



IMF Working Paper

Countering the Cycle—The Effectiveness of Fiscal Policy in Korea

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Abstract

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The Korean authorities having taken decisive and proactive fiscal measures to help stem the fallout from the current global economic and financial crisis, with the size of the fiscal stimulus well-above the average response of other G20 economies. In this context, a key question is how effective fiscal policy is as a stabilization tool, especially considering the high openness of Korea's economy. Results based on a macroeconomic model calibrated for Korea provide a strong case for using counter-cyclical fiscal policy, especially if measures appropriately focus on spending with a direct demand impact such as investment and targeted transfers. It also demonstrates the importance a complementary monetary response and the benefits to an open economy such as Korea's of global coordination of fiscal stimulus.

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I. INTRODUCTION

The spillovers from the ongoing global financial turmoil and economic downturn have triggered fiscal policy responses in a number of countries. This has reignited the long-standing debate among economists about the ability of fiscal policy to help stabilize economic cycles.

Supporters of an active role for fiscal policy suggest that economies lack an efficient mechanism to return to full potential. Critics, on the other hand, argue that economic agents will offset the impact of fiscal policy on aggregate demand through changes in their saving behavior (so-called Ricardian equivalence). A middle-of-the-road view holds that fiscal policy can be effective provided certain conditions hold, including sound macroeconomic fundamentals, nominal wage and price stickiness, and/or economic agents with finite horizons and liquidity constraints.

The paper will evaluate the size of fiscal multipliers in Korea using the IMF's Global Integrated Monetary and Fiscal (GIMF) model calibrated for Korea.¹ The sensitivity of the results to a number of key factors is also explored. Based on this, the impact of the recent fiscal stimulus packages is estimated and the appropriateness of the current mix of measures is assessed. In this context, the paper also draws on international operational experience with fiscal stimulus measures.

The paper is organized as follows: Section II discusses cross-country studies on the effectiveness of counter-cyclical fiscal policy; Section III will introduce the macroeconomic model used and present simulation results for Korea; Section IV discusses the role for counter-cyclical fiscal policy in the current downturn; and Section V concludes.

II. CROSS-COUNTRY EVIDENCE ON THE COUNTER-CYCLICAL ROLE OF FISCAL POLICY

The question of the effectiveness of fiscal policy is ultimately empirical. There is a vast literature on this topic. Studies generally support the role for counter-cyclical measures, but evidence on the size of fiscal multipliers varies with the analytical approach:

- *Event-studies* give mixed results. The 2001 income tax rebates in the United States are generally considered to have been effective in boosting domestic demand, although the impact on output was relatively small with multipliers well below 1 (Shapiro and others, 2002, 2003). The 1995 stimulus package in Japan is estimated to have been successful, but it did not have a lasting impact on economic activity (Posen, 1998 and Mühleisen, 2000). Finland's response to the 1991 output shock, by letting automatic stabilizers operate fully, is considered to have been largely

¹ I would like to thank Dirk Muir for his invaluable help explaining the workings of the GIMF model.

ineffective because it raised concerns about fiscal sustainability (Corsetti and Roubini, 1996). The IMF *World Economic Outlook* (October 2008) provides evidence that the size of public debt and composition of fiscal stimulus could be important determinants of the effect of fiscal policy.

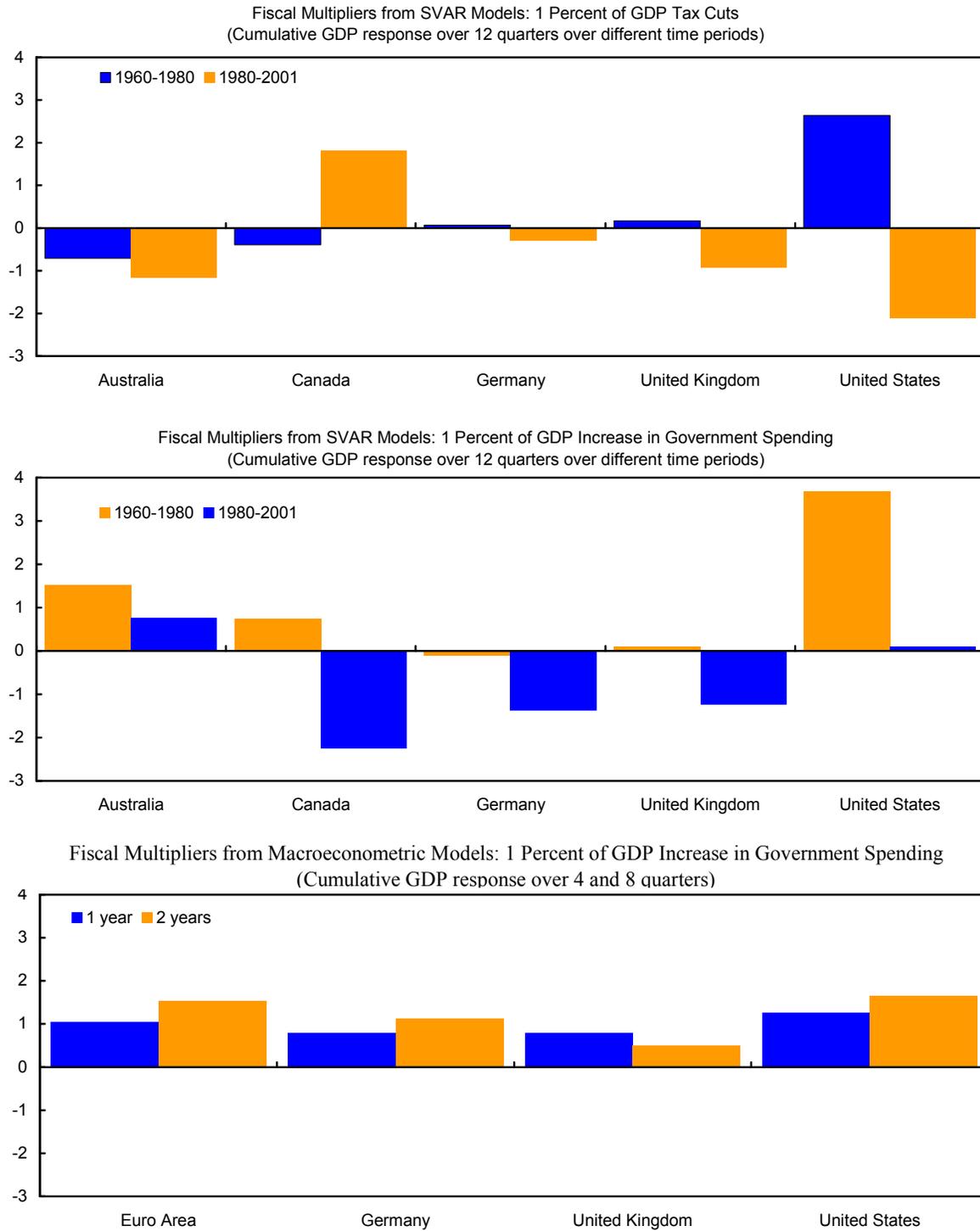
- Studies on advanced economies using *vector autoregression (VAR) methods* conclude that fiscal multipliers have declined over time and, in some cases, may even have been negative (see Perotti, 2005 for an overview). These results (Figure 1), which differ widely across countries, likely reflect (i) increasing leakage through the trade channel due to higher openness of economies; (ii) a decline in the share of liquidity-constrained households due to better access to credit; and (iii) a sharper focus of monetary policy on price stability. Studies for Korea show that multipliers are small and shortlived (see Hur, 2005 for a review of Korean studies and Zebregs, 2003). However, the relatively small multipliers could also reflect that it can be difficult to identify the true discretionary shock when using this method.
- Estimates from *macro models*, on the other hand, show that fiscal policy can be quite effective (Figure 1). Impact multipliers are in the range of 0.3–1.2 percent and expenditure measures appear to have a larger effect than tax measures (Hemming and others, 2002; Botman and others, 2006 and 2007). IMF *World Economic Outlook* (October 2008) finds that government investment has the largest impact on economic activity and inflation. However, the size of the estimated multipliers depends on assumptions about, among others, the monetary regime, labor supply elasticities, and the pervasiveness of liquidity constraints.

Generally, the cross-country evidence suggests that the success of fiscal policy is contingent on a number of factors. First, the fiscal response needs to be *well timed*. This will, in particular, reinforce the effectiveness of fiscal policy in countries with short implementation lags and/or large automatic stabilizers. Second, *strong fundamentals*, including macroeconomic stability and fiscal sustainability, will strengthen multiplier effects by lowering any possible offsets from precautionary savings. Finally, fiscal measures need to be *well targeted* to ensure the largest possible demand impact.

III. THE COUNTER-CYCLICAL ROLE OF FISCAL POLICY IN KOREA

This section will assess the effectiveness of counter-cyclical fiscal policy in Korea based on simulations using a multi-country macroeconomic model. Specifically, fiscal multipliers for different revenue and expenditure measures are estimated and their sensitivity to underlying assumptions is explored. Moreover, the complementary role of monetary policy and benefits of coordinated global fiscal stimulus are also analyzed. The section starts out with a

Figure 1. Fiscal Multipliers from SVAR and Macroeconometric Models
- Cross-country Evidence



Source: Perotti (2005).

nontechnical description of the model.² It then moves on to describe the calibration of the model and finally presents and discusses the results of the simulations.

A. The Structure of the Korea Calibrated Macroeconomic Model

Using a macroeconomic model has the advantage that the results are underpinned by economic theory, although the results are still sensitive to the imposed restrictions and assumptions. For the purpose of this paper, the IMF's GIMF model is used.³

GIMF is an open economy general equilibrium model based on household and firm optimizing behavior in a multi-country setting. It was developed at the IMF and is documented in Kumhof and Laxton (2007). It integrates domestic supply, demand, trade, and international asset markets in a single theoretical framework. This allows for a rich set of transmission mechanisms.

In the model, countries consist of two types of households, both of which consume final retailed output and supply labor to unions. First, there are overlapping generations households with finite planning horizons, and exhibiting external habit persistence. Second, there are liquidity constrained households who do not have access to financial markets, and therefore are forced to consume their after-tax income in every period. The model allows for different degrees of agent myopia. This simplified treatment of lifecycle income profiles adds another powerful channel through which fiscal policies can have non-Ricardian effects (see below). Households of both types are subject to a uniform labor income tax and a uniform consumption tax.

Firms are managed in accordance with the preferences of their owners, the myopic overlapping generation households. Therefore, they also have finite planning horizons.

- Each country's primary production is carried out by manufacturers producing tradable and nontradable goods. Manufacturers buy investment goods from distributors, and they buy labor from monopolistically competitive unions that are subject to nominal wage rigidities, and who in turn buy that labor from households. Manufacturers are subject to nominal rigidities in price setting as well as real rigidities in capital accumulation.
- Manufacturers' domestic sales go to domestic distributors. Their foreign sales go to import agents that are domestically owned but located in each export destination country. Import agents in turn sell their output to foreign distributors. When the pricing-to-market assumption is made, these import agents are subject to nominal rigidities in foreign currency. Distributors first assemble nontradable goods and domestic and foreign

² A technical description of the model can be found in the appendix.

³ This section borrows heavily from Kumhof and Laxton (2007).

tradable goods, where changes in the volume of imported inputs are subject to an adjustment cost.

- The private sector output is then combined with a publicly provided capital stock (infrastructure) as an essential further input. This capital stock is maintained through government investment expenditure that is financed by tax revenue. The combined domestic private and public sector output is then combined with foreign final output to produce domestic final output.
- Foreign final output is purchased through a second set of import agents that can price to the domestic market, and again changes in the volume of imported goods are subject to an adjustment cost. The second layer of trade at the level of final output is critical for allowing the model to produce the high trade to GDP ratios typically observed in small, highly open economies.
- Domestic final output is sold to domestic consumption goods retailers, domestic manufacturing firms (in their role as investors), the domestic government, and to final goods import agents located in foreign economies.
- Distributors are subject to another layer of nominal rigidities in price setting. This cascading of nominal rigidities from upstream to downstream sectors has important consequences for the behavior of aggregate inflation. Retailers, who are also monopolistically competitive, face real instead of nominal rigidities. While their output prices are flexible, they find it costly to rapidly adjust their sales volume. This feature contributes to generating inertia in the consumption dynamics.

Asset markets are also modeled but are incomplete. There is complete home bias in government debt, which takes the form of nominally noncontingent one-period bonds denominated in domestic currency. The only assets traded internationally are nominally noncontingent one-period bonds. There is also complete home bias in ownership of domestic firms. In addition, equity is not traded in domestic financial markets and households instead receive lump-sum dividend payments. This assumption is required to support our assumption that firm and not just household preferences feature myopia.

The model has a number of features that makes it particularly suitable for assessing the effectiveness and joint interaction of fiscal and monetary policy actions.

- **Fiscal policy.** It allows for non-Ricardian responses to fiscal actions by having: (i) overlapping generations with finite economic lifetimes and, thereby, high subjective discount factors; (ii) lifecycle productivity patterns implying a decline in productivity as workers age and a higher discount of any future increase in payroll taxes; (iii) liquidity-constrained households without access to financial markets to smooth consumption and, therefore, prone to spend any changes in their disposable income; and (iv) distortionary

taxes on labor and capital income causing agents to change behavior to changes in these taxes. Moreover, it assumes that government investment in infrastructure raises the government capital stock, which spills over to higher productivity of private factors of production. Other forms of government spending, however, are not productivity enhancing. Finally, a fiscal policy reaction function is applied, which can be set to be equal to a pro-cyclical, counter-cyclical, and cyclically neutral budget rule. In this paper, a cyclically neutral balanced structural budget rule is applied.

- **Monetary policy.** It is in the new-Keynesian tradition, with a number of nominal and real rigidities that allow monetary policy to have real effects on the economy in the short to medium run. Moreover, it uses a stylized Taylor-type interest rate reaction function in which central banks set interest rates on the basis of the deviation of current or forecast future inflation from the inflation target and output growth. A lagged dependent variable smoothes the response of policy interest rates to changes in these factors.

B. Model Calibration

The model is calibrated for two countries, Korea and the rest of the world, and is on an annual basis. The model is calibrated to reflect different features of the Korean economy and policy preferences, including (i) demand and supply side characteristics; (ii) trade structure; (iii) external position and composition of fiscal revenues and expenditures; (iv) fiscal and monetary reaction functions; and, finally, (v) structural parameters for household preferences and firm technology. In addition to author estimates, much of the input used for the model calibration draws on N'Diaye, Zhang, and Zhang (2008) and Kumhof and Laxton (2007).

- **Generally imposed assumptions.** Korea is assumed to comprise around 2 percent of global GDP, which is set to grow by 1½ percent per year in steady state. For Korea and the rest of the world, steady state inflation is set to 2 percent and annual population growth to 1 percent.
- **Demand and supply side structure.** The national accounts data are from the IMF World Economic Outlook databank and are used to calculate the GDP share in Korea and the rest of the world for consumption and investment, including government expenditure. The shares of the tradable and nontradable sectors are also calculated from national accounts data. The tradable sector comprises agriculture, mining and fishing, manufacturing, transport, and communication.
- **Trade structure and external position.** The structure of trade is calculated based on United Nations' COMTRADE database. Exports and imports are divided into three broad goods categories: intermediates, consumption, and investment. In Korea's case, they rely more on exports of consumption and investment goods compared to the rest of the world reflecting the importance of the auto, shipping, and high-end electronics industry.

Correspondingly, they rely more on imports of intermediates, including raw materials. Korea is a net debtor vis-à-vis the rest of the world.

- **Fiscal position, structures, and reaction function.** Korea's government debt-to-GDP ratio is relatively low at 35 percent compared to the 50 percent for the rest of the world. The composition of the fiscal revenue and expenditure side is calculated based on OECD and IMF data. On the fiscal policy reaction function, the authorities are assumed to follow a structural fiscal balance rule, which ensures through spending (or revenue) adjustment that the government debt-to-GDP ratio does not enter an explosive path.
- **Monetary policy reaction function.** To smooth the response of policy rates, the weight on the lagged interest rate is assumed to be 0.25. The coefficient on inflation is assumed to be 0.6, while the coefficient on the output gap is set at 0.25.
- **Structural parameters for households.** To reflect the degree of myopia in the baseline, the households are assumed to have a 20-year planning horizon, equivalent to a 5 percent probability of death. Moreover, workers' productivity is expected to decline by 5 percent annually over their lifetime and 39 percent of the households are assumed to be liquidity constrained. This is broadly in line with the assumption for the rest of the world (37.5 percent), which counts large industrialized economies with lower shares of liquidity constrained households (due to their advanced financial sectors and higher income levels) and emerging economies with higher shares of poor households. Other assumptions about consumer characteristics such as habit persistence and patience are identical between Korea and the rest of the world.
- **Production, depreciation rate, and markups.** The elasticity of substitution between capital and labor in both tradable and nontradable sectors are assumed to be 0.99. The elasticity of substitution between domestic and foreign traded intermediary goods, consumption good, and investment goods 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 nontradable goods is assumed to be 0.5, based on the evidence cited in Mendoza (2005). The annual depreciation rate of private capital is set to 9 percent. The degree of market power is reflected in the markup of price over marginal cost. It is set to 10 percent in the two manufacturing sectors and in the labor market, 5 percent in distribution and retail sectors, and 2.5 percent for import agents.

C. Results From Fiscal Stimulus Simulations

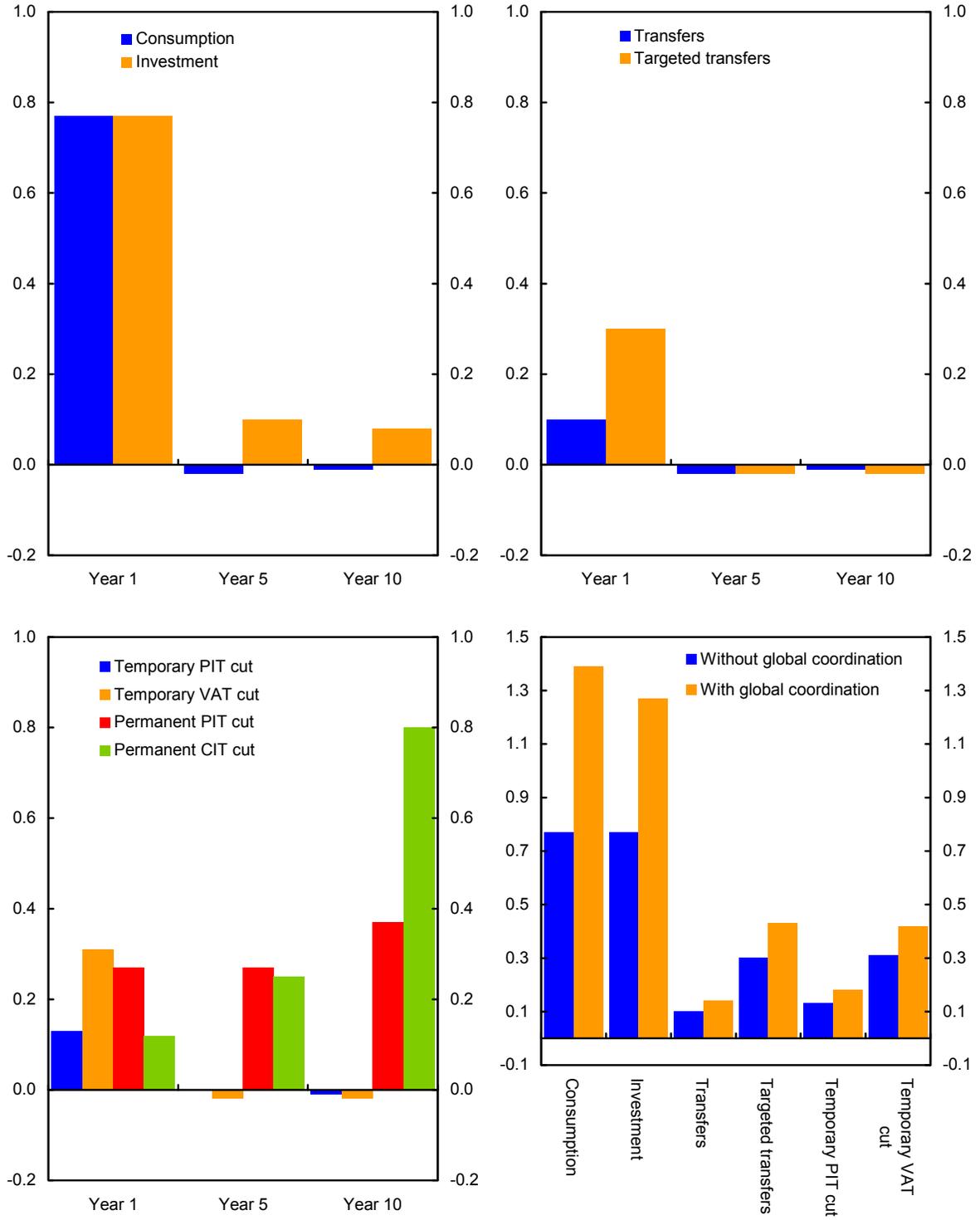
A number of stimulus measures and sensitivity analyses are simulated to derive fiscal multipliers. These simulations are stylized representations of reality and do not consider some of the practical constraints that policy makers may face, including the lag structure of

infrastructure investment projects and political bargaining about measures. Nevertheless, they do give a good sense of the potential growth impact of different fiscal measures, allowing for an assessment of relative effectiveness and overall impact of announced fiscal packages. Moreover, sensitivity analysis can shed light on some of the uncertainties and trade-offs that policymakers will need to consider when designing fiscal stimulus packages.

The simulations focus on both revenue and expenditure measures. On the revenue side, multipliers for temporary and permanent corporate income, personal income, and indirect taxes are derived. On the expenditure side, the growth impact of hikes in public investment, consumption, and transfers is considered. In each case, the fiscal stimulus is assumed at 1 percent of GDP for one year, except for the permanent cuts in corporate and personal income tax rates. To allow for an assessment of the pure discretionary impact on growth, lump-sum transfers are used to offset the impact of automatic stabilizers. In addition, in the period following the fiscal stimulus, lump-sum transfers adjust gradually to return government debt back to its steady-state value over time. The results are presented below and in Figure 2:

- **Investment and consumption.** A 1 percent of GDP temporary increase in government investment and consumption is estimated to increase growth in Korea by around 0.8 percentage points in the first year compared to the baseline without any fiscal stimulus. Over time, the impact on growth from the increase in investment will have the largest impact due to the positive spillovers on household spending as income increases (due to higher investment) and as wealth increases due to the higher productivity of the economy.
- **Income transfers.** General income transfers are found to have a low immediate impact on Korea's GDP the first year (0.1 percent) owing both to the leakage through higher imports and the poor targeting (i.e., the transfers are also given to well-off households with a low propensity to consume out of these transfers). If instead the 1 percent of GDP payout is targeted only at liquidity-constrained households, the impact triples despite the leakage, clearly demonstrating the importance of focusing transfers on low-income households.
- **Taxes.** A temporary cut in either the personal income tax (PIT) or corporate income tax (CIT) would have a very small impact on growth in the first year (0.1–0.15 percent). Like general income transfers, this is due to the poor targeting and the large import content of any associated increase in private consumption or investment. A temporary cut in the value-added tax, on the other hand, gives rise to a much stronger impact on growth in the first year (0.33 percent) as consumers are given the incentive to bring forward consumption while the tax cut lasts. Implementing a permanent cut in the PIT or CIT results in higher multipliers than temporary cuts. This is because it gives rise to a permanent shift in income and, therefore, a stronger consumption and investment response. In the first year, a cut in

Figure 2. Korea: Cumulative Fiscal Multipliers in the Base Case
 (Impact on real GDP from 1 percent of GDP stimulus in year 1 unless otherwise specified)



Source: Author's estimates.

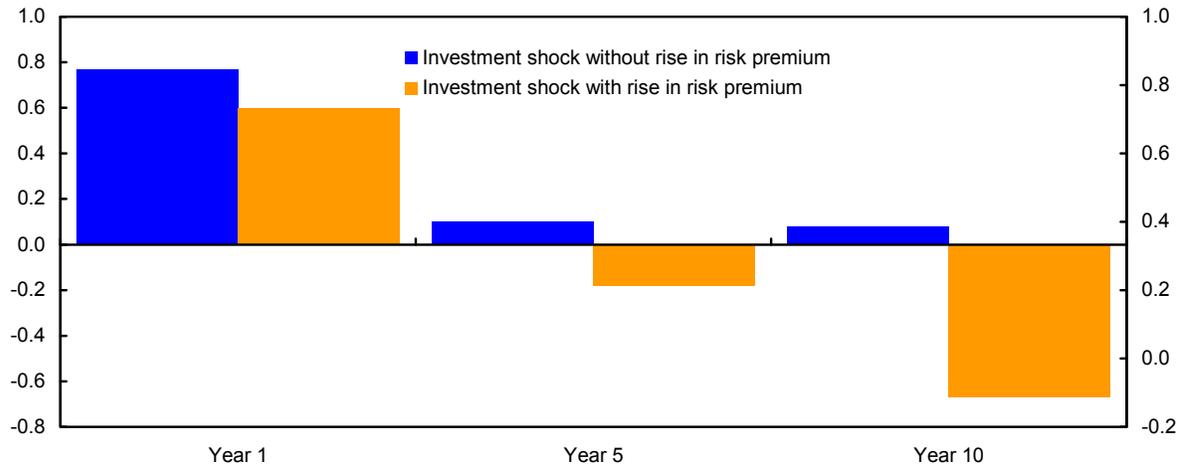
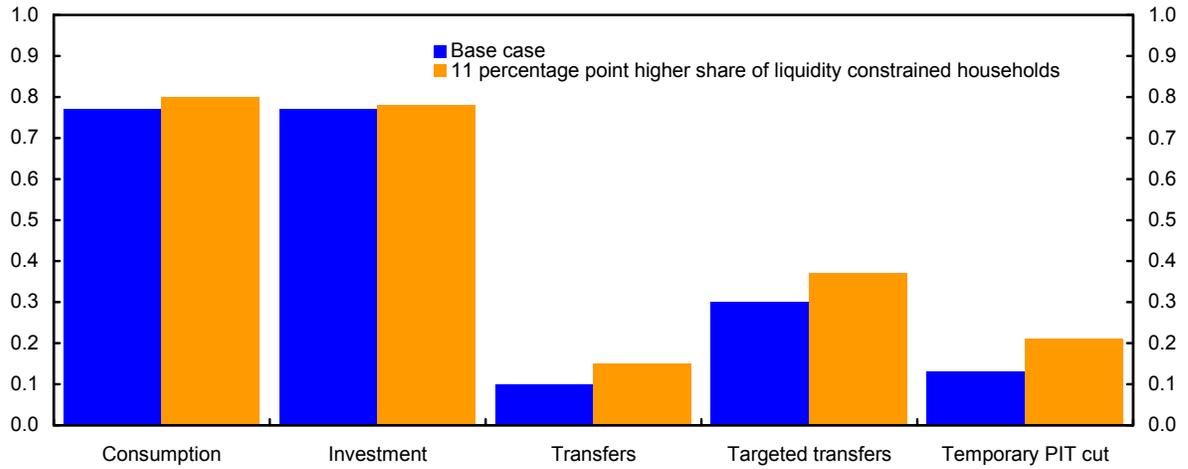
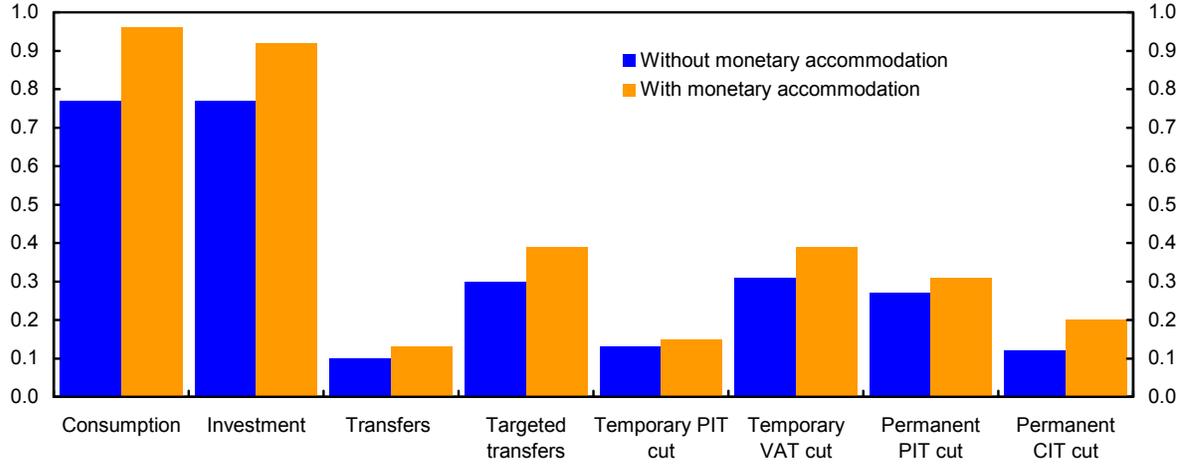
the PIT has the largest impact (0.27), more than twice the impact from a CIT cut and almost matching the effect of a temporary VAT cut. This is because a cut in the PIT has an immediate positive impact through higher consumption by liquidity-constrained households. However, the CIT impact is more persistent and rising as it spurs investment. Among the fiscal measures available, government consumption and investment are clearly found to be most effective as short-term, counter-cyclical tools. However, targeted transfers and a temporary cut in the VAT are also relatively effective in spurring growth immediately.

The multipliers for Korea are generally smaller compared to the rest of the world. This, to a large extent, reflects the more open nature of the Korean economy and, consequently, leakages through the trade channel. However, in the event of a simultaneous stimulus in the rest of the world, the multipliers for Korea increase significantly as the fiscal stimulus abroad translates into increased Korean exports of consumption and investment goods (Figure 2). In turn, this demonstrates the importance of coordinating counter-cyclical policy in an increasingly interconnected global economy.

Sensitivity analysis demonstrates the importance of complementary macroeconomic policies, household income structures, and fiscal credibility considerations (Figure 3).

- **Complementary monetary policy.** In the base case presented above, the central bank is assumed to respond to the increase in activity and inflation from the stimulus measures by raising interest rates, partly countering the initial stimulus. Assuming instead that monetary policy is accommodative during the first year and interest rates are left unchanged, the growth impact from the fiscal measures increases notably in the short term. This difference is, however, eliminated in the following years due to the higher level of inflation, leaving policymakers with a trade-off.
- **Degree of liquidity constraints.** The share of liquidity-constrained households assumed in the base case may be too low in the event of a more severe economic downturn. As unemployment rises and banks tighten credit standards during the downturn, more households could find themselves liquidity constrained. Therefore, if the share of liquidity-constrained households in Korea instead was assumed to be 50 percent, the multipliers for all fiscal measures would be larger. In particular, the impact from income transfers or personal income tax cuts would be higher as a relatively larger share of the beneficiaries would spend the entire increase in their disposable incomes.
- **Rising risk premium.** A significant fiscal stimulus could spark concerns about fiscal credibility and broader macroeconomic concerns, which could be reflected in the assignment of a higher risk premium on a country. If it assumed that the foreign exchange risk premium rises by 1 percentage point and the credit spread on private sector debt increases by 0.5 percentage point, it will reduce the impact of the temporary fiscal stimulus for Korea quite significantly in the short and especially the

Figure 3. Korea: Cumulative Fiscal Multiplier Sensitivity Analysis
 (Impact on real GDP from 1 percent of GDP stimulus in year 1 unless otherwise specified)



Source: Author's estimates.

medium term. Indeed, in the medium term the residual positive impact on GDP from a temporary government investment shock is more than countered by the adverse impact of the higher risk premiums, primarily through weaker investment. In turn, this underscores the importance of signaling continued commitment to fiscal prudence, as the Korean authorities have demonstrated in the past, especially during times of fiscal loosening.

IV. KOREA'S COUNTER-CYCLICAL RESPONSE TO THE CURRENT CRISIS

Korea has taken decisive steps to counter the fallout on the economy from the global economic slump. The government introduced two fiscal packages in 2009, with the original budget and the supplementary budget, totaling 3.6 percent of GDP:

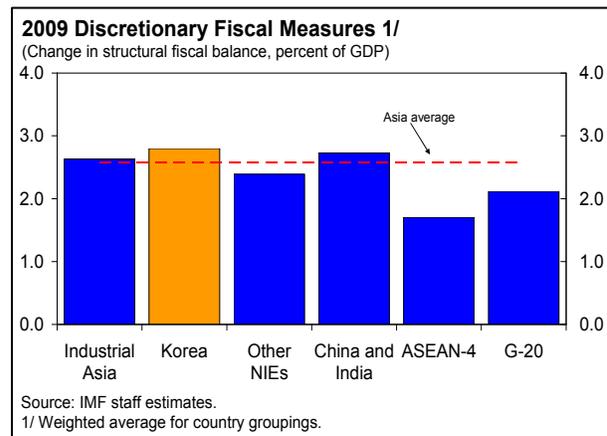
- Around a quarter of the package consisted of revenue measures, primarily permanent cuts in the PIT and CIT rates. The PIT tax brackets were to be cut by a cumulative 2 percentage points in 2009 and 2010 from 8–35 percent to 6–33 percent. The tax rate for the lowest tax bracket was to be reduced by the full 2 percentage points in 2009. Moreover, per-person deductions were increased. Further to this, the lowest CIT rates were to be reduced by 3 percentage points (13 percent to 10 percent) and the highest rates by 5 percentage points (25 percent to 20 percent) by 2010. Moreover, CIT tax brackets were doubled.

Fiscal Stimulus Packages (In percent of GDP)		
	2009	2010
Revenue measures	-1.0	-1.2
Permanent tax cuts	-0.7	-1.0
Temporary measures	-0.3	-0.2
Expenditure measures	2.6	...
2009 revised budget	1.0	...
- SOC expansion in regional areas	0.4	...
- Support for SMEs and self-employed	0.3	...
- Support for low-income households	0.1	...
- Local government support	0.1	...
- Other	0.1	...
2009 supplementary budget	1.7	...
- Support for low-income households	0.4	...
- Support for SMEs and self-employed	0.4	...
- Support for employment	0.3	...
- Local government support	0.3	...
- Green growth and other investment spending	0.2	...
Total	3.6	1.2

Source: Authorities' and author's estimates.

- The remainder of the stimulus measures (75 percent) comprised higher expenditure measures, consisting primarily of income support for low-income households, active-labor market policies, support for SMEs, and investment spending.

Reflecting this, the overall fiscal balance is expected to switch to a deficit of around 2¾ percent of GDP in 2009 and the discretionary fiscal impulse (measured as the change in the structural fiscal balance) is estimated at 2¾ percent of GDP, which is high by G-20 and Asian standards. The change in the structural balance is smaller than the size of the announced fiscal stimulus packages. This partly reflects the



fact that the automatic transfers from central to local governments tied to tax collections were expected to decline in 2009 due to the slowdown and, therefore, were replaced by increased lending to local governments. The increased lending can be considered as discretionary spending and was, consequently, part of the announced fiscal stimulus packages. However, it does not effectively represent additional spending compared to the spending envelope of 2008, but rather a switch between central government spending categories.

The results from the GIMF simulations clearly show that fiscal policy in Korea can be effective as a counter-cyclical tool. This supports the authorities' decision to rely heavily on fiscal policy as a key line of defense against the adverse economic spillovers from the global economic and financial turmoil. Moreover, Korea's relatively favorable fiscal position provided the authorities ample room to loosen fiscal policy during this downturn.

Given Korea's relatively small automatic stabilizers and the magnitude of the slowdown, a counter-cyclical response had to rely on discretionary measures.⁴ However, Korea benefits from relatively short fiscal implementation lags, which have allowed for a fast discretionary response to the weakening economic conditions. This was evident from the positive impetus to GDP growth from public consumption and construction investment during the first half of this year.

The authorities' fiscal response has also fulfilled many of the prerequisites for effective discretionary policy. The fiscal stimulus was *timely* and it was *significant* in size, which was crucial given both the depth of the slowdown and considerable uncertainty surrounding the outlook. However, given the introduction of *permanent* tax cuts, the objective of keeping stimulus *temporary* was not fully achieved. In light of the uncertainty about the global economic outlook and, therefore, Korea's economic outlook, the fiscal stimulus may have to be *prolonged*, so it will be important for the authorities to stand ready to introduce more temporary measures if needed in 2010. It is also important that they clearly signal the readiness to do more to help allay uncertainties about the outlook, thereby lessening precautionary saving motives of corporates and households.

While there is no "magic formula" for the right mix of fiscal stimulus measures, the GIMF simulations and international operational experience suggest a number of general lessons:

- **Revenue measures.** A lowering of personal and corporate income, dividend, and capital gains taxation is often effective in more normal circumstances, but may be less effective when economic conditions are weak because of the likely significant cyclical decline in the relevant tax bases. Personal income tax credits, on the other hand, can be effective through fast and targeted distribution. To foster intertemporal substitution, a possibility is to introduce a temporary tax credit on new investment. A

⁴ Korea does not have a comprehensive unemployment benefit scheme and corporate taxes are assessed on previous year's income.

temporary reduction in consumption taxes can also be effective by bringing forward private consumption, which was confirmed by the GIMF simulations.

- **Expenditure measures.** By international experience, frontloading existing investment projects and stepping up maintenance spending tend to have a more immediate impact on demand. This was demonstrated in the GIMF simulations, which also highlighted the longer-term benefits from higher investments through secondary multipliers. Targeted cash transfers can quickly be disbursed and support the neediest with the highest propensity to consume and who are most at risk during a downturn. Taking steps to further expand social safety nets can also help lessen the precautionary savings of households. However, such measures take time to implement and could serve more as a medium-term objective.

In light of this, the mix of the fiscal stimulus measures introduced in Korea in response to the current economic crisis was broadly appropriate. The stimulus focused mostly on spending measures, including spending with a potential large near-term impact on growth, such as investment spending and transfers to liquidity constrained agents. However, the corporate and personal income tax cuts are not expected to have a large impact on growth in the short term, although they can help support the recovery once it is under way. Assuming that the change in the structural fiscal balance represents the same relative mix of measures announced in the fiscal packages, the model-generated multipliers suggest that the impact on growth in 2009 could be around 1–1½ percentage points. As demonstrated in the simulations, factoring in simultaneous fiscal stimulus in the rest of the world and the positive spillovers to Korea’s exports, the impact from fiscal policy on growth is likely to be even larger this year. Nevertheless, it should be kept in mind that this assumes that the fiscal measures are fully implemented this year, with transfers in the hands of consumers and capital projects carried out.

V. CONCLUDING REMARKS

The analysis in this paper shows that fiscal policy can be effective as a stabilization tool for Korea, despite the openness of the economy. Simulations using a macroeconomic model calibrated for Korea point to a number of key lessons:

- Multipliers differ across fiscal measures—they are larger for infrastructure spending, consumption, and transfers targeted at liquidity-constrained agents. These measures should, therefore, figure prominently in stimulus packages, as they have in Korea. That said, the tax cuts included in Korea’s fiscal stimulus packages are not expected to have a significant short-term impact on growth and, given their permanent nature, will make it more difficult to achieve the needed fiscal consolidation over the medium term.
- The impact of the fiscal stimulus is relatively shortlived and an expansionary fiscal stance will need to be maintained if the recovery is moderate and drawn out, which remains a risk for both for Korea’s and the global economy. It will, therefore, be

important for the Korean government to avoid premature withdrawal of fiscal stimulus in 2010 unless signs of a self-sustaining recovery become firmly entrenched.

- The effectiveness of fiscal stimulus can be strengthened if supported by complementary monetary policy, although this may involve some trade-off between inflation and growth. The simultaneous easing of monetary policy in Korea has likely strengthened the impact of the fiscal stimulus, but not at the expense of the inflation target given the significant widening of the output gap.
- Concerns about fiscal sustainability can impair the effectiveness of short-term fiscal stimulus by raising precautionary savings and risk premiums. Therefore, it is important, even during a crisis, to signal commitment to fiscal sustainability, including by articulating medium-term fiscal consolidation plans.
- Given global economic interconnectedness, a globally coordinated fiscal response helps boost fiscal multipliers, especially for an open economy such as Korea's.

Technical Appendix: Main Equations of GIMF Model

In this version of the model, the world consists of 2 countries, Korea and the rest of the world (RW). The main equations of the model are presented and discussed below, reproducing the GIMF model description presented in Kumhof and Laxton (2007).

A. Households

Overlapping Generations Households

The optimization problem of overlapping generations, OLG, households is described first. A representative member of this group and of age a derives utility at time t from consumption $c_{a,t}^{OLG}$ relative to the consumption habit $h_{a,t}^{OLG}$, leisure $(1 - l_{a,t}^{OLG})$ (where 1 is the time endowment), and real balances $(M_{a,t} / P_t^R)$ (where P_t^R is the retail price index). The lifetime expected utility of a representative household of age a at time t has the form:

$$(1) \quad E_t \sum_{s=0}^{\infty} (\beta\theta)^s \left[\frac{1}{1-\gamma} \left(\left(\frac{c_{a+s,t+s}^{OLG}}{h_{a+s,t+s}^{OLG}} \right)^{\eta^{OLG}} (1 - \ell_{a+s,t+s}^{OLG})^{1-\eta^{OLG}} \right)^{1-\gamma} + \frac{u^m}{1-\gamma} \left(\frac{M_{a+s,t+s}}{P_{t+s}^R} \right)^{1-\gamma} \right]$$

where $\beta < 1$ is the discount factor, $\theta < 1$ determines the degree of myopia, $\gamma > 0$ is the coefficient of relative risk aversion, and $0 < \eta^{OLG} < 1$. The consumption habit is given by lagged per capita consumption of OLG households

$$(2) \quad h_{a,t}^{OLG} = \left(\frac{c_{t-1}^{OLG}}{n(1-\psi)} \right)^{\nu}$$

where ν parameterizes the degree of habit persistence. This is the external habit persistence. Consumption $c_{a,t}^{OLG}$ is given by a CES aggregate over retailed consumption goods varieties $c_{a,t}^{OLG}(i)$, with elasticity of substitution σ_R :

$$(3a) \quad c_{a,t}^{OLG} = \left(\int_0^1 (c_{a,t}^{OLG}(i))^{\frac{\sigma_R-1}{\sigma_R}} di \right)^{\frac{\sigma_R}{\sigma_R-1}}.$$

This gives rise to a demand for individual varieties

$$(3b) \quad c_{a,t}^{OLG}(i) = \left(\frac{P_t^R(i)}{P_t^R} \right)^{-\sigma_R} c_{a,t}^{OLG},$$

where $P_t^R(i)$ is the retail price of variety i , and the aggregate retail price level P_t^R is given by

$$(4) \quad P_t^R = \left(\int_0^1 (P_t^R(i))^{1-\sigma_R} di \right)^{\frac{1}{1-\sigma_R}}.$$

A household can hold two types of bonds, domestic government bonds $B_{a,t}$ denominated in domestic currency, and foreign bonds denominated in the RW currency. The nominal exchange rate vis-a-vis the RW is denoted by ε_t , and $\varepsilon_t F_{a,t}$ are nominal net foreign asset holdings in terms of domestic currency. In each case the time subscript t denotes financial claims held from period t to period $t+1$. Gross nominal interest rates on Korean and RW currency denominated assets held from t to $t+1$ are i_t and i_t^* , respectively. Participation by households in financial markets requires that they enter into an insurance contract with companies that pay a premium of $\frac{1-\theta}{\theta}$ on a household's financial wealth for each period in which that household is alive, and that encash the household's entire financial wealth in the event of his death.

Apart from returns on financial assets, households also receive labor and dividend income. The productivity of an individual household's labor declines throughout his lifetime, with productivity $\Phi_{a,t} = \Phi_a$ of age group a given by

$$(5) \quad \Phi_a = \kappa \chi^a$$

where $\chi < 1$. The overall population's average productivity is assumed without loss of generality to be equal to one. Household pre-tax nominal labor income is therefore $W_t \Phi_{a,t} l_{a,t}^{OLG}$. Dividends are received in a lump-sum fashion from all firms in the nontradables (N) and tradables (T) manufacturing sectors, the distribution (D), retail (R) and import agent (M) sectors, and from all unions (U) in the labor market, with after-tax nominal dividends received from firm/union i denoted by $D_{a,t}^j(i)$, $j = N, T, D, R, U, M$. OLG households are liable to pay lump-sum transfers $\tau_{T,a,t}^{OLG}$ to the government, which in turn redistributes them to the relatively less well off liquidity constrained, LIQ , agents. Household labor income is taxed at the rate $\tau_{L,t}$ and consumption is taxed at the rate $\tau_{c,t}$. It is assumed that retailers, due to adjustment costs, periodically offer incentives (or disincentives) that are incorporated into the effective retail purchase price P_t^R . The consumption tax $\tau_{c,t}$ is, however, assumed to be payable on the pre-incentive price P_t , which equals the price at which retailers purchase consumption goods from distributors.

The real wage is denoted by $w_t = W_t/P_t$, the nominal price, relative price and gross inflation rate of any good x by P_t^x , $p_t^x = P_t^x/P_t$ and $\pi_t^x = P_t^x/P_{t-1}^x$, gross final goods inflation by

$\pi_t = P_t/P_{t-1}$, and gross nominal exchange rate depreciation by $\varepsilon_t = E_t/E_{t-1}$. The production based real exchange rate vis-a-vis the RW is $e_t = (\varepsilon_t P_t^*)/P_t$, with $e_t^* = 1$. The convention that each nominal asset is deflated by the final output price index of the currency of its denomination is adopted, so that real domestic bonds are $b_t = B_t/P_t$ and real internationally traded bonds are $f_t = F_t/P_t^*$. The real interest rate in terms of final output is $r_t = i_t/\pi_{t+1}$.

The household's budget constraint in nominal terms is

$$(6) \quad P_t^R c_{a,t}^{OLG} + P_t c_{a,t}^{OLG} \tau_{c,t} + B_{a,t} + \varepsilon_t F_{a,t} = \frac{1}{\theta} [i_{t-1} B_{a-1,t-1} + i_{t-1}^* \varepsilon_t F_{a-1,t-1}] + W_t \Phi_{a,t} l_{a,t}^{OLG} (1 - \tau_{L,t}) \\ + \sum_{j=NT,D,R,U,M} \int_0^1 D_{a,t}^j(i) di - \tau_{T_{a,t}}^{OLG}$$

The *OLG* household maximizes (1) subject to (2), (3a), (5) and (6). Aggregation takes account of the size of each age cohort at the time of birth, and of the remaining size of each generation. Using the example of overlapping generations households' consumption, we have

$$(7) \quad c_t^{OLG} = n(1-\psi)(1-\theta) \sum_{a=0}^{\infty} \theta^a c_{a,t}^{OLG}$$

The first-order conditions for the goods varieties and for the consumption/leisure choice are, after rescaling by technology, given by

$$(8) \quad \tilde{c}_t^{OLG}(i) = \left(\frac{P_t^R(i)}{P_t^R} \right)^{-\sigma_R} \tilde{c}_t^{OLG},$$

$$(9) \quad \frac{\tilde{c}_t^{OLG}}{n(1-\psi) - l_t^{OLG}} = \frac{n^{OLG}}{1 - n^{OLG}} \tilde{w}_t \frac{(1 - \tau_{L,t})}{(p_t^R + \tau_{c,t})}$$

The arbitrage condition for foreign currency bonds (the uncovered interest parity relation) is

$$(10) \quad i_t = i_t^* \varepsilon_{t+1}$$

A key condition of the model is now discussed. It expresses current aggregate consumption of *OLG* households as a function of their real aggregate financial wealth $f w_t$ and human wealth $h w_t$, with the marginal propensity to consume of out of wealth given by $1/\Theta_t$. Human wealth is in turn composed of $h w_t^L$, the expected present discounted value of households' time endowments evaluated at the after-tax real wage, $h w_t^K$, the expected present discounted value of capital or dividend income, and the expected present discounted value of lump-sum transfers to or from the government τ_{T_t} . After rescaling by technology we have

$$(11) \quad \tilde{c}_t^{OLG} \Theta_t = \tilde{f}w_t + \tilde{h}w_t,$$

where

$$(12) \quad \tilde{f}w_t = \frac{1}{\pi_t g} [i_{t-1} \tilde{b}_{t-1} + i_{t-1}^* \varepsilon_t \tilde{f}_{t-1} e_{t-1}],$$

$$(13) \quad \tilde{h}w_t = \tilde{h}w_t^L + \tilde{h}w_t^K,$$

$$(14) \quad \tilde{h}w_t^L = (n(1-\psi)(\tilde{w}_t(1-\tau_{L,t}))) + \frac{\theta \chi g}{r_t} \tilde{h}w_{t+1}^L,$$

$$(15) \quad \tilde{h}w_t^K = (\tilde{d}_t^N + \tilde{d}_t^T + \tilde{d}_t^D + \tilde{d}_t^R + \tilde{d}_t^U + \tilde{d}_t^M - \tilde{\tau}_{T,t}) + \frac{\theta g}{r_t} \tilde{h}w_{t+1}^K$$

$$(16) \quad \Theta_t = \frac{p_t^R + \tau_{c,t}}{\eta^{OLG}} + \frac{\theta j_t}{r_t} \Theta_{t+1}$$

$$(17) \quad j_t = \left(\beta \frac{i_t}{\pi_{t+1}} \right)^{\frac{1}{\gamma}} \left(\frac{p_t^R + \tau_{c,t}}{p_{t+1}^R + \tau_{c,t+1}} \right)^{\frac{1}{\gamma}} \left(\frac{\tilde{w}_{t+1} g (1 - \tau_{L,t+1}) (p_t^R + \tau_{c,t})}{\tilde{w}_t (1 - \tau_{L,t}) (p_{t+1}^R + \tau_{c,t+1})} \right)^{(1-\eta^{OLG})(1-\frac{1}{\gamma})} \left(\frac{\tilde{c}_t^{OLG} g}{c_{t-1}^{OLG}} \right)^{\eta^{OLG} (1-\frac{1}{\gamma})} \chi^{(1-\eta^{OLG})(1-\frac{1}{\gamma})}$$

The intuition of (11) - (17) is as follows. Financial wealth (12) is equal to the domestic government's and foreign households' current financial liabilities. For the government debt portion, the government services these liabilities through different forms of taxation, and these future taxes are reflected in the different components of human wealth (13) as well as in the marginal propensity to consume (16). But unlike the government, which is infinitely lived, an individual household factors in that it might not be around by the time higher future tax payments fall due. Hence, a household discounts future tax liabilities by a rate of at least r_t/θ , which is higher than the market rate r_t , as reflected in the discount factors in (14), (15) and (16). The discount rate for the labor income component of human wealth is even higher at $r_t/\theta\chi$, due to the decline of labor incomes over individuals' lifetimes. The implication is that government debt is net wealth to the extent that households do not expect to become liable for the taxes necessary to service that debt. The more myopic households are, the greater the portion of outstanding government debt that they consider to be net wealth.

A fiscal expansion through lower taxes represents a tilting of the tax payment profile from the near future to the more distant future, so as to effect an increase in the debt stock. The government has to respect its intertemporal budget constraint in effecting this tilting, and this means that the expected present discounted value of its future primary surpluses has to remain equal to the current debt $i_{t-1} \tilde{b}_{t-1} / \pi_t$ when future surpluses are discounted at the market

interest rate r_t . But, when individual households discount future taxes at a higher rate than the government, the same tilting of the tax profile represents an increase in human wealth because it decreases the value of future taxes for which the household expects to be responsible. For a given marginal propensity to consume, this increase in human wealth leads to an increase in consumption.

The marginal propensity to consume $1/\theta_t$ is, in the simplest case of logarithmic utility, exogenous labor supply and no consumption taxes, equal to $(1 - \beta\theta)$. For the case of endogenous labor supply, household wealth can be used to either enjoy leisure or to generate purchasing power to buy goods. The main determinant of the split between consumption and leisure is the consumption share parameter η^{OLG} , which explains its presence in the marginal propensity to consume (16). While other forms of taxation affect the different components of wealth, the time profile of consumption taxes affects the marginal propensity to consume, increasing it with a balanced-budget shift of such taxes from the present to the future. The intertemporal elasticity of substitution $1/\gamma$ is another key parameter for the marginal propensity to consume. As can be seen in (17) it determines among other things the responsiveness of consumption to changes in the real interest rate r and the decline rate of labor income χ . For the conventional assumption of $\gamma > 1$, the income effect of an increase in r or a decrease in χ is stronger than the substitution effect and tends to increase the marginal propensity to consume, thereby partly offsetting the contractionary effects of a higher r or lower χ on human wealth $\tilde{h}w_t$. Expression (17) also reflects the effects of habit persistence on current consumption.

Liquidity Constrained Households

The objective function of *LIQ* households is assumed to be identical to that of *OLG* households except for the absence of money. But their budget constraint is different in that these agents can consume at most their current income, which consists of their after tax wage income plus government transfers $\tau_{T,a,t}^{LIQ}$. The aggregated first-order conditions for this problem, after rescaling by technology and letting $\tilde{\tau}_{T,t}$ be the lump sum transfer from *OLG* to *LIQ* agents, are

$$(18) \quad \tilde{c}_t^{LIQ}(i) = \left(\frac{P_t^R(i)}{P_t^R} \right)^{-\sigma_R} \tilde{c}_t^{LIQ},$$

$$(19) \quad \tilde{c}_t^{LIQ}(p_t^R + \tau_{c,t}) = \tilde{w}_t l_t^{LIQ} (1 - \tau_{L,t}) + \tilde{\tau}_{T,t}$$

$$(20) \quad \frac{\tilde{c}_t^{LIQ}}{n\psi - l_t^{LIQ}} = \frac{\eta^{LIQ}}{1 - \eta^{LIQ}} \tilde{w}_t \frac{(1 - \tau_{L,t})}{(p_t^R + \tau_{c,t})}$$

Aggregate Household Sector

To obtain aggregate consumption demand and labor supply, the respective quantities for OLG and LIQ households are simply added:

$$\begin{aligned}\tilde{C}_t &= \tilde{c}_t^{OLG} + \tilde{c}_t^{LIQ} \\ L_t &= l_t^{OLG} + l_t^{LIQ}\end{aligned}$$

B. Firms and Unions

In each sector there is a continuum of agents, indexed by $i \in [0, 1]$, that are perfectly competitive in their input markets and monopolistically competitive in their output markets. Their optimization 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. This becomes necessary because the model counterpart of the aggregate income share of capital equals not only the return to capital but also the profits of monopolistically competitive firms. Each sector pays out each period's net cash flow as dividends to *OLG* households. It maximizes the present discounted value of these dividends. The discount rate it applies in this maximization includes the parameter θ so as to equate the discount factor of firms θ/r_t with the pricing kernel for nonfinancial income streams of their owners, myopic households, which equals $\beta\theta (\lambda_{a+1,t+1}/\lambda_{a,t})$. This equality follows directly from *OLG* households' Euler equation $\lambda_{a,t} = \beta (\lambda_{a+1,t+1}r_t)$.

Manufacturers

There are two manufacturing sectors indexed by $J \in [N, T]$, and prices in these two sectors are indexed by $\tilde{J} \in [N, T H]$. Manufacturers buy labor from unions and capital from distributors. They sell goods to domestic distributors, to import agents abroad, and (for adjustment costs) back to manufacturers. Manufacturers' customers demand a CES aggregate of manufactured varieties, with elasticity of substitution σ_J . The aggregate demand for variety i produced by sector J can then be derived by aggregating over all sources of demand. This gives

$$(21) \quad Z_t^J(i) = \left(\frac{P_t^{\tilde{J}}(i)}{P_t^J} \right)^{-\sigma_J} Z_t^J,$$

where $P_t^{\tilde{J}}$ is defined similarly to (4), and where $Z_t^{\tilde{J}}(i)$ and Z_t^J remain to be specified by way of market clearing conditions. The technology of each manufacturing firm is given by a CES production function in capital $K_t^J(i)$ and union labor $U_t^J(i)$, with elasticity of substitution ξ_J and labor augmenting productivity T_i :

$$(22) \quad Z_t^J(i) = F(K_t^J(i), U_t^J(i)) = \left((1 - \alpha_J^U)^{\frac{1}{\xi_J}} (K_t^J(i))^{\frac{\xi_J - 1}{\xi_J}} + (\alpha_J^U)^{\frac{1}{\xi_J}} (T_t U_t^J(i))^{\frac{\xi_J - 1}{\xi_J}} \right)^{\frac{\xi_J}{\xi_J - 1}}$$

Manufacturing firms are subject to inflation adjustment costs $G_{p,t}^J(i)$. Following Ireland (2001) and Laxton and Pesenti (2003), they are quadratic in changes in the rate of inflation rather than in price levels, which helps to generate realistic inflation dynamics. Capital accumulation is subject to quadratic adjustment costs $G_{I,t}(i)$ in gross investment $I_t^J(i)$.

Dividends $D_t^J(i)$ equal nominal revenue $P_t^{\bar{J}}(i)Z_t^J(i)$ minus nominal cash outflows. The latter include the wage bill $V_t U_t^J(i)$ (where V_t is the aggregate wage rate charged by unions), investment $P_t I_t^J(i)$, investment adjustment costs $P_t G_{I,t}(i)$, a fixed cost $P_t^{\bar{J}} T_t w^J$ and price adjustment costs $P_t^{\bar{J}} G_{p,t}^J(i)$. The fixed resource cost arises as long as the firm chooses to produce positive output. Net output in sector J is therefore equal to $\max(0, Z_t^J(i) - T_t w^J)$.

The optimization problem of each manufacturing firm is given by

$$(23) \quad \text{Max}_{\{P_{t+s}^{\bar{J}}(i), U_{t+s}^J(i), I_{t+s}^J(i), K_{t+s+1}^J(i)\}_{s=0}^{\infty}} \sum_{s=0}^{\infty} \tilde{R}_{t,s} D_{t+s}^J(i),$$

where

$$(24) \quad \tilde{R}_{t,s} = \prod_{l=1}^s \frac{\theta}{i_{t+l-1}} \text{ for } s > 0 \text{ (=1 for } s = 0)$$

and subject to (21), (22), and inflation and capital adjustment costs. Apart from standard conditions for optimal choices of labor, investment and capital, the first-order conditions include a Phillips curve equation for sector-specific inflation $\pi_t^{\bar{J}}$.

Unions

Unions buy labor from households and sell labor to manufacturers. Manufacturers demand a CES aggregate of labor varieties, with elasticity of substitution σ_U . The aggregate demand for labor variety i is therefore

$$(25) \quad U_t(i) = \left(\frac{V_t(i)}{V_t} \right)^{-\sigma_U} U_t, \quad ,$$

where V_t is defined similarly to (4), and where U_t is aggregate labor demand by all manufacturing firms. Nominal wage rigidities in this sector take the same functional form

$G_{p,t}^U(i)$ as for inflation adjustment costs. The optimization problem of a union consists of maximizing the present discounted value of nominal wages paid by firms $V_t(i)U_t(i)$ minus nominal wages paid out to workers $W_tU_t(i)$, minus nominal wage inflation adjustment costs $P_tG_{p,t}^U(i)$. The first-order condition is a Phillips curve for wage inflation π_t^U .

Import Agents, Distributors, and Retailers

Korea owns two continua of import agents located in RW (and vice versa), and indexed by $J \in [T, D]$. Import agents in T (D) buy tradable goods (final goods) from manufacturers (distributors) in Korea and sell them to distributors in RW. The latter demand a CES aggregate of imported varieties $Y_t^{JM}(i)$, with elasticity of substitution σ_{JM} .

Distributors buy goods from manufacturers and import agents. They also use the stock of public infrastructure. Distributors sell final output to consumption goods retailers, manufacturing firms (in their role as investors), the government, final goods import agents located in foreign countries, and to various other sectors for fixed costs and adjustment costs. Retailers buy final output from distributors and sell to households.

C. Policy Makers

Fiscal Policy

Fiscal policy consists of a specification of taxes $\tau_{L,t}$ and $\tau_{c,t}$, transfers $\tau_{T,t}$, and government spending for consumption and investment purposes G_t^{cons} and G_t^{inv} . The government's policy rule for transfers from *OLG* agents to *LIQ* agents specifies that dividends of the retail and union sector are redistributed in proportion to *LIQ* agents' share in consumption and labor supply, while the redistributed share of dividends in the four remaining sectors is $\iota \leq \psi$. This gives the following rule:

$$(26) \quad \tilde{\tau}_{T,t} = \iota(\tilde{d}_t^N + \tilde{d}_t^T + \tilde{d}_t^D + \tilde{d}_t^M) + \frac{\tilde{c}_t^{LIQ}}{\tilde{C}_t} \tilde{d}_t^R + \frac{l_t^{LIQ}}{L_t} \tilde{d}_t^U$$

Government consumption spending is exogenous and unproductive. Government investment spending, on the other hand, augments the stock of publicly provided infrastructure capital K_t^G , the evolution of which is given by

$$(27) \quad \tilde{K}_{t+1}^G g_{t+1} = (1 - \delta_G) \tilde{K}_t^G + \tilde{G}_t^{inv}$$

The government issues nominally non-contingent one-period debt B_t at the gross nominal interest rate i_t . The real government budget constraint therefore takes the form

$$(28) \quad \tilde{b}_t = \frac{i_{t-1}}{\pi_t} \tilde{b}_{t-1} - \tilde{s}_t,$$

$$(29) \quad \tilde{s}_t = \tau_{L,t} \tilde{w}_t L_t + \tau_{c,t} \tilde{C}_t - \tilde{G}_t^{cons} - \tilde{G}_t^{inv}$$

where \tilde{s}_t is the structural surplus. Fiscal policy targets a (possibly time-varying) government surplus to GDP ratio, gb_t , which automatically ensures a nonexplosive government debt to GDP ratio by adjusting tax rates to generate sufficient revenue, or by reducing expenditure:

$$(30) \quad gb_t = \frac{\tilde{s}_t - \frac{(i_{t-1} - 1)\tilde{b}_{t-1}}{\pi_t g}}{\tilde{gdp}_t} = \frac{-\tilde{b}_t + \frac{\tilde{b}_{t-1}}{\pi_t g}}{\tilde{gdp}_t}$$

Monetary Policy

Monetary policy uses an interest rate rule to smooth nominal interest rates and to stabilize inflation and output growth. The rule is similar to the class of rules suggested by Orphanides (2003), with one important exception. This is that in our non-Ricardian model there is no unchanging steady state real interest rate. The term proxying the steady state nominal interest rate $r_t^{smooth} \pi_{t+1}$ therefore includes a moving average of past and future real interest rates:

$$(31) \quad i_t = (i_{t-1})^{\mu_i} (r_t^{smooth} \pi_t)^{1-\mu_i} \left(\frac{\pi_{t+1}}{\bar{\pi}} \right)^{(1-\mu_i)\mu_\pi} \left(\frac{\tilde{gdp}_t}{\tilde{gdp}_{t-1}} \right)^{(1-\mu_i)\mu_{gr}},$$

$$(32) \quad r_t^{smooth} = (r_{t-1} r_t r_{t+1})^{\frac{1}{3}}$$

Government policy is defined to be a sequence of policy instruments

$\{G_s^{inv}, G_s^{cons}, \tau_{L,s}, \tau_{c,s}, i_s\}_{s=t}^{\infty}$ such that (26), (28), (29), (30), (31) and (32) hold at all times.

REFERENCES

- Baxter, Marianne and Robert G. King, 1993, "Fiscal Policy in General Equilibrium," *American Economic Review*, American Economic Association, Vol. 83, No. 3 (June), pp. 315–34.
- Blanchard, Olivier and Roberto Perotti, 2002, "An Empirical Characterization of the Dynamic Effects of Changes in Government Spending and Taxes on Output," *Quarterly Journal of Economics* Vol.117, No. 4 (November), pp.1329–1368.
- Blinder, Alan, 2004, "The Case against Discretionary Fiscal Policy," CEPS Working Paper, No. 100.
- Botman, Dennis and Manmohan Kumar, 2006, "Fundamental Determinants of the Effects of Fiscal Policy," IMF Working Paper 06/72 (Washington: International Monetary Fund).
- Botman, Dennis, Phillip Karam, Douglas Laxton, and David Rose, 2007, "DSGE Modeling at the Fund: Applications and Further Developments," IMF Working Paper 07/2007 (Washington: International Monetary Fund).
- Corsetti, Giancarlo and Nouriel Roubini, 1996, "Budget Deficits, Public Sector Solvency and Political Biases in Fiscal Policy: A Case Study of Finland," *Finnish Economic Papers*, Spring, v. 9, iss. 1, pp. 18–36.
- Eskesen, Leif Lybecker, 2008, "The Role for Counter-cyclical Fiscal Policy in Singapore," IMF Working Paper 09/08 (Washington: International Monetary Fund).
- Hemming Richard, Michael Kell, and Selma Mahfouz, 2002, "The Effectiveness of Fiscal Policy in Stimulating Economic Activity—A Review of the Literature," IMF Working Paper 02/208 (Washington: International Monetary Fund).
- Hooper, Peter and Jamie Marquez, 1995, "Exchange Rates, Prices, and External Adjustment in the United States and Japan," in: Kenen, P., ed., *Understanding Interdependence*, Princeton University Press (Princeton).
- Hooper, Peter, Karen Johnson and Jamie Marquez, 2000, "Trade Elasticities in the G-7 Countries," *Princeton Studies in International Economics*, 87.
- Hur, Seok-Kyun, 2005, "Measuring the Effectiveness of Fiscal Policy in Korea," Korea Development Institute (Preliminary).
- International Monetary Fund, 2008a, *World Economic Outlook, April 2008*, World Economic and Financial Surveys (Washington: International Monetary Fund).
- International Monetary Fund, 2008b, *World Economic Outlook, October 2008*, World Economic and Financial Surveys (Washington: International Monetary Fund).

- Ireland, Peter, 2001, “Sticky-Price Models of the Business Cycle: Specification and Stability,” *Journal of Monetary Economics*, Vol. 47, pp. 3–18.
- Kumhof, Michael and Douglas Laxton, 2007, “A Party Without a Hangover? On the Effects of U.S. Fiscal Deficits,” IMF Working Paper 07/202 (Washington: International Monetary Fund).
- Laxton, Douglas and P. Pesenti, 2003, “Monetary Rules for Small, Open, Emerging Economies,” *Journal of Monetary Economics*, Vol. 50, No. 5, pp. 1109–1152.
- Linnemann, Ludger and Andreas Schabert, 2003, “Fiscal Policy in the New Neoclassical Synthesis,” *Journal of Money, Credit and Banking*, Vol. 35, No. 6, pp. 911–929.
- Mendoza, Enrique, 2005, “Real Exchange Rate Volatility and the Price of Nontradables in Sudden-Stop-Prone Economies,” *NBER Working Paper*, No. 11691.
- Mühleisen, Martin, 2000, “Too Much of a Good Thing? The Effectiveness of Fiscal Stimulus”, in *Post-Bubble Blues—How Japan Responded to Asset Price Collapse*, ed. by T. Bayoumi and C. Collyns (Washington: International Monetary Fund).
- N'Diaye, Papa, Ping Zhang, and Wenlang Zhang, 2008, “Structural Reform, Intra-Regional Trade, and Medium-Term Growth Prospects of East Asia and the Pacific—Perspectives from a New Multi-Region Model,” Hong Kong Monetary Authority, Working Paper 17/2008 (Hong Kong: Hong Kong Monetary Authority).
- Orphanides, Athanasios, 2003, “Historical Monetary Policy Analysis and the Taylor Rule,” *Journal of Monetary Economics*, Vol. 50, pp. 983–1022.
- Perotti, Roberto, 2005, “Estimating the Effects of Fiscal Policy in OECD Countries,” CEPR Discussion Paper 4842.
- Posen, Adam, 1998, “Restoring Japan’s Economic Growth,” Institute for International Economics, Washington DC.
- Shapiro, Matthew D. and Joel Slemrod, 2003, “Consumer Response to Tax Rebates,” *American Economic Review*, Vol. 93, No.1 (March), pp. 381–396.
- 2002, “Did the 2001 Tax Rebate Stimulate Spending? Evidence from Taxpayer Surveys,” NBER Working Paper 9308.
- Zebregs, Harm, 2004, “Fiscal Policy in the Korean Business Cycle,” Republic of Korea: Selected Issues, IMF Country Report 04/45 (Washington: International Monetary Fund).