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Did Output Recover from the Asian Crisis?

Valerie Cerra and Sweta Chaman Saxena

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Prepared by Valerie Cerra and Sweta Chaman Saxena[1]

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Abstract

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 of the countries studied.

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Author's E-Mail Address: vcerra@imf.org; ssaxena+@pitt.edu

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[1] Economist, European I Department, IMF; and Assistant Professor, Graduate School of Public and International Affairs, University of Pittsburgh, respectively. This paper was presented at the Asian Crisis III conference in Tokyo, Japan in July 2001. The authors gratefully acknowledge Chang-Jin Kim, Chris Murray, and Jeremy Piger for providing original Gauss programs upon which the program used in this paper was based. They would also like to thank Bas Bakker, Craig Beaumont, Peter Berezin, Tarhan Feyzioglu, Munehisa Kasuya, Kalpana Kochhar, and Papa N'Diaye for helpful suggestions.

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I. INTRODUCTION

While the recent Asian financial crisis of 1997 generated a plethora of research that analyzed the causes of the crisis, 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, which was eventually reversed as output reverted to trend (i.e., the recession temporarily lowered the level of output), or alternatively, whether the level of output tended to shift down permanently.

In order to answer this question, this paper employs a regime-switching approach. 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 adjustment in the temporary component is allowed to model the temporary "pluck" down from trend. Section II discusses these concepts in the context of their origin in the U.S. business cycle literature. In Section III, the model used for the empirical analysis is specified. Section IV discusses the data and procedure and presents the results. Concluding remarks are made in Section V.

II. THEORY AND LITERATURE REVIEW

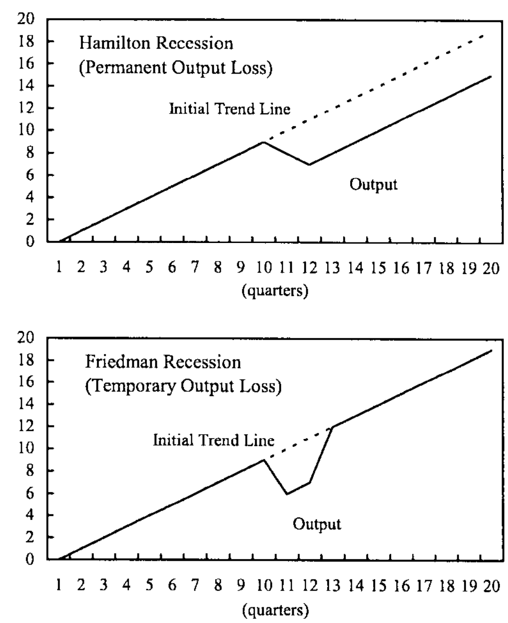
Causes of the Asian crisis have been fairly extensively discussed in the literature. Berg (1999), Corsetti, et al (1998), Kochhar, et al (1998), and Radelet and Sachs (1998), for example, provide overviews of the origins, onset, and spread of the Asian crisis. This literature points to several factors 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 of 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 recent exceptions include cross-country studies by Barro (2001) and Park and Lee (2002). Barro (2001) does not detect a persistent adverse influence of currency and banking crises on long-run economic growth. Park and Lee (2002) find that a V-shaped pattern of growth is associated with crises. The countries hit by the Asian crisis experienced recessions of varying intensities (Figure 2). Output and consumption declined, and investment was particularly hit hard. This study examines whether the Asian crisis had a long-run impact on the level, rather than the growth rate, of output.

In contrast to the general scarcity of studies on the behavior of crisis-driven recessions and recoveries, there has been a considerable amount of research devoted to examining the properties of business cycles in the United States. Two main focuses of the literature have been to incorporate the idea of comovement across economic times series using the dynamic linear factor models innovated by Stock and Watson (1989, 1991, 1993) and to probe the idea of asymmetry through regime switching as pioneered by Hamilton (1989).

The latter idea has spurred a considerable debate on the nature of US 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 (Figure 1).

Figure 1. Output in Hamilton and Friedman Recessions



The first type of model owes to Hamilton (1989), in which the stochastic trend in output undergoes regime switching between positive and negative growth states. Since the regime switch occurs in the growth rate of the permanent component, a negative state results in an output loss that is permanent.

The second type of 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 recessions can be characterized as a temporary "pluck" down of output. After this large negative transitory shock dissipates, output returns to trend in a high growth recovery phase. Since 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 debates about the US 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, parallel to those used in the business cycle literature. Moreover, the main interest of this paper is to study whether the asymmetry between expansions and crisis-driven recessions are more consistent with the Hamilton or Friedman model. Both models involve "V-shape" growth recoveries, except that the Friedman model suggests that growth would be temporarily higher during the recovery than during a normal expansion. This paper explores whether output springs back up to its original path following a crisis-driven recession, or whether growth simply recovers to its trend rate, implying that the level of output has been permanently reduced compared to the original path. Reverting to the original path could occur, for instance, if the crisis leads to a temporary disruption to economic conditions or a temporary reduction in capacity utilization or employment. In fact, if the crisis induces beneficial reforms, it may even be possible that output recovers 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 to a pre-crisis forecast.

A variety of methods and model specifications have been used to study the nature of the U.S. business cycle. Studies have been conducted under different assumptions on the source of asymmetry or with varying numbers of states. However, most of the literature that investigates asymmetry considers only regime switching in either a temporary or a permanent component. This stems from the typical use of univariate analysis. Two exceptions are Kim and Murray (2002) and Kim and Piger (2002), which investigate the comovement 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, uses only one state variable to control both components. Consequently, each recession is forced to contain 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. Such specification is considered superior to a single state variable model with two or three states, as it allows identification of whether the Asian crisis recessions involved regime switches in the temporary or permanent components of output. However, Kim and Murray use a series of variables intended to capture comovement 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.

III. Econometric Model

This section presents 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}.

$$\begin{aligned}
\vec{Y}_{it} &= DT_i + P_{it} + T_{it} \\
DT_i &= a_i + D_i t \\
P_{it} &= \gamma_i n_t + \varsigma_{it} \\
T_{it} &= \lambda_i x_t + \omega_{it}
\end{aligned}$$

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.

The growth rate of the common permanent component is stationary and is approximated by a second order autoregressive process. 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}:

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

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}=0, 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}.

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

In state S_{2t}=0, the intercept is zero. If $\tau_i<0$, then 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).[2]

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

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

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

$$\Pr[S_{1t} = 0 \mid S_{1t-1} = 0] = q_1 , \; \Pr[S_{1t} = 1 \mid S_{1t-1} = 1] = p_1 \quad \text{and}$$
$$\Pr[S_{2t} = 0 \mid S_{2t-1} = 0] = q_2 , \; \Pr[S_{2t} = 1 \mid S_{2t-1} = 1] = p_2$$

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[2] 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.

IV. Econometric Analysis and Results

Quarterly data from six Asian countries[3] (Hong Kong SAR, Indonesia, Korea, the Philippines, Malaysia, and Singapore) have been taken for the logs of GDP, private consumption, and gross fixed capital formation in constant prices, and the data have been seasonally adjusted using the Census X-12 method. The data sources are described in Appendix I.

Augmented Dickey-Fuller and Phillips-Perron tests provide strong evidence that each of these series contains a unit root (see Table 3). 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 only be rejected 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*.

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 papers (Kim and Piger, 2002) assume that consumption represents the stochastic trend in output. However, the 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 from supply and demand-side sources.

The model outlined in the previous section 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.

The maximum likelihood parameter estimates are shown in Table 4.[4] All of the factor loadings (γ_i) for output, investment, and consumption are positive on the permanent components for all of the countries.[5] This suggests that the permanent component is well

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

[4] 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 there 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)

identified, with the three variables for each country exhibiting comovement. The state-dependent mean on the permanent component is positive when $S_{1t}=0$ and negative when $S_{1t}=1$ (e.g., $\beta 0>0$ and $\beta 0+\beta 1<0$), identifying expansions and recessions. There is some evidence of binding liquidity constraints since the factor loadings on the temporary components are greater for consumption than output for four out of six countries (and are statistically significant for Indonesia and Korea), indicating that consumption contains a cyclical fluctuation and thus 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 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 are in Table 1, 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 of 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 (1927) noted that "Business contraction seems to be a briefer and more violent process than business expansion."

Table 1. 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 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.

[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.

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 permanent recession in all of the countries. The probability of being in the recession state reaches one in all of the countries at the time of the Asian crisis, except for the Philippines, for which it peaked 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. Figure 5 illustrates the common permanent component for each of the countries. The prevalence of permanent output losses in the Asian countries following their crises corroborate the findings that Sweden's crisis in the early 1990s led to a large permanent output loss (Cerra and Saxena, 2000).

The cumulative effects of regime switches in the permanent components of the six countries over the period 1997-99 are shown in Table 2.[7] The magnitude of the losses from the Asian crisis is economically significant for all countries, except perhaps the Philippines.

Table 2. 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/	7.0	22.3	10.3	19.0	1.5	12.9

1/ Difference in state dependent mean, $\beta_{S_{1t}}$, 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 1997-1999. Does not include the effects of the AR terms of the permanent component.

The parameter estimates shown in Table 4 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 of the λ coefficients are largest (consumption for Indonesia and Korea, and investment for Hong Kong SAR, Malaysia, and Singapore), the common temporary component (Figure 6) declines sharply at the time of the crisis.[8] Figure 4 shows the probability that S_{2t}=1, which corresponds to a contraction (expansion for Indonesia) in consumption or investment, as just discussed. The probability

[7] 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 (ϕ1 and ϕ2 in Table 4) sum to a positive number for all countries except Malaysia and the Philippines.

[8] The common temporary component increases for Indonesia, but λ3 is negative, thus the effect on consumption would be negative.

that the recessions associated with the Asian crisis contained a temporary component is most evident for Indonesia, Korea, and Singapore.

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 components account for most of the changes in actual output, although this also reflects effects of AR terms and deterministic drifts. 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.

V. 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. This was accomplished through a two-common-factor model with regime switching in each of the factors. Real GDP, gross fixed capital formation, and private consumption were used 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 therefore 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 different implications for the output gap and possibly the 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.

This paper represents an attempt to understand the nature of recessions and recoveries from economic crises, but there is still significant scope for further research that is beyond the scope of this paper.

- A wide range of methods have been used to examine the nature of U.S. business cycles, and more of these methods could be brought to bear in studying crisis-driven recessions and recoveries. Moreover, 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, but many more episodes of financial crises could be explored, with such research limited mainly by data availability.

- Future research could investigate the source of the 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 some permanent rise in unemployment (Cerra and Saxena, 2000). Furthermore, the source of productivity decline could be explored. For example, does productivity fall owing to 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 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.

Table 3. Unit Root Tests *

Country	No. 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

* 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.

Table 4. 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:						
$\phi 1$	0.476	-0.026	0.185	-0.064	-0.148	0.029
	(0.166)	(0.135)	(0.069)	(0.153)	(0.099)	(0.113)
$\phi 2$	0.053	0.490	0.062	-0.001	-0.006	0.000
	(0.156)	(0.116)	(0.065)	(0.005)	(0.007)	(0.002)
$\phi 11$	0.720	0.207	-0.179	0.135	0.083	0.473
	(0.129)	(0.123)	(0.140)	(0.132)	(0.142)	(0.075)
$\phi 12$	0.216	-0.011	-0.008	-0.005	0.010	0.346
	(0.130)	(0.013)	(0.012)	(0.009)	(0.900)	(0.070)
$\psi 11$	0.387	0.103	-0.360	-0.470	1.646	0.420
	(0.460)	(0.275)	(0.120)	(15.443)	(0.403)	(4.242)
$\psi 12$	0.136	-0.003	-0.032	-0.055	-0.677	-0.044
	(0.430)	(0.014)	(0.022)	(3.650)	(0.332)	(0.890)
$\psi 21$	-0.067	0.072	0.182	-0.200	-0.208	-1.548
	(10.348)	(0.238)	(0.166)	(34.100)	(32.351)	(2.036)
$\psi 22$	0.052	0.140	-0.008	0.022	-0.010	-0.599
	(1.966)	(0.232)	(0.015)	(2.416)	(2.564)	(1.591)
$\psi 31$	-0.439	0.829	0.190	-0.302	-0.140	-0.387
	(0.153)	(0.555)	(2.050)	(0.172)	(0.180)	(0.109)
$\psi 32$	-0.048	-0.172	-0.009	0.016	-0.005	-0.037
	(0.033)	(0.230)	(0.203)	(0.149)	(0.013)	(0.021)

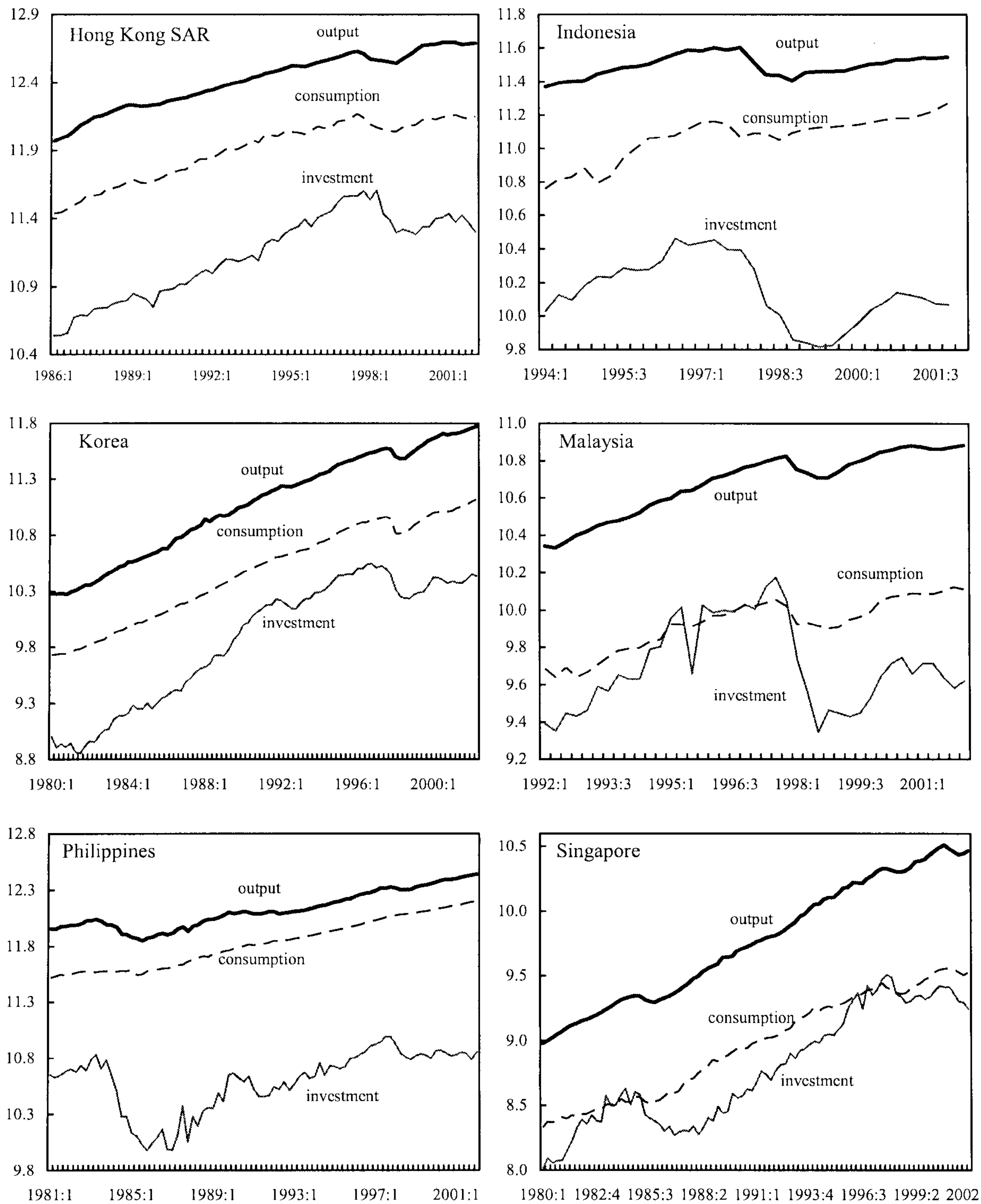
Note: Standard errors are in parentheses.

Table 4. Maximum Likelihood Estimates (continued)

Parameters	Hong Kong SAR	Indonesia	Korea	Malaysia	Philippines	Singapore
Factor loadings on permanent components:						
γ1	0.601	0.237	0.416	0.639	0.730	0.673
	(0.118)	(0.131)	(0.047)	(0.073)	(0.069)	(0.057)
γ2	0.215	0.222	0.415	0.504	0.463	0.313
	(0.086)	(0.131)	(0.059)	(0.063)	(0.052)	(0.060)
γ3	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:						
λ1	0.025	0.147	-0.083	-0.130	-0.025	-0.080
	(0.088)	(0.057)	(0.049)	(0.066)	(0.083)	(0.049)
λ2	0.888	0.072	-0.118	0.344	0.422	0.486
	(0.088)	(0.056)	(0.064)	(0.095)	(0.231)	(0.067)
λ3	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:						
σ1	0.320	0.457	0.598	0.000	0.027	0.006
	(0.171)	(0.102)	(0.058)	(0.040)	(0.046)	(0.316)
σ2	0.000	0.599	0.576	0.000	0.000	0.000
	(0.015)	(0.099)	(0.081)	(0.012)	(0.324)	(0.012)
σ3	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:						
β0	0.121	0.986	0.163	0.334	0.396	0.406
	(0.140)	(0.636)	(0.108)	(0.175)	(0.156)	(0.137)
β1	-4.170	-8.458	-14.300	-4.770	-3.417	-3.520
	(1.238)	(4.976)	(1.678)	(1.042)	(0.561)	(0.599)
τ1	0.233	-4.968	-6.686	-3.528	-2.506	2.984
	(0.421)	(1.248)	(1.892)	(0.988)	(3.035)	(0.446)
loglikelihood	-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

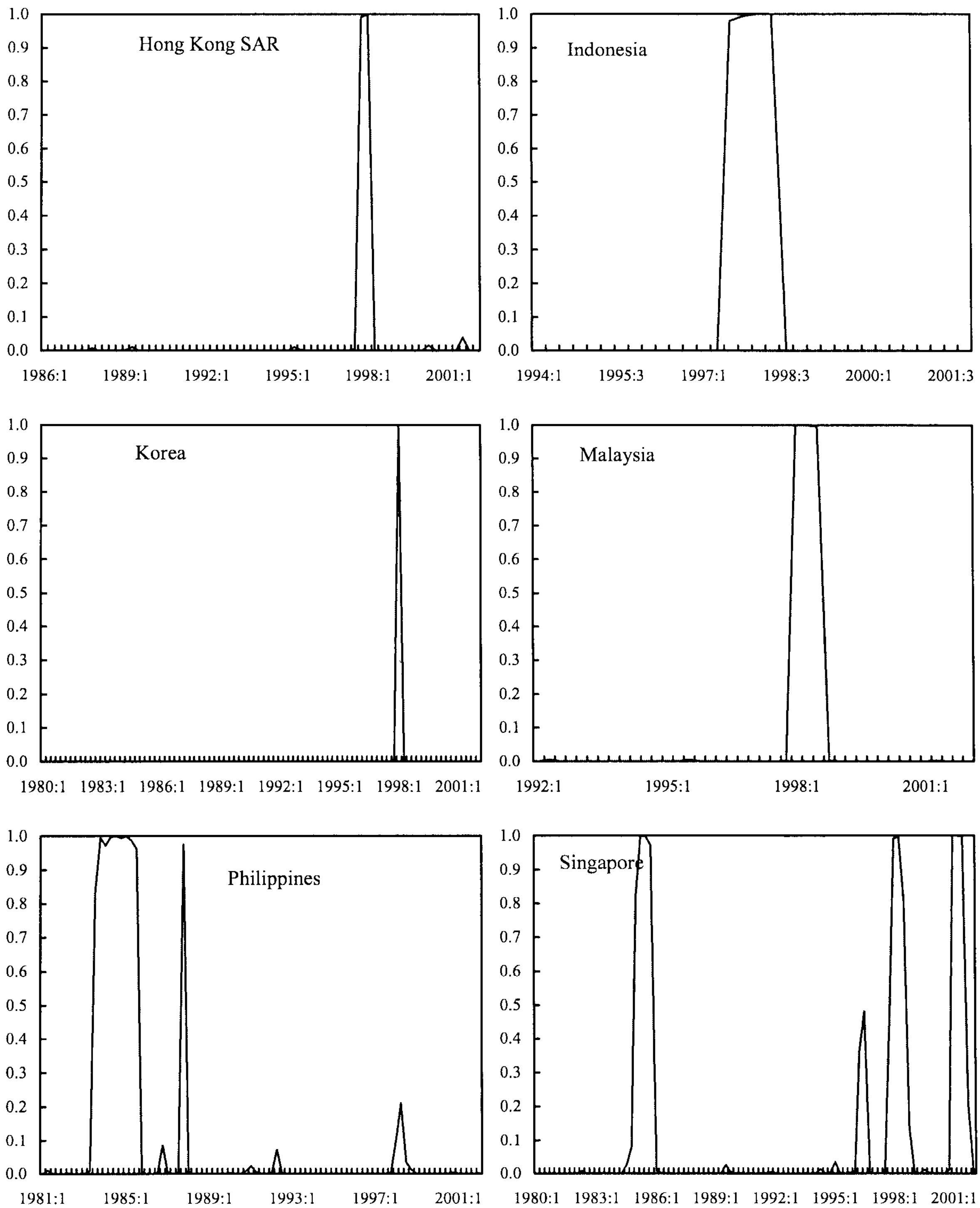
Note: Standard errors are in parentheses.

Figure 2. Actual Output, Consumption, and Investment
(log level)



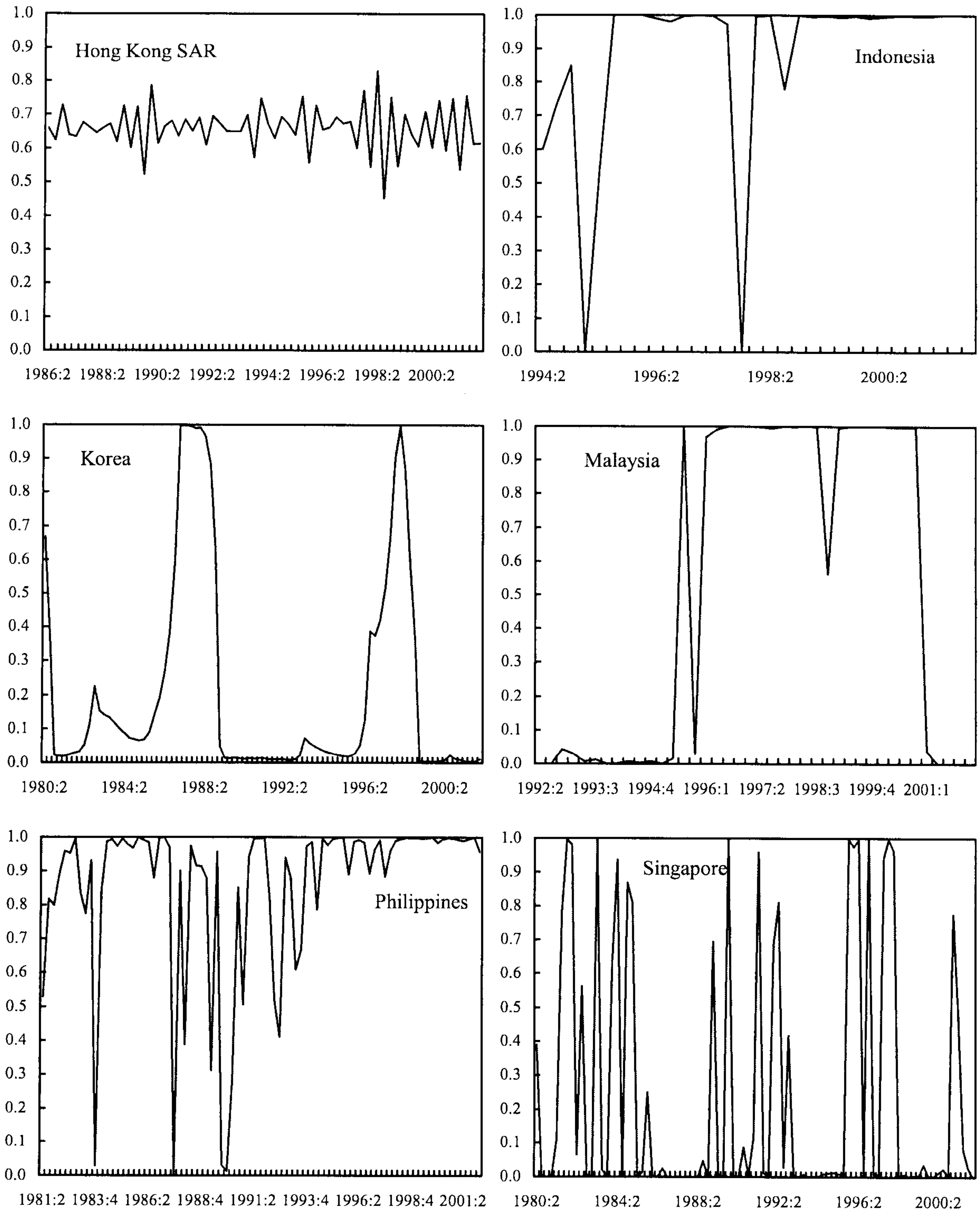
Note: The X-axis data labels refer to year:quarter.

Figure 3. Probability of Permanent Recession



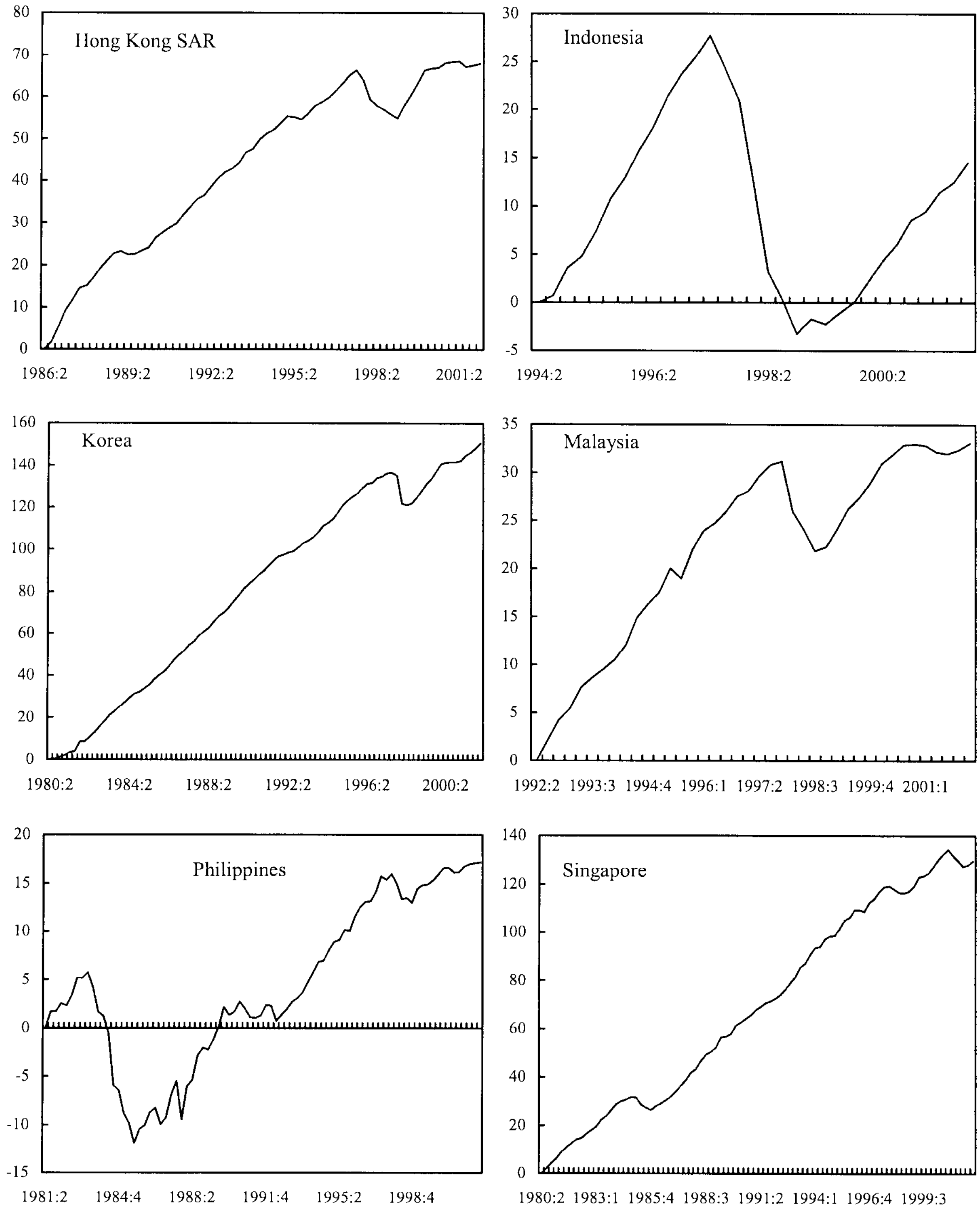
Note: The X-axis data labels refer to year:quarter.

Figure 4. Probability that State2 = 1



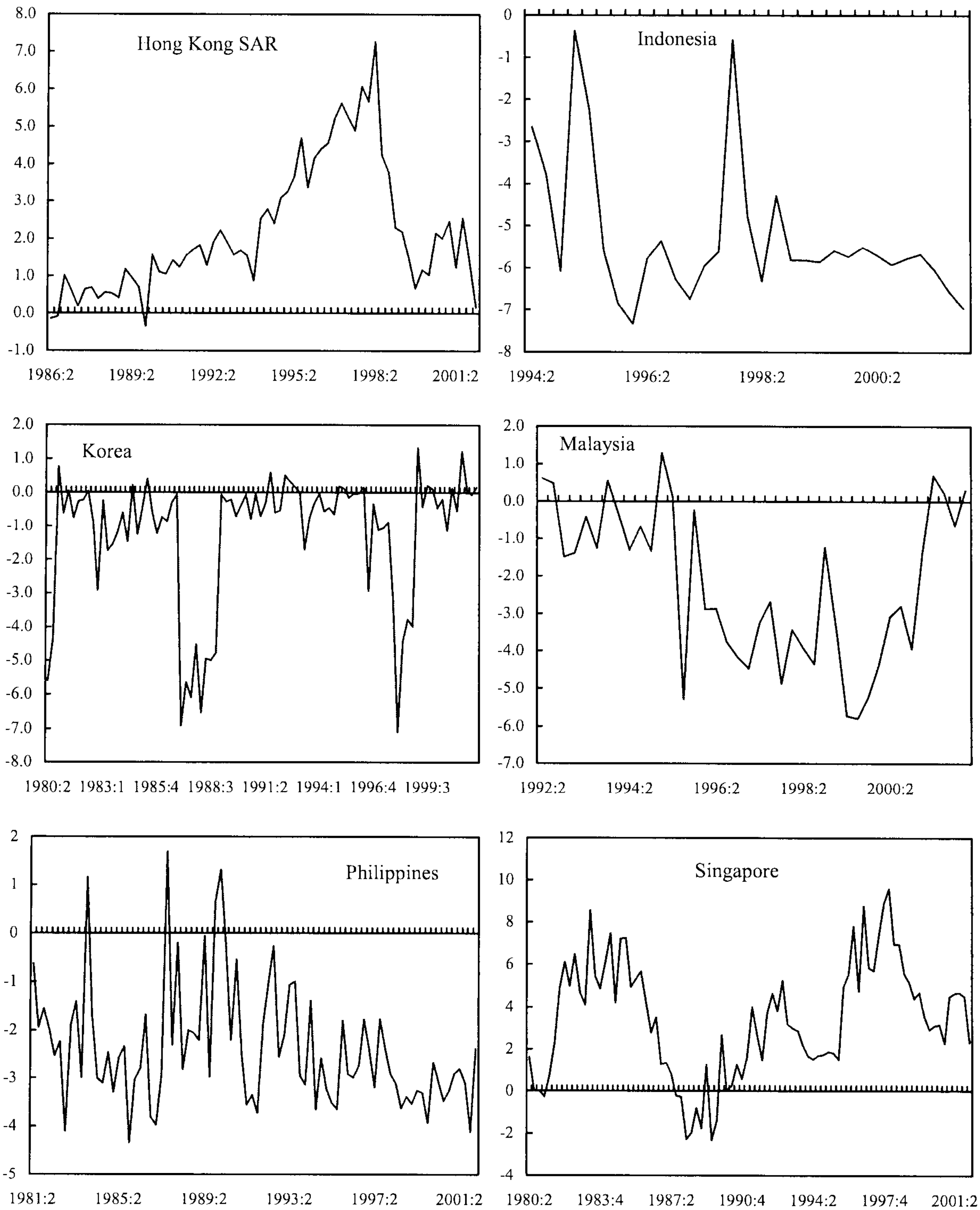
Note: The X-axis data labels refer to year:quarter.

Figure 5. Common Permanent Component
(log level)



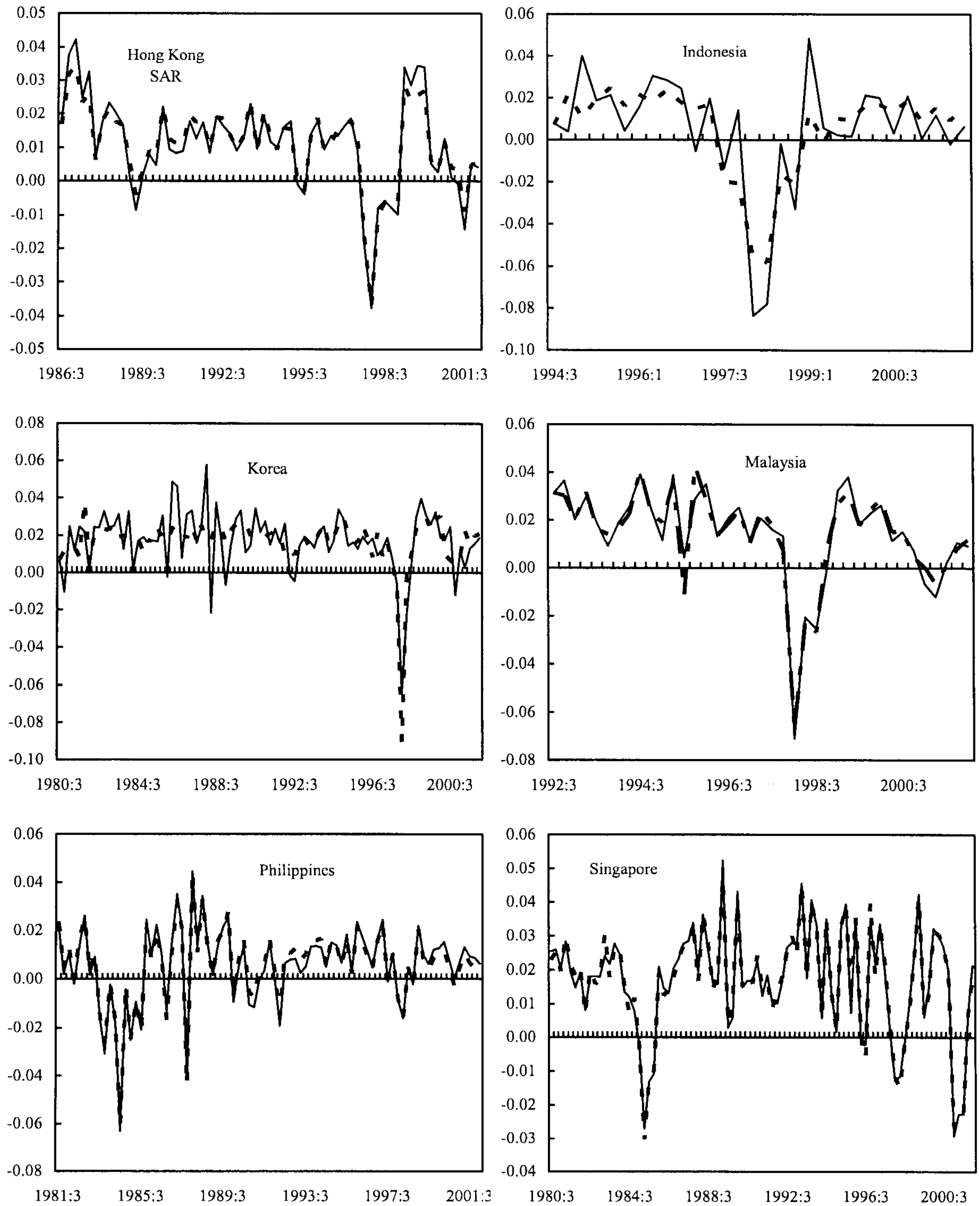
Note: The X-axis data labels refer to year:quarter.

Figure 6. Common Temporary Component
(log level)



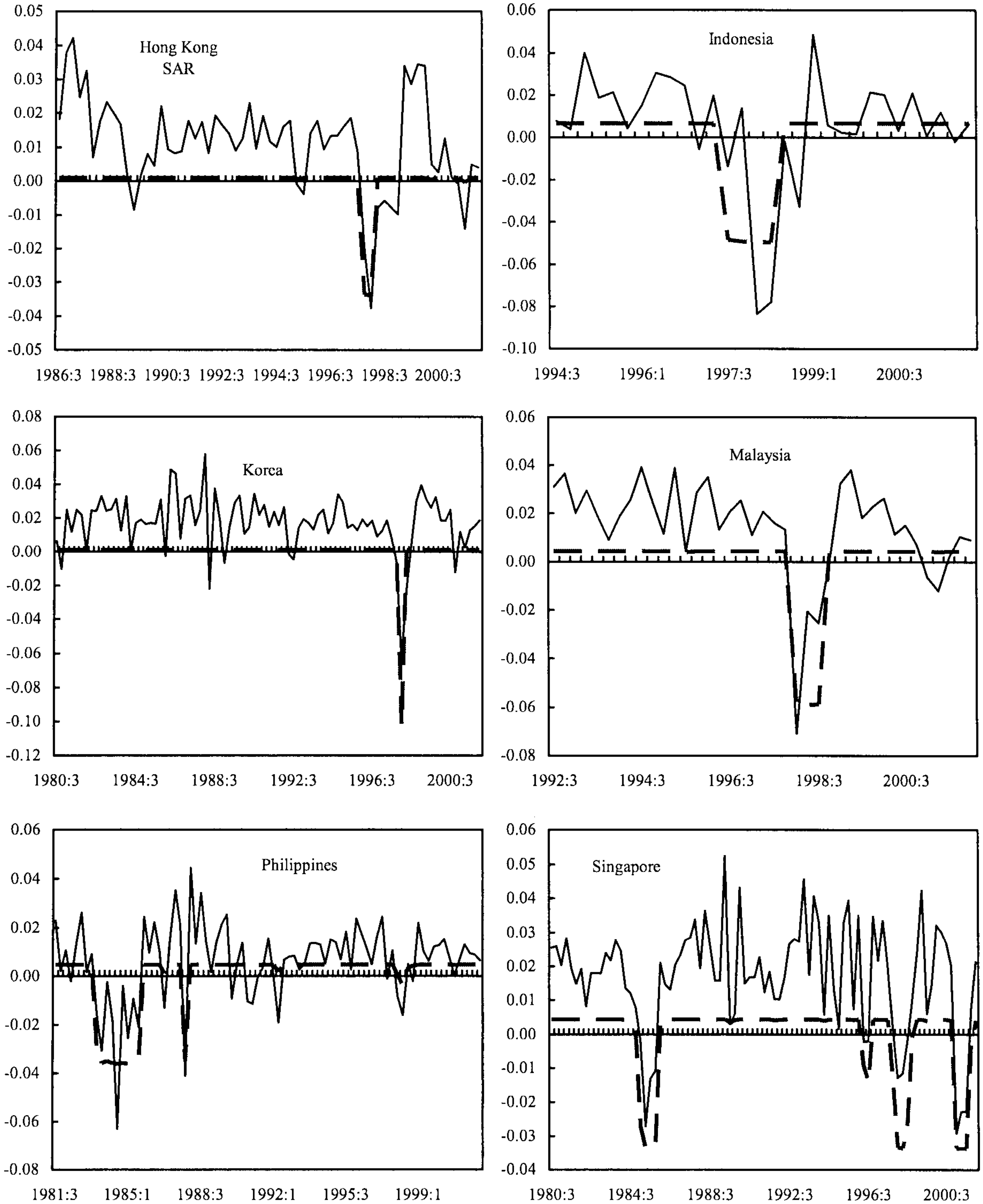
Note: The X-axis data labels refer to year:quarter.

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*
(change in log level)



*Contemporaneous effect only.
Note: The X-axis data labels refer to year:quarter.

Appendixes

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 refers to Wharton Econometric Forecasting Associates.

II. State Space Representation

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

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:

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

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