Bangko Sentral ng Pilipinas

**BSP Working Paper Series**

# Identifying and Measuring Asset Price Bubbles in the Philippines

*Eloisa T. Glindro and Vic K. Delloro*

*Series No. 2010-02*

***June 2010***

**Center for Monetary and Financial Policy**
*Monetary Policy Sub-Sector*

Bangko Sentral ng Pilipinas

**BSP Working Paper Series**

# Identifying and Measuring Asset Price Bubbles in the Philippines

*Eloisa T. Glindro and Vic K. Delloro*

*Series No. 2010-02*

***June 2010***

*The BSP Working Paper Series constitutes studies that are preliminary and subject to further revisions. They are being circulated in a limited number of copies for the purpose of soliciting comments and suggestions for further refinements.*

*The views and opinions expressed are those of the author(s) and do not necessarily reflect those of the Bangko Sentral ng Pilipinas.*



**Center for Monetary and Financial Policy**
*Monetary Policy Sub-Sector*

**Abstract**

We examine in this paper evidence of asset price bubbles in three asset markets, namely foreign exchange market, stock market and housing market. The analysis is done by decomposing asset prices into fundamentals, cyclical and bubble components using the Kalman filter.

The decomposition analysis reveals bubble episodes that generally parallel the major macroeconomic boom and bust cycles. This is particularly true for the exchange rate and stock markets. However, no bubble episode is detected in the housing markets.

The finding of no excessive bubble episodes in recent years is in accord with the current state of development in the asset markets. Capital markets are relatively underdeveloped and only a small portion of the population invests in the stock market while foreign investors' interest has steadily declined. There has also been greater exchange rate flexibility amidst greater foreign exchange flows since the Asian crisis. Reforms in the foreign exchange regulatory framework are more recent and coincided with benign economic conditions and a conservative banking system. Credit conditions remain subdued as there has been a general inclination towards greater cash holdings and debt payments during the recovery phase. As for the housing market, the institutional set-up in the housing finance market, statutory limits on mortgage loans, rent control and lack of effective demand temper excessive risk-taking.

*Key words: asset price bubbles, overvaluation, cycles, Kalman filter*

## Table of Contents

# Examining Asset Price Bubbles in the Philippines

by Eloisa T. Glindro and Vic K. Delloro[1]

## 1. Introduction

Episodes of financial instability in modern economies have been precipitated by boom-bust cycles. Among the prominent crisis episodes are the two-decade Japanese economic recession in the 1990s,[2] the 1997 Asian crisis, and the 2008 international financial crisis.

The role of asset prices in amplifying the business cycles has been at the forefront of policy debates in recent years. Gochoco (2008) found out that asset price booms in housing and equity markets, either separately or jointly, significantly raise the probability at the margin that output falls below its long-run trend and that the price level will rise above its trend. However, there is less consensus on the weight that should be attached to asset prices in setting monetary policy. In Asia, experience with strong capital inflows renders the use of the policy interest rate less appealing. The Bangko Sentral ng Pilipinas (BSP), for example, resorted to a number of measures such as prepayment of debt, reserve accumulation as a form of buffer, and further liberalization of the foreign exchange framework in 2006.[3] It also allowed greater flexibility in the exchange rate and encouraged the shift in the borrowing mix of the government in favor of domestic borrowing.

As prognosis for developed economies generally points to subdued recovery from the 2008 financial crisis, the possibility of interest rate differentials between advanced economies and Asian economies persisting for some time may intensify capital flows. Such prospect would render the withdrawal of interest rate stimulus more complicated. It may also spawn renewed concerns about the possibility of incipient asset price bubbles taking shape anew.

To design the appropriate policy response, we believe that it is essential to establish first the presence of asset price bubbles. In this paper, we argue that asset price overvaluation is a necessary but not a sufficient condition for identifying asset price bubbles. Just like in any other markets, we believe that adjustments in asset markets are not frictionless. There may be overshooting during the course of asset price adjustment towards the long-run trend. The overshooting may be due to improving economic fundamentals or structural factors that impair immediate adjustment to fundamentals or even irrational expectations of continuous asset price increases.

---

[1] Eloisa T. Glindro and Vic K. Delloro are Bank Officers V at the Center for Monetary and Financial Policy, Bangko Sentral ng Pilipinas. Views expressed herein do not represent the views of the Bangko Sentral ng Pilipinas. Errors and omissions are sole responsibilities of the authors.

[2] Kranier, et. al (2005) documented that weaknesses in the real estate sector primarily accounted for the difficulties in the banking sector in the early 1990s. Protracted declines in real estate values throughout the 1990s eroded the collateral positions of banks. Real estate owners who obtained mortgages prior to the collapse also suffered from reduced, and even, negative equity values.

[3] 2007 BSP Annual Report, box article.

To identify bubble episodes, we decompose asset price into fundamentals, frictions, and bubble components. The three asset markets we consider in the analysis are the foreign exchange, stock, and housing markets.

We structure the paper as follows: Section 2 expounds on the relevance of the asset price channel of monetary policy and the motivation of the study. Section 3 describes the data and the empirical methodology. Section 4 discusses the empirical results and section 5 concludes and discusses the policy implications.

## 2. Why Does the Asset Price Channel of Monetary Policy Matter?

Smets (1997) argued that there are two reasons why asset prices matter for a central bank's pursuit of price stability. First, the information content of asset prices as indicator of market expectations provides a useful gauge in assessing the timing and usefulness of policy actions. Second, to the extent that large asset price misalignments may give rise to widespread financial instability, there is merit for central banks to help in achieving asset price stability.

On the other hand, the policy action of the central bank has an important implication on asset prices. Higher market interest rate induced by a rise in the policy rate means lower value of existing assets, thus, lower wealth holdings, which in turn, dampens consumption. Investment is also affected by changes in asset prices through the valuation of equities, as embodied in the Tobin's *q* theory of investment. Brainard and Tobin (1968) define *q* as the ratio of the market value of firms to the replacement cost of capital. A low *q* means that the market value of firms is low relative to the replacement cost of capital, i.e., the acquisition of new plant equipment is expensive relative to the market value of business firms, thereby serving as a disincentive to investment spending.

By affecting asset valuation, the central bank's interest rate policy may therefore inadvertently contribute to the formation of asset price bubbles during cyclical upturns and asset price deflation during downturn. Borio (2006) talks about the 'paradox of credibility' which posits that a central bank's success in controlling inflation may help mask a build-up of financial imbalances. Adrian and Shin (2008) infer that the monetary policy in the US may have played a procyclical role as changes in short-term policy rates tend to amplify fluctuations in the balance sheets.

The preceding discussion implies that while monetary policy can be a contributory factor, it also has the capacity to help rein in asset price bubbles and avert a destabilizing asset price collapse. However, monetary policy cannot address asset price bubbles on its own.

There are two competing schools of thought on how monetary policy should react to asset price bubbles, assuming that the presence of such has been established. One school of thought argues that monetary policy should only respond to observed changes in asset prices to the extent that they signal current or future changes to inflation or output gaps (Bernanke and Gertler, 2000; Schwartz, 2002). On the other hand, another school of thought argues that a moderate rise in interest rate when asset prices rise above warranted levels can reduce the asset-price bubbles on output and inflation, thereby enhancing macroeconomic stability (Cechetti, Genberg and Wadhani, 2003; Bordo and Jeanne, 2002b).

A strategy of extra monetary policy action to moderate asset-price bubbles might be justified provided three tough conditions are satisfied (Kohn, 2008). First, policymakers must be able to identify bubbles in a timely manner with reasonable confidence. Second, a somewhat tighter monetary policy must have a high probability of containing some speculative activity. Finally, potential gains from mitigating bubbles must be sufficiently great.

There is, however, a downside to direct monetary action as put forward by Gruen, Plumb and Stone (2005).They contend that the information requirements for policy activism are fairly high, with potential risks that errors in policy making can lead to efficiency losses. Monetary policy's response to asset price bubbles will always involve balancing Type 1 and Type 2 errors in policy making. Dismissing the existence of asset price bubble when there is one (type 1) leads to delayed policy response. This stance runs the risk of further inflating asset prices that would require much bigger correction later. On the other hand, a policy that responds to perceived but non-existent asset price bubble (type 2) may constrain growth needlessly. Under such a scenario, interest rates may not be the best instrument in the central bank's policy toolkit to combat the destabilizing effects of asset price bubbles.

Asset price bubbles are difficult to estimate let alone predict. The identification of bubbles is tricky because it is often associated with asset price overvaluation. However, rising asset prices may be a reaction to upbeat economic outlook and not all the fundamental factors driving asset prices are directly observable. Normally, the recognition of asset bubbles happens after they have burst. In addition, there are also structural factors that may impede fast adjustment to fundamentals. Before one can even judge how destabilizing asset price bubbles are and how monetary policy ought to respond, central banks must first recognize the factors that explain asset price bubbles and crashes. Unfortunately, this is easier said than done. Root causes of bubbles, why they evolve, and how they burst are not well known, thereby, making it infeasible for monetary policy to single-handedly deal with asset price bubbles.

## 2.1 Motivation of the Study

No matter how imprecise the tool of analysis is, identifying the sources of asset price movements – fundamentals, frictions, and bubbles – is deemed an important first step for the purpose of designing the appropriate policy responses. For this purpose, some conceptual framework to guide the decomposition is essential. Kindleberger (1987) defined asset price bubble as a sharp rise in price of an asset or a range of assets. The price increase is a continuous process, which spawns expectations of further increases and attracts an increasing number of new buyers, who are generally more concerned about trading profits rather than assets' use or earning capacity.[4] Sharp reversal of expectations could then lead to a severe drop in asset prices that could induce a financial crisis. We believe that this definition underscores the 'irrationality' of asset price bubbles since asset price increases are fed largely by expectations for short-term gains without solid support from long-term fundamentals.

However, we believe that increasing asset prices or even asset price overvaluation do not automatically translate into irrational bubbles. Following the work of Glindro, Subhanij, Sweto and Zhu (henceforth GSSZ, 2008), price overvaluation refers to

[4] Kindleberger (1996) in "Manias, Panics, and Crashes: A History of Financial Crisis" noted that when this occurs, speculation for profit leads away from normal, rational behavior to what he described as "manias" or "bubbles". In this book, he defined the bubble as an upward price movement over an extended range that then implodes.

current asset prices being higher than their fundamental values or long-run trend. This overvaluation consists of two components: the cyclical and bubble components. We consider this cyclical component of overvaluation as simply reflecting inherent structural frictions in the market. The frictions can manifest in lagged response to new economic information or in the way market infrastructure, taxation policies and regulations affect transactions in the asset markets. Addressing these frictions takes awhile, particularly in less developed asset markets like the Philippines'. Thus, in the short-run, they can cause asset prices to exhibit fluctuations around their fundamental values. A bubble, on the other hand, is the residual component that cannot be explained by the market imperfections.

The distinction is essential for policy calibration. As expounded in GSSZ (2008), a run-up in asset prices that reflect improved fundamentals would not call for a tightening of regulatory measures or an increase in policy rates. In contrast, a cyclical run-up due to market imperfections may call for structural reforms that address frictions in the market, whereas asset price bubbles may require macroprudential actions that temper the speculative motive, such as a capital gains tax or capping the loan-to-value ratio of real estate lending, among others.

Moreover, in assessing the monetary policy response, the emphasis should be on the size of the bubble. Magnitudes matter and a relevant asset price bubble should be large enough to affect the macroeconomic variables that are relevant to monetary policy decisions (Filardo, 2004). In fact, the formation of an asset price bubble and its subsequent collapse need not be necessarily followed by severe economic and financial dislocations.

The decomposition should also be properly contextualized within the financial and economic landscape as well as the volatility in price movements among different assets. Equity prices and exchange rates react faster to economic news and may exhibit greater fluctuations. A house, on the other hand, is a slow clearing asset but tends to have a bigger wealth effect than most financial assets. This is because the housing market is more broad-based compared to the foreign exchange and equity markets. A house is valued both as a consumption and investment good. Whichever motive dominates may have an impact on the amplitude and frequency of cycles.

## 3. Data and Empirical Methodology

### 3.1 Data

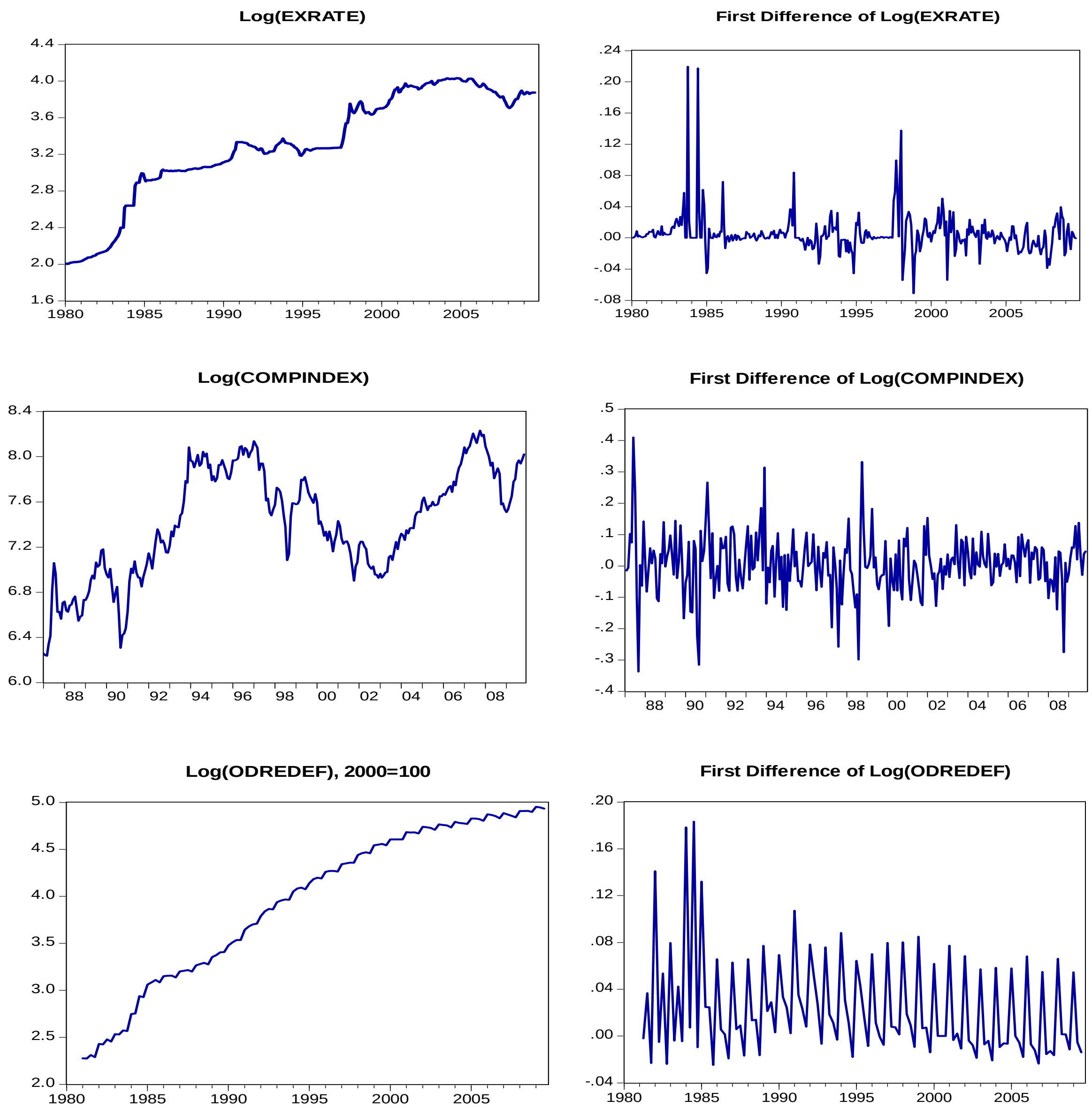
The asset prices we consider in the analysis are the exchange rate (EXRATE), composite stock price index (COMPINDEX), and price index for the ownership of dwellings and real estate (ODREDEF). EXRATE and COMPINDEX are both monthly series whereas ODREDEF is a quarterly series from 1980 – 2009.[5] All the series examined are in logarithms.

[5] The composite price index (COMPINDEX) used is the PSEi, the main stock market index of the Philippine Stock Exchange. Unlike the two other asset prices (the nominal exchange rate and house prices) which use data from 1980-2009, the series COMPINDEX is available only for the period 1987-2009. The house price used is the deflator for Ownership of Dwellings and Real Estate (ODRE), given by Nominal ODRE/Real ODRE in the National Income Accounts, which was rebased from 1985=100 to 2000=100. Real estate price index (REPI) is still non-existent in the Philippines.

An important reason why asset prices are important is that they tend to co-move. Borio and McGuire (2004) find strong linkages between equity price and house price movements. The linkage, however, is not definitive as it depends on which of the substitution effect and wealth effect dominates. For example, a real effective exchange rate appreciation renders domestic assets (stocks and houses) more attractive relative to foreign assets, particularly in markets with substantial demand from non-residents.

Figure 1 plots the data used in our study. Only ODREDEF has clear seasonal patterns both in terms of level and first difference. The log first differences of the more information-sensitive asset price series such as exchange rate and stock price index (Figure 1) show discernible rise and decline during the major crisis episodes that had severe confidence-eroding effects: The early 1980's balance of payments (BOP) crisis; the confluence of natural disasters (El Niño, Mt. Pinatubo eruption), political strife (coup attempts, removal of US bases and severe power shortages in the early 1990s; the 1997 Asian financial crisis; the 2001 retreat of the technology sector; and the recent global economic and financial crisis.

**Figure 1**
**Exchange Rate, Composite Stock Price Index and ODRE Deflator**



### 3.2 Empirical Methodology

We discuss in this section the empirical methodology for decomposing asset price movements into fundamental, friction and bubble components, following the approach used by GSSZ (2008) on house price dynamics. We define asset price overvaluation as a situation wherein asset prices are higher than their fundamental values. The overvaluation is not interpreted as a bubble because it still contains an intrinsic cyclical component that captures short-run frictions. As such, asset prices can exhibit fluctuations around the equilibrium fundamental values. The other component is the residual or what we interpret as the bubble because it cannot be explained by long-run and cyclical components.

Unlike the framework using the error correction mechanism (ECM) in GSSZ (2008), we apply the decomposition on univariate models. We argue that the current asset price embeds all information about the fundamentals, short-run frictions, and bubble. Given this, we can interpret the underlying trend as already reflecting what the price should be given the economy's fundamentals whereas the cyclical component reflects information on short-run frictions. We believe that the approach is a novel way of avoiding the difficulty of pinning down the long-run determinants of asset prices when doing multivariate analysis.[6] Given that we are simply doing decomposition of univariate time series to uncover bubble episodes, the properties of stationarity nor homoskedasticity of variance do not play any fundamental role in our analysis.[7]

The unobserved components model approach entails giving a state-space representation to the series under consideration. State-space representation always involves two equations: (i) a signal equation or the structural or measurement equation; and (ii) a state equation, which is the equation for unobserved parameters and is also known as the transition or latent equation. Unlike the static model with fixed or constant parameters, state space models have time-varying parameters, i.e., parameters are also a function of time.

In a nutshell, the decomposition procedures used are as follows:

3.2.1 Basically each series in consideration is seen as the sum of trend, seasonal and irregular components. Typically, these components may be inadequate. A necessary flexibility may be achieved by letting the coefficients change over time, a treatment that was accorded to other components such as the cycles (Harvey and Shephard, 1993).

3.2.2 The fundamental asset price level is given by the trend whereas the cyclical component corresponds to the short-run fluctuations in price level. The measurement equation for the univariate model may be written as:

6 The analyses used the Structural Time Series, Modeller and Predictor (STAMP) software which is part of the OxMetrics 6.0 Enterprise Edition. STAMP uses the Kalman filter approach to fit the unobserved components of the time series (Koopman, Harvey, Doornik and Shepard, 2007).

7 Classical time series analysis is based on the theory of stationary stochastic processes. Nonstationarity is dealt with by differencing, which leads to ARIMA class of models. Other models would also call for conditioning on observed explanatory variables, which require large information sets. Without any unobserved components, the estimation reverts to a simple regression.

$$y_t = \mu_t + \psi_t + \gamma_t + \varepsilon_t; \qquad \varepsilon_t \sim NID(0, \sigma_\varepsilon^2) \qquad t = 1,.....T$$

where:

$y_t$ - asset price
$\mu_t$ - trend component
$\psi_t$ - cyclical component
$\gamma_t$ - seasonal component
$\varepsilon_t$ - irregular component

The state equation for the trend $\mu_t$ typically consists of two parts, namely, the level and the slope, in which the latter may not be necessarily present. Some of the trend specifications are:

- Local level or random walk plus noise.

$$y_t = \mu_t + \varepsilon_t; \qquad \varepsilon_t \sim NID(0, \sigma_\varepsilon^2) \quad t = 1,.....T$$
$$\mu_t = \mu_{t-1} + \eta_t; \qquad \eta_t \sim NID(0, \sigma_\eta^2)$$

- Local linear trend (stochastic trend component):[8]

$$y_t = \mu_t + \varepsilon_t; \qquad \varepsilon_t \sim NID(0, \sigma_\varepsilon^2)$$
$$\mu_t = \mu_{t-1} + \beta_{t-1} + \eta_t; \qquad \eta_t \sim NID(0, \sigma_\eta^2)$$
$$\beta_t = \beta_{t-1} + \zeta_t; \qquad \zeta_t \sim NID(0, \sigma_\zeta^2)$$

A stochastic $\mu_t$ contains $\eta_t$. Otherwise, if $\mu_t$ is fixed, the state equation for $\mu_t$ does not have $\eta_t$, hence, $\sigma_\eta^2$=0. The choice of a fixed level results in a smooth trend and is also often combined with a cycle or autoregressive component.

The slope of the trend is given by $\beta_t$. It can either be stochastic, i.e. it contains $\zeta_t$ or fixed with no $\zeta_t$. The model can be specified without a slope either, as exemplified by the local level or random walk plus noise. The irregular $\varepsilon_t$, the level disturbance $\eta_t$, and the slope disturbance $\zeta_t$ are mutually uncorrelated.

The statistical treatment of each component, as discussed in Koopman et al (2009), is reproduced in Appendix 1.

In a nutshell, STAMP carries out maximum likelihood estimation of the variances, $\sigma_\varepsilon^2$, $\sigma_\eta^2$, and $\sigma_\zeta^2$. After estimation, STAMP runs the

8 Specifying the level and slope to be both stochastic, otherwise known as the local linear trend model, is the default specification in STAMP.

Kalman filter through the observations to estimate the state $\mu_t$. A Kalman filter is a recursive[9] data processing algorithm employed to generate an optimal estimate of the unobserved state given the set of measurements. It is optimal in the sense that it all noise is Gaussian, the Kalman filter minimizes the mean square error for the estimated parameters.[10] The process of finding the "best estimate" from noisy data leads to "filtering out" the noise. Essentially, the Kalman filter involves the following two (2) iterative steps: prediction and updating. In the first step, we use the initial conditions and previous information observations to produce an estimate of the current state. This predicted state estimate is referred to as the *a priori* state estimate because although it is an estimate of the state at time *t* it only includes observation information up to time *t-1*. In the second step, we update our estimate of the state by combining or blending it with the current observation information at time *t*. This refined estimate is referred to as the *a posteriori* state estimate. Note that by combining prediction and residual, we obtain an optimal estimate with a smaller variance.[11]

The state $\mu_t$ reported in the Appendix 2 refers to the estimated trend at all points in the sample using all observations, otherwise known as smoothing or signal extraction. [12]

3.2.3 The decomposition of asset price overvaluation into cyclical and bubble components is carried out as follows:

(a) First, price overvaluation is given by the difference between actual and long-run trend of the asset price. For clarity, we change the notation from $y_t$ to $p_t$.

$$p_{t,long-run}^{excess} = p_t - p_t^{lr}$$

where $p_t$ is actual asset price and $p_t^{lr}$ is the long-run trend.[13]

(b) Second, the proportion of price overvaluation that is explained by short-run frictions or cyclical factors is given by:

$$p_{t,short-run}^{excess} = \left(p_{t-1} + E\Delta p_t\right) - p_t^{lr}$$

[9] This means that new measurements can be processed as soon as they become available.

[10] Even if the noise is non-Gaussian, the Kalman filter, given only the mean and standard deviation of noise, is still the best *linear* estimator (Kleeman, 1996).

[11] Kleeman (1996).

[12] There are also the filtered estimate and the predicted estimate. The former is based only on previous and current observations whereas the latter is based only on previous observations.

[13] Seasonal factors, if present, are added back to the estimated long-run trend to derive a measure of $p^{lr}$.

where $p_{t-1} + E\Delta p_t$ is the short-run price that captures short-run frictions and $E\Delta p_t$ pertains to the values of the short-run cyclical component of the univariate model. The difference between the short-run price and long-run price is attributable to short-run frictions.

(c) The residual *(i.e., $p^{bubble}$)*, which is the difference between the price overvaluation and the portion attributable to the short-run frictions is then interpreted as the measure of asset price bubble. We assume a double-digit 10 percent as the threshold for irrational bubble although we recognize that the threshold itself is an empirical question.[14] Nonetheless, this approximates the minimum estimated bubble during the identified periods of economic distress.

$$p_t^{bubble} = \left(p_{t,long-run}^{excess} - p_{t,short-run}^{excess}\right)$$

## 4. Empirical Results

In this section, we present our analysis of the results of the decomposition. The decomposition is applied on higher frequency data, i.e., monthly data for exchange rate and stock price index and quarterly data for house price index. All the reported results posted strong to very strong convergence, have the highest log likelihood ratio for which steady states were found, and have stationary cyclical component. The predictive results are reported in Appendix 2.

The estimated bubble component reported in this section corresponds to the annual average of the monthly or quarterly estimates.

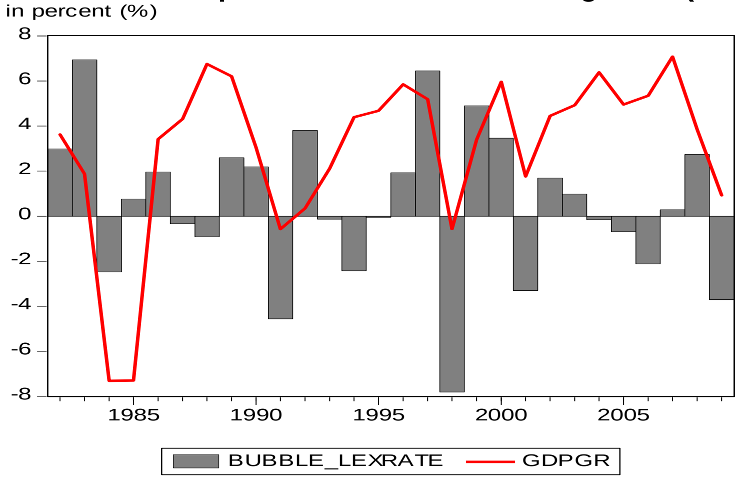
### 4.1 Foreign Exchange Market

The exchange rate is modeled as a local linear trend with a short cycle of 5 years and AR(1) and AR(2) components but no seasonal component. Earlier estimates indicate insignificance of the seasonal component.

The notable spikes and declines in bubble estimates coincide with prominent crisis periods: balance of payments crisis in the early 1980s, the energy crisis in the early 1990s, the Asian crisis in 1997-98 and the dot-com bubble collapse in 2001 (Figure 2). The absence of any bubble during the latest crisis episode is not surprising as there has been greater exchange rate flexibility after the Asian crisis, particularly after inflation targeting was adopted as the monetary policy framework. The latter coincided with a change in the nature of foreign exchange inflows, driven by current account surpluses that are largely fueled by overseas Filipino remittances.

[14] Threshold analysis is a subject of future research.

**Figure 2**
**Estimated bubble component in nominal exchange rate (1982-2009)**

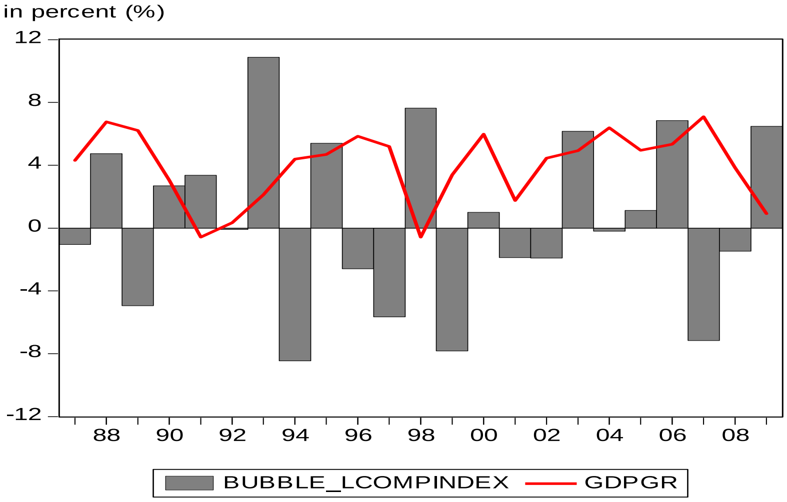



The BSP has hewed to its policy of allowing exchange rate flexibility while smoothing exchange rate fluctuations. With exchange rate flexibility and disinflation, there has been an observed decline in the short-run and long-run exchange rate pass-through (ERPT) compared to the pre-IT period. The decline in short-run exchange rate pass-through could be the result of measures taken by the BSP to ensure stability in the foreign exchange market as it endeavors to achieve the inflation target. These measures could have led to greater exchange rate stability that has helped temper inflation and inflation expectations (Tuaño-Amador, Claveria, and Glindro, 2009).

## 4.2 Stock Market

The most significant increase in the estimated bubble component that was followed by a significant reversal occurred in 1993, followed by 1998-99 and 2006-07.

**Figure 3**
**Estimated bubble component in stock price (1988-2009)**




In his analysis of daily stock returns using regime switching ARCH regression, Bautista (undated) identified the period April 1990 to September 1993 as the first bust period and the last quarter of 1993 as the third high volatility episode. He noted that the first bust period was preceded by a high volatility episode due to the 1989 coup attempts, 1990 fiscal crisis, 1992 power crisis, and the Gulf war. The high volatility episode in the last quarter of 1993, on the other hand, coincided with relaxation of rules on foreign exchange transactions, which allowed investors to freely repatriate their capital such that by mid-1993, the stock market climbed rapidly, reflecting greater market activity and heightened uncertainty about the foreign portfolio inflows. The general decline in bubble estimate in 2007 may be ascribed to the fallout from the US sub prime crisis, which triggered a worldwide "credit crunch" as sub prime mortgage-backed securities was discovered in portfolios of banks and hedge funds[15] (Figure 3).

We complement the analysis by examining bubble episodes in property and financial stock prices, which we deem to be more susceptible to asset price bubbles. It can be gleaned from Figure 3.1 that estimated property stock price bubbles also reflect the movement of the general stock price index although the magnitudes in property stock price bubble are much bigger. In fact, the widely considered pre-Asian crisis bubble episode and the contagion effect of the sub-prime crisis in the US that began to manifest in 2006 appear to be more apparent in the property stock price index.

On the other hand, asset price bubble estimates for financial stock price[16] (Figure 3.2) in recent years are much more subdued, reflecting the general soundness of the financial system following the financial sector reforms and balance sheet consolidation after the Asian crisis. The latest IMF's Financial System Stability Assessment Update on the Philippines (April 2010) reports that credit, interest rate, and foreign exchange risks for Philippine banks are manageable because of their relatively high capital buffer. The report further notes that the banking system's exposure to other risks (i.e., real estate price, equity price, derivative, liquidity and cross-border risks) is also small. Several reasons are identified. Loan-to-value ratios for real estate loans are conservative. Share of equity in the banks' trading portfolio is small. Derivative activity is governed by licensing requirements and limited to plain vanilla types. Liquidity risk is also low since banks hold bulk of government securities, deposits constitute bulk of funding and foreign currency deposits are subject to liquid asset requirement. Cross-border risks are also low since banks mostly raise funds and lend domestically, market share of foreign banks is only about 10 percent, and there are limits on repatriation of profits.[17] It should also be pointed out that the BSP issued a new Prompt Corrective Action (PCA) regulation in 2006, which serves as an important safety net to the banking system.

---

[15] Banks bailed out their hedge funds (e.g., Bear Stearns in June 2007, BNP Paribas in August 2007). State-owned banks in Germany initiated the first large-scale bailout of IKB Deutsche Industriebank (August 2007), followed by the Bank of England's emergency funding to Northern Rock (September 2007) which culminated in its nationalization in February 2008.

[16] The PSE property and financial indices are both modeled as having local linear trend with a short cycle of 5 years, AR(1) with the latter having a seasonal component.

[17] More detailed assessment can be found in IMF Country Report No. 10/90 entitled Philippines: Financial System Stability Assessment Update (April, 2010).

**Figure 3.1**
**Estimated Bubble Component in Property Stock Price (1994-2009)**

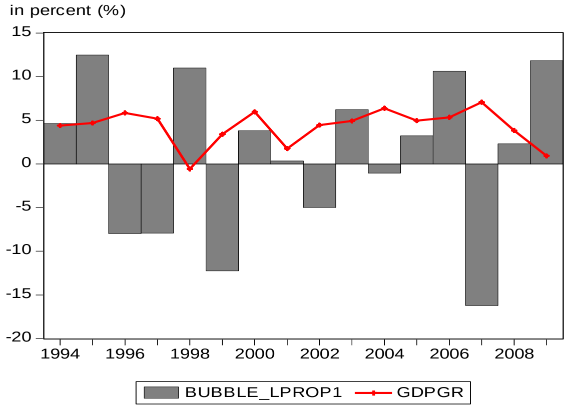
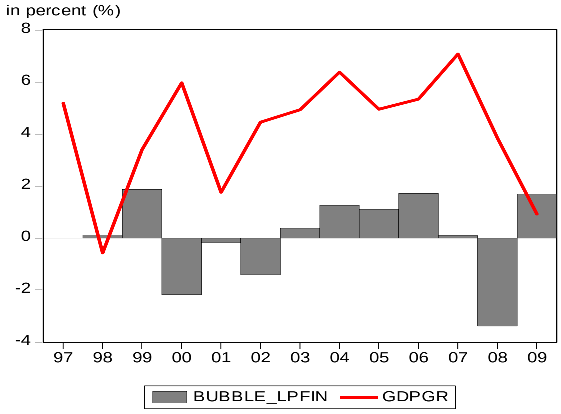



**Figure 3.2**
**Estimated Bubble Component in Financial Stock Price(1997-2009)**




Regardless of the stock price index used, the estimated stock price decline, however, did not significantly dent the economy in 2007. While market capitalization has been increasing over the years, majority of those who invest in the Philippine Stock Exchange (PSE) consist of high net worth individuals. Lastly, the market may not be liquid enough with daily trading volume of US$60 million, compared to almost US$500 million in Thailand and Indonesia.[18]

Moreover, the increase in market capitalization beginning 2004 has been largely accounted for by domestic issuers while foreign interest has steadily waned over the years (Figure 4). The economy became a net lender beginning 2003 when the financial sector gained traction after series of financial sector reforms. The non-financial corporate sector followed suit in 2004. As domestic savings increased, investment remained stagnant.[19] The increasing savings-investment gap implies less need for equity issuance that entails capital gains taxation and dilution of ownership (Figure 5). Capital needs of corporations are also noted to have been largely financed through bank lending and retained earnings.

**Figure 4**
**Market Capitalization in the Philippines**

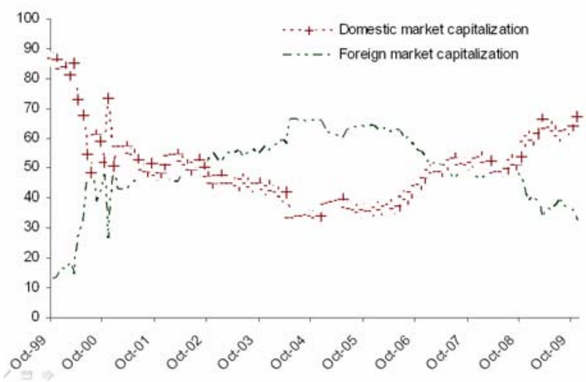
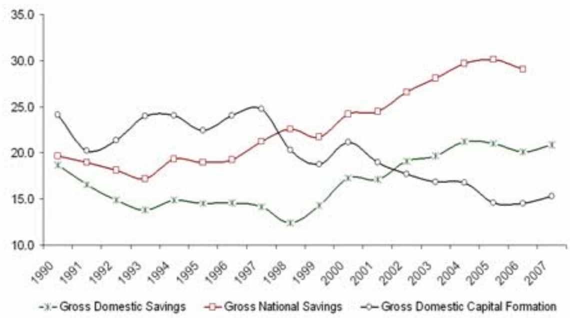



**Figure 5**
**Savings-Investment Gap as Percent of GDP at Current Prices (1990-2007)**




Source: 2008 ADB Key Indicators for Asia and the Pacific
The significant rise in 1998 of national savings partly reflects the change in the data reporting system of remittances from overseas Filipinos

[18] Based on the draft Financial Sector Assessment Program.

[19] The stagnant investment spending may also be partly attributed to the structural shift in the economy towards less capital-intensive services sector (Glindro, 2009).

### 4.3 Housing Market

House price in the average housing market, represented by ODRE price deflator[20] is modeled as a local linear trend with seasonal component and 5-year and 10-year cycles. Other than the significant bubble episode in the early eighties, no significant bubble episode is detected since then. In fact, bubble estimates have been declining over the years (Figure 6). This is not surprising because a house in the Philippines is generally valued more for its consumption rather than investment value. Rent control law is still enforced and the law on real estate investment trust (REIT) has not yet taken off, having been approved only in December 2009.[21] In the aftermath of the Asian crisis, the Bangko Sentral ng Pilipinas (BSP) imposed statutory limit of 30 percent on the share of real estate loans to the total loan portfolio.[22] Maximum loan-to-value ratio was set at 60 percent but 70 percent was allowed for real estate loans less than Php 3.5 million and housing loans guaranteed under the government's National Shelter Program.

The institutional set-up for housing development revolves around the provision of housing assistance to the low and low-middle income households. The government housing finance system consists of various government agencies with finance-linked subsidies such as those by the Home Development Mutual Fund (HDMF), Government Service Insurance System (GSIS) and the Social Security System (SSS), which are intended to benefit the low income classes. Many studies have noted that the eligibility requirements for availing of a mortgage loan have tended to benefit more the non-poor (Ballesteros, 2002; Chiquier, 2006).The 2004-2010 Medium-Term Philippine Development Plan (p.61) recognizes that the banking system and private sector cannot compete with the subsidized housing loan interest rates of the government housing programs. As such, their participation even in socialized housing is very minimal.

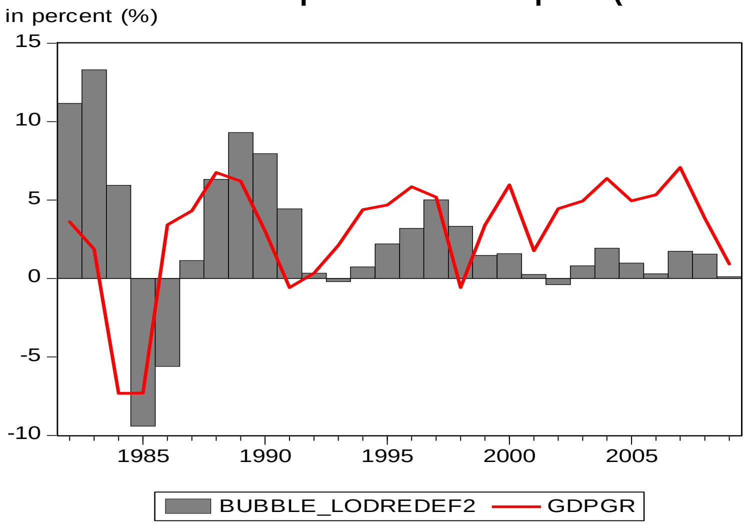
---

[20] Ownership of Dwellings and Real Estate (ODRE) deflator is given by Nominal ODRE/Real ODRE in the National Income Accounts (1985=100). Real estate price index (REPI) is still non-existent in the Philippines.

[21] Approved on December 17, 2009 as Republic Act No. 9856.

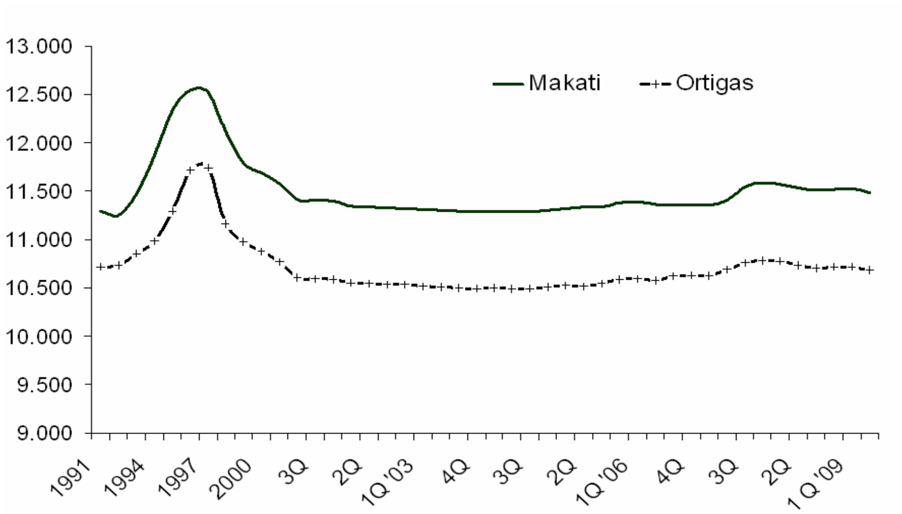
[22] The latest amendment, embodied in Circular No. 600 dated 4 February 2008, revised the prudential limit on real estate loan exposure of universal and commercial banks to not more than 20% of the total loan portfolio, net of interbank loans. The coverage excludes loans extended to individual households for their personal use, loans to developers for low-cost socialized and low-cost residential properties defined under the HUDCC guidelines, loans guaranteed by the Home Guaranty Corporation and loans collateralized by non-risk assets under existing regulations.

**Figure 6**
**Estimated bubble component in house price (1982-2009)**




The above finding is also apparent in the trend of land values in two most high-end housing markets in the Philippines, i.e., Makati City and Ortigas (Figure 7). While Kalman filter was not used given the paucity of data, the plot of the log of land values is very telling. Even in the buoyant high-end market, land values have yet to revert to the pre-Asian crisis level.

**Figure 7**
**Log of Land Values in Makati and Ortigas**




Nonetheless, for improved surveillance, it is opportune that a real estate price index (REPI) across different market segments (i.e., low, middle, and upscale market segments), localities, and real estate classification (i.e., commercial or residential) be developed. This assumes greater urgency considering that house prices have become more relevant an asset price to monitor and forecast domestic inflation.

Availability of real estate price index across market segments, localities and classification would greatly improve analysis on house price bubbles and aid policy makers in identifying areas that are most susceptible to bubble episodes. A house is a heterogeneous and slow-clearing asset that has very strong local character. Policy response, therefore, need not be national in scope nor borne solely by monetary policy. As such, a reliable REPI lessens the probability of costly monetary policy mistakes.

## 5. Conclusion

The decomposition analysis reveals bubble episodes that parallel the macroeconomic boom and bust cycles. This is particularly true for the exchange rate and the stock markets, which react faster to economic news. However, no bubble episode is detected in the housing markets, except for the early eighties.

The absence of significant bubble episodes in key asset markets in the more recent periods can be largely ascribed to the current state of development in the financial market and the overall regulatory framework that governs it. Unlike in advanced economies, the Philippine financial system remains bank-dominated, wherein five universal banks out of 38 banks account for half of the total assets. The banking system remains conservative in which deposit-taking and lending are still the dominant functions performed by banks. Bank lending and retained earnings remain the dominant financing sources of corporations. Equity investment, while on an uptrend, is comparatively low vis-à-vis neighboring economies and demand for which is limited to high net worth individuals.

Interestingly, even if savings-investment gap has been widening, credit take-up has not been keeping pace. In fact, loans-to-deposit ratio has been declining and market capitalization has been increasing. This may imply that high net worth borrowers may also be the ones exploring the equity market during the upcycle. Moreover, banks and non-financial corporates may have focused more on balance sheet consolidation and debt repayments during the recovery phase after the Asian crisis, which may have moderated the credit cycle-asset price feedback loop.

### 5.1 Implications for monetary policy

The findings of no significant asset price bubble episode implies that the more circumspect stance of BSP in responding to asset price movements remains a sensible and practical one, considering the current state of development in the financial market and the overall regulatory framework that governs it. The inflation targeting framework follows a comprehensive approach in assessing price developments, including asset prices. Monetary policy does not readily accommodate asset price overvaluation but sends signals to the markets via regular press briefings and publications. Trends and developments in the asset markets are reported in the BSP quarterly inflation report, semestral report on the Philippine financial system and a more comprehensive financial stability report. More importantly, addressing asset price bubbles is not solely borne by conventional monetary policy tools. The prudential and supervisory framework plays important complementary role in stabilizing asset prices in terms of credit policy, capitalization and provisioning requirements, among others.

Overvaluation due to strengthening fundamentals would not warrant strong policy action because doing so may inadvertently create conditions that would further inflate asset price bubbles. For example, raising interest rates to stem currency depreciation or rising house prices during times of huge foreign exchange inflows and improving macroeconomic fundamentals may just further reinforce expectations of ever rising prices or attract more inflows.

To mitigate overvaluation driven by intrinsic price cycles, the policy should be aimed at reducing the magnitude and frequency of intrinsic cycles. These measures such as strengthening the regulatory and physical infrastructure in the capital market; reducing turnaround time in each transaction; improving information availability and transparency; and enhancing property right protection are beyond the ambit of monetary policy. To address the bubble issue, the policymaker should adopt measures that control unwarranted high expectation of capital gains. One possibility is capital gains tax or regulatory limits on the loan-to-value and stronger prudential measures.

Monetary policy will not be able to solely address frictions due to intrinsic cycles as well as irrational bubbles. We believe that well-coordinated fiscal and prudential policies have important roles to play in averting the destabilizing effects of asset price bubbles.

## References

1. Adrian, T and Shin, H.S. (2008). Financial Intermediaries, Financial Stability and Monetary Policy. Paper prepared for the Federal Reserve Bank of Kansas City Symposium, Jackson Hole, August 21-23, 2008.

2. Amador, C.T.N., Claveria, R., and Glindro, E (2009). *Some Perspectives on the Monetary Policy Transmission Mechanisms in the Philippines.* Forthcoming in Bangko Sentral Review (2010).

3. Ballesteros, M. (2002). “Rethinking Institutional Reforms in the Philippine Housing Sector.” PIDS Discussion Paper no 2002-16. Philippine Institute for Development Studies, Makati City, Philippines.

4. Bautista, C. (undated). “Stock Market Volatility in the Philippines” Available at www.upd.edu.ph/~cba/bautista/docs/stock0000.pdf

5. Bernanke, B. and Gertler, M. (2000), Monetary Policy and Asset Price Volatility, National Bureau of Economic Research Working Paper No. 7759. Available at http://www.nber/org/papers/w7759.

6. Bordo, M. and Jeanne, O. (2002). *Boom-Busts in Asset Prices, Economic Instability and Monetary Policy.* National Bureau of Economic Research Working Paper No. 8966 (June 2002) <http://www.nber.org/papers/w8966>

7. Borio, C. (2006): Monetary and financial stability: Here to stay? *Journal of Banking & Finance*, 30 (12): 3407-3414.

8. Cecchetti, S. (2006). *Measuring the Macroeconomic Risks Posed by Asset Price Booms.* National Bureau of Economic Research, WP 12542.

9. Cecchetti, S., Genberg, H., and S. Wadhwani (2003): "Asset prices in a flexible inflation targeting framework", in Asset price bubbles, W. Hunter, G. Kaufmann and M. Pomerleano (eds.), The MIT Press: Cambridge

10. Chiquier, L. (2006). “Housing Finance in East Asia.” in East Asian Finance Flagship Book, ed.S. Ghosh. World Bank.

11. Filardo, A. (2004). *Monetary Policy and Asset Price Bubbles: Calibrating the Monetary Policy Trade-Offs.* Bank for International Settlements, WP No. 155 (June 2004).

12. Glindro, E., Subhanij, T., Sweto, Je. And Zhu, H. (2008). *Determinants of House Prices in Nine Asia Pacific Economies.* Bank for International Settlements WP No. 263

13. Glindro, E. (2009). *State of Investment in the Philippines.* Chapter 7 of the SEACEN Publication entitled Investment in the SEACEN Countries in the Post Crisis Era.

14. Gochoco-Bautista, M.S. (2008). *Asset Prices and Monetary Policy: Booms and Fat Tails in East Asia.* Bank for International Settlements WP No. 243 (January 2008).

15. Gruen, D., Plumb, M. and Stone, A. (2005). *How Should Monetary Policy Respond to Asset Price Bubbles*. International Journal of Central Banking, Vol. 1, No. 3 (December 2005).

16. Harvey, A. and Shephard, N. (1993). *Structural Time Series Models.* Handbook of Statistics, Volume 11 (G.S. Maddala, C.R. Rao and H.D. Vinod, eds.), Elsevier Science Publishers B.V.

17. Kindleberger, C. P. (1987). *Bubbles, The New Palgrave: A Dictionary of Economics*, John Eatwell, Murray Milgate & Peter Newman, eds., New York Stockton Press: 281.

18. ____________. (1996). *Manias, Panics and Crashes: A History of Financial Crises*, 3rd Edition, John Wiley & Sons, Inc.

19. Kleeman, L. (1996). *Understanding and Applying Kalman Filtering*. Proceedings of the Second Workshop on Perceptive Systems, Curtin University of Technology, Perth Western Australia (25-26 January 1996).

20. Kohn, D. L. (2008). *Monetary Policy and Asset Prices Revisited.* A speech given at the Cato Institute's 26th Annual Monetary Conference, Washington, D.C., November 19 available at http://www.federalreserve.gov/newsevents/speech/kohn20081119a.htm.

21. Koopman, SJ, Harvey, A.C., Doornik, J.A. and Shepard, N. (2007). *Structural Time Series Analyzer, Modeller, and Predictor (STAMP 8.2).* Timberlake Consultants, Ltd.

22. Krainer, J.M., M. Spiegel and N. Yamori (2005). *Asset Price Decline and Real Estate Market Illiquidity: Evidence from Japanese Land Values.* Federal Reserve Bank of San Francisco Working Paper No. 2004-16, Center for Pacific Basin Studies.

23. Medium-Term Philippine Development Plan 2004-2010. 2005. National Economic and Development Authority (NEDA), Philippines.

24. Schwartz, A. (2002). Asset Price Inflation and Monetary Policy. NBER Working Paper 9321 (November 2002) <http://www.nber.org/papers/w9320>

25. Smets, F. (1997). *Financial Asset Prices and Monetary Policy: Theory and Evidence.* Bank for International Settlements. WP No. 47 (September 1997).

## Appendix 1
## Statistical Treatment of the Components[23]

The state equation for the trend has two parts. These are the level and the slope, in which the latter may not be necessarily present. The trend may be specified as follows:

(1) Local level or random walk plus noise.

Measurement equation: $y_t = \mu_t + \varepsilon_t;$ $\varepsilon_t \sim NID(0, \sigma_\varepsilon^2)$ $t = 1,.....T$

State equation: $\mu_t = \mu_{t-1} + \eta_t;$ $\eta_t \sim NID(0, \sigma_\eta^2)$

(2) Local linear trend (stochastic trend component):[24]

Measurement equation: $y_t = \mu_t + \varepsilon_t;$ $\varepsilon_t \sim NID(0, \sigma_\varepsilon^2)$

State equation: $\mu_t = \mu_{t-1} + \beta_{t-1} + \eta_t;$ $\eta_t \sim NID(0, \sigma_\eta^2)$

State equation: $\beta_t = \beta_{t-1} + \zeta_t;$ $\zeta_t \sim NID(0, \sigma_\zeta^2)$

If $\mu_t$ is stochastic, then the state equation contains $\eta_t$. Otherwise, if $\mu_t$ is fixed, $\eta_t$, equals zero, hence, $\sigma_\eta^2$=0. The choice of a fixed level results in a smooth trend and is also often specified in combiantion with a cycle or autoregressive component. The slope of the trend is given by $\beta_t$, which can be stochastic, i.e. it contains $\zeta_t$ or fixed, without $\zeta_t$. The slope can even be excluded from the estimation, as exemplified by the local level or random walk plus noise specification. The irregular $\varepsilon_t$, the level disturbance $\eta_t$ and the slope disturbance $\zeta_t$ are mutually uncorrelated.

STAMP carries out maximum likelihood estimation of the variances, $\sigma_\varepsilon^2$, $\sigma_\eta^2$, and $\sigma_\zeta^2$. After estimation, STAMP runs Kalman filter through the observations to estimate the state $\mu_t$. The state $\mu_t$ reported in the Appendix refers to the estimated trend at all points in the sample using all observations, otherwise known as smoothing or signal extraction.[25]

---

[23] The discussion is taken from Koopman, S.J., Harvey, A.C., Doornik, J.A. and Shepard, N. (2007). *Structural Time Series Analyzer, Modeller, and Predictor (STAMP 8.2).* Timberlake Consultants, Ltd

[24] Specifying the level and slope to be both stochastic, otherwise known as the local linear trend model, is the default specification in STAMP.

[25] There are also the filtered estimate and the predicted estimate. The former is based only on previous and current observations whereas the latter is based only on previous observations.

(3) STAMP is also capable of modeling pseudo-cyclical behavior that characterizes many time series. It allows specification of up to three stochastic cycles. The statistical specification of a cycle $\psi_t$ is given by:

$$\begin{bmatrix} \psi_t \\ \psi_t^* \end{bmatrix} = \rho \begin{bmatrix} \cos\lambda_c & \sin\lambda_c \\ -\sin\lambda_c & \cos\lambda_c \end{bmatrix} \begin{bmatrix} \psi_{t-1} \\ \psi_{t-1}^* \end{bmatrix} + \begin{bmatrix} \kappa_t \\ \kappa_t^* \end{bmatrix}, t = 1,....,T$$

where $\lambda_c$ is the frequency in the range $0< \lambda_c < \pi$; $\rho$ is the damping factor; $\kappa_t$ and $\kappa_t$* are mutually uncorrelated white noise disturbances with common variance $\sigma_\kappa^2$ . The period is given by $2\pi/\lambda_c$. The stochastic cycle becomes a first-order autoregressive process is $\lambda_c$ is zero or $\pi$. The options available for cycles are 5-year, 10-year, and 20-year cycles.

(4) Whenever appropriate, a seasonal component (which can be detected also via visual inspection) may be included. It has trigonometric seasonal form given by:

$$\gamma_t = \sum_{j=1}^{[s/2]} \gamma_{j,t} \text{ and } \gamma_{j,t} \text{ is generated by}$$

$$\begin{bmatrix} \gamma_{j,t} \\ \gamma_{j,t}^* \end{bmatrix} = \begin{bmatrix} \cos\lambda_j & \sin\lambda_j \\ -\sin\lambda_j & \cos\lambda_j \end{bmatrix} \begin{bmatrix} \gamma_{j,t-1} \\ \gamma_{j,t-1}^* \end{bmatrix} + \begin{bmatrix} \omega_{j,t} \\ \omega_{j,t}^* \end{bmatrix}, \ \mathrm{j} = 1,....,[\mathrm{s}/2]; \mathrm{t} = 1,....,\mathrm{T}$$

where $\lambda_j = 2\pi j/s$ is the frequency in radians; $\omega_t$ and $\omega_t$* are mutually uncorrelated white noise disturbances with common variance $\sigma_\omega^2$ . When j=s/2, the component collapses to $\gamma_{j,t} = \gamma_{j,t-1} \cos\lambda_j + \omega_{j,t}$ .

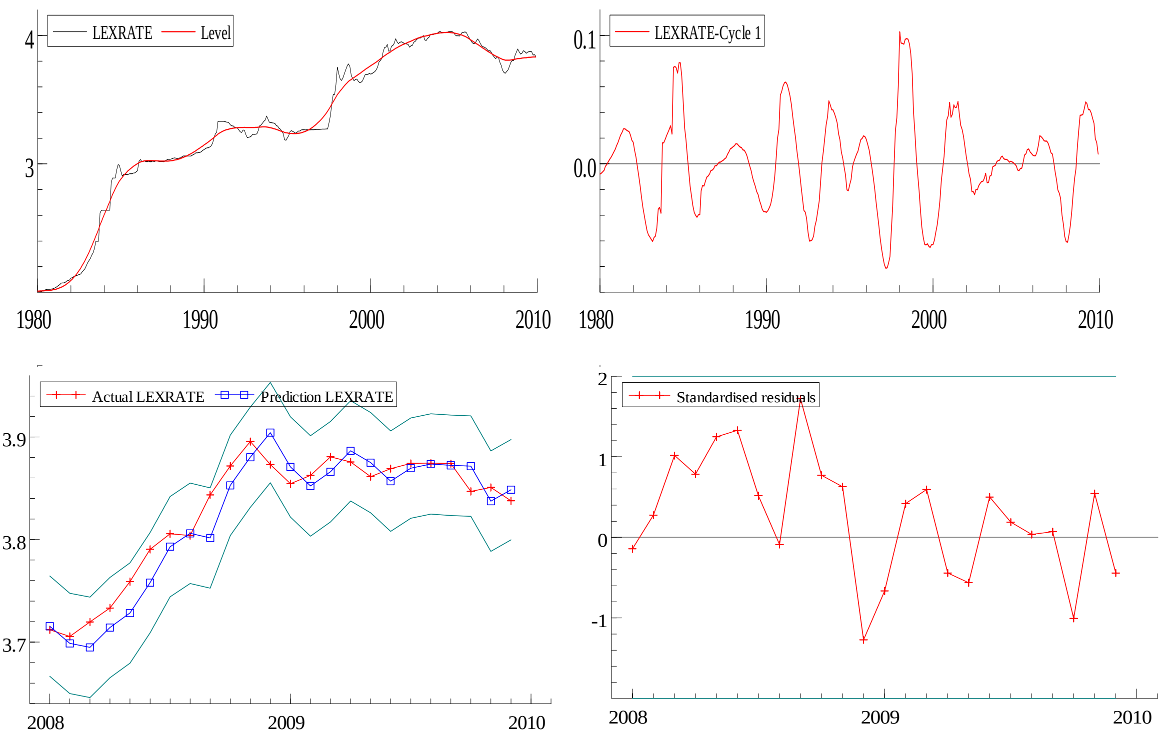
## Appendix 2
## Final State Vector Estimation Results[26]

The final state vector contains latest information on the components of the model. The *t-value* is the estimate of the state divided by the root mean square errors (RMSE). The probability values correspond to the absolute value of a standard normal variable exceeding the absolute value of the t-value. There are some important consideration in interpreting the results. The *t-value* may not appear for the level when no irregular is included or when the irregular variance is estimated to be zero. It is also not appropriate for a cycle because a cycle component is not persistent throughout the series. The same may be said for a slope estimate $\beta_T$ because of possible breaks. For the seasonal component, the relevant test statistic is the seasonal $Chi^2$ (s-1) under the null hypothesis of no seasonality. In the case of stochastic seasonal, the joint seasonal test is inappropriate whereas if the seasonal is quite persistent and changes quite slowly, then the test statistic provides useful information.

Since the data used are in logs, the slope component, when specified, gives the annual growth rate. The cycle component, on the other hand, gives the amplitude of the cycle relative to the level of the trend.

The goodness of fit all relate to the residuals. The prediction error variance (PEV) is the variance of the residuals in the steady state, which corresponds to the variance of the disturbance of the reduced form ARIMA model. Another measure of fit is the mean deviation (MD) of the residuals.

## I. Exchange Rate

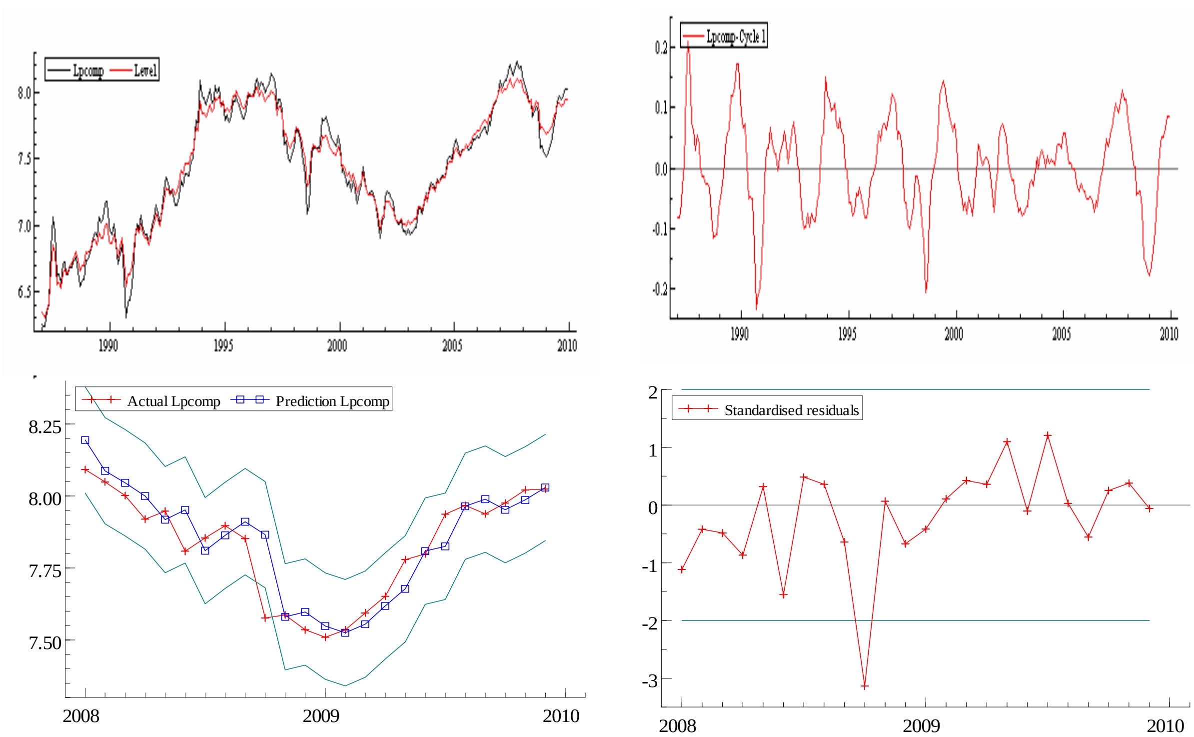



[26] The discussion on the interpretation of results is also culled from Koopman, S.J., Harvey, A.C., Doornik, J.A. and Shepard, N. (2007). *Structural Time Series Analyzer, Modeller, and Predictor (STAMP 8.2).* Timberlake Consultants, Ltd.

```
State vector anti-log analysis at period 2009(12)
It is assumed that time series is in logs.
                                  Value       Prob
Level (anti-log)               46.21583 [0.00000]
Level (bias corrected)         46.26191 [    .NaN]
Slope (yearly %growth)          0.69394 [0.93423]
Cycle 1 amplitude (%trend)      3.64696 [    .NaN]
```

```
Goodness-of-fit based on Residuals LEXRATE
                                               Value
Prediction error variance (p.e.v)         0.00059494
Prediction error mean deviation (m.d)      0.0003161
Ratio p.e.v. / m.d in squares                 2.2551
Coefficient of determination R^2             0.99826
... based on differences Rd^2                0.07687
... based on diff around seas mean Rs^2     0.038237
Information criterion Akaike (AIC)           -7.4104
... Bayesian Schwartz (BIC)                   -7.378
```

## II. Stock Price

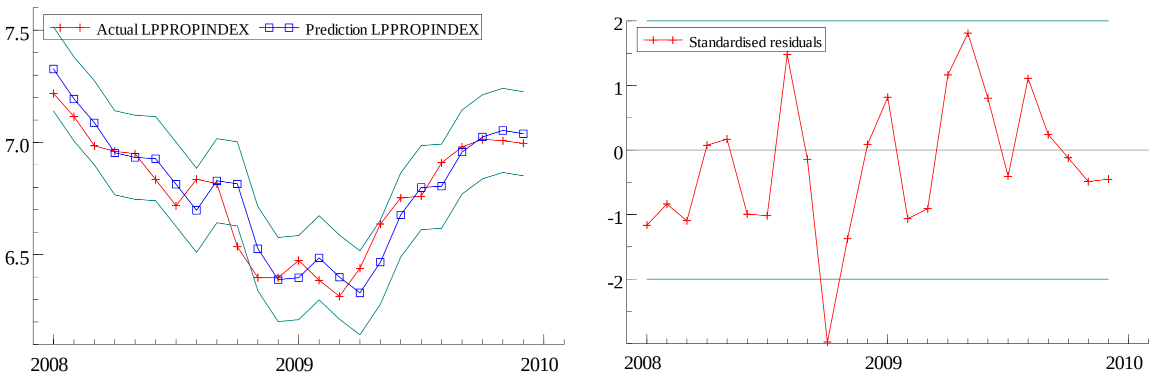



```
State vector anti-log analysis at period 2009(12)
It is assumed that time series is in logs.
                                  Value       Prob
Level (anti-log)             2805.62998 [0.00000]
Level (bias corrected)       2820.63717 [    .NaN]
Slope (yearly %growth)          6.98095 [0.21189]
Cycle 1 amplitude (%trend)      8.26874 [    .NaN]
```

**Goodness-of-fit based on Residuals Lpcomp**

| | Value |
|---|---|
| Prediction error variance (p.e.v) | 0.0084218 |
| Prediction error mean deviation (m.d) | 0.0061518 |
| Ratio p.e.v. / m.d in squares | 1.1932 |
| Coefficient of determination R^2 | 0.96296 |
| ... based on differences Rd^2 | 0.019139 |
| ... based on diff around seas mean Rs^2 | -0.048747 |
| Information criterion Akaike (AIC) | -4.7552 |
| ... Bayesian Schwartz (BIC) | -4.7158 |

## 2.1 Property Stock Price Index



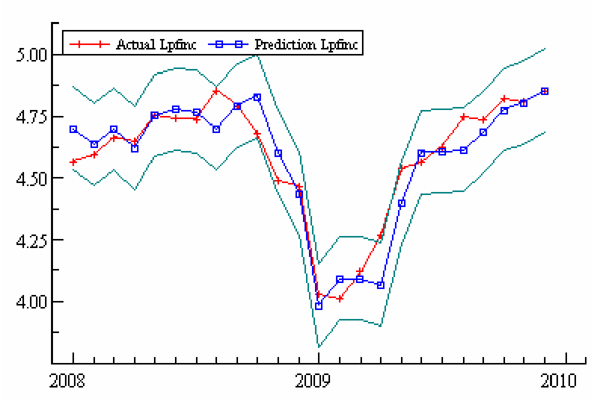

**State vector anti-log analysis at period 2009(12)**
**It is assumed that time series is in logs.**

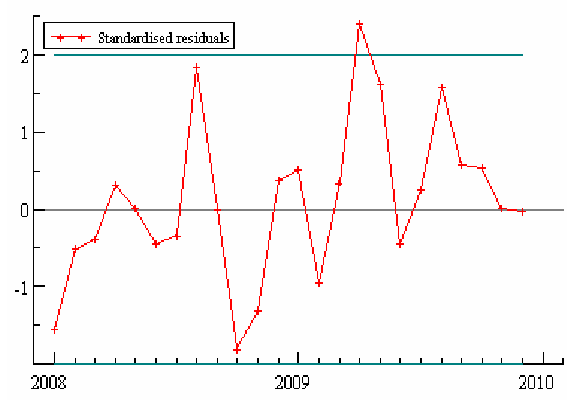
| | Value | Prob |
|---|---|---|
| Level (anti-log) | 930.30380 | [0.00000] |
| Level (bias corrected) | 945.24088 | [ .NaN] |
| Cycle 1 amplitude (%trend) | 21.65777 | [ .NaN] |

**Goodness-of-fit based on Residuals LPPROPINDEX**

| | Value |
|---|---|
| Prediction error variance (p.e.v) | 0.0087283 |
| Prediction error mean deviation (m.d) | 0.006721 |
| Ratio p.e.v. / m.d in squares | 1.0737 |
| Coefficient of determination R^2 | 0.94655 |
| ... based on differences Rd^2 | 0.034432 |
| ... based on diff around seas mean Rs^2 | -0.03946 |
| Information criterion Akaike (AIC) | -4.7192 |
| ... Bayesian Schwartz (BIC) | -4.684 |

## 2.2 Financial Stock Price Index

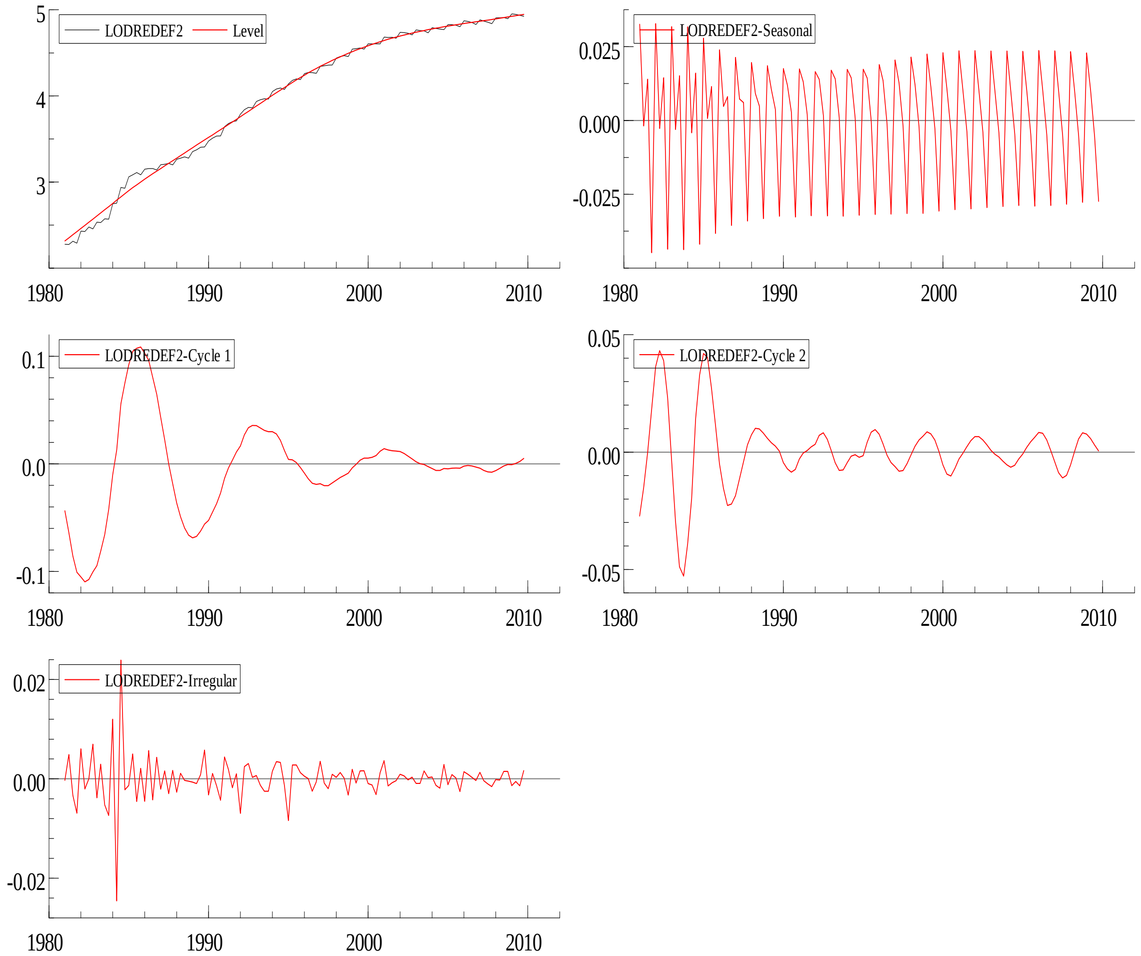


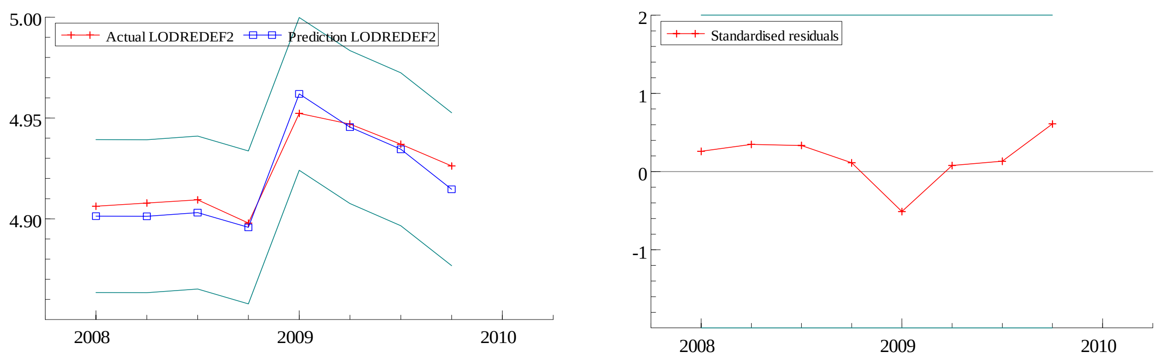




```
State vector anti-log analysis at period 2009(12)
It is assumed that time series is in logs.
                                  Value        Prob
Level (anti-log)              113.16600 [0.00000]
Level (bias corrected)        113.47729 [    .NaN]
Slope (yearly %growth)         41.77342 [0.26916]
Seasonal chi2 test            508.34947 [0.00000]
Cycle 1 amplitude (%trend)      4.06152 [    .NaN]
Seasonal effects:
                Period        Value        Prob      %Effect
                     1      0.73286 [0.00000]    -26.71384
                     2      0.80460 [0.00000]    -19.53955
                     3      0.91868 [0.00382]     -8.13153
                     4      0.91779 [0.00344]     -8.22132
                     5      1.03996 [0.17632]      3.99566
                     6      1.06912 [0.02181]      6.91220
                     7      1.12028 [0.00013]     12.02805
                     8      1.13625 [0.00002]     13.62459
                     9      1.06649 [0.02717]      6.64850
                    10      1.10781 [0.00052]     10.78135
                    11      1.07783 [0.01039]      7.78313
                    12      1.11602 [0.00022]     11.60241

Goodness-of-fit based on Residuals Lpfinc
                                                 Value
Prediction error variance (p.e.v)             0.006002
Prediction error mean deviation (m.d)        0.0044146
Ratio p.e.v. / m.d in squares                   1.1768
Coefficient of determination R^2               0.93952
... based on differences Rd^2                  0.76984
... based on diff around seas mean Rs^2        0.22901
Information criterion Akaike (AIC)             -4.9362
... Bayesian Schwartz (BIC)                    -4.6625
```

## III. House Price




```
State vector anti-log analysis at period 2009(4)
It is assumed that time series is in logs.
                                  Value      Prob
Level (anti-log)              140.65872 [0.00000]
Level (bias corrected)        140.71575 [    .NaN]
Slope (yearly %growth)          3.04909 [0.15240]
Seasonal chi2 test             41.93627 [0.00000]
Cycle 1 amplitude (%trend)      0.60429 [    .NaN]
Seasonal effects:
            Period     Value     Prob        %Effect
                     1     1.02307 [0.00002]     2.30683
                     2     1.01014 [0.04451]     1.01408
                     3     0.99447 [0.24571]    -0.55295
                     4     0.97302 [0.00000]    -2.69804
```

**Goodness-of-fit based on Residuals LODREDEF2**

| | Value |
|---|---|
| Prediction error variance (p.e.v) | 0.00034402 |
| Prediction error mean deviation (m.d) | 0.00023306 |
| Ratio p.e.v. / m.d in squares | 1.3871 |
| Coefficient of determination R^2 | 0.99951 |
| ... based on differences Rd^2 | 0.80788 |
| ... based on diff around seas mean Rs^2 | 0.48862 |
| Information criterion Akaike (AIC) | -7.8714 |
| ... Bayesian Schwartz (BIC) | -7.7289 |