IMF Staff Papers
Vol. 52, No. 1

Did Output Recover from the Asian Crisis?

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This paper investigates the extent to which output has recovered from the Asian crisis. A regime-switching approach that introduces two state variables is used to decompose recessions in a set of six Asian countries into permanent and transitory components. While growth recovered fairly quickly after the crisis, there is evidence of permanent losses in the levels of output in all the countries studied. [JEL F39, F41, F42, F49, C32, G15]

The Asian financial crisis of 1997 generated a plethora of research that analyzed the causes of the crisis, but less attention has been paid to the aftermath. How long do crises last and to what extent does output recover? Although there is copious evidence that a financial crisis induces a recession, the literature has not examined whether a recession following a crisis permanently lowers the level of output. This paper analyzes whether the output reduction after the Asian crisis was a temporary deviation downward from the trend level that was eventually reversed as output reverted to trend (that is, the recession temporarily lowered the level of output) or, alternatively, the level of output shifted down permanently.

The paper approaches the question using a regime-switching common factor model. Recessions are decomposed into permanent and temporary components in a multivariate framework by introducing different state variables that control recoveries and recessions for each of the two components. Asymmetric adjust-

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ment in the temporary component is allowed to model the temporary "pluck" down from trend. We discuss these concepts in the context of their origin in the U.S. business cycle literature and present the data and results.

I. Theory and Literature Review

The causes of the Asian crisis have been fairly extensively discussed in the literature. For example, Corsetti, Pesenti, and Roubini (1998); Kochhar, Loungani, and Stone (1998); Radelet and Sachs (1998); and Berg (1999) provide overviews of the origins, onset, and spread of the crisis. This literature points to several factors that contributed to the crisis. Poor financial sector supervision and weak prudential regulation facilitated excessive lending, much of it directed toward real estate, construction, stock purchase, and consumer loans. The prolonged maintenance of pegged exchange rates encouraged foreign-currency-denominated liabilities. As the crisis approached, the ratio of short-term debt to foreign exchange reserves rose to high levels. When investors lost confidence in the economy and the currency, stock market values fell and exchange rates depreciated sharply. Interest rates spiked, reflecting the rise in risk premia. These developments led to bankruptcies among banks and finance companies as loans soured.

The behavior of recessions and subsequent recoveries from economic crises has not been studied as extensively as the causes. Some exceptions include cross-country studies by Barro (2001) and Park and Lee (2002). Barro does not detect a persistent adverse influence of currency and banking crises on long-run economic growth; Park and Lee find that a V-shaped pattern of growth is associated with crises. The countries hit by the Asian crisis experienced recessions of varying intensities. Output and consumption declined, and investment was hit especially hard. This study examines whether the Asian crisis had a long-run impact on the *level,* rather than the *growth rate,* of output (see Figure 1).

In contrast to the general scarcity of studies on the behavior of crisis-driven recessions and recoveries, a considerable amount of research has been devoted to examining the properties of business cycles in the United States. Much of the literature focuses on (1) incorporating the idea of co-movement across economic time series, using the dynamic linear factor models created by Stock and Watson (1989, 1991, 1993) and (2) probing the idea of asymmetry, using the regime-switching approach pioneered by Hamilton (1989).

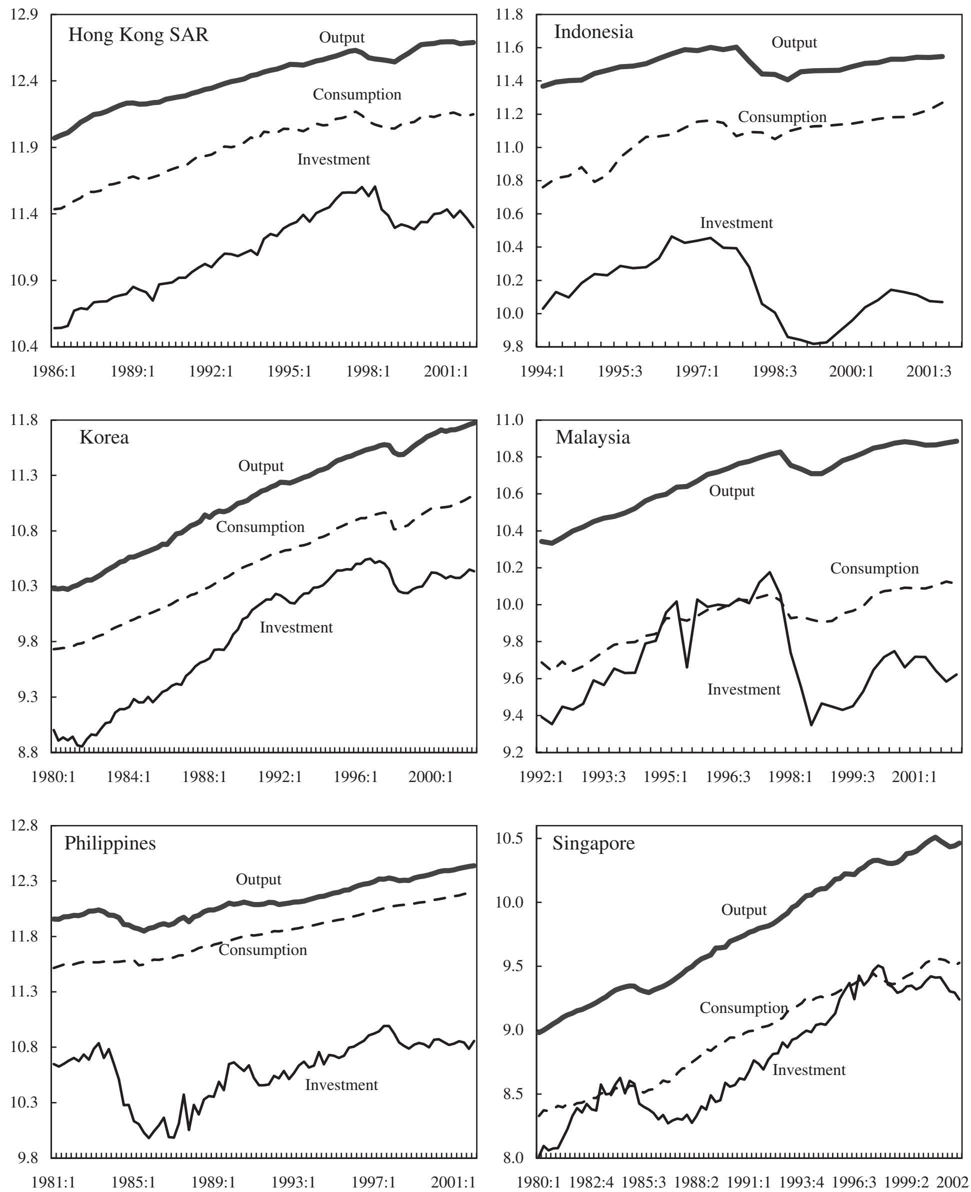
Regime switching has spurred a considerable debate on the nature of U.S. business cycle fluctuations. Two general types of parametric time-series models have been proposed, which have vastly different implications for the welfare effects of recessions (see Figure 2).

In Hamilton's model (1989), the stochastic trend in output undergoes regime switching between positive and negative growth states. Because the regime switch occurs in the growth rate of the permanent component, a negative state results in a permanent output loss.

The second model assumes that regime switching occurs in a common temporary component. This idea has its roots in the work of Friedman (1964, 1993), in which a recession can be characterized as a temporary "pluck" down of output.

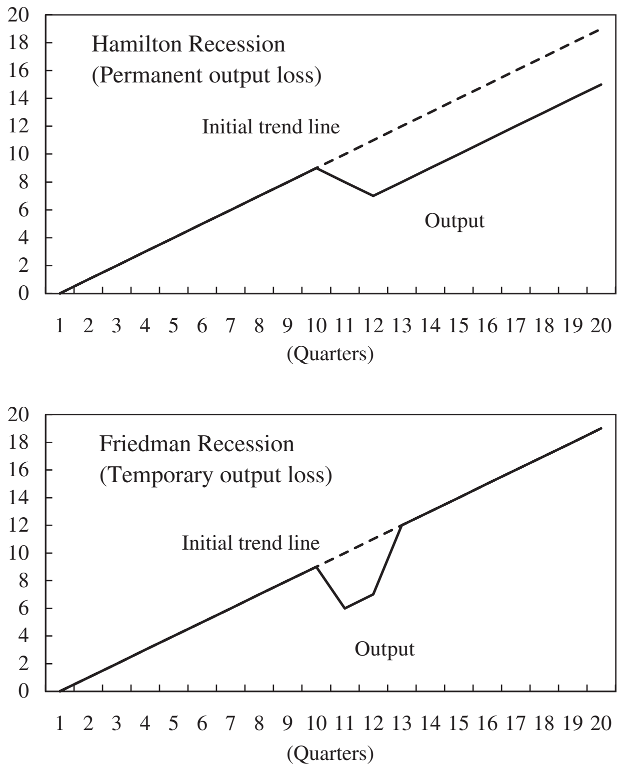
Figure 1. Actual Output, Consumption, and Investment

(Log level)



Note: The x-axis data labels refer to year:quarter.

Figure 2. Output in Hamilton and Friedman Recessions



After this large negative transitory shock dissipates, output returns to trend in a high-growth recovery phase. Because this type of recession represents a temporary deviation from trend followed by a full recovery to trend, the output loss is temporary.

The analysis in this paper draws on these concepts and on debates about the U.S. business cycle. The crisis-induced recessions in the Asian countries involved a simultaneous decline in several economic variables, which motivates the use of a common factor model like those used in the business cycle literature. In this paper, we are primarily interested in studying whether the asymmetry between expansions and crisis-driven recessions is more consistent with the Hamilton or the Friedman model. Both models involve V-shaped growth recoveries, although the Friedman model suggests that growth would be temporarily higher during recovery than during a normal expansion. This paper explores whether output springs back up to its original path following a crisis-driven recession or growth simply recovers to its trend rate, implying that the level of output has been permanently reduced compared with the original path. If the crisis leads to a temporary disruption in economic conditions or a temporary reduction in capacity utilization or employment, output could revert to its original path. In fact, if the crisis induces beneficial reforms, output may even recover to a higher path than before the crisis. In contrast, a switch to a lower state in the permanent component would imply a permanent output loss and could be characteristic, for example, of a reduction in productivity. After the crisis, productivity growth would resume, but there would be a permanent wedge in the level compared with pre-crisis forecasts.

A variety of methods and model specifications have been used to study the nature of the U.S. business cycle. Studies have been conducted using various assumptions about the source of asymmetry and with varying numbers of states. However, because of the use of univariate analysis, most of the literature that investigates asymmetry considers regime switching in only a temporary or a permanent component. Two exceptions are Kim and Murray (2002) and Kim and Piger (2002), which investigate the co-movement of several economic series and asymmetry in both temporary and permanent common factors. Kim and Piger, although specifying that output contains both permanent and temporary components, use only one state variable to control both components. Consequently, each recession is constrained to incorporate both temporary and permanent explanations. As in Kim and Murray, this paper uses a model that has two independent state variables for the temporary and permanent factors. This model is considered to be superior to a single-state-variable model with two or three states, as it allows researchers to determine whether a recession involves regime switches in the temporary or permanent components of output. However, Kim and Murray use a series of variables intended to capture co-movement with industrial production and focus on constructing a coincident indicator. As in Kim and Piger, this paper uses output, investment, and consumption, which theory predicts should share a common stochastic trend.

II. Econometric Model

In this section we present the specification of the dynamic two-factor model used for the empirical analysis. The logs of each of the three series of interest can be decomposed into a deterministic component, DT_i, a permanent component, P_{it}, and a transitory component, T_{it}.

$$\vec{Y}_{it} = DT_i + P_{it} + T_{it}$$

$$DT_i = a_i + D_i t$$

$$P_{it} = \gamma_i n_t + \varsigma_{it}$$

$$T_{it} = \lambda_i x_t + \omega_{it},$$

where $\vec{Y}$ = [output, investment, consumption], n is the common permanent component, x is the common temporary component, and ζ and ω are the independent idiosyncratic permanent and temporary components, respectively. The model can be written in differenced deviations from means as follows:

$$\Delta y_{it} = \gamma_i \Delta n_t + \lambda_i \Delta x_t + z_{it},$$

where $z_{it} = \Delta\varsigma_{it} + \Delta\omega_{it}$ is a stationary composite of the idiosyncratic components, and γ_i and λ_i are the factor loadings on the common permanent and common transitory components, respectively, for i = [output, investment, and consumption].

The growth rate of the common permanent component is stationary and is approximated by a second-order autoregressive process, AR(2). Note that a stationary *growth* rate implies that the *level* is nonstationary, in accordance with the definition of a stochastic trend. In addition, there is a trend, β, that depends on the permanent state, S_{1t}:

$$\Delta n_t = \beta_{S1t} + \phi_1 \Delta n_{t-1} + \phi_2 \Delta n_{t-2} + v_t,\ v_t \sim i.i.d.\ N(0,1).$$

The state-dependent trend introduces asymmetry along the lines of Hamilton (1989):

$$\beta_{S1t} = \beta_0 + \beta_1 S_{1t};\ S_{1t} = \{0,1\}.$$

During an expansion phase ($S_{1t} = 0$), the stochastic trend grows with the drift rate β_0. If β_1 is negative, the trend shifts to a lower growth state when $S_{1t} = 1$ and shifts to a recession phase if $\beta_0 + \beta_1 < 0$.

The common temporary component is stationary in its levels and is approximated by a second-order autoregressive process. To incorporate Friedman's type of asymmetry, we allow the temporary component to undergo regime switching in response to a second state variable, S_{2t}:

$$x_t = \tau S_{2t} + \phi_{11} x_{t-1} + \phi_{12} x_{t-2} + u_t,\ u_t \sim i.i.d.\ N(0,1).$$

In state $S_{2t} = 0$, the intercept is zero. If $\tau_i < 0$, the economic series is plucked down when $S_{2t} = 1$. When the state returns to normal, $S_{2t} = 0$, the economy reverts back to trend level.

Finally, each series has its own stationary idiosyncratic component, again approximated by an AR(2).[1]

$$z_{it} = \psi_{i1} z_{it-1} + \psi_{i2} z_{it-2} + e_{it},\ e_{it} \sim i.i.d.\ N(0,1)$$

$$E(v_r u_s e_{it}) = 0,\ \forall i,\ r,\ s,\ t.$$

Both state variables are assumed to be independent first-order Markov switching processes with transition probabilities given by

$$P[S_{1t} = 0 \mid S_{1t-1} = 0] = q_1,\ P[S_{1t} = 1 \mid S_{1t-1} = 1] = p_1 \text{ and}$$

$$P[S_{2t} = 0 \mid S_{2t-1} = 0] = q_2,\ P[S_{2t} = 1 \mid S_{2t-1} = 1] = p_2.$$

[1] The assumption of unitary variance is made for identification, but the assumption is not particularly restrictive, as the variances of the permanent and temporary components of output, investment, and consumption depend on the magnitude of the factor loadings.

Table 1. Unit Root Tests[1]

Country	Obs.	Variable	ADF Stat	ADF P-val	PP Stat	PP P-val
Hong Kong SAR	65	LRGDP	–2.05	0.26	–2.60	0.10
		LRINV	–2.05	0.26	–2.07	0.26
		LRCON	–2.68	0.08	–2.66	0.09
Indonesia	32	LRGDP	–2.59	0.11	–2.12	0.24
		LRINV	–2.31	0.18	–1.63	0.46
		LRCON	–1.80	0.37	–1.80	0.38
Korea	89	LRGDP	–0.97	0.76	–0.95	0.77
		LRINV	–1.17	0.68	–1.09	0.72
		LRCON	–0.61	0.86	–0.66	0.85
Malaysia	41	LRGDP	–2.43	0.14	–1.94	0.31
		LRINV	–1.98	0.29	–2.03	0.27
		LRCON	–1.10	0.71	–1.13	0.69
Philippines	85	LRGDP	1.01	1.00	0.45	0.98
		LRINV	–1.38	0.59	–1.26	0.65
		LRCON	0.95	1.00	0.97	1.00
Singapore	89	LRGDP	–0.91	0.78	–1.00	0.75
		LRINV	–1.38	0.59	–1.39	0.59
		LRCON	–0.81	0.81	–0.79	0.82

[1] Variables are defined in Appendix I. The lag lengths for the Augmented Dickey-Fuller tests were selected on the basis of the Schwartz Information Criterion, and the bandwidth for the Phillips-Perron tests were based on the Newey-West method using the Bartlett kernel. Critical values are from MacKinnon. The results shown are based on unit root tests in levels, with a constant. All series were stationary in first differences.

III. Econometric Analysis and Results

We use the available quarterly data from six Asian countries (Hong Kong SAR, Indonesia, Korea, the Philippines, Malaysia, and Singapore).[2] In particular, we take the logs of GDP, gross fixed capital formation, and private consumption in constant prices, and seasonally adjust them using Census X-12. (The data sources are described in Appendix I.) The number of available time-series observations ranges from 32 quarters to 89 quarters. However, stacking the three related economic variables in a common factor model effectively triples the number of observations.[3]

Augmented Dickey-Fuller and Phillips-Perron tests provide strong evidence that each of these series contains a unit root (see Table 1). Indeed, the null hypothesis of a unit root cannot be rejected for any of the variables in *levels* at the 5 percent significance level and can be rejected only at the 10 percent level for Hong Kong SAR's private consumption. The unit root hypothesis can easily be rejected at the 1 percent level for all variables in *changes.*

[2] Quarterly data for Thailand were available for only three years, so it was dropped from consideration.

[3] See Kim and Nelson (1999), Chapter 3, for an application of the dynamic common factor model to four coincident indicators in U.S. data.

Standard theoretical models of capital accumulation in an intertemporal optimizing framework imply that output, investment, and consumption share a common stochastic trend. The permanent income hypothesis would identify consumption with the stochastic trend. Indeed, some researchers (Kim and Piger, 2002) assume that consumption represents the stochastic trend in output. That restriction is not imposed here in order to allow for possible liquidity constraints that would make at least a fraction of the population consume out of current income and would thus imply a transitory component to consumption. The common temporary (or cyclical) component could reflect a variety of shocks, including those from supply- and demand-side sources.

The model outlined here can be written in state space form (Appendix II), which allows the application of a Kalman filter. The regime switch is estimated by Kim's (1994) approximate maximum likelihood algorithm, which is a computationally efficient method of estimating Markov switching in both the observation and transition equation.

In Table 2, we show the maximum likelihood parameter estimates for the transition probabilities and state-dependent means, as well as the factor loadings on permanent and temporary components, and the autoregressive parameters and error standard deviations of the idiosyncratic components for output, investment, and consumption.[4] All the factor loadings (γ_i) for output, investment, and consumption are positive on the permanent components for all the countries,[5] which suggests that the permanent component is well identified, with the three variables for each country exhibiting co-movement. The state-dependent mean on the permanent component is positive when $S_{1t} = 0$ and negative when $S_{1t} = 1$ (for example, $\beta_0 > 0$ and $\beta_0 + \beta_1 < 0$), identifying expansions and recessions. There is some evidence of binding liquidity constraints, as the factor loadings on the temporary components are greater for consumption than output for four of the six countries (and are statistically significant for Indonesia and Korea), indicating that consumption contains a cyclical fluctuation and, thus, that individuals are not fully capable of smoothing their consumption. The state-dependent mean ($\tau 1$) of the temporary component is negative except for Hong Kong SAR

[4]The common factor model makes use of the stacked information from the vector of variables: output, investment, and consumption. For each of the countries shown in Table 4, the complete set of factor loadings, and idiosyncratic AR parameters and error standard deviations are presented for the vector of variables. Several sets of initial values were employed to ensure the robustness of the results.

[5]Testing for the number of states in Markov switching models is complicated by a number of problems, particularly, nuisance parameters under the null hypothesis and a singular Hessian. If the nuisance parameters exist only under the alternative hypothesis but not under the null hypothesis, the likelihood ratio, LM, and Wald tests cannot be applied. In this particular model, some of the AR parameters and transition probabilities are unidentified under the null hypothesis that all of the gammas are zero, or that all of the lambdas are zero. Hansen (1992) and Garcia (1998), among others, have considered the problem of nuisance parameters under the null, but the distribution of the test statistic for the state space model employed in this paper is unknown when nuisance parameters exist only under the alternative hypothesis. Nevertheless, there is scope for inference in the model: the hypothesis that any particular factor loading equals zero does not involve any unidentified parameters and standard distribution theory is valid. Moreover, while the estimations assume the existence of two state variables, there is no reason to presuppose the estimated permanent loss would be economically significant.

Table 2. Maximum Likelihood Estimates

Parameters	Hong Kong SAR	Indonesia	Korea	Malaysia	Philippines	Singapore
Transition probabilities:						
$q1$	0.982	0.965	0.989	0.974	0.966	0.953
	(0.018)	(0.034)	(0.011)	(0.026)	(0.027)	(0.026)
$p1$	0.468	0.729	0.000	0.650	0.749	0.676
	(0.412)	(0.213)	(0.001)	(0.273)	(0.143)	(0.145)
$q2$	0.002	0.266	0.947	0.898	0.296	0.783
	(0.485)	(0.231)	(0.050)	(0.090)	(0.231)	(0.075)
$p2$	0.485	0.901	0.817	0.861	0.894	0.410
	(0.645)	(0.066)	(0.128)	(0.113)	(0.086)	(0.117)
AR(2) coefficients:						
$\phi1$	0.476	–0.026	0.185	–0.064	–0.148	0.029
	(0.166)	(0.135)	(0.069)	(0.153)	(0.099)	(0.113)
$\phi2$	0.053	0.490	0.062	–0.001	–0.006	0.000
	(0.156)	(0.116)	(0.065)	(0.005)	(0.007)	(0.002)
$\phi11$	0.720	0.207	–0.179	0.135	0.083	0.473
	(0.129)	(0.123)	(0.140)	(0.132)	(0.142)	(0.075)
$\phi12$	0.216	–0.011	–0.008	–0.005	0.010	0.346
	(0.130)	(0.013)	(0.012)	(0.009)	(0.900)	(0.070)
ψ_{Y1}	0.387	0.103	–0.360	–0.470	1.646	0.420
	(0.460)	(0.275)	(0.120)	(15.443)	(0.403)	(4.242)
ψ_{Y2}	0.136	–0.003	–0.032	–0.055	–0.677	–0.044
	(0.430)	(0.014)	(0.022)	(3.650)	(0.332)	(0.890)
ψ_{I1}	–0.067	0.072	0.182	–0.200	–0.208	–1.548
	(10.348)	(0.238)	(0.166)	(34.100)	(32.351)	(2.036)
ψ_{I2}	0.052	0.140	–0.008	0.022	–0.010	–0.599
	(1.966)	(0.232)	(0.015)	(2.416)	(2.564)	(1.591)
ψ_{C1}	–0.439	0.829	0.190	–0.302	–0.140	–0.387
	(0.153)	(0.555)	(2.050)	(0.172)	(0.180)	(0.109)
ψ_{C2}	–0.048	–0.172	–0.009	0.016	–0.005	–0.037
	(0.033)	(0.230)	(0.203)	(0.149)	(0.013)	(0.021)

(continued)

Table 2. (*Concluded*)

Parameters	Hong Kong SAR	Indonesia	Korea	Malaysia	Philippines	Singapore
Factor loadings on permanent components:						
γ_Y	0.601	0.237	0.416	0.639	0.730	0.673
	(0.118)	(0.131)	(0.047)	(0.073)	(0.069)	(0.057)
γ_I	0.215	0.222	0.415	0.504	0.463	0.313
	(0.086)	(0.131)	(0.059)	(0.063)	(0.052)	(0.060)
γ_C	0.447	0.108	0.466	0.431	0.176	0.380
	(0.076)	(0.060)	(0.041)	(0.083)	(0.111)	(0.057)
Factor loadings on temporary components:						
λ_Y	0.025	0.147	–0.083	–0.130	–0.025	–0.080
	(0.088)	(0.057)	(0.049)	(0.066)	(0.083)	(0.049)
λ_I	0.888	0.072	–0.118	0.344	0.422	0.486
	(0.088)	(0.056)	(0.064)	(0.095)	(0.231)	(0.067)
λ_C	0.137	–0.351	0.110	0.111	–0.087	0.029
	(0.107)	(0.085)	(0.046)	(0.089)	(0.094)	(0.060)
Standard errors:						
σ_Y	0.320	0.457	0.598	0.000	0.027	0.006
	(0.171)	(0.102)	(0.058)	(0.040)	(0.046)	(0.316)
σ_I	0.000	0.599	0.576	0.000	0.000	0.000
	(0.015)	(0.099)	(0.081)	(0.012)	(0.324)	(0.012)
σ_C	0.643	0.188	0.000	0.718	0.961	0.799
	(0.070)	(0.124)	(0.013)	(0.080)	(0.080)	(0.060)
State-dependent means:						
$\beta 0$	0.121	0.986	0.163	0.334	0.396	0.406
	(0.140)	(0.636)	(0.108)	(0.175)	(0.156)	(0.137)
$\beta 1$	–4.170	–8.458	–14.300	–4.770	–3.417	–3.520
	(1.238)	(4.976)	(1.678)	(1.042)	(0.561)	(0.599)
$\tau 1$	0.233	–4.968	–6.686	–3.528	–2.506	2.984
	(0.421)	(1.248)	(1.892)	(0.988)	(3.035)	(0.446)
Log likelihood	–107.176	–39.662	–98.418	–56.094	–153.867	–157.621
Sample period	1986:1–2002:1	1994:1–2001:4	1980:1–2002:1	1992:1–2002:1	1981:1–2002:1	1980:1–2002:1
Total observations	195	96	267	123	255	267

Note: Standard errors are in parentheses.

Table 3. Expected Durations of States Affecting the Permanent Component

(Quarters)

	Hong Kong SAR	Indonesia	Korea	Malaysia	Philippines	Singapore
Expansion	57	29	87	38	29	21
Contraction	2	4	1	3	4	3

and Singapore, but the effect of a switch in S_{2t} also depends on the sign of the factor loadings on the temporary components, which vary across countries and economic series.

The expected duration of the expansion and contraction phases is shown in Table 3, as derived from the parameter estimates of the transition probabilities.[6] For example, the expected durations for Hong Kong SAR are 57 quarters for the expansion phase of the permanent component and 2 quarters for the contraction phase of the permanent component. For all the countries, expansions are expected to last considerably longer than contractions. This finding is consistent with long-standing results in the U.S. business cycle literature. Indeed, Mitchell noted in 1927 that "business contraction seems to be a briefer and more violent process than business expansion."

Figures 3 and 4 show the probabilities that the permanent and temporary common components, respectively, undergo a regime switch. It is evident from Figure 3 that the crisis induced a recession in the permanent components of all the countries at the time of the Asian crisis. The probability of being in the recession state reaches one in all the countries except the Philippines, for which it peaks at about 0.2. The Philippines instead endured a deep and prolonged recession in the early 1980s associated with the debt crisis and domestic turmoil. The recession state is short-lived in Korea but lasts for several quarters in Indonesia. Figure 5 illustrates the common permanent component for each of the countries.[7]

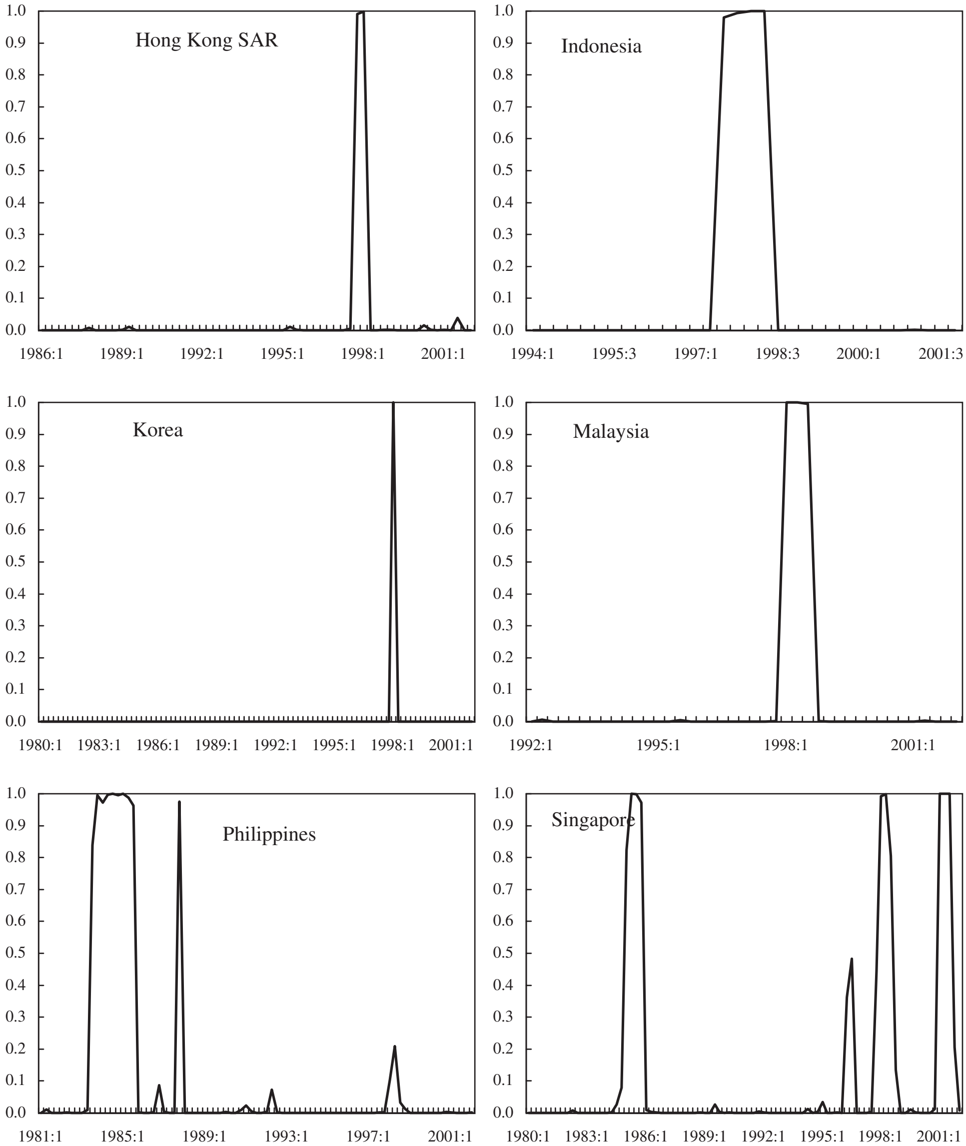
The cumulative effects of regime switches in the permanent components of the six countries over the period 1997–99 are shown in Table 4.[8] The magnitude of the

[6] Testing whether the transition probabilities, p and q, are zero or one, is complicated by the fact that if the parameter lies on the boundary, standard inference is invalid. As the expected duration of a state becomes either long-lasting or of very short duration, the associated transition probability would lie close to a boundary value.

[7] The prevalence of permanent output losses in the Asian countries following their crises corroborates the findings that Sweden's crisis in the early 1990s led to a large permanent output loss (Cerra and Saxena, 2000).

[8] These effects are the extent of contemporaneous output loss over 1997–99. To the extent that the sum of the AR coefficients on the permanent components are positive (negative), the output losses would continue to mount (would diminish) beyond the crisis period. The AR components ($\phi1$ and $\phi2$ in Table 2) sum to a positive number for all countries except Malaysia and the Philippines.

Figure 3. Probability of Permanent Recession

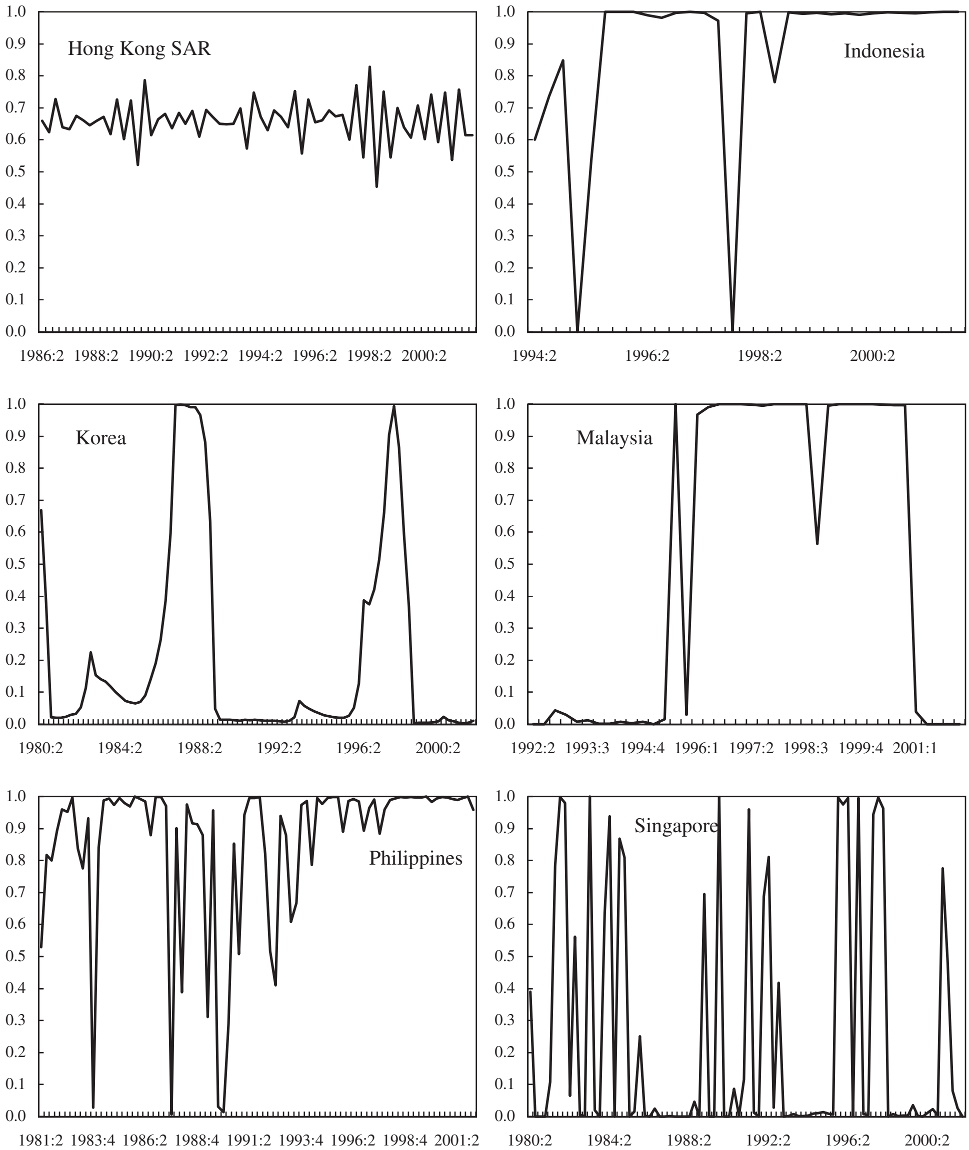


Note: The x-axis data labels refer to year:quarter.

losses from the Asian crisis is economically significant for all countries except perhaps the Philippines.

The parameter estimates shown in Table 2 indicate a lack of solid support for Friedman-style recessions with temporary output losses. More than half of the factor loadings on the temporary components are statistically insignificant, and the signs of the coefficients are inconsistent across the three economic series, except for Hong Kong SAR. However, where the magnitude and statistical significance

Figure 4. Probability That $State_{2t} = 1$

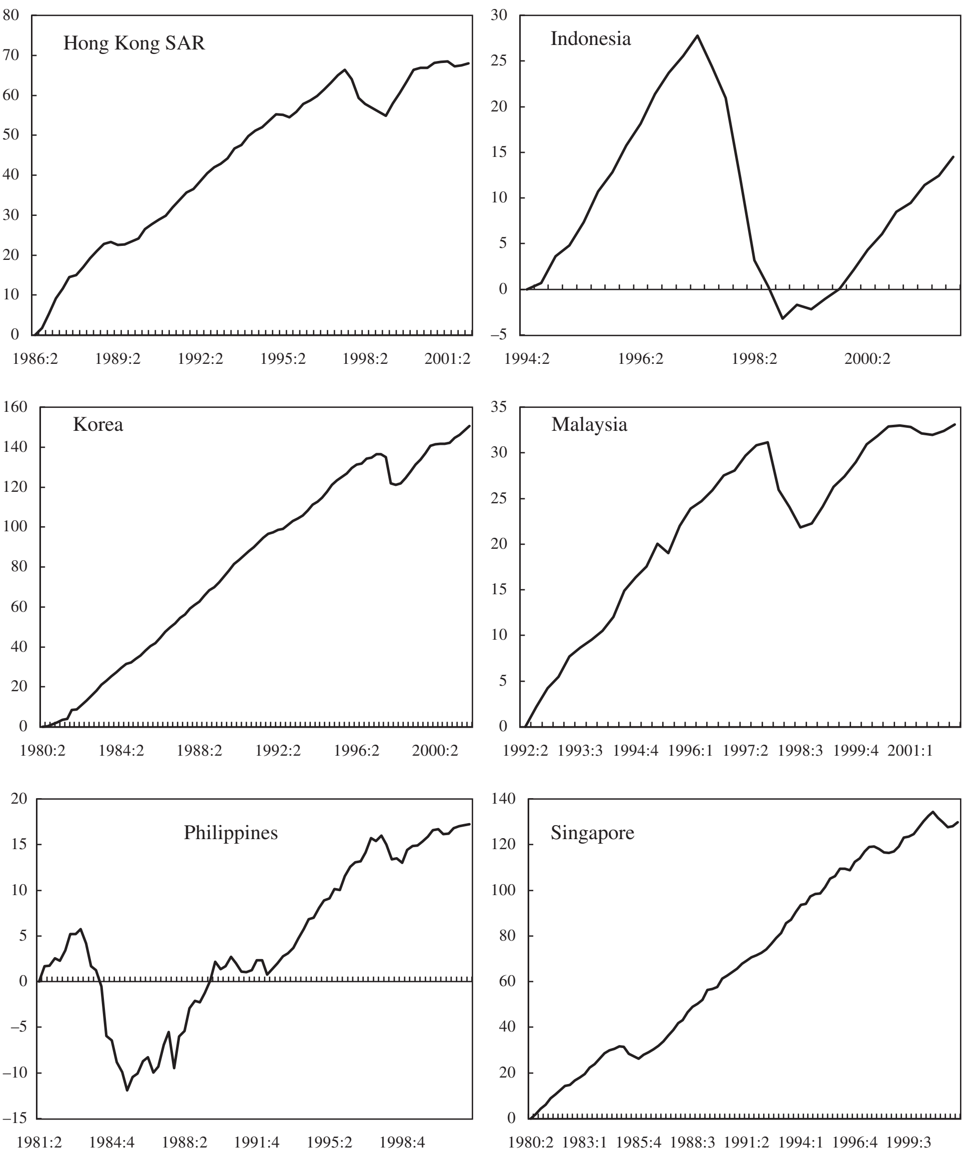


Note: The x-axis data labels refer to year:quarter.

of the λ coefficients are largest (consumption for Indonesia and Korea, and investment for Hong Kong SAR, Malaysia, and Singapore), the common temporary component declines sharply at the time of the crisis.[9] Figure 4 shows the probability that $S_{2t} = 1$, which corresponds to a contraction (expansion for Indonesia) in

[9]The common temporary component increases for Indonesia, but λ_C is negative, thus the effect on consumption would be negative.

Figure 5. Common Permanent Component
(Log level)



Note: The x-axis data labels refer to year:quarter.

consumption or investment, as just discussed. The probability that the recessions associated with the Asian crisis contained a temporary component is most evident for Indonesia, Korea, and Singapore, as shown in Figure 6.

The changes in actual output and the permanent component of output are shown in Figure 7 for each country. It is apparent that changes in the permanent component, including the effects of AR terms and deterministic drifts, account for

Table 4. Magnitude of Permanent Output Loss
(Percent)

	Hong Kong SAR	Indonesia	Korea	Malaysia	Philippines	Singapore
Average permanent loss per recession quarter[1]	3.5	5.6	10.3	6.3	4.1	3.8
Cumulative loss in Asian crisis[2] (excl. AR terms)	7.0	22.3	10.3	19.0	1.5	12.9
Cumulative Loss in Asian Crisis (incl. AR terms)	14.8	41.6	13.7	17.9	1.3	13.3

[1]Difference in state-dependent mean, β_{S1t}, when $S_{1t} = 1$ compared to $S_{1t} = 0$, and adjusted for the factor-loading coefficient and normalization.

[2]Reflects average loss multiplied by probability of permanent recession for the period 1997–99. Does not include the effects of the AR terms of the permanent component.

most of the changes in actual output. Figure 8 isolates the contemporaneous effects of changes in the state-dependent mean (β_{S1t}), excluding AR and deterministic drift terms. Clearly, the regime switch in the permanent component accounts for a considerable amount of the negative growth rate of output during the Asian crisis.

IV. Conclusions and Directions for Future Research

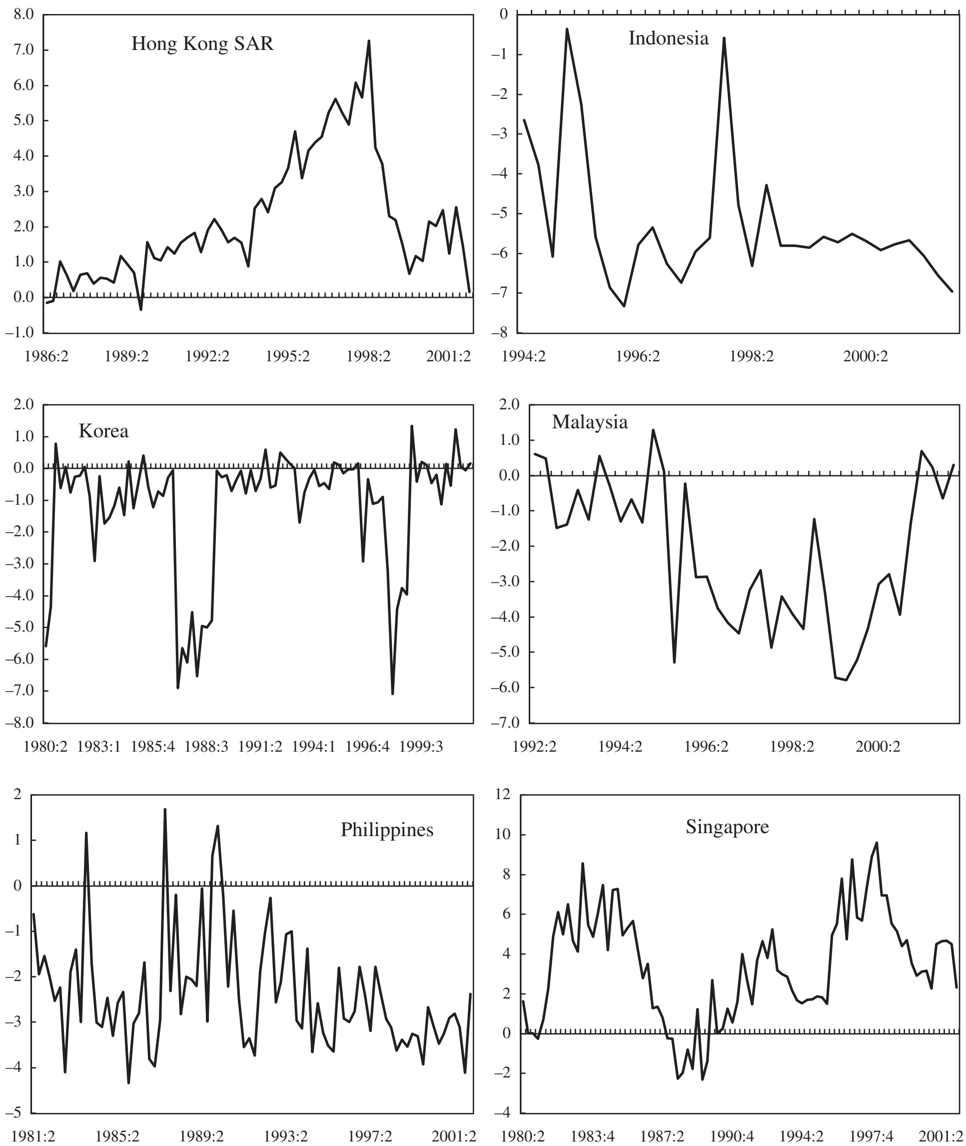
The chief objective of this paper has been to investigate whether output losses associated with the Asian crisis have been permanent or temporary. We used a two-common-factor model with regime switching in each of the factors and used real GDP, gross fixed capital formation, and private consumption to identify the common transitory and stochastic trends.

The results indicate some amount of permanent output loss in all countries, despite rapid returns to positive growth states. Output in most of the countries appears to behave according to Hamilton's model, in which the growth rate of output switches between positive and negative growth states. The recovery phase is predominantly characterized by a return to the normal growth rate of an expansion rather than a higher-than-normal growth rate. Thus, the level of output is permanently lower than its initial trend path.

The nature of the output loss has various implications for the output gap and for policy response. A permanent loss is associated with a downward shift of potential output, whereas a temporary loss is associated with a deterioration of the output gap. Nevertheless, the appropriate policy response depends on the source of the loss and the effectiveness of macroeconomic and structural policies in stimulating potential output and reducing any distortions.

Figure 6. Common Temporary Component

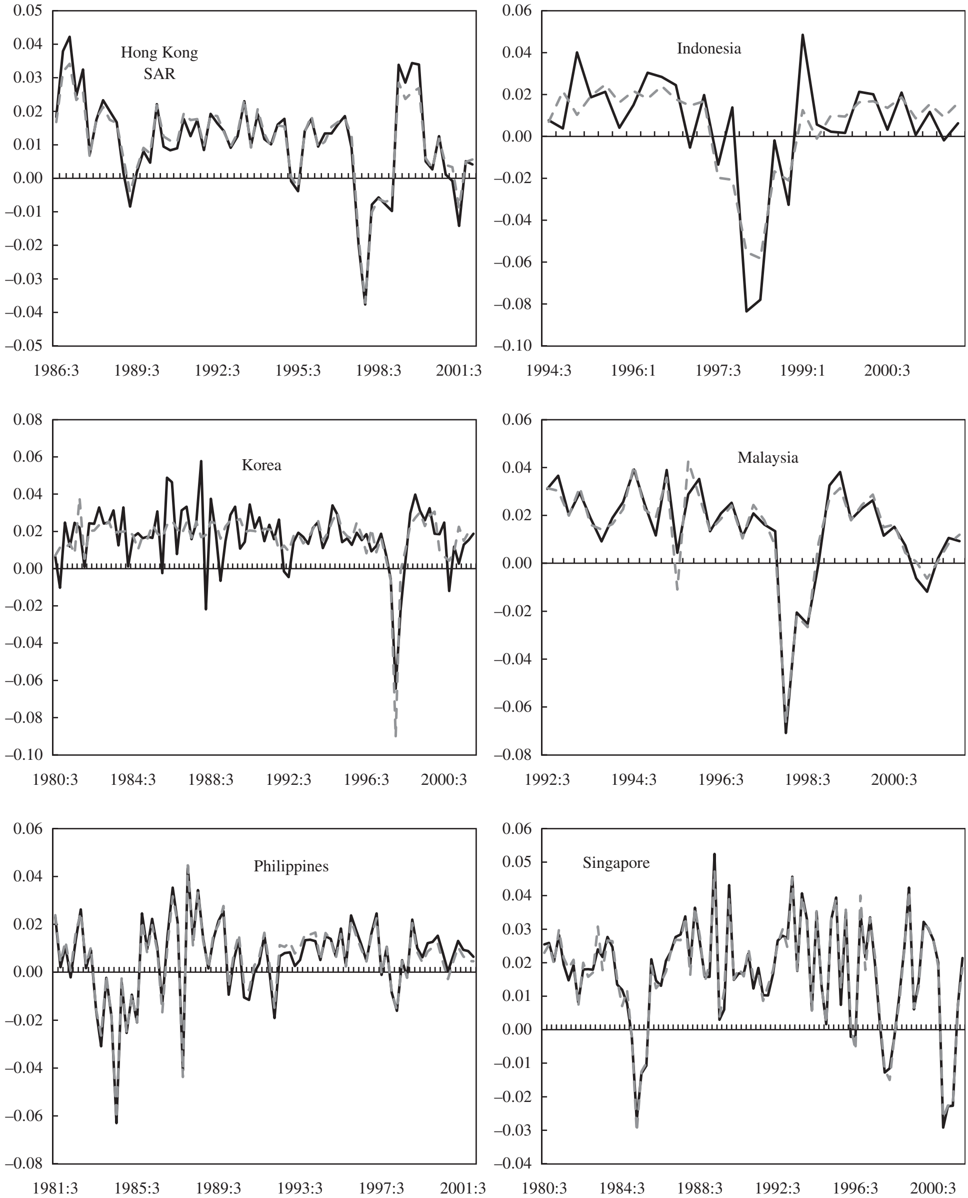
(Log level)



Note: The x-axis data labels refer to year:quarter.

Figure 7. Changes in Output: Actual and Permanent Components

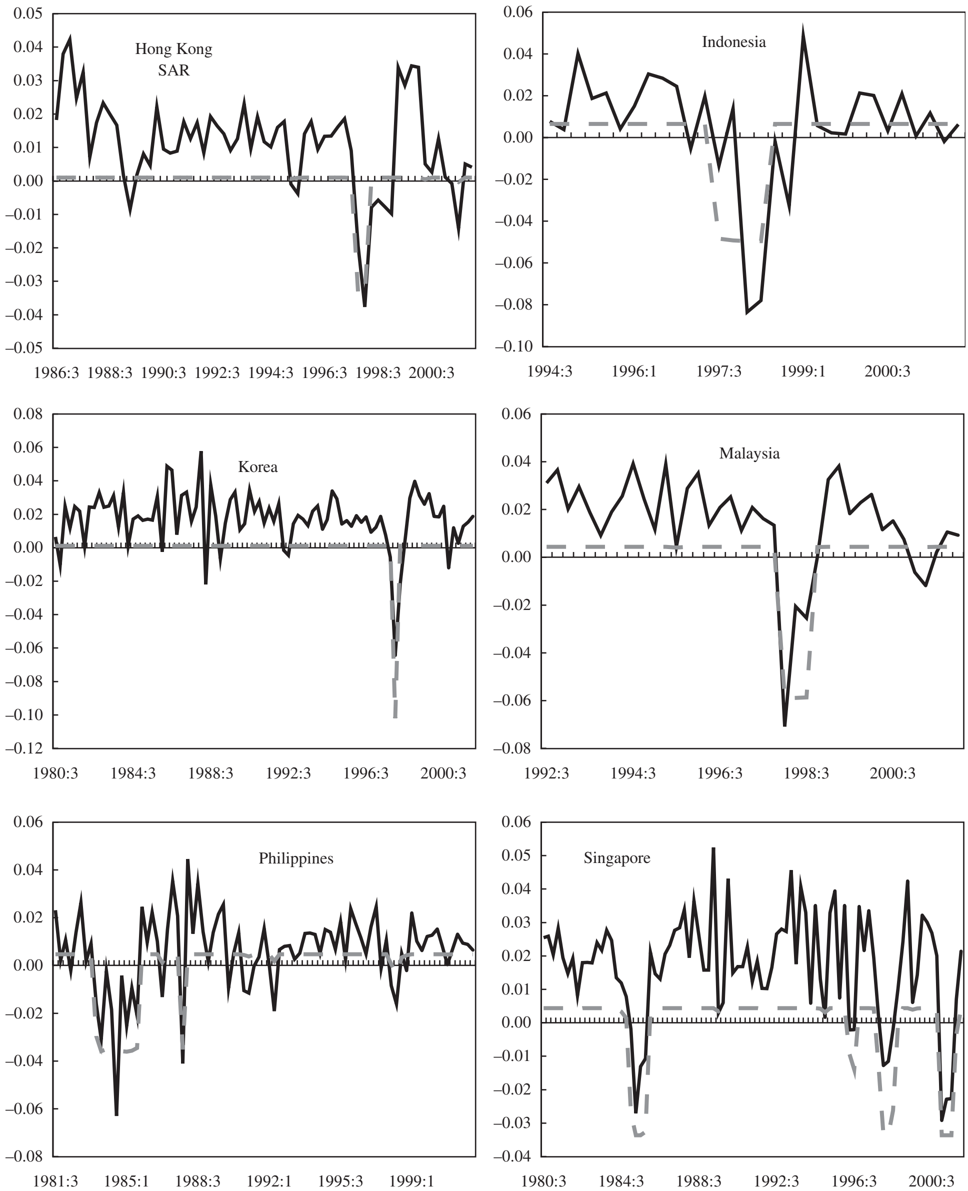
(Change in log level)



Note: The x-axis data labels refer to year:quarter.

Figure 8. Changes in Output: Actual and Component Attributed to State-Dependent Mean of Permanent Component[1]

(Change in log level)



Note: The x-axis data labels refer to year:quarter.
[1]Contemporaneous effect only.

This paper is an attempt to understand the nature of recessions and recoveries from economic crises, but significant scope remains for further research, as follows:

- A wide range of methods has been used to examine the nature of U.S. business cycles; many of these methods could be brought to bear in studying crisis-driven recessions and recoveries. Our understanding of these recessions and recoveries could benefit from advances in the estimation and diagnostics of nonlinear models.
- This study is limited to the Asian crisis; many other episodes of financial crisis could be explored, with the research limited mainly by data availability.
- Future research could investigate the source of permanent loss in output, such as from a permanent rise in unemployment or decline in productivity. The banking crisis in Sweden in the early 1990s, for instance, appears to have induced a deep recession that involved a permanent increase in unemployment (Cerra and Saxena, 2000). Also, the source of productivity decline could be explored. For example, does productivity fall as a result of a collapse in financial intermediation that creates a wedge between savings and its efficient allocation?
- Future research could also explore the relationship between the frequency and magnitude of crises, and the relationship between the trend growth rate and the prevalence of crises. More relevant for policy analysis would be research on whether the magnitude of output loss and the behavior of the subsequent recovery are functions of economic policy responses and reforms.

APPENDIX I
Data Sources

Variable	Country	Sample	Source
Real gross domestic product (RGDP)	Hong Kong SAR (HK)	1986:1–2002:1	WEFA
	Indonesia (IDN)	1994:1–2001:4	*Buletin Statistik Bulanan (Monthly Statistical Bulletin), Indikator Ekonomi*
	Korea (KOR)	1980:1–2002:1	Bank of Korea
	Malaysia (MYS)	1992:1–2002:1	*Sharan Perangkann Bulanan (Monthly Statistical Abstract),* Department of Statistics
	Philippines (PHL)	1981:1–2002:1	WEFA
	Singapore (SGP)	1980:1–2002:1	WEFA
Real gross fixed capital formation (RINV)	Hong Kong SAR (HK)	1986:1–2002:1	WEFA
	Indonesia (IDN)	1994:1–2001:4	*Buletin Statistik Bulanan (Monthly Statistical Bulletin), Indikator Ekonomi*
	Korea (KOR)	1980:1–2002:1	Bank of Korea
	Malaysia (MYS)	1992:1–2002:1	*Sharan Perangkann Bulanan (Monthly Statistical Abstract),* Department of Statistics
	Philippines (PHL)	1981:1–2002:1	WEFA
	Singapore (SGP)	1980:1–2002:1	WEFA
Real personal consumption (RPCON)	Hong Kong SAR (HK)	1986:1–2002:1	WEFA
	Indonesia (IDN)	1994:1–2002:1	*Buletin Statistik Bulanan (Monthly Statistical Bulletin), Indikator Ekonomi*
	Korea (KOR)	1980:1–2002:1	Bank of Korea
	Malaysia (MYS)	1992:1–2002:1	*Sharan Perangkann Bulanan (Monthly Statistical Abstract),* Department of Statistics
	Philippines (PHL)	1981:1–2002:1	WEFA
	Singapore (SGP)	1980:1–2002:1	WEFA

Note: WEFA = Wharton Econometric Forecasting Associates.

APPENDIX II

State Space Representation

This section presents the state space representation of the model discussed in Section III.

Observation Equation:

$$\begin{bmatrix} \Delta y_t \\ \Delta i_t \\ \Delta c_t \end{bmatrix} = \begin{bmatrix} \gamma_1 & 0 & \lambda_1 & -\lambda_1 & 1 & 0 & 0 & 0 & 0 & 0 \\ \gamma_2 & 0 & \lambda_2 & -\lambda_2 & 0 & 0 & 1 & 0 & 0 & 0 \\ \gamma_3 & 0 & \lambda_3 & -\lambda_3 & 0 & 0 & 0 & 0 & 1 & 0 \end{bmatrix} \begin{bmatrix} \Delta n_t \\ \Delta n_{t-1} \\ x_t \\ x_{t-1} \\ z_{1t} \\ z_{1t-1} \\ z_{2t} \\ z_{2t-1} \\ z_{3t} \\ z_{3t-1} \end{bmatrix}$$

Transition Equation:

$$\begin{bmatrix} \Delta n_t \\ \Delta n_{t-1} \\ x_t \\ x_{t-1} \\ z_{1t} \\ z_{1t-1} \\ z_{2t} \\ z_{2t-1} \\ z_{3t} \\ z_{3t-1} \end{bmatrix} = \begin{bmatrix} \beta_0 + \beta_1 S_{1t} \\ 0 \\ \tau S_{2t} \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix} + \begin{bmatrix} \phi_1 & \phi_2 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & \phi_{11} & \phi_{12} & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & \Psi_{11} & \Psi_{12} & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & \Psi_{21} & \Psi_{22} & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & \Psi_{31} & \Psi_{32} \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \end{bmatrix} \begin{bmatrix} \Delta n_{t-1} \\ \Delta n_{t-2} \\ x_{t-1} \\ x_{t-2} \\ z_{1t-1} \\ z_{1t-2} \\ z_{2t-1} \\ z_{2t-2} \\ z_{3t-1} \\ z_{3t-2} \end{bmatrix} + \begin{bmatrix} v_t \\ 0 \\ u_t \\ 0 \\ e_{1t} \\ 0 \\ e_{2t} \\ 0 \\ e_{3t} \\ 0 \end{bmatrix}$$

Covariance Matrix of the Disturbance Vector:

$$E\left(\begin{bmatrix} v_t \\ 0 \\ u_t \\ 0 \\ e_{1t} \\ 0 \\ e_{2t} \\ 0 \\ e_{3t} \\ 0 \end{bmatrix}\begin{bmatrix} v_t \\ 0 \\ u_t \\ 0 \\ e_{1t} \\ 0 \\ e_{2t} \\ 0 \\ e_{3t} \\ 0 \end{bmatrix}'\right) = \begin{bmatrix} \sigma_v^2 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & \sigma_u^2 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & \sigma_{e1}^2 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & \sigma_{e2}^2 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & \sigma_{e3}^2 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

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