia, display relatively more curvature than those for the other countries.

A fat-tailed distribution implies that expected tail losses in the tail of bad outcomes would be greater than if the distribution were normal at the same significance level.[9] The corresponding quantiles are what Cecchetti [2006] refers to as 'GDP-at-risk' and 'CPI-at-risk' in his analysis of macroeconomic risks. He computes the equivalent of a Value-at-Risk or VaR for both CPI gap and GDP gap assuming the normal as well as the student-t distribution which has relatively fatter tails.

Under the normal distribution, the VaR is just the product of -1.645 and the standard deviation of the series. Under the student-t distribution, VaR computation is not as simple because tail behavior depends on the so-called shape parameter which has to be determined. The inverse of this parameter, the Hill index, is a measure of the fatness of the tail.

The shape parameter can be estimated using the m largest observations of a time series x with T observations. Let x_i^o be the i^{th} order statistic of this time series, hence, $x_1^o \leq ... \leq x_T^o$. The shape parameter is:

[8] See Embrechts, 1993, p. 8. Note that this statement applies regardless of whether asset prices significantly affect expected output and price level outcomes at the margin.

[9] Expected tail loss (ETL) is also known as the conditional value-at-risk (VaR) in the risk management literature and is related to the unconditional VaR which is the quantile at that significance level.

$$s_m = \frac{1}{m}\sum_{i=1}^{m} \ln x^o_{T-i+1} - \ln x^o_{T-m+1}$$

The Hill index, $h_m = 1/s_m$, is the degrees of freedom used to compute the t-distribution-based VaR. That is, it is the standard deviation of the series in question multiplied by the 5% level of the t-distribution with degrees of freedom equal to the Hill index. Figure 3 plots the 5th percentile GDP-at-risk (left tail) and 5th percentile Price–level-at-risk (right tail) for the East Asian countries in this study. These particular tails reflect the typical concerns of policymakers, namely, unemployment and inflation.

The top graph in Figure 3 shows that both Indonesia and the Philippines are outliers in the group as the 5th-percentile (right tail) values of price-level gaps are very different from the normal using the student-t distribution. In the cases of Indonesia and the Philippines, the VaRs are roughly of the same magnitude. For Indonesia, for example, the 5th percentile right tail CPI-at-risk assuming the student-t distribution shows a price-level gap of about 27 percent, which implies that the expected outcome is that the price level will be more than 27 percent above its trend. The corresponding value assuming the normal is about 10 percent above trend. For the Philippines, the values are about 25 percent under the student-t versus about 10 percent under the normal.

The bottom graph in Figure 3 shows that there are very large discrepancies between the 5th percentile GDP-at-risk (left tail) values obtained using the student-t distribution and those obtained using the normal distribution in countries like Hong Kong, Indonesia, Korea, Malaysia, and the Philippines. For Indonesia, for example, the 5th percentile expected outcome using the normal distribution implies a GDP-at-risk of about -5 percent below trend. Using the student-t distribution yields an estimate of a little over -9 percent below trend. The same is the case for Malaysia. The comparable values for the Philippines, Hong Kong, and Korea are about –4 percent vs. –7 percent, –5 percent vs. –8 percent, and –5 percent vs. about –9 percent, respectively. Using the normal distribution approximation, therefore, may give rise to misleading inferences as there is a tendency toward a less pessimistic view of likely outcomes.

2.2 Asset Price Booms

Quarterly data for the logs of real housing and real equity prices are obtained. The real housing and real equity gaps are then calculated as deviations from their Hodrick-Prescott trends using a smoothing parameter set to 1600 for the eight countries. This study uses a two-sided filter, the Hodrick-Prescott or HP filter, to identify asset price booms. This procedure is standard in the literature and is the same one used in Cecchetti [2006].

However, use of the procedure raises some concerns.[10] One is that the asset boom periods identified using a two-sided filter would not be necessarily identifiable *ex-ante* to policymakers since the filtering procedure uses the entire data set to measure the trend. In real time, however, the data available to policymakers would only be those up to the point immediately prior to the period that policymakers are trying to forecast asset prices for the next period. This study may regarded as one which retrospectively uses historical data to assess whether there is a systematic and statistically significant relationship between asset price booms and future output and price outcomes, rather than one that is meant to be used by policymakers to identify asset price booms and calibrate policy responses to such booms in real time.

Another concern with the use of a two-sided filter is the possibility of defining the period before a sharp decline in asset prices as a boom episode even if asset prices had not risen prior to the decline. Also, as Cecchetti points out, boom periods, or periods of large positive deviations of asset prices from trend, must be followed by crashes. To see if this is the case, graphs of the boom periods identified by the procedure used in this study are shown in Figures 4 and 5.

Figure 4 shows the graphs of the log of real housing prices and its HP trend for each of the eight countries. The asset boom periods identified here are shaded on the graphs and are episodes in which asset prices exceed their trend by more than 10 percent. A single bar line is used to identify cases with only one boom episode. As can be seen in Figure 4, the boom periods identified start with rising asset prices and are typically periods of large positive deviations from trend, followed by declines in asset prices. This is true in practically all cases, with Hong Kong having the most number of distinct boom episodes. The exceptions are the cases of Indonesia and Thailand, in which the boom periods identified begin with flat rather than rising asset prices before sharp declines in asset prices are experienced. These countries saw much lower housing prices from previous highs in the aftermath of the Asian Financial Crisis of 1997.

Figure 5 shows the graphs of the log of real equity prices and its HP trend for each of the eight countries. Again, asset boom periods in which asset prices exceed their trend by more than 10 percent are shaded or are designated by a single bar line. Generally, the boom periods identified are preceded by a period of rising equity prices ended by sharp declines. Note that as compared to housing price booms, the number of equity price booms, in which equity prices exceed trend by more than 10 percent, is higher.

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[10] See Borio and Lowe, 2002, p.12 for a discussion.

The number and percentage of individual housing, equity, and joint booms at various threshold levels are shown below. The threshold levels measure the extent by which asset prices exceed their respective trends. Note that the percentage of housing booms at the 15 percent threshold level or higher is less than 10 percent of the total number of observations. The same is true of joint booms at the 10 percent threshold level and higher.

Threshold level of boom	**>0%**	**>5%**	**>10%**	**>15%**	**>20%**
Housing					
No. of booms	267	141	77	40	19
Total observations	604	604	604	604	604
Percent	44.2%	23.3%	12.7%	6.6%	3.1%
Equity					
No. of booms	387	300	214	162	119
Total observations	749	749	749	749	749
Percent	51.7%	40.1%	28.6%	21.6%	15.9%
Joint					
No. of booms	169	72	30	14	8
Total observations	602	602	602	602	602
Percent	28.1%	12.0%	5.0%	2.3%	1.3%

3 Examining Tail Events and Behavior

3.1 Simple Panel Probit Estimation

To ascertain whether asset price booms significantly affect the probability at the margin of being in the tails of the empirical distributions, we consider the 5th quantile (left tail) of the output gap, where output is significantly below trend, and the 5th quantile (right tail) of the price-level gap, where the price level is significantly above trend. A simple panel probit equation is used in which the dependent variable is a dummy variable equal to 1 if either the output gap is in the 5th quantile (left tail) or the price-level gap is the 5th quantile (right tail) of their respective empirical distributions.[11] Otherwise, the dummy variable is equal to zero.

We examine whether the probability that the level of real output will be significantly below trend or that the price level will be significantly above trend

[11] The data need to be pooled in the probit regression because of the scarcity of housing booms.

is affected at the margin by the occurrence of asset price booms in the past.

$$\Pr\left(Y_{it} = 1 \middle| X_{it-lags}\right) = F\left(\beta_0 + \beta_1 x_{it-lags}\right) \tag{1}$$

Where F(.) is the standard normal CDF. The explanatory variables are dummy variables for either housing or equity deviations from their respective trends at different lag lengths of 4, 8, 12, and 16 quarters, and different threshold levels, namely, 0, 5, 10, 15, and 20 percent. A threshold of 0 means that asset prices are simply above trend. The results of the simple panel probit estimation are reported in Table 2. The numbers beside the coefficient estimates are *p*-values of *z*-statistics computed using Huber/White standard errors to test statistical significance at the 5-percent level.

The two top panels of Table 2 report the effects of simple lagged housing or equity deviations from trend and those greater than 5, 10, 15, or 20 percent from trend on the probability that the CPI gap will be in the 5th quantile (right tail) of its empirical distribution. The lag lengths are indicated in the left column while the threshold levels for the asset price booms are indicated in the top row of the table.

Housing booms at the various lags and threshold levels, but especially when housing prices exceed their trend by more than 5 percent, significantly raise the probability at the margin that the price-level gap will be in the 5th quantile (right tail) of its empirical distribution, where the price level will be significantly above trend. Housing booms that occurred 1 to 2 years ago or up to 4 years ago for booms in excess of 15 percent, likewise generally raise the probability at the margin that the GDP gap will be in the 5th quantile (left tail) of its empirical distribution, where the level of output will be significantly below its trend.

In contrast, only the 8th lag of the dummy for equity booms at all threshold levels, and the 12th lag additionally at threshold levels above 5 percent are statistically significant. In general, only an equity price deviation from trend of more than 5 percent that occurred 2 to 3 years ago increases the probability at the margin that the price-level gap will be in the 5th quantile (right tail) of its empirical distribution, where the price level is significantly above trend.

The bottom panels of Table 2 report the effects of housing or equity booms at the same lags and threshold levels on the probability at the margin that the GDP gap will be in the 5th quantile (left tail) of its empirical distribution, where output is significantly below trend. The results for housing price booms of more than 5 percent above trend are quite striking compared to those for the other threshold levels. At this threshold level, the housing dummy is statistically significant at all lags used and implies that housing booms of this magnitude always raise the probability at the margin that output will be much lower than its trend. In general, the same is true about housing booms that occurred 1 to 2 years ago, as the 4th and 8th lags of the dummy for housing are always significant when housing prices boom. Furthermore, housing booms in excess of 15 percent above trend and occurring 3 or more years ago, compared to more recent but smaller-sized housing booms, increase the probability at the margin that the GDP gap will be in the 5th quantile (left tail) of its empirical distribution.

Generally, the probability at the margin that the output gap will be in the left tail of its distribution, where output is significantly below trend, rises when equity prices simply exceed trend or are more than 5 percent above trend 2 to 4 years ago. As in the previous case, the larger the boom, even if it occurred in the more distant past, the more it matters.

Note, however, that a recent equity boom of a year ago **lowers** the probability at the margin that output will be in the 5th quantile (left tail) of its empirical distribution at threshold levels of 0 and 5 percent. This is contrary to all previous findings. It suggests that a recent equity boom is expected to continue and would not predict output to be significantly lower than its trend at the margin. In short, equity booms give rise to different expected output outcomes depending on how large they are and how recently they occurred. Hence, equity boom episodes generally give a less consistent assessment of the risk of bad tail events occurring compared with housing booms.

3.2 Expanded Panel Probit Estimation

Other explanatory variables are included to test whether the results regarding housing and equity booms obtained from the simple panel probit estimation are robust to alternative specifications of the regression model. These other variables include lags of the detrended real exchange rate, detrended real world oil prices, detrended real money, and for the CPI gap equation, includes lagged values of detrended real GDP.[12]

$$\Pr\left(Y_{it} = 1 \middle| X_{it-lags}\right) = F\left(\beta_0 + \beta_1 x_{it-lags} + \beta_2 XR_{t-lags} + \beta_3 PO_{t-lags} + \beta_4 M2_{t-lags} + \beta_5 GDP_{t-lags}\right) \quad (2)$$

[12]The real exchange rate is calculated as the product of the nominal exchange rate in domestic currency per US$ and the ratio of the US CPI to domestic CPI. The log of the real exchange rate is then detrended using the same HP filtering technique described earlier. The same detrending procedure was used for the other additional explanatory variables. An increase in the real exchange rate, therefore, is a real depreciation of the domestic currency which is normally expected to increase exports via an expenditure switching technique. The expected sign on this coefficient is therefore positive in the CPI equation and negative in the GDP gap equation. As can be seen in Table 3, while generally significant, the signs on this variable are mixed. In the GDP gap equation, for example, only the most distant lags are significantly negative, which means that a real depreciation has an expansionary effect on the economy with a lag.

The results are shown in Tables 3 and 4. Table 3 reports the results of this expanded panel probit estimation for the price-level gap using four different regression models at the same threshold levels and lags for housing and equity booms as those used previously.

When housing prices exceed their trend by more than 5 percent, the result obtained earlier holds: at the margin, housing booms that occurred between 1 and 4 years ago significantly raise the probability at the margin that the price level will be significantly higher than its trend and in the 5th quantile (right tail) of its empirical distribution. With very few exceptions, this result is fairly robust to the addition of other explanatory variables.

In stark contrast to the earlier results, equity booms that happened in the past do not generally raise the probability at the margin that the price level will be very much above trend. Only the 8th lag when equity prices are simply above their trend is statistically significant when other explanatory variables are included. Equity prices evidently do not add any additional information regarding the risk of bad tail outcomes not already contained in the usual set of explanatory variables.

Table 4 reports the results for the GDP gap using the expanded probit model. Housing booms that occurred one to two years ago at all the threshold levels used in this study significantly raise the probability at the margin that the output gap will be in the 5th quantile (left tail) of its empirical distribution, where output is significantly lower than trend. These results are similar to those obtained using the simple panel probit model.

Generally, an equity boom that occurred 2 to 3 years ago, but sometimes up to 4 years ago, significantly raises the probability at the margin that the output gap will be in the left tail of its empirical distribution, where output is significantly lower than trend. However, as previously explained, a recent equity boom does the opposite. Again, equity booms tend to be less consistent indicators of the probability at the margin of significantly lower output relative to trend in the future compared with housing booms.

3.3 Probit Estimation using Joint Asset Price Booms

There are cogent reasons for considering the effects of simultaneous booms in housing and equity markets. Detken and Smets [2003] and Borio and McGuire [2004], for example, combine housing and equity prices as a way to capture the effects of excessive liquidity or credit growth in generating asset price booms. Indeed, Borio and Lowe [2003] examine annual asset movements in 34 countries since 1962 and find that credit and asset price cycles usually proceed in tandem. They posit that because the combination of rapid credit growth and asset price booms exposes the financial system to increased risk, central banks should use aggregate asset prices as a tool for conducting monetary policy. Stock and Watson [2003] also point out that forecasts based on an individual indicator tend to be unstable in the sense that the predictive ability of the indicator changes from one period to another. Combining the information from various indicators seems to circumvent such instability in predictive ability to a large extent.

Hence, periods of joint asset price booms in housing and equity markets are used in the probit regression model. The dependent variable is the same as in the previous regressions. Now, however, the explanatory variable for asset price booms is a dummy variable equal to 1 when there are simultaneous booms in housing and equity markets at the same threshold levels as before, and zero otherwise.[13] The results are shown in Tables 5 and 6.

Table 5 presents the results of tests of the probability at the margin that the price-level gap will be in the 5th quantile (right tail) of its empirical distribution, where the price level is significantly above trend, when there are joint asset booms. The results here, when no other explanatory variables are included, are the same as those obtained earlier and shown in Table 3, when housing and equity booms were considered separately.

When other explanatory variables are included, joint booms that occurred a year ago are always significant, but now, joint booms of more than 10 percent but which occurred 2 and 4 years ago are likewise significant. This was not the case when the booms were treated separately in the previous case, shown in Table 4. The difference in the results may be indicative of the greater extent of financial imbalances created when there are joint booms.

Table 6 presents the results of tests of the probability that the output gap will be in the 5th quantile (left tail) of its empirical distribution when there are joint asset booms in housing and equity markets. The dummy variable for a joint boom is significant at the 0 threshold level for a boom that occurred 2 to 3 years ago, at the 5 percent threshold level for one that occurred 3 years ago, and at a threshold level of 10 percent for one that occurred as recently as a year ago. Once again, larger booms raise the probability at the margin that the output gap will be in the 5th quantile (left tail) of its empirical distribution, where output is significantly below trend.

[13] For both Tables 5 and 6, the probit estimation procedure using the 15 and 20 percent threshold levels did not converge, presumably due to the lack of joint booms at such threshold levels. As pointed out earlier, only 2.3 percent and 1.3 percent of the total number of observations have joint booms at these threshold levels, respectively.

3.4 Symmetric versus Asymmetric Risks

Thus far, we have examined the effect of asset price booms on the right tail of the CPI gap, or the probability at the margin that the price level will be much higher than its trend, and the left tail of the GDP gap, or the probability at the margin that the level of output will be very much below trend. One may ask whether these increased risks at the margin of bad outcomes from asset price booms are symmetric, i.e., whether they have the same effect on the tails of good outcomes of the two probability distributions under consideration. Hence, the effects of asset price booms on the 5th quantile (left tail) of the CPI gap, or the probability at the margin that the price level will be much lower than its trend, and the 5th quantile (right tail) of the GDP gap, or the probability at the margin that the level of output will be very much higher than its trend, are examined. The results are shown in Figure 6 and Table 7.

Figure 6 shows that the 5th percentile CPI-at-risk (left tail) assuming the normal distribution is much smaller than would be the case assuming the student-t distribution, especially in the cases of Indonesia and the Philippines, as before, and also for Korea. For the 5th percentile GDP-at-risk (right tail), assuming the normal distribution shows a much greater risk than assuming the student-t distribution in the case of Indonesia and, to a lesser extent, the other countries.

Table 7 presents the results of the simple panel probit estimation for the tails of good outcomes in the price-level and output gaps. In contrast with the earlier results in Table 2, two general observations can be made: (i) There are very few statistically significant coefficients on the dummy variables for asset price booms; and (ii) The few significant coefficients are typically significant only at a lag of 4 quarters or 1 year. In particular, a housing boom larger than 10 percent that occurred a year ago affects the probability at the margin that the price level will be significantly below trend or that output will be significantly above trend. An equity boom does not generally affect the probability at the margin that the price level will be significantly below trend while one that occurred a year ago affects the probability at the margin that output will be significantly higher than trend. The latter finding is compatible with the earlier one in Table 2 that an equity boom that occurred a year ago lowers the probability that the level of output will be much lower than trend.

In short, the extent to which asset price booms raise the risk at the margin of outcomes either in the left tail of the price-level gap where the price level is significantly below trend, or the right tail of the GDP gap, where output is significantly higher than trend, is much lower than the previous results obtained for the tails of bad outcomes. These findings suggest that at the margin, the risk of the occurrence of tail events due to asset price booms is largely asymmetric: at the margin, bad outcomes are more likely to occur than good outcomes.

3.5 GDP-at-Risk and Price-Level-at-Risk Based on the Empirical Density, Unconditional versus Conditional on Asset Price Booms

As the previous results show that asset price booms affect the probability at the margin that the output- and price-level gap will be in the tails of bad outcomes, we presume that forecasts of GDP and price-level gaps conditioned on asset price booms will differ from those that are not. To verify this, we examine the behavior of the tails of the empirical distribution of the output- and price-level gaps conditional on asset price booms, and compare these with the values at the 5th quantile of the unconditional forecasts for both variables. We plot the 5 percent GDP-at-risk or price-level-at-risk 4, 8 and 12 quarters ahead following a housing or equity boom at different threshold levels. The results are shown in Figure 7.

In Figure 7, the horizontal axis of each graph shows different threshold levels or minimum sizes of the asset price deviation from trend. The vertical axis shows the expected outcomes or the values at the 5th quantile of GDP-at-risk or price-level-at-risk in a particular tail of their respective distributions. The horizontal broken line in the graph is the unconditional forecast. It is quite apparent from Figure 7 that the unconditional forecasts of GDP-at-risk and price-level-at-risk based on the empirical distribution are quite different from those obtained conditional on asset price booms for different forecast horizons.

The upper graph panels in Figure 7 report the 5 percent GDP-at-risk (left tail) 4, 8 and 12 quarters ahead conditional on either a housing or equity boom. The values for GDP-at-risk conditioned on housing booms are for much lower output than trend compared with the unconditional at all forecast horizons. The graphs conditioned on a housing boom are always below the unconditional 5 percent GDP-at-risk of -4.72 percent. This means that housing booms predict an increase in the risk of much lower output relative to trend in the future. For example, if housing prices are at least 10 percent above trend, the value of the 5th percentile GDP-at-risk 4 quarters into the future is -8.16 percent below trend, while that 12 quarters into the future is -5.34 percent below trend. These are both lower than the unconditional estimate, and in the case of the 4-quarter-ahead forecast, almost twice as low. Indeed, the plots of GDP-at-risk 4 and 8 quarters ahead diverge further from the unconditional mean as housing booms get larger.

The 8- and 12-quarter-ahead forecasts for GDP-at-risk conditioned on an equity boom predict much lower output, but the 4-quarter-ahead forecast does not as the latter graph is above that of the unconditional forecast. The latter finding is consistent with the earlier probit findings, which suggest that asset booms are likely to continue and the horizon for the collapse of equity prices and any adverse effect on GDP is beyond 4 quarters. As before, equity booms generally give rise to mixed outcomes, here depending on the forecast horizon.

As Cecchetti points out, some central bankers may care about prices rising while others may care about prices falling. Hence, we examine values of the conditional forecasts of either the left or right tail of the CPI gap and compare these with the value at the 5th quantile of the unconditional forecast. The middle graphs in Figure 7 show the 5 percent price-level-at-risk (left tail) of the price level falling below trend 4 , 8 and 12 quarters ahead conditional on a housing or equity boom compared to the unconditional forecast. Similar to Cecchetti's results, we find that with a housing boom, the risk of the price-level falling significantly below trend is largely eliminated at the 12-quarter horizon. However, the opposite is true in the cases of the 4- and 8-quarter horizons. Hence, not conditioning the forecast of the CPI gap on the occurrence of a housing boom underestimates this extreme deflationary outcome.

Conditioning on an equity boom also largely eliminates the risk of the price level falling significantly below trend in the 8- and 12-quarter-ahead forecasts, as seen in Figure 7, centre right-hand panel. Hence, not conditioning on an equity boom overestimates the extent of the deflationary impact on the CPI gap. The results for the 4-quarter-ahead forecast are somewhat different in that the conditional forecast is below the unconditional forecast, implying that the unconditional forecast underestimates the deflationary impact of the price level falling below trend.

The bottom graphs in Figure 7 report the 5 percent price-level-at-risk (right tail) 4, 8 and 12 quarters ahead conditional on a housing boom or an equity boom at the different asset boom thresholds indicated on the horizontal axis of the graph. Here, the value of the unconditional forecast is 5.63 percent, meaning that without taking into account asset price booms in the past, the expected loss is that the price level will be about 5.63 percent above its trend. Conditioning the forecast for the price-level gap on a housing boom predicts a greater loss. The price level will be very much higher than trend 4, 8 and 12 quarters ahead. The 4-quarter-ahead forecast is initially close to the unconditional forecast, but diverges from it when housing prices exceed their trend by more than 6 percent or greater. Indeed, when housing booms are very large, the 4-quarter-ahead price-level at risk of prices rising above its trend converges to the 8- and 12-quarter-ahead forecasts.[14]

As for an equity boom, the bottom right-hand panel of Figure 7 shows that both the 4- and 8-quarter-ahead forecasts of the 5 percent price-level-at risk of prices rising above trend are fairly close to the unconditional forecast until a threshold level of about 8 percent for asset prices being above trend. Beyond this threshold

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[14] Of course, in all cases, the caveat that there are fewer booms at higher threshold levels applies.

level, the conditional forecast predicts an explosive price-level gap the larger the equity boom.

3.6 GDP-at-Risk and Price-Level-at-Risk Conditioned on Asset Price Booms, Based on the Empirical versus the Normal Distribution

Even if a central banker had conditioned forecasts of both GDP-at-risk and price-level-at-risk on asset booms but used a normal approximation to do so, would he or she have had very different expected outcomes compared to those based on the empirical distribution? The answer is yes.

Figure 8 compares the 5th percentile GDP-at-risk and price-level-at-risk using a normal approximation versus the empirical distribution, both conditional on a housing boom. Figure 9 shows the same but conditional on an equity boom. The 4-, 8- and 12-quarter-ahead forecasts are obtained for both variables for the different threshold levels of the asset price boom shown on the horizontal axis of the graphs. As is quite obvious, the expected outcomes using the normal approximation are quite different from those obtained from the empirical distribution.

The top graph panels of Figure 8 show the 5th percentile values of GDP-at-risk at the different forecast horizons conditional on housing booms. In all cases, the normal approximation presents a more optimistic picture compared with the empirical distribution. The expected outcomes based on the normal approximation are generally above those based on the empirical distribution. Conditional on a housing boom greater than 10 percent, for example, the 4-quarter-ahead GDP-at-risk is for real output to be below trend by -6.85 percent while the forecast based on the empirical density is for real output to be below trend by -8.16 percent. The 8-quarter-ahead forecast is somewhat different from the 4-and 12-quarter-ahead forecasts as larger-sized housing booms, or those larger than 12 percent, lead to a very large divergence between expected GDP-at-risk outcomes obtained using the normal approximation and those from the empirical distribution. While both the 4- and 8-quarter-ahead forecasts based on the empirical distribution are for real output to be very much lower than trend, especially when there are very large booms in housing prices, the 8-quarter-ahead forecast based on the normal approximation does not capture this large expected decline in real output. In contrast, the 12-quarter-ahead forecast based on the normal distribution, at least beyond the 17 percent threshold, overestimates GDP-at-risk. At the 12-quarter horizon, GDP-at-risk becomes relatively stable based on the empirical distribution.

The graphs in the middle part of Figure 8 show the 5th percentile values at different forecast horizons of the risk of the price level falling very substantially below trend conditional on a housing boom. Again, the expected outcomes obtained using the normal approximation are all above those obtained using the empirical distribution. The normal approximation once again paints a more optimistic picture by underestimating the extent of deflation. The 8-quarter-ahead forecasts at different threshold levels are again different from the 4- and 12-quarter-ahead forecasts in that they are more volatile and, where available, the forecasts conditioned on a very large housing boom of about 15 percent or more are closer to the forecasts based on the normal approximation. Generally, however, larger housing booms yield even larger underestimates of the risk of the price level falling below its trend based on the empirical distribution compared with those obtained using the normal approximation.

The bottom graph panels of Figure 8 show the 5th percentile values at different forecast horizons of the risk of the price level being very substantially above trend conditional on a housing boom. Here, the expected outcomes based on the normal approximation are generally below those obtained from the empirical distribution. Once again, those based on the normal approximation are more optimistic and tend to underestimate the extent to which the price level will be very much above its trend conditional on a housing boom. In general, larger-sized housing booms, such as those above 8 or 9 percent, lead to the expectation that the price level will be very much above its trend based on the empirical distribution. In contrast, the expected outcomes based on the normal approximation hardly change.

The graphs in the top part of Figure 9 show the 5th percentile values of GDP-at-risk at the different forecast horizons conditional on equity booms. The normal approximation provides a more optimistic picture and underestimates the degree to which real output will be below its trend at the 8- and 12-quarter horizons, but this is not the case at the 4-quarter horizon. In the latter case, the decline in real output below its trend is overestimated when the normal approximation is used.

The centre graph panels of Figure 9 show the 5th percentile values of the risk of the price level falling very substantially below trend conditional on equity booms. Here, the expected outcomes obtained using the normal approximation are generally more optimistic than those based on the empirical distribution, especially for larger equity booms. Specifically, this is the case for equity booms larger than 5 percent at the 8-quarter horizon, and larger than 8 percent at the 12-quarter horizon. The graph using the normal is generally above that for the empirical distribution. However, the expected outcomes for the price level being very substantially below trend are more mixed and less clear for the 4-quarter horizon using the normal approximation compared with the empirical distribution.

The bottom graph panels of Figure 9 show the 5th percentile values of the risk of the price level rising very substantially above trend conditional on equity booms.

Using the normal approximation, the graphs at the 4- and 12-quarter horizons exhibit mixed findings, while that for the 8-quarter horizon becomes explosive when equity booms become larger than 11 percent above trend, compared with the empirical distribution. When equity prices exceed their trend by between 10 and about 16 percent, however, the expected outcomes for the risk of the price level being substantially above its trend 4 quarters ahead using the normal approximation are generally more pessimistic than below or above these threshold levels. In general, equity booms give more mixed and, therefore, less clear expected outcomes for both real output and the price level relative to their trends compared with housing booms.

4 Conclusions and Policy Implications

The main contribution of this study to the existing literature on the relevance of asset prices for monetary policy is to provide empirical evidence for the proposition that asset price booms matter because they affect the probability of the occurrence of adverse extreme macroeconomic developments in the case of 8 East Asian countries. Whereas previous studies of the importance of asset prices for monetary policy focus on whether or not asset prices play a role in affecting the *means* of variables of interest such as inflation and output, the findings of this study suggest that looking at what happens to the tails of the distribution may also be important.

Indeed, this study finds that asset price booms raise the risk at the margin that outcomes of heavy losses will be realized.[15] Hence, the findings may present a challenge to how a simple quadratic loss minimizing framework can take into account the risks of extreme outcomes. The main implication of the study is to suggest that optimal monetary policy probably cannot be captured by a simple rule that is invariant to the probability of extreme events. In practice, monetary authorities do seem to make judgments about the probability of such events, and when risks are perceived, they do not hesitate to deviate from the simple policy rules derived from a quadratic loss minimizing framework. Whether a more coherent monetary policy framework in the face of such risks would be one based on principles of risk management in which the probabilities of adverse tail events are minimized should be considered.

The problem of how such a risk management approach can be reasonably undertaken, especially in the case of small open economies, is formidable. As Bordo and Jeanne [2002, p. 162] state, the rule paradigm has not developed a well-articulated doctrine as regards tail probability events, and the relationship

[15] This finding is subject to the caveats cited earlier regarding the use of a two-sided filter to identify asset boom episodes.

between monetary policy and financial stability. Even assuming that monetary authorities wish to take into account the heightened probability of tail events from asset booms, critical unsettled issues remain. These issues include the following: (i) the tool box or instruments available to monetary authorities with which to intervene and the timing of such intervention based on an assessment of when asset price booms begin and/or are likely to reverse; (ii) a deeper understanding of the transmission process from asset booms to the macroeconomy given the complex and inherently non-linear relationships among asset prices, financial stability, and monetary policy, and the non-trivial but contrasting outcomes of 'good' and 'bad' booms in real life[16]; and (iii) the nature and extent of the tradeoffs to be made by monetary authorities were they to buy insurance against the probability of bad outcomes and act preemptively, and how these can be communicated to the public in a way that does not undermine the authorities' credibility, create moral hazard, or raise the stakes for political intervention.

For small, open economies in particular, the constraints imposed by the Impossible Trinity apply. In a world with capital mobility and one that is more financially integrated, the ability to use policy interest rates to control inflation, and/or affect certain asset markets in a particular way is not a given. Consistency with the tenets of the Impossible Trinity means recognizing that leaving the exchange rate alone can cool an overheating economy or prevent asset bubbles from developing. But allowing domestic currency appreciation to slow capital inflows and prevent asset bubbles from forming is no less a blunt instrument for small, open economies than the interest rate is for developed countries.[17] The potential tradeoffs involved in doing so are perhaps severe enough to make a country like Thailand contemplate the imposition of capital controls, as it did recently. Hence, while allowing more flexibility in the exchange rate is an option, it is not the only one.

The links among capital inflows, underestimation of risk and bank lending to the real estate sector on the basis of collateral value, real estate booms and then bursting bubbles and recession is less controversial in East Asia than in the West given the experience of the Asian Crisis. The problem at the time stemmed from trying to fix the exchange rate and control inflation in an environment where capital markets had been liberaliszed without adequate financial supervision having been put in place. But this does not take away from the fact that much of the inflows went through the banking system and into the real estate sector,

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[16] See Detken and Smets [2003].

[17] In this study, the effects of real currency depreciation on the risk of tail events vary depending on when real depreciation occurs. Recent episodes of real currency appreciation raise the risk of tail events occurring, but more distant episodes do the opposite.

creating an asset boom. An asset boom in a non-tradeable sector led to real currency overvaluation and problems in the real sector and external accounts. Apart from greater exchange rate flexibility and currency appreciation in the face of large capital inflows, which can be used to reduce inflows and prevent real estate and other asset booms from forming, monetary authorities should also continue their efforts at strengthening bank supervision and regulatory frameworks. As Collyns and Senhadji [2003] point out, Hong Kong, Malaysia, and Singapore survived the real estate fallout prior to the Asian Crisis and minimized damage to their economies. But they also point out that these countries had relatively strong banking regulatory frameworks even before the Asian Crisis and the authorities acted decisively to contain the adverse effects when the bubbles burst.

In the end, price stability does not seem to be enough. A low, stable inflation environment has not simultaneously brought about financial stability and a more stable asset price environment.[18] This study implies that asset price booms are unlikely to have benign effects on the economy and can compromise the goals of monetary policy. While loose monetary policy may not be the reason for asset booms in East Asia today, large capital inflows might be. Countries in East Asia are faced with large capital inflows once again and are using a variety of methods to deal with them, including some sterilization, prepaying of foreign debt, liberalization of capital outflows, etc. There is room for more research on whether these and other measures deal sufficiently with the risk of extreme outcomes.

[18] Filardo [2004].

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Figure 1: QQ Plots, CPI Gap

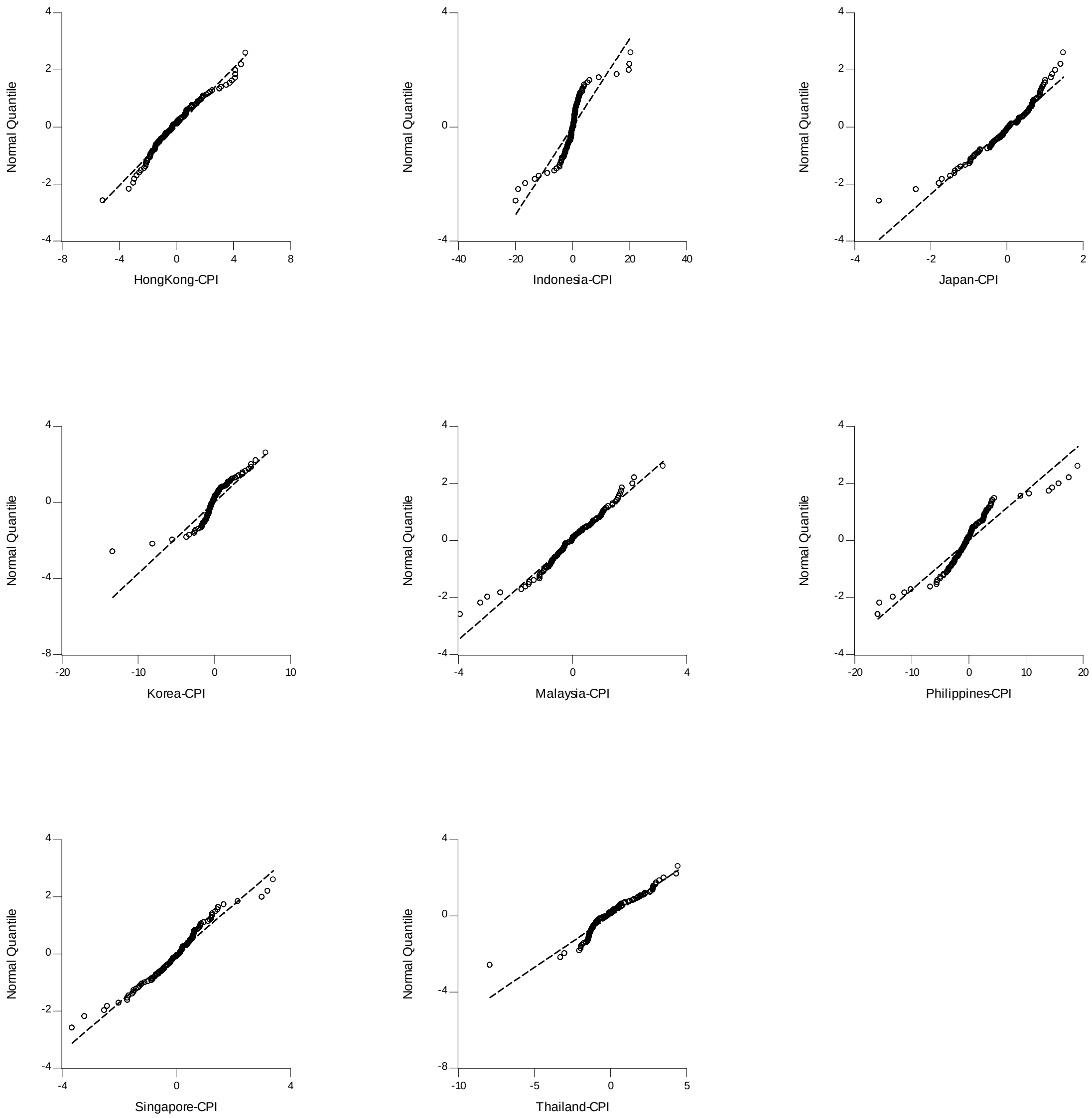


Figure 2: QQ Plots, GDP Gap

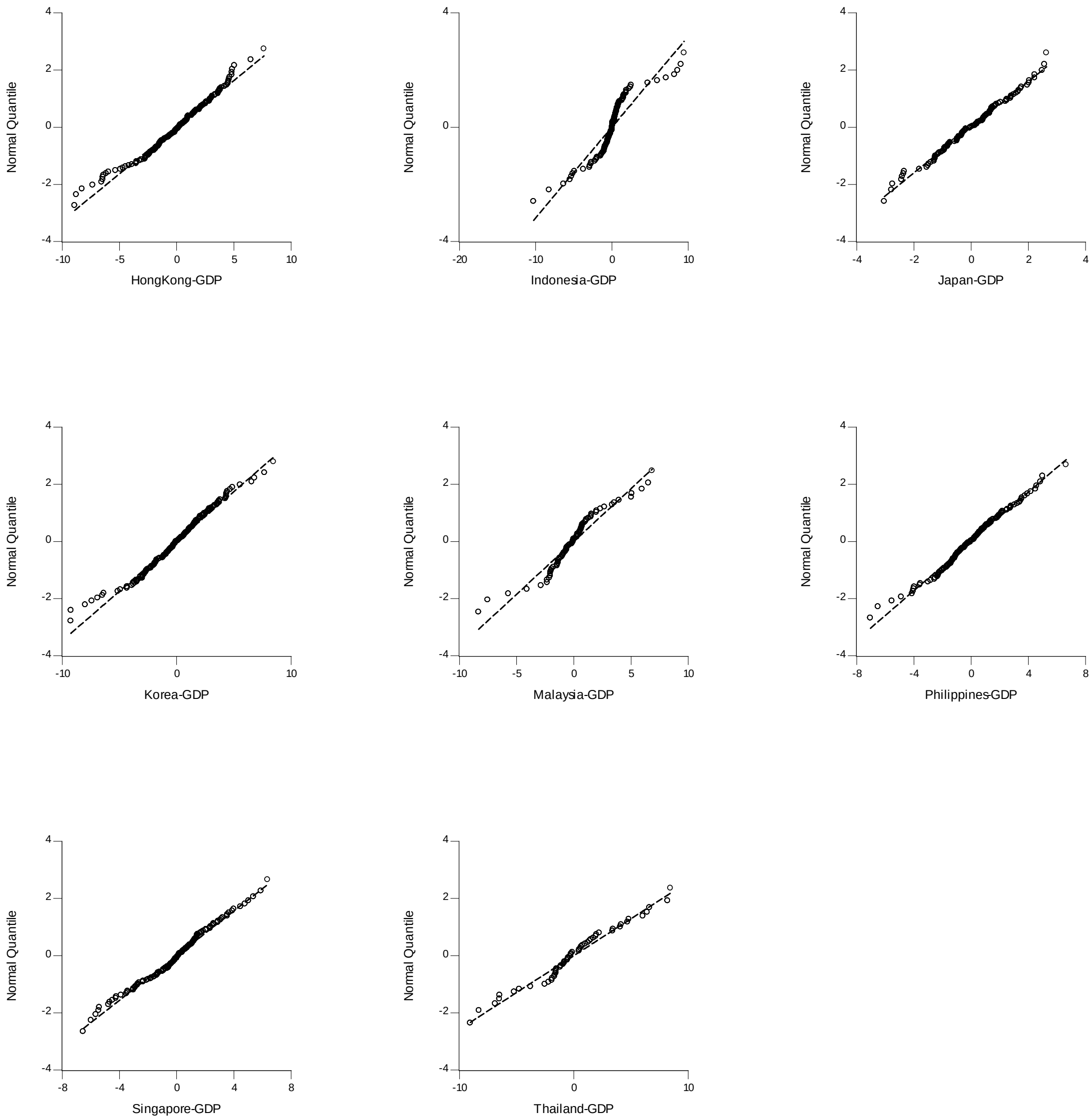
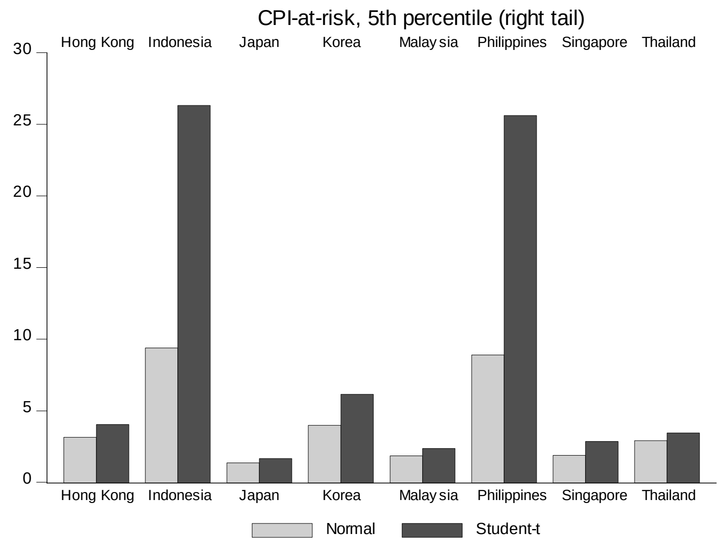


Figure 3:
GDP-at-risk and CPI-at-risk
Normal vs. student-t distribution approximation



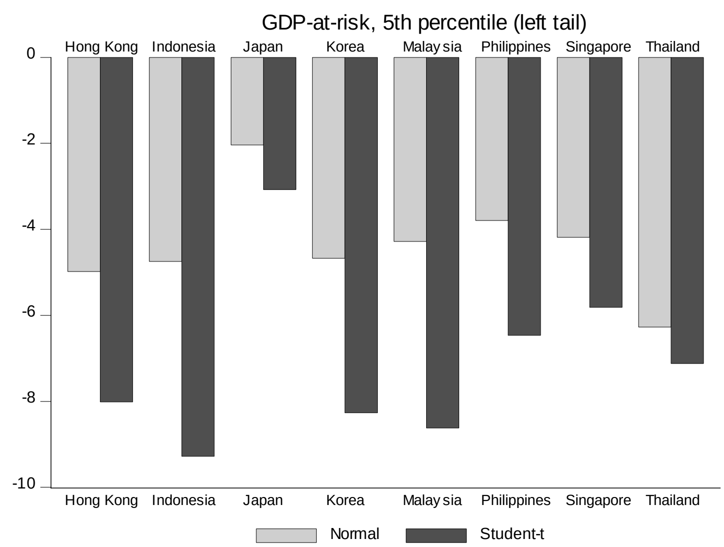


Figure 4:
Graph of Actual Log Real Housing Price and its HP Trend
Shaded boom periods of >10 percent above trend

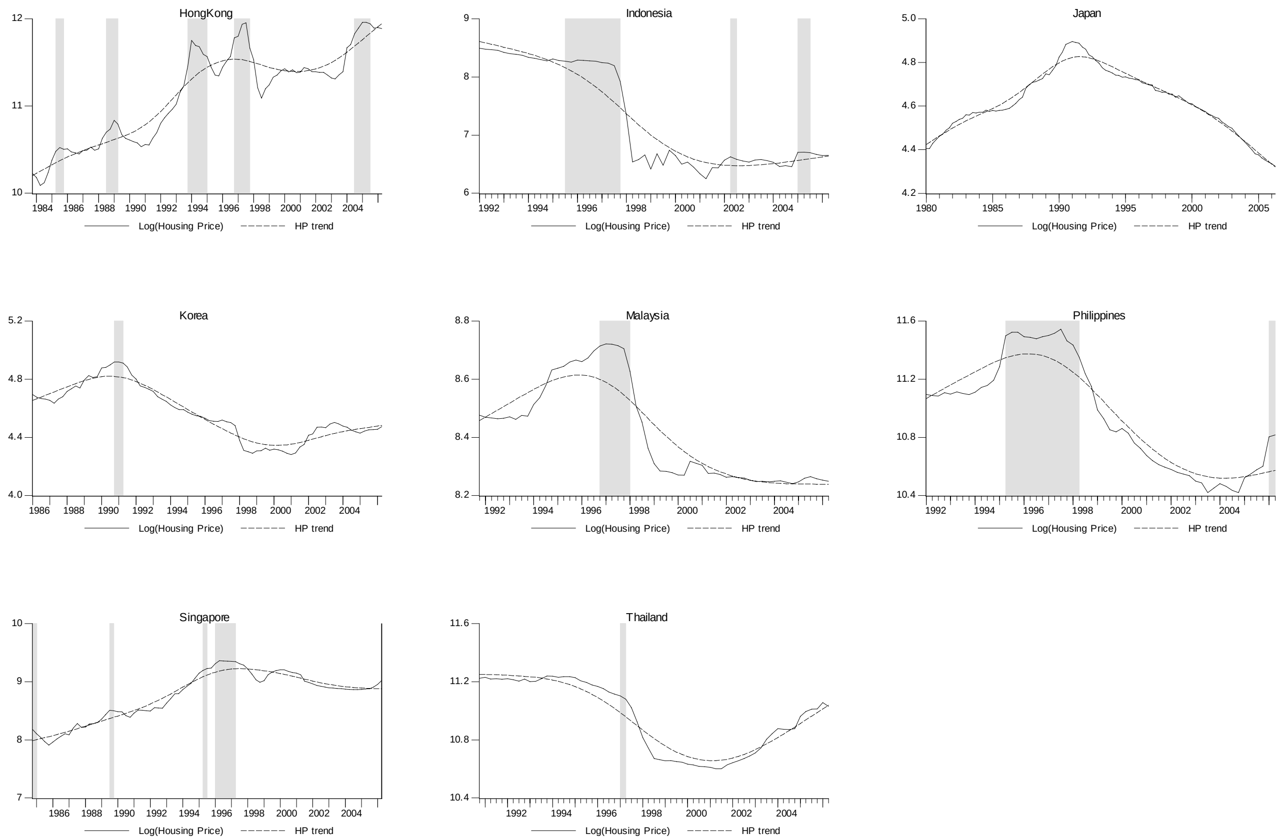


Figure 5:
Graph of Actual Log Real Equity Price and its HP Trend
Shaded boom periods of >10 percent above trend

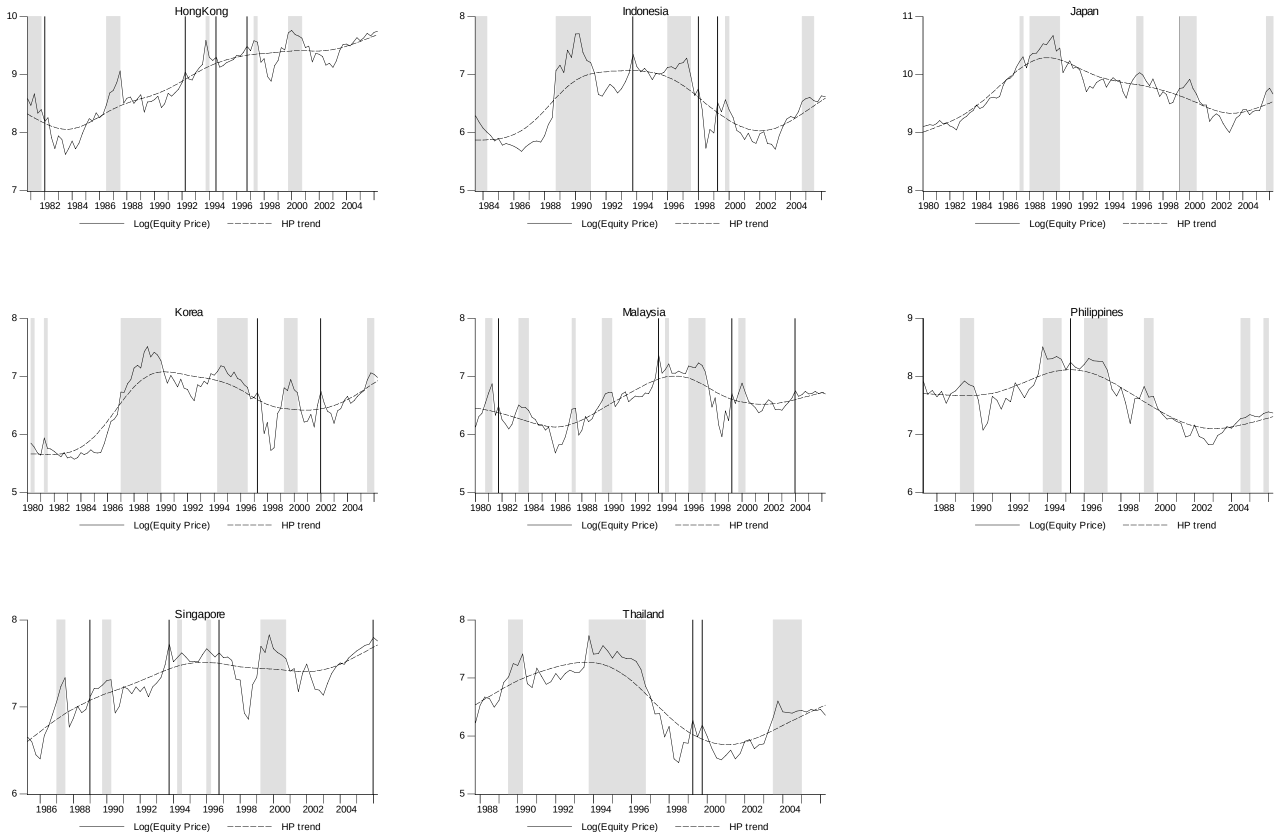
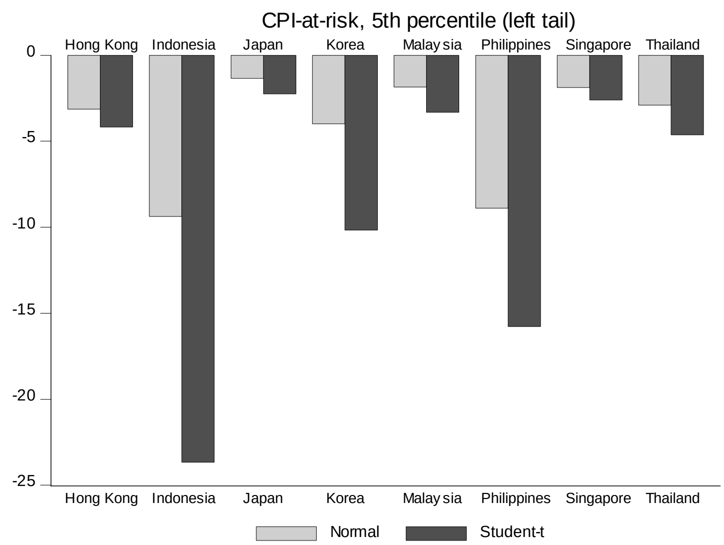


Figure 6:
GDP-at-risk and CPI-at-risk
Normal vs. student-t distribution approximation



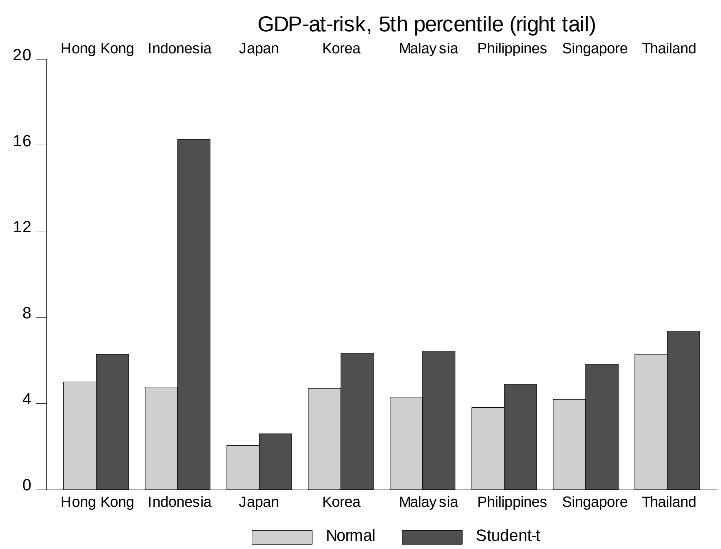


Figure 7: Empirical Distribution
Price-level at-risk and GDP-at-risk conditional on asset price booms

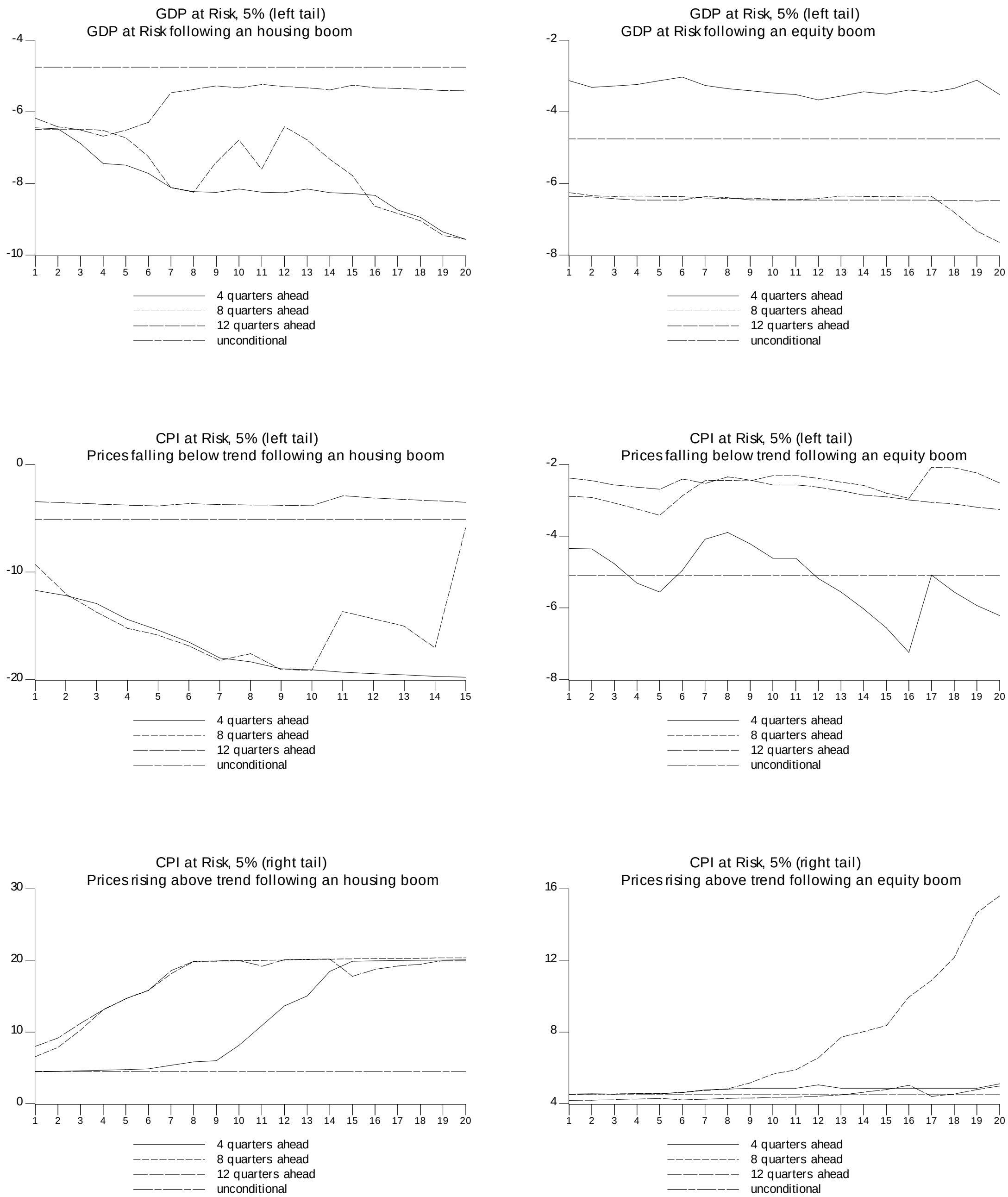


Figure 8:
Normal vs. Empirical Distribution
Price-level-at-risk and GDP-at-risk conditional on a housing boom

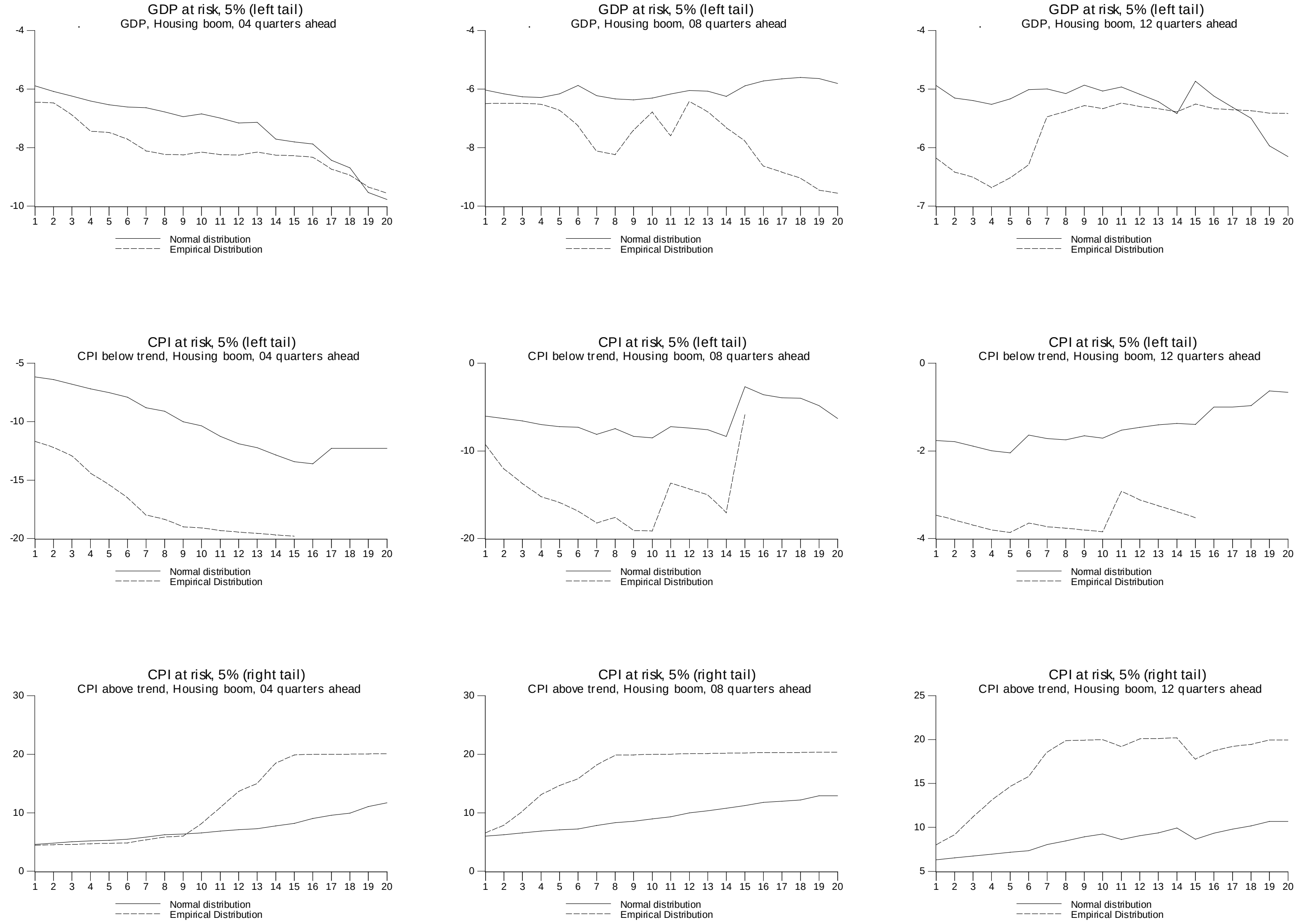


Figure 9:
Normal vs. Empirical Distribution
Price-level-at-risk and GDP-at-risk conditional on an equity boom

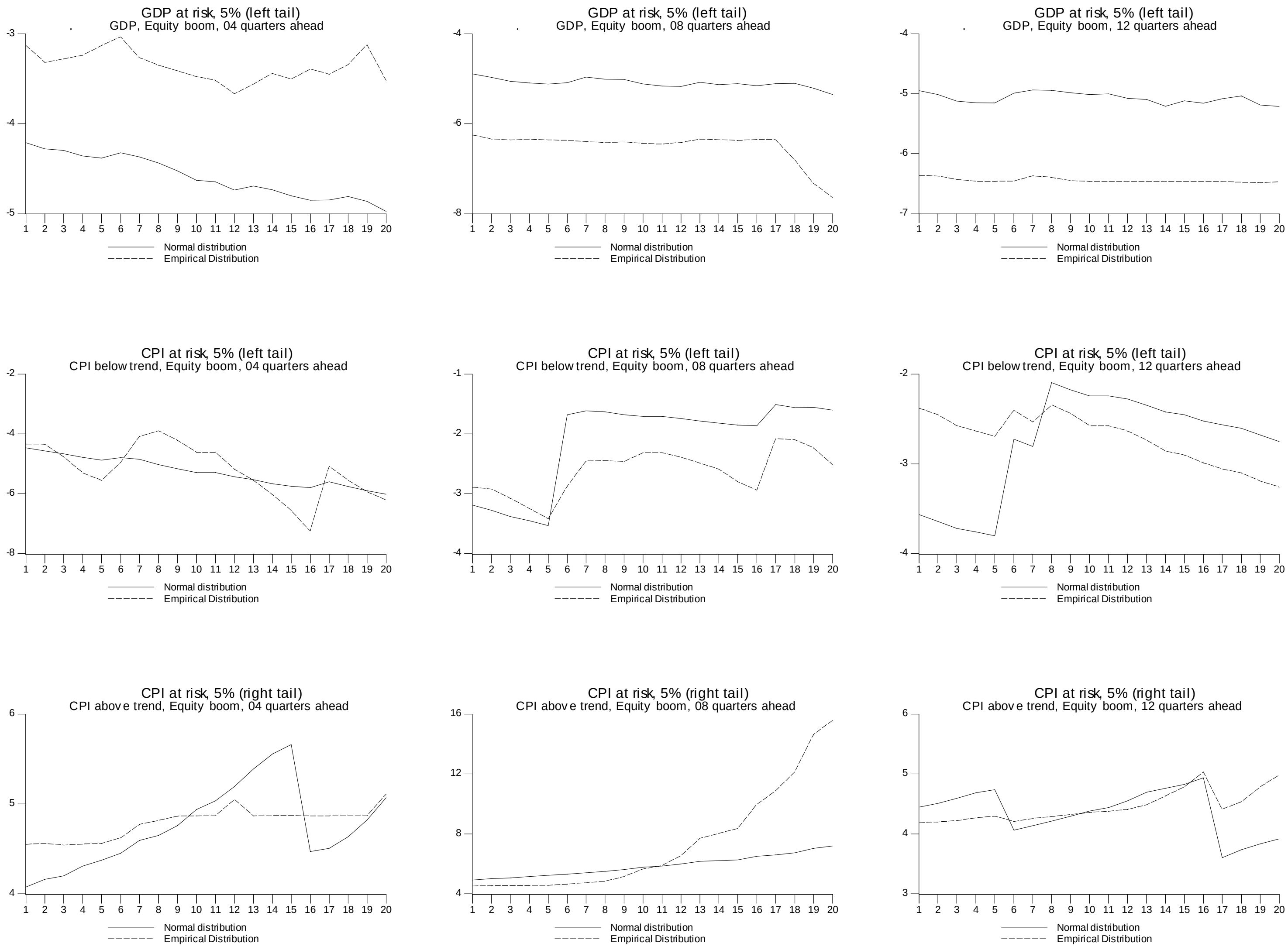


Table 1

CPI gap	Skewness	Kurtosis	Jarque-Bera	Probability	Number of Observations
Hong Kong	0.47	3.14	3.94	0.14	103
Indonesia	0.28	8.83	151.42	0.00	106
Japan	-0.98	4.70	29.62	0.00	106
Korea	-1.40	11.90	384.79	0.00	106
Malaysia	-0.42	4.33	10.95	0.00	106
Philippines	0.64	6.60	64.57	0.00	106
Singapore	-0.12	4.55	10.85	0.00	106
Thailand	-0.25	5.82	36.19	0.00	106

GDP gap	Skewness	Kurtosis	Jarque-Bera	Probability	Number of Observations
Hong Kong	-0.50	3.44	8.09	0.02	162
Indonesia	0.35	6.94	70.74	0.00	106
Japan	-0.11	2.75	0.48	0.79	106
Korea	-0.29	4.21	14.03	0.00	186
Malaysia	-0.08	5.08	13.45	0.00	74
Philippines	-0.10	3.64	2.51	0.29	134
Singapore	-0.18	3.11	0.78	0.68	126
Thailand	-0.05	3.20	0.11	0.95	54

Table 2:
Simple Panel Probit

Asset price deviation from trend:		> 0%		>5%		> 10%		> 15%		> 20%	
	lags	coef	p-value	coef	p-value	coef	p-value	coef	p-value	coef	p-value
CPI Gap, right tail											
Housing	4	0.43	**0.04**	0.86	**0.00**	1.06	**0.00**	1.28	**0.00**	1.83	**0.00**
	8	0.68	**0.00**	0.76	**0.00**	0.86	**0.00**	1.31	**0.00**	1.81	**0.00**
	12	0.85	**0.00**	1.28	**0.00**	1.06	**0.00**	1.01	**0.00**	1.39	**0.00**
	16	0.47	**0.03**	0.68	**0.00**	0.69	**0.00**	0.82	**0.00**	1.15	**0.00**
Equity	4	0.15	0.37	0.18	0.27	0.28	0.10	0.32	**0.08**	0.20	0.33
	8	0.92	**0.00**	0.79	**0.00**	0.68	**0.00**	0.70	**0.00**	0.61	**0.00**
	12	0.26	0.17	0.36	**0.05**	0.41	**0.03**	0.49	**0.01**	0.43	**0.04**
	16	0.26	0.20	0.25	0.20	0.09	0.68	0.13	0.55	-0.09	0.73
GDP Gap, left tail											
Housing	4	0.26	0.13	0.55	**0.00**	0.66	**0.00**	0.85	**0.00**	0.88	**0.01**
	8	1.27	**0.00**	0.99	**0.00**	1.00	**0.00**	1.13	**0.00**	1.87	**0.00**
	12	0.61	**0.00**	0.72	**0.00**	0.38	0.11	0.50	0.09	1.00	**0.00**
	16	0.29	0.14	0.40	**0.05**	0.23	0.36	0.05	0.90	0.06	0.91
Equity	4	- 0.53	**0.00**	-0.57	**0.01**	-0.36	0.09	-0.32	0.17	-0.28	0.28
	8	0.57	**0.00**	0.56	**0.00**	0.52	**0.00**	0.48	**0.01**	0.55	**0.00**
	12	0.77	**0.00**	0.78	**0.00**	0.78	**0.00**	0.81	**0.00**	0.69	**0.00**
	16	0.54	**0.00**	0.51	**0.00**	0.40	**0.02**	0.43	**0.02**	0.35	0.08

Table 3:
Expanded Probit Results, CPI Gap, right tail

	Housing		Equity		Exchange Rate		Oil price		Money		GDP	
	coef	p-val	coef	p-val	Coef	p-val	coef	p-val	coef	p-val	coef	p-val
Asset price deviation from trend > 0%												
Lags: 4	0.42	**0.05**	0.10	0.65	-	-	-	-	-	-	-	-
8	0.58	**0.02**	0.80	**0.01**	-	-	-	-	-	-	-	-
12	0.84	**0.00**	0.09	0.70	-	-	-	-	-	-	-	-
16	0.44	**0.05**	0.20	0.39	-	-	-	-	-	-	-	-
4	0.26	0.15	-	-	0.04	**0.01**	-0.01	0.10	0.00	0.86	0.17	**0.01**
8	-0.16	0.62	-	-	0.00	0.82	0.00	0.46	0.00	0.98	0.27	**0.00**
12	0.41	0.26	-	-	-0.07	**0.00**	-0.01	0.15	-0.07	**0.01**	0.08	0.11
16	0.50	0.07	-	-	-0.03	**0.04**	-0.01	0.23	-0.07	**0.04**	-0.02	0.53
4	-	-	0.06	0.76	0.04	**0.01**	-0.01	0.27	0.01	0.72	0.20	**0.00**
8	-	-	0.74	**0.04**	0.00	0.94	0.00	0.47	0.01	0.55	0.25	**0.00**
12	-	-	-0.41	0.11	-0.07	**0.00**	-0.01	0.06	-0.03	**0.01**	0.11	**0.01**
16	-	-	0.21	0.38	-0.03	**0.04**	0.00	0.28	-0.03	**0.00**	-0.02	0.50
4	0.26	0.15	0.19	0.38	0.04	**0.01**	-0.01	0.08	-0.01	0.80	0.17	**0.01**
8	-0.18	0.58	0.62	0.09	0.00	0.97	0.00	0.38	0.00	0.94	0.26	**0.00**
12	0.43	0.25	-0.45	0.12	-0.08	**0.00**	0.00	0.30	-0.06	**0.01**	0.09	0.09
16	0.47	0.08	0.25	0.37	-0.03	0.07	-0.01	0.21	-0.08	**0.03**	-0.02	0.48
Asset price deviation from trend > 5%												
Lags: 4	0.86	**0.00**	0.08	0.72	-	-	-	-	-	-	-	-
8	0.67	**0.00**	0.67	**0.00**	-	-	-	-	-	-	-	-
12	1.27	**0.00**	0.13	0.60	-	-	-	-	-	-	-	-
16	0.66	**0.00**	0.17	0.45	-	-	-	-	-	-	-	-
4	0.94	**0.00**	-	-	0.04	**0.01**	-0.01	0.08	0.00	0.89	0.12	0.06
8	-0.34	0.35	-	-	-0.01	0.78	0.00	0.49	0.00	0.98	0.29	**0.00**
12	0.94	**0.01**	-	-	-0.07	**0.00**	-0.01	0.12	-0.07	**0.01**	0.03	0.54
16	0.76	**0.01**	-	-	-0.03	**0.05**	-0.01	0.21	-0.07	**0.03**	-0.04	0.17
4	-	-	0.10	0.65	0.04	**0.01**	-0.01	0.27	0.01	0.72	0.20	**0.00**
8	-	-	0.50	0.07	0.00	0.88	0.00	0.60	0.01	0.57	0.24	**0.00**
12	-	-	-0.25	0.31	-0.07	**0.00**	-0.01	0.06	-0.03	**0.01**	0.10	**0.02**
16	-	-	0.21	0.39	-0.03	**0.04**	0.00	0.28	-0.03	**0.00**	-0.02	0.49
4	0.97	**0.00**	0.29	0.23	0.04	**0.01**	-0.01	0.06	0.00	0.98	0.11	0.07
8	-0.32	0.38	0.35	0.24	0.00	0.88	0.00	0.45	0.00	0.89	0.28	**0.00**
12	0.92	**0.01**	-0.20	0.49	-0.07	**0.00**	-0.01	0.23	-0.06	**0.01**	0.04	0.46
16	0.76	**0.01**	0.26	0.38	-0.02	0.09	-0.01	0.18	-0.08	**0.03**	-0.04	0.14

Table 3, cont.
Expanded Probit Results, CPI Gap, right tail

	Housing		Equity		Exchange Rate		Oil price		Money		GDP	
	coef	p-val	coef	p-val	coef	p-val	coef	p-val	coef	p-val	coef	p-val
Asset price deviation from trend > 10%												
Lags: 4	1.04	**0.00**	0.19	0.41	-	-	-	-	-	-	-	-
8	0.78	**0.00**	0.54	**0.01**	-	-	-	-	-	-	-	-
12	1.04	**0.00**	0.31	0.18	-	-	-	-	-	-	-	-
16	0.72	**0.00**	-0.04	0.85	-	-	-	-	-	-	-	-
4	1.16	**0.00**	-	-	0.04	**0.00**	-0.01	0.12	-0.01	0.70	0.14	**0.03**
8	0.04	0.89	-	-	0.00	0.87	0.00	0.44	0.00	0.94	0.25	**0.00**
12	0.60	**0.05**	-	-	-0.06	**0.00**	-0.01	0.09	-0.08	**0.00**	0.09	**0.03**
16	0.70	**0.01**	-	-	-0.02	0.08	-0.01	0.23	-0.08	**0.02**	-0.01	0.82
4	-	-	0.20	0.38	0.04	**0.00**	-0.01	0.27	0.00	0.76	0.19	**0.00**
8	-	-	0.07	0.78	-0.01	0.76	0.00	0.61	0.01	0.47	0.25	**0.00**
12	-	-	-0.34	0.20	-0.07	**0.00**	-0.01	0.07	-0.03	**0.01**	0.10	**0.01**
16	-	-	0.01	0.96	-0.03	**0.03**	0.00	0.31	-0.03	**0.00**	-0.01	0.66
4	1.19	**0.00**	0.38	0.14	0.05	**0.00**	-0.01	0.09	-0.02	0.52	0.13	**0.04**
8	0.05	0.84	0.01	0.97	0.00	0.90	0.00	0.41	0.00	1.00	0.25	**0.00**
12	0.59	**0.05**	-0.10	0.72	-0.07	**0.00**	-0.01	0.14	-0.08	**0.00**	0.09	**0.02**
16	0.71	**0.01**	-0.04	0.90	-0.02	0.10	-0.01	0.26	-0.08	**0.02**	0.00	0.87
Asset price deviation from trend > 15%												
Lags: 4	1.23	**0.00**	0.37	0.11	-	-	-	-	-	-	-	-
8	1.21	**0.00**	0.67	**0.00**	-	-	-	-	-	-	-	-
12	0.94	**0.00**	0.35	0.11	-	-	-	-	-	-	-	-
16	0.84	**0.00**	-0.02	0.92	-	-	-	-	-	-	-	-
4	1.34	**0.00**	-	-	0.04	**0.00**	-0.01	0.14	-0.02	0.48	0.15	**0.02**
8	0.65	**0.01**	-	-	0.00	0.95	0.00	0.36	-0.01	0.72	0.23	**0.00**
12	0.41	0.24	-	-	-0.07	**0.00**	-0.01	0.15	-0.07	**0.00**	0.10	**0.01**
16	0.85	**0.01**	-	-	-0.03	0.07	-0.01	0.28	-0.08	**0.02**	0.00	0.92
4	-	-	0.39	0.09	0.04	**0.00**	-0.01	0.26	0.00	0.83	0.19	**0.00**
8	-	-	0.29	0.22	-0.01	0.79	0.00	0.64	0.01	0.61	0.24	**0.00**
12	-	-	-0.22	0.39	-0.07	**0.00**	-0.01	0.06	-0.03	**0.01**	0.10	**0.01**
16	-	-	0.07	0.79	-0.03	**0.02**	0.00	0.30	-0.03	**0.00**	-0.01	0.63
4	1.34	**0.00**	0.55	0.06	0.05	**0.00**	-0.01	0.09	-0.02	0.32	0.14	**0.04**
8	0.65	**0.01**	0.26	0.31	0.00	0.88	0.00	0.37	-0.02	0.50	0.22	**0.00**
12	0.41	0.23	-0.08	0.79	-0.07	**0.00**	-0.01	0.19	-0.07	**0.01**	0.11	**0.00**
16	0.86	**0.01**	-0.04	0.90	-0.03	0.07	0.00	0.29	-0.08	**0.02**	0.00	0.95

Table 3, cont.
Expanded Probit Results, CPI Gap, right tail

	Housing		Equity		Exchange Rate		Oil price		Money		GDP	
	coef	p-val	coef	p-val	coef	p-val	coef	p-val	coef	p-val	coef	p-val
Asset price deviation from trend > 20%												
Lags: 4	1.77	**0.00**	0.19	0.48	-	-	-	-	-	-	-	-
8	1.64	**0.00**	0.58	**0.01**	-	-	-	-	-	-	-	-
12	1.31	**0.00**	0.23	0.35	-	-	-	-	-	-	-	-
16	1.24	**0.00**	-0.36	0.36	-	-	-	-	-	-	-	-
4	2.11	**0.00**	-	-	0.05	**0.00**	-0.01	0.06	-0.01	0.53	0.14	**0.03**
8	0.92	**0.00**	-	-	0.00	0.95	0.00	0.53	0.00	0.87	0.22	**0.00**
12	0.50	0.15	-	-	-0.07	**0.00**	-0.01	0.14	-0.07	**0.00**	0.10	**0.01**
16	1.22	**0.00**	-	-	-0.02	0.08	-0.01	0.27	-0.08	**0.02**	-0.01	0.69
4	-	-	0.38	0.14	0.04	**0.00**	-0.01	0.27	0.00	0.86	0.19	**0.00**
8	-	-	0.13	0.59	-0.01	0.81	0.00	0.61	0.01	0.52	0.25	**0.00**
12	-	-	-0.31	0.26	-0.07	**0.00**	-0.01	0.06	-0.03	**0.02**	0.10	**0.01**
16	-	-	-0.15	0.65	-0.03	**0.02**	0.00	0.33	-0.03	**0.00**	-0.01	0.77
4	2.08	**0.00**	0.60	0.08	0.05	**0.00**	-0.02	**0.04**	-0.02	0.30	0.14	**0.04**
8	0.92	**0.00**	0.14	0.56	0.00	0.88	0.00	0.50	-0.01	0.71	0.22	**0.00**
12	0.53	0.13	-0.24	0.46	-0.07	**0.00**	-0.01	0.15	-0.07	**0.01**	0.11	**0.00**
16	1.26	**0.00**	-0.38	0.41	-0.03	0.06	-0.01	0.28	-0.08	**0.02**	-0.01	0.87

Table 4:
Expanded Probit Results, GDP Gap, right tail

	Housing		Equity		Exchange Rate		Oil price		Money		GDP	
	coef	p-val	coef	p-val	coef	p-val	coef	p-val	coef	p-val	coef	p-val
Asset price deviation from trend > 0%												
Lags: 4	0.35	**0.04**	-0.64	**0.00**	-	-	-	-	-	-	-	-
8	1.20	**0.00**	0.60	**0.01**	-	-	-	-	-	-	-	-
12	0.49	**0.02**	0.84	**0.00**	-	-	-	-	-	-	-	-
16	0.22	0.27	0.49	**0.03**	-	-	-	-	-	-	-	-
4	0.57	**0.00**	-	-	0.03	**0.00**	0.00	0.90	0.00	0.91	-	-
8	0.90	**0.00**	-	-	-0.08	**0.00**	0.02	**0.00**	0.03	0.43	-	-
12	0.30	0.18	-	-	-0.07	**0.00**	0.01	0.22	-0.02	0.41	-	-
16	0.23	0.26	-	-	-0.02	**0.00**	0.00	0.76	-0.04	0.14	-	-
4	-	-	-0.33	0.06	0.02	**0.04**	0.00	0.83	0.01	0.59	-	-
8	-	-	0.40	0.16	-0.09	**0.00**	0.02	**0.00**	0.01	0.74	-	-
12	-	-	0.71	**0.01**	-0.07	**0.00**	0.00	0.79	-0.01	0.34	-	-
16	-	-	0.43	**0.05**	-0.02	**0.03**	0.00	0.46	-0.02	**0.02**	-	-
4	0.63	**0.00**	-0.49	**0.01**	0.03	**0.01**	0.00	0.92	0.01	0.79	-	-
8	0.86	**0.01**	0.26	0.38	-0.07	**0.00**	0.02	**0.00**	0.02	0.47	-	-
12	0.23	0.31	0.58	**0.03**	-0.06	**0.00**	0.00	0.38	-0.03	0.24	-	-
16	0.18	0.39	0.51	**0.04**	-0.02	0.11	0.00	0.57	-0.05	0.06	-	-
Asset price deviation from trend > 5%												
Lags: 4	0.62	**0.00**	-0.71	**0.00**	-	-	-	-	-	-	-	-
8	0.93	**0.00**	0.60	**0.00**	-	-	-	-	-	-	-	-
12	0.63	**0.00**	0.80	**0.00**	-	-	-	-	-	-	-	-
16	0.36	0.10	0.43	**0.04**	-	-	-	-	-	-	-	-
4	0.90	**0.00**	-	-	0.04	**0.00**	0.00	0.64	-0.01	0.83	-	-
8	0.54	**0.02**	-	-	-0.08	**0.00**	0.02	**0.00**	0.02	0.54	-	-
12	0.28	0.23	-	-	-0.07	**0.00**	0.01	0.22	-0.02	0.44	-	-
16	0.27	0.22	-	-	-0.02	**0.01**	0.00	0.72	-0.04	0.13	-	-
4	-	-	-0.40	**0.05**	0.02	**0.04**	0.00	0.82	0.01	0.54	-	-
8	-	-	0.24	0.31	-0.09	**0.00**	0.02	**0.00**	0.01	0.72	-	-
12	-	-	0.66	**0.00**	-0.07	**0.00**	0.00	0.90	-0.01	0.33	-	-
16	-	-	0.38	0.07	-0.02	**0.03**	0.00	0.42	-0.02	**0.03**	-	-
4	0.91	**0.00**	-0.52	**0.01**	0.03	**0.00**	0.00	0.63	0.01	0.81	-	-
8	0.54	**0.02**	0.24	0.32	-0.08	**0.00**	0.02	**0.00**	0.02	0.60	-	-
12	0.27	0.25	0.57	**0.02**	-0.06	**0.00**	0.00	0.50	-0.03	0.22	-	-
16	0.28	0.22	0.46	**0.05**	-0.02	0.12	0.00	0.46	-0.05	0.06	-	-

Table 4, cont.
Expanded Probit Results, GDP Gap, left tail

	Housing		Equity		Exchange Rate		Oil price		Money		GDP	
	coef	p-val	coef	p-val	coef	p-val	coef	p-val	coef	p-val	coef	p-val
Asset price deviation from trend > 10%												
Lags: 4	0.63	**0.00**	-0.45	**0.04**	-	-	-	-	-	-	-	-
8	0.95	**0.00**	0.53	**0.01**	-	-	-	-	-	-	-	-
12	0.30	0.24	0.81	**0.00**	-	-	-	-	-	-	-	-
16	0.22	0.40	0.37	0.07	-	-	-	-	-	-	-	-
4	0.95	**0.00**	-	-	0.04	**0.00**	0.00	0.88	-0.01	0.65	-	-
8	0.42	0.12	-	-	-0.08	**0.00**	0.02	**0.00**	0.01	0.65	-	-
12	-0.47	0.12	-	-	-0.09	**0.00**	0.01	0.06	-0.02	0.42	-	-
16	0.08	0.78	-	-	-0.03	**0.01**	0.00	0.97	-0.04	0.12	-	-
4	-	-	-0.19	0.36	0.03	**0.02**	0.00	0.74	0.01	0.62	-	-
8	-	-	-0.09	0.66	-0.10	**0.00**	0.02	**0.00**	0.01	0.60	-	-
12	-	-	0.59	**0.01**	-0.07	**0.00**	0.00	0.81	-0.01	0.24	-	-
16	-	-	0.22	0.30	-0.03	**0.02**	0.00	0.49	-0.02	**0.02**	-	-
4	0.91	**0.00**	-0.25	0.27	0.03	**0.00**	0.00	0.80	0.00	0.90	-	-
8	0.43	0.11	-0.07	0.72	-0.08	**0.00**	0.02	**0.00**	0.01	0.65	-	-
12	-0.41	0.17	0.46	**0.05**	-0.08	**0.00**	0.01	0.14	-0.03	0.20	-	-
16	0.12	0.68	0.36	0.11	-0.02	0.08	0.00	0.73	-0.05	**0.05**	-	-
Asset price deviation from trend > 15%												
Lags: 4	0.89	**0.00**	-0.47	**0.05**	-	-	-	-	-	-	-	-
8	1.05	**0.00**	0.46	**0.02**	-	-	-	-	-	-	-	-
12	0.30	0.31	0.90	**0.00**	-	-	-	-	-	-	-	-
16	0.01	0.98	0.47	**0.02**	-	-	-	-	-	-	-	-
4	1.14	**0.00**	-	-	0.04	**0.00**	0.00	1.00	-0.01	0.50	-	-
8	0.64	0.06	-	-	-0.08	**0.00**	0.02	**0.00**	0.01	0.68	-	-
12	-0.40	0.27	-	-	-0.08	**0.00**	0.01	0.07	-0.02	0.45	-	-
16	-0.09	0.82	-	-	-0.03	**0.01**	0.00	0.96	-0.04	0.12	-	-
4	-	-	-0.18	0.44	0.03	**0.02**	0.00	0.73	0.01	0.62	-	-
8	-	-	-0.12	0.59	-0.10	**0.00**	0.02	**0.00**	0.01	0.57	-	-
12	-	-	0.73	**0.00**	-0.07	**0.00**	0.00	0.96	-0.02	0.14	-	-
16	-	-	0.32	0.14	-0.03	**0.01**	0.00	0.42	-0.03	**0.02**	-	-
4	1.19	**0.00**	-0.28	0.20	0.03	**0.00**	0.00	0.79	-0.01	0.76	-	-
8	0.64	**0.05**	-0.15	0.52	-0.09	**0.00**	0.02	**0.00**	0.02	0.61	-	-
12	-0.51	0.17	0.69	**0.00**	-0.08	**0.00**	0.01	0.23	-0.04	0.09	-	-
16	-0.10	0.82	0.49	**0.03**	-0.02	0.06	0.00	0.73	-0.05	**0.04**	-	-

Table 4, cont. Expanded Probit Results, GDP Gap, left tail												
	Housing		Equity		Exchange Rate		Oil price		Money		GDP	
	coef	p-val	coef	p-val	coef	p-val	coef	p-val	coef	p-val	coef	p-val
Asset price deviation from trend > 20%												
Lags: 4	1.14	**0.00**	-0.56	**0.01**	-	-	-	-	-	-	-	-
8	1.75	**0.00**	0.45	**0.04**	-	-	-	-	-	-	-	-
12	0.79	**0.03**	0.66	**0.00**	-	-	-	-	-	-	-	-
16	-0.02	0.97	0.33	0.16	-	-	-	-	-	-	-	-
4	1.42	**0.00**	-	-	0.04	**0.00**	0.00	0.91	-0.01	0.62	-	-
8	1.33	**0.00**	-	-	-0.08	**0.00**	0.02	**0.00**	0.01	0.74	-	-
12	-0.04	0.92	-	-	-0.08	**0.00**	0.01	0.10	-0.02	0.40	-	-
16	-0.18	0.77	-	-	-0.03	**0.01**	0.00	0.95	-0.04	0.13	-	-
4	-	-	-0.02	0.94	0.03	**0.02**	0.00	0.68	0.00	0.70	-	-
8	-	-	-0.11	0.60	-0.10	**0.00**	0.02	**0.00**	0.01	0.55	-	-
12	-	-	0.52	**0.03**	-0.07	**0.00**	0.00	0.66	-0.01	0.20	-	-
16	-	-	0.17	0.47	-0.03	**0.01**	0.00	0.59	-0.02	**0.02**	-	-
4	1.50	**0.00**	-0.21	0.33	0.03	**0.00**	0.00	0.67	0.00	0.85	-	-
8	1.33	**0.00**	-0.14	0.59	-0.09	**0.00**	0.02	**0.00**	0.01	0.65	-	-
12	-0.11	0.82	0.39	0.13	-0.07	**0.00**	0.01	0.14	-0.03	0.17	-	-
16	-0.22	0.73	0.33	0.19	-0.03	**0.03**	0.00	0.98	-0.05	**0.04**	-	-

Table 5:
Probit Estimation - CPI Gap, right tail, with Joint Asset Price Booms

	Dummy for Joint Housing and Equity Booms		Detrended Real Exchange Rate		Detrended Real Oil Price		Detrended Real Money		Detrended Real GDP	
	coef	p-val	coef	p-val	coef	p-val	coef	p-val	coef	p-val
Asset price deviation from trend > 0%										
Lags: 4	0.47	**0.03**	-	-	-	-	-	-	-	-
8	0.93	**0.00**	-	-	-	-	-	-	-	-
12	0.63	**0.00**	-	-	-	-	-	-	-	-
16	0.49	**0.03**	-	-	-	-	-	-	-	-
4	0.52	**0.03**	0.04	**0.01**	-0.01	0.06	-0.01	0.77	0.18	**0.00**
8	0.34	0.24	0.00	0.98	0.00	0.40	0.00	0.91	0.24	**0.00**
12	-0.13	0.69	-0.07	**0.00**	0.00	0.30	-0.07	**0.00**	0.12	**0.01**
16	0.51	0.09	-0.03	0.08	-0.01	0.21	-0.08	**0.02**	-0.01	0.84
Asset price deviation from trend > 5%										
Lags: 4	0.76	**0.00**	-	-	-	-	-	-	-	-
8	1.12	**0.00**	-	-	-	-	-	-	-	-
12	1.00	**0.00**	-	-	-	-	-	-	-	-
16	0.60	**0.02**	-	-	-	-	-	-	-	-
4	0.91	**0.01**	0.04	**0.00**	-0.01	**0.04**	0.00	0.90	0.16	**0.01**
8	0.28	0.40	0.00	0.98	0.00	0.43	0.00	0.96	0.24	**0.00**
12	0.30	0.37	-0.07	**0.00**	-0.01	0.17	-0.07	**0.00**	0.09	**0.04**
16	0.62	0.06	-0.03	0.08	-0.01	0.23	-0.08	**0.02**	-0.01	0.70
Asset price deviation from trend > 10%										
Lags: 4	1.19	**0.00**	-	-	-	-	-	-	-	-
8	1.38	**0.00**	-	-	-	-	-	-	-	-
12	1.19	**0.00**	-	-	-	-	-	-	-	-
16	0.82	**0.01**	-	-	-	-	-	-	-	-
4	1.59	**0.00**	0.05	**0.00**	-0.02	**0.01**	-0.02	0.51	0.19	**0.00**
8	0.68	**0.04**	0.00	0.81	0.00	0.52	-0.01	0.67	0.24	**0.00**
12	0.36	0.32	-0.07	**0.00**	-0.01	0.14	-0.08	**0.00**	0.11	**0.01**
16	0.80	**0.04**	-0.02	0.13	0.00	0.31	-0.08	0.02	0.00	0.98

Table 6:
Probit Estimation - GDP Gap, left tail, with Joint Asset Price Booms

	Dummy for Joint Housing and Equity Booms		Detrended Real Exchange rate		Detrended Real Oil price		Detrended Real Money	
	coef	p-val	coef	p-val	coef	p-val	coef	p-val
Asset price deviation from trend > 0%								
Lags: 4	-0.13	0.52	-	-	-	-	-	-
8	1.18	**0.00**	-	-	-	-	-	-
12	0.94	**0.00**	-	-	-	-	-	-
16	0.31	0.12	-	-	-	-	-	-
4	0.18	0.37	0.03	**0.01**	0.00	0.75	0.00	0.85
8	0.79	**0.00**	-0.07	**0.00**	0.02	**0.00**	0.02	0.49
12	0.55	**0.02**	-0.06	**0.00**	0.00	0.38	-0.02	0.30
16	0.20	0.38	-0.02	**0.01**	0.00	0.83	-0.04	0.12
Asset price deviation from trend > 5%								
Lags: 4	0.03	0.91	-	-	-	-	-	-
8	1.12	**0.00**	-	-	-	-	-	-
12	1.04	**0.00**	-	-	-	-	-	-
16	0.27	0.29	-	-	-	-	-	-
4	0.42	0.12	0.03	**0.00**	0.00	0.71	0.00	0.88
8	0.40	0.10	-0.08	**0.00**	0.02	**0.00**	0.02	0.63
12	0.53	**0.04**	-0.07	**0.00**	0.00	0.35	-0.02	0.32
16	0.09	0.76	-0.03	**0.01**	0.00	0.97	-0.04	0.12
Asset price deviation from trend > 10%								
Lags: 4	0.34	0.29	-	-	-	-	-	-
8	1.35	**0.00**	-	-	-	-	-	-
12	0.66	**0.03**	-	-	-	-	-	-
16	-0.18	0.70	-	-	-	-	-	-
4	0.86	**0.01**	0.03	**0.00**	0.00	0.71	0.00	0.99
8	0.29	0.41	-0.08	**0.00**	0.02	**0.00**	0.01	0.67
12	-0.64	0.12	-0.09	**0.00**	0.01	**0.05**	-0.01	0.55
16	-0.48	0.41	-0.03	**0.01**	0.00	0.83	-0.04	0.14

Table 7:
Simple Panel Probit

Asset price deviation from trend:		> 0%		>5%		> 10%		> 15%		> 20%	
	Lags	coef	p-value	coef	p-value	coef	p-value	coef	p-value	coef	p-value
CPI Gap, left tail,											
Housing	4	0.70	**0.01**	0.83	**0.00**	0.85	**0.00**	0.96	**0.00**	1.56	**0.00**
	8	0.51	**0.03**	0.93	**0.00**	0.48	0.08	0.05	0.92	0.40	0.43
	12	-0.25	0.30	0.12	0.65	0.05	0.88	0.02	0.97	-	-
Equity	4	0.33	0.09	0.36	**0.05**	0.07	0.73	0.22	0.28	-	-
	8	-0.18	0.38	-0.09	0.65	-0.29	0.25	-0.16	0.53	-	-
	12	-0.44	0.06	-0.27	0.24	-0.43	0.14	-0.31	0.30	-	-
GDP Gap, right tail											
Housing	4	1.23	**0.00**	0.85	**0.00**	0.45	**0.05**	0.46	0.11	-	-
	8	0.40	**0.03**	0.25	0.22	-0.05	0.85	-0.27	0.54	-	-
	12	-0.10	0.60	-0.03	0.88	0.08	0.77	0.27	0.39	-	-
Equity	4	1.37	**0.00**	0.94	**0.00**	0.92	**0.00**	0.97	**0.00**	-	-
	8	0.25	0.15	0.26	0.13	0.06	0.75	-0.05	0.81	-	-
	12	0.17	0.34	0.29	0.10	0.07	0.71	0.05	0.79	-	-

Appendix A
Data sources

	Source	Time Period	Frequency	Units
HONG KONG				
Equity Index	HSI index from Bloomberg	1970Q1 – 2006Q3	Quarterly	Index
Housing Prices	Jones Lang La Salle Research	1983Q4- 2006Q2	Quarterly	HKD/m2
GDP	IFS Line 99b	1980Q4- 2006Q2	Quarterly	Billions HKD
Exchange Rate	IFS Line rf	1970Q1- 2006Q2	Quarterly	HKD/1USD
Money Growth	IFS Lines 34-35	1960Q1- 2006Q2	Quarterly	
CPI	IFS Line 64	1980Q4- 2006Q2	Quarterly	Index (2000=100)
INDONESIA				
Equity Index	JCI index from Bloomberg	1983Q3 – 2006Q3	Quarterly	Index
Housing Prices	Jones Lang La Salle Research	1992Q1- 2006Q2	Quarterly	IDR/m2
GDP	IFS Line 99b	1980Q1- 2006Q2	Quarterly	Billions IDR
Exchange Rate	IFS Line rf	1970Q1- 2006Q2	Quarterly	IDR/1USD
Money Growth	IFS Lines 34-35	1970Q1- 2006Q2	Quarterly	
CPI	IFS Line 64	1980Q1- 2006Q2	Quarterly	Index (2000=100)
JAPAN				
Equity Index	NKY index from Bloomberg	1970Q1 – 2006Q3	Quarterly	Index
Housing Prices	Japan Real Estate Institute	1960Q1- 2006Q2	Half-yearly[1]	
GDP	IFS Line 99b.c	1980Q1- 2006Q2	Quarterly SA	Billions JPY
Exchange Rate	IFS Line rf	1970Q1- 2006Q2	Quarterly	JPY/1USD
Money Growth	IFS Lines 34-35	1970Q1- 2006Q2	Quarterly	
CPI	IFS Line 64	1980Q1- 2006Q2	Quarterly	Index (2000=100)
KOREA	BIS data bank			
Equity Index	KOSPI index from Bloomberg	1980Q1 – 2006Q3	Quarterly	Index
Housing Prices		1986Q1- 2006Q2	Monthly[2]	
GDP	IFS Line 99b	1960Q1- 2006Q2	Quarterly	Billions KRW
Exchange Rate	IFS Line rf	1970Q1- 2006Q2	Quarterly	KRW/1USD
Money Growth	IFS Lines 34-35	1970Q1- 2006Q2	Quarterly	
CPI	IFS Line 64	1980Q1- 2006Q2	Quarterly	Index (2000=100)
MALAYSIA				
Equity Index	KLCI index from Bloomberg	1977Q1 – 2006Q3	Quarterly	Index
Housing Prices	Jones Lang La Salle Research	1991Q4- 2006Q2	Quarterly	MYR/m2
GDP	IFS Line 99b	1988Q1- 2006Q2	Quarterly	Millions MYR
Exchange Rate	IFS Line rf	1970Q1- 2006Q2	Quarterly	MYR/1USD
Money Growth	IFS Lines 34-35	1970Q1- 2006Q2	Quarterly	
CPI	IFS Line 64	1980Q1- 2006Q2	Quarterly	Index (2000=100)

PHILIPPINES				
Equity Index	PCOMP index from Bloomberg	1987Q1 – 2006Q3	Quarterly	Index
Housing Prices	Jones Lang La Salle Research	1992Q1- 2006Q2	Quarterly	PHP/m2
GDP	IFS Line 99b	1993Q1- 2006Q2	Quarterly	Millions PHP
Exchange Rate	IFS Line rf	1970Q1- 2006Q2	Quarterly	PHP/1USD
Money Growth	IFS Lines 34-35	1970Q1- 2006Q2	Quarterly	
CPI	IFS Line 64	1980Q1- 2006Q2	Quarterly	Index (2000=100)
SINGAPORE				
Equity Index	STI index from Bloomberg	1985Q1 – 2006Q3	Quarterly	Index
Housing Prices	Jones Lang La Salle Research	1984Q4- 2006Q2	Quarterly	SGD/m2
GDP	IFS Line 99b	1975Q1- 2006Q2	Quarterly	Millions SGD
Exchange Rate	IFS Line rf	1970Q1- 2006Q2	Quarterly	SGD/1USD
Money Growth	IFS Lines 34-35	1970Q1- 2006Q2	Quarterly	
CPI	IFS Line 64	1980Q1- 2006Q2	Quarterly	Index (2000=100)
THAILAND				
Equity Index	SET index from Bloomberg	1987Q3– 2006Q3	Quarterly	Index
Housing Prices	Jones Lang La Salle Research	1992Q1- 2006Q3	Quarterly	THB/m2
GDP	IFS Line 99b	1993Q1- 2006Q2	Quarterly	Billions THB
Exchange Rate	IFS line rf	1970Q1- 2006Q2	Quarterly	THB/1USD
Money Growth	IFS, Lines 34-35	1970Q1- 2006Q2	Quarterly	
CPI	IFS Line 64	1980Q1- 2006Q2	Quarterly	Index (2000=100)

Oil Price: Price of Dubai Crude per barrel USD monthly. Source: BSP.
US CPI: BIS

[1] Converted from low frequency data to high frequency data using Eviews.
[2] Converted into quarterly observations by taking the value of the last month in the quarter.