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ABSTRACT

The Persistence of Capital Inflows and the Behaviour of Stock Prices in East Asia Emerging Markets: Some Empirical Evidence*

We examine the view that the recent East Asian crisis was precipitated by bursting asset price bubbles that had been fuelled by strong capital inflows, which were largely the result of a moral hazard problem in financial intermediation, and was exacerbated by a vicious cycle of asset price deflation and incipient and actual capital flight. We find evidence of stock market bubbles in all the East Asian economies examined, except Australia. We examine various categories of capital flows to these countries and find, in particular, relatively high reversible components in portfolio flows to East Asian economies.

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NON-TECHNICAL SUMMARY

A widely held view concerning the severe financial crisis which afflicted a number of East Asian economies during 1997 is that strong capital inflows (themselves largely due to a moral hazard problem whereby investors mistakenly perceived implicit guarantees on their investment) generated asset market bubbles which, when they burst, precipitated an actual or incipient capital flight which strongly exacerbated asset price falls and set into motion a vicious cycle of further asset price falls, insolvency of financial intermediaries, and further actual or incipient capital flight.

This paper provides the first tests of this 'moral hazard' interpretation. In particular, we test for the presence of bubbles in a number of East Asian stock markets in the period leading up to the crisis and we also examine the time series properties of capital flows to the same set of countries for evidence of reversibility.

Visual examination of stock price and dividend indices for the East Asian markets we examined strongly suggests the presence of bubbles, and our formal statistical tests allow us to reject the bubbles hypothesis at the five percent significance level only for Australia – which was not a victim of the crisis. This would therefore seem to support the moral hazard interpretation.

Our empirical results from Kalman filtering analysis of the data also provide strong evidence that the permanent component in equity and bond flows to East Asian economies was very small in size compared to the temporary component over the sample period. The results for East Asian emerging markets contrast with the finding that for both Japan and Australia the permanent component, whilst smaller than the temporary component in relative size, explains a very significant proportion of the variation in both equity and bond capital inflows. This is consistent with the hypothesis that the sudden actual or incipient reversal of portfolio flows may have played an important part in the East Asian crisis, as the moral hazard interpretation suggests. Moreover, while we are not able to reject the hypothesis of stock price bubbles for Japan, the high permanent component of portfolio flows to that country may well have protected it from the worst of the East Asian crisis in that, when its stock market declined in 1997, the vicious cycle described above was largely prevented from going into operation.

Of the other categories of flows, commercial bank credit and foreign direct investment show very much higher permanent components, while official flows show greater cross-country variation and, in any case, are generally very much smaller in magnitude than the other categories.

Taken together, our findings corroborate the moral hazard interpretation of the East Asian currency and financial crisis. The fact that Australia, in particular, displays much more permanence in private portfolio flows and no evidence of stock price bubbles is particularly interesting; and the high permanent component of portfolio flows to Japan may well have shielded it from the full brunt of the crisis which was experienced in other East Asian economies.

I. Introduction

The financial and currency crisis which afflicted a number of East Asian economies during 1997 has, within a very short period, been the subject of a very large number of analyses[1]. In this paper we provide the first tests of a widely held view that the recent East Asian financial and currency crisis was precipitated by bursting asset price bubbles which had been fuelled by strong capital inflows and was exacerbated by a vicious cycle of asset price deflation and incipient and actual capital flight. Private capital flows to East Asian countries recorded a remarkable increase in the 1990s, as a consequence of the structural change in world financial markets in the form of increasing globalization and the transition of some East Asian countries from isolated to integrated financial markets. This surge of capital inflows, which, in a highly integrated environment, are subject to potentially fast and large reversals, has generated a number of concerns for policy makers. In particular, a number of authors - notably the World Bank (1997) - have suggested that portfolio inflows to emerging financial markets may tend to generate bubble behavior in asset markets. Indeed, a plausible interpretation of the East Asian crisis may be based on the link between large capital inflows, a moral hazard problem induced by financial intermediaries, subsequent overinvestment and an explosive bubble in asset prices (e.g. see Bhattacharya, Claessens, Ghosh, Hernandez and Alba, 1998; Corsetti, Pesenti and Roubini, 1998; Edison, Luangaram and Miller, 1998; Krugman, 1998)[2]. Thus, a crucial role in the process leading to the crisis may have been played by financial intermediaries, whose liabilities were perceived as having an implicit government guarantee, but were essentially unregulated and hence subject to severe moral hazard problems. The excessive risky lending of these financial intermediaries generated strong asset price inflation or even bubbles, sustained by a circular process in which the proliferation of risky lending drove up the prices of risky assets, making the financial condition of these institutions appear to be sounder than it actually was. At some point, however, the bubble bursts and the mechanics of the crisis is then described by the same circular process in reverse: asset prices begin to fall, making the insolvency of financial intermediaries highly visible, forcing them to cease operations and generating increasingly fast asset price deflation, leading to actual or incipient capital flight as asset prices collapse.

This 'moral hazard' interpretation appears, at least at a casual empirical level, to fit the facts of the East Asian crisis well, whereas other standard currency crisis models apparently do not. Indeed,

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both 'first-generation' currency crisis models (Krugman. 1979: Flood and Garber, 1984) as well as 'second-generation' models (Obstfeld. 1994, 1996) appear to miss some important features of the East Asian crisis in the sense that, in the countries concerned, there appeared no evidence of the kind of fiscal deficits which typically trigger a crisis in 'first-generation' models, nor did there appear to be any strong temptation for the authorities to abandon a fixed exchange rate system in order to pursue a more expansionary monetary policy, as one might expect in a 'second-generation' model. While this casual empiricism would tend to favor the moral hazard interpretation, it is the purpose of the present paper to advance the empirical status of the moral hazard interpretation beyond the casual empirical level.

We therefore provide the first empirical tests of the 'moral hazard' interpretation of the East Asian crisis through an examination both of stock market behavior and of the nature of various categories of capital flows to East Asian economies. We first test for the presence of asset price bubbles in a set of East Asian economies (as well as Australia and Japan) in the period leading up to the crisis. Evidence of asset market bubbles in the East Asian economies affected by the crisis - and evidence of the absence of bubbles in economies not strongly affected by the crisis - would tend to support the moral hazard interpretation. We then break down time series on various capital flows to the same set of countries into their permanent and temporary components to see whether any of the categories do indeed display a high temporary component, since the reversibility of capital inflows is an important element of the moral hazard interpretation of the crisis. The moral hazard interpretation would be supported if certain categories of capital flows - notably portfolio flows - displayed a high reversible component, especially if flows to economies left relatively unscathed by the crisis displayed higher permanent components.

The remainder of the paper is set out as follows. In Section II we describe the data set used. In Section III we describe our method of testing for asset price bubbles and report the empirical results of applying these tests to our data set. In Section IV we establish our priors as to the expected time series properties of the varioius capital account items, describe the techniques employed to decompose the time series into permanent and temporary components, and report and discuss the empirical results on the persistence of capital inflows. A final section concludes.

II. Data

II.1 Stock market data

We employ data on monthly aggregate stock prices and dividends for eight East Asian countries - China, Indonesia, Malaysia, Philippines, Singapore, South Korea, Taiwan and Thailand - in addition to Japan and Australia. Data for the emerging market countries are from the Emerging Markets Data Base (EMDB) of the International Finance Corporation (IFC), except for Singapore, which is not considered an emerging market by the IFC[3]. Data for Singapore, Japan and Australia are standard stock price and dividend indices downloaded from *Datastream*. The sample period varies by market: all time series end in 1997M12, but there are several starting dates, namely 1994M1 for China, 1992M1 for Indonesia and Taiwan, 1989M11 for Malaysia, Philippines and Thailand, 1993M1 for South Korea, and 1988M1 for Singapore, Japan and Australia. Data for consumer price indices for each of the countries under investigation were taken from the International Monetary Fund's *International Financial Statistics* CD.[4]

In general, the IFC (or IFC Global, IFCG) indices are intended to represent the performance of the most active stocks in their respective stock markets and to be the broadest possible indicator of market movements. In order to ensure that the IFCG indices capture the real market, the target aggregate market capitalization of IFCG index constituents is 60 to 75 percent of the total capitalization of all exchange-listed shares (see IFC, 1998)[5]. The EMDB data employed here, however, are the IFC Investable (IFCI) indices, which are specifically designed to measure the type of returns foreign portfolio investors might receive from investing in emerging market securities that are legally and practically available to them. The calculation methodology is the same as for the IFCG indices, but applied to a subset of IFCG index constituents that IFC has determined as 'investable', that is stocks which are available to foreign institutional investors and which pass screens for minimum size and liquidity (see IFC, 1998, pp. 28-34). The time series of interest are the real stock price index and the real dividend index, constructed by deflating the IFCI stock price and dividend indices by the consumer price indices for each country examined[6].

II.2 Capital flows data

We employ a data base on the various categories of US capital flows to the same set of

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countries (China. Indonesia. Malaysia. Philippines. Singapore. South Korea. Taiwan. Thailand. Japan and Australia) as well as for Hong Kong from the beginning of 1988 through to the end of 1997.

For US portfolio (equity and bond) flows and official flows to these countries. the frequency of our data base is monthly. These time series were constructed using the *International Capital Reports* of the US Treasury Department[7]. Following a number of studies. we use net equity flows and gross bond flows to these developing countries[8]. since even if in principle we are concerned with modeling net capital flows, it seems preferable to use gross measures for bond flows in order to abstract from the effect of sterilization policy actions and other types of reserve operations by monetary authorities (see e.g. Chuhan, Claessens and Mamingi, 1998; Taylor and Sarno, 1997; Sarno and Taylor, 1998).

Quarterly data on US commercial bank credit flows to the same developing countries were taken from the *US Treasury Bulletin* (Capital Movements Section, Table CM-II-2) which presents claims on foreigners reported by US banks and other depository institutions. brokers. and dealers[9]. Also, quarterly data for foreign direct investment (FDI) to those developing countries were taken from the diskette *US Direct Investment Abroad* of the US Department of Commerce[10]. The sample period runs from 1988M1 to 1997M12 for equity flows (EF), bond flows (BF) and official flows (OF), and from 1988Q1 to 1997Q4 for the series on bank credit (BC) and FDI.

III. Testing for Bubbles in East Asian Stock Markets

In Figure 1 we have graphed the real stock price and dividend series (in deviations from mean) for three representative East Asian markets - Indonesia. Thailand and Korea - as well as for Australia. This gives a strong visual impression of the differences in asset market behavior in the East Asian economies compared with Australia over the sample periods. In particular, the three East Asian markets appear to display text book examples of periodically collapsing stock price bubbles: by and large, the real stock price series appear often to diverge rapidly away from the real dividend series. often collapsing after a period of rapid price advancement and then proceeding again[11]. All three also show apparently unwarranted strong rises in stock prices in the period preceeding the 1997 crisis and catastrophic declines during 1997. Australia, in contrast, displays a declining trend in real stock prices which largely mirrors the declining trend in the real dividend series, and there appears to be no tendency towards the 'boom-bust-crash' behavior evident in the three East Asian markets.

Informally, therefore, this visual evidence suggests that testing for bubbles in these markets may be a fruitful exercise, especially since the presence of bubbles is a key element in the moral hazard interpretation of the East Asian crisis.

III.1 Explosive stock price bubbles and present value relations

A stock price bubble may be thought of as an explosive component of the stock price which is not present in the underlying fundamentals such as the dividend and which therefore drives an explosive wedge between the stock price series and the underlying fundamentals. Intuitively, a bubble may be present where the stock price is diverging rapidly away from the price suggested by the economic fundamentals; formally, rational bubbles arise where there is a failure of a transversality condition and so a unique solution cannot be assumed from among the infinite number of solutions to the basic Euler equation of the system. Specifically, if the fair price of the stock at time t , P_t, is equal to the present value of its expected price next period plus any expected dividend income, D_{t-1}, then assuming for the moment a constant expected return r, the basic Euler equation is:

$$P_t = E_t\left[\frac{P_{t+1} + D_{t+1}}{1+r}\right] \tag{1}$$

If P_t^* is a solution to (1), then so is any stock price of the form $P_t = P_t^* + B_t$, where B_t - which can be thought of as the rational bubble - is any term which satisfies:

$$B_t = E_t(1+r)^{-1}B_{t+1} \tag{2}$$

From (2), the bubble term B_t is explosive by construction.

Diba and Grossman (1988) suggest testing for cointegration between real stock prices and dividends as a test for the presence of bubbles. The rationale of this test is that if stock prices and dividends are realizations of I(1) (i.e. difference-stationary) processes, then in the absence of bubbles the standard present value model of stock prices implies cointegration between the stock price and dividend series (see e.g. Campbell and Shiller, 1987; Campbell, Lo and MacKinlay, 1997). In other words, the difference between the stock price and a multiple of the dividend should define a stationary process. If the stock price series contains an explosive bubble term, however, which is not by

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definition in the dividend price series. then this will drive a wedge between prices and dividends so that they will not be cointegrated[12].

The Diba-Grossman analysis is couched in terms of a present value model of stock prices with constant expected returns. Their approach can. however. be extended to the time-varying expected returns case as follows. Begin by writing the definition of the *ex post* stock return r_{t+1}, as[13]:

$$r_{t+1} \equiv \log(P_{t+1} + D_{t+1}) - \log(P_t) \tag{3}$$

Taking a Taylor series approximation of (3), Campbell. Lo and MacKinlay (1997, pp. 261-2) derive the relationship:

$$r_{t+1} \approx \kappa + \rho p_{t+1} + (1 - \rho) d_{t+1} - p_{t+1} \tag{4}$$

where $\rho \equiv 1/[1+\exp(d-p)]$, $\kappa \equiv -\log(\rho)-(1-\rho)\log(1/\rho-1)$ and d-p is the average log dividend-price ratio and where lower case letters denote the logarithms of the variables denoted by the corresponding upper case letters. Solving (4) forward. imposing the transversality condition that

$$\lim_{j \to \infty} \rho^j p_{t+j} = 0 \tag{5}$$

and taking expectations conditional on information at time t. we obtain:

$$p_t = \frac{\kappa}{1-\rho} + E_t \left[\sum_{j=0}^{\infty} \rho^j [(1-\rho)d_{t+1+j} - r_{t+1+j}] \right] \tag{6}$$

Rearranging this equation. we can obtain an expression for the log dividend-price ratio:

$$d_t - p_t = \frac{\kappa}{1-\rho} + E_t \left[\sum_{j=0}^{\infty} \rho^j [-\Delta d_{t+1+j} + r_{t+1+j}] \right] \tag{7}$$

If d_t and p_t are each generated by I(1) processes, then (7) implies that the log dividend-price ratio will be a stationary, I(0) process if and only if the stock price return series r_t is generated by a stationary, I(0) process. In practice, Campbell, Lo and MacKinlay (1997) point out that, at least with US data, r_t appears to be generated by a highly persistent process which may be hard to distinguish from an I(1) process. Thus, testing for stationarity of the log dividend-price ratio may be problematic in the varying-returns model. Rearranging (7) further, however, we obtain:

$$d_t - p_t - \frac{1}{1-\rho}r_t = \frac{\kappa}{1-\rho} + E_t\left[\sum_{j=0}^{\infty} \rho^j [-\Delta d_{t+1-j} - \frac{1}{1-\rho}\Delta r_{t+1-j}]\right] \qquad (8)$$

which implies that the problem may be ameliorated by testing for cointegration between the log dividend-price ratio and the stock return. Even if r_t is only highly persistent rather than a strictly I(1) process - i.e. has a root just within rather than actually on the unit circle - the left-hand side of (8) should appear as a realization of a stationary process in the of bubbles.

Nevertheless, in the presence of a rational bubble - in other words a failure of the transversality condition (5) - none of the relations (4)-(8) can be derived because they are dependent upon a Taylor series approximation of the *ex post* stock return which is derived assuming a constant mean log dividend-price ratio. In the presence of a bubble in stock prices then cointegration between the log of prices and the log of dividends. or between the log dividend-price ratio and the real rate of return cannot be established.

The procedure for testing for bubbles which we adopt is therefore as follows. We first test for stationarity of the log dividend-price ratio and the *ex post* rate of return, and we then test for cointegration between the log dividend-price ratio and the rate of return. If the log dividend-price ratio series and the ex post return series were both stationary, or if the log dividend-price ratio series and *ex post* returns cointegrated to a stationary series, this would indicate a rejection of the hypothesis of stock price bubbles.

The interpretation of cointegration tests as tests for rational bubbles has. however. been shown to be potentially misleading in the presence of bubbles which collapse from time to time over the sample period - i.e. periodically collapsing bubbles (Evans, 1991)[14]. Specifically, Evans (1991) shows that cointegration tests will tend to reject the null hypothesis of no bubbles more often than suggested by the chosen significance level when there are periodically collapsing bubbles. This may be particularly problematic in the present context given the strong visual impression. noted above, that the East Asian markets may have been prone to periodically collapsing bubbles.

The essence of this problem lies in the fact that periodically collapsing stock price bubbles will tend to generate skewness and excess kurtosis in time series for stock prices over and above that which may be present in time series for dividends [15]. Taylor and Peel (1998) point out that since in standard

unit root and cointegration tests. the maintained hypothesis is a linear autoregressive model in which the error term is essentially assumed to follow a Gaussian process. then a test based on the estimated autoregressive coefficients will tend to average out the exploding part of the bubble and its collapse in the estimated coefficients. so that it will be biased towards rejection of non-stationarity. They also note that if a test for non-stationarity is used which allows the collapse in the bubble to be attributed largely to a sudden movement in a non-normal error term rather than the estimated coefficients of the autoregressive model, then the bias should be reduced. Taylor and Peel then propose a test statistic based on the work of Im (1996) which explicitly exploits the skewness and excess kurtosis which bubbles engender in the data, and show by Monte Carlo methods that the problem of size distortion is greatly reduced with their proposed test.

The essential features of the test proposed by Taylor and Peel may briefly be described as follows. Consider the simple linear regression model:

$$y_t = \Psi' z_t + u_t \tag{9}$$

where $z_t = (1 \ x_t')'$, x_t is a $(k-1) \times 1$ vector of time series observed at time t, while $\Psi = (\vartheta \ \beta')'$ is the parameter vector where ϑ is the intercept and β is the $(k-1) \times 1$ vector of parameters of interest. As noted by Wooldridge (1993) and others, greater efficiency can be obtained by including in a regression variables which covary with the errors but are uncorrelated with the regressors. Im (1996) designs covariates which have these properties when the residuals are characterized by the presence of skewness and excess kurtosis and which can therefore be used to obtain a more efficient estimator. In particular, excess kurtosis in the residuals beyond what would be expected given Gaussian errors implies that the standardized fourth central moment of the series exceeds three, so that

$$E(u_t^4 - 3\sigma^4) = E[u_t(u_t^3 - 3\sigma^2 u_t)] \neq 0 \tag{10}$$

implying that $u_t^3 - 3\sigma^2 u_t$ is correlated with u_t but not with the regressors since x_t and u_t are by assumption independent. Similarly, when the errors are skewed the standardized third central moment is non-zero, so that

$$E(u_t^3 - \sigma^3) = E[u_t(u_t^2 - \sigma^2)] \neq 0 \tag{11}$$

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which implies that $u_t^2 - \sigma^2$ is correlated with u_t but not with the regressors (again since x_t and u_t are by assumption independent). Im (1996) therefore suggests a two-step estimator which can be computed from ordinary least squares (OLS) applied to (9) augmented by the term $\hat{w}_t = [(\hat{u}_t^3 - 3\hat{\sigma}^2\hat{u}_t) \times (\hat{u}_t^2 - \hat{\sigma}^2)]'$, where $\hat{u}_t$ denotes the residual and $\hat{\sigma}^2$ the standard residual variance estimate obtained from OLS applied to (9). The resulting estimator is the residuals-augmented least squares (RALS) estimator of β, β^* say, and Im derives analytically its asymptotic distribution and shows how the covariance matrix for β^* can be consistently estimated. Im also provides a measure of the asymptotic efficiency gain from employing RALS as opposed to OLS through the statistic ρ^2 constructed as the ratio of the OLS and RALS residual variance terms (ρ^2 is small for large efficiency gains), and also shows that this gain can be substantial for a range of alternative non-normal error distributions[16]. Im suggests that the decision as to whether to employ the RALS estimator might be based on the results of tests of normality of the error distribution such as that suggested by Jarque and Bera (1987), which is based directly on the estimated coefficients of skewness and excess kurtosis.

The unit root and cointegration test statistics employed and analyzed by Taylor and Peel (1998) are Dickey-Fuller and cointegrating regression Dickey-Fuller test statistics constructed using the RALS estimator - the RALS Dickey-Fuller and RALS cointegrating regression Dickey-Fuller test statistics.

III.2 Testing for bubbles in East Asia

Hansen (1995) shows that, in general, the asymptotic critical values for unit root tests generated from auxiliary regressions with covariates may lead to substantial small-sample size distortion. Accordingly, we generated the appropriate finite-sample critical values for the RALS Dickey-Fuller statistic, τ_A, from 20,000 draws across an assumed random-walk data-generating process with Gaussian errors, with the drift and error variance calibrated from OLS estimates of a random walk model for the monthly log dividend-price ratio data for each of the countries and sample periods described in Section II.1[17]. In addition to calculating the empirical distribution of τ_A, we also used the Monte Carlo experiments to calculate the empirical distribution of the standard Dickey-Fuller test statistic, τ.

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We also generated the empirical distribution of the RALS cointegrating regression Dickey-Fuller statistic, $CR\tau_A$, applied to the residuals from a regression of artificial log dividend-price ratios onto artificial *ex post* returns under the null hypothesis of no-cointegration, using the same artificial data generating process for the log dividend-price ratios and another drifting random walk process for returns, calibrated from least squares estimation using actual real *ex post* return series for each country and sample period. The critical values were again generated using 20.000 draws. In addition to calculating the empirical distribution of $CR\tau_A$, we also calculated the empirical distribution of the standard cointegrating regression Dickey-Fuller statistic $CR\tau$.

In Table 1 Panel A we report the resulting empirical critical values at the one and five percent level for each of τ, τ_A, $CR\tau$ and $CR\tau_A$. The empirical distributions of τ and $CR\tau$ are unsurprising and their empirical critical values are close to those implied by the response surface results of MacKinnon (1991). Although the asymptotic distribution of τ_A and $CR\tau_A$ are identical to those of τ and $CR\tau$ for $\rho^2=1$, their small-sample distributions appear to differ reasonably substantially from one another, so that the critical values for τ_A and $CR\tau_A$ deviate more from the corresponding values of the normal distribution compared to τ and $CR\tau$.

Next, we applied the τ, τ_A, $CR\tau$ and $CR\tau_A$ test statistics to the monthly aggregate *ex post* return r_{t+1} defined in equation (3), and the logarithm of the dividend-price ratio $(d-p)_t$. The results, reported in Table 1 Panel B, again suggest that strong non-normality characterizes the residual series, suggesting that the τ_A statistic is the more appropriate with the $\hat{\rho}^2$ statistic indicating very large efficiency gains from using the RALS estimator. In general, the I(1) null hypothesis cannot be rejected at standard significance levels for r_t and $(d-p)_t$ for any of the countries[18]. The null hypothesis of I(1) behavior is easily rejected for the log dividend-price ratio and the *ex post* return for Australia, however.

Given the apparent nonstationarity of the *ex post* stock return for all countries except Australia, the nonstationarity of the log dividend-price ratio might possibly be rationalized in terms of the omission of the time-varying return series in the cointegrating regression rather than in terms of explosive bubbles. Tests of nonstationarity of the residuals from a regression of $(d-p)_t$ onto r_t, based on either the $CR\tau$ or the $CR\tau_A$ statistics allowed us, however, to reject the null hypothesis of no-cointegration at the five percent level *only* for Australia (Table 1 Panel C).

Further corroborating evidence of the presence of bubbles in all markets examined except Australia can be adduced by noticing that the log dividend-price ratio series for all countries except Australia displays stong evidence of non-normality, as evidenced by the very high Jarque-Bera statistics (Table 1 Panels B and C). If a periodically collapsing stock price bubble is present, this will impart skewness and excess kurtosis into the stock price series over and above that which is present in the dividend series. If, however, movements in stock prices are in fact largely echoing movements in dividends and expected dividends and bubbles are not the cause of the non-normality then any skewness and excess kurtosis in the dividend series will be a 'common feature' of the two series which should disappear in the log dividend-price ratio (Engle and Kozicki, 1993).

Overall, our results allow us to reject the bubbles hypothesis at the five percent level only for Australia[19]. Given that this country was not a casualty of the recent East Asian crisis, this provides corroborating evidence for the view that the roots of the East Asian crisis lay in domestic asset market bubbles.[20]

The presence of asset price bubbles is only one key element of the moral hazard interpretation of the crisis, however: another key element is that the bubbles were fuelled by capital inflows which exacerbated the declines by taking flight - or attempting to take flight - when the bubbles burst spectacularly in 1997 in many of these economies. The consistency of the data with this second element of the moral hazard interpretation requires an analysis of the potential reversibility or otherwise of capital flows to these countries in the period preceeding the crisis. We now turn to such an analysis.

IV. The persistence of capital inflows

The sustained rise in capital flows to emerging markets in general remains one of the salient features of developments in world capital markets during the 1990s[21]. As discussed above, our primary motivation for examining the temporary and permanent components of various categories of capital flows to East Asian economies in the period leading up to the recent crisis is that an important element of at least one interpretation of the East Asian crisis is the sudden withdrawal or reversal of certain categories of flows following the collapse of an asset price bubble. Hence, determining whether certain categories of flows - in particular portfolio flows - to these countries had a high

reversible component may be seen as a test of this interpretation of the crisis.

Bhattacharya, Claessens. Ghosh. Hernandez and Alba (1998) document the actual reversals in capital flows to East Asian economies in the wake of the crisis. It is nevertheless important to analyse the time series properties of the flows, however, for two reasons. First, it is of course well known that incipient rather than actual capital flows have strong effects on price movements in financial markets (see eg. Begg, 1982), so that examining actual capital reversals, whilst highly informative, does not tell the whole story, and establishing that East Asian capital inflows had high temporary component remains an important test of the moral hazard view of the crisis. Second, establishing that important capital flows to these countries had high reversible components in the period prior to the crisis would imply that the danger signals might have been read before the event, and such an analysis may therefore serve as an important indicator for the future.

IV.1 Priors concerning capital inflow persistence

Given that fixed investment typically involves important irreversibilities (see e.g. Dixit and Pindyck, 1994), it is plausible that this will generate an important permanent component in FDI flows, given that the sunk costs of investment in one country will make it less likely that an investor will rashly seek alternative locations in which to invest. Hence, at the empirical level, the permanent component of FDI time series may reasonably be expected effectively to coincide with the series themselves. Figure 2, which graphs FDI flows for the three representative East Asian economies - Indonesia, Thailand and Korea - and Australia, appears informally to support this view: although short-term reversals are evident in each of the series, each appears to display a strong permanent upward trend.

Portfolio flows (i.e. equity and bond flows), on the other hand, might be expected to be significantly more volatile then FDI flows and - with increasing deregulation and decreasing transactions costs - more sensitive to movements in short-term differentials in rates of return. Also, given that East Asian emerging markets are still underweighted in foreign investors' portfolios (World Bank, 1997) and that foreign investors are still relatively unfamiliar with emerging markets, these markets may be quite susceptible to cyclical conditions in major industrialized countries and more prone to investor herding behavior than industrial countries' financial markets (World Bank, 1997)[22].

This again appears to be borne out informally by graphs of gross portfolio bond flows (Figure 3) and net equity flows (Figure 4) for three East Asian economies and Australia. High reversible, temporary components are evident in each of these series, although the series for portfolio bond flows to Australia does appear to display an underlying permanent trend.

A priori, then, we might expect portfolio - bond and equity - flows and FDI flows to define the most volatile or temporary and the least volatile or permanent capital-account items respectively. The remaining category of private capital flows, commercial bank credit - the least important fraction of private capital flows to East Asian developing countries in the 1990s in terms of relative size - one might expect to be potentially reversible, albeit perhaps less easily than portfolio flows. In particular, because of the lack of a well-developed, organized secondary market in commercial bank loans, one might expect commercial bank lending to be more sensitive than portfolio flows to fundamental factors such as creditworthiness ratings, political risk, growth and export performance, macroeconomic stability, the level of indebtedness and other structural forces of the recipient countries. Hence, the permanent component in commercial bank credit time series may reasonably be expected to be relatively large and perhaps dominating the transitory component, albeit to a lesser extent than for FDI flows. This again appears to be supported by informal visual inspection of the data (Figure 5).

Although official flows to emerging markets in general have been considerably dwarfed by private capital flows in the 1990s (World Bank, 1997, p. 9), they still remain of some importance for various low-income developing countries. More generally, official flows continue to play a valuable complementary role to private capital flows for a number of reasons, such as sustaining improvements in the policy and institutional framework, and acting as a catalyst for private flows in countries with increasingly sound macroeconomic policies (World Bank, 1997, pp. 66-71). During the 1990s, official flows appear to have mainly played a minor complementary role to private capital flows and seem largely motivated by cyclical rather than by structural factors (World Bank, 1997). Hence, while official flows might be expected to be more persistent than private portfolio flows, they may also be expected to be largely temporary. Figure 6, which graphs official flow series for Australia and the three representative East Asian economies, is consistent with this view in that, although they each appear to display a high reversible component, there also appears to be a discernible underlying permanent trend.

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IV.2 Modeling capital inflows using an unobserved components model

The persistence of capital flows can be examined by employing the unobserved components model suggested by Harvey (1981, 1989). Consider a panel data set of N countries with capital flows of a certain category for the ith country at time t generically denoted f_{it}. The unobserved components model may be written[23]:

$$f_{it} = \mu_{it} + \nu_{it} + \epsilon_{it} \qquad i = 1,...,N; \quad t = 1,...,T \qquad (12)$$

where f_{it} may be any of the capital-account items discussed in Section II.2, μ_{it} is a trend component, the irregular component ϵ_{it} is approximately normally independently distributed with zero mean and constant variance $\sigma_{i\epsilon}^2$, and ν_{it} represents a first-order autoregressive, AR(1) component:

$$\nu_{it} = \rho_{\nu_i} \nu_{it-1} + \xi_{it} \qquad (13)$$

where ξ_{it} is approximately normally independently distributed with zero mean and constant variance $\sigma_{i\nu}^2$, and the autoregressive coefficient is constrained to be less than unity in absolute value in order to ensure stationarity of the component.[24]

The stochastic trend component is modeled as:

$$\mu_{it} = \mu_{it-1} + \beta_{it-1} + \eta_{it} \qquad (14)$$

and

$$\beta_{it} = \rho_{\beta_i} \beta_{it-1} + \zeta_{it} \qquad (15)$$

where β_{it} represents the slope or gradient of the trend component μ_{it} and $\rho_{\beta i}$ represents the damping factor, while each of the disturbances η_{it} and ζ_{it} is approximately normally independently distributed with zero mean and constant variance $\sigma_{i\eta}^2$ and $\sigma_{i\zeta}^2$ respectively.

The irregular component ϵ_{it}, the level disturbance η_{it} and the slope disturbance ζ_{it} are mutually uncorrelated. The slope component may be treated as fixed rather than stochastic and also excluded from the trend specification when this is appropriate.

Intuitively, (12) expresses the capital flow as the sum of a permanent component (μ_{it}), a purely temporary, zero persistence component (ϵ_{it}) and a more slowly decaying temporary component (ν_{it}). In addition, the drift in the random walk component (β_{it}) may itself vary over time. Thus the model

separates out the persistent and temporary components of the data in a very general. comprehensive fashion.[25] [26]

It should be clear that the unobservable components model is 'non-standard' in the sense that one cannot apply least squares estimation directly to the above equations. The statistical treatment of the unobserved components model outlined above may be conveniently handled. however. by writing it in state space form, involving a measurement equation relating the unobserved components (the state vector) to an observed series. together with a transition equation governing the evolution of the state vector. The state-space parameters can then be estimated by maximum likelihood Kalman filtering methods (Harvey, 1989; Cuthbertson. Hall and Taylor, 1992).

The estimated hyperparameters (i.e. the variance parameters) indicate the relative contribution of each component in the state vector to explaining the total variation in the time series under consideration. In some sense, therefore. the estimated variances allow us - by providing information on the size of the nonstationary and the stationary components in the series - to quantify the degree of persistence of the series in question. If a large and statistically significant proportion of the variation in flows is attributed to the stochastic level. for example, then one may expect that a large part of the capital flows will remain in the country concerned for an indeterminate period of time. By contrast, if a large portion of the variation in the time series is explained by movements in the temporary components, then the capital flows under consideration may be regarded as characterized by low persistence. indicating a higher degree of potential reversibility.[27]

The modeling procedure is essentially a general-to-specific procedure where we start from the most general unobserved components model (12)-(15) and test down by imposing exclusion restrictions on the parameters found to be statistically insignificant at conventional nominal levels of significance. In choosing the most appropriate model for each country and label flow, we relied not only on standard measures such as the coefficient of determination: the fit of alternative models was also compared on the basis of the Akaike information criterion (Harvey, 1989, pp. 263-270).

IV.3 Empirical results on capital flow persistence

In Table 2 we classify the various model specifications which were selected for capital flows to our set of East Asian countries on the basis of the goodness of fit criteria discussed above. In Table

3 we report the results of estimating the most appropriate structural time series model in state space form by Kalman filter maximum likelihood methods for each of the capital inflows series examined. In the second and third columns of these tables we report details of the unobserved components included in the estimated structural time series model. In the fourth column we report the estimated standard deviations of the disturbances of the stochastic components included in the state and in parentheses we report the Q-ratios - i.e. the ratios of each estimated standard deviation to the largest standard deviation across components - for each model, which indicates the relative statistical importance of the components. In the last three columns we report the estimated AR(1) coefficient (the damping factor ρ_v), which provides evidence on the degree of persistence of the stationary AR(1) component of the model, the coefficient of determination (which can be regarded as quite high for all of the estimated models), and the p-value from Ljung-Box test statistics of the hypothesis of no-serial correlation in the residuals (which always indicates absence of serial correlation).[28]

a) bond and equity flows

As Panels A and B of Table 3 display, for all countries and for both private equity and private bond inflows. the largest variance of the disturbances is always one of the stationary components in the state vector, either the irregular or the AR(1) component.

For Thai equity flows, for example, model 4 of Table 2 was arrived at after our general-to-specific procedure search. This is a structural model of the form:

$$f_t = \mu_t + \epsilon_t \tag{16}$$

$$\mu_t = \mu_{t-1} + \eta_t \tag{17}$$

so that equity flows to Thailand are seen to have both a permanent component (μ_t) and a purely temporary component (ϵ_t). The standard deviation of the temporary component (σ_ϵ) is more than ten times the standard deviation of the innovation to the permanent component (σ_η). In Table 3, Panel A, this shows up as a Q-ratio for the irregular component of 1.0 (since it is the largest component) and a Q-ratio for the permanent (or level) component of 0.091. This indicates that although there is a permanent component in Thai equity inflows, it is dominated by a large temporary component.

In fact, in 10 out of 22 cases for bond and equity flows. the largest estimated parameter is the

variance of the disturbance of the irregular component. which has no persistence at all. In the other 12 cases, the AR(1) parameter has the largest variance, which implies some slight degree of persistence. Note, however, that this persistence is also very small, as suggested by the fact that the estimated damping factors in the AR(1) components are always relatively low. Indeed, the half life of shocks affecting private portfolio flows to East Asian emerging markets implied by the estimated AR(1) coefficients ranges from 0.245 (hence about one week) for equity flows to Indonesia to 0.574 (about two weeks and a half) for equity flows to Hong Kong[29]. Moreover, while the stochastic slope is never found to be statistically significant, the Q-ratios for the stochastic level are very low, suggesting that the contribution of the nonstationary, more persistent, component in explaining the variance of equity and bond flows is extremely low, whereas the temporary component is, by contrast, very large. Nevertheless, the stochastic level is always found to be statistically significantly different from zero at conventional nominal levels of significance, as implied by the estimated coefficients of the final state vector and the corresponding root mean square errors for the nonstationary stochastic component included in the estimated model.

Most interestingly, the results for East Asian emerging markets contrast, however, with the finding that for both Japan and Australia the permanent component, whilst smaller than the temporary component in relative size, explains a very significant proportion of the variation in both equity and bond capital inflows in relative size - ranging from some 44 percent for equity flows to Australia and 96 percent for bond flows to Japan. The corresponding range for the other East Asian countries runs from about 3 percent for bond flows to Indonesia to about 28 percent for bond flows to Singapore, with around half of them recording proportions under 10 percent.

Hence, the results from estimating the unobserved components model for private equity and bond flows to developing countries suggest that a statistically significant nonstationary component is present in the data, but that this is generally very small in size, contributing very little to explaining variation in the series. That is to say, private portfolio flows to East Asian developing countries over the sample period may be regarded as largely temporary and reversible in nature. The results for the corresponding capital inflows to Japan and Australia suggest, however, that the temporary component explains a significantly larger proportion of the variation in those time series in relative size and therefore contain a relatively lower reversible component.

b) official flows

Panel C of Table 3 shows the results from estimating the most appropriate structural time series model for official flows to each of the countries examined. On the basis of the estimated Q-ratios, the results suggest that official flows to all countries also display a rather small temporary component, albeit quite different in size across countries. The stationary AR(1) component is, however, always found to be statistically significantly different from zero, indicating non-zero persistence - ranging from a half life of 0.266 (slightly more than one week) for shocks to official flows to Singapore to a maximum half life of 1.669 (about seven weeks) for official flows to Hong Kong. These results imply that official flows - which represent a rather small fraction of total capital flows to emerging markets in the 1990s - have perhaps played only a complementary, albeit significant, role to private capital flows and may be motivated by different factors and objectives for different countries (see World Bank, 1997, pp. 66-71). While the permanent component is always dominated by the temporary component for each estimated model, the different degree of persistence of official flows across countries suggests that in some cases the flows may have been motivated by mere portfolio adjustment reasons and cyclical factors, but, for relatively higher-persistence models, official flows may have responded more strongly to long-term structural factors.

c) commercial bank credit

In Panel D of Table 3 we report the results from the Kalman filter maximum likelihood estimation of structural time series models for commercial bank credit flows to the East Asian developing countries examined as well as to Japan and Australia. Consistent with our priors as defined in Section IV.1, the estimated Q-ratios indicate that for both sets of countries the largest variance (standard deviation) of the disturbances is now always the one relating to the permanent component in the model. Also, the overall relative size of the temporary component of bank credit flows - i.e. the sum of the Q-ratio of the irregular component plus the Q-ratio of the AR(1) component - lies between about 18 percent for bank credit flows to South Korea and about 47 percent for bank credit flows to Malaysia, while being about 36 percent for each of Japan and Australia and displaying significant variation within this range across countries. In addition, for 3 out of 11 cases, the AR(1) parameter is statistically significant and therefore the temporary component has a non-zero degree of

persistence.

Thus, bank credit flows to developing countries display a permanent component which largely dominates the transitory component in all cases, presumably because they tend to respond significantly to long-term structural forces, such as - for example - a country's creditworthiness ratings, political risk, growth and export performance, macroeconomic stability, and level of indebtedness.

d) foreign direct investment

As one might expect, our empirical analysis suggests that the capital-account item with the largest relative permanent component is FDI, as suggested by the results in Panel E of Table 3. In particular, for each country not only is the largest variance of the disturbances always the one relating to the permanent component, but the variance of both the irregular component and the AR(1) component - the latter found statistically significant only in one case - are considerably small and, in relative size, lie within the range between less than 3 percent for Malaysia and about 13 percent for Thailand. This is obviously consistent with our prior that FDI is irreversible and hence largely permanent in nature.

e) overall findings on persistence

The results reported and discussed in this section suggest that private portfolio flows to East Asian emerging markets are characterized by a statistically significant but very small permanent component, therefore being potentially susceptible to large reversals. The temporary component is, however, relatively much smaller for private capital flows to Japan and Australia. Official flows also display a relatively large temporary component, albeit smaller than for private portfolio flows and varying in size across countries. Nevertheless, as one would expect, commercial bank credit and, to a greater extent, foreign direct investment flows contain a relatively very large permanent component.[30] The finding of a high reversible component in portfolio flows to East Asia is consistent with the moral hazard interpretation of the East Asian crisis, especially as the temporary component is much smaller for private portfolio flows to Japan and, in particular, Australia.

V. Conclusions

A widely held view concerning the severe financial crisis which afflicted a number of East Asian economies during 1997 is that strong capital inflows - themselves largely due to a moral hazard problem whereby investors mistakenly perceived implicit guarantees on their investment - generated asset market bubbles which, when they burst, precipitated an actual or incipient capital flight which strongly exacerbated the asset price falls and set into motion a vicious cycle of further asset price falls, insolvency of financial intermediaries, and further actual or incipient capital flight. The empirical results reported in this paper provide the first tests of this 'moral hazard' interpretation of the East Asian crisis. In particular, we tested for the presence of bubbles in a number of East Asian stock markets in the period leading up to the crisis and we also examined the time series properties of capital flows to the same set of countries for evidence of reversibility.

Visual examination of stock price and dividend indices for the East Asian markets we examined strongly suggested the presence of bubbles, and our formal statistical tests allowed us to reject the bubbles hypothesis at the five percent significance level only for Australia - which was not a victim of the crisis. This would therefore seem to support the moral hazard interpretation.

Our empirical results also provide strong evidence that there is a statistically significant permanent component in equity and bond flows to East Asian economies over the sample period, but that this is very small in size compared to the temporary component. The results for East Asian emerging markets also contrast with the finding that for both Japan and Australia the permanent component, whilst smaller than the temporary component in relative size, explains a very significant proportion of the variation in both equity and bond capital inflows. This is consistent with the hypothesis that the sudden actual or incipient reversal of portfolio flows may have played an important part in the East Asian crisis, as the moral hazard interpretation suggests. Moreover, while we were not able to reject the hypothesis of stock price bubbles for Japan, the high permanent component of portfolio flows to that country may well have protected it from the worst of the East Asian crisis in that, when its stock market declined in 1997, the vicious cycle described above was largely prevented from going into operation.

Of the other categories of flows, commercial bank credit and foreign direct investment showed very much higher permanent components, while official flows showed greater cross-country variation

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and, in any case, were generally very much smaller in magnitude than the other categories.

Taken together, our findings appear to corroborate the moral hazard interpretation of the East Asian currency and financial crisis. The fact that Australia in particular displays much more permanence in private portfolio flows and no evidence of stock price bubbles provides further corroboration of this view, since it was not a victim of the crisis; and the high permanent component of portfolio flows to Japan may well have shielded it from the full brunt of the crisis which was experienced in other East Asian economies.

While there is clearly substantial scope for further work on the East Asian crisis, therefore, the widely held moral hazard interpretation may be seen to have passed these first tests.

Table 1. Testing for Stock Price Bubbles

Panel A: τ, τ_A, $CR\tau$, $CR\tau_A$: *empirical critical values at the 1 and 5 percent level*

	τ		τ_A		$CR\tau$		$CR\tau_A$	
	1%	5%	1%	5%	1%	5%	1%	5%
China	-3.6556	-2.9617	-4.4196	-3.4018	-4.2370	-3.5645	-4.9892	-4.0649
Indones.	-3.4957	-2.8953	-4.1735	-3.3118	-4.1249	-3.5020	-4.8335	-3.9390
Malaysia	-3.4531	-2.9067	-3.9967	-3.1725	-4.0730	-3.4718	-4.6455	-3.9157
Philipp.	-3.3949	-2.8984	-4.0039	-3.2036	-4.0893	-3.4814	-4.6538	-3.9231
Singap.	-3.3760	-2.8812	-4.0982	-3.1892	-4.0302	-3.4662	-4.6311	-3.8502
S. Korea	-3.5601	-2.9283	-4.2738	-3.3457	-4.1706	-3.5274	-4.9018	-4.0031
Taiwan	-3.5107	-2.9099	-4.1349	-3.2679	-4.1307	-3.5033	-4.8414	-3.9705
Thailand	-3.4641	-2.8934	-4.1302	-3.1421	-4.0925	-3.4782	-4.6694	-3.8782
Japan	-3.3653	-2.8806	-4.1012	-3.1829	-4.0283	-3.4678	-4.6392	-3.8581
Austral.	-3.3762	-2.8876	-4.0956	-3.1797	-4.0334	-3.4671	-4.6284	-3.8465

Notes: τ denotes the standard DF test statistic, while τ_A is the residuals-augmented DF statistic; the empirical critical values for τ and τ_A are based on 20,000 draws from the data generating process of a random walk with drift with a IIN error term, as described in the text, with T=48 for China, T=60 for South Korea, T=72 for Indonesia and Taiwan, T=98 for Malaysia, Philippines and Thailand, and T=120 for Singapore, Japan and Australia. $CR\tau$ denotes the DF statistic and $CR\tau_A$ the residuals-augmented DF statistic, each applied to the residuals from a cointegrating regression under the null hypothesis of non-cointegration, as described in the text, again based on 20,000 draws (Fuller, 1976; Dickey and Fuller, 1979, 1981; MacKinnon, 1991).

(continued ...)

(... Table 1 continued)

Panel B: τ *and* τ_A *unit root tests on* r_t *and* *(d-p)*$_t$

	r_t				$(d-p)_t$			
	τ	τ_A	$\hat{\rho}^2$	ω	τ	τ_A	$\hat{\rho}^2$	ω
China	-1.4274	-1.0139	0.7743	9.5458 (.0084)	-1.8366	-1.1240	0.7099	6.3792 (.0412)
Indones.	-1.3479	-1.1658	0.5304	48.1564 (.0000)	-1.4853	-1.2385	0.6279	47.7719 (.0000)
Malaysia	-0.9358	-1.0125	0.7345	86.5659 (.0000)	-0.9731	-0.9962	0.6930	74.1939 (.0000)
Philipp.	-0.9124	-0.7915	0.6935	61.9919 (.0000)	-0.8959	-1.1905	0.7919	38.3036 (.0000)
Singap.	-0.0464	-1.2623	0.8333	33.2221 (.0000)	-1.9886	-2.8072	0.7612	70.7239 (.0000)
S. Korea	-1.3392	-1.8181	0.6668	55.9417 (.0000)	-0.3590	-1.5752	0.7284	42.2080 (.0000)
Taiwan	-0.3514	-0.0558	0.5286	78.2019 (.0000)	-1.9534	-1.5180	0.5313	48.8177 (.0000)
Thailand	-0.9249	-0.8663	0.7244	37.4455 (.0000)	-0.1578	-0.5301	0.8343	22.1686 (.0000)
Japan	-1.2699	-1.5291	0.8502	6.3948 (.0409)	-1.3955	-1.9399	0.8587	6.7458 (.0343)
Austral.	-5.2097	-6.4389	0.8486	2.3683 (.3060)	-3.2389	-3.7027	0.9214	2.8514 (.2403)

Notes: One and five percent critical values for τ and τ_A are as given in Panel A. For the Jarque-Bera statistics ω we report in parentheses the marginal significance levels from referring the value of ω to the $\chi^2(2)$ distribution.

(continued ...)

(... Table 1 continued)

Panel C: *CRτ and CRτ₁ test statistics - cointegration between (d-p)₁ and r₁*

	CRτ	CRτ_A	$\hat{\rho}^2$	ω
China	-2.3620	-2.1670	0.7670	19.8163 (.0000)
Indonesia	-2.3302	-1.9003	0.7656	21.3156 (.0000)
Malaysia	-2.4401	-3.0111	0.7808	12.5698 (.0019)
Philippines	-1.8714	-2.5751	0.7349	80.9043 (.0000)
Singapore	-2.0896	-2.8416	0.7784	67.8997 (.0000)
South Korea	-2.5558	-3.2892	0.2864	93.0723 (.0000)
Taiwan	-1.3650	-0.0093	0.6839	29.9024 (.0000)
Thailand	-1.1104	-1.2682	0.7733	28.6352 (.0000)
Japan	-1.5141	-2.3933	0.7915	7.3874 (.0249)
Australia	-6.6728	-7.2671	0.8492	2.2737 (.3208)

Notes: One and five percent critical values for CRτ and CRτ_A are as given in Panel A. For the Jarque-Bera statistics ω we report in parentheses the marginal significance levels from referring the value of ω to the $\chi^2(2)$ distribution.

Table 2. Restricted structural time-series models adopted in modeling capital flows

Model 1: Stochastic level (fixed slope) + AR(1) + irregular component [$\sigma_\zeta^2=0$]

$$f_t = \mu_t + \nu_t + \epsilon_t$$

$$\mu_t = \mu_{t-1} + \beta + \eta_t$$

$$\nu_t = \rho_\nu \nu_{t-1} + \xi_t \qquad |\rho_\nu| < 1$$

Model 2: Stochastic level (no slope) + AR(1) + irregular component [$\sigma_\zeta^2=0$, $\rho_\beta=0$]

$$f_t = \mu_t + \nu_t + \epsilon_t$$

$$\mu_t = \mu_{t-1} + \eta_t$$

$$\nu_t = \rho_\nu \nu_{t-1} + \xi_t \qquad |\rho_\nu| < 1$$

Model 3: Stochastic level (no slope) + AR(1) [$\sigma_\zeta^2=0$, $\rho_\beta=0$, $\sigma_\epsilon^2=0$]

$$f_t = \mu_t + \nu_t$$

$$\mu_t = \mu_{t-1} + \eta_t$$

$$\nu_t = \rho_\nu \nu_{t-1} + \xi_t \qquad |\rho_\nu| < 1$$

Model 4: Stochastic level (no slope) + irregular component [$\sigma_\zeta^2=0$, $\rho_\beta=0$, $\sigma_\xi^2=0$, $\rho_\nu=0$]

$$f_t = \mu_t + \epsilon_t$$

$$\mu_t = \mu_{t-1} + \eta_t$$

Model 5: Stochastic level (fixed slope) + AR(1) [$\sigma_\zeta^2=0$, $\sigma_\epsilon^2=0$]

$$f_t = \mu_t + \nu_t$$

$$\mu_t = \mu_{t-1} + \beta + \eta_t$$

$$\nu_t = \rho_\nu \nu_{t-1} + \xi_t \qquad |\rho_\nu| < 1$$

Model 6: Stochastic level (fixed slope) + irregular component [$\sigma_\zeta^2=0$, $\sigma_\xi^2=0$, $\rho_\nu=0$]

$$f_t = \mu_t + \epsilon_t$$

$$\mu_t = \mu_{t-1} + \beta + \eta_t$$

Notes: The country subscript, i is dropped for clarity; notation is the same as in Section IV.1. Models 1-6 are the estimated parsimonious models found to fit the capital flows series using a general to specific procedure where we started from the general model set out in equations (12)-(15) in IV.1, and tested down by imposing exclusion restrictions on the insignificant parameters. The restrictions are reported in square brackets for each model.

Table 3. Unobserved Component Estimation Results

Panel A: Private portfolio equity flows

	model	components	est. s.d. of error term (Q-ratios)	est. AR parameter ρ	R^2	LB(p)
China	1	Stc lvl, Fxd Slp, AR(1), Irr	Lvl: 4.577 (0.091) AR(1): 50.009 (1.000) Irr: 0.985 (0.020)	0.214	0.838	0.503
Hong Kong	2	Stc lvl, AR(1), Irr	Lvl: 1.909 (0.069) AR(1): 27.324 (1.000) Irr: 18.584 (0.680)	0.299	0.853	0.433
Indonesia	3	Stc lvl, AR(1)	Lvl: 3.873 (0.065) AR(1): 59.686 (1.000)	0.059	0.920	0.394
Malaysia	4	Stc lvl, Irr	Lvl: 10.971 (0.181) Irr: 60.653 (1.000)	---	0.792	0.748
Philipp.	4	Stc lvl, Irr	Lvl: 2.997 (0.107) Irr: 27.944 (1.000)	---	0.765	0.547
Singapore	2	Stc lvl, AR(1), Irr	Lvl: 6.616 (0.131) AR(1): 50.502 (1.000) Irr: 28.382 (0.562)	0.290	0.843	0.328
South Korea	1	Stc lvl, Fxd Slp, AR(1), Irr	Lvl: 5.071 (0.055) AR(1): 92.740 (1.000) Irr: 39.957 (0.431)	0.120	0.803	0.756
Taiwan	3	Stc lvl, AR(1)	Lvl: 2.420 (0.050) AR(1): 47.958 (1.000)	0.264	0.829	0.482
Thailand	4	Stc lvl, Irr	Lvl: 3.134 (0.091) Irr: 34.581 (1.000)	---	0.801	0.636
Japan	3	Stc lvl, AR(1)	Lvl: 52.809 (0.572) AR(1): 92.323 (1.000)	0.547	0.822	0.751
Australia	4	Stc lvl, Irr	Lvl: 9.280 (0.447) Irr: 20.761 (1.000)	---	0.850	0.453

(continued ...)

(... Table 3 continued)

Panel B: Private portfolio bond flows

	model	components	est. s.d. of error term (Q-ratios)	est. AR parameter ρ	R^2	LB(p)
China	1	Stc lvl, Fxd slp, AR(1), Irr	Lvl: 3.660 (0.046) AR(1): 5.764 (0.073) Irr: 79.360 (1.000)	0.270	0.736	0.745
Hong Kong	4	Stc lvl, Irr	Lvl: 9.089 (0.211) Irr: 43.108 (1.000)	---	0.802	0.645
Indonesia	1	Stc lvl, Fxd slp, AR(1), Irr	Lvl: 2.837 (0.032) AR(1): 89.094 (1.000) Irr: 27.529 (0.309)	0.230	0.793	0.563
Malaysia	3	Stc lvl, AR(1)	Lvl: 9.483 (0.110) AR(1): 85.801 (1.000)	0.088	0.894	0.496
Philipp.	2	Stc lvl, AR(1), Irr	Lvl: 13.184 (0.175) AR(1): 75.394 (1.000) Irr: 60.162 (0.798)	0.112	0.931	0.572
Singapore	4	Stc lvl, Irr	Lvl: 5.654 (0.279) Irr: 20.267 (1.000)	---	0.824	0.462
South Korea	2	Stc lvl, AR(1), Irr	Lvl: 4.137 (0.216) AR(1): 19.160 (1.000) Irr: 11.310 (0.590)	0.103	0.839	0.854
Taiwan	2	Stc lvl, AR(1), Irr	Lvl: 2.263 (0.057) AR(1): 19.721 (0.498) Irr: 39.628 (1.000)	0.225	0.863	0.441
Thailand	3	Stc lvl, AR(1)	Lvl: 6.755 (0.079) AR(1): 85.007 (1.000)	0.168	0.942	0.746
Japan	4	Stc lvl, Irr	Lvl: 87.724 (0.965) Irr: 90.884 (1.000)	---	0.904	0.467
Australia	4	Stc lvl, Irr	Lvl: 18.095 (0.543) Irr: 33.343 (1.000)	---	0.856	0.692

(... Table 3 continued)

Panel C: Official flows

	model	components	est. s.d. of error term (Q-ratios)	est. AR parameter ρ	R^2	LB(p)
China	1	Stc lvl, Fxd slp, AR(1), Irr	Lvl: 12.496 (0.199) AR(1): 62.712 (1.000) Irr: 36.048 (0.575)	0.385	0.736	0.328
Hong Kong	1	Stc lvl, Fxd slp, AR(1), Irr	Lvl: 15.828 (0.262) AR(1): 60.411 (1.000) Irr: 45.248 (0.749)	0.665	0.831	0.462
Indonesia	4	Stc lvl, Irr	Lvl: 11.708 (0.605) AR(1): 5.283 (0.273) Irr: 19.351 (1.000)	0.236	0.934	0.640
Malavsia	2	Stc lvl, AR(1), Irr	Lvl: 11.708 (0.277) AR(1): 42.290 (1.000) Irr: 38.466 (0.910)	0.605	0.877	0.547
Philipp.	2	Stc lvl, AR(1), Irr	Lvl: 21.669 (0.375) AR(1): 53.182 (0.920) Irr: 57.833 (1.000)	0.560	0.883	0.912
Singapore	3	Stc lvl, AR(1)	Lvl: 26.925 (0.401) AR(1): 67.146 (1.000)	0.074	0.811	0.523
Korea	3	Stc lvl, AR(1)	Lvl: 10.095 (0.302) AR(1): 33.460 (1.000)	0.147	0.874	0.374
Taiwan	3	Stc lvl, AR(1)	Lvl: 29.545 (0.300) AR(1): 98.448 (1.000)	0.208	0.832	0.435
Thailand	2	Stc lvl, AR(1), Irr	Lvl: 6.204 (0.246) AR(1): 25.250 (1.000) Irr: 17.192 (0.681)	0.426	0.821	0.631
Japan	4	Stc lvl, Irr	Lvl: 57.865 (0.831) Irr: 69.644 (1.000)	---	0.893	0.536
Australia	3	Stc lvl, AR(1)	Lvl: 32.785 (0.584) AR(1): 56.117 (1.000)	0.121	0.887	0.468

(continued ...)

(... Table 3 continued)

Panel D: Bank credit flows

	model	components	est. s.d. of error term (Q-ratios)	est. AR parameter ρ	R^2	LB(p)
China	2	Stc lvl, AR(1), Irr	Lvl: 27.927 (1.000) AR(1): 8.507 (0.305) Irr: 4.249 (0.152)	0.504	0.942	0.453
Hong Kong	4	Stc lvl, Irr	Lvl: 37.353 (1.000) Irr: 8.101 (0.217)	---	0.819	0.650
Indonesia	4	Stc lvl, Irr	Lvl: 54.717 (1.000) Irr: 24.402 (0.446)	---	0.912	0.511
Malaysia	5	Stc lvl, Fxd Slp, AR(1)	Lvl: 96.414 (1.000) AR(1): 44.950 (0.466)	0.247	0.832	0.395
Philipp.	3	Stc lvl, AR(1)	Lvl: 73.398 (1.000) AR(1): 13.469 (0.183)	0.654	0.891	0.756
Singapore	4	Stc lvl, Irr	Lvl: 86.412 (1.000) Irr: 37.589 (0.435)	---	0.827	0.459
Korea	6	Stc lvl, Fxd Slp, Irr	Lvl: 89.948 (1.000) Irr: 16.088 (0.179)	---	0.884	0.372
Taiwan	4	Stc lvl, Irr	Lvl: 36.404 (1.000) Irr: 12.307 (0.338)	---	0.811	0.612
Thailand	4	Stc lvl, Irr	Lvl: 92.287 (1.000) Irr: 28.151 (0.305)	---	0.902	0.330
Japan	4	Stc lvl, Irr	Lvl: 73.692 (1.000) Irr: 26.573 (0.360)	---	0.847	0.540
Australia	6	Stc lvl, Fxd slp, Irr	Lvl: 57.347 (1.000) Irr: 20.723 (0.361)	---	0.863	0.761

(continued ...)

(... Table 3 continued)

Panel E: FDI flows

	model	components	est. s.d. of error term (Q-ratios)	est. AR parameter ρ	R^2	LB(p)
China	6	Stc lvl, Fxd Slp, Irr	Lvl: 66.880 (1.000) Irr: 2.546 (0.038)	---	0.921	0.439
Hong Kong	4	Stc lvl, Irr	Lvl: 87.199 (1.000) Irr: 4.468 (0.051)	---	0.943	0.550
Indonesia	3	Stc lvl, AR(1)	Lvl: 54.807 (1.000) AR(1): 3.027 (0.055)	0.097	0.883	0.478
Malaysia	4	Stc lvl, Irr	Lvl: 54.926 (1.000) Irr: 1.623 (0.029)	---	0.879	0.672
Philipp.	4	Stc lvl, Irr	Lvl: 48.668 (1.000) Irr: 3.920 (0.080)	---	0.936	0.620
Singapore	4	Stc lvl, Irr	Lvl: 56.064 (1.000) Irr: 2.979 (0.053)	---	0.882	0.472
Korea	4	Stc lvl, Irr	Lvl: 70.258 (1.000) Irr: 4.424 (0.063)	---	0.901	0.638
Taiwan	6	Stc lvl, Fxd Slp, Irr	Lvl: 41.362 (1.000) Irr: 1.687 (0.041)	---	0.890	0.467
Thailand	6	Stc lvl, Fxd Slp, Irr	Lvl: 46.927 (1.000) Irr: 6.346 (0.135)	---	0.925	0.632
Japan	4	Stc lvl, Irr	Lvl: 34.949 (1.000) Irr: 3.120 (0.089)	---	0.826	0.591
Australia	6	Stc lvl, Fxd slp, Irr	Lvl: 57.219 (1.000) Irr: 3.605 (0.063)	---	0.347	0.567

Notes: The Q-ratios equal the ratio of the standard deviation (s.d.) of each component to the largest standard deviation across components for each model, and are reported in parentheses in the fourth column. LB(p) is the p-value from executing Ljung-Box test statistics for residual no-serial correlation which, under the null, are distributed as $\chi^2(p)$ where $p=p_1 \cdot p_2$ and p_1 and p_2 denote the number of lags (12 for equity and portfolio flows and official flows, and 4 for commercial bank credit and official flows) and the number of hyperparameters in the state respectively. Other abbreviations used are: est. for estimated, coef. for coefficient, stc for stochastic, lvl for level, fxd for fixed, slp for slope, irr for irregular.

References

Agenor. P.-R. (1998), "The Surge in Capital Flows: Analysis of 'Pull' and 'Push' Factors". *International Journal of Finance and Economics*, 3(1), pp. 39-57.

Agenor. P.-R. and Hoffmeister. A.W. (1998), "Capital Inflows and the Real Exchange Rate: Analytical Framework and Econometric Evidence." in Glick (1998) Chapter 4. pp. 101-146.

Agenor. P.-R. and Montiel. P.J. (1996), *Development Macroeconomics*. Princeton: Princeton University Press.

Akerlof, G. and Romer, P. (1993), "Looting: The Economic Underworld of Bankruptcy for Profit." *Brookings Papers on Economic Activity*, 2, pp. 1-60.

Bank of England (1998), "Recent Developments in Asia: Implications for the World Economy", *Inflation Report*, February, pp. 14-15.

Begg, D.K.H. (1982), "The Rational Expectations Revolution in Macroeconomics: Theory and Evidence". Oxford: Philip Allan.

Beveridge, S. and Nelson. C.R. (1981), "A New Approach to Decomposition of Economic Time Series into Permanent and Transitory Components with Particular Attention to Measurement of the 'Business Cycle'", *Journal of Monetary Economics*, 7, pp. 151-174.

Bhattacharya, A., Claessens. S., Ghosh. S., Hernandez, L., and Alba, P. (1998) "Volatility and Contagion in a Financially-integrated World: Lessons from East Asia's Recent Experience." paper presented at the CEPR-World Bank Conference *Financial Crises: Contagion and Market Volatility*, London, May.

Blanchard. O.J. and Watson, M.W. (1982),"Bubbles, Rational Expectations and Financial Markets," in P. Wachtel (ed.) *Crises in the Economic and Financial Structure*, Lexington MA: Lexington Books.

Calvo, G., Leiderman, L. and Reinhart. C. (1993), "Capital Inflows and the Real Exchange Rate Appreciation in Latin America: The Role of External Factors", *IMF Staff Papers*, 40(1), pp. 108-151.

Calvo, G., Leiderman, L. and Reinhart, C. (1994), "The Capital inflows Problem: Concepts and Issues," *Contemporary Economic Policy*, 12, pp. 54-66.

Calvo, G., Leiderman, L. and Reinhart, C. (1996), "Inflows of Capital to Developing Countries in the 1990s", *Journal of Economic Perspectives*, 10, pp. 123-139.

Christiano, L.J. and Eichenbaum, M. (1992), "Unit Roots in Real GNP: Do We Know, and Do We Care?", *Carnegie Rochester Conference Series on Public Policy*, 32, pp. 7-61.

Chuhan, P., Claessens, S. and Mamingi, N. (1998), "Equity and Bond Flows to Latin America and Asia: The Role of Global and Country Factors", *Journal of Development Economics*, 55, pp. 439-463.

Claessens. S., Dooley, M. and Warner, A. (1995), "Portfolio Capital Flows: Hot or Cold?". *The World Bank Economic Review*, 9, pp. 153-174.

Claessens. S. and Gooptu. S. (eds.) (1993). "Portfolio Investment in Developing Countries". *World Bank Discussion Papers.* The World Bank. Washington DC.

Cochrane. J.H. (1988), "How Big Is the Random Walk in GNP?", *Journal of Political Economy,* 96, pp. 893-920.

Corbo, V. and Hernandez. L. (1993), "Macroeconomic Adjustment to Portfolio Capital Inflows: Rationale and Some Recent Experiences". in Claessens. S. and Gooptu. S. (eds.), op. cit..

Corbo, V. and Hernandez. L. (1996), "Macroeconomic Adjustment to Capital Inflows: Lessons from Recent Latin American and East Asian Experience", *World Bank Research Observer,* 11 (1), pp. 61-85.

Corsetti, G.. Pesenti, P., and Roubini, N. (1998) "What Caused the East Asian Currency and Financial Crisis?" paper presented at the CEPR-World Bank Conference *Financial Crises: Contagion and Market Volatility,* London, May.

Cuthbertson, K., Hall, S.G. and Taylor, M.P. (1992), *Applied Econometric Techniques,* Oxford: Philip Allan, and Ann Harbor: University of Michigan Press.

Diba. B.T. and Grossman. H.I. (1988), "Explosive Rational Bubbles in Stock Prices?" *American Economic Review,* 98, pp. 746-754.

Dickey, D. and Fuller, W.A. (1979), "Distribution of the Estimators for Autoregressive Time Series with a Unit Root", *Journal of the American Statistical Association,* 74, pp. 427-431.

Dickey, D. and Fuller, W.A. (1981), "Likelihood Ratio Statistics for Autoregressive Time Series with a Unit Root", *Econometrica,* 49, pp. 1057-1072.

Diebold, F.X. and Rudebusch, G.D. (1991), "Is Consumption Too Smooth? Long Memory and the Deaton Paradox", *Review of Economics and Statistics,* 73, pp. 1-9.

Dixit. A.K. and Pindyck, R.S. (1994), *Investment Under Uncertainty,* Princeton. NJ: Princeton University Press.

Dooley, M.P. (1995), "A Retrospective on the Debt Crisis", in Kenen, P. (ed.), *Understanding Interdependence,* Princeton University Press, Princeton, New Jersey.

Dooley, M.. Fernandez-Arias, E. and Kletzer, K. (1996), "Is the Debt Crisis History? Recent Private Capital Inflows to Developing Countries", *The World Bank Economic Review,* 10, pp. 27-50.

Edison. H., Luangaram, P., and Miller, M. (1998), "Asset Bubbles, Domino Effects and 'Lifeboats': Elements of the East Asian Crisis," paper presented at the CEPR-World Bank Conference *Financial Crises: Contagion and Market Volatility,* London, May.

Enders, W. (1995), *Applied Econometric Techniques,* New York: Wiley and Sons.

Engle, R.F. and Kozicki, S. (1993), "Testing for Common Features," *Journal of Business and Economic Statistics,* 11, pp. 369-95.

Evans, G.W. (1991), "Pitfalls in Testing for Explosive Bubbles in Asset Prices", *American Economic Review,* 81, 922-930

Fernandez-Arias, E. (1996), "The New Wave of Capital Inflows: Push or Pull?", *Journal of Development Economics*, 48, pp. 389-418.

Fernandez-Arias, E. and Montiel, P.J. (1996), "The Surge in Capital Inflows to Developing Countries: An Analytical Overview", *The World Bank Economic Review*, 10, pp. 51-77.

Flood, R. and Garber, P. (1984), "Collapsing Exchange Rate Regimes: Some Linear Examples", *Journal of International Economics*, 17, pp. 1-13.

Frankel, J.A. and Okongwu, C. (1996), "Liberalized Portfolio Capital Inflows in Emerging Markets: Sterilization, Expectations, and the Incompleteness of Interest Rate Convergence", *International Journal of Finance and Economics*, 1(1), pp. 1-24.

Fuller, W.A. (1976), *Introduction to Statistical Time Series*, New York: Wiley and Sons.

Glick, R. (ed.) (1998) *Managing Capital Flows and Exchange Rates: Perspectives from the Pacific Basin*, Cambridge: Cambridge University Press.

Goldstein, M., Mathieson, D.J. and Lane, T. (1991), "Determinants and Systemic Consequences of International Capital Flows", in *Determinants and Systemic Consequences of International Capital Flows* (March), Occasional Paper No. 77, International Monetary Fund, Washington DC.

Gooptu, S. (1993), "Portfolio Investment Flows to Emerging Markets", in Claessens, S. and Gooptu, S. (eds.), op. cit..

Granger, C.W.J. and Morris, M.J. (1976), "Time Series Modelling and Interpretation", *Journal of the Royal Statistical Society*, Series A, 139, pp. 246-257.

Hansen, B.E. (1995), "Rethinking the Univariate Approach to Unit Root Testing: Using Covariates to Increase Power," *Econometric Theory*, 11, pp. 1148-71.

Harvey, A.C. (1981), *Time Series Models*, Hemel Hempstead, Philip Allan.

Harvey, A.C. (1989), *Forecasting, Structural Time Series Models and the Kalman Filter*, Cambridge: Cambridge University Press.

Hernandez, L. and Rudolph, H. (1995), "Sustainability of Private Capital Flows to Developing Countries: Is a General Reversal Likely?", Policy Research Working Paper 1518, World Bank, Policy Research Department, Washington, DC.

Im, K.S. (1996), "A Least Squares Approach to Non-Normal Disturbances," Working Paper 9603, Department of Applied Economics, University of Cambridge.

Jarque, C.M. and Bera, A. (1987), "Efficient Tests for Normality, Heteroscedasticity and Serial Independence of Regression Residuals", *Economics Letters*, 6, pp. 255-59.

International Finance Corporation (1998), *Emerging Markets Data Base for Windows User Guide*, Washington D.C.: International Finance Corporation.

International Monetary Fund (1994), *International Capital Markets: Developments, Prospects and Policy Issues*, Washington DC: International Monetary Fund, September.

International Monetary Fund (1995). *World Economic Outlook.* World Economic and Financial Surveys, Washington DC: International Monetary Fund. October.

Kalman, R.E. (1960a), 'A New Approach to Linear Filtering and Prediction Theory', *Journal of Basic Engineering*, March, pp. 1-35.

Kalman, R.E. (1960b), 'A New Approach to Linear Filtering and Prediction Problems'. *Journal of Basic Engineering, Transactions of the ASME.* Series D, vol. 82. pp. 35-45.

Kaminsky, G.L. and Reinhart. C.M. (1998a), "The Twin Crises: The Causes of Banking and Balance-of-Payments Problems", University of Maryland, Department of Economics, mimeo.

Kaminsky, G.L. and Reinhart, C.M. (1998b), "Financial Crises in Asia and Latin America: Then and Now", *American Economic Review*, 88(2), pp. 444-448.

Kiguel, M. and Caprio, G. (1993), "Capital Inflows - Hot or Cool?", *Outreach* 8, pp. 1-28.

Krugman, P. (1979) "A Model of Balance of Payments Crises", *Journal of Money, Credit, and Banking* 11, pp.311-325.

Krugman, P. (1998), "What Happened to Asia?", mimeo, Department of Economics, Massachusetts Institute of Technology, January.

Lucas, R.E. Jr. (1978), "Asset Prices in an Exchange Economy," *Econometrica*, 46, pp. 1429-45.

MacKinnon, J. (1991) "Critical Values for Cointegration Tests," in Engle, R.F. and Granger, C.W.J. (eds.), *Long-Run Economic Relationships*, Oxford: Oxford University Press.

Maravall, A. (1994), "Use and Misuse of Unobserved Components in Forecasting", *Journal of Forecasting*, 13, pp. 157-178.

Maravall, A. (1995), "Unobserved Components in Economic Time Series" in Pesaran, M.H. and Wickens, M. (eds.), *Handbook of Applied Econometrics: Macroeconomics*, Oxford: Blackwell.

McKinnon, R. and Pill, H. (1996), "Credible Liberalizations and International Capital Flows: The Overborrowing Syndrome", in Ito, T. and Krueger, A.O. (eds.), *Financial Deregulation and Integration in East Asia*, Chicago: Chicago University Press.

Montiel, P.J. (1993), "Capital Mobility in Developing Countries", PRE Paper No.1103, The World Bank, Washington DC.

Nunnenkamp, P. (1993), "The Return of Foreign Capital to Latin America", Kiel Working Paper 574.

Obstfeld, M. (1994), "The Logic of Currency Crises", *Cahiers Economiques et Monetaires*, 43, pp.189-213.

Obstfeld, M. (1996), "Models of Currency Crisis with Self-Fulfilling Features," *European Economic Review*, 40, pp. 1037-1048.

Quah, D. (1990), "Permanent and Transitory Movements in Labor Income: An Explanation for 'Excess Smoothness' in Consumption", *Journal of Political Economy*, 98, pp. 449-475.

Razin, A., Sadka, E. and Yuen, C.-W. (1998), "A Pecking Order of Capital Inflows and International Tax Principles", *Journal of International Economics*, 44(1), pp. 45-68.

Reinhart, C.M., and Smith, R.T. (1998), "Too Much of a Good Thing: The Macroeconomic Effects of Taxing Capital Inflows," in Glick (1998), Chapter 14. pp. 436-464.

Reisen, H. (1993), "The Case of Sterilized Intervention in Latin America," paper presented at the 6th Annual Inter-American Seminar in Economics, May 28-29, Caracas, Venezuela.

Roubini, N. (1998), "Chronology of the Asian Currency Crisis and its Global Contagion," mimeo, Stern School of Business, New York University.

Sarno, L. and M.P. Taylor (1998), "Hot Money, Accounting Labels and the Permanence of Capital Flows to Developing Countries," mimeo. Department of Economics, Oxford University, forthcoming *Journal of Development Economics*.

Schweppe, F.C. (1965), "Evaluation of Likelihood Functions for Gaussian Signals", *IEEE Transactions on Information Theory*, 11, pp. 61-70.

Shiller, R. J. (1989), *Market Volatility*, Cambridge MA: MIT Press.

Taylor, M.P. and Peel, D.A. (1998), "Periodically Collapsing Stock Price Bubbles: A Robust Test," mimeo. Department of Economics, Oxford University, forthcoming *Economics Letters*.

Taylor, M.P. and Sarno, L. (1997), "Capital Flows to Developing Countries: Long- and Short-Term Determinants", *World Bank Economic Review*, 11(3), pp. 451-470.

Tesar, L. and Werner, I. (1994), "International Equity Transactions and US Portfolio Choice", in Frankel, J. (ed.), *The Internationalization of Equity Markets*, National Bureau of Economic Research, University of Chicago Press, pp. 185-216.

United Nations (1997), *World Investment Report: Transnational Corporations, Market Structure and Competition Policy*, New York and Geneva.

Watson, M.W. (1986), "Univariate Detrending Methods with Stochastic Trends", *Journal of Monetary Economics*, 18, pp. 49-75.

Williamson, J. (1993), "Issued Posed by Portfolio Investment in Developing Countries", in Claessens, S. and S. Gooptu (1993).

Wooldridge, J. (1993), "Efficient Estimation with Orthogonal Regressors," *Econometric Theory*, 9, pp. 153-168.

World Bank (1995), *Trends in Developing Economies*, Oxford and New York: Oxford University Press.

World Bank (1997), *Private Capital Flows to Developing Countries: The Road to Financial Integration*, World Bank Policy Research Report, Oxford and New York: Oxford University Press.

FIGURE 1: STOCK PRICES AND DIVIDENDS
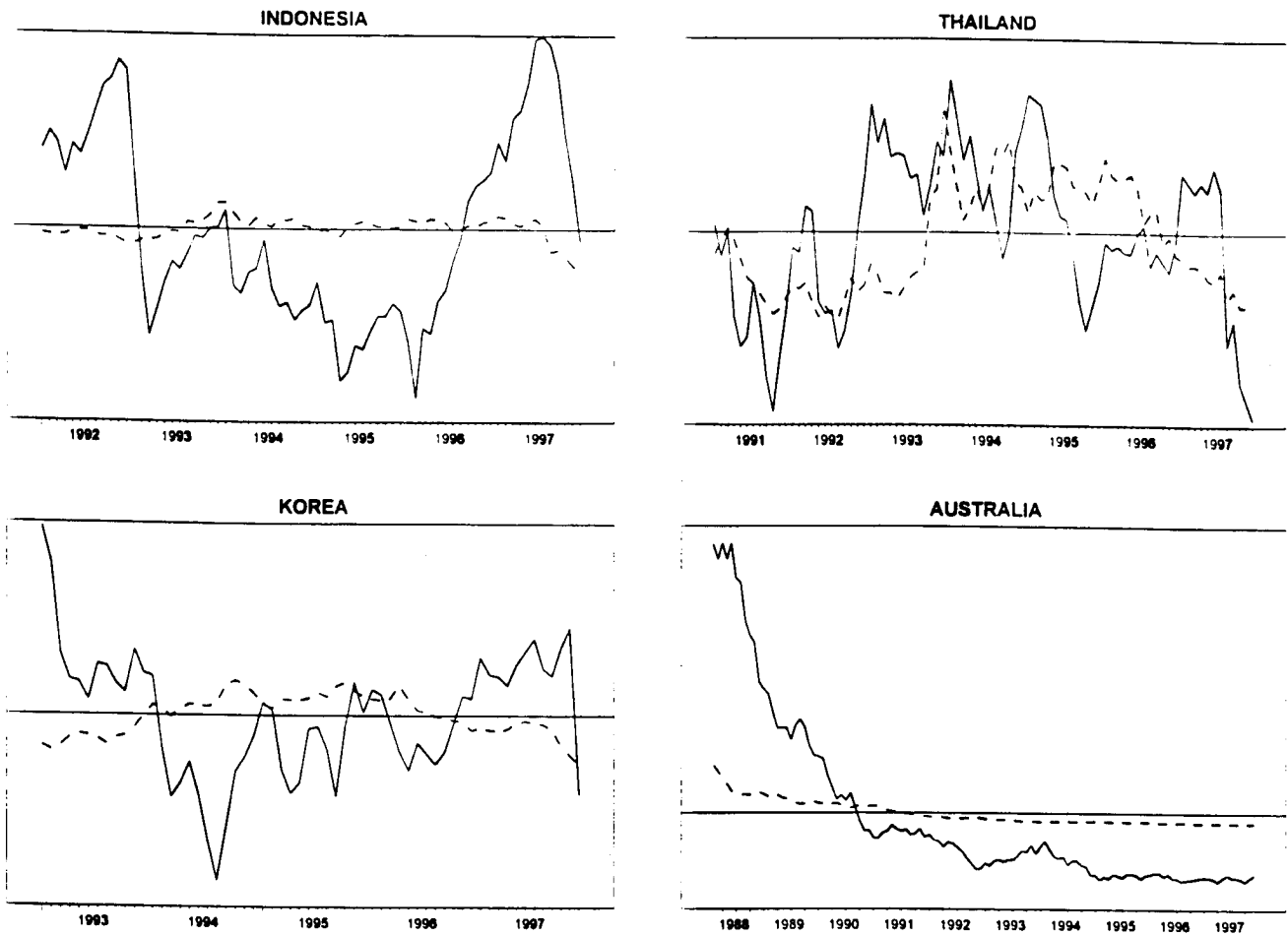
Stock prices = solid line -- Dividends = broken line

INDONESIA

1992 1993 1994 1995 1996 1997
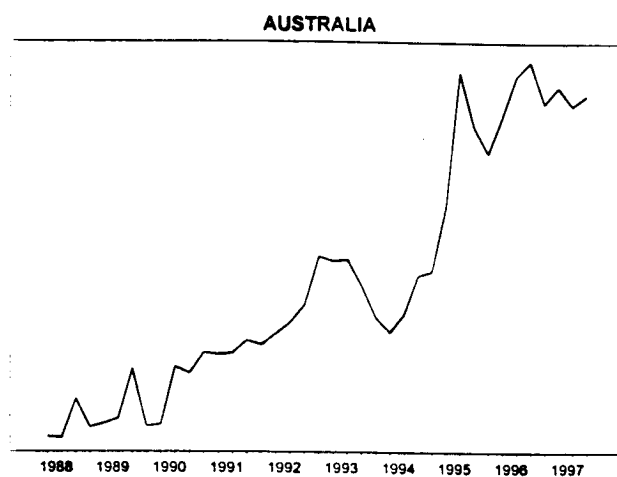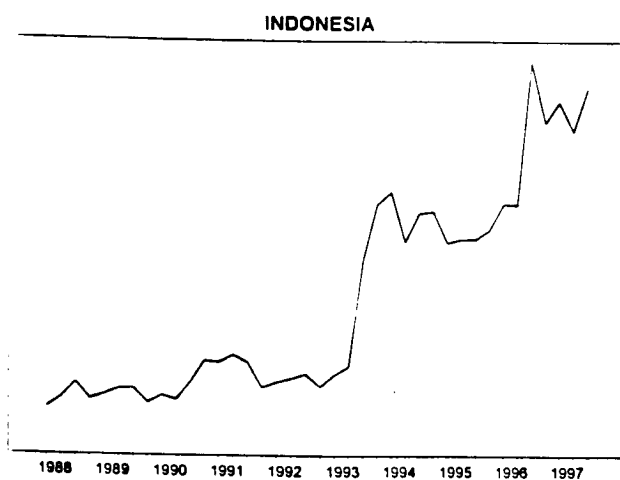
THAILAND

1991 1992 1993 1994 1995 1996 1997

KOREA

1993 1994 1995 1996 1997

AUSTRALIA

1988 1989 1990 1991 1992 1993 1994 1995 1996 1997

FIGURE 2: FOREIGN DIRECT INVESTMENT FLOWS

INDONESIA

1988 1989 1990 1991 1992 1993 1994 1995 1996 1997

THAILAND

1988 1989 1990 1991 1992 1993 1994 1995 1996 1997

KOREA

1988 1989 1990 1991 1992 1993 1994 1995 1996 1997

AUSTRALIA

1988 1989 1990 1991 1992 1993 1994 1995 1996 1997

FIGURE 3: GROSS PORTFOLIO BOND FLOWS

INDONESIA

THAILAND

KOREA

AUSTRALIA
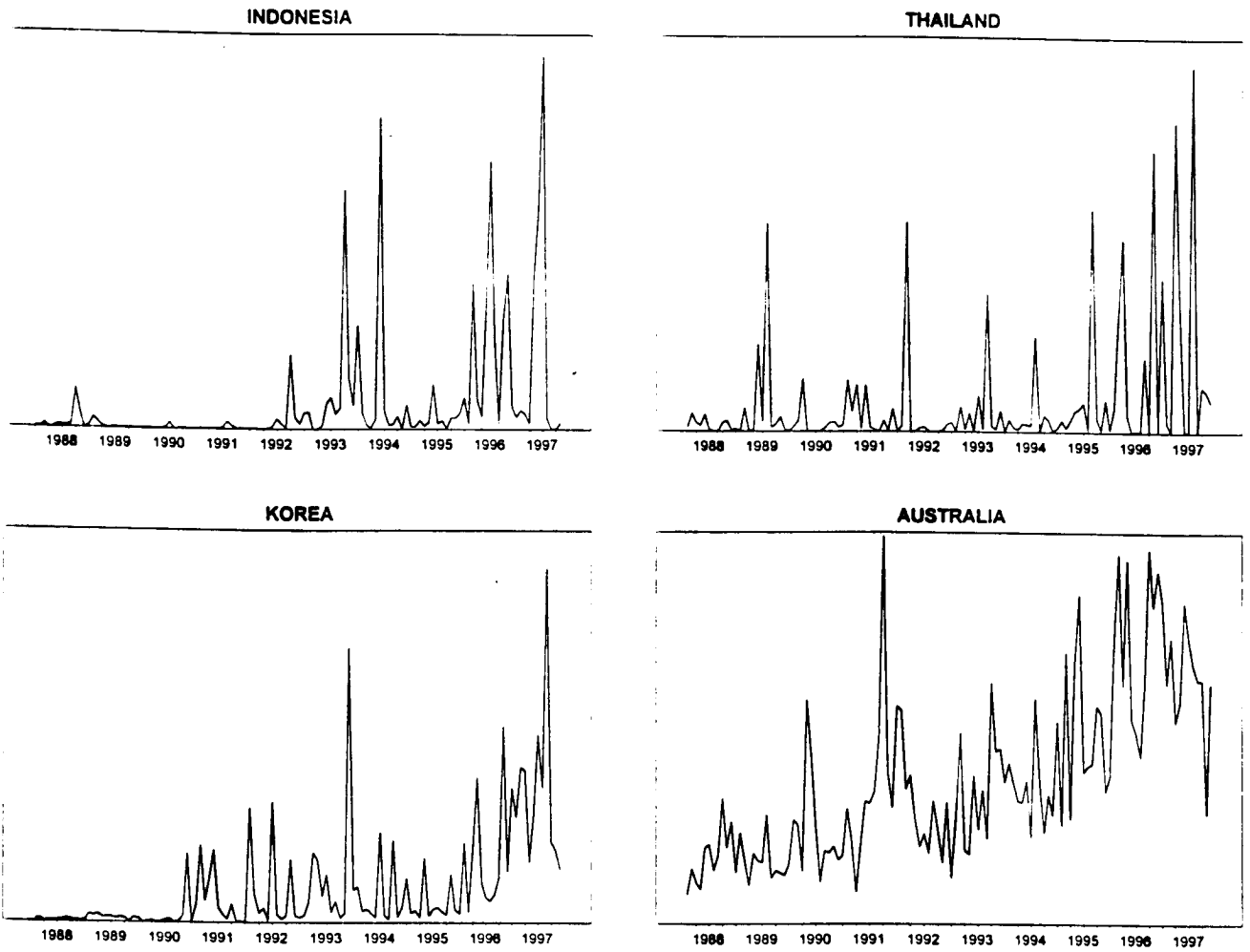
FIGURE 4: NET PORTFOLIO EQUITY FLOWS

INDONESIA

1988 1989 1990 1991 1992 1993 1994 1995 1996 1997

THAILAND

1988 1989 1990 1991 1992 1993 1994 1995 1996 1997

KOREA

1988 1989 1990 1991 1992 1993 1994 1995 1996 1997
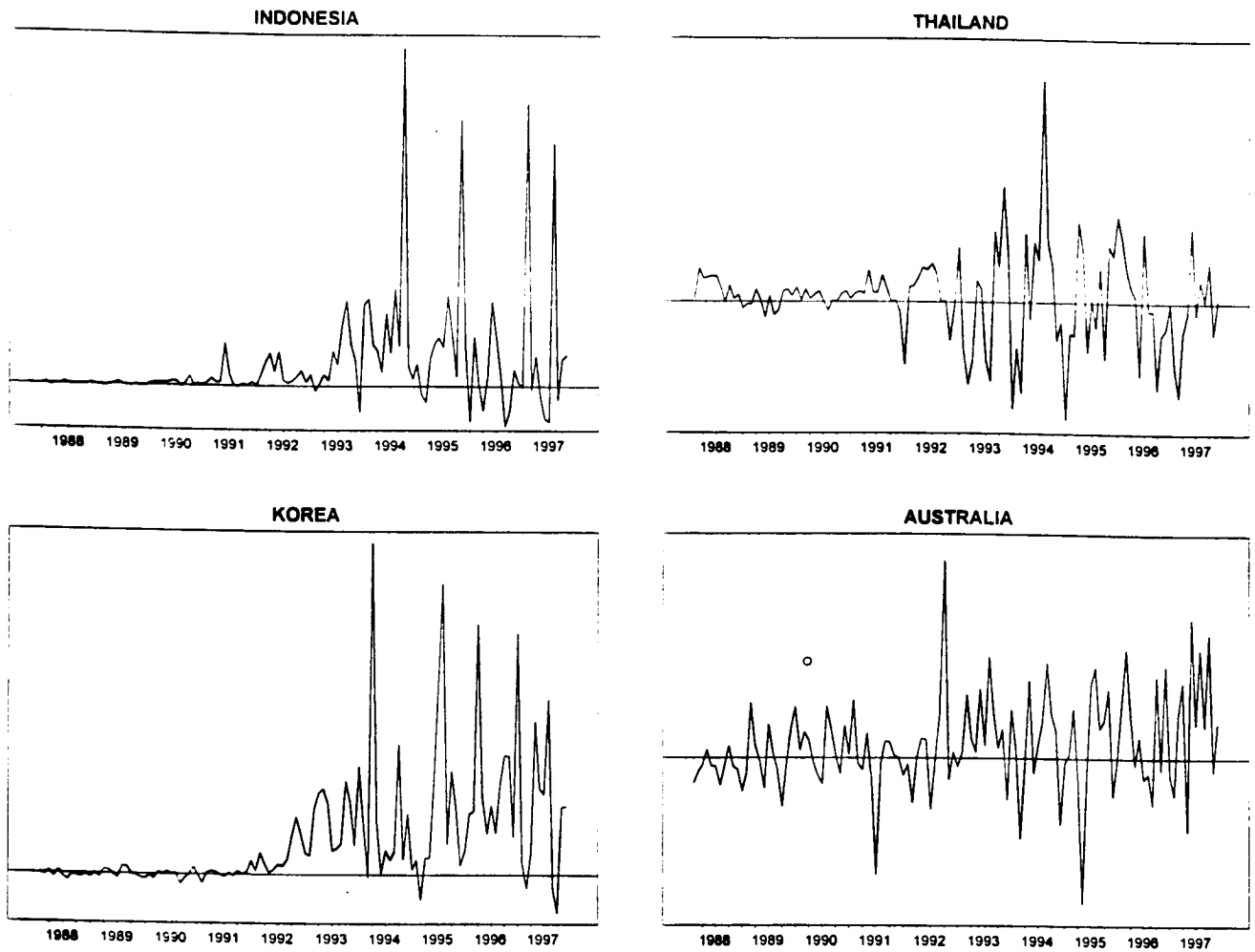
AUSTRALIA

1988 1989 1990 1991 1992 1993 1994 1995 1996 1997

FIGURE 5: COMMERCIAL BANK CREDIT FLOWS

INDONESIA

1988 1989 1990 1991 1992 1993 1994 1995 1996 1997

THAILAND

1988 1989 1990 1991 1992 1993 1994 1995 1996 1997

KOREA

1988 1989 1990 1991 1992 1993 1994 1995 1996 1997

AUSTRALIA

1988 1989 1990 1991 1992 1993 1994 1995 1996 1997

FIGURE 6: OFFICIAL FLOWS

INDONESIA

1988 1989 1990 1991 1992 1993 1994 1995 1996 1997

THAILAND

1988 1989 1990 1991 1992 1993 1994 1995 1996 1997

KOREA

1988 1989 1990 1991 1992 1993 1994 1995 1996 1997
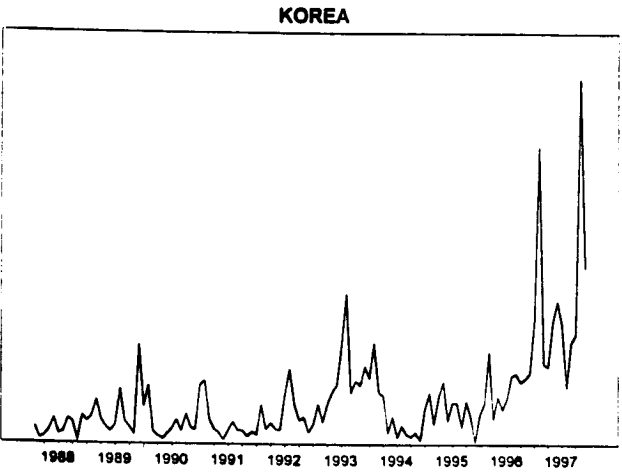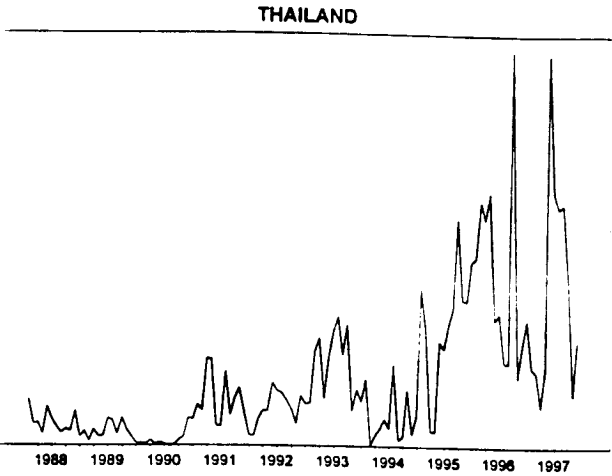
AUSTRALIA

1988 1989 1990 1991 1992 1993 1994 1995 1996 1997

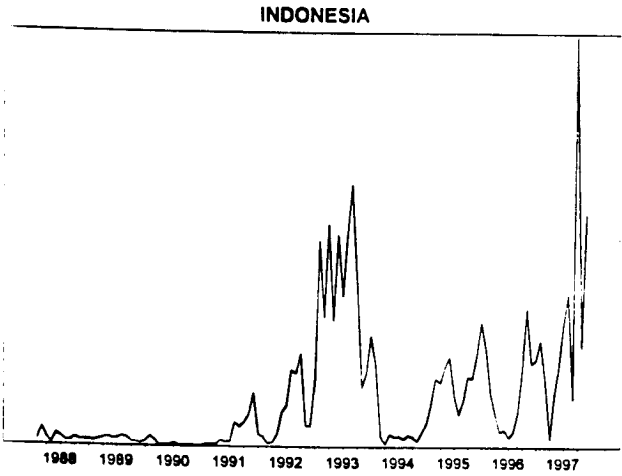## Endnotes

1. As well as the references to the relevant literature given in the remainder of the paper. Nouriel Roubini's website at the Stern School of Business. New York University currently provides and excellent resource center. For a chronology of the East Asian crisis. see Roubini (1998).

2. See also Akerlof and Romer (1993) and McKinnon and Pill (1996), who show how over-guaranteed and under-regulated intermediaries may potentially lead to excessive investment by the whole economy. In a very interesting paper. Kaminsky and Reinhart (1998a) analyze the link between banking and currency crises for a number of countries. providing evidence that problems in the banking sector typically precede a currency crisis; that the currency crisis generally deepens the banking crisis, activating a vicious spiral: that financial liberalization often precedes a banking crisis; and that these episodes may be explained by common macroeconomic causes, typically when a country enters a recession following a prolonged boom in economic activity that is usually fuelled by credit, large capital inflows and domestic currency overvaluation.

3. Also, the Hong Kong stock exchange is considered in China's stock price and dividend index by the IFC and so is not considered separately here.

4. For some countries for which the consumer price index was not available from the *International Financial Statistics* we used the closest available price index.

5. In some cases. it is not possible to reach the targeted capitalization range without conflicting with other index rules, such as the use of specific classes of stock for index capitalization weighting. Also, IFC indices are built 'from the bottom up'. That is to say, IFC analysts do not look at composite, regional. or industry balances in overall market capitalization in determining stock coverage for each IFC index. EMDB market analysts construct IFC indices for markets qualified as emerging by the World Bank GNP per capita definition. if IFC views the market as appropriate for an IFC index; the process begins with a survey of the market and all listed companies and shares, and is repeated each year during an annual review process.

6. Using IFCG indices, however, did not change qualitatively the empirical results reported below.

7. Quarterly data are published in the *US Treasury Bulletin*. while monthly data are now available from the website of the US Treasury Department. Most of these data are collected by the Treasury from financial intermediaries in the US through the International Capital Form S reports. Hence, the data do not include direct dealings of US investors with foreign intermediaries as these transactions bypass the system. Note also that the data on bonds cover transactions of foreign securities in the US from and to developing countries; transactions in bonds not issued by the developing country concerned nor by US parties are expected to be quite insignificant (see Chuhan, Claessens and Mamingi, 1998, pp. 446-451; Tesar and Werner, 1994; Taylor and Sarno, 1997).

8. *Net* capital flows arise when savings and investment are unbalanced across countries, and therefore a transfer of real resources is generated through a trade or current account imbalance. *Gross* capital flows, on the other hand, need not involve any transfer of real resources, since they may be offsetting across countries. Nevertheless, they allow individuals and firms to adjust the composition of their financial portfolios and are therefore important in improving the liquidity and diversification of portfolios.

9. In fact, data on bank claims held for their own account are collected monthly. However, information on claims held for their domestic customers as well as foreign currency claims is collected only on a quarterly basis and, therefore, relatively reliable and comprehensive data on bank credit are

only available on a quarterly basis.

10. These data are also published in the *Survey of Current Business* of the US Department of Commerce.

11. If one compares these figures to the graphs of the artificially generated periodically collapsing stock price bubbles in Evans (1991), the similarity is striking.

12. Diba and Grossman (1988) also argue that testing for nonstationarity of the first-differenced stock price series may also be a useful test for bubbles since, if the stock price includes an explosive bubble component, first-differencing should not remove it. Monte Carlo experiments revealed, however, that unit root tests may display very significant size distortion when a periodically collapsing price bubble is present and suggested that the cointegration test was the more reliable. The present authors are currently pursuing this issue.

13. A rational bubble in the time-varying returns case may be defined analogously to the constant returns case - i.e. as in (6) but with a time subscript for the return r. The analysis is now a little more complicated, however, because of expectations being taken with respect to a product of future variables (the bubble term and the stock return). The general principles remain the same, however, and these details need not detain us for the purposes of this paper.

14. Periodically collapsing bubbles are particularly interesting in analyzing stock market behavior since they collapse almost surely in finite time and are strictly positive. This is an attractive property because bubbles do not appear to be empirically plausible unless they collapse after reaching high levels. Moreover, the impossibility of negative rational bubbles in stock prices implies that, in theory, they can never restart if they fall to zero since the present value of a strictly positive series cannot be zero.

15. Note, however, that non-normality is a necessary but not sufficient condition for the existence of rational bubbles in stock prices. For example, Campbell and Hentschell (1992) develop a model of volatility feedback under the assumption of the absence of bubbles using a quadratic generalized autoregressive conditionally heteroskedastic model. The asymmetric behavior captured by their model is found to explain some proportion of the skewness and kurtosis of US monthly and daily stock returns over the sample period 1926-1988.

16. See Im (1996) and Taylor and Peel (1998) for further details.

17. Critical values calculated with an artificial data generating process calibrated using the *ex post* return series led to quantitatively similar and qualitatively identical results.

18. We also tested for unit roots in the stock price and dividend series in both logarithms and in levels and were in every case unable to reject the unit root null hypothesis at the five percent level.

19. In an earlier version of this paper, we also tested for cointegration between the level of stock prices and dividends using the same set of tests, which is a test for bubbles conditonal on the assumption of constant expected returns, as in Diba and Grossman (1988), and the results were qualitatively the same - we were able to reject the bubbles hypothesis at the five percent level only for Australia.

20. We also tested the log-linear time-varying return model using short-term interest rates in place of the *ex post* real rate of return, withy data obtained from the *International Financial Statistics* CD of the International Monetary Fund. Nevertheless, the results (not reported to conserve space but

available from the authors) were qualitatively identical.

21. For recent analyses of the issue of capital flows to emerging markets, see World Bank (1995, 1997), United Nations (1997), International Monetary Fund (1994, 1995); important, slightly earlier studies include Goldstein, Mathieson and Lane (1991) and Montiel (1993). A number of authors have stressed the point that capital inflows to developing countries, may have deleterious side effects on the recipient economies which may require offsetting action see e.g. Kiguel and Caprio (1993); Corbo and Hernandez (1993, 1996); Calvo, Leiderman and Reinhart (1993, 1994); Frankel and Okongwu (1996); Fernandez-Arias and Montiel (1996); Agenor and Montiel (1996); World Bank (1997); Razin, Sadka and Yuen (1998); Reinhart and Smith (1998); Agenor and Hoffmeister (1998). See also Kaminsky and Reinhart (1998b) for an empirical investigation of the extent to which past financial crises share common characteristics in Latin America, Asia, Europe and the Middle East, as well as an examination of the recent crises in Asia and Latin America in order to determine the extent to which regional differences may have eroded over time.

22. Indeed, portfolio equity flows to developing countries may be expected to be sensitive to the degree of openness of the country considered, and in particular to the rules concerning the repatriation of capital and income (Goldstein, Mathieson and Lane, 1991; Williamson, 1993). The International Finance Corporation differentiates between countries which give foreign investors free and unrestricted repatriation of capital and income from equity investment, and countries, defined "relatively open", which apply some restrictions on the repatriation of capital and income, and still other countries, defined "relatively closed", which apply very strict restrictions to the way in which capital may be repatriated.

23. A possible extension of the model would be to consider one or more cyclical components. We neglect this possibility because, in our empirical analysis, the inclusion of a cycle in the model was not found to improve the goodness of fit on the basis of the prediction error variance and the Akaike information criterion.

24. The need to impose stationarity on the AR(1) process arises because of the risk of it being confounded with the random-walk component in the trend specification, in which case the model would effectively be unidentified.

25. Note that the structural time series model outlined above also nests an I(2) process for f_{it} (see Granger and Morris, 1976); that would be the case, for example, if $\sigma_\zeta \neq 0$ and $\rho_\beta \geq 1$. Nevertheless, the finding - discussed in Section IV.3 - that the stochastic slope is not found to be statistically significantly different from zero at conventional nominal levels of significance clearly implies that all the series modeled in this paper are first-difference stationary.

26. An alternative and popular method for decomposing time series is due to Beveridge and Nelson (1981), who show how to decompose any ARIMA(p,1,q) process into the sum of a random walk plus drift and a stationary component - i.e. the trend plus an irregular component. In particular, in the Beveridge-Nelson decomposition the trend is defined as the conditional expectation of the limiting value of the forecast function or the long-term forecast, while the irregular component is the residual. Because of the way the decomposition is obtained, however, the trend and irregular components are perfectly correlated with a correlation coefficient equal to -1 rather than 0 as is the case in the unobserved components model outlined above (see e.g. Enders, 1995, pp. 186-195). While the decomposition of a time series in a univariate context requires in any case a restriction on the correlation between the innovations in order to achieve identification, in general - and in the present application - there will be no prior knowledge on the relationship between the innovations in the stochastic trend and the stationary component. Nevertheless, the unobserved components model representation of the process describing the data should yield, in theory, exactly the same

representation as the ARIMA representation (i.e. both techniques imply exactly the same long-run behavior of the data), although estimated ARIMA and unobserved components models may potentially imply somewhat different long-run behavior of economic time series essentially because the Wold representation of the data is unknown (Watson. 1986). Our decision to employ the unobserved components model rather than the Beveridge-Nelson decomposition was motivated by the fact that the use of ARIMA models in economics has typically been found relatively more suitable for short-term monitoring, but has been found to perform relatively poorly in the context of long-term inference (see e.g. Cochrane, 1988; Quah. 1990: Harvey, 1989; Christiano and Eichenbaum. 1992: Diebold and Rudebusch. 1991: Maravall. 1994. 1995). As far as estimation is concerned. moreover. Kalman filter maximum likelihood estimation of a state space form unobserved components model is known to produce fairly accurate estimates in finite samples of the size of 100 observations or more (Harvey, 1989; Maravall, 1995).

27. While the irregular component is totally temporary, the AR(1) component displays some degree of positive persistence determined by the size of the damping factor, albeit still mean reverting.

28. Preliminary unit root tests (not reported but available on request) provided *prima facie* evidence of a permanent component in each of the capital flow series examined in levels, not in first difference.

29. The half life is the number of periods it would take a shock to the autoregressive component of the capital flow series to be reversed by fifty percent, and can be estimated as $[(\ln 0.5)/(\ln \rho_v)]$. Since ρ_v is estimated by the method of maximum likelihood which is invariant to transformation, this will in fact be the maximum likelihood estimator of the half life.

30. While net private capital flows to East Asia were at record levels in 1996 - totalling about 115 billion US dollars - a fall in those flows is now occurring in some East Asian countries or is still expected to occur in other countries at the time of writing, as a consequence of the increased perceived riskiness of lending to the developing countries affected by the recent financial and banking crises. This issue and its implications for the world economy are discussed, for example, in Bank of England (1998) and Bhattacharya, Claessens, Ghosh, Hernandez and Alba (1998).