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STRUCTURAL REFORM, INTRA-REGIONAL TRADE, AND MEDIUM-TERM GROWTH PROSPECTS OF EAST ASIA AND THE PACIFIC

--- PERSPECTIVES FROM A NEW MULTI-REGION MODEL

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Abstract

This paper analyses the potential benefits from reforms aimed at promoting domestic demand in the region, as well as the effects of slower growth in the United States and the G3 on EMEAP economies.[1] The analysis is based on simulation scenarios using an expanded version of the IMF Global Integrated Monetary and Fiscal (GIMF) model. The GIMF model is particularly useful for conducting medium-term policy analysis, because it incorporates rich layers of intra-regional trade, production, and demand that allow the transmission mechanism of structural reforms and external shocks to be fully articulated. The simulation results show that reforms to rebalance the pattern of demand in regional economies (such as Mainland China) more towards domestic demand could entail non-negligible benefits for the EMEAP. These benefits could be even larger for those economies that more flexibly adjust to the shift in China's trade pattern. The simulation results also illustrate structural reforms in EMEAP economies will allow them to reduce vulnerabilities to economic downturns in the major advanced economies.

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[1] EMEAP is the abbreviation of the Executives' Meeting of East Asian-Pacific Central Banks. Founded in 1991, EMEAP is a cooperative organisation of central banks and monetary authorities in the East Asia and Pacific region. It comprises central banks and monetary authorities of the following eleven economies: Australia, China, Hong Kong, Indonesia, Japan, Korea, Malaysia, New Zealand, Philippines, Singapore, and Thailand.

Executive Summary:

- *The GIMF model is a dynamic stochastic general equilibrium model with overlapping generations developed at the IMF and documented in Kumhof and Laxton (2008). The GIMF integrates domestic supply, demand, trade, and international asset markets in a single theoretical structure, thereby allowing transmission mechanisms to be fully articulated. The model is well suited for analysing monetary, fiscal, and structural policies as well as the regional implications of such policies and the transmission of other shocks.*

- *This paper captures EMEAP's increased regional integration by extending the GIMF to include eight economic blocks, five of which are EMEAP economies. The calibration uses actual 2006 data and information from existing literature. In particular, bilateral trade linkages are calibrated using the United Nation's COMTRADE database. Trade is disaggregated into intermediary and final goods, with the latter further broken down into consumption and investment goods. Disaggregating the trade matrix enables us to better capture the regional transmission of shocks.*

- *This paper uses the extended GIMF model to analyse the impact of slower growth in the United States and the G3 on EMEAP economies, and the potential benefits from reforms aimed at promoting domestic demand in the region. The simulation results show that a one percentage point decline in growth in the United States or the G3 could lower growth in EMEAP and China by a quarter percentage points to as much as two full percentage points, depending on monetary policy responses, the degree of exchange rate flexibility, and whether the slowdown is accompanied with financial disruptions. The results also indicate wide disparities across countries, with smaller spillovers for Australia-New Zealand, Japan, and South Korea.*

- *With regard to the potential benefits from reforms aimed at promoting domestic demand in the region, we consider the case of a demand rebalancing scenario in China. The scenario assumes that: (i) the share of the non-tradable sector in GDP reaches 50 per cent after 10 years, the same level as in South Korea; (2) additional government spending on health, education, and other social transfers lifts the ratios of government spending and transfers to GDP by 1½ and 1 percentage points, respectively; (3) further reforms of the domestic financial market reduce the share of households without access to financial markets by 10 percentage points; and (4) improved social services and better access to financial markets reduce households' precautionary savings. The simulation results show that such reforms could entail non-negligible benefits for the EMEAP economies. The benefits could be even larger for those economies that more flexibly adjust to the shift in China's trade pattern.*

I. INTRODUCTION

Emerging Asia is generally considered vulnerable to external shocks because of its heavy dependence on exports. However, stellar growth and rapid expansion of intra-regional trade in recent years have prompted some economists to argue that the region has become more resilient to shocks emanating from major economies. In particular, some studies argue that Mainland China (China hereafter) is a major driver of growth in the region. Other studies (MAS, ADB, and IMF 2007), however, point out that while intra-regional trade linkages have increased in recent years, about two thirds of the trade flows still consist of intermediary goods, assembled in China and shipped to markets mostly outside the region. In particular, HKMA (2008a) finds that for Korea, the Philippines, Singapore, Thailand and Malaysia, roughly half their total exports to China in 2006 were used as inputs for exports to other countries. The analyses also point to emerging Asia's increased integration in the global financial system as a potential source of exposure of the region to external shocks (He et al. 2007 and HKMA 2008b).

In this context, reforms that promote domestic demand in regional economies could mitigate the negative spillover effects from protracted slowdown in major developed economies, although the benefits of such reforms may take time to materialise. Rebalancing of the sources of demand could also have a positive impact on other economies in the region (He et al. 2007). Blanchard and Giavazzi (2005) and Lardy (2007) prescribed a three-handed reform package for China which includes lowering households' savings rate, allowing the renminbi to appreciate, and reducing or reallocating investment away from the tradable sector.

This paper simulates spillover effects from external shocks and structural reform in the region. It does so by extending the Global Integrated Monetary and Fiscal (GIMF) model to include eight economic blocks, five of which are EMEAP economies.[2] The GIMF model is a dynamic stochastic general equilibrium multi-country model with overlapping generations, and can be used to conduct short-term as well as medium-term policy analysis.

The model has some unique features that make it suitable for policy analysis of EMEAP economies. It is built with a stratified multilateral trade matrix, which can be calibrated to reflect intra-regional trade flows among EMEAP economies at the levels of intermediate, consumption and investment goods.

[2] The version of the GIMF used for this exercise has eight country-blocks, namely Australia-New Zealand, China, euro area, Japan, Korea, rest of EMEAP, rest of the world, and the US.

The model also incorporates rich layers of supply and demand. For example, production is not simplified into one giant production function that generates final output using labor and capital. Rather, the production process is broken down into manufacturing of intermediate goods, distribution of intermediate goods to domestic and foreign assemblers, and final production of consumption and investment goods. Consumption and investment goods are then sold to consumers through retailers and to investors and the government. This production structure thereby allows transmission mechanisms of external shocks or structural reforms to be fully articulated.

Simulations of a protracted US and G3 slowdown show significant adverse effects on growth in EMEAP, with the size of the spillovers depending in particular on the economies' openness, net foreign position, and financial market development.

Simulations of a successful implementation by the Chinese government of its 11th five-year plan to achieve a balanced and sustainable growth going forward indicate that such reforms could entail non-negligible output gains for the region. China's imports of consumption goods would likely rise, while its demand for intermediary goods would likely fall. Regional economies that more flexibly adjust to this likely shift in China's trade pattern would hence benefit more.

The rest of this paper is organised as follows: section II gives a brief non-technical overview of the GIMF model; section III presents the key equations of the model; section IV describes the calibration of the model parameters; Section V discusses the main results of the simulation scenarios considered; and section VI concludes.

II. THE STRUCTURE OF THE GIMF

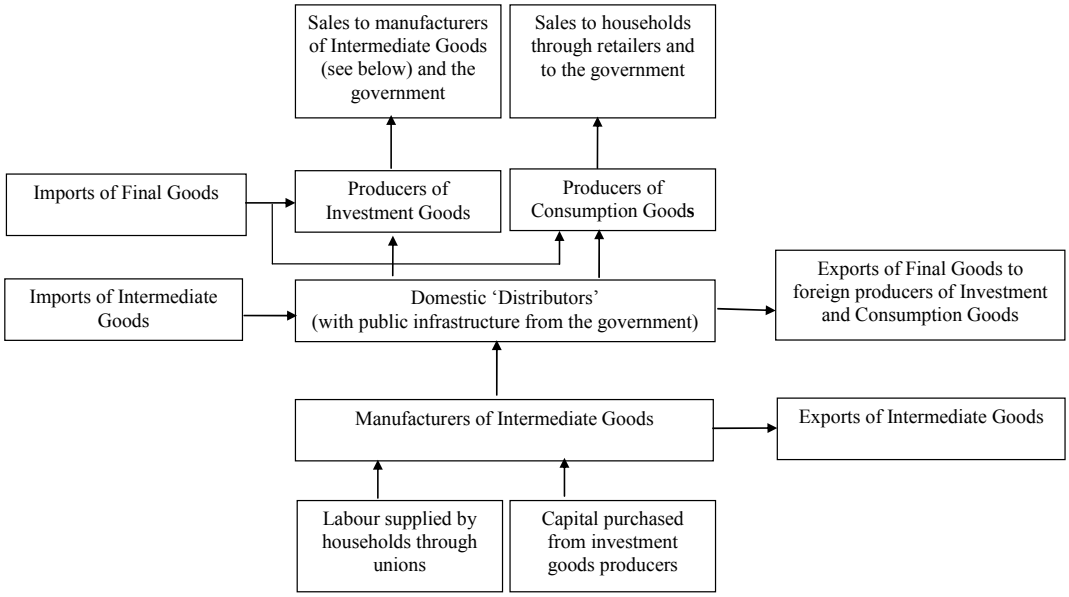
The GIMF model, developed at the IMF and documented in Kumhof and Laxton (2008), has been widely used at the IMF in background papers during Article IV consultations.[3] The model integrates domestic supply, demand, trade, and international asset markets in a single theoretical structure, thereby allowing transmission mechanisms to be fully articulated. It is well suited for analysing the effects of monetary policy, fiscal policy, and structural reforms, as well as the global and regional implications of these policies and other events.

[3] See, for example, IMF (2008a), and Kumhof and Laxton (2007).

The GIMF divides an economy into ten sectors that allows a more detailed exploration of the interaction between sectors and the transmission of shocks and effects of policies. There are wide-ranging nominal and real rigidities at the sectoral level generating realistic inertial dynamics for the key macroeconomic aggregates. Unions, manufacturers, and distributors face nominal rigidity in price setting, while retailers and importers are subject to real rigidities as it is costly to rapidly adjust their sales volume. Manufacturers are also subject to real rigidity in capital accumulation.

Each economy is populated with two types of households, overlapping generations (OLG) households and liquidity constrained (LIQ) households. The main difference between these two types of households is that latter do not have access to financial markets, and hence are forced to consume their after tax income every period. Both types of households consume retailed outputs and supply labor to unions. Unions buy labor services and sell them to manufacturers at a premium, while manufactures purchase investment goods from distributors and combine them with labour to produce tradable and non-tradable goods. The manufacturing goods, which serve as inputs in the production of final goods, are sold to domestic distributors and imports agents who operate in foreign economies—this is the first layer of multilateral trade (intermediary goods). Distributors combine domestic and foreign-produced tradable goods with public infrastructure to produce an output that will be used in the production of domestic consumption and investment goods, and will be exported abroad—this is the second layer of multilateral trade (final goods). Investment goods producers sell their final composite to manufacturers and the government; consumption goods producers sell their final composite to the government and retailers, who in turn sell their output to households. A simplified flowchart of the sectors is shown in Figure 1.

Figure 1: A Schematic Representation of the Production Structure in a Representative Economy



While goods and factor markets are modeled with considerable detail in the GIMF, the specification of asset markets is relatively limited. There is home bias in government debt, which takes the form of nominally non-contingent one–period bonds denominated in domestic currency. The only assets traded internationally are nominally non-contingent one-period bonds denominated in US dollars. Equity from non-financial corporations is not traded in domestic financial markets, instead households receive lump-sum dividend payments out of firms' profits.

Monetary policy can be characterised in various ways, including a clear commitment to stabilising output growth and inflation under a flexible exchange rate regime or under a managed float exchange rate regime where smoothing exchange rate fluctuations becomes an additional objective of monetary policy. Monetary policy can also be entirely devoted to stabilising the exchange rate under a fixed rate regime. In the model, the policy instrument is the short-term interest rate. Monetary policy matters because of a wide range of nominal rigidities. These nominal rigidities are compounded by real rigidities in labor hiring, capital investment, imports of investment and consumption goods, distribution, and retail.

For fiscal policy analysis, the model has four key assumptions that imply non-Ricardian features, making fiscal policy matter both in the short term and in the longer term: (i) households have finite economic lifetime which makes them incorporate in their spending decisions only the effects of fiscal policies that

are likely to occur during their lifetime; (ii) some of the households are liquidity constrained and are forced to consume all their after-tax income every period; (iii) households' labour productivity declines with age, which implies a higher discount rate for future labour income tax than otherwise; and (iv) labour and consumption taxes are distortionary because they affect labour effort and spending behavior. Fiscal policy aims at stabilising the debt-to-GDP ratio over the long term by controlling spending or levying taxes. Public spending on investment is productive, providing longer-term output benefits. Governments levy lump-sum taxes, a consumption tax, a labor income tax, and a capital income tax.

With regard to structural reforms, the model's wide range of rigidities in labor and product markets, which could reflect barriers to competition, imply that prices are higher than they would be under a more competitive environment (prices are at a markup over marginal costs in these markets). These features are useful for analysing the effects of removing or reducing rigidities in labour and product markets, often an outcome of structural reform.

The GIMF model used in this paper includes eight regions: the US, euro area, and Japan (about 60 per cent of the world GDP), China, Korea, EMEAP6[4], and Australia and New Zealand (treated as one block because of their large commodity production). All the other economies are represented in the block of the rest of the world.

It should be noted that economies lumped together into one block are by no means homogenous. In fact, these economies differ significantly in monetary, exchange rate and fiscal policies, not to mention the relatively subtle differences in their economic structures. Theoretically, these economies could be represented individually in the model given the malleability of the GIMF. However, each block in the model is described with hundreds of parameters and equations, adding an extra block would require an enormous amount of resources for the calibration and simulation. This eight-region GIMF is an initial effort to apply this model to the region and demonstrates how it can be used to facilitate policy analysis of regional and global issues. Further extension and fine-tuning of the model is left for future research.

[4] EMEAP6 includes Hong Kong, Indonesia, Malaysia, the Philippines, Singapore, and Thailand. The six economies are grouped together largely because of the similarity in their trade structure and their position in the vertical specialisation of production in the region.

II. KEY EQUATIONS OF THE GIMF[5]

The behaviour of the ten sectors is sketched out below. Block indices are ignored except when interactions between two economies are concerned. All parameters except population and technology growth can differ across economies.

A. Households

1. Overlapping Generations Households

Overlapping generations households are modelled following Blanchard (1985) with habit persistence. A representative member of this group of age a derives utility at time t from consumption $c_{a,t}^{OLG}$ relative to the consumption habit $h_{a,t}^{OLG}$, leisure $(S_t^L - \ell_{a,t}^{OLG})$ (where S_t^L denotes the stochastic time endowment) and real cash balances $(M_{a,t}/P_t^R)$ (where P_t^R is the retail price index). The consumption habit is defined as:

$$h_{a,t}^{OLG} = \left(\frac{c_{t-1}^{OLG} g_t}{N n^{t-1} (1-\psi)} \right)^{v},$$

where v, c_t^{OLG}, ψ, N, n and g_t denote the degree of habit persistence, aggregate consumption of OLG households across ages at time t, the share of liquidity constrained households in total population, the absolute population size in period 0, world population growth rate and world economy growth rate respectively.

Households hold domestic government bonds $B_{a,t}$ denominated in domestic currency, and foreign bonds denominated in the currency of country $\tilde{N}$, $F_{a,t}$. The nominal exchange rate vis-à-vis $\tilde{N}$ is denoted by $\mathbf{E}_t$ with $\varepsilon_t = \mathbf{E}_t / \mathbf{E}_{t-1}$. Households' labour productivity declines throughout their lifetime, with productivity $\Phi_{a,t} = \Phi_a$ of age group a given by:

$$\Phi_a = \kappa \chi^a,$$

where $\chi < 1$. Households also receive labour and dividend income. Dividends are paid in a lump-sum fashion by all firms in the non-tradable (N) and tradable (T)

[5] This section draws heavily from Kumhof and Laxton (2008).

manufacturing sectors, from the distribution (D), consumption goods distribution (C) and investment goods distribution (I) sectors, from the retail (R) sector and the import agent (M) sector, and from all unions (U) in the labor market, with after-tax nominal dividends received from firm/union i denoted by $D_{a,t}^{j}(i)$, $j = N,T,D,C,I,R,U,M$. OLG households are liable to pay lump-sum transfers $\tau_{T_{a,t}}^{OLG}$ to the government. These transfers are then redistributed by the government to the relatively less wealthy LIQ agents. Households' labour income is taxed at the rate $\tau_{L,t}$, and consumption is taxed at the rate $\tau_{c,t}$. In addition, there are lump-sum taxes $\tau_{a,t}^{ls}$ and transfers $\Upsilon_{a,t}$ paid to/from the government. The first-order conditions for the OLG households read[6]

$$\breve{c}_t^{OLG}(i) = \left(\frac{P_t^R(i)}{P_t^R} \right)^{-\sigma_R} \breve{c}_t^{OLG}, \tag{2}$$

$$\frac{\breve{c}_t^{OLG}}{N(1-\psi)S_t^L - \breve{\ell}_t^{OLG}} = \frac{\eta^{OLG}}{1-\eta^{OLG}} \breve{w}_t \frac{(1-\tau_{L,t})}{(p_t^R + \tau_{c,t})}. \tag{3}$$

where σ_R denotes the elasticity of substitution between consumption goods varieties. The arbitrage condition for foreign currency bonds (the uncovered interest parity relation) turns out to be

$$i_t = i_t(\widetilde{N}) \widetilde{E}_t \varepsilon_{t+1} (1 + \xi_t^f). \tag{4}$$

In the above equations, $P_t^R(i)$, w_t, $\tau_{L,t}$, $\tau_{c,t}$ denote the retail price of variety i, real household wage $\frac{W_t}{P_t}$ (W_t denotes nominal household wage), labor tax rate and consumption tax rate, respectively. i_t, $i_t(\widetilde{N})$, and ξ_t^f denote domestic gross nominal interest rate, nominal interest rate of $\widetilde{N}$, and foreign exchange risk premium respectively.

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[6] The GIMF assumes a constant positive trend growth for the world economy $g_t = T_t / T_{t-1}$ with T_t being the level of labor augmenting world technology. The notation $\breve{x}$ is defined as $\breve{x} = x_t / (T_t n^t)$. The relative price of any good x is given by $p_t^x = P_t^x / P_t$, and gross inflation for any good x is given by $\pi_t^x = P_t^x / P_{t-1}^x$. In addition, E in the model denotes the expectation assuming certainty equivalence.

2. Liquidity Constrained Households

The optimisation problem of LIQ households is similar to that of OLG households except that LIQ households do not hold financial assets. Their first-order conditions are

$$\breve{c}_t^{LIQ}(i) = \left(\frac{P_t^R(i)}{P_t^R} \right)^{-\sigma_R} \breve{c}_t^{LIQ} ,$$

$$\frac{\breve{c}_t^{LIQ}}{N\psi S_t^L - \breve{\ell}_t^{LIQ}} = \frac{\eta^{LIQ}}{1-\eta^{LIQ}} \breve{w}_t \frac{(1-\tau_{L,t})}{(p_t^R + \tau_{c,t})} .$$

Aggregate household consumption and employment are given by the following equations:

$$\breve{C}_t = \breve{c}_t^{OLG} + \breve{c}_t^{LIQ} ,$$

$$\breve{L}_t = \breve{\ell}_t^{OLG} + \breve{\ell}_t^{LIQ} .$$

B. Firms and Unions

In each sector, there is a continuum of agent indexed by $i \in [0,1]$, that are assumed to be perfectly competitive in the input markets and monopolistically competitive in the output markets. The optimisation problem is subject to nominal rigidities for manufacturers, unions, import agents and distributors, and subject to real rigidities for retailers. Manufacturers and distributors face a fixed cost of production that is calibrated to make the steady state shares of labor and capital in GDP consistent with the data. Each sector pays out each period's net cash flow as dividends to OLG households.

1. Manufacturers

Manufacturers produce both tradable goods (T) and non-tradable goods (N) using as inputs capital bought from investment goods producers and labor bought from unions.

The CES production function of capital $K_t^J(i)$ ($J \in [N,T]$) and

union labor $U_t^J(i)$ reads

$$\begin{aligned} Z_t^J(i) &= F(K_t^J(i), U_t^J(i)) \\ &= \mathbf{T}\left(\left(1-\alpha_J^U\right)^{\frac{1}{\xi_{ZJ}}} \left(K_t^J(i)\right)^{\frac{\xi_{ZJ}-1}{\xi_{ZJ}}} + \left(\alpha_J^U\right)^{\frac{1}{\xi_{ZJ}}} \left(T_t A_t^J U_t^J(i)\right)^{\frac{\xi_{ZJ}-1}{\xi_{ZJ}}} \right)^{\frac{\xi_{ZJ}}{\xi_{ZJ}-1}} . \end{aligned} \tag{5}$$

where $T_t A_t^J$ denotes labor augmenting productivity with A_t^J being a country specific stationary technology shock. Manufacturing firms are subject to three types of adjustment costs: (i) quadratic inflation adjustment costs

$$G_{P,t}^J(i) = \frac{\phi_{P^J}}{2} Z_t^J \left(\frac{\frac{P_t^J(i)}{P_{t-1}^J(i)}}{\frac{P_{t-1}^J}{P_{t-2}^J}} - 1 \right)^2 . \tag{6}$$

(ii) investment adjustment costs

$$G_{I,t}^J(i) = \frac{\phi_I}{2} I_t^J \left(\frac{(I_t^J(i)/(g_t n)) - I_{t-1}^J(i)}{I_{t-1}^J(i)} \right)^2 \tag{7}$$

with I_t^J outside the brackets being a scale factor and (iii) labor hiring adjustment costs

$$G_{U,t}^J(i) = \frac{\phi_U}{2} U_t^J \left(\frac{(U_t^J(i)/n) - U_{t-1}^J(i)}{U_{t-1}^J(i)} \right)^2 . \tag{8}$$

where ϕ_{P^J}, ϕ_I and ϕ_U are all scale factors.

The law of motion of capital reads

$$K_{t+1}^J(i) = (1-\delta) K_t^J(i) + S_t^{inv} I_t^J(i) ,$$

where δ represents the depreciation rate of capital and S_t^{inv} is a shock to investment. Manufacturers maximise the present discounted value of dividends, which equal nominal revenue minus nominal cash outflows. We do not report all first-order conditions here and just present that with respect to prices (the Phillips curve):

$$\begin{aligned} &\left[\frac{\sigma_J}{\sigma_J - 1} \frac{\lambda_t^J}{p_t^J} - 1 \right] = \frac{\phi_{P^J}}{\sigma_J - 1} \left(\frac{\pi_t^J}{\pi_{t-1}^J} \right) \left(\frac{\pi_t^J}{\pi_{t-1}^J} - 1 \right) \\ &- E_t \frac{\theta g_{t+1} n}{r_t} \frac{\phi_{P^J}}{\sigma_J - 1} \frac{p_{t+1}^J}{p_t^J} \frac{Z_{t+1}^J}{Z_t^J} \left(\frac{\pi_{t+1}^J}{\pi_t^J} \right) \left(\frac{\pi_{t+1}^J}{\pi_t^J} - 1 \right) \end{aligned} \tag{9}$$

where σ_J denotes the elasticity of substitution in the demand function for products

across manufacturers, ϕ_{P^J} denotes the scale factor in the price adjustment costs, and r_t denotes real interest rate (policy rate minus expected inflation rate)**.**

2. Unions

Manufacturers demand a CES aggregate of labour varieties from unions, with elasticity of substitution σ_U. The aggregate demand for labor variety *i* is given by

$$U_t(i) = \left(\frac{V_t(i)}{V_t} \right)^{-\sigma_U} U_t \ ,$$

with V_t^i denoting the wage of variety *i* and V_t denoting aggregate wage. U_t is aggregate labor demand by all firms. Nominal wage rigidities in this sector take the same functional form $G_{P,t}^U(i)$ as in (6). The optimisation problem of a union consists of maximising the present discounted value of nominal wages paid by firms minus nominal wages paid out to workers, minus nominal wage inflation adjustment costs. The first-order condition is a wage Phillips curve similar to (9).

3. Import Agents

There exist two continua of import agents, each indexed by $i \in [0,1]$, one for intermediary tradable manufacturing goods (T) and another for final goods (D), $J \in [T, D]$. Import agents sell varieties of output to distributors or consumption/investment goods producers which are indexed by $z \in [0,1]$. Domestic distributors z require a separate CES imports aggregate $Y_t^{JM}(1, j, z)$ from the import agents of each country j ($j = 2,..., \widetilde{N}$). Demands for varieties i is given by

$$Y_t^{JM}(1, j, z, i) = \left(\frac{P_t^{JM}(1, j, i)}{P_t^{JM}(1, j)} \right)^{-\sigma_{JM}} Y_t^{JM}(1, j, z) \, .$$

Denoting the price of inputs imported from country j at the border of country 1 by $P_t^{JM,cif}(1, j)$ (the cost, insurance and freight import price), and assuming purchasing power parity this satisfies $P_t^{JM,cif}(1, j) = P_t^{JH}(j)\mathbf{E}_t(1) / \mathbf{E}_t(j)$, or

$$p_t^{JM,cif}(1,j) = p_t^{JH}(j)\tilde{p}_t^{\exp}\frac{e_t(1)}{e_t(j)}.$$

where $\tilde{p}_t^{\exp}$ denotes unit root shocks to the relative price of exported goods, with e_t being the real exchange rate against the currency in country $\tilde{N}$. Import agents maximise the expected present discounted value of nominal revenue $P_t^{JM}(1,j,i)Y_t^{JM}(1,j,i)$ net of the nominal costs of inputs $P_t^{JM,cif}(1,j)Y_t^{JM}(1,j,i)$, and net of the nominal inflation adjustment costs $P_t G_{P,t}^{JM}(1,j,i)$. The first-order condition is similar to (9).

4. Distributors

Distributors produce domestic final output. The technology of distributors can be divided into four stages. In the first stage, a foreign input composite $Y_t^{JF}(1)$ is produced from intermediary manufacturing inputs originating in all foreign economies and sold to distributors by import agents. In the second stage, a tradable composite Y_t^T is produced by combining these foreign tradable with domestic tradable goods, subject to an adjustment cost that makes rapid changes in the share of foreign tradable costly. In the third stage, a tradable-nontradable composite Y_t^A is produced. In the fourth stage, the tradable-nontradable composite is combined with a publicly-provided stock of infrastructure to produce the private-public composite, Z_t^D.

The following is a set of nested production functions:

$$Y_t^{JF}(1) = \left(\sum_{j=2}^{N}\tilde{\zeta}^{J}(1,j)^{\frac{1}{\xi_{JM}}}\left(Y_t^{JM}(1,j)\right)^{\frac{\xi_{JM}-1}{\xi_{JM}}}\right)^{\frac{\xi_{JM}}{\xi_{JM}-1}}$$

$$Y_t^T = \left(\left(\tilde{\alpha}_{TH}\right)^{\frac{1}{\xi_T}}\left(Y_t^{TH}\right)^{\frac{\xi_T-1}{\xi_T}} + \left(\tilde{\alpha}_{TF}\right)^{\frac{1}{\xi_T}}\left(Y_t^{TF}(1-G_{F,t}^T)\right)^{\frac{\xi_T-1}{\xi_T}}\right)^{\frac{\xi_T}{\xi_T-1}},$$

$$Y_t^A = \left(\left(\tilde{\alpha}_T\right)^{\frac{1}{\xi_A}}\left(Y_t^T\right)^{\frac{\xi_A-1}{\xi_A}} + \left(\tilde{\alpha}_N\right)^{\frac{1}{\xi_A}}\left(Y_t^N\right)^{\frac{\xi_A-1}{\xi_A}}\right)^{\frac{\xi_A}{\xi_A-1}}.$$

$$Z_t^D = Y_t^A\left(K_t^{G1}\right)^{\alpha_{G1}}\left(K_t^{G2}\right)^{\alpha_{G2}}\mathbf{S}.$$

In the CES production function for $Y_t^{JF}(1)$, the share of foreign inputs $\zeta^J(1,j)$ are identical across firms and add up to 1 $\Sigma_{j=2}^{\tilde{N}}\zeta^J(1,j)=1$. However, this intermediary input share parameter is allowed to change with technology shocks. It is assumed that an improvement in technology in a foreign country j not only leads to a lower cost in that country, but also to a higher demand for the good produced in that country from all foreign countries, reflecting quality improvements due to better technology. Likewise, the model assumes an additional relative demand effect in response to non-tradable productivity shocks in the production of the composite non-tradable and tradable good, with the share of non-tradable goods increasing with productivity.

5. Investment and Consumption Goods Producers

Investment (consumption) goods producers sell the final composite Z_t^I (Z_t^C) to manufacturers (retailers), to the government, and back to other investment (consumption) goods producers for the purpose of fixed and adjustment costs. The technology of investment goods producers consists of a CES production function that uses domestic final output, $Y_t^{IH}(i)$, and foreign final output imported via import agents, $Y_t^{IF}(i)$, with a share coefficient for domestic final output, α_{IH}, and an elasticity of substitution, ξ_I:

$$Z_t^I(i)=\left((\alpha_{IH})^{\frac{1}{\xi_I}}\left(Y_t^{IH}(i)\right)^{\frac{\xi_I-1}{\xi_I}}+(1-\alpha_{IH})^{\frac{1}{\xi_I}}\left(Y_t^{IF}(i)(1-G_{F,t}^I(i))\right)^{\frac{\xi_I-1}{\xi_I}}\right)^{\frac{\xi_I}{\xi_I-1}},$$

with $G_{F,t}^I(i)$ being a quantity adjustment cost function. Similarly, the CES production function of consumption goods producer reads the following:

$$Z_t^C(i)=\left((\alpha_{CH})^{\frac{1}{\xi_C}}\left(Y_t^{CH}(i)\right)^{\frac{\xi_C-1}{\xi_C}}+(1-\alpha_{CH})^{\frac{1}{\xi_C}}\left(Y_t^{CF}(i)(1-G_{F,t}^C(i))\right)^{\frac{\xi_C-1}{\xi_C}}\right)^{\frac{\xi_C}{\xi_C-1}},$$

Investment (consumption) goods producers maximise the expected present discounted value of nominal revenue, minus nominal costs of production, a fixed cost, and inflation adjustment costs under the assumption that producers pay out each period's nominal net cash flow as dividends. The first-order condition with respect to prices reads similar to the Phillips curve in (9).

6. Retailers

Household demand for the output varieties $C_t(i)$ supplied by retailers is:

$$C_t(i) = \left(\frac{P_t^R(i)}{P_t^R} \right)^{-\sigma_R} C_t .$$

The optimisation problem of retailers consists of maximising the present discounted value of nominal revenue minus nominal costs of inputs and nominal quantity adjustment costs (similar to (7)).

C. Government Policy Rules

Fiscal policy consists of a specification of public investment spending G_t^{inv}, public consumption spending G_t^{cons}, transfers from *OLG* agents to *LIQ* agents $\tau_{T,t}$, lump-sum taxes $\tau_{ls,t} = \tau_t^{ls,OLG} + \tau_t^{ls,LIQ}$, lump-sum transfers $\Upsilon_t = \Upsilon_t^{OLG} + \Upsilon_t^{LIQ}$, and three different distortionary taxes $\tau_{L,t}$, $\tau_{c,t}$, and $\tau_{k,t}$. The government is assumed to follow a structural fiscal balance rule of the following form:

$$gdef_t^{rat} = gdef_t^{rat^*} - d^{tax} \left(\frac{\breve{\tau}_t - \breve{\tau}_t^{pot}}{g\breve{d}p_t} \right),$$

where $gdef_t^{rat}$ is the government deficit-to-GDP ratio, given by

$$gdef_t^{rat} = \frac{B_t - B_{t-1}}{GDP_t} = \frac{\breve{b}_t - \frac{\breve{b}_{t-1}}{\pi_t g_t n}}{g\breve{d}p_t} = \frac{\frac{i_{t-1}-1}{\pi_t g_t n}\breve{b}_{t-1} + \breve{G}_t + \breve{\Upsilon}_t - \breve{\tau}_t}{g\breve{d}p_t},$$

where τ_t and τ_t^{pot} denote actual and potential tax revenues respectively. $gdef_t^{rat^*}$ denotes potential government deficit-to-GDP ratio. This fiscal policy rule considers both dynamic stability and business cycle stabilisation through a long-run debt target and automatic stabilisers.

Monetary policy uses an interest rate rule that features interest rate smoothing and responds to either one or a combination of the following factors: (i) deviations of year-on-year inflation from the inflation target π_t^*, which can be subject to unit root shocks, (ii) the year-on-year GDP growth rate, (iii) the output gap, and (iv) deviations of current exchange rate changes from their steady state value ε_t^*.

Furthermore, the rule also allows for correlated discretionary monetary policy shocks, S_t^{int}.

$$i_t = \left(i_{t-1}\right)^{\delta_i}\left(r_t^{\,filter}\,\pi_{t+k}\right)^{1-\delta_i}\left(\frac{\pi_{t+k}}{\pi_t^*}\right)^{(1-\delta_i)\delta_\pi}\left(\frac{g\breve{d}p_t}{g\breve{d}p_t^{\,filter}}\right)^{(1-\delta_i)\delta_y}\left(\frac{g\breve{d}p_t}{g\breve{d}p_{t-4}}\right)^{(1-\delta_i)\delta_{ygr}}\left(\frac{\varepsilon_t}{\varepsilon_t^*}\right)^{\delta_\varepsilon} S_t^{\text{int}} ,$$

$$r_t^{\,filter} = E_t\left(\Pi_{k=k_l}^{k_h} r_{t+k}\right)^{\frac{1}{k_h-k_l+1}} ,$$

$$g\breve{d}p_t^{\,filter} = E_t\left(\Pi_{k=k_l}^{k_h} g\breve{d}p_{t+k}\right)^{\frac{1}{k_h-k_l+1}} ,$$

$$\pi_{4,t} = \left(\pi_t\pi_{t-1}\pi_{t-2}\pi_{t-3}\right)^{\frac{1}{4}} ,$$

$$S_t^{\text{int}} = (1-\rho^{\text{int}}) + \rho^{\text{int}} S_{t-1}^{\text{int}} + \boldsymbol{e}_t^{\text{int}} .$$

IV. CALIBRATION OF THE EIGHT-BLOCK GIMF MODEL

In general, calibrating the GIMF requires detailed data on national accounts by expenditure and industry, labour shares in the tradable and non-tradable sectors, the external position, the trade structure, the fiscal position, setting monetary and fiscal policy reaction functions, and last but not least, setting the behavioural parameters.[7] The main behavioural parameters have been chosen using information from existing literature and empirical evidence gathered in previous work using the GIMF model. In this paper, the steady-state ratios have been set to match actual 2006 national accounts data and shares of different expenditure and income categories in GDP. In more details:

National accounts by expenditure (Table A1). The national account data are from the IMF World Economic Outlook (WEO) databank. With regard to the GDP components, the steady state consumption-to-GDP ratio is highest in the United States and the lowest in China (70 per cent compared with 38 per cent), with an average ratio around 57 per cent across regions. Private investment in relation to GDP is highest in China and lowest in the US (39.5 per cent compared with 18 per cent), and the average of the rest of the blocks is 25 per cent. Government expenditures account for about 20 per cent of GDP in all the blocks, with a ratio slightly above average in OECD economies.

[7] See Annex A for tables of values of major GDP ratios and behavioral parameters.

National accounts by industry (Table A2). Production is broken down into a tradable sector and a non-tradable sector. The tradable sector includes agriculture, mining and fishing, manufacturing, utilities, transportation, storage and communication. The tradable sector accounts for less than half of output in Australia-New Zealand, Japan, euro area, the US and EMEAP6, but more than half of output in China (54 per cent) and South Korea (56 per cent). The data are calculated using the National Accounts Main Aggregates Database from the United Nations Statistics Division for all regions except for China where the data are from the China National Bureau Statistical Year Book 2007.[8]

Labour shares in the manufacturing sector (Table A3). The labour share parameters in the manufacturers' production function are set to their actual values. For China, the labor share is estimated at around 40 per cent using data from the China National Bureau Statistical Year Book 2007, an estimate consistent with the findings of He, Zhang and Shek (2007). Given the limited availability of wage data for private sector employees and self employed, this estimate assumes that wages of private sector employees and self-employed are about 30 per cent higher than the average public employee wage, while wages for rural peasants are at about 30 per cent of public sector employees' wages. For the remaining economies, the labour share is 55 per cent in euro area, 60 per cent in the US (European Commission 2007), 55 per cent in Japan (IMF 2008b), and 50 per cent in other EMEAP economies (Malte 2008). The labour share in non-tradable sectors is assumed to be the same as the labor share in GDP in individual blocks.

External position (Table A4). All EMEAP blocks record current account surpluses, except Australia-New Zealand. The euro area reports a balanced current account, while the US has the largest current account deficit (around 6 per cent of GDP). The constellation of current account positions is reflected in the economies' net holdings of foreign assets with EMEAP6, China, and Japan registering large net creditor positions, while South Korea, Australia-New Zealand, the US and the euro area are net debtors. In terms of openness, EMEAP6 economies are more open than any other region in the model, followed by South Korea, China, Australia-New Zealand, and Japan.

[8] The web address of the National Accounts Main Aggregates database is http://unstats.un.org/unsd/snaama/selectionbasicFast.asp.

Trade structure (Table A5). The trade decomposition is calculated using data from the United Nation's COMTRADE database, which reports imports into four categories: raw materials, intermediary goods, consumer, and capital goods. Because calibrating the model's commodity sector was not part of this exercise, raw materials were treated as intermediary goods. Such a strategy may overstate the share of intermediary goods in total trade because some raw materials, such as petroleum products, could be directly consumed by households and manufacturers. This simplification could then affect the size of the spillovers to resource-rich economies in the model. Overall, bilateral trade includes imports and exports of intermediary and final goods, where the latter consists of consumption and investment goods. Imports are more or less evenly spread among the three types of goods in developed economies such as the US, euro area, Australia-New Zealand, and Japan, but they are mainly of investment and intermediary goods for China, EMEAP6, and South Korea. In particular, investment goods account for 50 per cent of total imports in China, 45 per cent in EMEAP6, and 32 per cent in South Korea, while intermediary goods account for 50 per cent of total imports in South Korea, 41 per cent and 35 per cent in China and EMEAP6, respectively.

Fiscal position (Table A6). The ratio of government debt to GDP is calculated using the IMF WEO Database, which shows that Japan has the largest ratio of government debt to GDP (at 87 per cent), while Australia-New Zealand has the lowest ratio (2 per cent). The ratios of public investment and social transfers to GDP are calculated using data from the EuroStat for the euro area, from the OECD for the other OECD economies, from CEIC for EMEAP6, and from the China's National Bureau Statistical Yearbook 2007 for China. The ratio of public investment to GDP ranges between 2½ per cent of GDP (for Australia-New Zealand) and about 6 per cent of GDP (for South Korea), while social transfers range between 9 per cent of GDP (for China) and 23 per cent of GDP (for the euro area).

With regard to the tax structure, the shares of different taxes in total tax revenue in Japan, South Korea, and the US are calibrated using data from OECD Economic Outlook database (No. 83, June 2008). The tax shares in euro area are calculated using data from the EUROSTAT, and those for Australia-New Zealand are extracted from a report by the Australia Treasury (Australia Government 2006). The tax shares in EMEAP6 and China are obtained from the IMF. In general, the proceeds from the consumption tax in relation to total tax revenue are the highest in China (61 per cent), and lowest in Japan (19 per cent) and the United States (17 per cent). The labour income tax amounts to about 40 per cent of the total tax revenue in Australia-New Zealand and the United States, while it accounts for only 7 per cent in

China. For the corporate income tax, it is higher in the euro area (32 per cent), and lower in the United States, Japan (12 per cent) and South Korea(14 per cent). The lump-sum tax represents about half of the total tax revenue in Japan, ⅓ of tax revenue in South Korea and the US, and 11 per cent in China.

Monetary reaction function (Table A7). Given that this is an annual model, relatively little interest rate smoothing is assumed (the weight on the lagged interest rate is set to 0.25). The coefficient on inflation is assumed to be 1, and the coefficient on output growth is 0.25. For economies with a managed floating exchange rate against the US dollar, the coefficient on bilateral exchange rate is set at 0.8, and for economies with a managed float against a basket of currencies, the coefficient on nominal effective exchange rate is set at 0.8.

Fiscal policy (Table A7). As regards the fiscal policy, the government is assumed to follow a structural fiscal balance rule under which a long-term, non-explosive government debt to GDP ratio is ensured by adjusting tax rates to generate sufficient revenue, or by reducing expenditures. On average, tax revenue should be equal to the potential tax revenue, which is calculated at the current tax rates multiplied by the tax base in steady state. The coefficient on the deviation from the debt target (d^{tax}) is set to 1, so that fiscal policy can flexibly respond to the business cycle. When tax revenue exceeds its long-run potential value during a boom, the government uses the extra funds to pay off government debt by reducing the deficit below its long-run value. Tax rates on consumption, labor and capital income are allowed to adjust to ensure the rules ($d^{ctax} = d^{ktax} = 1$).

Behavioural parameters (Table A8). There are also differences in key parameters that characterize consumption, production, and pricing.

- *Consumption.* With regard to consumption behavior, the share of consumers facing liquidity constraints is set to be equal to 30 per cent in the US (Kumhof and Laxton, 2007b), and 70 per cent in China (Zhang and Wan, 2004). The share is assumed to be 40 per cent in Japan, Australia-New Zealand, and euro area, and 50 per cent in South Korea and EMEAP6. Consumers' preferences are further differentiated by their planning horizon, assumed to be 20 years in all blocks except in EMEAP6 (18 years). Such an assumption reflects the lower level of development of financial markets and provision of social welfare in the region. In addition, households labour is assumed to have an average remaining time at work of 20 years in all the blocks except in Japan and euro area where the remaining work life is assumed to be 14 years and 18 years respectively,

reflecting the relative older age profiles of the labor forces in the two blocks. Other consumers' characteristics are assumed to be identical across regions, including the degree of patience and habit persistence. The Frisch elasticity of labour supply is calibrated at 0.5 for all blocks. Most microeconomic estimates of the Frisch elasticity are between 0 and 0.45 (Pencavel, 1986), this calibration is at the upper end of that range, in line with much of the business cycle literature.

- *Production.* The elasticity of substitution between capital and labor in both tradable and non-tradable sectors are assumed to be 0.99. The elasticity of substitution between domestic and foreign traded intermediary goods, consumption good, and investment goods, which corresponds to the long-run price elasticity of demand for imports, is assumed to be 0.75 (see Hooper and Marquez, 1995 and Hooper, Johnson and Marquez, 2000). The elasticities of substitution between foreign traded intermediary and final goods from different economies are also assumed to be 0.75. Finally, the elasticity of substitution between tradable and non-tradable goods is assumed to be 0.5, based on the evidence cited in Mendoza (2005).

- *Depreciation rate of capital.* Calibrating the depreciation rate of private capital is not straightforward in the model. There are four ratios related to investment: the two capital income shares in the tradable and non-tradable sectors, the investment to GDP ratio, and profits. However only three free parameters are available for the calibration: the labor share in the non-tradable sector, the labor share in the tradable sector, and the depreciation rate. To specify the fourth free parameter, fixed costs are introduced in manufacturing and distribution. Because the income of capital in the model consists not only of the return to capital in manufacturing, but also of economic profits due to market power in multiple sectors, the fixed costs can be used to partly or wholly eliminate the monopolistic profits. The percentage of steady state economic profits net of the fixed costs are therefore used as a fourth free parameter. The annual depreciation rate of private capital is calibrated as the conventional 10 per cent in all the economy blocks except in Japan and China, where the depreciation rate is 7 per cent and 15 per cent, respectively.

- *Markups.* The degree of market power is reflected in the mark-up of price over marginal cost. The mark-up is assumed to be equal to 10 per cent in the two manufacturing sectors and in the labor market, and is assumed to be smaller of 5 per cent in distribution and retail sectors, and even less for import agents of 2.5 per cent.

- *Adjustment costs.* Adjustment cost parameters associated to the nominal and real aggregates are set in order to deliver realistic dynamics for macro variables.

V. SCENARIOS

A. US and G3 Slowdown Scenarios

This scenario envisages a reduction in the US aggregate demand by about 1 percentage point in the first year, which gradually dies out over four years. The fall in demand is assumed to be brought about by a decline in private investment and consumption. The scenario also assumes a temporary increase in the risk premium on US assets (by about 25 basis points) as households around the world move away from US assets.

The impact on the EMEAP region of such a slowdown is explored under different assumptions on regional economies' exchange rate regimes and monetary policy responses. It is first assumed that all countries have a flexible exchange rate regime with monetary policy aimed at stabilizing a weighted average of inflation and output. The results of this scenario are reported in Table 1 (column A, first panel).[9] The simulations show that under such a scenario real GDP growth would fall most in EMEAP6 (by about 0.2 percentage points), followed by China (slightly less than in EMEAP6), South Korea, Japan, and Australia and New Zealand. A brief description of the transmission reads as follows.

Lower demand from the US reduces net exports and inflation throughout the region. These effects in turn influence the domestic policy rate as well as the exchange rate against the US dollar. Exchange rates are determined by the uncovered interest parity condition in equation (4). As nominal policy rates respond to both the GDP slowdown and lower inflation, real policy rates decline, stimulating investment in all economies. Since the external slowdown is temporary, labour and wages will decline initially, but recover in the medium term. Overall human wealth rises, supporting private consumption. Private consumption is also influenced by wealth effects stemming from valuation gains/losses on countries' holdings of net foreign assets. Two factors determine the wealth effects: exchange rate movements and changes in US interest rate. As foreign assets are denominated

[9] See Annex B (Figures B1-B7) for more details on the behaviour of consumption, investment, government spending, trade balance, current account, nominal and real interest rates, inflation as well as bilateral and effective exchange rates.

in US dollar, a depreciation of domestic currency against the US dollar shows positive wealth effects for net creditors and negative effects for net debtors. Increases in US interest rates will exert positive effects for creditors and negative effects for debtors. Valuations effects from currency changes and interest rates sometimes play in opposite directions. The overall impact partly determines the movement of consumption in EMEAP6, which declines initially, and in Korea, Australia and New Zealand (where it rises).[10] Private spending also hinges on households' access to financial markets, the better the access the larger the increase in private consumption. As a result, better access to financial markets by households helps to mitigate the negative effects of the US slowdown.

With regard to trade, the appreciation of real effective exchange rates (REER) in EMEAP6, Australia-New Zealand, Japan and South Korea further deteriorates net external demand, while in China the REER depreciation mitigates somewhat the downward pressure on net exports. The main reason for the difference in the REER movement is that interest rate declines more in China than in other EMEAP economies due to more significant declines in consumption and therefore inflation on the Mainland. In China, there is no appreciable valuation loss initially as the effects of lower world interest rates on its foreign currency holdings are offset by the depreciation of its currency.

When the US slowdown is accompanied with weaker demand in the euro area and Japan (also stemming from weaker private consumption and business investment), the spillovers to the region are, as expected, somewhat larger. Assuming that growth falls by about 1 percentage point in the euro area and by about ½ percentage points in Japan, growth would decline by 0.3 percentage points in China and EMEAP6, followed by a 0.2 percentage point drop in South Korea (Table 1, columns C, first panel).

As discussed above, columns A and C show the simulation results with flexible exchange rates assuming policy rates react to changes in output and inflation immediately, columns B and D in the first panel show the results assuming that monetary policy in all countries except the US (or in Euro area, Japan and the US in the case of the G3 slowdown) does not respond to changes in growth and inflation in the first year---monetary policy responds with a one year lag. Obviously,

[10] While the wealth effect could somewhat be overstated in countries where most net foreign assets are foreign official reserves, a case could be made that to the extent that these official reserves are perceived as a source of financing future social security outlays, they could make consumers feel wealthier and hence boost their spending.

the spillovers in EMEAP6, China and Korea in column B are about twice as large those in column A. Similar finding is obtained comparing column C and column D. With lower inflation and a constant nominal interest rate, real interest rates rise, adding further downward pressure on economic activity.

The exchange rate regime also determines the size of the spillovers to the region. When China is assumed to pursue a managed floating exchange rate regime against the US dollar, the negative spillovers to China become somewhat larger than when the exchange rate is allowed to move freely. In particular, while China sees a decline in GDP growth of 0.3 percentage points in column B of the first panel, it experiences a negative spillover of 1.4 percentage points in column B of the second panel. Likewise, the loss China suffers in column D of the second panel is three times that shown in the same column in the first panel. This is because monetary policy can not be loosened enough in response to the declining inflation and output when exchange rate becomes an additional target variable in the monetary policy rule. As a result, real interest rate goes up more under the managed floating exchange rate regime than under the flexible one, leading to weakening investment.[11] Similarly, when EMEAP6 is assumed to have a managed floating exchange rate against a basket of currencies, the negative impacts of the US and G3 slowdown are much larger than when a flexible exchange rate regime is pursued. For example, it sees a drop of 0.6 percentage points in column B of the third panel, compared with losses of 0.3 percentage points in the same column of the first and second panels.

[11] Exchange rate moves in line with expected interest rate differentials between two economies even if monetary policy does not respond in the first year following the shock.

Table 1. Spillovers to EMEAP Economies *Without* Confidence Effects (1st year, in per cent)

	US Slowdown		G3 Slowdown	
	w/ Monetary Policy Response (A)	w/o Monetary Policy Response (B)	w/ Monetary Policy Response (C)	w/o Monetary Policy Response (D)
	Assuming Flexible Exchange Rate Regimes in All Countries			
United States	-1.0	-1.0	-1.0	-1.0
EMEAP6 [1]	-0.2	-0.3	-0.3	-0.5
China	-0.2	-0.3	-0.3	-0.5
South Korea	-0.1	-0.2	-0.2	-0.3
Japan	-0.1	-0.1	-0.6	-0.6
Australia and New Zealand	-0.1	-0.1	-0.1	-0.1
Euro Area	-0.1	-0.1	-1.0	-0.9
	Assuming Managed Float in China [2]			
United States	-1.0	-1.0	-1.0	-1.0
EMEAP6 [1]	-0.2	-0.3	-0.3	-0.5
China	-0.2	-1.4	-0.4	-1.5
South Korea	-0.1	-0.2	-0.2	-0.3
Japan	-0.1	-0.1	-0.6	-0.5
Australia and New Zealand	-0.1	-0.1	-0.1	-0.1
Euro Area	-0.1	-0.1	-1.0	-0.9
	Assuming Managed Float in China and EMEAP6 [3]			
United States	-1.0	-1.0	-1.0	-1.0
EMEAP6 [1]	-0.2	-0.6	-0.3	-0.8
China	-0.2	-1.4	-0.4	-1.5
South Korea	-0.1	-0.2	-0.2	-0.3
Japan	-0.1	-0.1	-0.6	-0.5
Australia and New Zealand	-0.1	-0.1	-0.1	-0.1
Euro Area	-0.1	-0.1	-1.0	-0.9

1. EMEAP6 includes Hong Kong, Indonesia, Malaysia, the Philippines, Singapore, and Thailand.
2. Assumes a managed floating exchange rate against the US dollar in China and free floating exchange rate in the remaining economies.
3. Assumes a managed floating exchange rate against the US dollar in China and a managed effective exchange rate in EMEAP6, and a free float in the remaining economies.

Capturing additional spillovers from financial linkages

With the region's large exposure to global financial markets (Table 2), a slowdown in the US or the G3 accompanied with financial disruptions could amplify the spillovers presented above. It is difficult to fully capture in the GIMF the additional spillovers through the financial linkages because the financial sector is relatively limited in the model. Nonetheless, these spillovers through financial linkages could be mimicked by assuming that the slowdown in the United States and the G3 engender negative confidence effects in the regional economies. Negative confidence or weaker sentiment could embody in a sudden drop in risk

appetite, which shifts up of the whole yield curve with the impact particularly larger on the longer term because of the gloomy expectation of prolonged slowdown or recession. Expectation of heightened interest rate in the medium to longer term could reduce private spending beyond the direct effect from the slowdown in the advanced economies.

The magnitude of the additional impact on private spending depends on the economies' financial exposure to the US.[12] The financial exposure to the US is calculated using the US Treasury Department TIC data on holdings of portfolio securities (Table 2). Based on this simplified measure of exposure, consumption is calculated to contract by ¼ percentage points in Australia-New Zealand, by ½ percentage points in South Korea and EMEAP6, and by ¾ percentage points in China.

Table 2. Financial Exposure to the United States
(in per cent of GDP)

	US Holding of Asia Portfolio Securities	Asia Holding of US Portfolio Securities
Australia	20.4	15.0
China	2.2	28.8
Hong Kong	42.2	61.3
Indonesia	3.7	3.4
Japan	13.0	25.0
Korea	12.4	14.2
Malaysia	9.2	10.5
New Zealand	9.3	12.7
Philippines	7.9	7.9
Singapore	35.8	129.2
Thailand	5.7	8.2
euro area	15.8	16.2

Sources: IMF REO APRIL 2008 page 29 and US Treasury Department.

Overall, the spillovers are more than twice as large when financial linkages are accounted for, suggesting that demand shocks in the G3 accompanied with financial disruptions can have a significant impact on the region (Table 3). For example, in the case of China, the negative spillovers now range between

[12] For this exercise, we measure financial exposure using the US Treasury Department TIC data on holdings of portfolio securities, bearing in mind that the model already captures some of the wealth effects stemming from changes in net foreign assets.

½ percentage points and 2 percentage points, about twice as large as the decline in growth in the US and the G3 (depending on the exchange rate regime and the monetary policy response). For EMEAP6, this range is between ½ percentage points and 1¼ percentage points, while it is between ¼ percentage points and ½ percentage points in the case of South Korea. Simulation results of major macroeconomic variables are presented in Figures B8-B14, Annex B.

Table 3. Spillovers to EMEAP Economies *With* Confidence Effects (1st year, in per cent)

	US Slowdown		G3 Slowdown	
	w/ Monetary Policy Response (A)	w/o Monetary Policy Response (B)	w/ Monetary Policy Response (C)	w/o Monetary Policy Response (D)
	Assuming Flexible Exchange Rate Regimes in All Countries			
United States	-1.1	-1.1	-1.0	-1.0
EMEAP6 [1]	-0.4	-0.8	-0.5	-0.9
China	-0.5	-0.9	-0.6	-1.0
South Korea	-0.3	-0.6	-0.4	-0.7
Japan	-0.3	-0.5	-0.7	-0.6
Australia and New Zealand	-0.3	-0.5	-0.3	-0.4
Euro Area	-0.3	-0.4	-1.0	-0.9
	Assuming Managed Float in China [2]			
United States	-1.0	-1.1	-1.0	-1.0
EMEAP6 [1]	-0.4	-0.8	-0.5	-0.8
China	-0.5	-2.0	-0.6	-2.0
South Korea	-0.3	-0.6	-0.4	-0.7
Japan	-0.3	-0.5	-0.7	-0.6
Australia and New Zealand	-0.3	-0.4	-0.3	-0.4
Euro Area	-0.3	-0.4	-1.0	-0.9
	Assuming Managed Float in China and EMEAP6 [3]			
United States	-1.0	-1.1	-1.0	-1.0
EMEAP6 [1]	-0.5	-1.1	-0.5	-1.2
China	-0.5	-2.0	-0.6	-2.0
South Korea	-0.3	-0.6	-0.4	-0.6
Japan	-0.3	-0.5	-0.7	-0.6
Australia and New Zealand	-0.3	-0.4	-0.3	-0.4
Euro Area	-0.3	-0.4	-1.0	-0.9

1. EMEAP6 includes Hong Kong, Indonesia, Malaysia, the Philippines, Singapore, and Thailand.
2. Assumes a managed floating exchange rate against the US dollar in China and free floating exchange rate in the remaining economies.
3. Assumes a managed floating exchange rate against the US dollar in China and a managed effective exchange rate in EMEAP6, and a free float in the remaining economies.

B. China Growth Rebalancing Scenario

This scenario assumes structural reform plans that yield broad-based productivity gains, with larger gains in the non-tradable sector. Those reforms

could include opening up further the economy, leveling the playing field between the tradable and non-tradable sector (e.g. by removing subsidies or tax rebates to exporters and unifying the tax treatment of domestic and foreign firms), developing the domestic financial market, liberalising the capital account and the service sector (such as retail, finance and insurance, and so on), and promoting R&D spending. This reform package could also include increased government spending on items such as healthcare and education, which, with all the above measures, would lower households' saving rates.

The reforms are assumed to raise the share of the non-tradable sector in GDP to the level of South Korea in 10 years, around 50 per cent (up from 46 per cent). Additional government spending on health, education, and other social transfers results in a 1½ percentage point increase in the government investment-to-GDP ratio and a 1 percentage point rise in the government transfers-to-GDP ratio initially. These supplementary outlays are assumed to fade gradually in the subsequent 10 years. The development of the domestic financial market is assumed to lower the share of households who do not hold financial assets by 10 percentage points to 60 per cent of the population, closing half the gap between China and EMEAP6. Improved social services, together with better access to financial markets, are assumed to lower households' subjective discount rate and reduce precautionary savings.

The simulation results show that under such circumstances the level of output could be significantly higher than under a no-reform scenario (20 per cent increase over 10 years). Under the reform scenario, consumption, investment and government spending would be boosted, while trade balance would deteriorate (at least during the first few years immediately after the reforms, see Figure 2).

The scenario envisages relative larger gains of productivity hence higher profitability in the non-tradable than in the tradable sector. With perfect foresight, firms invest more into the non-tradable sector and less into the tradable sector, and hire more workers in the former and less in the latter. In sum, total investment increases, aggregate demand for labour rises, and real wage also rises.

Private consumption also rises because households are wealthier. Households are wealthier not only because of the rise in labor income, but also because they get more dividends. In addition, with higher real interest rates, households' marginal propensity to consume out of wealth also rises (beyond what is implied by the assumed lower subjective discount rate).

Overall, although investment increases after the reform, it does not rise as fast as private consumption, hence its share in GDP would fall. Together with the relative gain in productivity in the non-tradable sector, strengthened domestic demand subsequently contributes to the rising share of non-tradable in the economy.

Increased domestic demand boosts China's imports of final goods, particularly imports of consumption goods; while its imports of intermediary goods decline (Figure 2). With an appreciation of the nominal exchange rate in the short- to medium-term, China's exports fall, and its trade balance deteriorates. Because China is a net creditor in terms of NFA, an appreciation of its currency engenders valuation losses that further reduce the current account surplus.

Stronger domestic demand also generates inflationary pressure. Although firms invest heavily in the non-tradable sector, increased production is not large enough to meet the increased demand in the short run because of the rigidities in the production process as well as the small size of the non-tradable sector in China. From a sectoral point of view, non-tradable goods prices rise. Tradable goods prices also increase since higher labour demand raises the real wages across the sectors and increases the cost to produce tradable goods. However, the effect of the higher domestic goods prices on aggregate inflation is offset in part by lower import prices.

Monetary policy is set to respond to the expected build-up of future inflationary pressure and the stronger demand. Higher inflation and faster growth prompt a tightening of monetary policy in China, which dampens investment somewhat.

Regional economies would in general benefit from China's stronger demand for their exports (Figure 3). Nevertheless, the benefits could be larger if these economies adjust their export to meet the larger demand for consumption goods. In the rest of the EMEAP economies, exports of final goods increase, while their exports of intermediary goods decline. Imports rise gradually, supported by stronger domestic demand and a real appreciation of the effective exchange rate in EMEAP6 and South Korea. On balance, real net exports improve in the short term for EMEAP6, while in South Korea, the rise in exports is more than offset by stronger imports. In Japan and Australia-New Zealand, the improvement in net exports reflects stronger exports and weaker imports as the real effective exchange

rate depreciates in the short term.

Overall, the stronger demand from China would create opportunities for profits for firms in EMEAP6, South Korea, and Japan, which employ more workers and offer higher wages. Stronger labor income in these economies supports private consumption. However, in Australia and New Zealand, since the benefits from China's stronger demand for final goods are not enough to offset the losses from the decline in China's demand for intermediary goods, labor demand and wages fall, lessening private consumption.[13]

However, the stronger demand from China would also add upward pressure to world real interest rates, dampening global investment in the short run and offsetting in part the positive spillovers from China's stronger households' spending. In sum, the level of output rises by 1½ per cent in the rest of EMEAP, by ½ per cent in South Korea, and by a small amount in Japan. Australia-New Zealand benefits only temporarily from the consumption boom in China.

VI. CONCLUSION AND AREAS FOR FUTURE RESEARCH

This paper has presented an illustration of the spillovers from a US and a G3 slowdown to EMEAP as well as the potential benefits from reforms aimed at promoting growth of domestic demand in the region. The main conclusions are:

- The spillovers from a 1 percentage point decline in demand in the US or the G3 range between -¼ percentage points and -1½ percentage points to EMEAP6, and between -¼ percentage points and -2 percentage points to China, depending on monetary policy responses, the degree of exchange rate flexibility, and whether the slowdown is accompanied with financial disruptions. This range of spillovers is smaller for Australia-New Zealand, Japan, and South Korea.

- Reforms that promote productivity gains and more private spending in China would entail non-negligible benefits for the region as a whole. The benefits could be larger for regional economies that more

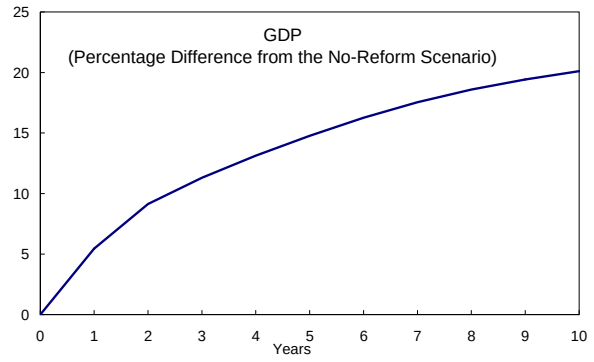
[13] Australia-New Zealand's strong commodity exports are considered as intermediary goods exports, the demand of which declines under the China growth rebalancing scenario. This result may not hold if a separate commodity sector is added to the model. This possibility is left for future research.

flexibly adjust to the shift in China's trade pattern.

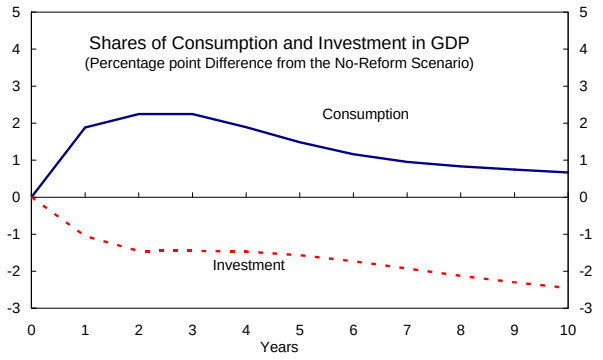
The scenario analyses above demonstrate a number of features of the GIMF that make it well suited for policy analysis. The model integrates rich layers of demand and supply, and allows transmission mechanisms to be fully articulated. Equipped for both monetary and fiscal policy analysis, the GIMF allows the study of a wide range of policy issues to the interest of the region, including structural reform and spillovers from and policy responses to external shocks. While the 8-region version of the GIMF is up and running, it could benefit from further refinements, particularly in the following areas: turning on and calibrating the GIMF commodity module; fine-tuning the calibration of the degree of competition in different sectors (e.g. in the non-tradable and the tradable sectors, in retail, in distribution, and in the labor market), by changing the mark-ups; and differentiating further the monetary reaction functions.

Figure 2. China Growth Rebalancing Scenario

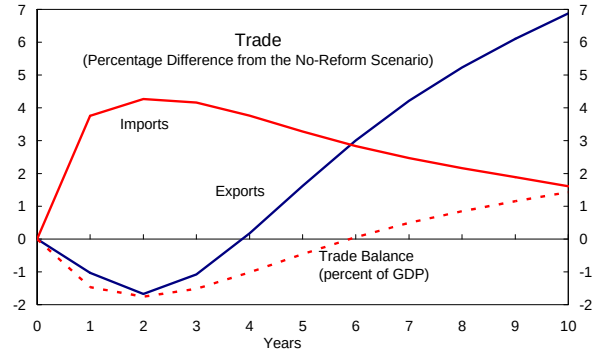
Under this scenario, the level of GDP increases



…with a higher share of private consumption and a lower share of investment.



The trade balance deteriorates as exports weaken and imports surge,...



…reflecting stronger demand for final goods.

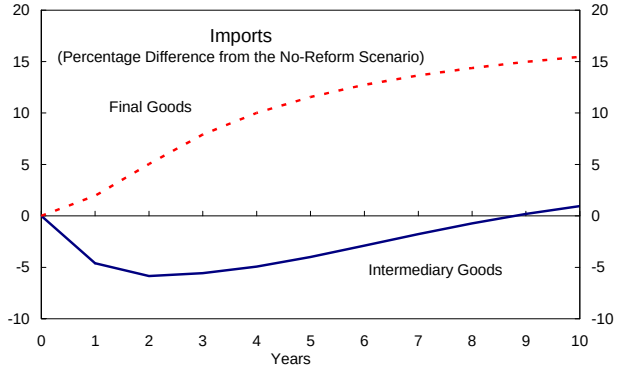
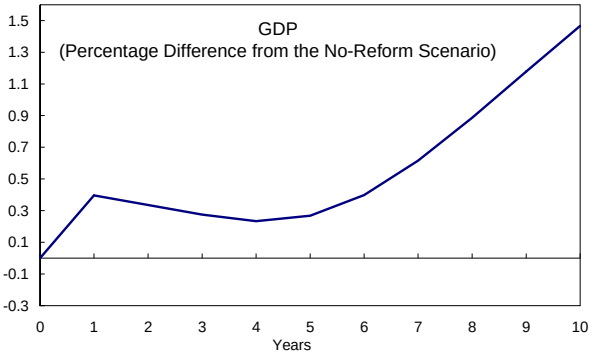
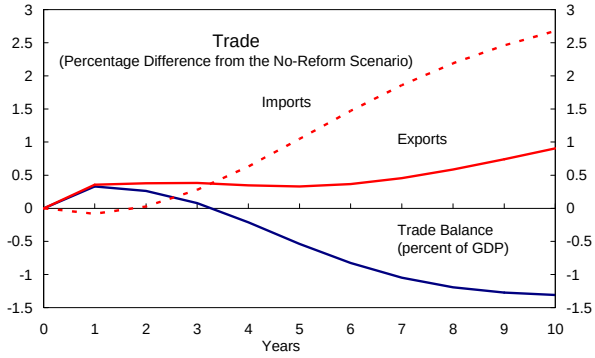


Figure 3. China Growth Rebalancing Scenario: Spillovers to Rest of EMEAP

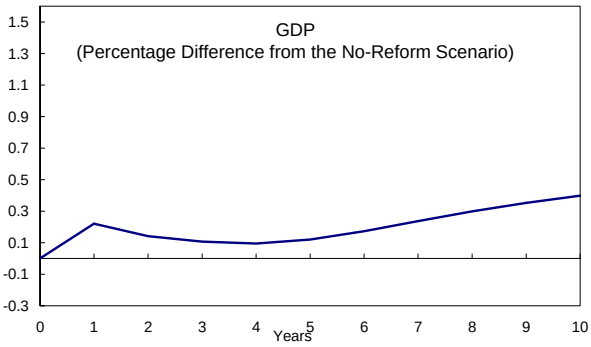
For EMEAP6, the GDP level rises…



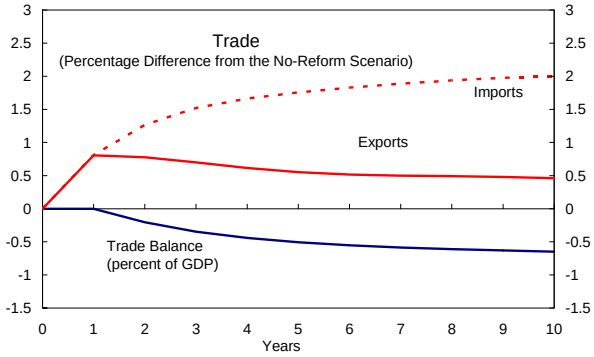
…and net exports improve in the short term



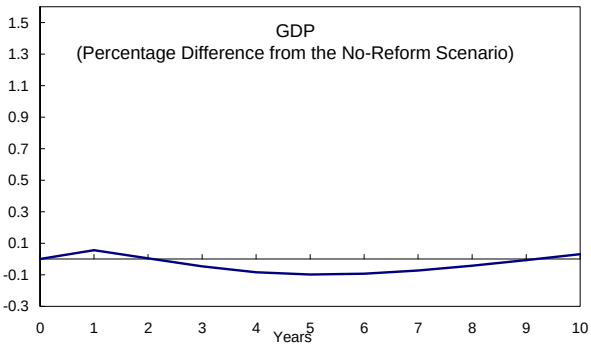
Output also rises in Korea…



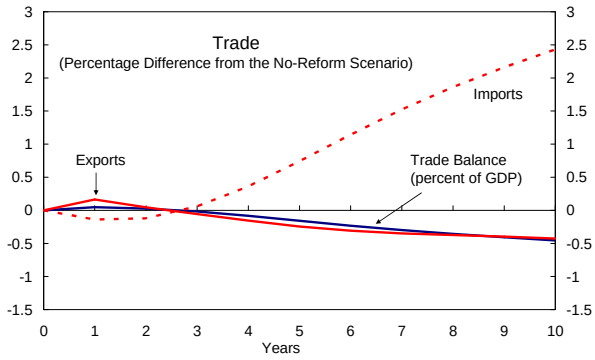
…while net exports worsen.



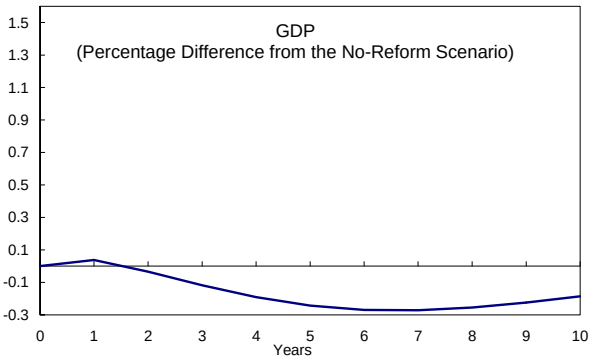
For Japan, the output gains are limited…



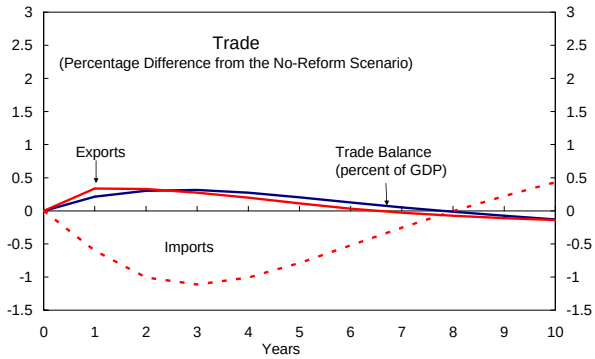
…owing partly to minor increases in exports in the short run.



For Australia and New Zealand, output falls...



…despite a temporary improvement in net exports



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Annex A. Tables of Major GDP Ratios and Behavioral Parameters

Table A1. Steady-State National Accounts by Expenditure
(Percentage of GDP)

	Private Consumption	Private Investment	Public Expenditure
Australia-New Zealand	57	24	21
China	38	40	18
EMEAP6	57	22	16
Euro Area	57	19	23
Japan	57	21	21
Rest of the World	57	18	24
South Korea	54	25	20
United States	70	18	18

Table A2. Steady-State National Accounts by Industry
(Percentage of GDP)

	Tradable Sector	Non-tradable Sector
Australia-New Zealand	34	66
China	54	46
EMEAP6	49	51
Euro Area	36	64
Japan	36	64
Rest of the World	50	50
South Korea	56	44
United States	46	54

Table A3. Steady-State Labor Shares in Manufacturing Sectors
(Percentage of Output)

	Tradable Sector	Non-tradable Sector
Australia-New Zealand	50	50
China	40	40
EMEAP6	50	50
Euro Area	55	55
Japan	55	55
Rest of the World	60	60
South Korea	50	50
United States	60	60

Table A4. Steady-State External Positions
(Percentage of GDP)

	Current Account Balance	Net Foreign Assets	Imports
Australia-New Zealand	-2	-68	22
China	8	20	33
EMEAP6	8	48	75
Euro Area	0	-14	20
Japan	1	41	15
Rest of the World	4	4	28
South Korea	1	-22	42
United States	-6	-18	17

Table A5. Steady-State Trade Matrix
(Percentage of Total Trade)

	Intermediate Goods	Investment Goods	Consumption Goods
		Imports	
Australia-New Zealand	27	34	39
China	41	50	9
EMEAP6	35	45	20
Euro Area	37	28	35
Japan	46	24	30
Rest of the World	40	34	26
South Korea	50	32	18
United States	32	30	38
		Exports	
Australia-New Zealand	74	8	18
China	20	44	36
EMEAP6	24	49	27
Euro Area	29	34	37
Japan	21	53	26
Rest of the World	62	10	28
South Korea	23	53	24
United States	30	47	23

Table A6. Steady-State Fiscal Position

	Government Debt	Public Investment (Percentage of GDP)	Social Transfer	
Australia-New Zealand	2	3	12	
China	16	3	9	
EMEAP6	26	6	12	
Euro Area	60	2	23	
Japan	87	3	19	
Rest of the World	43	4	14	
South Korea	37	5	10	
United States	44	3	12	
	Consumption Tax	**Labor Income Tax**	**Capital Income Tax**	**Lump-sum Tax**
		(Percentage of Total Tax Revenue)		
Australia-New Zealand	28	40	17	15
China	61	7	21	11
EMEAP6	40	30	10	20
Euro Area	22	35	32	12
Japan	19	19	14	48
Rest of the World	25	10	40	25
South Korea	32	17	14	36
United States	17	37	12	35

Table A7. Monetary Policy and Fiscal Policy Parameters

	δ_i	δ_π	δ_{ygr}	d^{tax}	d^{ctax}	d^{ktax}
Australia-New Zealand	0.25	1	0.25	1	1	1
China	0.25	1	0.25	1	1	1
EMEAP6	0.25	1	0.25	1	1	1
Euro Area	0.25	1	0.25	1	1	1
Japan	0.25	1	0.25	1	1	1
Rest of the World	0.25	1	0.25	1	1	1
South Korea	0.25	1	0.25	1	1	1
United States	0.25	1	0.25	1	1	1

Table A8. Behavioral Parameters

Consumption Parameters

	Share of Liquidity Constrained Consumers	Planning Horizon $1/(1-\theta)$	Remaining Time at Work	Inter-temporal Elasticity of Substitution	Degree of Habit Persistence
Australia-New Zealand	0.4	20	20	0.25	0.4
China	0.7	20	20	0.25	0.4
EMEAP6	0.5	18	20	0.25	0.4
Euro Area	0.4	20	18	0.25	0.4
Japan	0.4	20	14	0.25	0.4
Rest of the World	0.5	20	20	0.25	0.4
South Korea	0.5	20	20	0.25	0.4
United States	0.3	20	20	0.25	0.4

Production Parameters
(Elasticity of Substitution between)

	Capital and Labor	Domestic and Foreign Traded Goods	Foreign Traded Goods	Tradable and Non-tradable Goods	Depreciation Rate
Australia-New Zealand	0.99	0.75	0.75	0.5	0.1
China	0.99	0.75	0.75	0.5	0.15
EMEAP6	0.99	0.75	0.75	0.5	0.1
Euro Area	0.99	0.75	0.75	0.5	0.1
Japan	0.99	0.75	0.75	0.5	0.07
Rest of the World	0.99	0.75	0.75	0.5	0.1
South Korea	0.99	0.75	0.75	0.5	0.1
United States	0.99	0.75	0.75	0.5	0.1

Price and Wage Mark-ups

	Manufacturers	Unions	Retail	Distribution	Imports
Australia-New Zealand	0.1	0.1	0.5	0.5	0.25
China	0.1	0.1	0.5	0.5	0.25
EMEAP6	0.1	0.1	0.5	0.5	0.25
Euro Area	0.1	0.1	0.5	0.5	0.25
Japan	0.1	0.1	0.5	0.5	0.25
Rest of the World	0.1	0.1	0.5	0.5	0.25
South Korea	0.1	0.1	0.5	0.5	0.25
United States	0.1	0.1	0.5	0.5	0.25

Nominal and Real Rigidity
(Adjustment Cost Parameters)

	Price& Wage	Investment	Consumption	Labor Hiring	Trade
Australia-New Zealand	10	10	2	1	1
China	10	10	2	1	1
EMEAP6	10	10	2	1	1
Euro Area	10	10	2	1	1
Japan	10	10	2	1	1
Rest of the World	10	10	2	1	1
South Korea	10	10	2	1	1
United States	10	10	2	1	1

Annex B. Simulation Results of the Two Scenarios

Figure B1. Behaviour of Major Macroeconomic Indicators in the Scenario of a US Slowdown (Assuming Flexible Exchange Rate Regimes in all blocks)
Australia-New Zealand

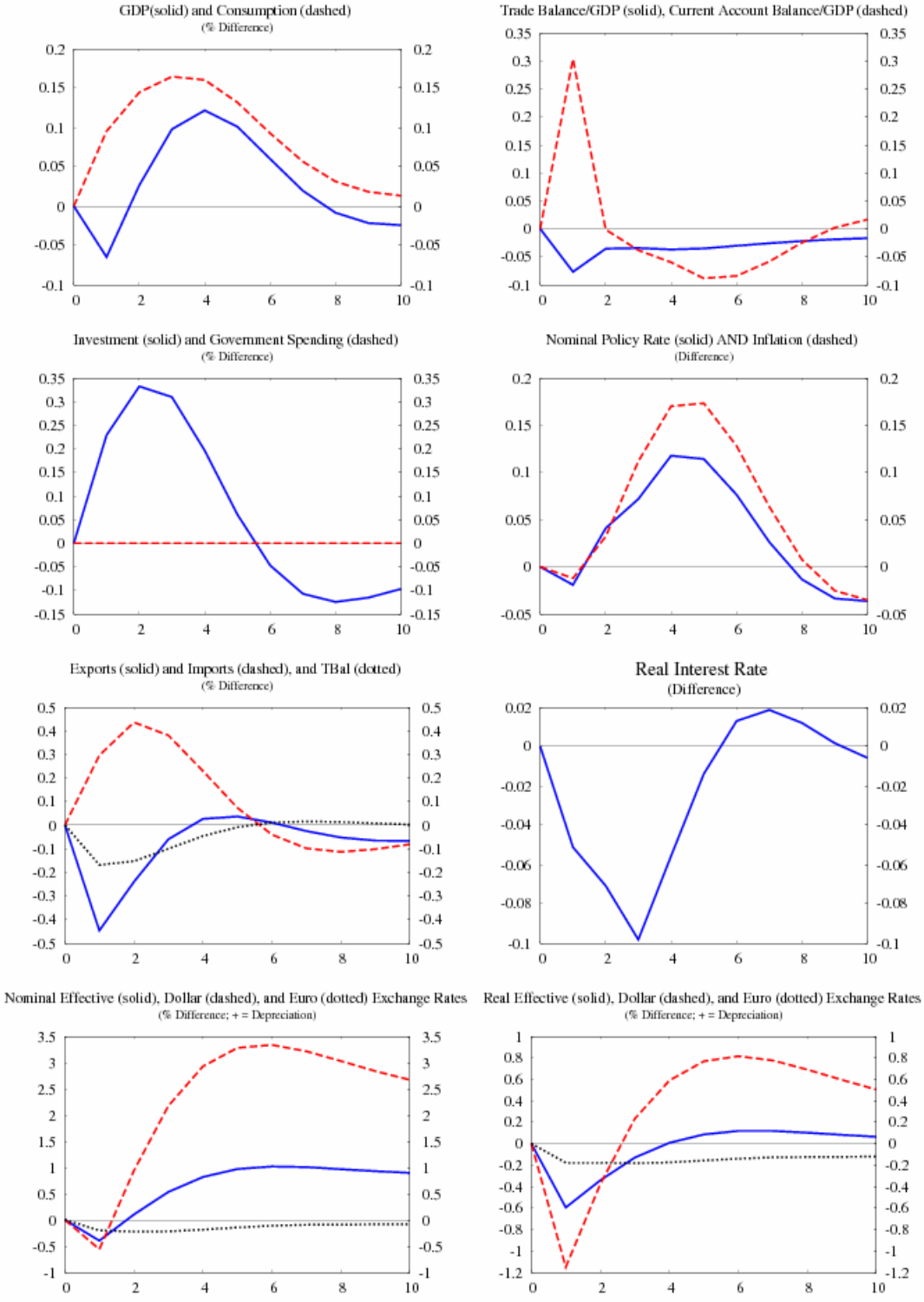

Figure B2. Behaviour of Major Macroeconomic Indicators in the Scenario of a US Slowdown (Assuming Flexible Exchange Rate Regimes in all blocks)
China

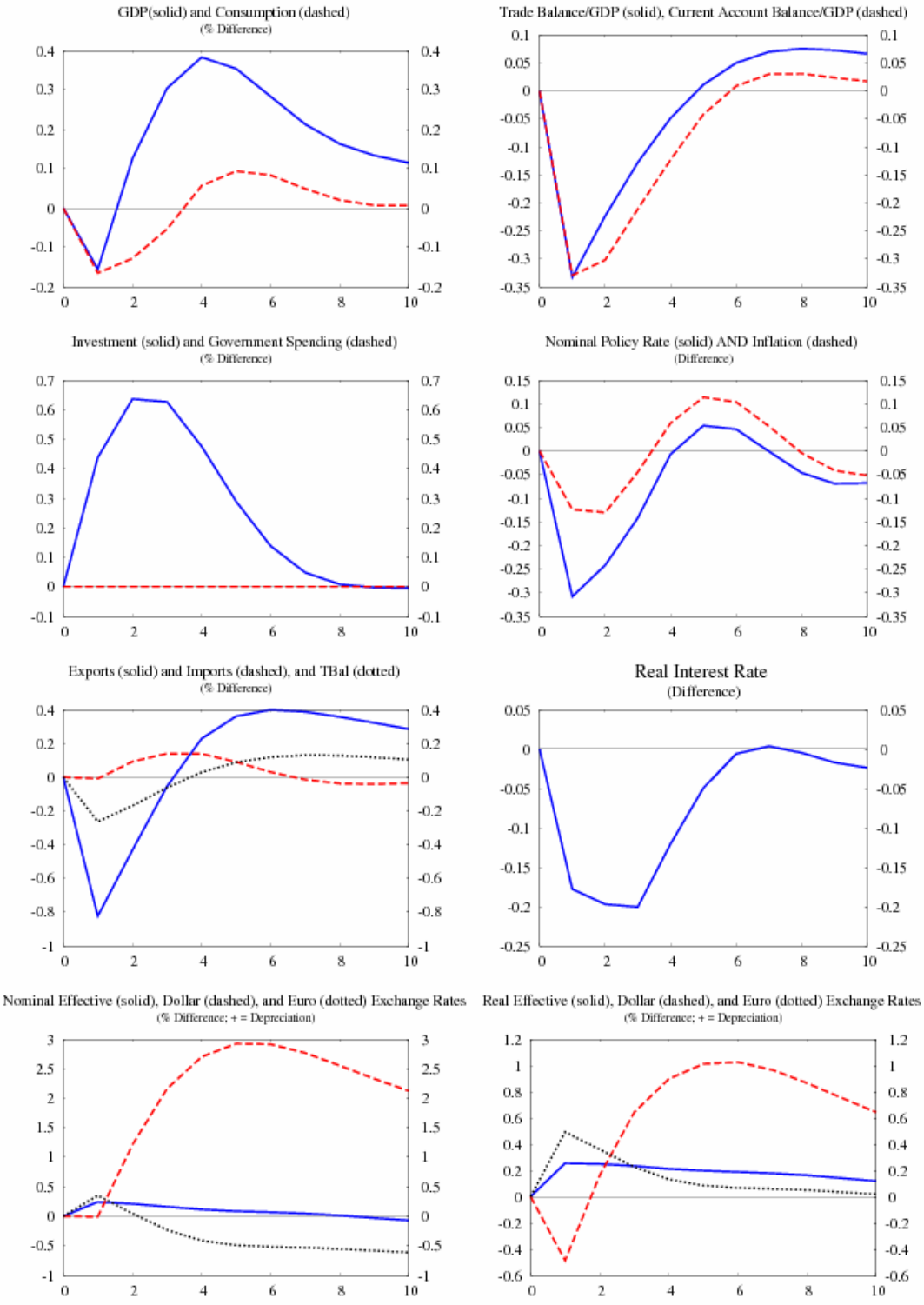

Figure B3. Behaviour of Major Macroeconomic Indicators in the Scenario of a US Slowdown (Assuming Flexible Exchange Rate Regimes in all blocks)
EMEAP6

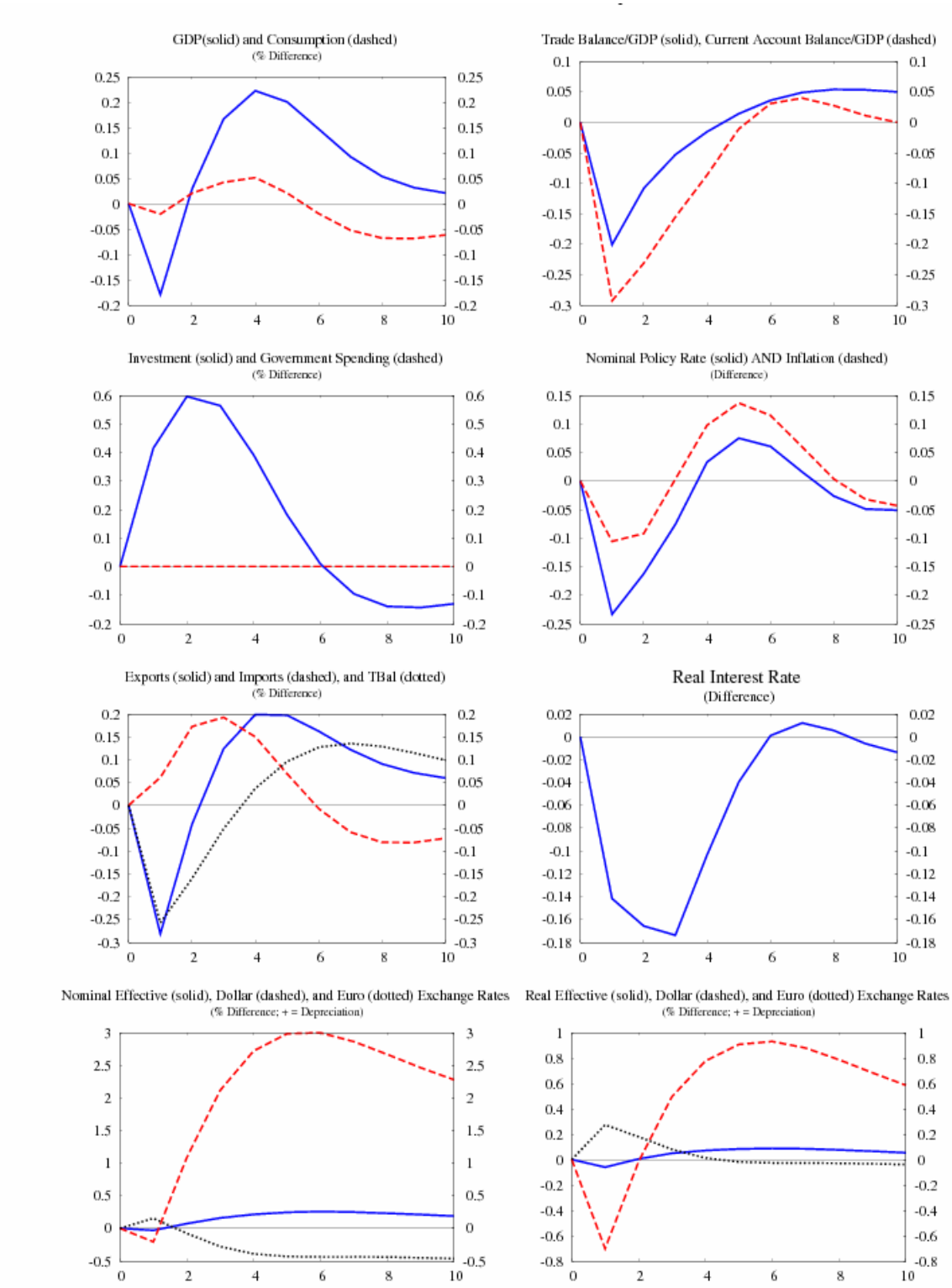

Figure B4. Behaviour of Major Macroeconomic Indicators in the Scenario of a US Slowdown (Assuming Flexible Exchange Rate Regimes in all blocks)
Euro Area

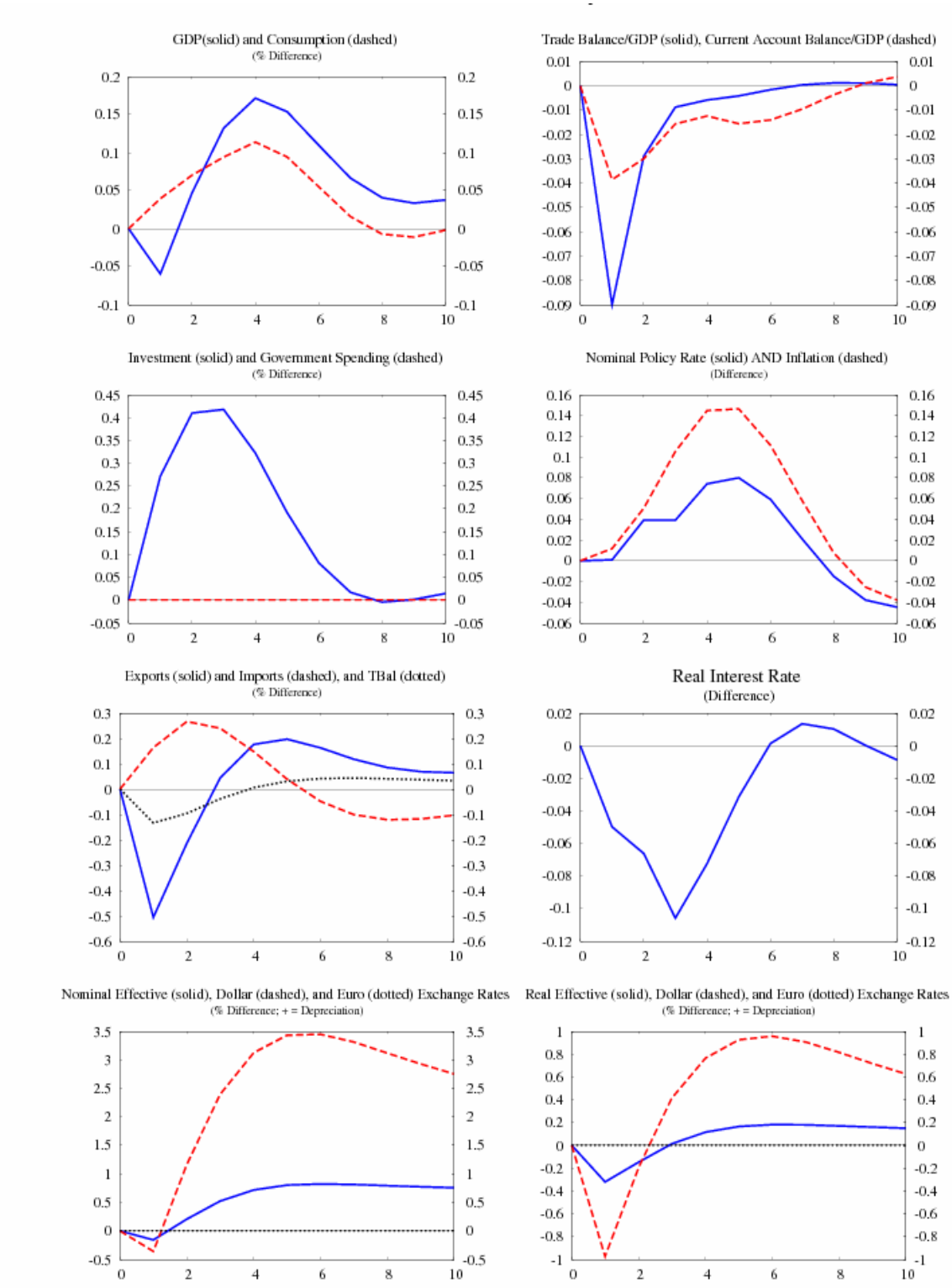

Figure B5. Behaviour of Major Macroeconomic Indicators in the Scenario of a US Slowdown (Assuming Flexible Exchange Rate Regimes in all blocks)
Japan

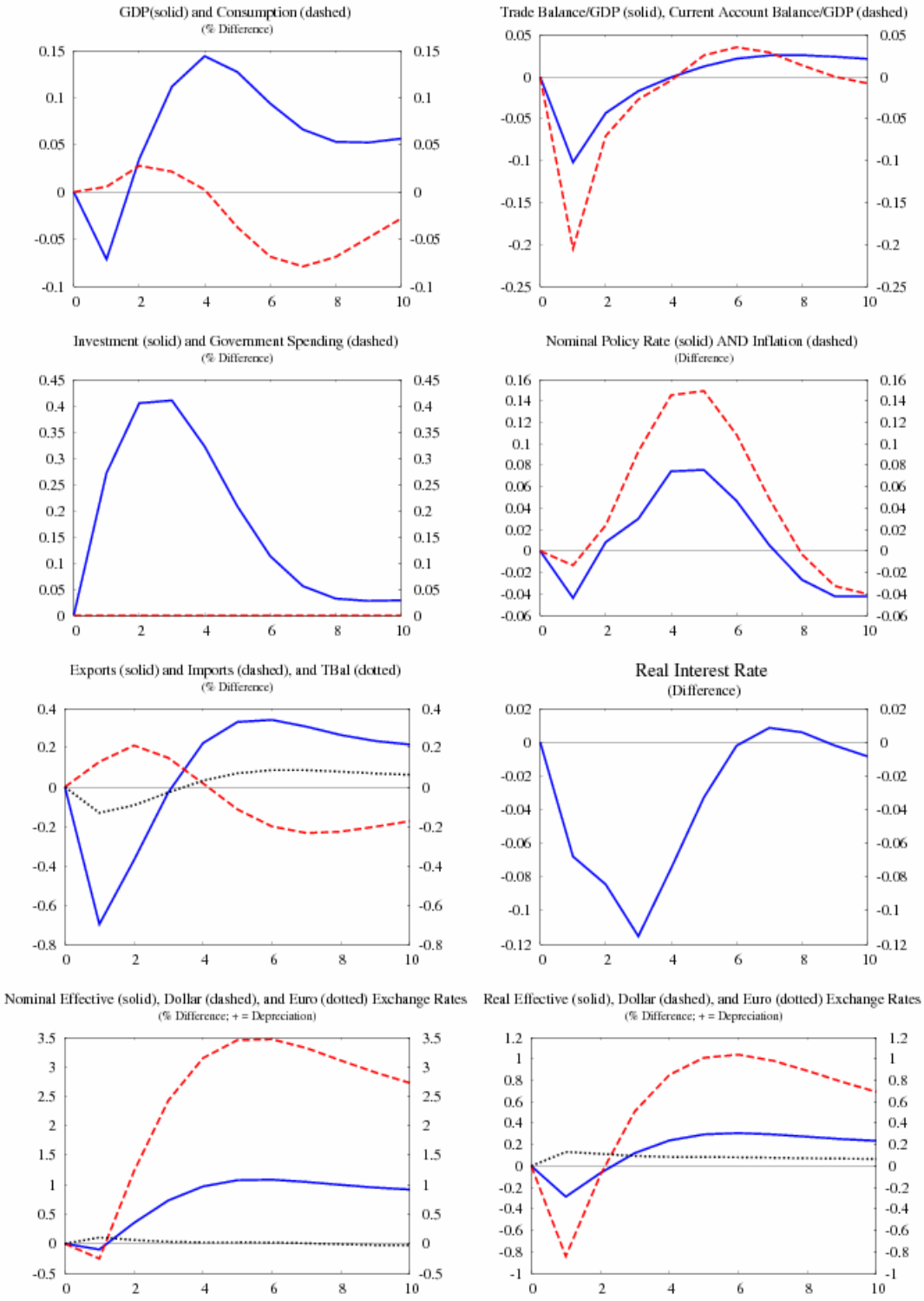

Figure B6. Behaviour of Major Macroeconomic Indicators in the Scenario of a US Slowdown (Assuming Flexible Exchange Rate Regimes in all blocks)
South Korea

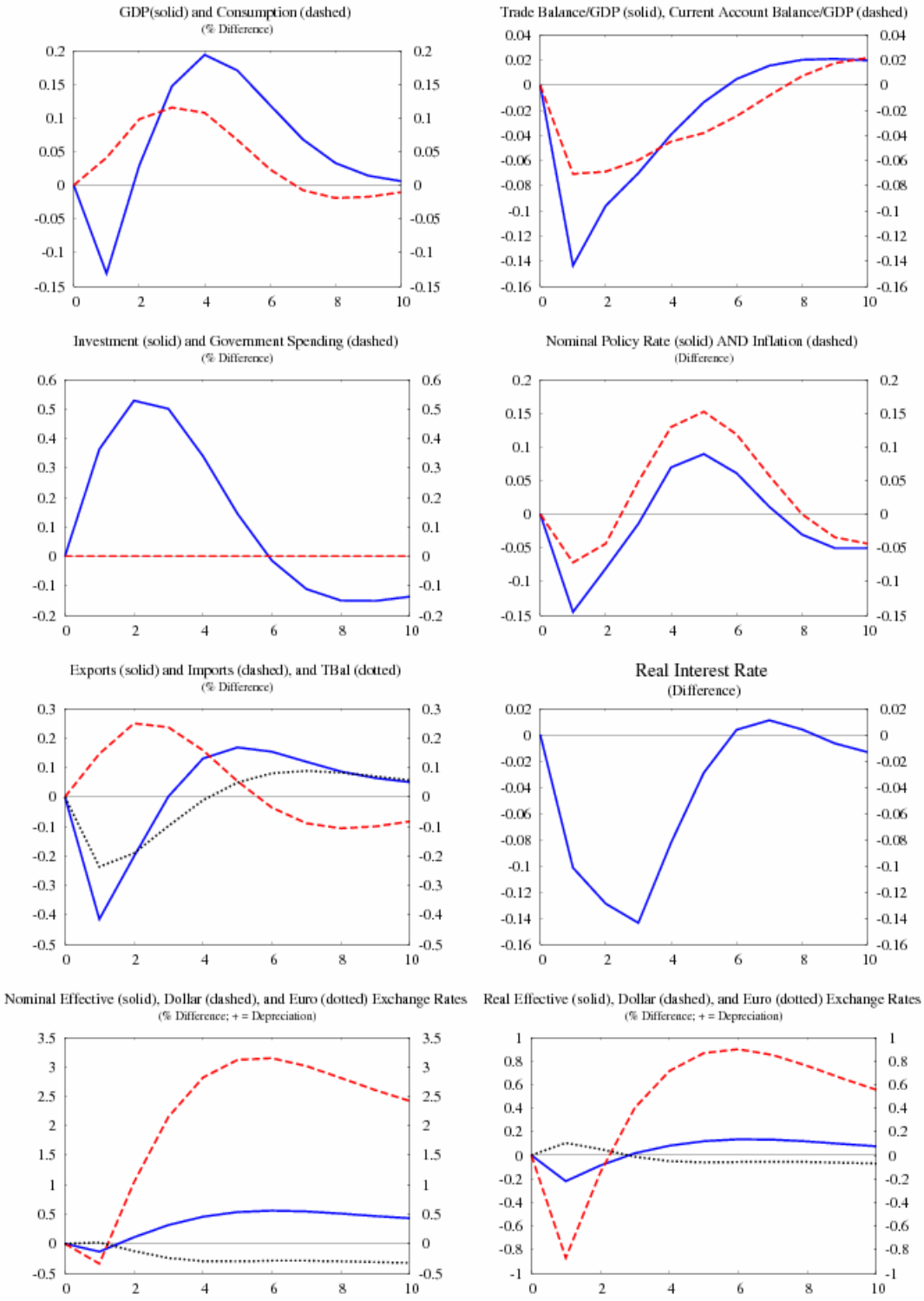

Figure B7. Behaviour of Major Macroeconomic Indicators in the Scenario of a US Slowdown (Assuming Flexible Exchange Rate Regimes in all blocks)
United States

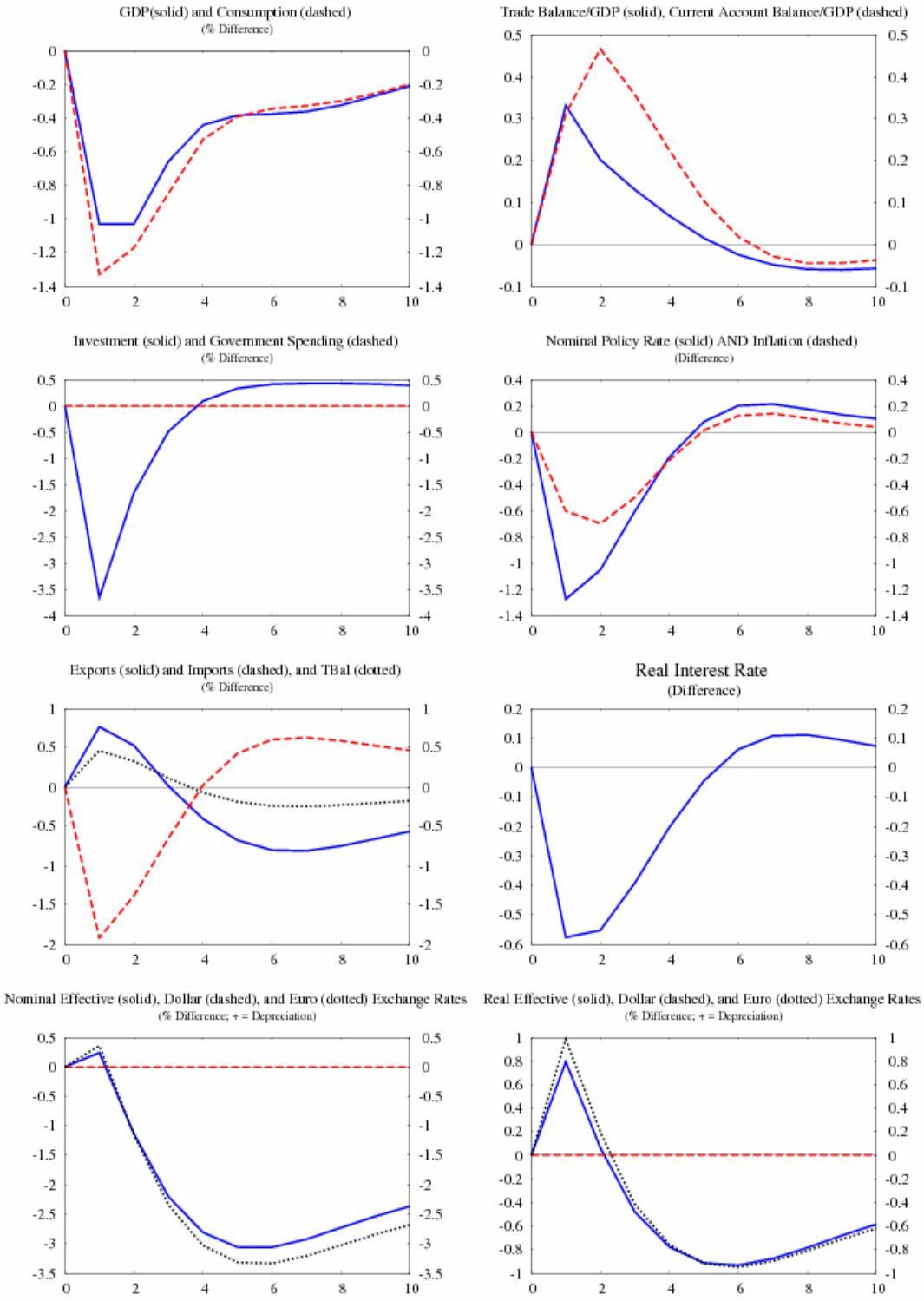

Figure B8. Behaviour of Major Macroeconomic Indicators in the Scenario of a G3 Slowdown with Confidence Effect
(Assuming Flexible Exchange Rates in all blocks)
Australia-New Zealand

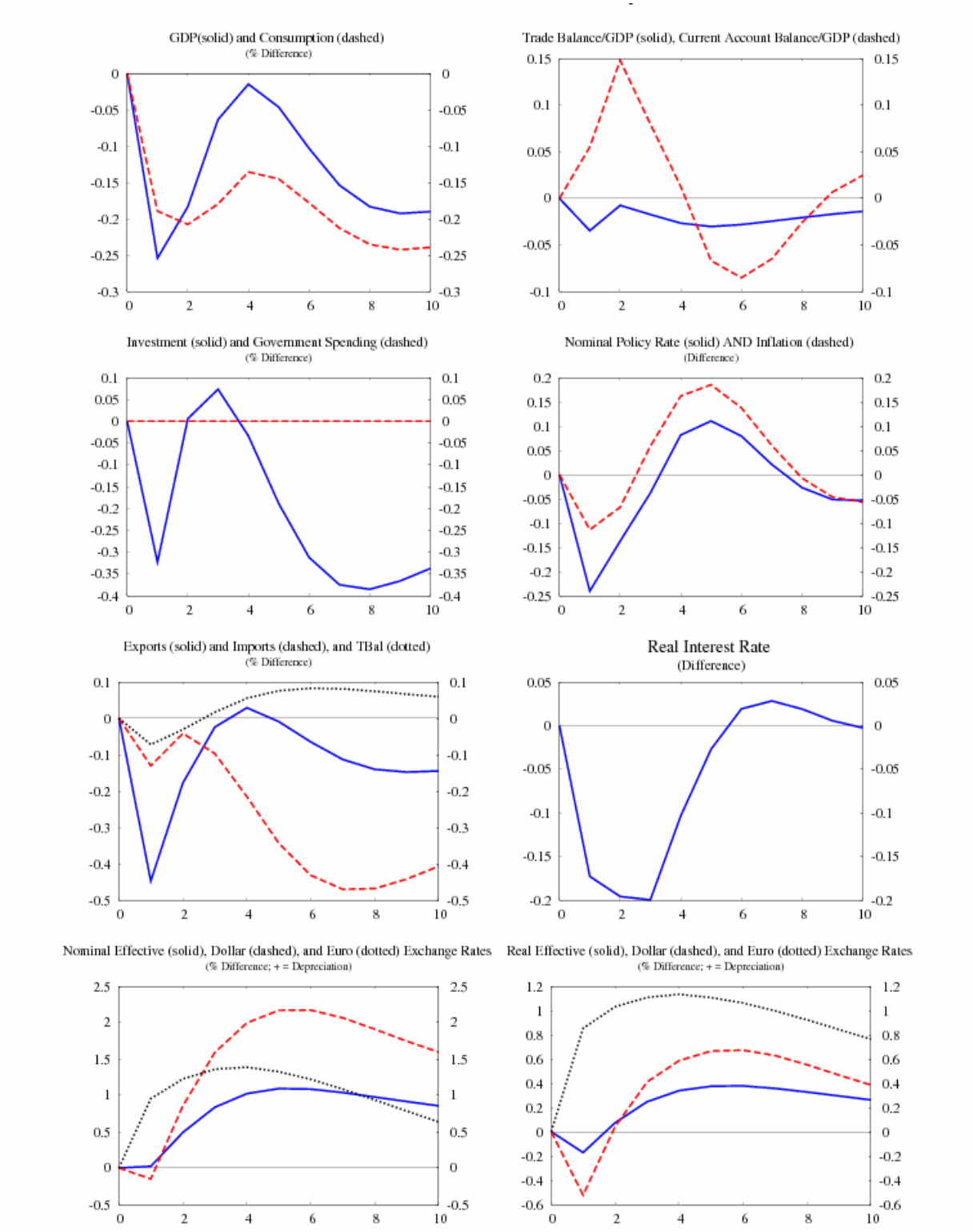

Figure B9. Behaviour of Major Macroeconomic Indicators in the Scenario of a G3 Slowdown with Confidence Effect (Assuming Flexible Exchange Rates in all blocks)
China

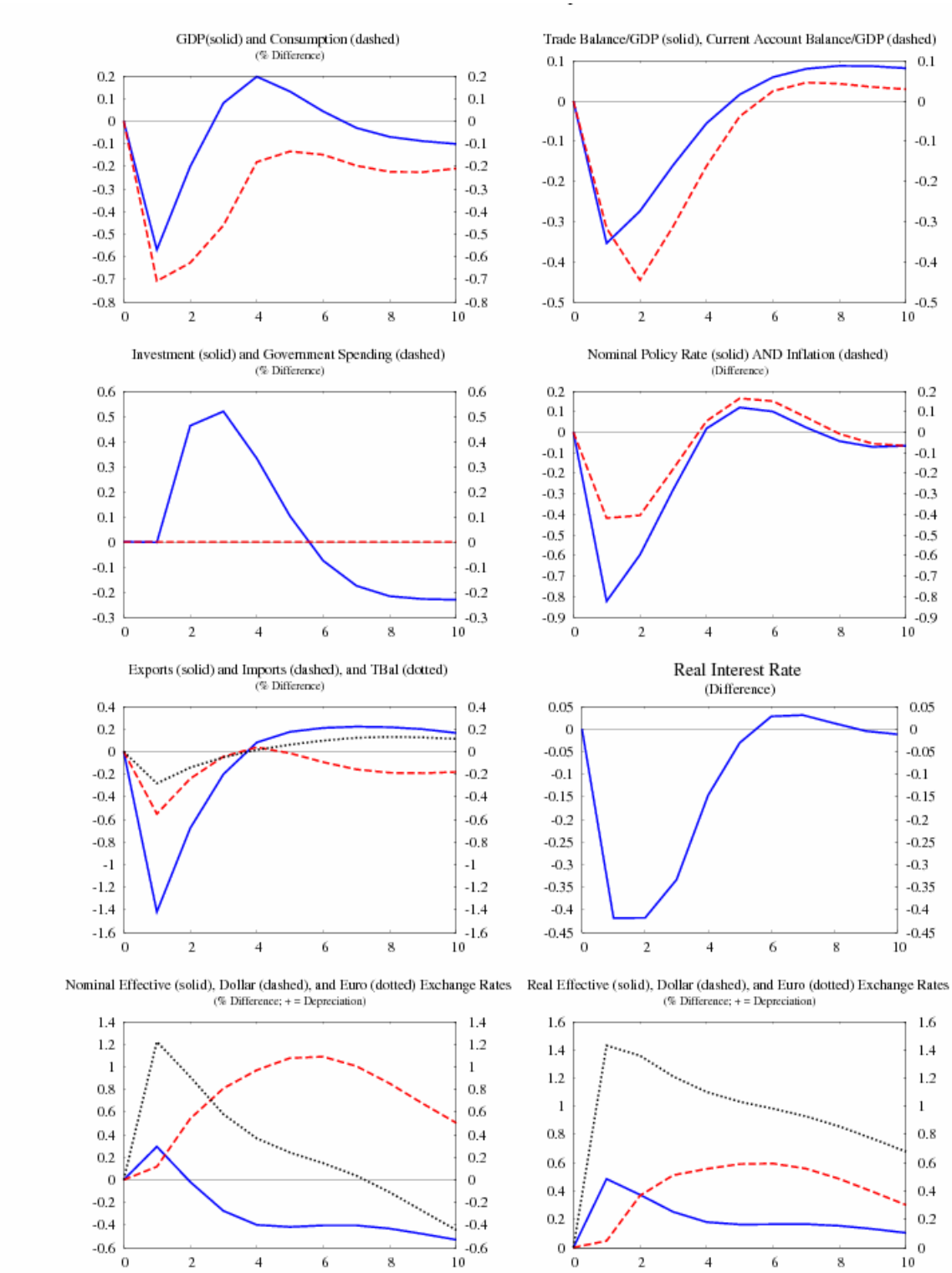

Figure B10. Behaviour of Major Macroeconomic Indicators in the Scenario of a G3 Slowdown with Confidence Effect (Assuming Flexible Exchange Rates in all blocks)
EMEAP6

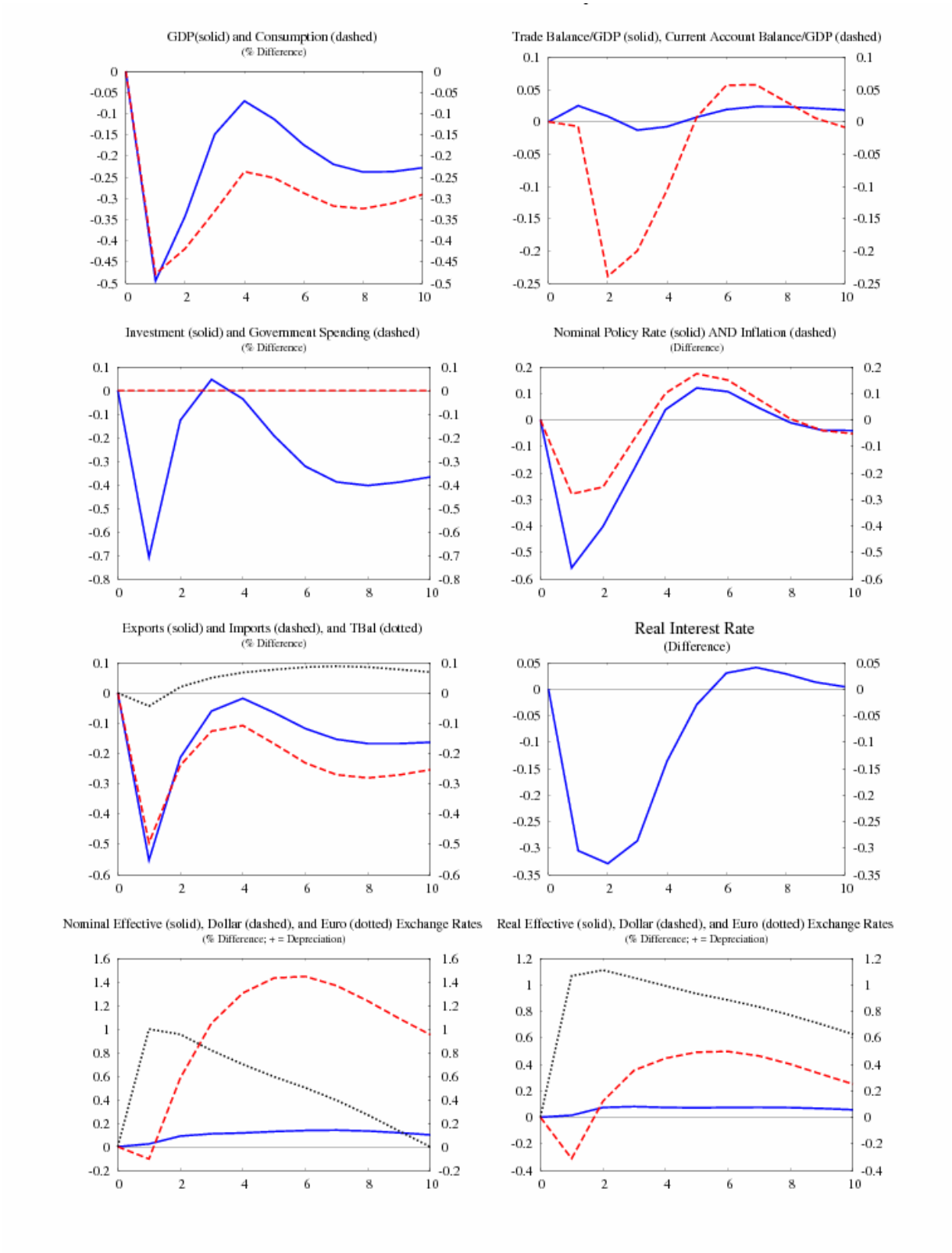

Figure B11. Behaviour of Major Macroeconomic Indicators in the Scenario of a G3 Slowdown with Confidence Effect (Assuming Flexible Exchange Rates in all blocks)
Euro Area

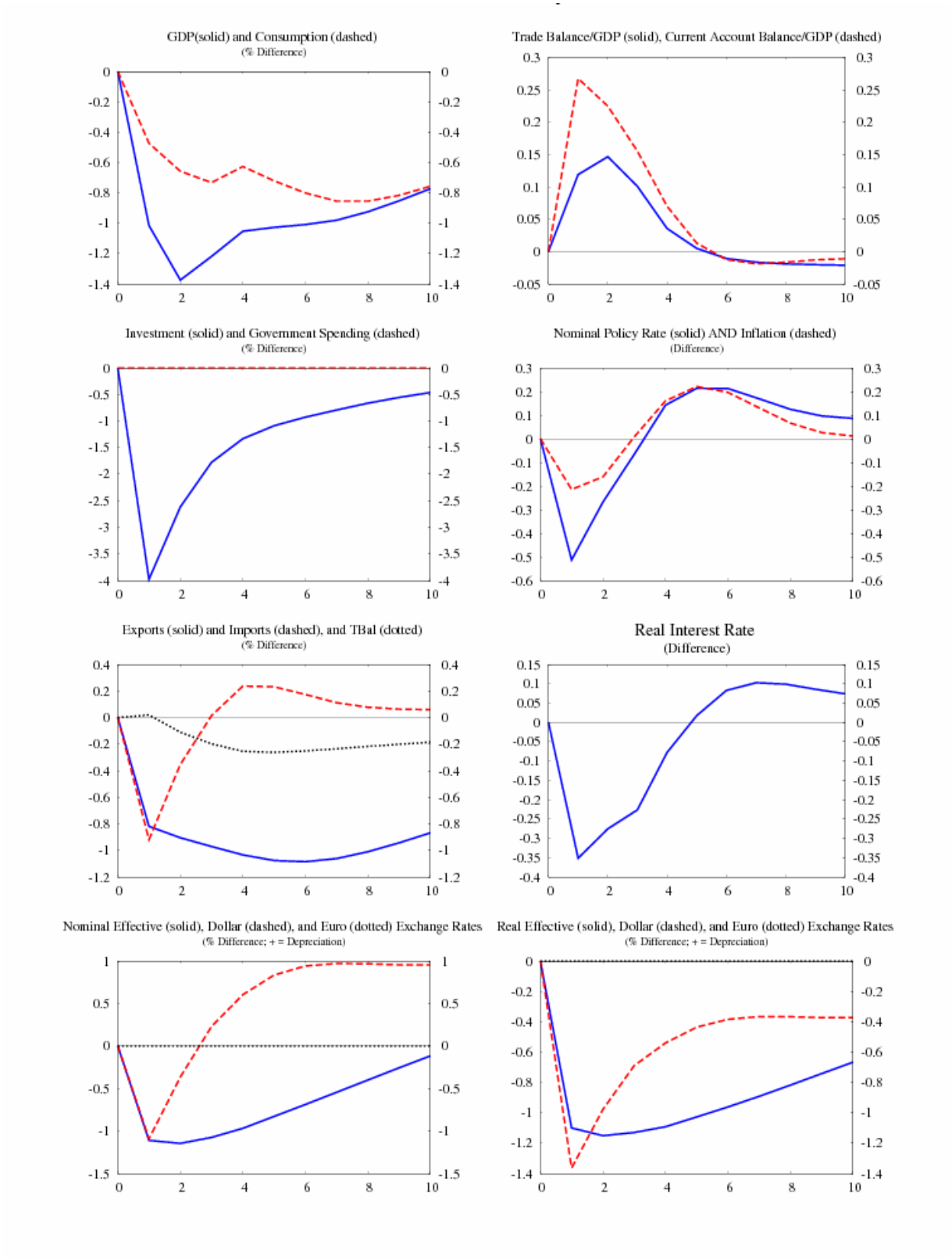

Figure B12. Behaviour of Major Macroeconomic Indicators in the Scenario of a G3 Slowdown with Confidence Effect (Assuming Flexible Exchange Rates in all blocks)
Japan

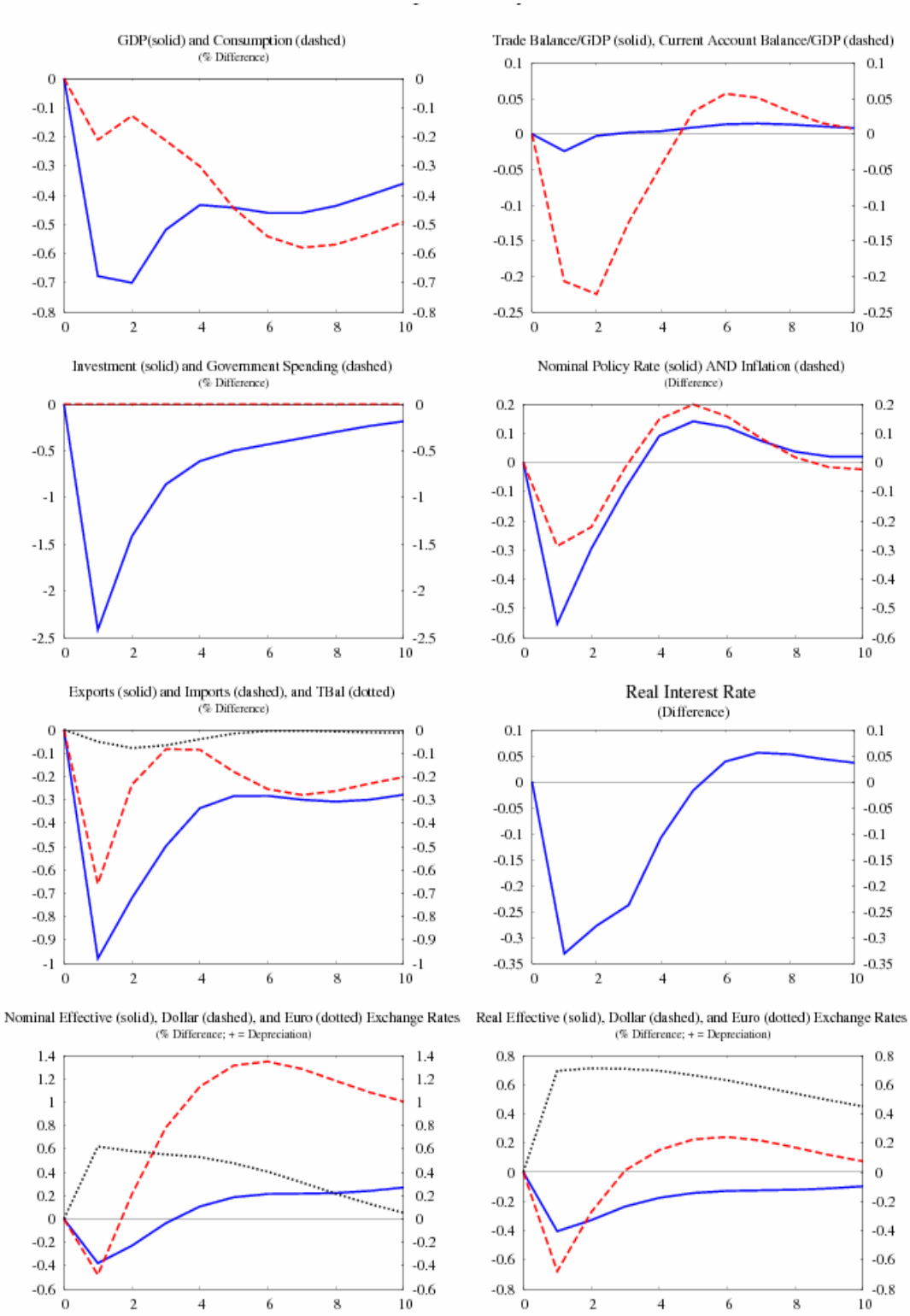

Figure B13. Behaviour of Major Macroeconomic Indicators in the Scenario of a G3 Slowdown
with Confidence Effect (Assuming Flexible Exchange Rates in all blocks)
South Korea

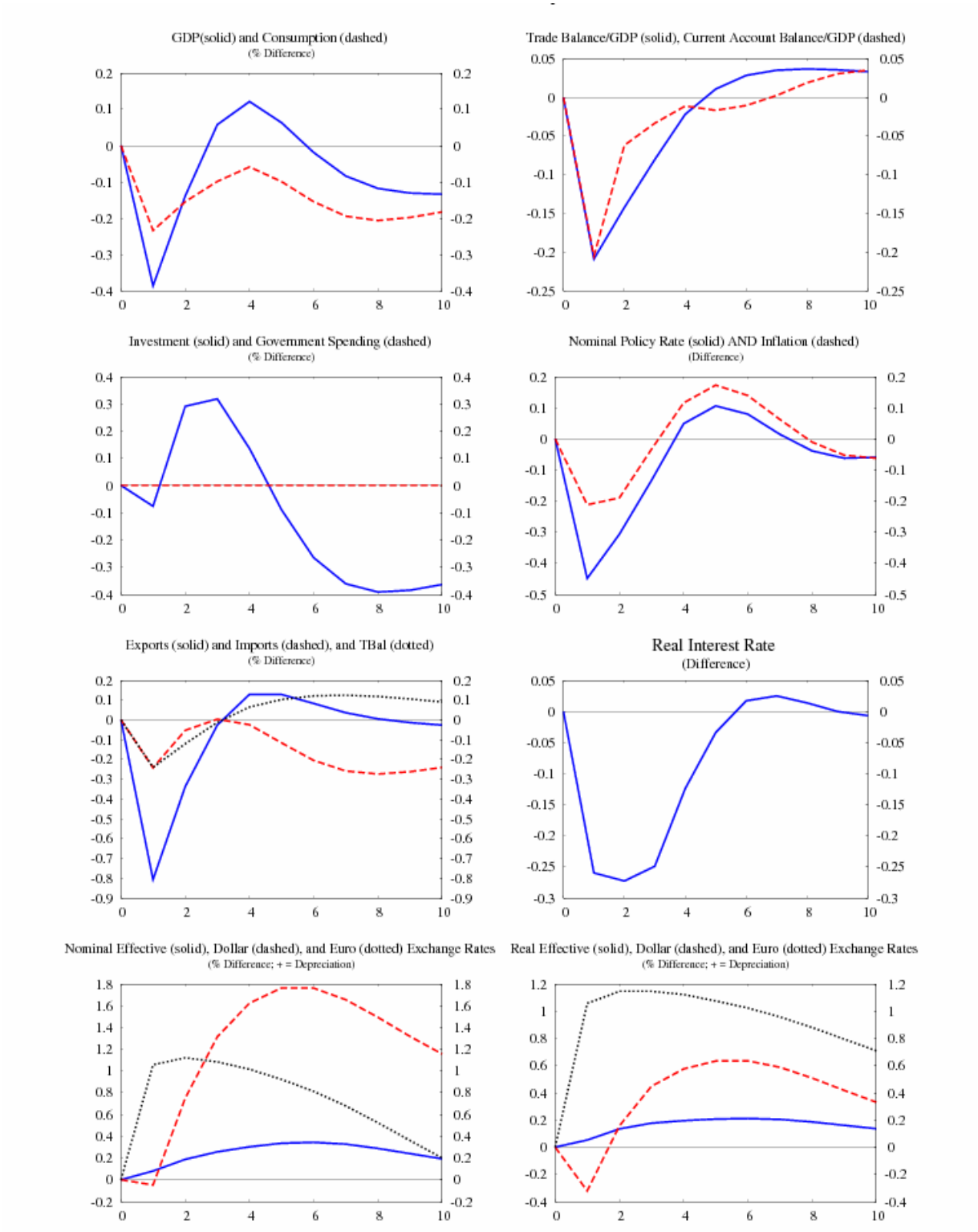

Figure B14. Behaviour of Major Macroeconomic Indicators in the Scenario of a G3 Slowdown with Confidence Effect (Assuming Flexible Exchange Rates in all blocks)
United States