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## Policies and Prospects in Japan and The Implications for the Asia-Pacific Region

*Tim Callen and Warwick J. McKibbin*



## IMF Working Paper

Asia and Pacific Department and the Regional Office for Asia and the Pacific

### **Policies and Prospects in Japan and The Implications for the Asia-Pacific Region**

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#### **Abstract**

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This paper uses the G-Cubed (Asia-Pacific) model—a macroeconomic model with rich cross-country links—to explore the implications for Japan and Asia of several shocks to the Japanese economy. The results suggest that, while fiscal consolidation in Japan would initially dampen domestic growth, over the medium term the impact on both the domestic and regional economies would be positive. Quantitative monetary easing in Japan would boost domestic activity in the short-run, while being basically neutral for the region. Finally, a loss of confidence in the yen would be negative for Japan, but positive for the region because of a reallocation of capital flows toward non-Japan Asia.

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## I. INTRODUCTION

Economic and financial developments in Japan have important implications for the Asia-Pacific region. Japan is not only an important trading partner, but also a significant supplier of capital to the region. However, the nature of these relationships has changed over time with the rapid growth in Japan from the 1950s until the bursting of the bubble economy, the subsequent poor economic performance during the 1990s, the sharp appreciation of the yen, the rapid growth in the Asian economies, and the Asian financial crisis all playing an important part. This paper assesses the role Japan currently plays in the Asia-Pacific regional economy, and how policies and developments in Japan affect the region.

The paper is structured as follows. Section II provides a brief overview of economic developments in Japan during the 1990s and examines the nature of the economic and financial relations between Japan and its regional neighbors. Section III outlines the G-Cubed (Asia-Pacific) model that is used to assess the transmission of shocks and policies between Japan and the region. Section IV explores shocks that have, or currently are, impacting the Japanese economy (a decline in productivity growth, a sharp rise in government spending, and a decline in equity prices) to understand some of the factors underpinning the poor recent economic performance and the likely evolution of the economy in the near future.<sup>2</sup> Section V considers a number of the current issues facing Japan—fiscal consolidation, quantitative monetary easing, and a possible loss of confidence in the yen—and assesses the potential implications of each of these for the Japanese and regional economies. Conclusions and policy implications are drawn in Section VI.

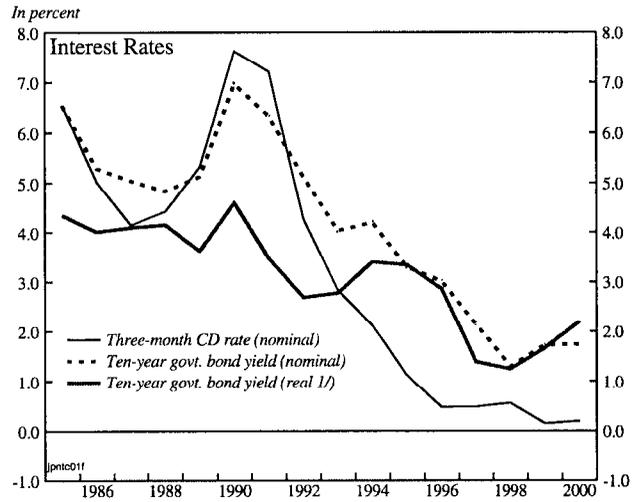
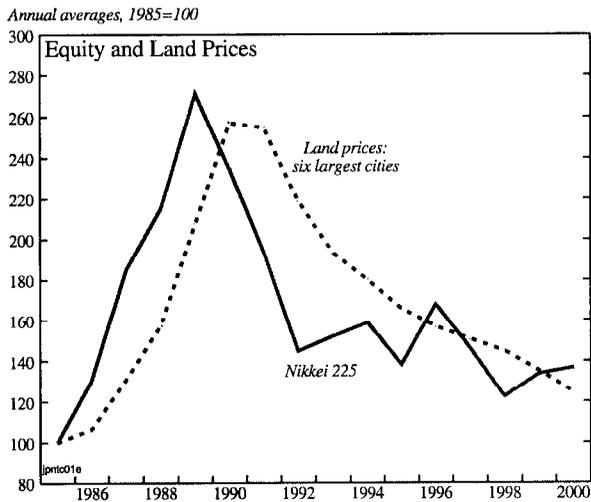
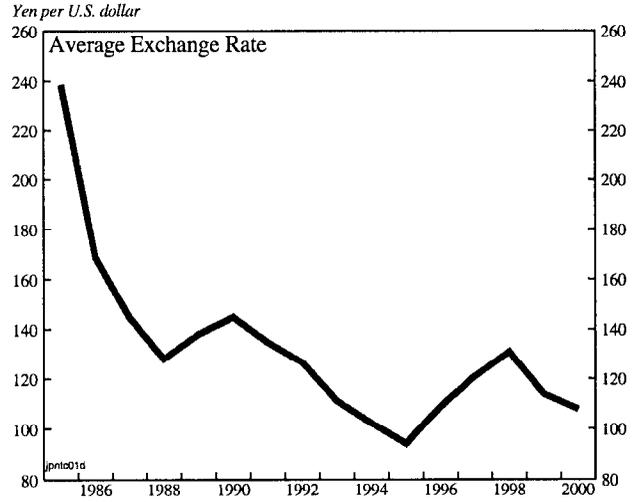
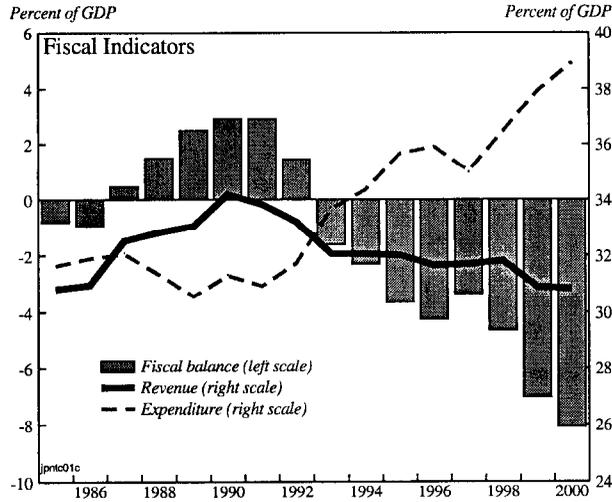
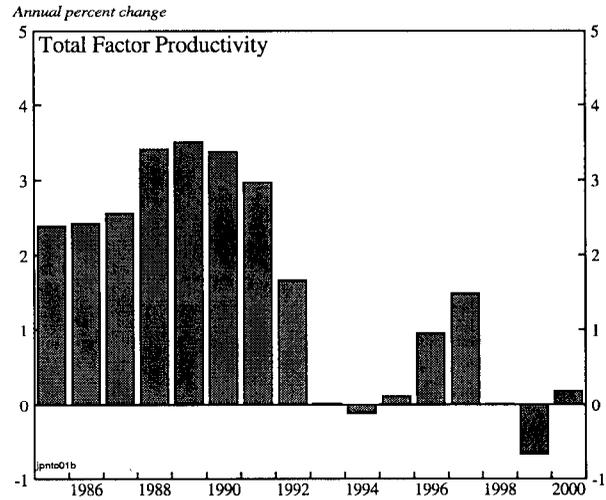
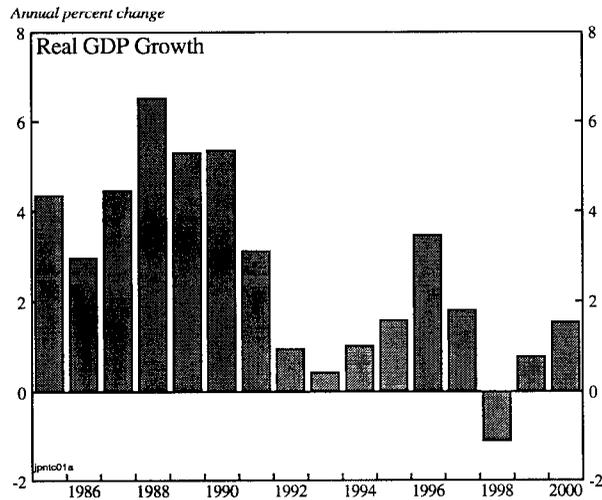
## II. JAPAN'S ECONOMIC PERFORMANCE AND ITS IMPLICATIONS FOR THE ASIA-PACIFIC REGION

Japan's economic performance during the 1990s was disappointing. Real GDP grew by only 1¾ percent per annum, down considerably from the 4 percent average during the 1980s, and below the average in other OECD countries. It also stands in contrast to the strong growth in the rest of the Asia-Pacific region during the decade. The roots of the economic problems in Japan lie at least as far back as the overheating of the economy in the late-1980s and the development of a major asset price bubble. The proximate cause of the initial slowdown in growth was the tightening of monetary policy in mid-1989 and the eventual pricking of the asset price bubble. Equity and land prices declined, and the resulting massive loss of wealth severely impacted corporate and household behavior (Figure 1). In response, fiscal and monetary policies were eased substantially—the budget balance moved from a surplus of close to 3 percent of GDP in 1991 to an estimated deficit of 8 percent of GDP in 2000, while short-term interest rates have been reduced from 8 percent to zero—but without successfully reinvigorating growth.

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<sup>2</sup> See McKibbin (1996) for an earlier assessment of Japanese macroeconomic policy and the likely impacts on the economy.

Figure 1. Japan: Selected Economic Indicators, 1985-2000



Sources: Nikkei Telecom; and staff estimates.

1/ Deflated by the CPI adjusted for changes in indirect taxes and administered prices.

While the growth slowdown was initially viewed as a cyclical downturn in response to the decline in asset prices, the extended period of weak growth has led to a number of competing hypotheses being advanced to explain the poor performance (see Bayoumi and Collins (1999) and Boltho and Corbett (2000) for concise summaries). Bayoumi (1999) highlights the central role played by financial institutions in magnifying the impact of the decline in asset prices on the economy. Increases in bank lending, operating both directly and through a self-reinforcing cycle with increases in land prices (the main source of collateral) and stock prices (an important component of bank capital), helped explain the strong growth in the second half of the 1980s. But, once asset prices began to fall, the reverse of this process operated as undercapitalized banks restrained lending to maintain capital adequacy standards. In turn, this blunted the impact of macroeconomic policies as households and corporates were unable to respond to monetary and fiscal stimulus because of the limited availability of funds from the banking system. Hayashi and Prescott (2001), however, argue that it is hard to reconcile this view with the large growth in internal financing by Japanese firms even while bank financing was falling sharply, and instead argue that the primary problem was a sharp fall in productivity over the decade, possibly stemming from the increasing failure of the traditional Japanese economic model to adapt to the requirements of a more deregulated and competitive world economy.

Yoshikawa (2000) argues that the slowdown in productivity growth has been due to the decline in demand as the introduction of new technologies is strongly conditioned by the prospects for future demand. Krugman (1998) also believes there is an insufficiency of demand, and argues that Japan is in a “liquidity trap”—with nominal interest rates unable to fall below zero and prices declining, real interest rates are too high for the economy to recover. Posen (1998) argues that despite the numerous fiscal packages that were implemented during the 1990s, the measures that actually had a direct impact on activity were insufficient.

These economic and financial developments have had important implications for the Asia-Pacific region as Japan is a large supplier of capital to the region and an important trading partner. Developments in the region also have increasingly had significant implications for the Japanese economy.

Japanese FDI outflows accelerated following the liberalization of capital controls in the early 1980s, and surged during the second half of the decade to a peak of close to \$50 billion in 1990 (Table 1). This sharp rise reflected both the strong economic growth in Japan and in foreign markets, and the appreciation of the yen which encouraged companies to relocate production overseas to maintain cost competitiveness (Bayoumi and Lipworth, 1998). Initially, the U.S. attracted most of this capital, with much of the investment being concentrated in the real estate, service, and finance and insurance sectors. However, that going to the Asia-9 countries (Taiwan POC, Korea, Hong Kong SAR, Singapore, Thailand, Indonesia, Malaysia, Philippines and China) also picked-up—with Hong Kong SAR, Thailand, Malaysia, and Indonesia seeing the largest increases—and was more concentrated in the industrial sector. This Japanese investment accounted for a significant proportion of the total FDI inflows received by the Asia-9 countries (for which data is available) during the second half of the 1980s (Table 2).

Table 1: Foreign Direct Investment From Japan to Asia

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
	(In millions of U.S. dollars)												
Asia-9	3,199	5,691	5,328	2,997	2,535	2,336	5,233	8,307	9,187	12,045	7,200	1,574	1,970
NICs	2,071	3,427	2,640	1,000	617	293	1,614	1,766	3,031	5,235	2,309	869	-658
Taiwan	236	347	351	184	93	36	158	418	401	742	325	-4	-104
Korea	306	419	225	119	72	30	227	344	403	172	426	367	1,082
Hong Kong	1,055	1,312	1,402	419	238	151	636	332	1,099	1,760	797	-158	-123
Singapore	474	1,349	662	278	215	77	594	672	1,128	2,561	761	665	-1,512
ASEAN-4	617	1,578	2,282	1,766	1,392	1,229	1,832	3,334	3,832	4,949	3,585	341	1,691
Thailand	258	723	813	464	287	303	342	936	1,339	2,038	1,684	-126	593
Indonesia	204	357	774	682	724	424	825	945	1,498	1,568	930	200	588
Malaysia	115	383	511	504	310	397	352	376	518	996	453	-331	-1
Philippines	40	114	184	116	71	105	312	1,077	477	347	517	599	511
China	511	686	406	231	526	814	1,787	3,208	2,325	1,860	1,306	363	937
<i>Memorandum items:</i>													
World	34,210	44,130	48,024	30,726	17,222	13,714	17,938	22,630	23,428	25,993	24,151	22,743	31,547
U.S.	18,969	21,238	25,584	15,213	8,914	6,755	6,193	8,891	11,090	7,392	5,683	7,094	14,109
Europe	5,793	9,746	11,027	7,974	3,370	3,168	2,843	3,290	3,220	2,575	2,178	8,217	10,938

Source: Bank of Japan.

1/ Data prior to 1995 refer only to long-term capital flows. Country breakdown of NICs and ASEAN-4 prior to 1995 is based on notification data.

Table 2: Share of Japanese Foreign Direct Investment in Host Country

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
	(In percent of total FDI inflow)															
Taiwan	...	...	30.5	37.6	27.6	36.4	30.1	28.8	22.9	24.3	19.6	22.2	20.0	16.4	12.3	9.6
Korea	68.4	39.1	46.4	54.2	42.7	29.3	16.2	17.3	27.4	32.5	21.8	8.0	3.8	5.7	11.3	15.6
Singapore	...	15.7	16.5	19.8	22.9	24.7	24.8	27.0	25.3	26.0	24.8	24.7	22.9	23.1	...	...
Thailand	34.5	44.1	36.1	52.2	41.1	43.2	30.3	16.2	17.7	9.3	27.8	23.1	36.0	28.8	13.8	24.5
Indonesia	36.7	9.2	35.2	7.7	16.6	23.9	10.4	14.8	10.3	6.6	9.5	25.6	16.0	9.8	5.9	12.7
Malaysia	...	...	...	...	...	...	36.8	19.6	17.2	13.2	22.8	10.0	18.5	17.7	12.4	14.0
Philippines	...	...	...	...	...	...	46.2	51.5	12.2	7.9	30.0	36.8	31.4	17.0	16.0	7.2
China	...	...	...	...	...	...	...	...	...	6.1	8.2	8.8	9.6	7.5	7.4	7.2

Source: CEIC Database.

FDI flows moderated significantly in the first half of the 1990s with the sharp decline in asset prices in Japan and the subsequent slowdown in growth and balance sheet difficulties in the business sector, but recovered somewhat in the second half of the decade. These weaker FDI flows, however, were largely the result of lower investment in the U.S. and Europe, and investment to Asia increased—Japanese FDI to the Asia-9 countries increased from \$3 billion (10 percent of the total) in 1991 to \$12 billion (50 percent of the total) in 1997—until the financial crisis in the region. Investment continued to be focused in Hong Kong SAR, Thailand, and Indonesia, while from the mid-1990s investment into China also accelerated.<sup>3</sup> However, despite the greater concentration of Japanese FDI in the Asia region, the relative importance of Japanese investment to these countries declined during 1995–2000 (to around 18 percent of the total).

Portfolio flows between Japan and the region have been more two way than FDI due to investments in Japan from the regional financial centers of Hong Kong SAR and Singapore (Table 3). Indeed, stock data show that Japan was in a net portfolio liability position with the rest of Asia at end-2000. With respect to other countries, investments have generally been small, with the exception of Thailand, where significant investment took place during 1995–97.

Japanese banks were large lenders to Asian countries during the second half of the 1980s and early 1990s.<sup>4</sup> According to BIS data, the outstanding stock of lending by Japanese banks to the Asia-9 countries rose from \$140 billion in 1985 to a peak of \$333 billion in 1994 (Table 4). The largest recipients were the regional financial centers of Hong Kong and Singapore, although all countries except Taiwan POC, Malaysia, and the Philippines experienced significant growth in lending. In the early 1990s, Japanese banks are estimated to have supplied between 60 and 70 percent of the total outstanding international bank lending to Hong Kong SAR, Singapore, Thailand, and Indonesia. It is likely that at least part of this increase was associated with financing Japanese subsidiaries operating in these countries. With the onset of their financial difficulties and the emergence of a significant Japan premium, however, Japanese banks have withdrawn from Asian markets since 1995, a process accelerated by the Asian financial crisis. The outstanding stock of lending to the Asia-9 declined to \$114 billion in 2000. While this has been part of the trend toward a lower exposure to bank finance by the Asian countries since the financial crisis, Japanese banks have withdrawn

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<sup>3</sup> At end-2000, 18 percent of the outstanding stock of Japanese FDI (at market prices) was in the Asia-9, compared to 47 percent in the U.S. and 20 percent in Europe. Within Asia, Japanese FDI is largely concentrated in Singapore, China, and Hong Kong SAR.

<sup>4</sup> This discussion is based on BIS data. As noted by Kohsaka (1996), there are significant two-way financial flows between Japan, Hong Kong, and Singapore in their roles as international and regional financial centers. The data for Singapore and Hong Kong therefore likely overestimate the impact on domestic resource use in these countries.

Table 3: Net Portfolio Investment Flows Between Japan and Asia

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
	(In millions of U.S. dollars)												
Asia-9	4,798	4,346	-15	-11,011	-1,284	332	-6,002	2,811	-2,751	-10,818	20,361	-19,745	-11,757
NICs	5,037	4,887	1,314	-10,716	2,363	1,815	-6,035	-14,279	-8,701	-22,485	15,473	-28,708	-12,417
Taiwan	...	...	...	...	...	...	...	-380	2,054	673	-783	-166	765
Korea	...	...	...	...	...	...	...	1,463	2,812	-760	-1,067	-2,196	-3,428
Hong Kong	...	...	...	...	...	...	...	-17,142	-8,822	-14,390	16,689	-21,933	-9,174
Singapore	...	...	...	...	...	...	...	1,780	-4,744	-8,008	634	-4,412	-581
ASEAN-4	303	-448	-622	-489	-3,101	-537	-438	17,256	6,817	8,649	2,845	7,541	-470
Thailand	...	...	...	...	...	...	...	14,180	3,729	4,985	1,689	1,679	184
Indonesia	...	...	...	...	...	...	...	-79	312	2,592	1,797	145	520
Malaysia	...	...	...	...	...	...	...	168	395	-65	-728	6,256	698
Philippines	...	...	...	...	...	...	...	2,986	2,382	1,137	87	-539	-1,872
China	-542	-93	-707	194	-546	-946	471	-166	-868	3,018	2,043	1,421	1,131
<i>Memorandum items:</i>													
World	66,651	28,034	5,028	-40,978	26,191	62,748	48,944	32,717	41,497	-30,755	45,468	21,545	37,633
U.S.	33,320	22,074	12,495	-1,045	14,289	47,419	5,612	-10,191	9,070	11,851	19,521	-21,129	33,852
Europe	21,229	-24,562	9,409	-45,273	10,112	12,827	31,687	32,855	-39,231	-91,722	-30,168	-8,642	-25,568

Source: Bank of Japan.

1/ Data prior to 1995 refer only to long-term capital flows.

Table 4: Stock of Outstanding Lending by Japanese Banks to the Asia-9 Countries

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Asia-9	140,056	173,313	174,797	194,625	221,584	235,930	255,483	280,122	333,021	318,525	260,398	244,677	150,537	119,341	114,247
NICs	115,820	141,976	140,308	157,166	179,617	188,203	207,613	228,598	267,288	234,765	173,278	158,715	87,612	73,002	75,240
Taiwan	1,758	5,996	6,709	3,735	2,884	4,110	3,449	4,075	5,407	3,236	2,683	3,516	2,182	2,723	2,994
Korea	11,032	10,688	8,277	8,436	9,144	11,070	12,004	12,039	17,428	21,454	24,324	20,278	17,179	12,677	10,306
Hong Kong	59,188	75,177	73,678	83,261	88,278	99,489	102,184	123,510	150,445	133,146	87,462	76,272	38,742	36,430	35,259
Singapore	43,842	50,115	51,644	61,734	79,311	73,534	89,976	88,974	94,008	76,929	58,809	58,649	29,509	21,172	26,681
ASEAN-4	19,965	23,223	24,100	26,093	29,877	34,224	35,145	38,603	51,586	66,124	69,328	66,373	47,808	34,548	28,684
Thailand	3,716	4,614	5,041	6,768	7,403	10,726	12,561	16,089	26,452	36,845	37,525	33,180	22,445	13,087	9,840
Indonesia	7,424	9,184	10,151	11,072	15,124	16,730	16,890	16,401	18,351	20,974	22,035	22,018	16,403	12,494	10,225
Malaysia	5,778	5,841	5,276	5,224	4,398	4,354	4,473	5,179	5,831	7,321	8,210	8,551	6,633	6,038	5,600
Philippines	3,047	3,584	3,632	3,029	2,952	2,414	1,221	934	952	984	1,558	2,624	2,327	2,929	3,019
China	4,271	8,114	10,389	11,366	12,090	13,503	12,725	12,921	14,147	17,636	17,792	19,589	15,117	11,791	10,323
Asia-9	54.2	56.3	58.6	60.3	59.2	61.1	61.2	57.9	57.2	49.1	39.5	36.1	31.6	30.4	33.1
NICs	55.7	56.4	58.5	60.1	58.7	61.4	62.2	59.2	58.5	48.4	37.5	33.8	27.9	28.5	33.8
Taiwan	26.0	40.9	50.0	33.1	31.2	33.0	26.4	25.8	27.6	15.4	12.8	14.5	11.2	14.4	20.4
Korea	45.8	51.6	45.2	42.4	39.7	41.3	41.2	41.3	44.0	39.3	34.5	29.7	32.8	26.5	24.6
Hong Kong	62.6	61.3	62.4	64.5	62.8	67.5	66.1	64.8	65.2	58.2	45.2	39.2	31.5	35.0	37.6
Singapore	53.0	53.5	57.3	60.8	59.6	61.4	65.5	59.0	56.2	42.5	33.3	32.1	24.9	24.9	36.8
ASEAN-4	44.9	51.0	55.6	59.5	60.3	59.5	57.9	54.5	56.2	54.1	46.6	43.8	41.3	35.6	33.4
Thailand	60.9	68.0	66.3	69.5	61.9	62.1	62.2	60.7	65.7	63.1	57.8	60.1	56.9	48.9	45.6
Indonesia	48.6	54.5	60.0	62.9	68.3	67.7	65.0	59.3	57.3	52.1	43.5	42.1	39.4	32.4	29.5
Malaysia	59.0	63.6	68.9	72.6	68.2	62.2	58.0	47.3	45.6	47.4	40.3	33.8	34.8	36.8	35.5
Philippines	23.0	28.3	32.5	32.5	32.8	28.3	18.0	16.3	14.2	12.2	12.3	13.9	14.8	19.2	21.6
China	70.3	74.8	68.6	66.5	63.6	61.1	56.7	48.6	42.7	42.4	36.2	34.4	31.7	29.7	28.7
Memo item:															
Using total lending 2/	50.9	52.7	54.3	56.2	54.6	55.8	55.5	52.7	52.4	44.6	35.4	30.4	26.3	24.8	25.4

Source: Consolidated Banking Statistics, Bank for International Settlements.

1/ Based on a constant sample of 17 lending countries.

2/ Based on the full BIS data which does not use a constant sample during the time period covered.

at a faster pace than banks of other nationalities, and the share of Japanese bank lending to the region has declined to around 30 percent, although they are still estimated to be the largest (identified) lender to eight of the nine countries.<sup>5</sup> Despite these swings in lending, Kawai and Liu (2001) find that Japanese banks did not provide loans excessively to East Asia before the financial crisis or withdraw loans excessively during the crisis after economic fundamentals and other linkages are accounted for.

Japanese FDI to Asia has been focused in the industrial sector—particularly the electrical machinery sector in the second half of the 1990s—and has implied a movement of productive capacity out of Japan to the recipient countries. Consequently, these investments are likely to have had important implications for the pattern of trade between these countries. Indeed, Bayoumi and Lipworth (1998) find evidence that both FDI flows and stocks have a significant impact on imports from the recipient country to Japan, but that only FDI flows have an impact on exports from Japan to the recipient country. They argue this is consistent with the view that while FDI permanently raises imports from the recipient country to Japan, it only temporarily raises Japanese exports largely through the short-term need to equip new factories. Kawai (1998), however, argues that FDI has a permanent impact on both imports and exports, although the impact on imports is larger.

Trade flows between Japan and the Asia region have indeed undergone significant change over the past fifteen years. Japan has become increasingly reliant on Asia as a market for its exports and as a source of imports. The growth of Japanese exports to the Asia-9 averaged close to 11 percent per annum (in U.S. dollar terms) during 1985–2000, compared to aggregate growth of only 7 percent per annum, and the share of exports to these nine economies increased from 24 percent in 1985 to 40 percent in 2000 (Table 5). Asia is now the largest destination for Japanese exports, with Taiwan POC, Korea, and China being the most important countries, while the U.S. and Europe have both declined in importance as export destinations.

Nearly 40 percent of Japan's imports also now come from Asia, compared to 26 percent in the mid-1980s (Table 6). Imports from China, in particular, have shown remarkable growth, rising by an average of 15 percent per annum—twice the rate of growth of aggregate imports—and their share has risen from 5 percent to 14½ percent of the total. Korea and Taiwan POC are other important, and growing, sources of imports, while the ASEAN-4 countries have generally seen much weaker growth. The share of imports from the U.S. and Europe have both declined.

There have also been substantial changes in the composition of trade between Japan and Asia. Japan's imports of machinery and transport equipment from the Asia-9 have increased from less than 5 percent of total imports in 1985 to nearly 35 percent currently, while other

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<sup>5</sup> This conclusion needs to be qualified, however, for China, Singapore, and Korea where there is a large unidentified component (larger than the exposure of Japanese banks) in the country breakdown of outstanding lending. For China, and possibly Singapore, these are related to Hong Kong banks which, while included in the aggregate data, are not separately identified for confidentiality reasons.

Table 5: Japanese Exports to the Asian Region

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
	(in percent of total exports)															
Asia-9	24.2	22.6	24.9	27.3	28.3	29.6	32.1	33.0	36.1	38.6	42.1	42.4	40.6	33.2	35.8	39.7
NICs	12.8	14.3	17.2	18.8	19.2	19.7	21.3	21.4	22.3	23.6	25.0	24.7	24.0	20.2	21.5	23.9
Taiwan	2.9	3.7	4.9	5.4	5.6	5.4	5.8	6.2	6.1	6.0	6.5	6.3	6.5	6.6	6.9	7.5
Korea	4.0	5.0	5.8	5.8	6.0	6.1	6.4	5.2	5.3	6.1	7.0	7.1	6.2	4.0	5.5	6.4
Hong Kong	3.7	3.4	3.9	4.4	4.2	4.6	5.2	6.1	6.3	6.5	6.3	6.2	6.5	5.8	5.3	5.7
Singapore	2.2	2.2	2.6	3.1	3.4	3.7	3.9	3.8	4.6	5.0	5.2	5.1	4.8	3.8	3.9	4.3
ASEAN-4	4.2	3.6	4.1	4.9	6.1	7.7	8.1	8.1	9.0	10.3	12.1	12.4	11.4	7.8	8.6	9.5
Thailand	1.2	1.0	1.3	1.9	2.5	3.2	3.0	3.1	3.4	3.7	4.5	4.4	3.5	2.4	2.7	2.8
Indonesia	1.2	1.3	1.3	1.2	1.2	1.7	1.8	1.6	1.7	1.9	2.3	2.2	2.4	1.1	1.2	1.6
Malaysia	1.2	0.8	0.9	1.2	1.5	1.9	2.4	2.4	2.7	3.1	3.8	3.7	3.4	2.4	2.7	2.9
Philippines	0.5	0.5	0.6	0.7	0.9	0.9	0.8	1.0	1.3	1.5	1.6	2.0	2.1	1.9	2.1	2.1
China	7.1	4.7	3.6	3.6	3.1	2.1	2.7	3.5	4.8	4.7	5.0	5.3	5.2	5.2	5.6	6.3
<i>Memorandum items:</i>																
U.S.	37.1	38.4	36.5	33.8	33.9	31.5	29.1	28.2	29.2	29.7	27.3	27.2	27.8	30.5	30.7	29.7
Europe	16.3	19.9	21.4	22.8	22.0	23.5	23.1	21.9	18.8	17.1	17.4	17.0	16.6	19.4	18.3	15.9

Source: Bank of Japan.

Table 6: Japanese Imports from Asian Countries

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
	(In percent of total imports)															
Asia-9	25.5	25.2	28.4	28.8	28.5	26.6	28.9	30.1	31.7	32.9	34.4	35.2	34.7	34.9	37.6	39.6
NICs	7.6	9.8	12.5	13.4	12.9	11.1	11.5	11.2	11.2	11.3	12.3	11.7	10.4	10.2	11.6	12.2
Taiwan	2.6	3.7	4.8	4.7	4.2	3.6	4.0	4.1	4.0	3.9	4.3	4.3	3.7	3.6	4.1	4.7
Korea	3.1	4.1	5.4	6.3	6.2	5.0	5.2	5.0	4.8	4.9	5.1	4.6	4.3	4.3	5.2	5.4
Hong Kong	0.6	0.8	1.0	1.1	1.1	0.9	0.9	0.9	0.8	0.8	0.8	0.7	0.7	0.6	0.6	0.4
Singapore	1.2	1.2	1.4	1.2	1.4	1.5	1.4	1.3	1.5	1.7	2.0	2.1	1.7	1.7	1.8	1.7
ASEAN-4	12.9	11.0	10.9	10.1	10.3	10.4	11.3	11.6	12.1	11.6	11.4	11.9	12.0	11.4	12.1	12.8
Thailand	0.8	1.1	1.2	1.5	1.7	1.8	2.2	2.6	2.7	3.0	3.0	2.9	2.8	2.9	2.9	2.8
Indonesia	7.8	5.9	5.6	5.1	5.2	5.4	5.4	5.2	5.2	4.7	4.2	4.4	4.3	3.9	4.1	4.3
Malaysia	3.3	3.1	3.2	2.5	2.4	2.3	2.7	2.8	3.2	3.0	3.1	3.4	3.4	3.1	3.5	3.8
Philippines	1.0	1.0	0.9	1.1	1.0	0.9	1.0	1.0	1.0	1.0	1.0	1.3	1.5	1.6	1.7	1.9
China	5.0	4.5	4.9	5.3	5.3	5.1	6.0	7.3	8.5	10.0	10.7	11.6	12.4	13.2	13.8	14.5
<i>Memorandum items :</i>																
U.S.	20.0	22.8	21.1	22.4	22.9	22.4	22.5	22.4	23.0	22.9	22.4	22.7	22.3	23.9	21.7	19.0
Europe	10.9	16.2	17.0	18.2	18.5	19.9	18.3	17.6	16.7	17.2	17.9	17.0	15.8	16.3	16.3	13.1

Source: Bank of Japan.

manufactured goods increased from less than 20 percent to 35 percent.<sup>6</sup> Imports of fuel and other crude materials, on the other hand, have fallen substantially. While imports from most countries are heavily weighted toward machinery and transport equipment, those from China and Indonesia are mainly in the form of low-end consumer goods and raw materials respectively. On-the-other-hand, the composition of Japanese exports to Asia has remained largely unchanged with machinery and transport equipment accounting for a little under 60 percent of the total and other manufactured goods most of the remainder.

While Japan remains a very significant trading partner, Asia has actually become relatively less reliant on Japan (although given the significant increase in the importance of trade in the Asian countries in recent years the absolute reliance has still increased).<sup>7</sup> The share of Asian exports going to Japan has declined markedly (Table 7). While in 1985, 18 percent of exports from the Asia-9 went to Japan, this share had fallen to 12 percent by 2000. The U.S. (22 percent) and Europe (15 percent) are both more important export destinations than Japan. The rise in importance of the U.S. as an export destination since the mid-1990s is closely related to Asia's role in the supply of IT-related goods (see Isogai and Shibanuma, 2000). Indonesia, Malaysia, and China have all greatly reduced their reliance on Japan, although for the ASEAN-4, particularly Indonesia, China, Korea, and Taiwan, Japan remains a very important destination.<sup>8</sup> The importance of Japan as a supplier of goods has also declined, although it remains the single most important supplier to the region (Table 8). While in 1985, around one-quarter of the Asia-9's imports came from Japan, this had declined to 20 percent in 2000.

The discussion above has highlighted that while the trade and financial links between Japan and the Asian region have declined, they remain very important, and economic developments in Japan continue to have significant implications for other countries in the region. Thailand, Philippines, and Indonesia are at the high end of relative reliance on Japan, while Singapore and Hong Kong SAR are at the low end. Japan has also become more reliant on trade with Asia.

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<sup>6</sup> Nakamura and Matsuzaki (1997) find that Asian companies have been very successful at penetrating the Japanese market for electrical machinery and other manufactured goods, partly at the expense of the U.S. and European companies.

<sup>7</sup> These developments have taken place within the context of a near doubling between 1985 and 1999 in the share of world trade that is accounted for by Asian countries, and a decline in Japan's share of world trade.

<sup>8</sup> The country breakdown of Chinese trade data needs to be treated with caution, particularly for industrial countries, as trade with these countries is classified as trade with Hong Kong if it passes through Hong Kong ports.

Table 7: Asian Country Exports to Japan

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
	(In percent of total exports from Asian country)															
Asia-9	18.1	14.9	15.0	15.4	15.4	14.5	13.7	12.3	12.3	12.3	12.9	13.1	11.8	10.5	11.5	11.9
NICs	9.6	10.3	11.6	12.5	12.5	11.3	10.5	9.3	8.7	8.9	9.5	9.4	8.2	7.2	8.3	8.3
Taiwan	...	11.6	13.2	14.6	13.8	12.6	12.3	11.1	10.7	11.2	12.0	12.0	9.8	8.6	10.0	10.0
Korea	15.0	15.6	17.8	19.8	21.8	18.6	17.1	15.0	13.5	14.0	13.6	12.2	10.8	9.2	11.0	11.1
Hong Kong	4.2	4.7	5.1	5.8	6.2	5.7	5.4	5.2	5.2	5.6	6.1	6.6	6.1	5.3	5.4	5.6
Singapore	9.4	8.6	9.1	8.6	8.6	8.8	8.7	7.6	7.5	7.0	7.8	8.2	7.1	6.6	7.4	7.4
ASEAN-4	31.1	28.3	26.0	24.6	24.4	24.3	22.8	20.2	19.2	17.5	17.4	17.8	16.5	13.8	14.6	15.8
Thailand	13.4	14.2	15.0	16.0	17.0	17.2	17.8	17.5	17.0	17.0	16.6	16.8	15.2	13.7	14.5	15.7
Indonesia	46.2	44.9	43.1	41.7	42.2	42.5	36.9	31.7	30.3	27.3	27.1	25.8	23.4	18.7	20.0	21.7
Malaysia	24.6	23.3	19.5	17.0	16.0	15.3	15.9	13.3	13.0	11.9	12.5	13.4	12.7	10.5	11.6	12.6
Philippines	19.0	17.7	17.2	20.1	20.4	19.8	20.0	17.8	16.1	15.0	15.8	17.9	16.6	14.4	13.1	14.4
China	22.3	16.2	16.2	16.9	15.9	14.7	14.2	13.7	17.2	17.8	19.1	20.4	17.4	16.2	16.6	15.6
<i>Memorandum items :</i>																
U.S.	23.2	29.4	28.3	25.7	25.0	22.5	20.9	21.1	21.9	21.3	19.9	19.3	19.6	21.7	22.1	22.0
Europe	14.7	13.9	13.9	14.0	13.7	14.9	15.0	14.5	14.7	13.8	14.0	13.9	14.3	16.6	15.8	15.4

Source: Direction of Trade Statistics, International Monetary Fund.

Table 8. Asian Country Imports from Japan

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
	(In percent of total imports into the Asian country)															
Asia-9	25.6	26.8	25.4	24.0	23.2	21.9	22.5	22.2	23.1	23.1	22.6	20.5	19.4	18.4	19.2	20.2
NICs	21.7	26.9	26.4	25.0	23.8	22.1	22.7	22.2	21.9	21.7	21.2	18.8	18.1	17.4	18.1	18.4
Taiwan	...	34.4	34.1	29.9	30.7	29.3	30.0	30.3	30.1	29.1	29.3	26.9	25.4	25.8	27.7	27.6
Korea	24.3	34.3	33.3	30.6	28.5	25.0	25.8	23.5	23.1	24.8	24.1	20.8	19.2	18.0	20.2	21.9
Hong Kong	23.1	20.4	19.0	18.6	16.6	16.1	16.4	17.4	16.6	15.6	14.8	13.6	13.7	12.6	11.7	12.0
Singapore	17.1	19.9	20.5	22.0	21.4	20.1	21.3	21.1	21.9	21.9	21.1	18.2	17.6	16.7	16.7	17.3
ASEAN-4	23.3	24.1	23.9	24.1	25.4	25.7	25.9	25.6	26.7	27.0	26.5	24.3	22.3	20.2	21.4	22.1
Thailand	26.5	26.4	26.0	27.1	30.5	30.4	29.1	29.3	30.3	30.2	29.3	27.9	25.7	23.6	24.8	25.9
Indonesia	25.7	29.2	28.0	25.4	23.3	24.8	24.4	22.0	22.1	24.2	22.7	19.8	19.8	15.7	18.6	21.4
Malaysia	23.0	20.5	21.7	23.0	24.1	24.2	26.1	26.0	27.5	26.7	27.3	24.5	22.0	19.7	20.8	20.6
Philippines	14.0	17.0	16.6	17.4	19.5	18.4	19.4	21.2	22.8	24.2	22.3	21.8	20.3	20.3	19.6	20.8
China	35.7	28.8	23.3	20.0	17.8	14.2	15.7	16.7	22.5	22.7	21.9	21.0	20.4	20.2	20.4	19.0
<i>Memorandum items :</i>																
U.S.	14.7	15.1	15.1	16.6	16.5	15.6	15.3	14.7	14.2	14.2	14.5	14.7	14.8	15.0	14.1	13.7
Europe	16.8	16.4	15.2	14.4	14.2	14.5	13.9	13.8	14.6	14.7	14.8	15.0	14.1	13.2	12.8	12.4

Source: Direction of Trade Statistics, International Monetary Fund.

### III. MODELING ECONOMIC INTERDEPENDENCE IN THE ASIA-PACIFIC REGION

Given the important trade and financial linkages, an analysis of the implications of developments and policies in Japan on the Asia-Pacific region needs to be undertaken with a model that adequately captures these interrelationships. The G-Cubed (Asia-Pacific) model—based on the theoretical structure of the G-Cubed model outlined in McKibbin and Wilcoxon (1998)—is well suited for such analysis, having both a detailed country coverage of the region and rich links between the countries through goods and asset markets.<sup>9</sup> The principal features of the model are:

- It is based on explicit intertemporal optimization by agents (households and firms) in each economy.
- In order to track the macro time series, however, the behavior of agents is modified to allow for short-run deviations from such behavior either due to myopia or to restrictions on the ability of households and firms to borrow at the risk free rate on government bonds. For both households and firms, these deviations take the form of rules of thumb which are consistent with an optimizing agent that does not update predictions based on new information about future events. These rules of thumb are chosen to generate the same steady state behavior as optimizing agents so that in the long run there is only a single intertemporal optimizing equilibrium of the model. In the short run, actual behavior is assumed to be a weighted average of the optimizing and rule of thumb assumptions. Thus aggregate consumption is a weighted average of consumption based on wealth (current asset valuation and expected future after tax labor income) and consumption based on current disposable income. This is consistent with the econometric results in Campbell and Mankiw (1987) and Hayashi (1982). Similarly, investment is a weighted average of investment based on Tobin's  $q$  (a market valuation of the expected future change in the marginal product of capital relative to the cost) and investment based on a backward looking version of  $q$ .
- There is an explicit treatment of financial assets, including money. Money is introduced through a restriction that households require money to purchase goods.
- There is short run nominal wage rigidity (by different degrees across countries), and the model therefore allows for significant periods of unemployment depending on the labor market institutions in each country. This assumption, together with the explicit role for money, is what gives the model its "macroeconomic" characteristics.
- The model distinguishes between the stickiness of physical capital within sectors and within countries and the flexibility of financial capital which immediately flows to where expected returns are highest. This important distinction leads to a critical difference

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<sup>9</sup> A number of studies—summarized in McKibbin and Vines (2000)—have shown that the G-cubed model has been useful in assessing a range of issues across a number of countries since the mid-1980s. A stylized two-country G-cubed model is outlined in the Appendix, while full details of the model, including a listing of equations and parameters, can be found at: <http://www.msgpl.com.au/msgpl/apgcubed46n/index.htm>

between the quantity of physical capital that is available at any time to produce goods and services, and the valuation of that capital as a result of decisions about the allocation of financial capital.

As a result of this structure, the G-Cubed model contains rich dynamic behavior, driven on the one hand by asset accumulation and on the other by wage adjustment to a neoclassical steady state. It embodies a wide range of assumptions about individual behavior and empirical regularities in a general equilibrium framework. The interdependencies are solved out using a computer algorithm that solves for the rational expectations equilibrium of the global economy. It is important to stress that economies are not in a full market clearing equilibrium at each point in time, and unemployment does emerge for long periods due to wage stickiness (which differs between countries due to differences in labor market institutions), but it is assumed that market forces eventually drive the world economy to a neoclassical steady state growth equilibrium.

#### **IV. THE IMPACT OF RECENT SHOCKS IN JAPAN ON ASIA**

In this section, the G-cubed (Asia-Pacific) model is used to assess the implications of three developments in the Japan during the 1990s—the slowdown in productivity growth, the increase in government expenditure, and the decline in equity prices—for the domestic and regional economies. In all the simulations, the Bank of Japan (BoJ) and other central banks are assumed to follow a fixed money stock rule.

##### **A Decline in Productivity Growth in Japan**

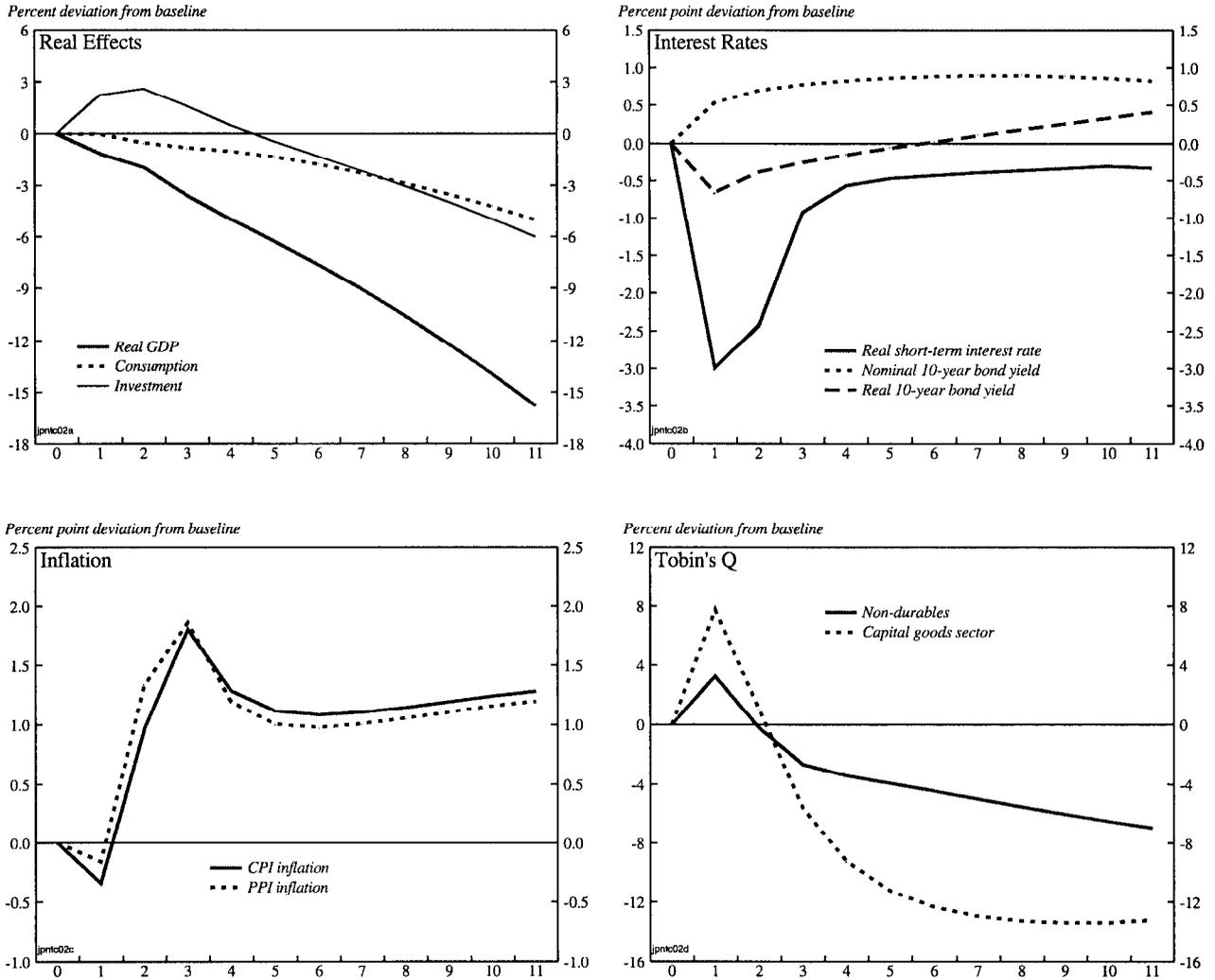
The decline in productivity growth in Japan is modeled as a decline (relative to baseline) in the expected growth rate of labor augmenting technical change of 3 percent per annum for three years, 1 percent per annum for another eight years, and then returning to trend after 11 years. The results of the simulation are shown in Figure 2 for Japan and Figure 3 for the other countries.

Following the negative shock to productivity, real GDP in Japan immediately falls relative to the baseline, although the impact on growth is initially dampened by two factors.<sup>10</sup> First, because there will be less Japanese goods available globally in the longer run, the relative price of these goods rises, i.e., the long run real exchange rate (the relative price of Japanese goods) appreciates. Forward-looking financial markets understand this outcome, and the exchange rate actually appreciates in the short-run, lowering inflation and inducing a relaxation of monetary policy. Second, because of the expected fall in future labor productivity, there is a substitution in the production process away from labor towards capital and other inputs which, in the short-run, causes investment to increase. This rise is reinforced by the price effect from

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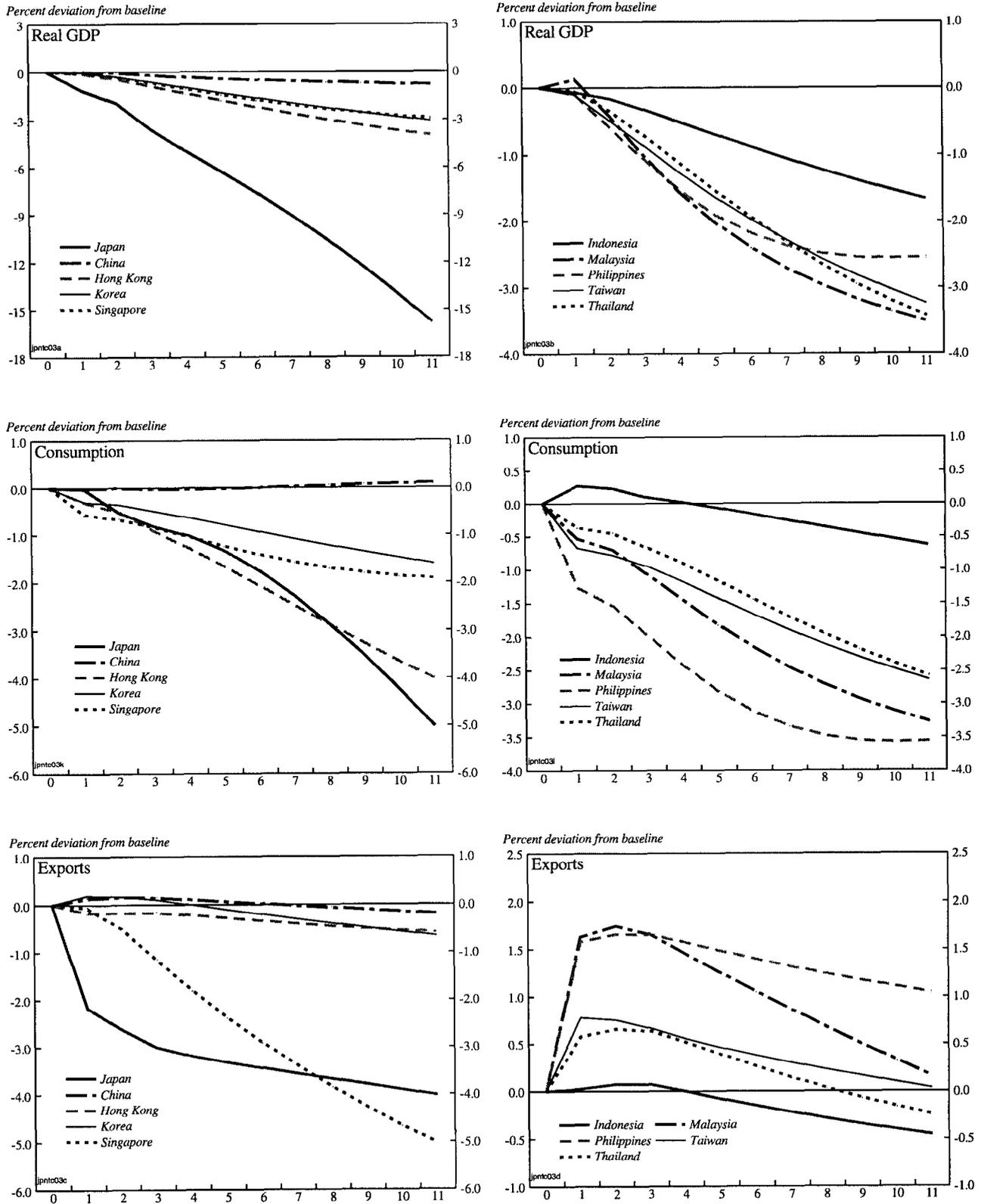
<sup>10</sup> With the productivity slowdown in Japan argued by many to have begun in the early 1990s, Japan could be considered to be around year 10 in the simulation figures.

Figure 2. Japan: Effects of a Decline in Productivity Growth



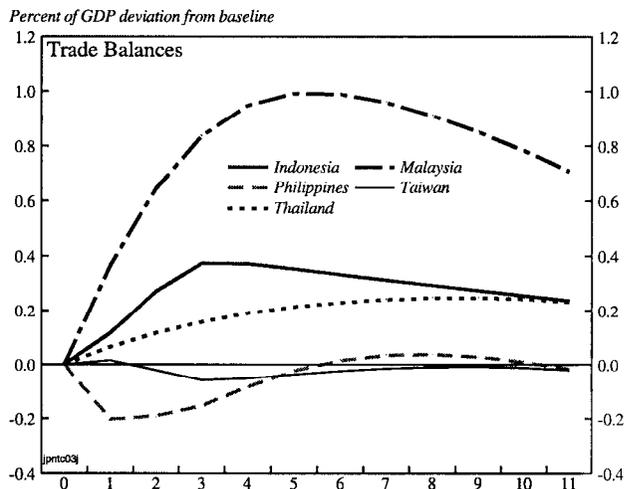
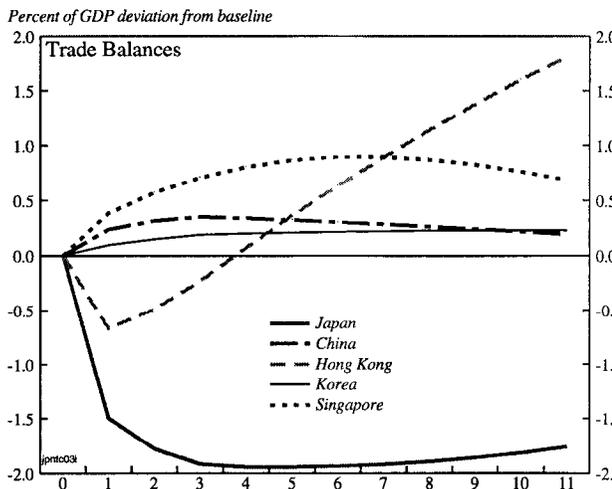
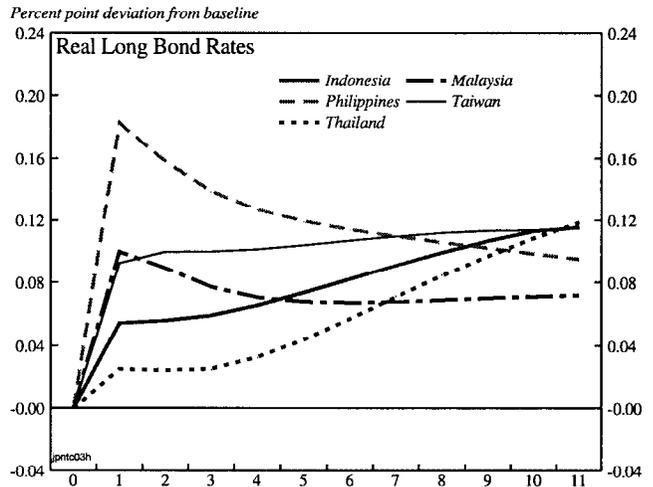
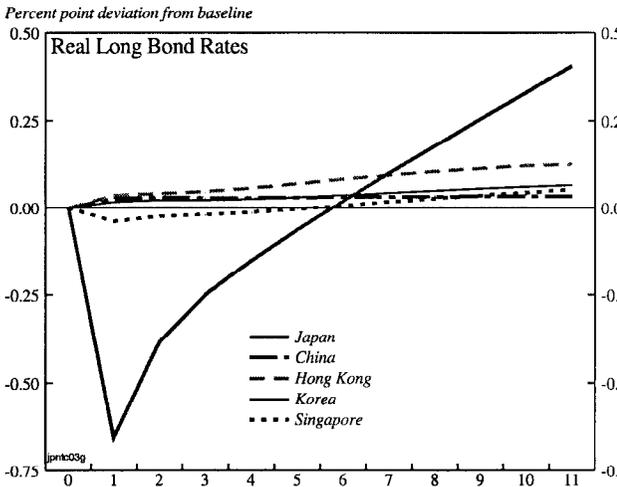
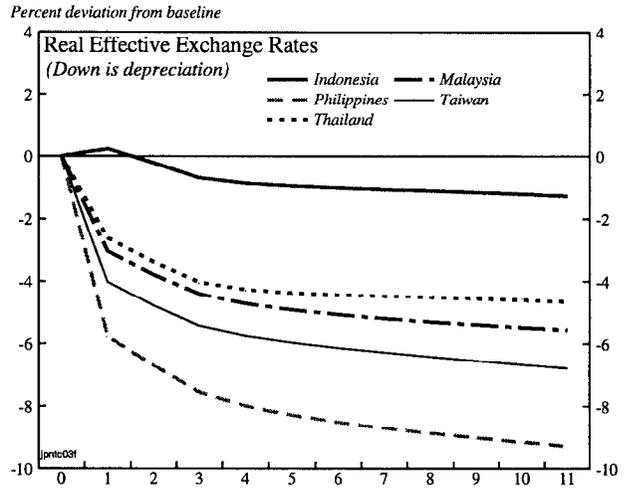
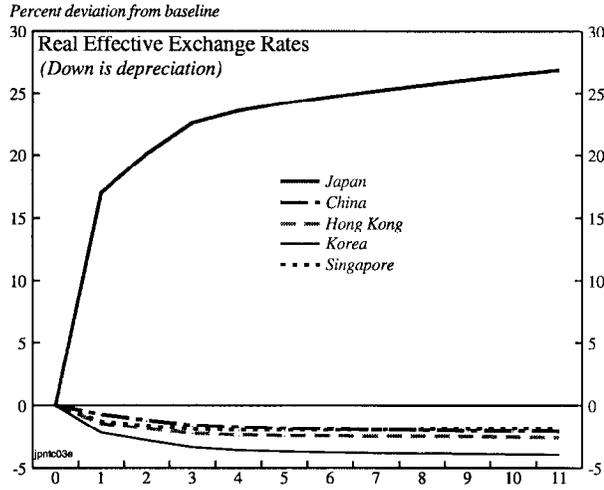
Source: Staff estimates.

Figure 3. Asia: Effects of a Decline in Japanese Productivity Growth



Source: Staff estimates.

Figure 3. Asia: Effects of a Decline in Japanese Productivity Growth (Cont'd)



Source: Staff estimates.

the exchange rate appreciation which makes imported capital goods less expensive. However, as the initial rise in investment peters out in the second year after the shock, the impact of the decline in productivity is fully felt and real GDP begins to decline sharply, falling 15 percent below the baseline after 10 years.

The productivity slowdown in Japan has a negligible impact on the regional economies in the short-term. The appreciation of the yen boosts their competitiveness, offsetting the decline in production in Japan, which reduces the demand for intermediate inputs, and the lower real income, which reduces the demand for final goods. However, over time, the decline in activity in Japan dominates the impact of the lower real exchange rate, and real GDP in the regional economies falls below baseline, although there is some reallocation of capital away from Japan which acts to reduce the negative spillovers. The largest impact is felt in the Philippines, Taiwan, and Malaysia.

### **A Rise in Government Expenditure**

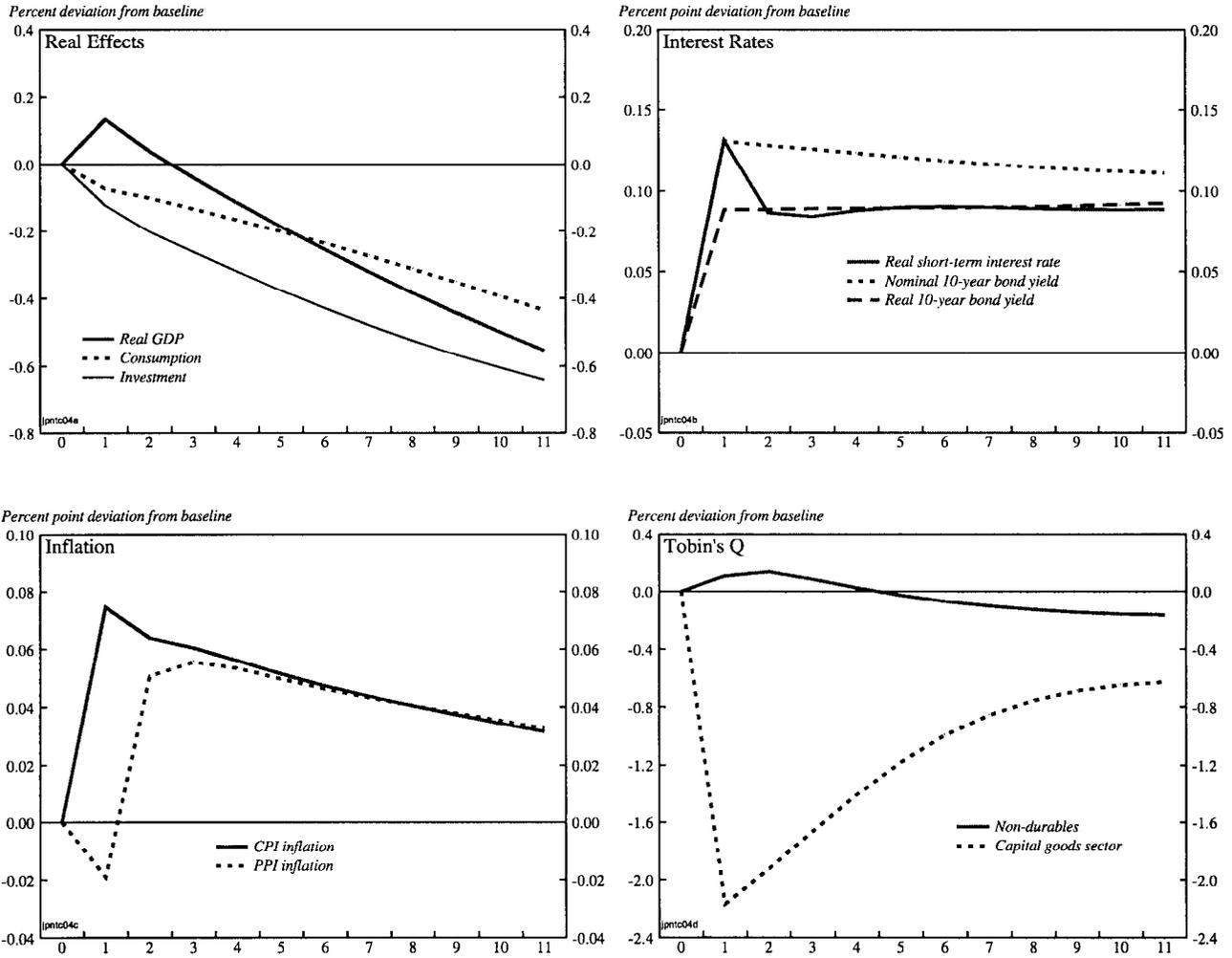
The nature of the Japanese fiscal expansion during the 1990s is open to some interpretation. The increase in expenditure and rise in the deficit may initially have been viewed as temporary in nature, responding to a perceived cyclical downturn in the economy. Given Japan's relatively strong fiscal position at the time, this move into deficit may have been viewed as having few implications for future financing costs, a view consistent with the decline in real long-term bond yields during the first half of the 1990s. However, as the deficit continued to widen, particularly over the past three years, it is likely to increasingly have been viewed as a permanent fiscal expansion, particularly in the absence of a credible policy to bring about medium-term fiscal consolidation. Again, this view appears consistent with the increase in real long-term bond yields since 1998. Consequently, while in this section the implications of a permanent increase in government expenditure are the main focus of the analysis, a discussion is also included of the impact of a temporary fiscal expansion (detailed results from a simulation of a temporary rise in government expenditure can be found in McKibbin and Callen, 2001).

A permanent rise in government spending on goods and services of 1 percent of GDP (relative to baseline), financed by the issuance of government debt, is considered. The additional spending is assumed to be distributed as: 0.1 percent of GDP on durable manufacturing; 0.2 percent of GDP on non-durable manufacturing; and 0.7 percent of GDP on services. Over time, the fiscal closure rule in the model ensures that lump sum taxes on households rise to cover the servicing costs of the additional debt issued. The results are shown in Figure 4 for Japan and Figure 5 for the other countries.

The results suggest that a permanent fiscal expansion offers only a very short term stimulus to the Japanese economy, and has a negative effect over time. The fiscal expansion has a positive impact on activity in the first year, although this is not as large as the direct stimulus itself due to the negative impact on consumption and investment. The additional government spending on goods and services raises aggregate demand through conventional Keynesian channels in the short run. As there is some stickiness in wages, real wages fall, and additional labor is forthcoming to temporarily satisfy the additional demand.

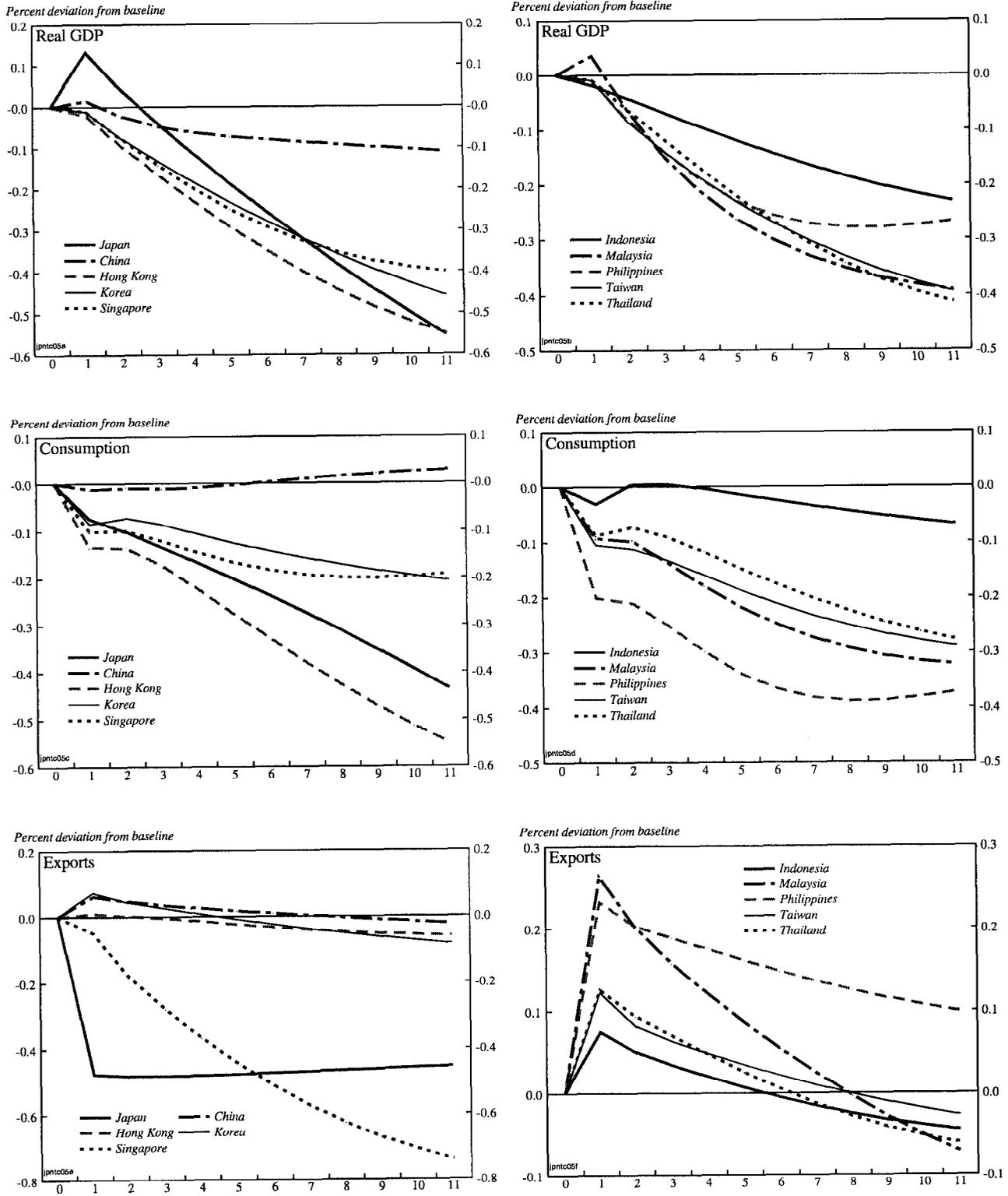
Figure 4. Japan: Effects of a Permanent Increase in Government Spending

(Increase = 1 percent of GDP)



Source: Staff estimates.

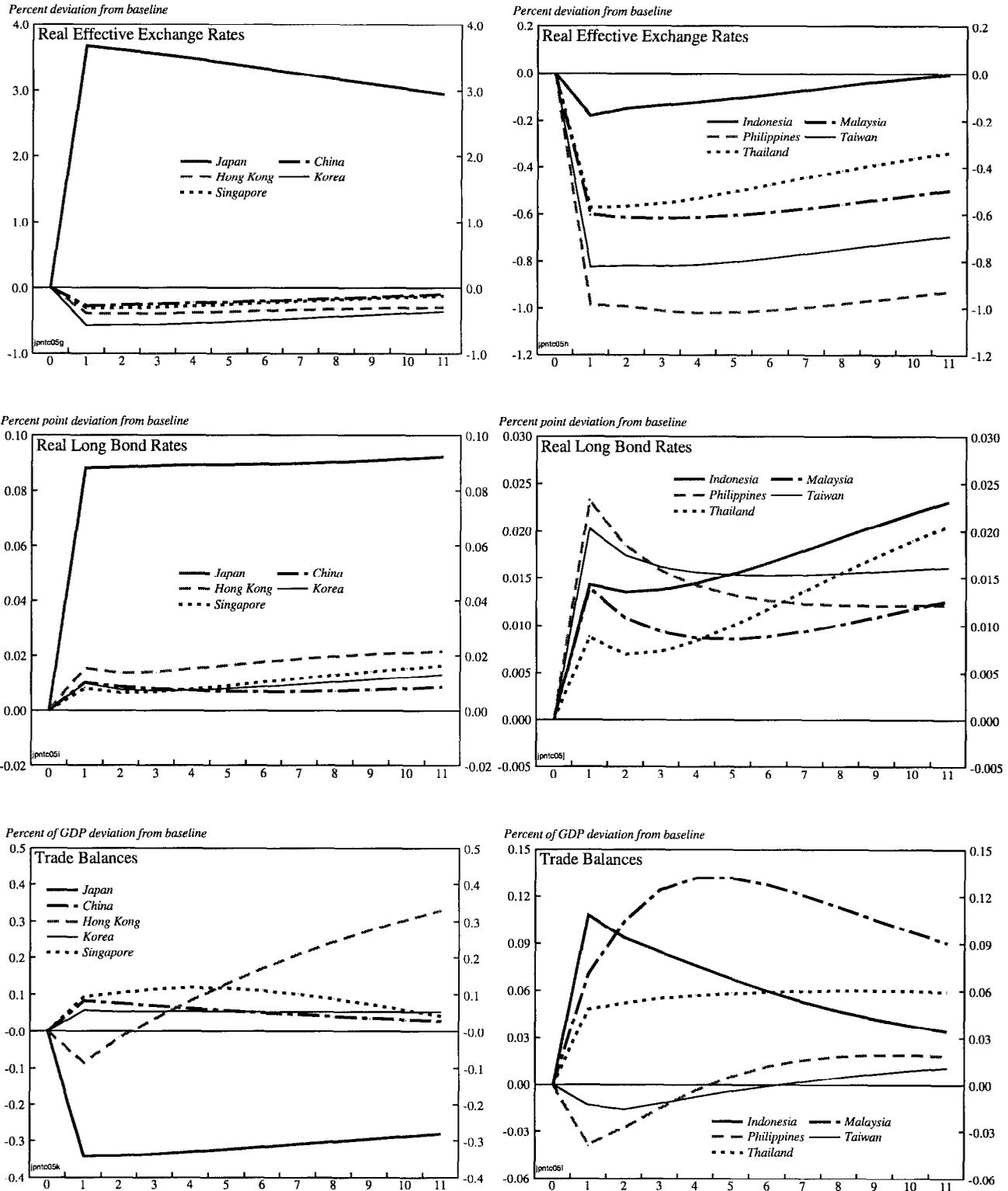
Figure 5. Asia: Effects of a Permanent Increase in Japanese Government Spending  
(Increase = 1 percent of GDP)



Source: Staff estimates.

Figure 5. Asia: Effects of a Permanent Increase in Japanese Government Spending (Cont'd)

(Increase = 1 percent of GDP)



Source: Staff estimates.

However, the effects of the anticipated future fiscal deficits are also important. In anticipation of higher future taxes, households increase their saving and consumption therefore falls. But this effect is relatively small, and the additional resources required to finance the future deficits requires higher future real interest rates as the government competes with the private sector for domestic and foreign savings. The higher expected future real interest rates cause real long-term interest rates to rise, which attracts capital from overseas (either the repatriation of Japanese capital from abroad or new foreign capital inflows) and appreciates the exchange rate. In turn, these developments hurt equity prices, result in a decline in Tobin's  $q$ , and a fall in private investment, while exports are negatively impacted by the more appreciated exchange rate. Thus, real GDP rises slightly above the baseline in the first year, but by the third year is below the baseline as the debt burden rises and crowds out private activity (growth is roughly 0.1 percent per annum lower than in the baseline over the medium-term—the impact on the growth rate can be calculated from the slope of the GDP line in Figure 4). As government expenditure has risen by around 8 percent of GDP over the past decade, the results suggest that real GDP growth will be a little under 1 percent lower over the medium-term (relative to the baseline).

The relative trade reliance on Japan and the size of the external debt stock determines the transmission of the rise in government expenditure in Japan to other countries in the region. While in some countries there is a very small positive impact in the short run as the temporary demand stimulus in Japan raises the demand for their exports, the impact quickly turns negative both directly through higher real interest rates and because equity prices in Asia fall, affecting private consumption and investment, and in the longer run the negative effects on Asia reflect those in Japan. The smallest impact is estimated to be in China and the largest in Hong Kong.

In contrast to the permanent increase in government expenditure, the economic implications of a temporary fiscal stimulus are more favorable. The key difference is the impact on real interest rates and future tax liabilities. Because the stimulus is only temporary, it has a minimal impact on real interest rates and household expectations of future tax liabilities, and in contrast to the permanent expansion, private consumption and investment are not therefore significantly affected. Consequently, the additional government expenditure boosts the economy in the short-run without having significant negative consequences for other components of demand.

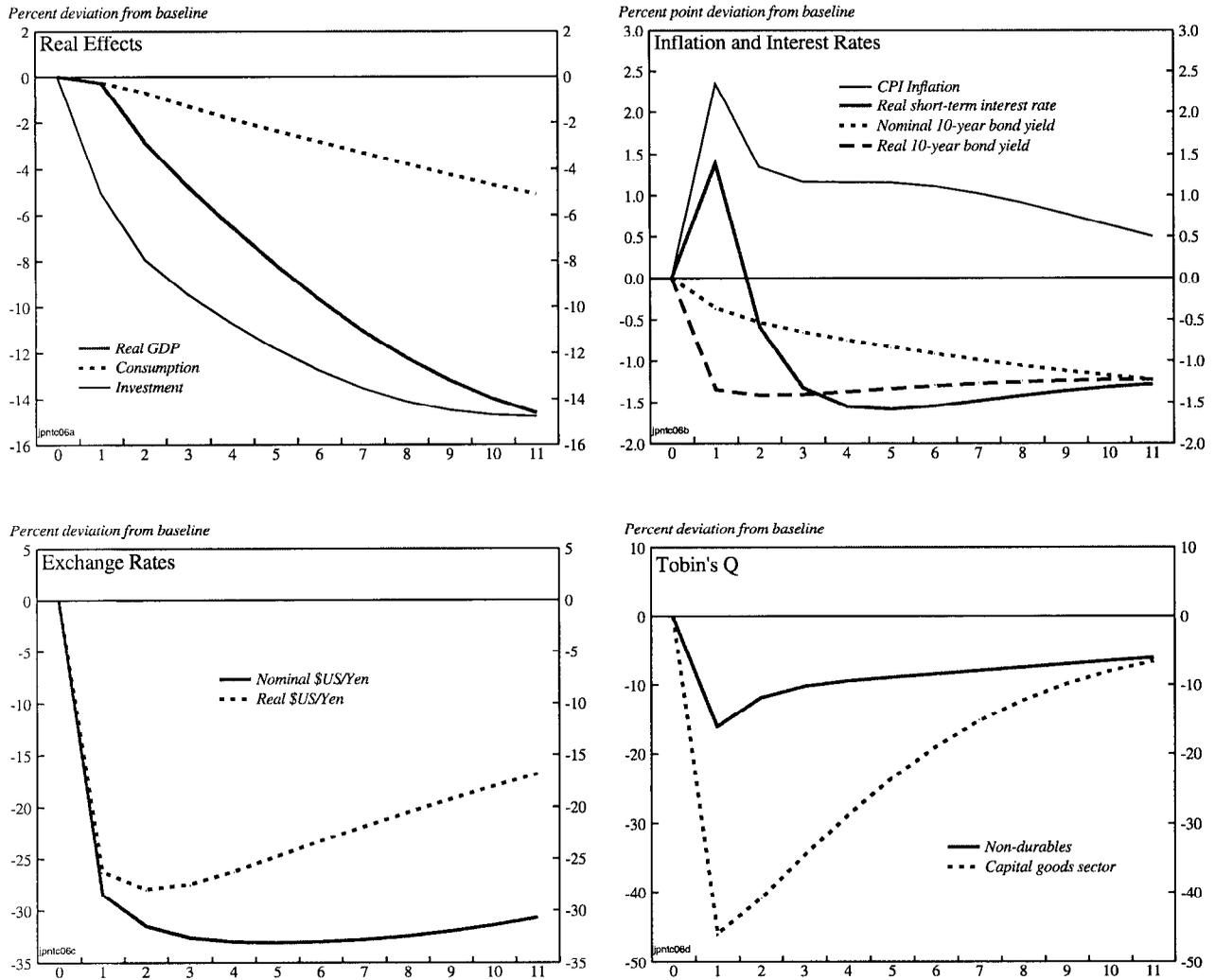
### **A Decline in Japanese Equity Prices**

A decline in Japanese equity prices is modeled as a permanent 3 percent rise in the equity risk premium (implying that Japanese equities require a rate of return 3 percent higher relative to government bonds compared to the baseline).<sup>11</sup> The results are shown in Figure 6 for Japan and Figure 7 for other countries.

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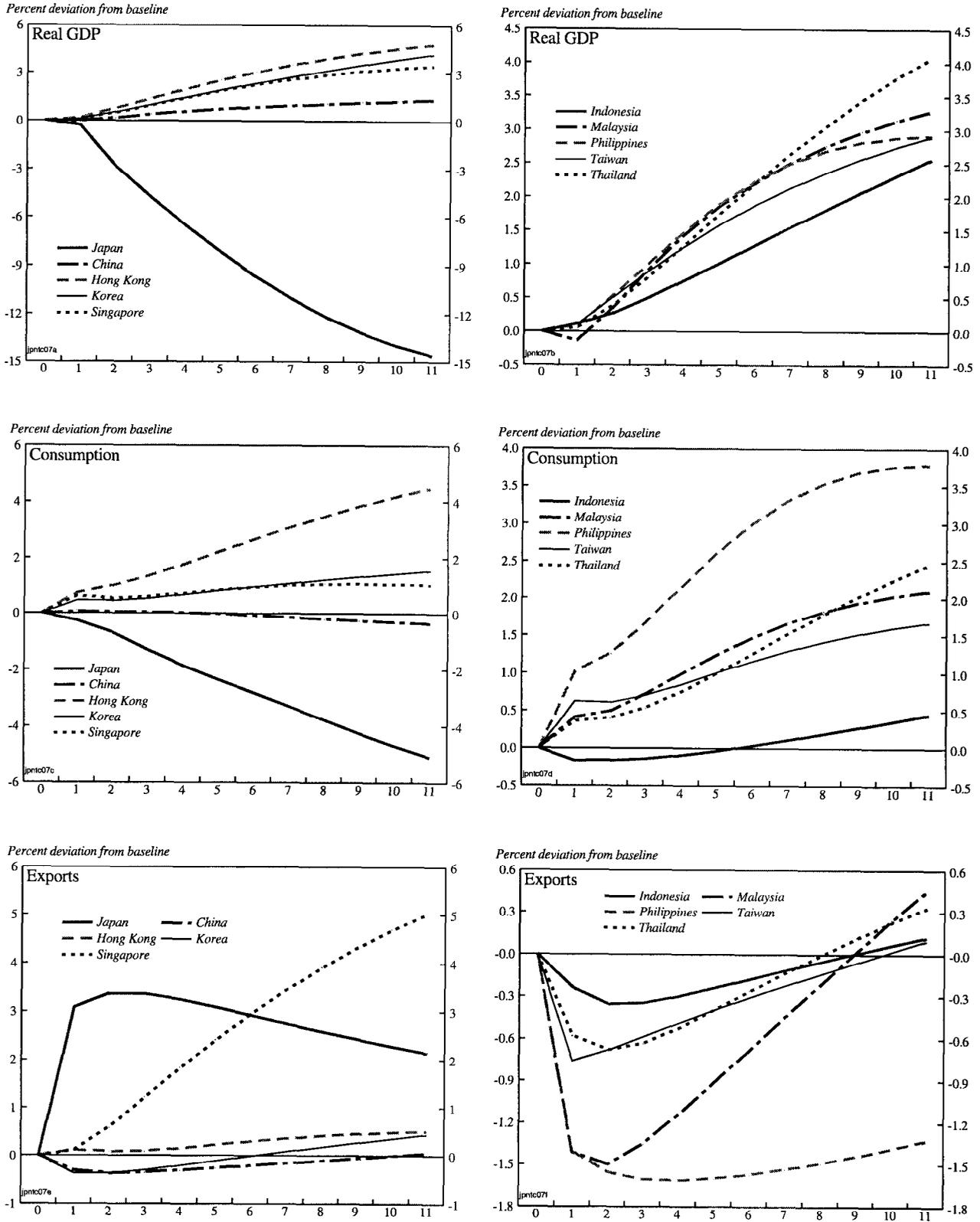
<sup>11</sup> The model includes risk premia on certain assets calibrated to be equal to whatever is required to make the model-generated asset returns equal to the observed returns in the base year (1999). These risk premia are held constant during the simulations unless they are exogenously changed (as in the current simulation).

Figure 6. Japan: Effects of an Increase in the Risk of Holding Japanese Equity



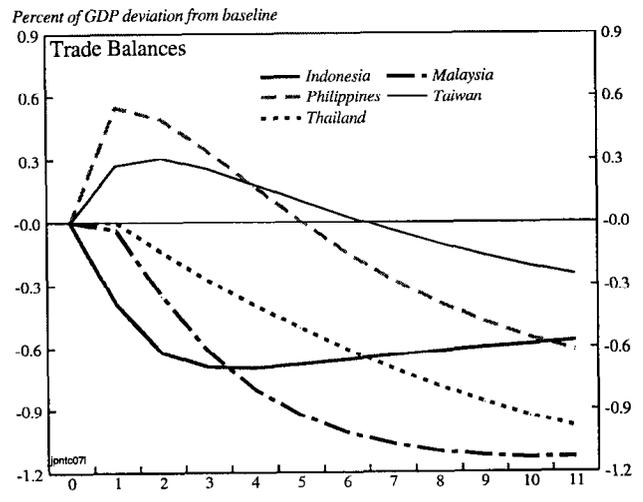
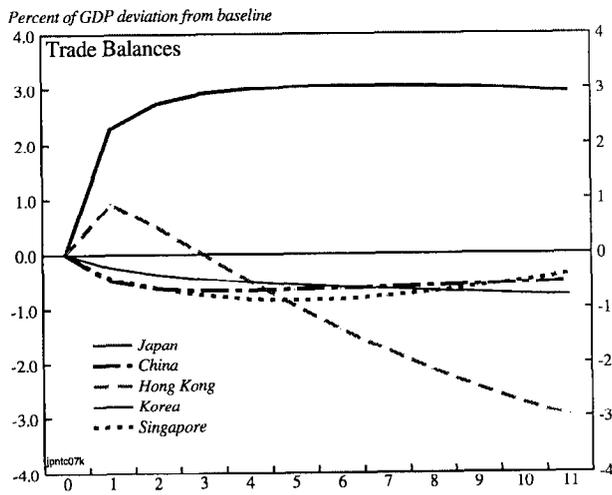
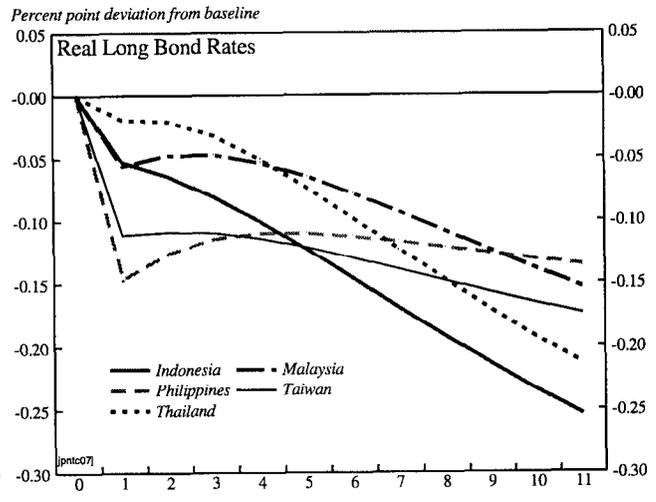
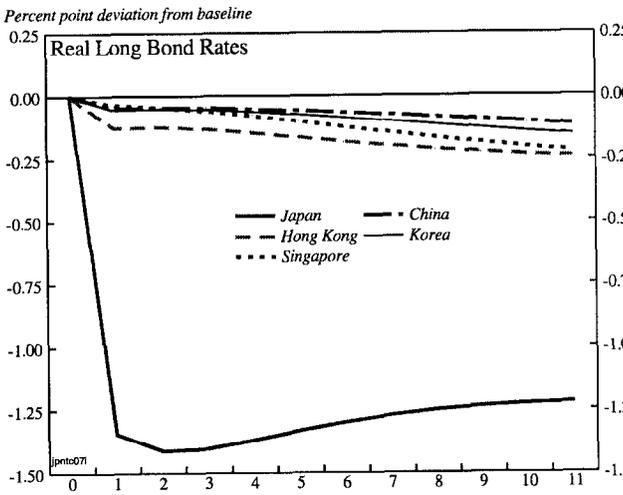
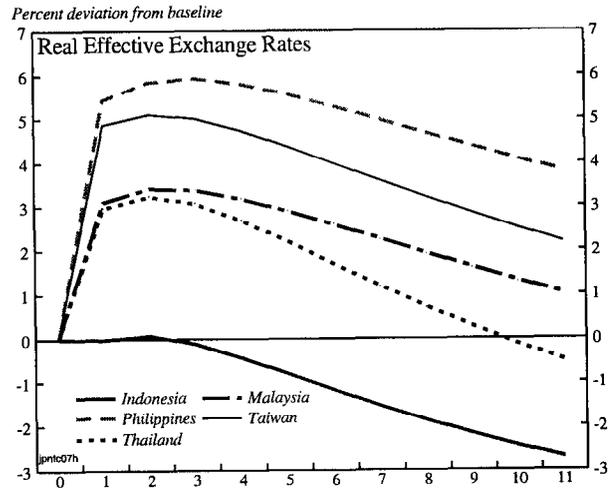
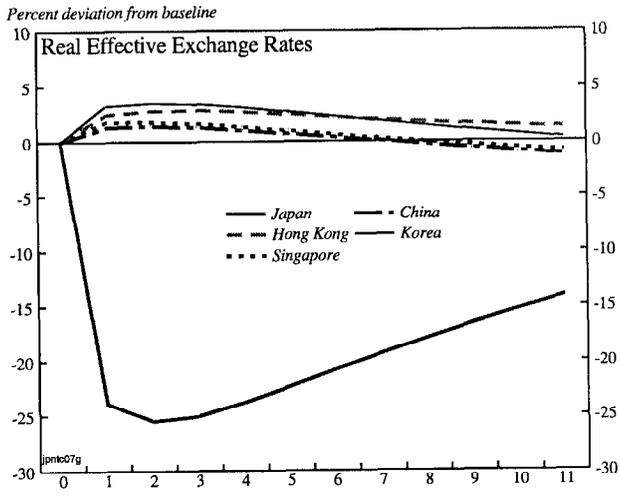
Source: Staff estimates.

Figure 7. Asia: Effects of an Increase in the Risk of Holding Japanese Equity



Source: Staff estimates.

Figure 7. Asia: Effects of an Increase in the Risk of Holding Japanese Equity (Cont'd)



Source: Staff estimates.

The immediate impact of a rise in the equity risk premium is a sharp drop in equity prices. The resulting decline in Tobin's  $q$  causes investment to fall, while consumption is also adversely affected by the decline in private wealth. However, as capital flows out of Japan, the yen weakens, which boosts net exports, improves the current account balance, and dampens the initial negative impact on real GDP. Long term interest rates also decline, although there is a spike in short-term nominal interest rates because of a tightening of monetary policy in response to the rise in inflation (this reflects the assumed monetary policy reaction function—an alternative reaction function could change this short run outcome, but would not affect the medium to long term adjustment path). However, as consumption and investment weaken over the medium-term, real GDP falls sharply relative to the baseline.

A slowdown due to a rise in equity risk (i.e., a loss of confidence) in Japan is transmitted positively to the rest of the world. Again there are a number of things happening. The capital outflow from Japan lowers real interest rates outside Japan, which raises investment and helps economies with high foreign debt levels. However, exports are negatively affected, although because the slowdown in Japan is asymmetric within the economy—exporting firms gain from the weaker yen whereas firms focused on the domestic economy suffer—countries that sell goods to the domestic Japanese market are more affected than those that sell inputs for exports. In addition, countries that compete with Japan in third markets will lose competitiveness because of the yen depreciation. Adding these effects together, all Asian countries gain in terms of GDP (although not necessarily in terms of income) because ultimately Japanese production is partially relocated to countries with lower financing costs.

## **V. THE IMPACT OF FUTURE SHOCKS AND POLICY CHANGES IN JAPAN ON ASIA**

With the economy having again faltered since the middle of 2000, there has been a renewed focus on the policies needed to bring about a sustained economic recovery in Japan over the medium-term. The new Prime Minister, Mr. Koizumi, has advocated measures to address the NPL problem in the banking sector, bring about fiscal consolidation, and accelerate structural reforms to raise productivity growth, while there has been an active debate about the scope for further monetary easing and the impact this may have on the economy and the region, including through a depreciation of the yen. This section explores a number of these issues.

### **Fiscal Consolidation**

Prime Minister Koizumi has indicated his intention to move toward fiscal consolidation, committing to limit net issuance of JGBs to ¥30 trillion in FY2002, and suggesting a medium-term objective of achieving primary budgetary balance. In this simulation, the impact of a phased, fully credible, fiscal consolidation is considered, where government expenditure is reduced by 1.7 percent of GDP in the first year, 3.4 percent of GDP in the second year, and

5 percent of GDP from the third year onwards (relative to baseline).<sup>12</sup> The results are presented in Figure 8 for Japan and Figure 9 for other countries (the impact of a permanent, one-off, reduction in government expenditure can be seen by inverting the results in Figures 4 and 5).

In response to the announcement of the fiscal consolidation plan, the model predicts that real interest rates would fall as financial markets react to the lower expected future deficits. At the same time, the yen would depreciate by around 15 percent. As households anticipate the lower future tax obligations, consumption would rise, while the exchange rate depreciation would boost net exports. These factors would more than offset the declines in government expenditure and private investment, the latter due to the lower expected growth during years 2–4 which would push down equity prices, and real GDP rises in the first year. Because inflation rises in response to the depreciation and the pick-up in growth, short-term interest rates rise (if the BoJ did not raise interest rates, the initial output response would be even more positive). However, real GDP would fall below baseline in the second and third years as the positive impact from the financing gains is more than offset by the actual decline in government expenditure, and it is only from the fifth year that it once again moves above the baseline as the positive impact of the decline in real interest rates and the real exchange rate on consumption, investment, and net exports is fully felt.

When compared to the (inverse) of the temporary fiscal expansion considered in the previous section, this simulation shows the potential benefits of announcing a fully credible fiscal consolidation strategy as against one that is not believed. While even in the case of a credible consolidation there are short-run costs to output as government demand is withdrawn from the economy, these are partly mitigated by the positive announcement effect on consumption and investment brought about by the rise in equity prices, decline in long-term interest rates, and the lower future tax liabilities of households. In the case of the temporary consolidation, none of these offsetting factors are apparent.

The impact on the other Asian economies is similar (but opposite in sign) to the results discussed earlier for a fiscal expansion in Japan. In the first year, the impact depends on the relative importance of trade and financial links, but is small. While the depreciation of the yen offsets the rise in demand in Japan, countries with high debt levels (such as Indonesia) actually see an increase in real GDP. In the second year, all the Asian economies are gaining more from lower capital costs than they are losing from a temporary slowdown in Japan and the weaker yen, and the benefits over the medium term are estimated to be considerable.

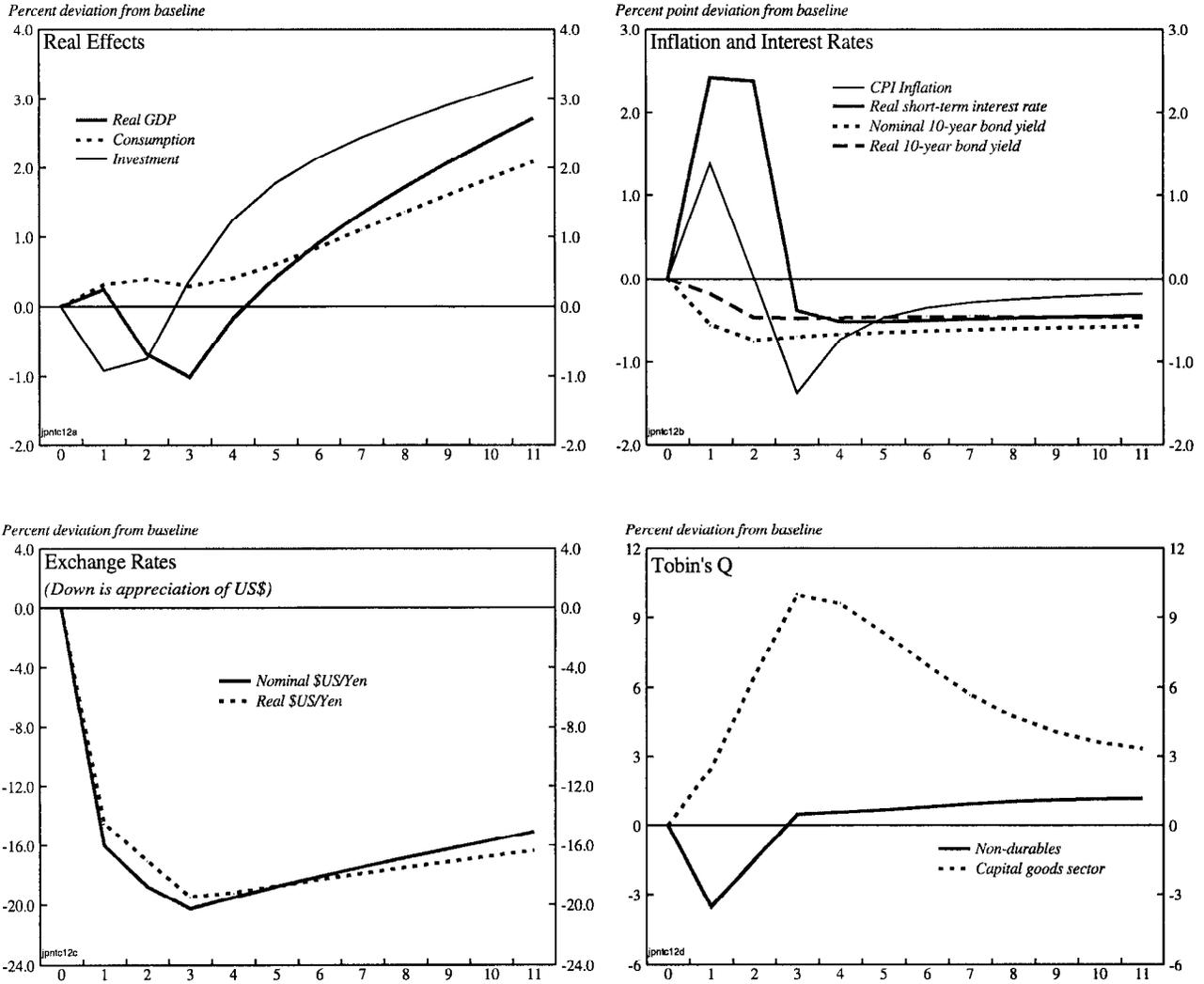
### **Quantitative Monetary Easing**

With nominal short-term interest rates in Japan having been at, or near zero, for a number of years, debate has focused on whether the BoJ should seek to undertake quantitative easing, including through increased *rinban* operations, to provide additional liquidity to the

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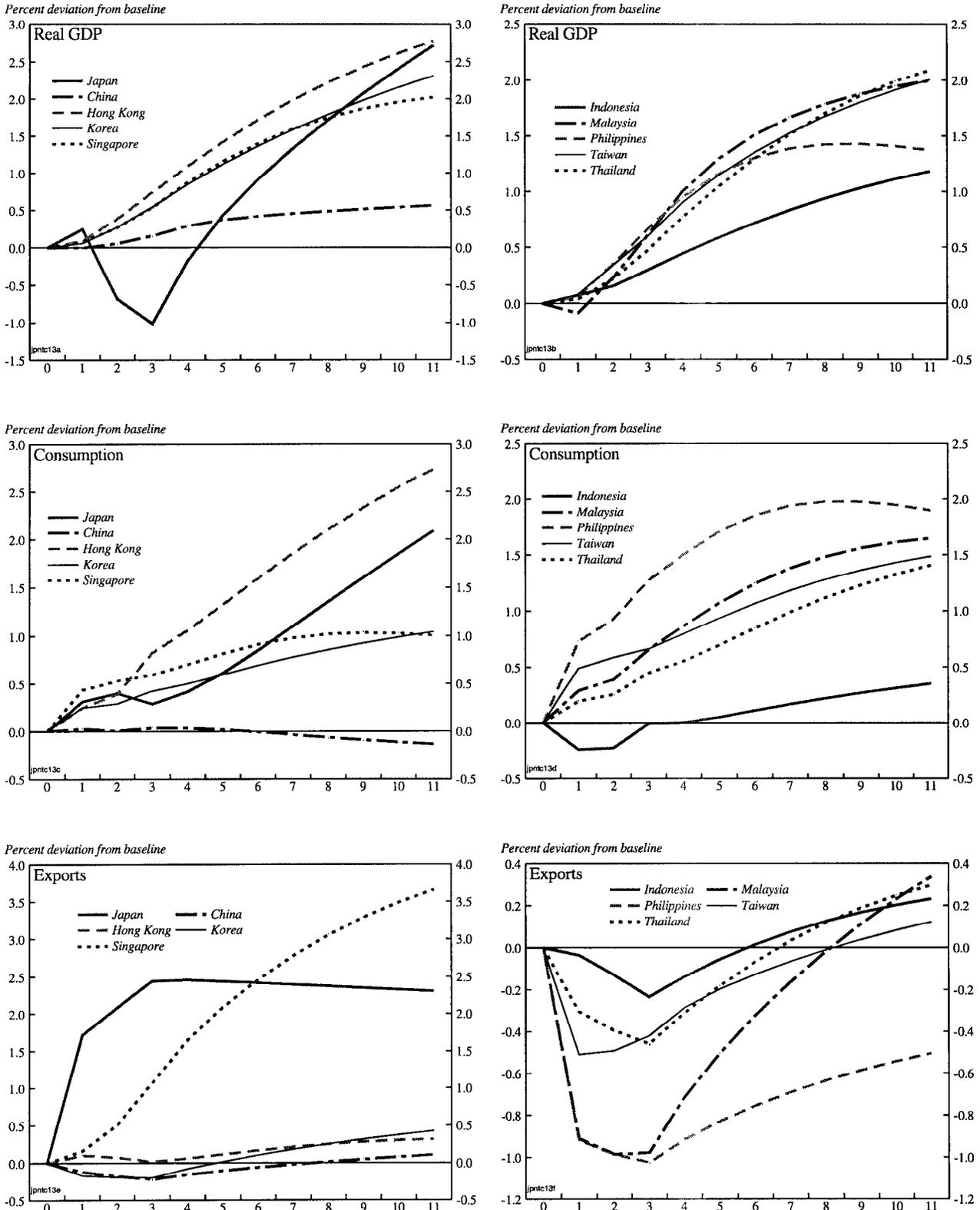
<sup>12</sup> While it is unlikely that any consolidation would happen this quickly, for the purposes of the simulations it is useful to have it occurring in a relatively short period of time so that the competing effects of the policy become more clearly visible.

Figure 8. Japan: Effects of a Phased Fiscal Consolidation



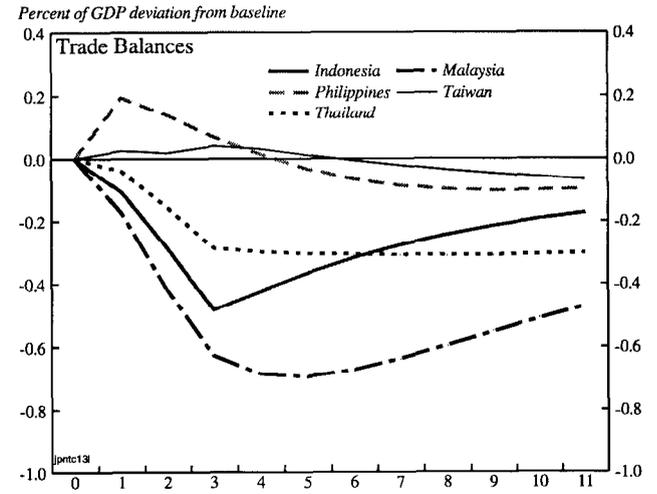
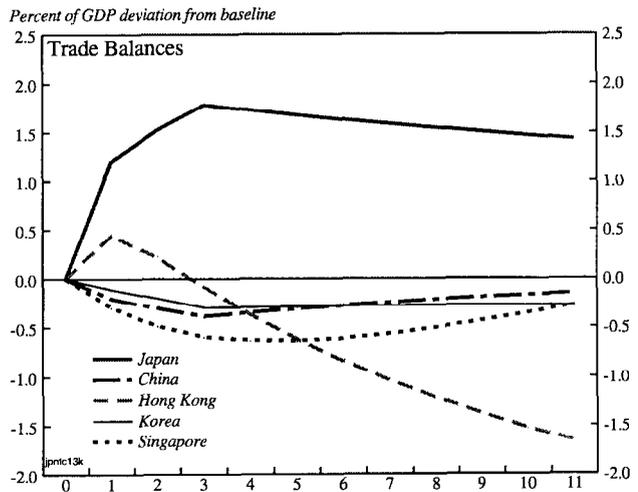
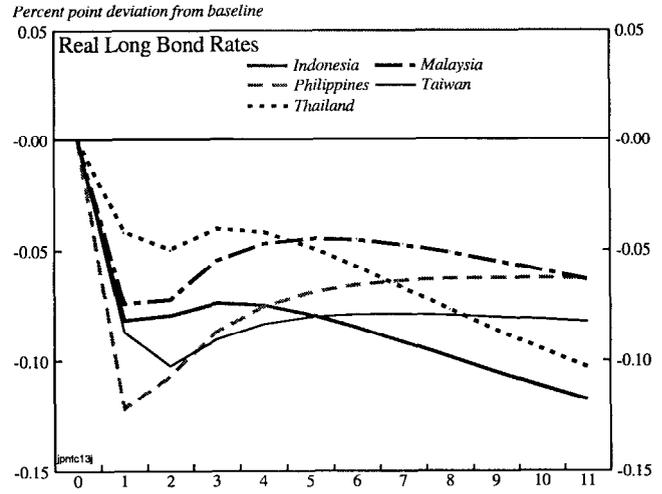
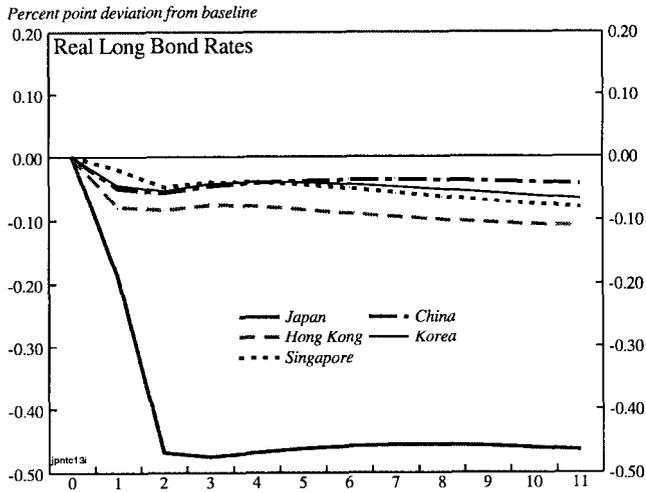
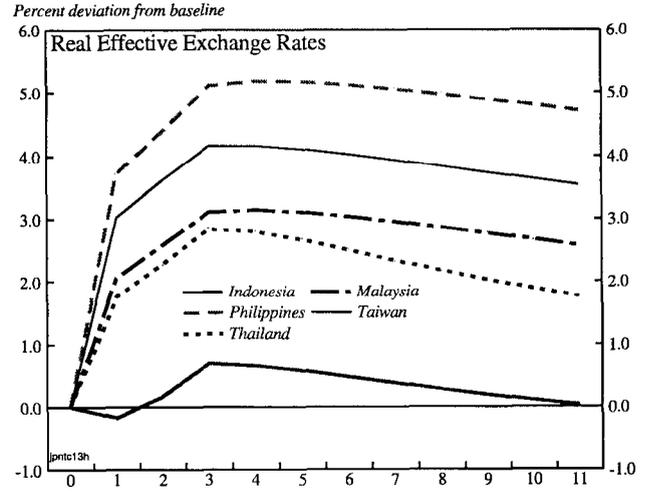
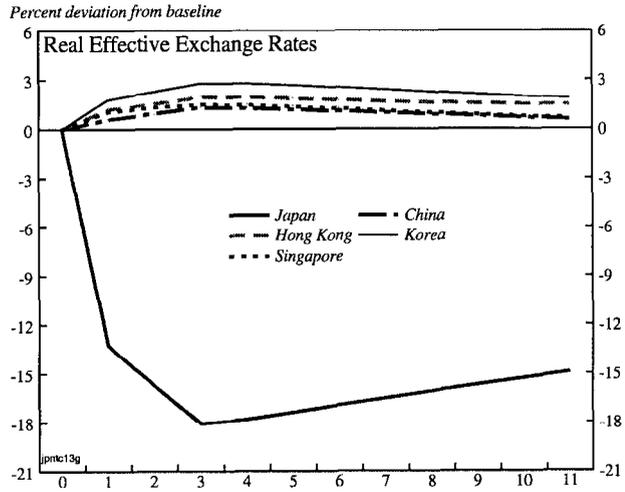
Source: Staff estimates.

Figure 9. Asia: Effects of a Phased Fiscal Consolidation in Japan



Source: Staff estimates.

Figure 9. Asia: Effects of a Phased Fiscal Consolidation in Japan (Cont'd)



Source: Staff estimates.

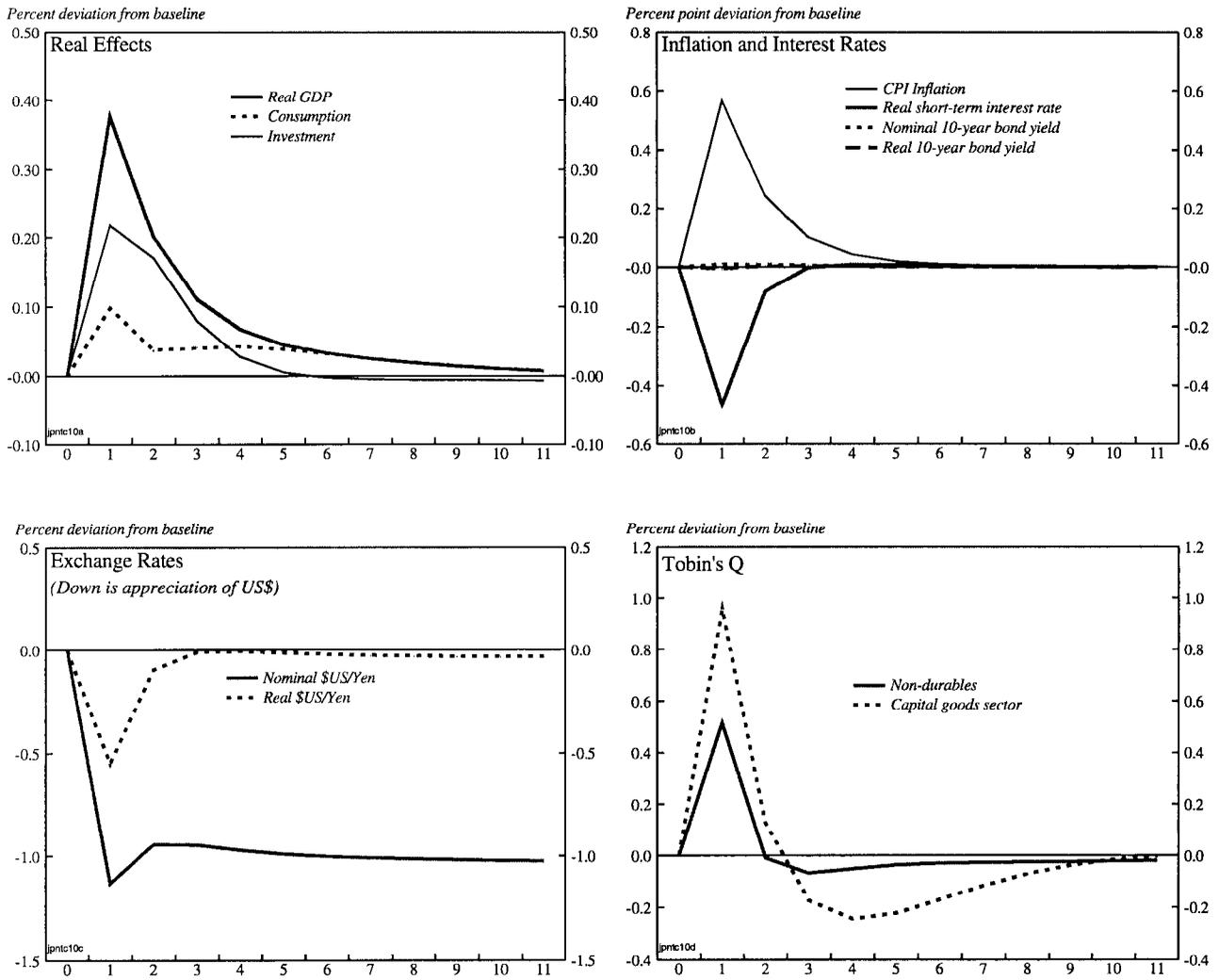
economy. While such a policy would be moving into uncharted waters, and consequently is difficult to quantify, the G-cubed model provides an insight into the possible transmission mechanism of such a policy both in Japan and across the region more broadly. In the simulation, the BoJ is assumed to purchase government bonds sufficient to bring about a permanent 1 percent increase in the money supply relative to the baseline. The results are shown in Figure 10 for Japan and Figure 11 for the other countries.

The monetary injection raises inflation expectations and consequently lowers short-term real interest rates (nominal interest rates, of course, are constrained by the zero-bound) and depreciates the exchange rate. The decline in real interest rates and rise in equity prices temporarily stimulates private consumption and investment and the yen depreciation temporarily boosts net exports. The result is a temporary rise in real GDP through standard Keynesian channels—a demand stimulus accompanied by a fall in real wages and real interest rates temporarily increasing aggregate supply. Over time, however, price adjustment removes the real effects of the monetary shock and the economy settles down to the original baseline with higher prices, but not higher inflation due to the shock being a rise in the level of money balances (a shock to the rate of growth of money results in a larger stimulus to demand, but also a permanent change in the underlying inflation rate in Japan). Long-term interest rates change little because the inflationary impulse is temporary, while the change in the real exchange rate that stimulates net exports is largely eroded by the second year.

The effects on the rest of Asia are small. The temporary boost to aggregate demand leads to an increase in the demand for Asian goods in Japan, but this is offset by the rise in the price of these goods when converted into yen within the Japanese economy. Indeed, in the first year, the exchange rate effect dominates, and exports from each Asian economy to Japan, and into third markets in which they compete with Japanese goods, falls. In the second year, the demand stimulus in Japan has not declined as quickly as the real exchange rate, and therefore Asian exports are higher than in the baseline for several more years. Despite the export response being negative for growth in Asian economies in the first year, real GDP is broadly unchanged as equity prices rise in anticipation of the growth in periods 2 through 5, which raises private wealth and consumption sufficiently to offset the export decline.

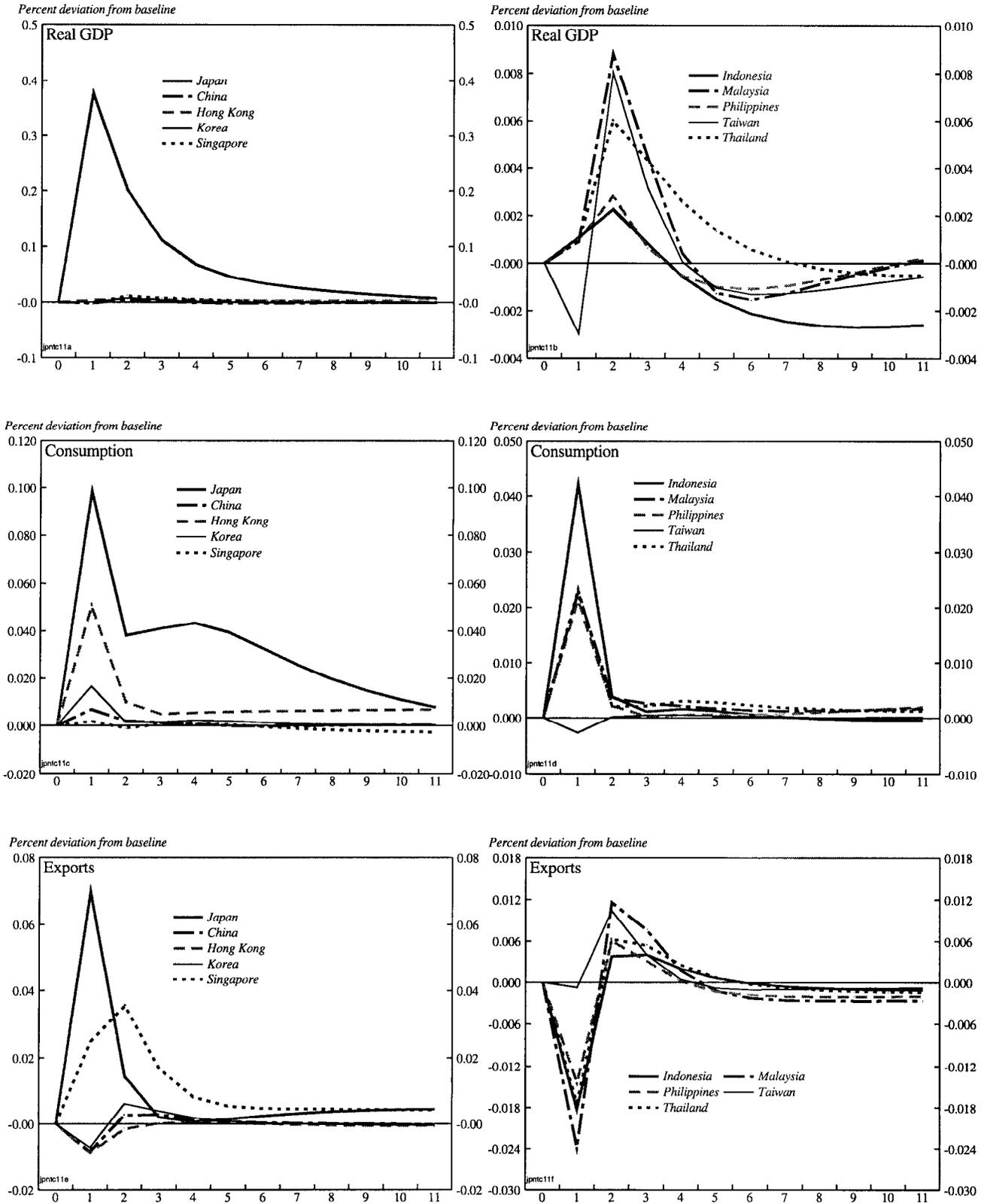
Of course, the numerical results from the simulations are subject to considerable uncertainty in the current economic environment (for example, the behavior of velocity, which is assumed to remain constant in the simulation, is very difficult to predict under such a quantitative easing scenario), while the model is obviously unable to address the questions of whether an increase in the BoJ's quantitative target could actually be achieved through stepped-up purchases of government bonds and whether, in the presence of a weak banking system, a higher quantitative target would impact on the real economy. However, the simulation suggests that the primary transmission channels of such a bond purchase would be through inflation expectations, the exchange rate, and equity prices. Further, it suggests that if part of an overall monetary easing that was successful in boosting the Japanese economy, a depreciation of the yen would have a minimal impact on other regional economies.

Figure 10. Japan: Effects of a 1 Percent Monetary Expansion



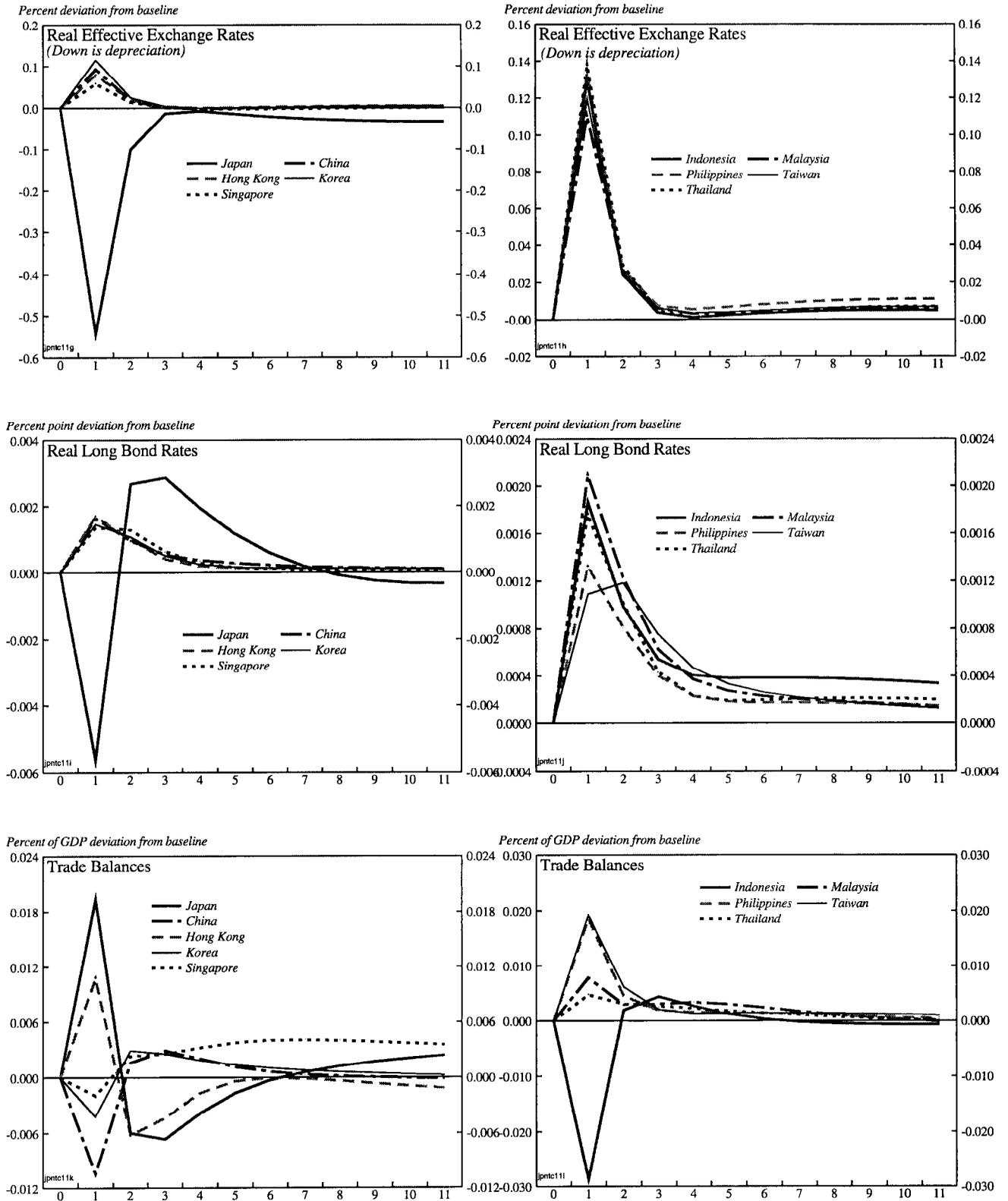
Source: Staff estimates.

Figure 11. Asia: Effects of a 1 Percent Japanese Monetary Expansion



Source: Staff estimates.

Figure 11. Asia: Effects of a 1 Percent Japanese Monetary Expansion (Cont'd)



Source: Staff estimates.

### **A Loss of Confidence in the Yen**

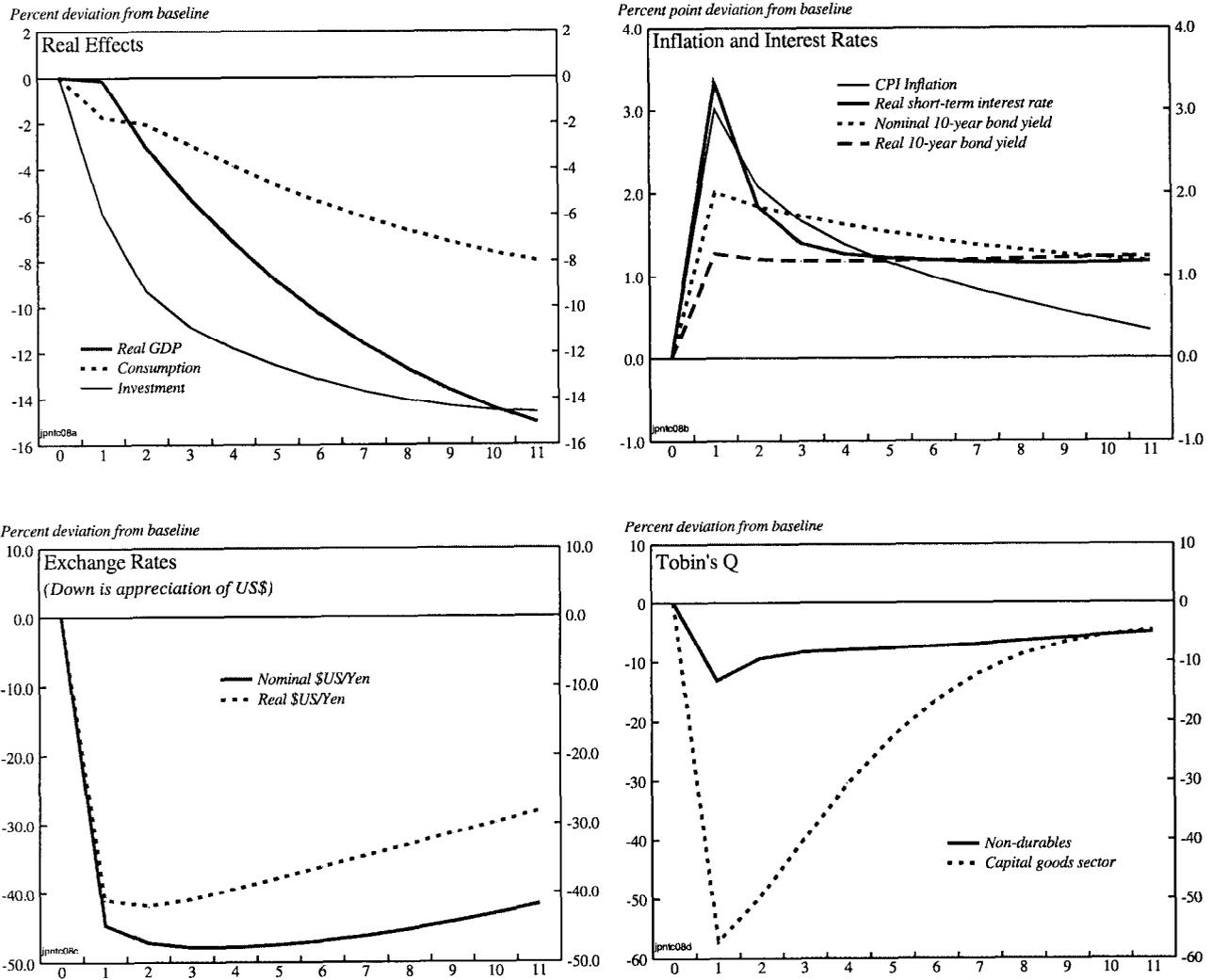
If investors perceive that the reforms needed to restore healthy growth in Japan over the medium-term are not being implemented, thus increasing the risk of a further round of financial difficulties in the banking sector and raising questions about the sustainability of public debt, a significant outflow of capital is possible. In this simulation, this is modeled as a 3 percentage point increase in the risk premium on all Japanese assets in the interest parity condition between yen and U.S. dollar denominated government bonds (the simulation is similar to the loss of confidence in Japanese equities discussed earlier, but in this case the risk shock is applied to the entire Japanese economy reflecting the loss of confidence in the yen). The results are shown in Figure 12 for Japan and Figure 13 for the other countries.

The results are similar to those for the rise in the equity risk premium. The major difference is that whereas in that simulation there was a shift into Japanese government bonds, which pushed down long-term real interest rates in Japan, in this simulation the asset substitution is solely into foreign assets and therefore long-term real interest rates rise. The depreciation of the yen is larger—around 45 percent—and the domestic output loss in Japan is more significant. The impact on other countries in the region is broadly neutral in the first year, but positive thereafter as the benefits of the lower capital costs caused by the additional inflow of capital (the mirror of the outflows from Japan) push down real interest rates and stimulate investment which more than offsets the decline in exports that result from the weaker growth in Japan and the loss of competitiveness due to the depreciation of the yen.

## **VI. CONCLUSIONS AND POLICY IMPLICATIONS**

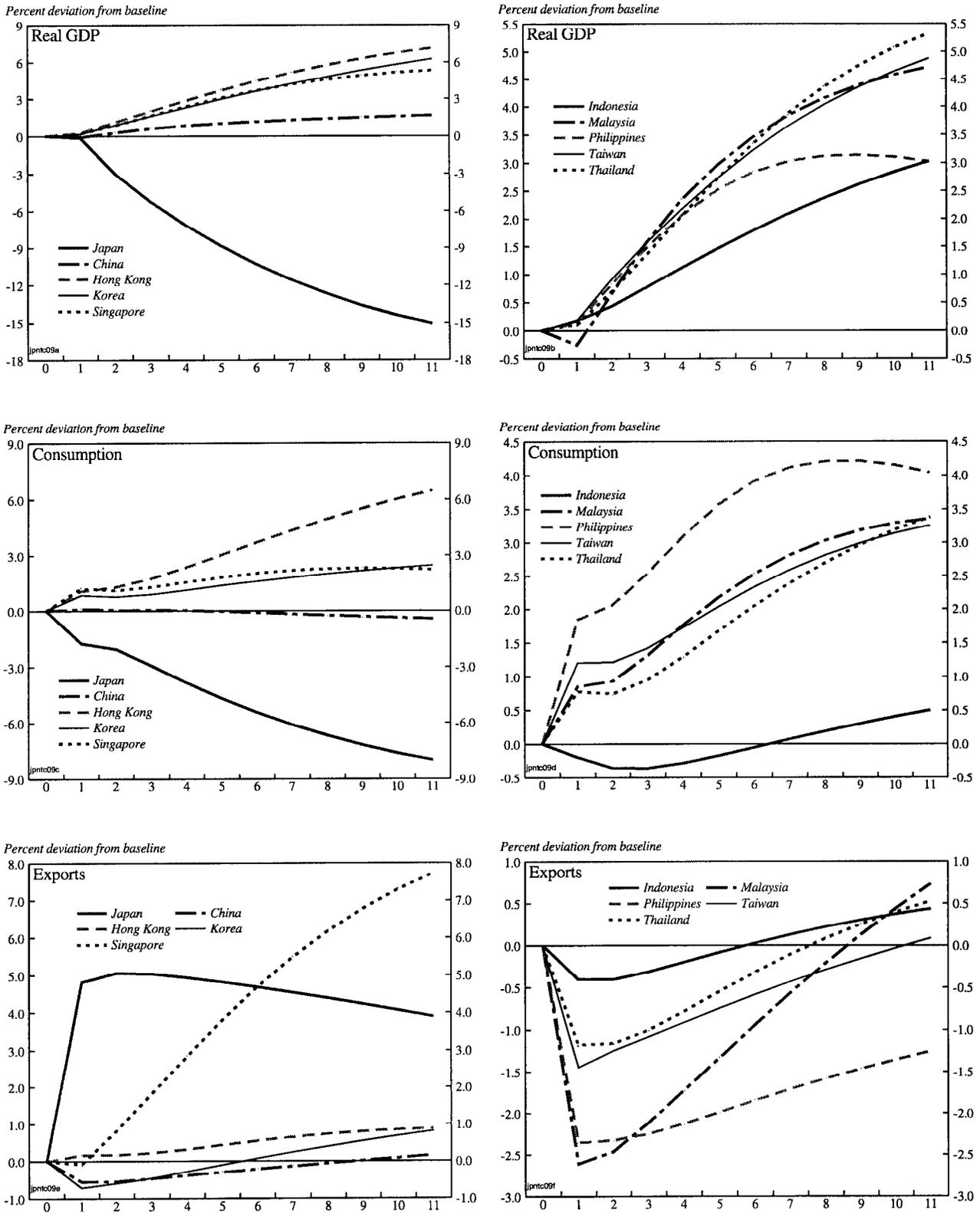
This paper has highlighted a number of important issues in understanding the transmission of shocks between Japan and the Asia-Pacific region. Because trade and financial linkages are significant, shocks are transmitted across countries through goods and asset markets, and the adequate modeling of these links is important if a complete assessment of the impact of the shocks is to be made. While the actual magnitude of the impact of the shocks considered will likely be different to the precise numerical predictions of the model, the insights provided about the transmission mechanism are important. For example, the results suggest that trade linkages often work in the opposite direction to financial linkages, and that there is often a tradeoff between the positive effects from a shock through one channel and the negative effects through the other. Indeed, financial flows act as automatic stabilizers in many of the simulations considered. It also appears to matter whether the trade linkages are for final consumption goods or for intermediate goods to be used in production. The relative importance of each channel determines the overall impact of the shocks.

Figure 12. Japan: Effects of a Loss in Confidence in the Yen



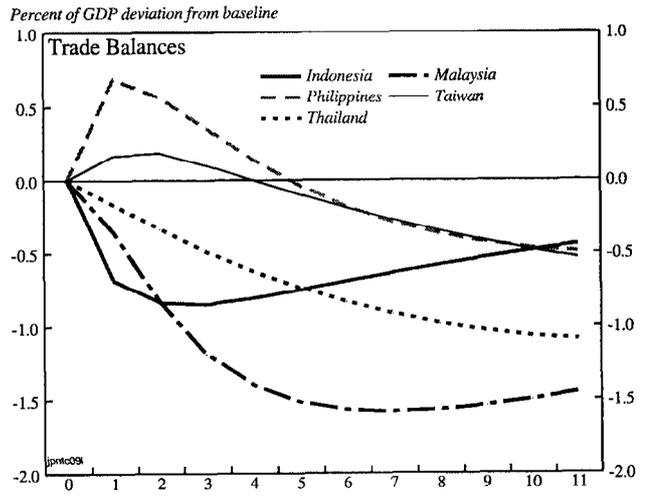
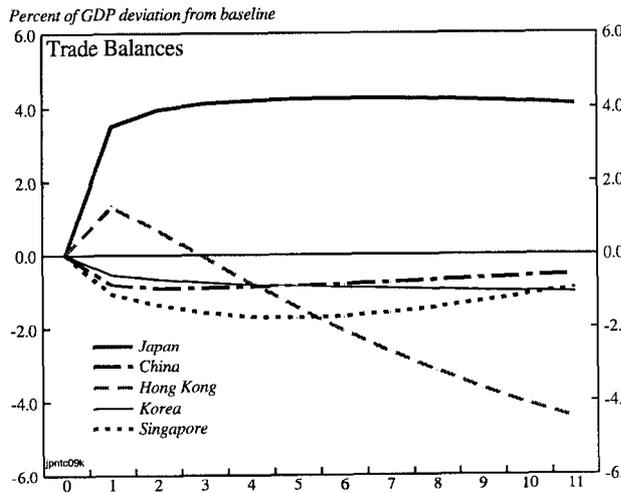
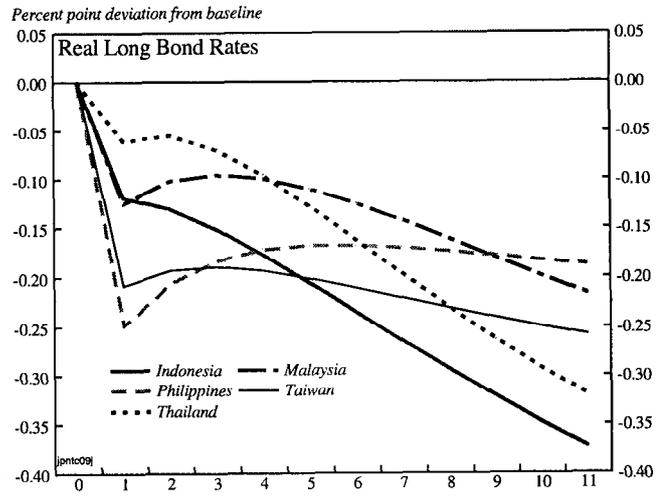
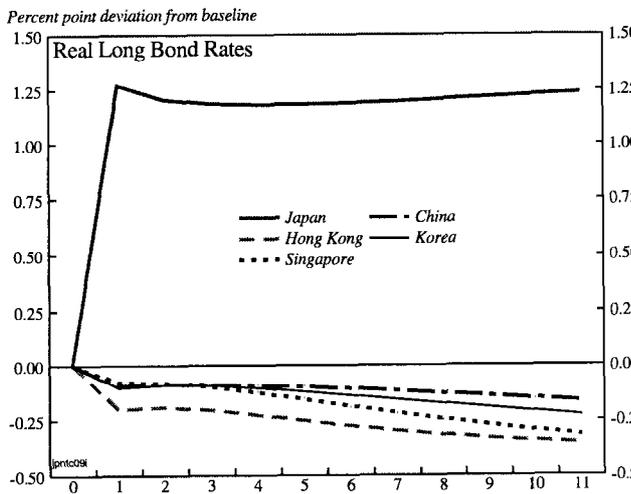
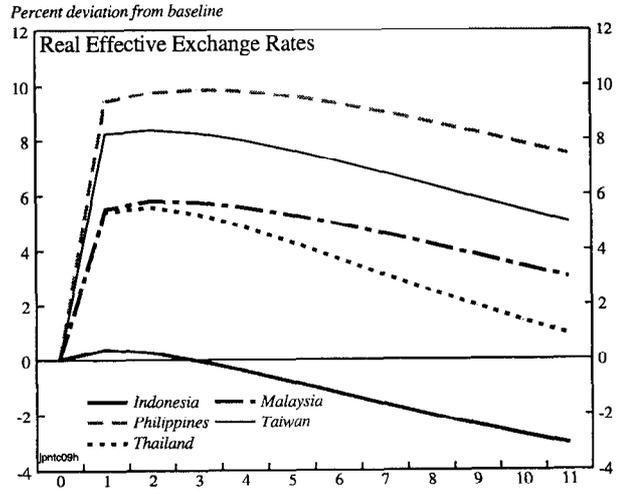
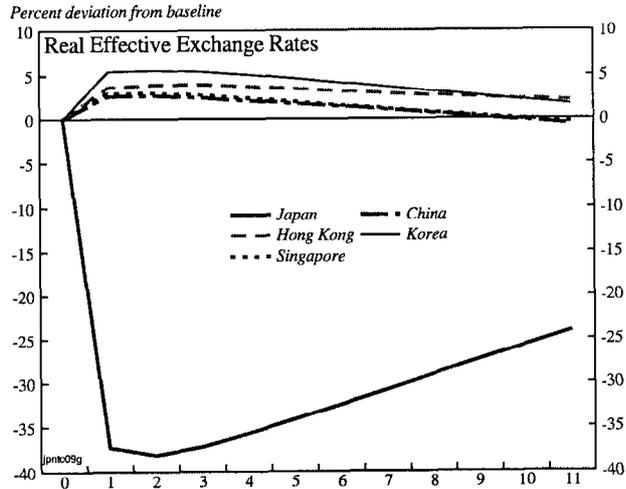
Source: Staff estimates.

Figure 13. Asia: Effects of a Loss of Confidence in the Yen



Source: Staff estimates.

Figure 13. Asia: Effects of a Loss of Confidence in the Yen (Cont'd)



Source: Staff estimates.

Impact on Real GDP: Summary of Selected Simulation Results (Percent Deviation of GDP from Baseline)									
Impact After	Phased Fiscal Consolidation <sup>1</sup>			Monetary Easing <sup>2</sup>		Decline in Productivity Growth <sup>3</sup>		A loss of confidence in the Yen <sup>4</sup>	
	1 year	3 years	5 years	1 year	5 years	1 year	5 years	1 year	5 years
Japan	0.2	-1.0	0.4	0.4	0.0	-1.2	-6.3	-0.1	-8.8
Taiwan	0.1	0.6	1.1	0.0	0.0	-0.1	-1.6	0.2	2.7
Korea	0.1	0.5	1.1	0.0	0.0	-0.1	-1.3	0.2	3.0
Hong Kong	0.1	0.7	1.4	0.0	0.0	-0.1	-1.8	0.2	3.7
Singapore	0.1	0.5	1.2	0.0	0.0	-0.1	-1.4	0.2	3.1
Thailand	0.0	0.5	1.0	0.0	0.0	-0.1	-1.5	0.1	2.7
Indonesia	0.1	0.3	0.6	0.0	0.1	-0.1	-0.7	0.2	1.5
Malaysia	-0.1	0.6	1.3	0.0	0.0	0.1	-2.0	-0.3	3.0
Philippines	0.1	0.7	1.2	0.0	0.0	-0.1	-1.9	0.1	2.5
China	0.0	0.2	0.4	0.0	0.0	0.0	-0.4	-0.1	1.0

<sup>1</sup> Reduction in government expenditure of 1.7 percent of GDP in the first year, 3.4 percent in the second year, and 5 percent from the third year onward.

<sup>2</sup> BoJ purchase of government bonds sufficient to bring about a permanent 1 percent increase in the money supply.

<sup>3</sup> Decline in growth rate of labor augmenting technical change of 3 percent per annum for three years, 1 percent per annum for another eight years, and then returning to trend.

<sup>4</sup> A 3 percentage point increase in the risk premia on all Japanese assets.

The simulation results have a number of implications for the ongoing policy debate in Japan, and for policymakers in other Asian countries as they assess the potential impact of any policy changes in Japan on their own economies:

- As Japan moves toward fiscal consolidation over the medium-term, the results give some grounds for optimism that the economic impact can be limited. While undoubtedly there will be a negative short-term impact on activity, this could be fairly limited if the announcement were credible—perhaps legislated in a fiscal responsibility act which specified a long-term public debt target and the tax, expenditure, and social security policies to back-up that target—and would be quite quickly replaced by the positive impact from the decline in real interest rates and rise in equity prices. The negative short-run impact could also be offset by a more expansionary monetary policy through the central bank’s purchase of government debt. The existence of financial as well as trade linkages means that the effects of the fiscal consolidation in Japan is broadly neutral for the region in the short-run, but beneficial over the medium term.
- The results suggest that a quantitative easing of monetary policy through the BoJ’s outright purchase of government bonds would stimulate the economy in the short-run, and from a position of insufficient demand would help close the output gap. However, it needs to be recognized that in the current situation the impact of such a monetary stimulus is highly uncertain, and the results should be taken more as indicating the transmission channels through which a policy relaxation could work, rather than the actual size of the impact it would have.

- Trends in Japanese productivity growth have important implications for the domestic economy and the region. Therefore structural reforms that boost productivity growth over the medium-term will provide a boost to growth domestically and in the region (the results can be seen as the inverse of the first simulation presented in Section D).
- In terms of the exchange rate, an important point that emerges from the results is that the implications of a depreciation of the yen depend importantly on the reasons for the depreciation.<sup>13</sup> For example, a depreciation due to a loss of confidence in Japan has a large negative effect on Japan, but could actually be positive for the region because of the increase in capital inflows they would receive. If the depreciation is due to monetary easing, however, this has a positive impact on the Japanese economy, but is broadly neutral for the region because the positive effect on growth in Japan offsets the loss of competitiveness from the yen's depreciation.

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<sup>13</sup> This is stressed in Chapter 6 of McKibbin and Sachs (1991) with respect to the debate in the mid-1980s on policies to force down the strong U.S. dollar.

### A STYLIZED TWO-COUNTRY G-CUBED MODEL

A stylized two-country model is presented below which distills the essence of the G-Cubed model and in particular how the intertemporal aspects of the model are handled. Greater detail is provided in McKibbin and Wilcoxon (1998).

Each country consists of several economic agents: households, the government, the financial sector, and two firms, one each in the two production sectors. The two sectors of production are energy and non-energy. The following gives an overview of the theoretical structure of the model by describing the decisions facing these agents in one of the countries. Throughout the discussion all quantity variables will be normalized by the economy's endowment of effective labor units. Thus, the model's long run steady state will represent an economy in a balanced growth equilibrium.

#### Firms

It is assumed that each of the two sectors can be represented by a price-taking firm which chooses variable inputs and its level of investment in order to maximize its stock market value. Each firm's production technology is represented by a constant elasticity of substitution (CES) function. Output is a function of capital, labor, energy and materials:

$$Q_i = A_i^o \left( \sum_{j=k,l,e,m} (\delta_{ij}^o)^{1/\sigma_i^o} x_{ij}^{(\sigma_i^o-1)/\sigma_i^o} \right)^{\sigma_i^o/(\sigma_i^o-1)} \quad (1)$$

where  $Q_i$  is the output of industry  $i$ ,  $x_{ij}$  is industry  $i$ 's use of input  $j$ , and  $A_i^o$ ,  $\delta_{ij}^o$ , and  $\sigma_i^o$  are parameters.  $A_i^o$  reflects the level of technology,  $\sigma_i^o$  is the elasticity of substitution, and the  $\delta_{ij}^o$  parameters reflect the weights of different inputs in production; the superscript  $o$  indicates that the parameters apply to the top, or "output", tier. Without loss of generality, the  $\delta_{ij}^o$  s are constrained to sum to one.

The goods and services purchased by firms are, in turn, aggregates of imported and domestic commodities which are taken to be imperfect substitutes. It is assumed that all agents have identical preferences over foreign and domestic varieties of each commodity. Preferences are represented by defining composite commodities that are produced from imported and domestic goods. Each of these commodities,  $Y_i$ , is a CES function of inputs, domestic output,  $Q_i$ , and an aggregate of goods imported from all of the country's trading partners,  $M_i$ :

$$y_i = A_i^{fd} \left( (\delta_{id}^{fd})^{1/\sigma_i^{fd}} Q_i^{(\sigma_i^{fd}-1)/\sigma_i^{fd}} + (\delta_{if}^{fd})^{1/\sigma_i^{fd}} M_i^{(\sigma_i^{fd}-1)/\sigma_i^{fd}} \right)^{\sigma_i^{fd}/(\sigma_i^{fd}-1)} \quad (2)$$

where  $\sigma_i^{fd}$  is the elasticity of substitution between domestic and foreign goods. For example, the energy product purchased by agents in the model are a composite of imported and domestic energy. The aggregate imported good,  $M_i$ , is itself a CES composite of imports from individual countries,  $M_{ic}$ , where  $c$  is an index indicating the country of origin:

$$M_i = A_i^{ff} \left( \sum_{c=1}^7 (\delta_{ic}^{ff})^{1/\sigma_i^{ff}} M_{ic}^{(\sigma_i^{ff}-1)/\sigma_i^{fd}} \right)^{\sigma_i^{ff}/(\sigma_i^{ff}-1)} \quad (3)$$

The elasticity of substitution between imports from different countries is  $\sigma_i^{ff}$ .

By constraining all agents in the model to have the same preferences over the origin of goods, it is required that, for example, the agricultural and service sectors have identical preferences over domestic oil and imported oil.<sup>14</sup> This accords with the input-output data used, and allows a very convenient nesting of production, investment and consumption decisions.

In each sector the capital stock changes according to the rate of fixed capital formation ( $J_i$ ) and the rate of geometric depreciation ( $\delta_i$ ):

$$\dot{k}_i = J_i - \delta_i k_i \quad (4)$$

Following the cost of adjustment models of Lucas (1967), Treadway (1969) and Uzawa (1969), the investment process is assumed to be subject to rising marginal costs of installation. To formalize this, Uzawa's approach is adopted by assuming that in order to install  $J$  units of capital a firm must buy a larger quantity,  $I$ , that depends on its rate of investment ( $J/k$ ):

$$I_i = \left( 1 + \frac{\phi_i J_i}{2 k_i} \right) J_i \quad (5)$$

where  $\phi_i$  is a non-negative parameter. The difference between  $J$  and  $I$  may be interpreted various ways; here it is viewed as installation services provided by the capital-goods vendor. Differences in the sector-specificity of capital in different industries will lead to differences in the value of  $\phi_i$ .

The goal of each firm is to choose its investment and inputs of labor, materials and energy to maximize intertemporal net-of-tax profits. For analytical tractability, it is assumed

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<sup>14</sup> This does not require that both sectors purchase the same amount of oil, or even that they purchase oil at all; only that they both feel the same way about the origins of oil they buy.

that this problem is deterministic (equivalently, the firm could be assumed to believe its estimates of future variables with subjective certainty). Thus, the firm will maximize:<sup>15</sup>

$$\int_t^{\infty} (\pi_i - (1-\tau_4) p^I I_i) e^{-(R(s)-n)(s-t)} ds \quad (6)$$

where all variables are implicitly subscripted by time. The firm's profits,  $\pi$ , are given by:

$$\pi_i = (1-\tau_2)(p_i^* Q_i - w_i x_{il} - p_i^e x_{ie} - p_i^m x_{im}) \quad (7)$$

where  $\tau_2$  is the corporate income tax,  $\tau_4$  is an investment tax credit, and  $p^*$  is the producer price of the firm's output.  $R(s)$  is the long-term interest rate between periods  $t$  and  $s$ :

$$R(s) = \frac{1}{s-t} \int_t^s r(v) dv \quad (8)$$

Because all real variables are normalized by the economy's endowment of effective labor units, profits are discounted adjusting for the rate of growth of population plus productivity growth,  $n$ . Solving the top tier optimization problem gives the following equations characterizing the firm's behavior:

$$x_{ij} = \delta_{ij}^{\sigma} (A_i^{\sigma})^{\sigma_i^{\sigma} - 1} Q_i \left( \frac{p_i^*}{p_j} \right)^{\sigma_i^{\sigma}} \quad j \in \{l, e, m\} \quad (9)$$

$$\lambda_i = (1 + \phi_i \frac{J_i}{k_i}) (1 - \tau_4) p^I \quad (10)$$

$$\frac{d\lambda_i}{ds} = (r + \delta_i) \lambda_i - (1 - \tau_2) p_i^* \frac{dQ_i}{dk_i} - (1 - \tau_4) p^I \frac{\phi_i}{2} \left( \frac{J_i}{k_i} \right)^2 \quad (11)$$

where  $\lambda_i$  is the shadow value of an additional unit of investment in industry  $i$ .

Equation (9) gives the firm's factor demands for labor, energy, and materials, and equations (10) and (11) describe the optimal evolution of the capital stock. Integrating (11)

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<sup>15</sup> The rate of growth of the economy's endowment of effective labor units,  $n$ , appears in the discount factor because the quantity and value variables in the model have been scaled by the number of effective labor units. These variables must be multiplied by  $\exp(nt)$  to convert them back to their original form.

along the optimum trajectory of investment and capital accumulation,  $(\hat{J}(t), \hat{k}(t))$  gives the following expression for  $\lambda_i$  :

$$\lambda_i(t) = \int_t^{\infty} \left( (1-\tau_2) p_i^* \frac{dQ_i}{dk_i} \Big|_{j,\hat{k}} + (1-\tau_4) p^I \frac{\phi_i}{2} \left( \frac{\hat{J}_i}{\hat{k}_i} \right)^2 \right) e^{-(R(s)+\delta)(s-t)} ds \quad (12)$$

Thus,  $\lambda_i$ , is equal to the present value of the after-tax marginal product of capital in production (the first term in the integral) plus the savings in subsequent adjustment costs it generates. It is related to  $q$ , the after-tax marginal version of Tobin's Q, as follows:

$$q_i = \frac{\lambda_i}{(1-\tau_4) p^I} \quad (13)$$

Thus, (10) can be rewritten as:

$$\frac{J_i}{k_i} = \frac{1}{\phi_i} (q_i - 1) \quad (14)$$

Inserting this into (5) gives total purchases of new capital goods:

$$I_i = \frac{1}{2\phi_i} (q_i^2 - 1) k_i \quad (15)$$

Based on Hayashi (1979), who showed that actual investment seems to be partly driven by cash flows, (15) is modified by writing  $I_i$  as a function not only of  $q$ , but also of the firm's current cash flow at time  $t$ ,  $\pi_i$ , adjusted for the investment tax credit:

$$I_i = \alpha_2 \frac{1}{2\phi_i} (q_i^2 - 1) k_i + (1-\alpha_2) \frac{\pi_i}{(1-\tau_4) p^I} \quad (16)$$

This improves the model's ability to mimic historical data and is consistent with the existence of firms that are unable to borrow and therefore invest purely out of retained earnings.

Investment goods are supplied by a third industry that combines labor and the outputs of other industries to produce raw capital goods. This firm is assumed to face an optimization problem identical to those of the other two industries: it has a nested CES production function, uses inputs of capital, labor, energy and materials in the top tier, incurs adjustment costs when changing its capital stock, and earns zero profits. The key difference between it and the other sector is that the investment column of the input-output table is used to estimate its production parameters.

## Households

Households have three distinct activities in the model: they supply labor, they save, and they consume goods and services. Within each region, it is assumed that household behavior can be modeled by a representative agent with an intertemporal utility function of the form:

$$U_t = \int_t^{\infty} (\ln c(s) + \ln g(s)) e^{-\theta(s-t)} ds \quad (17)$$

where  $c(s)$  is the household's aggregate consumption of goods and services at time  $s$ ,  $g(s)$  is government consumption at  $s$ , which we take to be a measure of public goods provided, and  $\theta$  is the rate of time preference.<sup>16</sup> The household maximizes (17) subject to the constraint that the present value of consumption is equal to the sum of human wealth,  $H$ , and initial financial assets,  $F$ :<sup>17</sup>

$$\int_t^{\infty} p^c(s) c(s) e^{-(R(s)-n)(s-t)} = H_t + F_t \quad (18)$$

Human wealth is defined as the expected present value of the future stream of after-tax labor income plus transfers:

$$H_t = \int_t^{\infty} (1 - \tau_1) (W(L^G + L^C + L^I + \sum_{i=1}^{12} L^i) + TR) e^{-(R(s)-n)(s-t)} ds \quad (19)$$

where  $\tau_1$  is the tax rate on labor income,  $TR$  is the level of government transfers,  $L^C$  is the quantity of labor used directly in final consumption,  $L^I$  is labor used in producing the investment good,  $L^G$  is government employment, and  $L^i$  is employment in sector  $i$ . Financial wealth is the sum of real money balances,  $MON/P$ , real government bonds in the hand of the public,  $B$ , net holding of claims against foreign residents,  $A$ , and the value of capital in each sector:

$$F = \frac{MON}{p} + B + A + q^I k^I + q^C k^C + \sum_{i=1}^{12} q^i k^i \quad (20)$$

<sup>16</sup> This specification imposes the restriction that household decisions on the allocations of expenditure among different goods at different points in time are separable.

<sup>17</sup> As before,  $n$  appears in (18) because the model's scaled variables must be converted back to their original basis.

Solving this maximization problem gives the familiar result that aggregate consumption spending is equal to a constant proportion of private wealth, where private wealth is defined as financial wealth plus human wealth:

$$p^c c = \theta (F + H) \quad (21)$$

However, based on the evidence cited by Campbell and Mankiw (1987) and Hayashi (1982) we assume some consumers are liquidity-constrained and consume a fixed fraction,  $\gamma$ , of their after-tax income (*INC*).<sup>18</sup> Denoting the share of consumers who are not constrained and choose consumption in accordance with (21) by  $\alpha_8$ , total consumption expenditure is given by:

$$p^c c = \alpha_8 \theta (F_t + H_t) + (1 - \alpha_8) \gamma \text{INC} \quad (22)$$

The share of households consuming a fixed fraction of their income could also be interpreted as permanent income behavior in which household expectations about income are myopic.

Once the level of overall consumption has been determined, spending is allocated among goods and services according to a CES utility function.<sup>19</sup> The demand equations for capital, labor, energy, and materials can be shown to be:

$$p_i x_i^c = \delta_i^c y \left( \frac{p^c}{p_i} \right)^{\sigma_c^o - 1}, \quad i \in \{k, l, e, m\} \quad (23)$$

where  $y$  is total expenditure,  $x_i^c$  is household demand for good  $i$ ,  $\sigma_c^o$  is the top-tier elasticity of substitution, and the  $\delta_i^c$  are the input-specific parameters of the utility function. The price index for consumption,  $p^c$ , is given by:

$$p^c = \left( \sum_{j=k,l,e,m} \delta_j^c p_j^{\sigma_c^o - 1} \right)^{\frac{1}{\sigma_c^o - 1}} \quad (24)$$

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<sup>18</sup> One side effect of this specification is that it prevents the computation of equivalent variation. Since the behavior of some of the households is inconsistent with (21), either because the households are at corner solutions or for some other reason, aggregate behavior is inconsistent with the expenditure function derived from the utility function.

<sup>19</sup> The use of the CES function has the undesirable effect of imposing unitary income elasticities, a restriction usually rejected by data. An alternative would be to replace this specification with one derived from the linear expenditure system.

Household capital services consist of the service flows of consumer durables plus residential housing. The supply of household capital services is determined by consumers themselves who invest in household capital,  $k^c$ , in order to generate a desired flow of capital services,  $c^k$ , according to the following production function:

$$c^k = \alpha k^c \quad (25)$$

where  $\alpha$  is a constant. Accumulation of household capital is subject to the condition:

$$\dot{k}^c = J^c - \delta^c k^c \quad (26)$$

It is assumed that changing the household capital stock is subject to adjustment costs so household spending on investment,  $I^c$ , is related to  $J^c$  by:

$$I^c = \left( 1 + \frac{\phi^c}{2} \frac{J^c}{k^c} \right) J^c \quad (27)$$

Thus, the household's investment decision is to choose  $I^c$  to maximize:

$$\int_t^{\infty} (p^{ck} \alpha k^c - p^I I^c) e^{-(R(s)-n)(s-t)} ds \quad (28)$$

where  $p^{ck}$  is the imputed rental price of household capital. This problem is nearly identical to the investment problem faced by firms and the results are very similar. The only important differences are that no variable factors are used in producing household capital services and there is no investment tax credit for household capital. Given these differences, the marginal value of a unit of household capital,  $\lambda_c$ , can be shown to be:

$$\lambda_c(t) = \int_t^{\infty} \left( p^{ck} \alpha + p^I \frac{\phi_c}{2} \left( \frac{\hat{J}_c}{\hat{k}_c} \right)^2 \right) e^{-(R(s)+\delta)(s-t)} ds \quad (29)$$

where the integration is done along the optimal path of investment and capital accumulation,  $(\hat{J}_c(t), \hat{k}_c(t))$ . Marginal  $q$  is:

$$q_c = \frac{\lambda_c}{p^I} \quad (30)$$

and investment is given by:

$$\frac{J_c}{k_c} = \frac{1}{\phi_c} (q_c - 1) \quad (31)$$

### The Labor Market

Labor is assumed to be perfectly mobile among sectors within each region, but is immobile between regions. Thus, wages will be equal across sectors within each region, but will generally not be equal between regions. In the long run, labor supply is completely inelastic and is determined by the exogenous rate of population growth. Long run wages adjust to move each region to full employment. In the short run, however, nominal wages are assumed to adjust slowly according to an overlapping contracts model where wages are set based on current and expected inflation and on labor demand relative to labor supply. The equation below shows how wages in the next period depend on current wages; the current, lagged and expected values of the consumer price level; and the ratio of current employment to full employment:

$$w_{t+1} = w_t \left( \frac{p_{t+1}^c}{p_t^c} \right)^{\alpha_5} \left( \frac{p_t^c}{p_{t-1}^c} \right)^{1-\alpha_5} \left( \frac{L_t}{\bar{L}} \right)^{\alpha_6} \quad (32)$$

The weight that wage contracts attach to expected changes in the price level is  $\alpha_5$  while the weight assigned to departures from full employment ( $\bar{L}$ ) is  $\alpha_6$ . Equation (32) can lead to short-run unemployment if unexpected shocks cause the real wage to be too high to clear the labor market. At the same time, employment can temporarily exceed its long run level if unexpected events cause the real wage to be below its long run equilibrium.

### The Government

Each region's real government spending on goods and services is exogenous and assumed to be allocated among inputs in fixed proportions, which are set to 1996 values. Total government outlays include purchases of goods and services plus interest payments on government debt, investment tax credits, and transfers to households. Government revenue comes from sales taxes and corporate and personal income taxes, while the government can also sell new bonds. The government budget constraint may be written in terms of the accumulation of public debt as follows:

$$\dot{B}_t = D_t = r_t B_t + G_t + TR_t - T_t \quad (33)$$

where  $B$  is the stock of debt,  $D$  is the budget deficit,  $G$  is the total government spending on goods and services,  $TR$  is transfer payments to households, and  $T$  is total tax revenue net of any investment tax credit.

It is assumed that agents will not hold government bonds unless they expect them to eventually be paid off, and accordingly impose the following transversality condition:

$$\lim_{s \rightarrow \infty} B(s) e^{-(R(s)-n)s} = 0 \quad (34)$$

This prevents per capita government debt from growing faster than the interest rate forever. If the government is fully leveraged at all times, (34) allows (33) to be integrated to give:

$$B_t = \int_t^{\infty} (T - G - TR) e^{-(R(s)-n)(s-t)} ds \quad (35)$$

Thus, the current level of debt will always be exactly equal to the present value of future budget surpluses.<sup>20</sup>

The implication of (35) is that a government running a budget deficit today must run an appropriate budget surplus at some point in the future, otherwise the government would be unable to pay interest on the debt and agents would not be willing to hold it. To ensure that (35) holds at all points in time, it is assumed that the government levies a lump sum tax in each period equal to the value of interest payments on the outstanding debt.<sup>21</sup> In effect, therefore, any increase in government debt is financed by consols, and future taxes are raised sufficiently to accommodate the increased interest costs. Other fiscal closure rules are also possible; for example, requiring the ratio of government debt to GDP to be unchanged in the long run.

### Financial Markets and the Balance of Payments

The regions in the model are linked by flows of goods and assets. Flows of goods are determined by the import demands described above. These demands can be summarized in a set of bilateral trade matrices which give the flows of each good between exporting and importing countries. Trade imbalances are financed by flows of assets between countries. Each region with a current account deficit will have a matching capital account surplus, and vice versa.<sup>22</sup> Asset markets are assumed to be perfectly integrated across regions. With free mobility of capital, expected returns on loans denominated in the currencies of the various regions must be equalized period to period according to a set of interest arbitrage relations of the following form:

$$i_k + \mu_k = i_j + \mu_j + \frac{\dot{E}_k^j}{E_k^j} \quad (36)$$

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<sup>20</sup> Strictly speaking, public debt must be less than or equal to the present value of future budget surpluses. For tractability it is assumed that the government is initially fully leveraged so that this constraint holds with equality.

<sup>21</sup> In the model the tax is actually levied on the difference between interest payments on the debt and what interest payments would have been if the debt had remained at its base case level. The remainder, interest payments on the base case debt, are financed by ordinary taxes.

<sup>22</sup> Global net flows of private capital are constrained to be zero at all times—the total of all funds borrowed exactly equals the total funds lent. As a theoretical matter this may seem obvious, but it is often violated in international financial data.

where  $i_k$  and  $i_j$  are the interest rates in countries  $k$  and  $j$ ,  $\mu_k$  and  $\mu_j$  are exogenous risk premiums demanded by investors (calibrated in the baseline to make the model condition hold exactly with actual data), and  $E_k^j$  is the exchange rate between the currencies of the two countries.

Capital flows may take the form of portfolio investment or direct investment, but it is assumed that these are perfectly substitutable *ex ante*, adjusting to the expected rates of return across economies and across sectors. Within each economy, the expected returns to each type of asset are equated by arbitrage, taking into account the costs of adjusting the physical capital stock and allowing for exogenous risk premiums. However, because physical capital is costly to adjust, any inflow of financial capital that is invested in physical capital will also be costly to shift once it is in place. This means that unexpected events can cause windfall gains and losses to owners of physical capital and *ex post* returns can vary substantially across countries and sectors. For example, if a shock lowers profits in a particular industry, the physical capital stock in the sector will initially be unchanged, but its financial value will drop immediately.

### Money Demand

Finally, money enters the model via a constraint on transactions.<sup>23</sup> A money demand function is used in which the demand for real money balances is a function of the value of aggregate output and short-term nominal interest rates:

$$MON = PY_i^\varepsilon \quad (37)$$

where  $Y$  is aggregate output,  $P$  is a price index for  $Y$ ,  $i$  is the interest rate, and  $\varepsilon$  is the interest elasticity of money demand. The supply of money is determined by the balance sheet of the central bank and is exogenous.

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<sup>23</sup> Unlike other components of the model, this is assumed rather than derived from optimizing behavior. Money demand can be derived from optimization under various assumptions: money gives direct utility; it is a factor of production; or it must be used to conduct transactions. The distinctions are unimportant for our purposes.

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