



IMF Working Paper

DSGE Modeling at the Fund: Applications and Further Developments

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Abstract

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Researchers in policymaking institutions have expended significant effort to develop a new generation of macro models with more rigorous microfoundations. This paper provides a summary of the applications of two of these models. The Global Economy Model is a quarterly model that features a large assortment of nominal and real rigidities, which are necessary to create plausible short-run dynamics. However, because this model is based on a representative-agent paradigm, its Ricardian features make it unsuitable to study many fiscal policy issues. The Global Fiscal Model, which is an annual model that uses an overlapping-generations structure, has been designed to analyze the longer-term consequences of alternative fiscal policies.

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I. INTRODUCTION

We provide a nontechnical overview of two large Dynamic Stochastic General Equilibrium (DSGE) models developed at the IMF for research and policy analysis. The paper updates a summary by Bayoumi (2004), which described the Global Economy Model (GEM), the Fund's first multi-country DSGE model.² We then discuss another DSGE model we call the Global Fiscal Model (GFM).³

GEM was one of the first large-scale, micro-founded, multi-country DSGE models to be used in a policy institution.⁴ It is based to a large extent on what is now commonly referred to in the literature as the New Open Economy Macroeconomics (NOEM) paradigm.⁵ The development of DSGE models like GEM has brought together the work in policy institutions and academic research on macroeconomic modeling. The key contribution is building in the nominal and real rigidities necessary to provide plausible properties for practical policy analysis within an optimizing framework.⁶

Developing analytical frameworks that integrate supply and demand factors in a way that can account for the growing interdependency of the global economy through international trade and asset markets has become an important priority at the Fund. The development of GEM has provided a richer articulation of the dynamic interactions between countries and has facilitated a better analysis of policy issues and in very practical terms has allowed the

² See Bayoumi (2004) for a nontechnical summary of GEM and a discussion of some early applications. Douglas Laxton (IMF, Research Department) and Paolo Pesenti (Federal Reserve Bank of New York; IMF at the time of GEM development) were the primary developers—see Laxton and Pesenti (2003). GEM owes much to Dirk Muir, who spent 3 years on leave from the Bank of Canada working on the project. He remains involved through a collaborative effort between the Bank, the IMF, and the Federal Reserve Bank of New York. A large number of others, both inside and outside the Fund, have contributed to GEM's development or its applications.

³ The Global Fiscal Model was developed by Botman, Laxton, Muir and Romanov (2006).

⁴ A similar project has been underway in the International Finance Division at the Federal Reserve Board of Governors—see Erceg, Gust and Guerrieri (2005). DSGE models are also being developed by other central banks. It remains to be seen whether these models will be adopted for their core forecasting and policy analysis frameworks, or whether they will remain tools used to assist in that process from outside the core framework.

⁵ See Lane (2001) for a survey.

⁶ See The Economist (2006) for a discussion of the recent history of developing practical models based on microfoundations. The article suggests that the Bank of Canada's Quarterly Projection Model (QPM), which was developed in the early-1990s, was the first practical model in a policymaking institution sporting microfoundations. QPM and its siblings were an important step forward for central bank models because they included rigorous microfoundations for general equilibrium with stocks. However, most dynamic equations were ad hoc and motivated by capturing stylized facts about cycles and the transmission mechanism. The new DSGE models add considerable rigor by providing microfoundations for the dynamic equations.

staff to use a more structured approach to studying the multilateral and spillover implications of policies taken at a country level.

The first version of GEM was developed to provide a satisfactory initial representation of international macroeconomic interdependencies, with certain features deliberately designated as areas for future development. In particular, the fiscal and financial aspects of the model were kept simple to reduce the risk that the model would be viewed as a black box. Subsequent development of the model was also influenced by this concern. As a result, it was designed so that any extended version can be built in layers so users can more easily track the influence of new features on model properties. Economists both inside and outside the Fund have used variants of GEM, sometimes extending it to a multi-country setup to consider global policy questions.

Emphasis has been placed on using the model to address real-world policy issues and a decision was taken early on to devote time periodically to provide a nontechnical summary of the model and applications, so that a much wider audience would have access to the material. Thus, a few GEM simulations pertinent to the Fund's work were summarized in Bayoumi (2004), including assessing: the effectiveness of alternative monetary policy rules in emerging-market and industrialized economies (Laxton and Pesenti, 2003); the domestic and international spillover effects of structural reform policies (Bayoumi, Laxton, and Pesenti, 2004); and the impact of oil price hikes (Hunt, 2005).

GFM was developed to study the medium and long-term implications of alternative fiscal policies. GEM is focused on cycle dynamics. It is quarterly and lacks many of the important features necessary for long-term fiscal policy issues. GFM is annual and has the necessary structure to deal with those issues.⁷

The remainder of this paper is organized as follows. Section II provides a summary of GEM and its applications. We group the various GEM applications in five main categories, namely: monetary policy rules, structural reforms (in labor and product markets), current account imbalances, and issues related to oil prices and trade. Section III then provides a summary of the Global Fiscal Model (GFM) and applications. Finally, Section IV describes some weaknesses of these models and the implications for model development.

II. THE GLOBAL ECONOMY MODEL (GEM): STRUCTURE AND APPLICATIONS

In recent years there has been growing interest in policy institutions in developing a new generation of models based on the NOEM paradigm. GEM is a large-scale version of these models that nests many of the features found in existing smaller models. In a nutshell, GEM

⁷ GEM uses a representative-agent paradigm, which cannot deal with the departures from Ricardian equivalence necessary for realistic analysis of fiscal issues. GFM uses an overlapping-generations paradigm.

combines microeconomic foundations with a large assortment of both nominal and real rigidities that provide plausible short-term dynamics with a fully articulated description of the monetary transmission mechanism. Moreover, full trade and financial integration creates a coherent theoretical structure for the analysis of global interdependencies, with clear mechanisms for shock transmission. With GEM based on optimizing consumers and producers, it is well-suited to analyze the impact of structural changes that modify underlying behavior and other model relationships, making it less susceptible to the Lucas critique.

This paper presents an overview of the main features as well as the simulation and policy properties of GEM, while avoiding the technical details. Interested readers are referred to the various papers on GEM and its applications for details on the equations and solution procedures.⁸

The model comprises firms that produce goods, households that consume and provide labor and capital to firms, and a government that taxes and spends. Consumption and production are characterized by standard constant elasticity of substitution (CES) utility and production functions. Many small firms produce differentiated goods based on identical (CES) production functions using labor, capital, and intermediate goods such as components or commodities. Goods are differentiated, and as a result firms possess market power and restrict output to create excess profits—this setup allows for a consideration of the effects of wage and price markups. Capital and intermediate goods can be produced and traded while the labor force in each country is fixed, with workers making a choice between work and leisure. Workers also have market power and hence restrict their labor to raise their real wage. The workers own the firms in their country, and hence generate revenues in the form of wages and profits. Workers' income is subsequently spent on home and foreign goods based on a CES utility function.

An innovative feature of GEM is its flexible structure. Users can include or exclude features such as nontraded goods, distribution sectors, or trade in commodities or other intermediate goods. In addition, the model can be calibrated to any number of countries, and most recent work has featured multi-regional blocks.

Figure 1 illustrates a two-country version of GEM. Production is split into two stages. In the first stage, labor, capital, and (possibly) land are used to create intermediate goods that can be traded, such as oil or components for manufacturing. These intermediate goods are then combined with additional labor and capital at home and abroad to produce final goods.⁹

⁸ Laxton and Pesenti (2003) provide a detailed description of GEM.

⁹ The addition of intermediate goods allows the model to examine issues that are important for developing countries. This includes policy challenges in economies that supply low value-added components to industrial countries, or assemble higher-technology components from such countries into final products, or are commodity producers and exporters.

A second feature is the split of final goods into traded and nontraded goods. Differentiating between traded and nontraded goods is central to a number of issues in international macroeconomics. Most notably, rapid productivity increases in traded goods relative to nontraded goods help explain why real exchange rates tend to appreciate in countries that are growing rapidly—the Balassa-Samuelson effect. Including nontraded goods is also useful for many industrial country issues, such as the degree to which actual (and anticipated) productivity increases in information technology goods help explain the strong appreciation of the U.S. dollar over the late 1990s (Hunt and Rebucci, 2005). Another important feature to note is the distribution sector. There is strong evidence from microeconomic studies that the same goods are sold at different prices across countries. One way of incorporating this observation is to include a distribution sector in the model (Corsetti and Dedola, 2002). All domestic and foreign goods need to go through this sector before they can be bought. As the distribution sector is assumed to consist of nontraded goods, this means that the final prices of all goods include both the cost of producing these goods and domestic distribution costs, so prices of final goods that are imported may not fully reflect changes in the exchange rate (even in the long run).¹⁰

A. Parameterization of GEM

The quantitative responses of the model obviously depend on the parameter values. The approach to calibration has been very pragmatic. The basic idea has been to choose coefficients that seem reasonable based on economic principles and an informed understanding of the functioning of the economy, and then examine how sensible the properties of the resulting model are. For most deep parameters that define long-term responses of firms and consumers, such as the responsiveness of hours worked to changes in real wages or the substitutability of different types of goods, estimates from microeconomic studies are used.¹¹ Other coefficients are selected to mimic key characteristics of the economic environment, such as the relative size of the countries, their levels of trade, and their capital-output ratios. Costs of adjustment and habit persistence parameters are chosen to generate realistic dynamic responses.

How well does a policy model like GEM fit the dynamics seen in the data? In this respect, GEM features adjustment costs on real and nominal variables, elongating the responses to shocks and ensuring that consumption and production do not immediately jump to a new long-term equilibrium in response to new information.¹² On the real side, such costs

¹⁰ The answer to this depends on the reason the exchange rate has changed. See Laxton and Rose (2007).

¹¹ See Bayoumi (2004), Box 2.1 on estimating parameters in GEM.

¹² The parameters that are key for the nominal rigidities and real adjustment costs, are chosen in accordance with estimates from the literature and our own empirical work.

prolong the adjustment of the capital stock and the level of imports, while ‘habit persistence’ plays a similar role in prolonging the responses of consumption and hours worked. Sticky prices are also modeled using adjustment costs, with the prices of domestic goods and imports, as well as wages, displaying inertia. These costs are modeled parsimoniously with only one or two parameters determining the speed of response, and are fully integrated into the theoretical structure.

In reviewing the fit of GEM to existing evidence from policy models and estimated vector autoregressions (VARs), Bayoumi, Laxton and Pesenti (2004) provide simulations of temporary exogenous increases in nominal interest rates in the Euro Area (EA) and the United States. The responses of key macroeconomic variables are compared to those of models maintained by the European Central Bank (ECB) and the Board of Governors of the Federal Reserve System (FRB), as well as to VAR studies. The judicious use of adjustment costs enables GEM to mimic the typical hump-shape reaction of GDP to shocks found in these models; that is, hikes in interest rates do not result in instantaneous changes in real activity, but require several quarters to work their effects through the economy.

B. Applications

GEM simulations have been used to provide insights on a wide range of issues. They have been incorporated into the IMF staff’s analysis in the *World Economic Outlook* and research reports on: the evaluation of monetary policy rules, the macroeconomic impact on central European countries of joining the EA, the effects of oil price hikes, and the impact of labor and product structural market reforms on welfare in various countries and regions.

We review briefly some initial GEM applications as well as more recent applications of multi-country versions of the model. We limit our analysis to highlighting the importance of specific or novel features of GEM, crucial economic relations and parameters calibration, and isolated or combined shock configurations for the policy conclusions drawn from the applications. For example, the central tendencies underlying the global macroeconomic imbalances in the early 2000s can be attributed to a combination of related but distinct shocks from changes in savings behavior and changes in relative productivity in different regions of the world. Other simulations conducted to evaluate the optimal monetary policy in open economies examine the frequency of risk premia and productivity supply shocks vis-à-vis demand shocks, and compare the importance of measures of detrended output and the inflation gap in providing signals to monetary authorities.

Optimization role of monetary policy and monetary policy rules

The first application of GEM examined the performance of monetary policy rules in small open economies based on stabilizing variability in inflation and output.¹³ A two-country setup comprising the EA (a relatively-large closed country) and the Czech Republic (a relatively small open country) was designed to capture the trade interlinkages as well as a trend real exchange rate appreciation attributed in part to a strong productivity growth in the tradables sector in the small country. The two-stage trade structure, the inclusion of nontradable goods, and the presence of a distribution sector are highlighted in Figure 1. In this application, the impact of different kinds of disturbances on the optimality of the monetary rule is discussed. The results show that a small economy exhibiting more wage and price flexibility requires a smaller response to aggregate demand shocks compared to a large closed economy with more prevalent aggregate demand disturbances. The small economy's susceptibility to more frequent 'risk premium' financial shocks and productivity disturbances has further resulted in a Taylor efficiency frontier exhibiting less favorable tradeoffs compared to the EA's.¹⁴ Moreover, the highly uncertain effects of potential output shocks on the economy, led to a monetary policy with more weight attached to inflation.¹⁵

A formal welfare analysis measuring gains to consumers is applied to evaluate monetary rules. Research over the last decade has been based on linearized versions of models, and policy rules evaluated with simple quadratic loss functions that penalize variability in output, inflation and interest rates.¹⁶ We use perturbation methods to take second-order approximations of nonlinear models and conduct formal welfare analysis that accounts for the effects that variability has on the mean levels of macro variables. In this GEM application, a stochastic steady state under alternative parameterizations of a simple monetary policy rule is computed, and the parameters are optimized to maximize the unconditional mean of utility, yielding a so-called welfare-based policy rule. The results of this analysis are then compared with the

¹³ See Laxton and Pesenti (2003). Generalized Taylor rules (differing from a traditional Taylor rule by including a lagged policy-interest-rate term) and inflation-forecast-based rules are evaluated.

¹⁴ The Taylor efficiency frontier is a locus of the most efficient pairs of standard deviations for inflation and output by searching over a large number of combinations of weights on interest rate inertia, inflation deviation from desired level, and output gap. South-West locations are considered superior to their North-East analogues.

¹⁵ Schadler, Drummond, Kuijs, Murgasova, and van Elkan (2005) have used results from GEM to study the effects on macroeconomic variability of a representative Central European country joining the European union.

¹⁶ See Juillard, Karam, Laxton and Pesenti (2006). The initial computational burdens constrained this analysis to a single economy that was closed to trade, but with improvements in developing more robust and efficient solution techniques this work will likely be extended in significant ways.

more conventional analysis of Taylor efficiency frontiers, and suggest that consumers' utility is maximized when the monetary authority responds to both inflation and real activity. Significant welfare benefits to adopting a sound monetary framework (located almost directly on the frontier) are noted as a direct outcome of the large number of distortions introduced in GEM, which then afford monetary policies a bigger potential role in reducing distortions and improving welfare.

GEM has also been used to analyze the implications of capital account volatility on monetary policy in a small trade-dependent economy with strong movements in productivity and relative prices.¹⁷ The macroeconomic and policy implications of two different types of capital account shocks on the optimally-calibrated simple monetary policy rules are considered. Foreign direct investment and portfolio investment shocks are characterized as productivity and country risk premium shocks, respectively. The results suggest that shocks associated with supply-side improvements could help offset the demand-side effects and dampen the inflationary impact and hence require less aggressive monetary policy responses to keep inflation close to target. To the extent that capital account volatility increases the volatility of key macroeconomic variables, however, monetary policy may need to become more responsive and be somewhat less constrained by past interest rates.

A version of GEM calibrated to the Japanese economy has been used to study the effects of demand and supply shocks contingent on whether or not a zero interest floor (ZIF) is binding.¹⁸ The results show that negative demand shocks have more prolonged effects on the economy when the ZIF is binding than otherwise. In this regard, positive supply shocks that raise potential output can extend the period of time over which the ZIF may be expected to bind and therefore make the economy more sensitive to negative demand shocks. The problems with inflation-targeting rules in a deflationary environment are further reviewed and the advantages of policy rules that include price-level-path targeting are illustrated through the provision of better guidelines for monetary policy in a deflationary environment.¹⁹

Structural reforms

Significant reform in labor and product markets has been the subject of great debate on how economies can achieve their full potential in terms of employment and productivity growth.

¹⁷ See Karam, Laxton and Tamirisa (2005).

¹⁸ Laxton, N'Diaye and Pesenti (2006) employ a variant of the multi-country version of GEM used in Faruquee, Laxton, Muir and Pesenti (2005).

¹⁹ In another application of GEM pertinent to rigidities and monetary policy rules, Batini (2005) employs two calibrations of GEM depicting high and low integration environments and assesses the changing role of nominal and real rigidities in the past three decades in G-7 countries.

Conceptually, rigidities in labor and product markets can be modeled in a stylized manner by the size of markups in these markets. GEM is well suited to do this. It incorporates monopolistic competition in markets specified through markups, which allows the explicit analysis of removing distortions. Frictions in the adjustment to shocks and a monetary policy reaction function are crucial features in GEM for exploring the transition costs of reforms and their monetary policy implications. Furthermore, GEM multi-country dimension allows for consideration of international linkages.

Bayoumi, Laxton and Pesenti (2004) provide a model-based quantitative assessment of macroeconomic adjustments paths and welfare-based measures of the impact of structural reforms that increase the competition levels in the EA labor and product markets to U.S. levels. The results in this two-country version of GEM show that greater competition in product and labor markets benefits an economy through ensuring more efficient allocation of resources, boosting both investment and hours worked; increasing the responsiveness of prices and wages to market conditions as a direct result of lowering the monopolistic power of producers and workers; and easing the task of monetary policymakers in stabilizing domestic output and inflation, leading to lower sacrifice ratios (see Table 1).²⁰ Positive spillovers to the rest of the world are also observed mainly through a favorable terms-of-trade abroad.

The issue of labor and product markets reforms in the European Union (EU) is analyzed with GEM by Schule (2005) and Everaert and Schule (2006). The model is used to quantify the steady-state effects of market reforms on key macroeconomic variables, to investigate international spillovers, and to explore transition costs and monetary policy implications for the EA. Novel features of this analysis of the impact of product and labor market reforms include: multi-country blocks (within EU, calibrated for France and then Belgium, the EA, and old and new non-Euro-area EU member states –see attached Figure 2); and a focus on reform in prototype large and small Euro-area countries, permitting the quantification of spillovers and the discussion of the monetary policy reaction of the ECB.²¹ Moreover, the role of complementary reforms (across labor, services and tradable good markets) and coordinated reforms (Euro-area-wide) is emphasized.

The findings point to sizeable *steady-state* effects of product and labor market reforms on output (well above 10 percent), with the size depending in a nonlinear manner on the degree

²⁰ A useful metric is provided through the ‘sacrifice ratio’ (the cumulative annual output gap that is required to permanently reduce the inflation rate by one percentage point). Intuitively, monetary policy is easier to operate if the output losses associated with changing inflation are small.

²¹ Schule (2005) explores some fiscal policy implications of market reforms by modifying the model to allow for (i) rule-of-thumb consumers, (ii) distortionary taxes, and (iii) a fiscal rule operating through a discretionary tax adjustment to keep the public debt on a trend commensurate with the announced plans of the authorities.

of pre-reform rigidity in the various markets.²² More flexible countries, with already high level of per-capita GDP, reap less benefits from reforms, though possible gains are still substantial (e.g., for Denmark by Hunt, 2004; and for Finland by Luna, Lutz and Stavrev, 2005). Steady-state spillover effects are modest because supply and demand in the reforming country rises broadly proportionally. While all reforms are welfare enhancing, labor market reforms are associated with lower steady-state real wages, whereas product market reforms with higher steady-state real wages. On the other hand, *transition dynamics* are important. Synchronizing the timing of product and labor market reforms mitigates the downward effect on real wages when labor market reforms are undertaken separately. Reforms in a third market (nontradable services) boost real wages with a likely negative impact on consumption and output. Finally the distinction between small and large countries is highlighted: reforming product and labor markets concurrently may be sufficient to avoid a decline in real wages, consumption, and output in a small country but not in a large country (given the difficulty of selling its products abroad without a decline in prices). Another element of synchronization of reforms among EA economies could modify this result—to the extent that reforms boost potential output significantly for the entire EA, monetary policy could be eased, thereby eliminating transition costs.²³

Current account imbalances

An apparent macroeconomic risk for the world economy is the unprecedented widening of external imbalances in recent years. The current global constellation of imbalances has expanded the roster of players considerably and suggests the need for a broader adjustment—diversified across countries and policy instruments—to achieve a more orderly unwinding of the imbalances without a protectionist backlash. Moreover, although sanguine views about this issue abound, real-world features and frictions present a less complacent stance on the risks of the large global imbalances and large shocks—including uneven economic and fiscal expansions—that have accompanied them. Although a number of factors and policies have contributed to the current imbalances, the center of concern is the massive U.S. current account deficit and whether its resolution will trigger large exchange rate changes.

GEM has been used to view these multi-faceted issues coherently through the lens of a dynamic, multi-region model of the global economy, asking whether the present current-account imbalances are sustainable and for how long, and if unwinding is required how an

²² Table 2 and Table 3 illustrate two GEM simulations concerning the implementation of reforms in France only, and in France and the EA simultaneously, reporting the long-run impact on France.

²³ Chami, Elekdag, and Tchakarov (2004) apply a similar industrial structure of GEM to investigate the economic impact of economic integration of Yemen and the Cooperation Council for the Arab States of the Gulf (GCC) across a plausible range of markup parameters. Integration is found to improve competition with sizable economic benefits to be reaped for both countries—gains in GDP in the 18 to 20 percent range, and substantial increases in the other real variables. A more cognizant account of the ‘rigid’ reality of the markets in the region still points to reduced but still large gains—more in favor of the poorer accession country.

orderly process could be realized without substantial disruption to global growth, trade and capital flows. Laxton and Milesi-Ferreti (2005) address the sustainability of global imbalances in the long run and their unwinding.²⁴ They depict certain stylized facts regarding current account imbalances, real exchange rate movements, and the dispersion in net foreign asset positions (see Figure 3) and present model-based adjustment scenarios and policy initiatives that can help reduce the risks of a disorderly adjustment. A benign scenario is characterized by a sizable private-sector-led adjustment, accompanied by somewhat lower U.S. and global growth, and noticeable but orderly exchange rate adjustments in a number of regions. However, potential risks from a more disorderly adjustment highlight the danger that sudden shifts in market sentiment along with rising protectionist pressures could have on global growth. Adjustment scenarios illustrate the benefits and costs of three public policy actions—increased exchange rate flexibility in emerging Asia, faster fiscal consolidation in the U.S., and growth-enhancing structural reforms in the EA and Japan. It is found that benefits would be magnified and risks minimized by joint action on the part of all major players in the global economy, a clear instance where coordinated policies would be welfare enhancing. Global imbalances in general, and the ultimate buildup in U.S. net foreign liabilities in particular, would be significantly reduced (see Figure 4), and the risk of an abrupt adjustment in imbalances considerably limited.

The above analysis focused on the current global outlook. Hunt and Rebucci (2005) examine the dynamics of the U.S. current account imbalances over the 1990s; they conclude that accelerating productivity growth contributed to the real exchange rate appreciation and the trade balance deterioration witnessed in the second half of the 1990s. However, adding a portfolio preference shift in favor of U.S. assets and learning about the persistence of both shocks seem to explain the data a bit better.

A multi-region variant of GEM comprising the U.S., EA, and the rest-of-the-world (RW) explores the factors that facilitate an orderly rebalancing process from an EA perspective. A reversal of a positive total factor productivity differential in favor of the U.S. since the mid-1990s, combined with a reversal in the persistent decline in perceived U.S. asset risk profiles would unwind the current account imbalances in an orderly manner. The implications of this benign global rebalancing scenario on the EA (see Table 4) can be summarized by: wider swings in the euro, insignificant realignments in the area-wide current account, and a monetary policy easing to accommodate the disinflationary impulses from the shock. Risks to this rebalancing scenario are then considered in terms of (i) the RW limiting its nominal exchange rate flexibility, and (ii) a loss of appetite of investors for U.S. instruments. In the first case, this would exacerbate the adjustment process, leading to larger swings in domestic and net external demand across regions. Larger effective euro appreciation initially, and deteriorating competitiveness would harm the area's external balance and growth at the outset, but would be reversed eventually with the RW exhibiting stronger growth, higher inflation and a real appreciation. Under (ii), if global adjustment was largely realized through a loss of appetite for U.S. held assets—without a supportive underlying reallocation of domestic demand and potential output growth, the implications for the EA economy could

²⁴ See also Faruqee, Laxton, Muir and Pesenti (2005).

become more disruptive, but the reduction in global imbalances would be minimal. The current account and growth implications would be especially acute if the euro were to bear the brunt of the currency realignment.

On the issue of rising protectionism and global imbalances, a multi-region version of GEM (emerging Asia included) has also been used to provide a quantitative assessment of the implications for the world economy of a potential resurgence in protectionism. At the heart of the issue are persistent and widening trade and payments imbalances—particularly, sizable trade surpluses in emerging Asia, accompanied by substantial foreign reserve accumulation and large-scale intervention in currency markets to limit exchange rate flexibility, possibly resulting in undervaluation of Asian currencies. In short, the results indicate that protectionism cannot defuse global imbalances. A baseline scenario is constructed in which imbalances have developed owing to the country-specific shocks in the past. The shocks have been calibrated so the model generates values for the relevant endogenous variables that are broadly consistent with observed levels. The model then generates dynamic paths for all endogenous variables that converge to new world equilibrium levels, providing plausible quantitative price and quantity adjustments associated with global rebalancing. Further simulation exercises consider the effects of protectionism through the imposition of uniform and discriminatory tariffs, as well as the case of tariff retaliation. Estimates indicate that a generalized 10 percent hike against emerging Asia has a small positive effect on the U.S. current account that disappears after about two years. Furthermore, in the absence of further adjustment in net saving, there could even be deterioration. Similar effects hold in the RW.

The systemic effect of oil prices

Volatility in world energy prices has been a major policy issue. The Research Department at the Fund has provided scenarios pertaining to oil price shocks using different modeling methodologies. Recent GEM simulations of the effects of oil-price hikes are based on an integrated structure that models both the supply and demand for energy, capturing the channels through which energy affects the economy.²⁵

In GEM, energy is produced using capital, labor and a fixed factor, land, using a CES technology. Energy is traded and consumed by firms and individuals—thus the effects of oil-price shocks are seen across a wide range of relationships, which helps to identify economic linkages more precisely. Price shocks can originate from two sources on the supply side: changes in the quantity of land available for energy production, or changes in the monopolistic behavior of energy firms.²⁶ Energy (a tradable good) is

²⁵ In past MULTIMOD simulations, the effects of oil prices were approximated through changes to total factor productivity. Berg, Karam, and Laxton (2006) study oil price shocks using a small two-country model, where demand and supply effects are introduced via a Phillips curve and a potential output equation. More recently, this analysis has been extended to a multi-country setting (Japan, the EA, the U.S. and RW). The results are found to be close to the ones generated in more elaborate models, like GEM.

²⁶ The market power of the OPEC was captured by assuming that oil producers are monopolistic competitors, so that oil price hikes can be triggered by an increase in market power through greater compliance of individual OPEC members with production quotas; see Bayoumi (2004).

used as an intermediate input in production of both traded and nontraded intermediate goods; it also enters as a final consumption good. The model incorporates a distribution sector to make the energy input available (using local nontradable goods only) to firms producing intermediate and final goods, which reduces the impact of changes in the producer price of energy on the final consumption price. In this application, these distribution services represent things like transportation and refining.

The impact of oil price hikes on U.S. growth simulated under the two roles of energy in the model, each with different frictions, is expected to affect volumes and prices with different speeds. A 50 percent increase in the price of oil (and gas), under three alternative durations, is induced via a change in energy producer markup. Hunt (2003) shows that the impact on growth of temporary shocks is mild,²⁷ and those shocks of more persistence would exert only a marginally larger effect on output, with CPI inflation increasing initially but returning to baseline relatively quickly. Magnifying risks to this benign scenario exist: a portfolio shift out of U.S. denominated assets would exacerbate the effect on the current account deficit, with deeper impact on consumption and investment; a rise in labor bargaining to preserve real consumption wage, in contrast to the model's structure of nominal wage stickiness, would also generate more persistent CPI inflation and longer-lived output effects; and finally, a loss of consumer and business confidence may also complicate matters.

In a separate paper, Hunt (2005) reports that oil price shocks alone cannot account for the stagflation of the 1970s, but with two main caveats: (i) if households resisted the decline in their real incomes arising from the increase in energy costs, and (ii) monetary authorities facilitated that resistance with accommodative policy because it was overestimating the level of potential output (Orphanides, 2003), then oil price shocks could have had a bigger role in the stagflation.

Trade

The benefits and costs of joining a monetary union—the macroeconomic costs of the loss of monetary sovereignty and the microeconomic gains from greater international integration—are assessed using a macroeconomic model underpinned by a microeconomic theory of international trade based on comparative advantage.

Under this extension of the NOEM paradigm, GEM tries to answer to the interesting dynamic puzzles in accession countries (the Czech Republic, for example), in particular understanding the trend real exchange rate appreciation, the high levels of investment and the rise in the consumption share over the last decade. While Halpern and Wyplosz (2001) suggest that the Balassa-Samuelson Hypothesis (BSH) may be able to account for some of the upward trend in the real exchange rate, substantial room for other explanations remains, given that the trend has been much stronger than implied by the catch-up in productivity levels. Moreover, the

²⁷ This reflects the theoretical structure, as producers and consumers feel less pressure to adjust knowing that the impact is not permanent.

tradables-nontradables framework, which is the basis for the BSH, cannot easily explain the strong trends observed in trade flows. In this regard, GEM extends this framework in an effort to better understand the observed trends.

A number of novel features associated with the interaction of trade and macroeconomic dynamics were added. The production structure is extended to give rise to an increase in trade volumes in response to shocks such as the rapid improvements in technology and reductions in trading costs. Trade in intermediate goods (the stage of production where the main trade expansion occurred) is based on a Dornbusch-Fischer-Samuelson comparative advantage theory, where what is traded is determined endogenously by the interaction between the costs of trading and relative productivity levels of the potential producers of any given good in the two countries. A ‘time-to-build markets’ constraint on trade is added to reproduce the gradual response of trade to movements in the real exchange rate. This captures the significant efforts in terms of time and resources that are typically necessary for companies to develop new supplier relationships.

The model is well suited to analyze the benefits that can be obtained from the most important medium- to long-term effects of EMU in an integrated framework, while cognizant of some limitations dealing with the fiscal compliance standards facing new EU entrants. Based on some long-run comparative statics and dynamic simulation results concerning the trade-related benefits of EMU, the model shows substantial long-run increases in trade, output and welfare that are almost certainly larger than the short-run adjustment costs. However, these long-run benefits accumulate slowly and may not exceed the costs in the early stages of adjustment.

III. THE GLOBAL FISCAL MODEL (GFM)

We have described how a prototype two-country GEM with an initial emphasis on monetary issues was extended to cover a wide range of policy issues in a multilateral context. The multi-country version of GEM permitted a detailed examination of international spillover effects, a core theme of the Fund’s work.²⁸ However, in part owing to its representative-agent paradigm, GEM is not well-suited to deal with fiscal policy and debt issues.

The appeal to the Fund of extending the rigorous microfoundations of a NOEM to analyzing fiscal policy issues was clear, and this led to the development of GFM.²⁹ We turn to this now, starting by laying out the main features and microfoundations of GFM—a DSGE model designed to examine fiscal issues including: medium-term and long-term multipliers, government debt crowding out effects, spillover effects of domestic fiscal policies to the rest of the world, and effects of tax distortions. Extensions dealing with tax reforms, privatization

²⁸ See IMF Spring Meetings, *World Economic Outlook* Communiqué, April 2006, emphasizing the importance of the multilateralism aspect in the Fund surveillance work.

²⁹ The seminal paper is by Botman, Laxton, Muir and Romanov (2006).

of retirement savings, the timing of tax changes, and fiscal reforms and consolidation efforts across a wide range of countries are also reviewed here.³⁰

GFM is similar in spirit to GEM in its strong microeconomic foundations, but as the name implies it is focused on fiscal matters. It has been developed precisely to assess more realistically the implications of alternative fiscal policies, particularly those involving permanent changes in government debt and net foreign liabilities under a non-Ricardian-equivalence hypothesis. These are longer-term structural issues, so GFM was developed as an annual model. First and foremost, GFM is based on an overlapping generations structure (OLG) in the spirit of Blanchard and Weil.³¹ In the OLG structure, agents have finite planning horizons and current generations are disassociated from future ones. As a result, agents change consumption and leisure behavior in response to even temporary changes in fiscal policy, depending on their subjective discount rate. The latter is a combination of the pure rate of time preference and the probability of living and could include myopic expectations. This structure implies that government debt is perceived to add to net wealth. Second, GFM is a non-Ricardian model because taxes are distortionary. Specifically, labor effort and capital formation respond endogenously to relative price movements that result directly from tax wedges. Third, it is assumed that a certain proportion of wage income accrues to income-constrained consumers. These agents have no access to financial markets and therefore do not smooth their consumption over time unlike forward-looking agents who can accumulate wealth. Instead, their marginal propensity to consume out of disposable income is equal to unity and changes in fiscal policy that affect their disposable income directly affect their consumption. Together, these three channels provide an important departure from Ricardian equivalence and fiscal policy matters.

A key advantage of microfounded models such as GFM is that one can provide insight into the fundamental determinants of the effects of fiscal policy. For example, one can explore to what extent the planning horizon of consumers, the fraction of consumers who are income-constrained, and the elasticity of labor supply are fundamental determinants of the qualitative and quantitative effects of fiscal policy. Furthermore, as GFM is rooted in consumer and producer optimization, one can explore the extent to which the intertemporal elasticity of substitution and the substitutability between capital and labor affect the impact of fiscal policy. In addition, since GFM features monopolistic competition, one can analyze to what extent the degree of competition matters. Finally, the multi-country dimension of GFM allows a consideration of how trade openness and the relative size of an economy affect the response of the real exchange rate and the real interest rate to changes in fiscal policy.

In general, the total impact of a fiscal consolidation on real activity, for example, depends on

³⁰ The IMF's Fiscal Affairs Department organized a workshop on fiscal policy analysis using the Global Fiscal Model (GFM) on June 14, 2006. A number of presentations were made explaining the structure and implementation of the model, the range of fiscal policy issues GFM can help analyze, the domestic and international transmission channels of fiscal policy, country applications, and possible extensions.

³¹ See Ghironi (2003a and 2003b), and Ganelli (2003a and 2003b) for an earlier introduction of an OLG structure in NOEM models.

the response of aggregate supply and demand. The *supply-side* effects come through changes in incentives, such as a reduced desire to work if labor taxes are raised, a reduction in the desired capital stock when corporate taxes are raised, or a reallocation of factors between sectors when government spending is reduced (assuming that government spending is biased towards nontraded goods). On the *demand side*, private consumption would decline to the extent that individuals view a smaller fiscal deficit as decreasing their permanent income as they discount the reduction in future taxes. This, in turn, depends on the households' degree of impatience, the proportion of wages associated with income-constrained consumers, and the persistence of the consolidation effort. Domestic and foreign investment would benefit from a real interest rate reduction induced by fiscal consolidation, which in turn depends on the size of the domestic economy in the world economy, while net exports also respond to movements in the real exchange rate. In the short term, the real exchange rate moves in line with changes in money demand in the domestic economy relative to the foreign economy, while in the medium term the real exchange rate moves to generate a trade balance consistent with current account stability. A simplified graphical illustration of GFM is provided in Figure 5.

A. Long-Term Crowding Out Effects of Government Debt

We begin with an illustrative two-region calibration of GFM—a home country (the U.S.), and the rest of the world. We examine the implications of a 10-year, 1-percentage-point (of GDP) tax cut on labor income in the United States. After the tenth year, labor income taxes increase to give rise to a primary surplus in order to stabilize the government-debt-to-GDP ratio at its new value, which is 15 percentage points above its baseline value when the impact of higher interest payments is taken into account.

Consistent with empirical evidence, the base-case parameterization of the model has a fairly inelastic labor supply response to changes in after-tax real wages. This, together with flexible wages and prices in GFM reduces the effect on aggregate demand of the tax cut and hence the short-term multipliers. The impact of the shock at various time horizons is reported in Table 5. The tax cut results in a short-term expansion of U.S. output with a multiplier of about 0.2, which then gradually declines and turns negative after six years. The short-term multiplier is small, with relatively long-lasting effects on output. The rise in consumption is prolonged by the expected depreciation of the real exchange rate, leading individuals to take advantage of lower prices on foreign goods now compared to later. The real exchange rate depreciates over time to generate positive trade balances to finance the higher interest burden on the stock of net foreign liabilities. Higher tax rates and real interest rates in response to higher government debt crowd out consumption and investment, resulting in a reduction in the level of U.S. GDP of about 1 percent in the long run. In the rest of the world, the multiplier is negligible as the path of increasing real interest rates crowds out investment, offsetting the gains from the improvement in the trade balance. Consumption falls initially and then steadily returns to its original level owing to the anticipated appreciation of the real exchange rate, despite long-term crowding out of a similar magnitude in the United States.

Alternative simulations examined the impact of changing the following structural parameters:

- Increasing the incentive effects of tax cuts. An increase in the sensitivity of hours worked to changes in the after-tax real wage—a more elastic labor supply—amplifies and prolongs the short-run expansion in the home economy as workers respond to the temporary lower tax rates by increasing their labor effort (higher after-tax wage income) and firms increase investment to raise their capital stock (higher after-tax rate of return on capital). These stronger supply-side responses increase the short-term output multiplier and the effects are prolonged. This, however, is reversed when taxes are eventually raised to finance the interest burden on the higher level of government debt, resulting in larger negative consequences in the long run. For the rest of the world, the tax cut is more expansionary because there is less crowding out of investment and workers increase their labor effort although, as in the United States, there are larger losses in the long run.
- Increasing the effects of deficits on interest rates. Lower sensitivity of consumption to changes in the real interest rate (measured by a reduced intertemporal elasticity of substitution of consumption) will result in larger increases in real interest rates when government debt rises. Higher real interest rates cause a larger fall in investment, but this is offset by a larger increase in consumption as individuals indulge in more consumption smoothing. A larger increase in real interest rates is required in the long term to equilibrate saving and investment, implying greater long-run crowding-out effects in the United States and the rest of the world.
- Extending consumers' planning horizon results in a smaller short-run boost to consumption and a reduced short-term multiplier as individuals are more sensitive to the prospect of higher tax liabilities in the future. The long-run crowding out effects are likewise smaller because real interest rates rise by less and hours worked remain higher as consumption and leisure are positively linked in the long run—this is an important insight born out of the stronger microeconomic structure of GFM. The negative impact on the rest of the world is smaller because there is less crowding out of investment.

B. Fiscal Consolidation and the Current Account—the United States

Recent staff analysis has reexamined the link between a U.S. fiscal consolidation and its current account deficit using a four-region version of GFM (the U.S., the EA and Japan, Emerging Asia, and an RW block).³² The model was also extended to include a country-risk premium that depends positively on the ratio of net foreign liabilities to exports. The

³² See Kumhof, Laxton, and Muir (2005).

potential effect of U.S. fiscal adjustment on the current account is an important theme in the policy debate about how to reduce global imbalances. While several fiscal instruments were considered (increases in labor- or corporate income tax, and reductions in government absorption or transfers), we focus primarily on an increase in the labor income tax.

For a large country like the U.S., a key transmission channel of a fiscal consolidation is the induced change in the world real interest rate. With perfect international financial integration, the reduction in U.S. and foreign real interest rates is the same in the long-run and investment opportunities expand by similar percentages.³³ The portion of domestic excess saving that finances domestic and foreign investment depends on the relative size of the domestic economy, with the latter type of investment being reflected in a significant improvement in the current account. If U.S. real interest rates fall by more than those in the rest of the world under less-than-fully-integrated capital markets, the benefits of fiscal consolidation show up more as a rise in U.S. investment and less in the current account balance.

The simulations under a plausible parameterization³⁴ of GFM indicate that, in a world of integrated capital markets, a permanent reduction in U.S. fiscal deficits (of 1 percentage point of GDP) would lead to a reduction in current account imbalances of almost ½ percent of GDP over the first ten years (reflecting large changes in net exports and an improving net foreign asset position), with positive spillover effects to the RW through increased world saving and lower real interest rates.³⁵ However, the current account improvement is significantly smaller when the duration of the consolidation is shorter, equal to five or ten years, where households would perceive only a limited reduction in their wealth. Simulations where deficits were lowered by 1 percentage point relative to GDP for only five years and then allowed to return to baseline find that long-run debt is reduced by just 5 percentage points of GDP. This leads to an improvement of the current account of 0.2 percent of GDP, on average over these five years, similar to that reported in Erceg, Guerrieri and Gust (2005). Their model does not depart enough from Ricardian equivalence for permanent increases in government debt to have permanent consequences for the stock of net foreign liabilities and the world interest rate.

The significantly smaller effects occurring under an assumed short-lived consolidation (or when international capital markets are imperfectly integrated) illustrates the importance of planning for a credible, permanent reduction in government debt, and the importance of the

³³ National saving rises in response to a fiscal consolidation as there is an incomplete private sector offset to a reversal in public dissavings. The U.S. interest rate falls to help re-equilibrate savings and investment.

³⁴ Certain parameters influence primarily the impact of domestic distortions, and changing their values will alter the impact of tax or expenditure changes on domestic saving and investment, with little impact on the world interest rate and the current account.

³⁵ The permanent nature of the consolidation is reflected in forward-looking consumers' income expectations.

degree to which U.S. real interest rates are linked with those of other countries. In a subsequent analysis at the Fund, Botman and Kumar (2006) reiterate the substantial deterioration in the current account resulting from fiscal deficits and highlight the potentially important contribution fiscal adjustment could make to reducing external imbalances in a large economy suffering from twin government and current account deficits.

C. Tax Distortions and Tax Reform

GFM features an extensive menu of taxes including: payroll taxes on workers and social security contributions levied on employers; personal income taxes on wage income, dividends, transfers, and interest income; corporate taxes on the return to capital and monopolistic rents; and a VAT. An application of GFM to Canada investigated the efficiency costs of each of these taxes (Botman, 2006). To analyze tax distortions, it is assumed that Canada has fiscal space to reduce taxes as a result of a reduction in lump-sum transfers from the government to households. It is assumed that this space allows for a reduction in the effective Goods and Services Tax (GST) by 1 percentage point. If taxation is not distortionary, the income effects of lower taxes and lump-sum transfers would offset each other and there would be no effect on GDP. The more distortionary the tax, the larger the resulting increase in GDP.

The simulations suggest that a reduction in personal income taxation provides considerably larger efficiency gains than a reduction in the effective GST.

- A reduction in the GST by 1 percentage point generates only modest gains in potential output as the increase in purchasing power leads predominantly to higher consumption. On the other hand, a reduction in the personal income tax (PIT) rate has a stronger effect on private saving by stimulating incentives to invest.
- There is also a considerable difference in timing. The effects of a reduction in GST are felt immediately on consumption and then decline over time, whereas the gain in potential output is larger but takes longer to materialize, given that investment is subject to adjustment costs.

The results confirm the view that the GST (or more generally a VAT) is a relatively efficient form of taxation:

- Similar to a payroll tax, the GST also affects the consumption-leisure decision. However, since accumulated savings are an implicit component of the tax base, the GST is less distortionary.
- Personal income taxes are, in turn, more distortionary than payroll taxes, since their base includes dividend income in addition to wage and interest income and transfers.
- Finally, corporate income taxation is the least efficient form of taxation, although the presence of monopolistic competition in GFM implies that part of the tax burden falls on rents rather than the return to capital.

This order of tax efficiency is consistent with evidence from various international studies—see Baylor (2005) for a survey—as well as results of a general equilibrium model for the Canadian economy (Department of Finance, 2004).³⁶ The findings are also robust to variations in the underlying parameters. Interestingly, lower price markups imply larger efficiency gains from reducing taxation of corporate income, since a larger share of the tax burden falls on the return to capital rather than excess profits.

Since different taxes imply different degrees of distortion, the potential efficiency gains from tax reform have been studied using GFM. Bayoumi, Botman, and Kumar (2005) find that the elimination of the double taxation of dividends in the U.S., compensating for the revenue loss through higher payroll taxes levied on workers, would imply substantial efficiency gains as it would stimulate incentives to save and invest. Eliminating the personal income taxation of dividends in a revenue-neutral manner has significant long-term positive effects in the large economy. In the short run, narrowing the personal income tax base, while raising rates on labor income to prevent revenue losses, causes a small decline in real GDP as higher labor taxes dampen consumption, since this policy is essentially regressive—as reflected in the large decline in consumption by liquidity-constrained consumers. Over time, however, national saving increases substantially, the interest rate declines, and increased capital accumulation results in output rising about 2¾ percentage points above the baseline.³⁷ As such, this particular type of tax reform also contributes to improving the current account balance in a sustained manner.

- Botman and Kumar (2006) revisit this issue and find that the gains from such tax reforms are smaller in a small economy than in a large one like the United States. In a small economy, the long-term benefits are less pronounced—with about 1 percentage point less gain in potential output than for a large economy. This is because the increase in investment is not as marked, owing to a smaller reduction in real interest rates as the increase in savings in the small economy has a small effect on world savings. However, savings in this economy increase by more, leading to a larger increase in the current account balance.

The benefits of tax reform, as well as its spillover effects depend on several factors.

- First, if consumers have a longer planning horizon, the decline in initial consumption is smaller, as optimizing agents capitalize on their anticipation of lower corporate income taxation and therefore higher future returns on investment. The counterpart of

³⁶ See Baylor and Beauséjour (2004) for a description of the model and a demonstration that these conclusions are robust under alternative values for important model parameters.

³⁷ If tax reform results in a reduction in the taxation of overall savings, instead of capital income only, the benefits are smaller. The reason is that increasing labor income taxes to reduce taxes on interest income increases distortions in the economy. Also, see Bayoumi, Botman, and Kumar (2005) for a discussion of the implications of non-revenue-neutral tax reform.

this result is that saving does increase by more in the medium term. However, overall investment increases by less in this case even though savings increase much more in the long term with longer planning horizons.

- Second, a more elastic labor supply implies more distortionary labor income taxation and therefore smaller benefits from shifting the tax burden from capital to labor. The benefits are particularly muted for the smaller economy. If all consumers optimize and have access to financial markets, the results move in the same direction as for an extension of the planning horizon, although to a much smaller degree.
- Third, a lower intertemporal elasticity of substitution has a substantial effect on the benefits of tax reform, particularly for the large economy. Following the increase in national savings, the current account turns positive, and trade deficits are needed to stabilize the current account in the long term. As a result, interest rates need to decline to stimulate higher consumption and mitigate the increase in saving. If consumers are less responsive to changes in the real interest rate, it needs to decline by more to induce the required increase in consumption. This then stimulates capital accumulation and significantly larger long-term output gains. The effect in the small economy is much more muted, given smaller effects on the world real interest rate.
- Fourth, imposing a Cobb-Douglas production function implies greater substitutability between capital and labor compared with the baseline and therefore a stronger response of investment and somewhat larger decline in labor effort following this policy change. This again implies substantially larger long-term output gains in the larger economy. In the smaller economy, the effects are less marked as the increased after-tax return of capital interacts with the decline in the real interest rate.
- Finally, higher markups reduce the distortionary effects of dividend taxation, as a larger share falls on rents rather than capital accumulation. As a result, the benefits of tax reform are somewhat smaller for both economies.

D. The Effects of Privatizing Retirement Saving

GFM has also been used to explore the macroeconomic effects of partially privatizing saving for retirement, which could be implemented through either a compulsory or a voluntary program. Given the rising concerns about the solvency of the publicly funded pension plans and adverse demographics, such schemes have been proposed or are under consideration in a variety of industrial and emerging market countries, including the United States and the Czech Republic. This issue was explored in Bayoumi, Botman, and Kumar (2005) for the U.S. and in Botman and Kumar (2006) for a large and representative small open economy.

The simulations suggest a significant increase in federal deficits and debt over several decades if personal retirement accounts (PRAs) were to be introduced in the United States. As payroll contributions are diverted from the Social Security system to PRAs, government revenue declines markedly. As a result, government debt starts rising quickly and reaches a peak when the benefit payments from PRAs start, and as they do so, “traditional” Social Security payments decline by a corresponding amount, which allows government deficits and debts to begin to decline. Nonetheless, in the long run, government debt still exceeds the baseline by 50 percentage points of GDP.

The simulations for the U.S. assume compulsory saving for retirement, as in the Administration’s proposals for introducing PRAs. As a result, private saving through PRAs offsets government dissaving and there is no impact on national saving. Real interest rates are virtually unchanged and there is little effect on investment. Hence, there is no significant impact on GDP, national saving, and financial markets from privatizing retirement saving in a compulsory manner. However, it should be emphasized that these results follow from the stipulation that workers cannot borrow against accumulated savings held in their PRAs. In this case, a shift from government to private saving does not affect perceived wealth, and there is no change in consumer behavior.

Contrary to the above case, the application of GFM to the U.S. also suggests that significant macroeconomic benefits may accrue when PRAs are accompanied by greater fiscal discipline that prevents PRA-related increase in government debt. In essence, such a policy amounts to prefunding higher future pension liabilities.

GFM has also been used to study the effects of privatizing retirement saving if individuals can opt out of the public pension system. Botman and Kumar (2006) argue that this simulation essentially implies a permanent tax cut—social security contributions decline—followed by lower future public pension outlays. Given the resulting incentives—whether to save for future retirement or to consume—consumers who are liquidity constrained and the optimizing agents who are impatient or myopic do not fully save the surplus that accrues from the reduction in social security taxes. Effectively, the myopic consumers discount the lack of traditional social security benefits in the future. Consumption and output increase in the short run at the cost of a long-run decline. In the long run, consumption falls due to a decline in the social security payments and an increase in taxes required to stabilize debt.

As a result, the macroeconomic impact of voluntary private pension contributions depends on the extent of consumer myopia. If consumers have longer planning horizons—making them more Ricardian—there is less of an initial consumption boom as they factor in the longer-term loss of traditional pension benefits. Consumers save more in the form of private pension contributions, which results in higher capital accumulation, output, and consumption in the long run. Conversely, if labor supply is relatively inelastic, the effective tax reduction does not induce greater incentives to work and higher output, lowering

savings, which results in a somewhat greater output loss in the long run. The question of whether individuals will actually save for retirement is shown to depend primarily on the degree of consumption smoothing, as indicated by the intertemporal elasticity of substitution. Also, a longer planning horizon results in a relatively flatter savings profile. For a small open economy, the sensitivity analysis yields similar qualitative results, although the quantitative effects are substantially smaller than in the case of the large economy.

E. Reducing Taxes Now or in the Future

In the context of the Canadian economy, Fund staff have assessed the benefits of delaying tax cuts today to get larger ones in the future, and the distortions created by alternative forms of taxation (on labor- or corporate income taxes) over different horizons.³⁸ Within the context of a two-country calibration of GFM to Canada and the U.S as the rest of world, they have also examined the impact of tax competition and fiscal-spillover effects across countries.

The analysis takes into consideration the persistent fiscal surpluses in Canada, modeled as coming from a permanent cut in lump-sum transfers, which allows fiscal authorities to respond with either (i) an immediate permanent cut in tax rates, or (ii) a larger future cut in tax rates afforded by lower interest payments on the consequently lower debt. We illustrate the loss-benefit ratio of a stylized wage tax cut in Figure 6, which compares the effect on real activity of differently timed cuts over different time horizons. Evidently, significant long-term benefits accrue from a delay in the wage tax cut, but at the cost of negative aggregate demand effects in the short run. A similar exercise conducted for a corporate income tax cut results in larger long-term benefits. Overall, the short-term benefits of a debt-financed fiscal expansion do not outweigh the long-term cost of required future fiscal adjustments.

The fiscal spillover effect of a reduction in wage tax rates in the U.S. followed by a necessary subsequent increase (to finance the interest burden on the higher debt from the transition) is negative and can be significant. The interest rate movements and trade linkages are the main channels through which these spillover effects to the rest of the world take place. The losses in Canadian real activity accumulate as investment is crowded out in response to a rise in global interest rates. U.S. corporate income tax cuts followed by future increases can have an even larger negative impact. The spillover effect of a country's fiscal policy outside its boundaries depends of course on the structure and behavior of the global economy and how it alters global debt and real interest rates. However, the medium-term benefits of further reducing debt rather than cutting taxes in Canada discussed above is not changed after taking into account U.S. fiscal policy. Being a relatively small open economy, Canada would not be able to offset the higher interest rates following the U.S. tax cut.

³⁸ See Bayoumi and Botman (2005) for details.

F. Fiscal Adjustment in the U.K. and Japan

Staff has also used GFM to analyze options for fiscal adjustment in the United Kingdom and Japan. For the United Kingdom there have been concerns that the current fiscal stance will lead to a breach of its golden rules, while for Japan the already high level of debt will become unsustainable in the future owing to spending pressures related to an aging population.

Botman and Honjo (2005) examine the macroeconomic effects of different composition and timing of fiscal adjustment in the United Kingdom. Early consolidation reduces aggregate demand in the short term, but increases output in the long term as smaller primary surpluses are needed as a result of lower interest payments. Reducing government transfers or current government spending provides larger output gains than increasing taxes, in particular compared to raising corporate or personal income taxes. They show that these conclusions are robust under alternative behavioral assumptions and parameterizations. Simulations also explore to what extent the timing of adjustment depends on the global environment, in particular the effect of a reduction in global saving. They show that this would make early consolidation more urgent from both cyclical and long-term perspectives. Finally, simulation results show that tax reform aimed at increasing incentives to save could provide support to fiscal consolidation measures.

Botman, Edison, and N'Diaye (2006) use a two-country version of GFM, calibrated to the Japanese economy. For this application, GFM was extended to include a VAT. The main findings of the simulations are that lowering social security transfers has a less negative impact on growth than other measures. However, given the limited room for further reducing transfers, there is a need to increase taxes and or reduce other expenditures. Amongst possible tax measures, raising the consumption tax entails the smallest output cost. A front-loaded consolidation that stabilizes the debt ratio involves greater long-term benefits than an adjustment that just targets a primary balance. However, such a strategy carries somewhat larger short-term output costs. A less front-loaded or a stop-and-go approach limits short-term output costs, but also reduces longer-term benefits. Shifting from corporate taxation to consumption taxation facilitates fiscal adjustment and locks in permanent gains. The spillovers to the rest of the world from consolidation in Japan are positive in the medium term, but modest.

IV. CONCLUDING REMARKS

GEM and GFM have already been used in a large number of applications; both models were designed with specific objectives and this is probably the main reason for their success. We expect that both models will be further developed to address new policy issues as they arise.

The strength of GEM is that it has an assortment of nominal and real rigidities sufficient to address questions that require plausible short-run quarterly responses to shocks. As is the case with other models that are based on the representative-agent paradigm, the main weakness of GEM is that its basic theoretical structure does not provide a very realistic characterization of the effects of fiscal policy. By contrast, GFM, which is an annual model based on an overlapping-generations framework, provides a much richer framework for examining fiscal issues, but because of the absence of nominal and real rigidities cannot be used for issues where short-term dynamics are important. For this reason, work has been underway in the Research Department to build another multi-country macro model that attempts to integrate the best ideas from both of these models into one coherent theoretical framework. As in the past, our objective will be to strive for modest improvements in the analytical framework that will facilitate better policy advice over time. This new model, called the Global Integrated Monetary Fiscal Model (GIMF), will no doubt be more complicated than its predecessors and for many purposes the additional complexity will not be useful. For this reason, we do not anticipate that existing users/developers of the GEM and GFM models will want to switch models anytime soon. On the contrary, given the interest in developing these models further we expect that both GEM and GFM will remain the tools of choice for many applications.

Table 1. GEM: Estimates of the Long-Run Effects of More
 Competition-Friendly Policies in the Euro Area
(Percent deviations from baseline)

	Product Market Reforms	Labor Market Reforms	Both Reforms
Euro Area			
GDP	8.6	3.5	12.4
Consumption	4.9	3.3	8.3
Investment	17.0	3.5	21.2
Labor effect	4.5	3.6	21.2
Real exchange rate	4.2	1.1	5.3
Utility ¹	1.9	0.9	2.4
Sacrifice ratio	2.0 => 1.7	2.0 => 1.7	2.0 => 1.4
Rest of the world			
GDP	0.7	0.2	0.8
Consumption	1.0	0.3	1.3
Investment	0.5	0.1	0.7
Labor effort	0.1	0.0	0.2
Utility ¹	0.9	0.3	1.2

Source: Bayoumi, Laxton, and Pesenti (2004).

¹ Percentage increase in terms of steady –state consumption.

Table 2. GEM: Long-Run Effects of Reducing Markups in Labor and Product Markets in France ¹
(Deviations from baseline in percent)

	Real GDP	Consumption	Hours Worked	Capital Stock
Labor market	6.1	6.1	6.7	5.9
Labor supply elasticity (Frisch) 0.165	3.4	3.4	3.7	3.2
Share of liquidity-constrained consumers 0.25	7.5	7.5	8.2	7.2
Trade elasticity 1.005	4.0	3.9	5.6	3.3
Services	7.3	5.1	6.2	10.1
Labor supply elasticity (Frisch) 0.165	4.5	2.4	3.1	7.3
Share of liquidity-constrained consumers 0.25	7.3	5.1	6.2	10.1
Trade elasticity 1.005	4.2	2.9	3.8	5.8
Goods	1.6	1.3	1.4	4.9
Labor supply elasticity (Frisch) 0.165	1.0	0.7	0.7	4.3
Share of liquidity-constrained consumers 0.25	1.6	1.3	1.4	4.9
Trade elasticity 1.005	0.7	0.3	1.3	4.0
All markets simultaneously	16.0	13.1	15.0	22.5
Tradables markup 1.1	12.5	9.9	11.4	17.0
Labor supply elasticity (Frisch) 0.165	9.3	6.6	7.7	15.7
Share of liquidity-constrained consumers 0.25	17.3	14.4	16.4	23.7
Trade elasticity 1.005	9.3	7.2	10.9	13.8

Source: Everaert, L. and Schule, W. (2006).

¹ Markups were reduced by 22 percentage points in labor markets, 17 percentage points in nontradables, and 7 percentage points in tradables.

Table 3. GEM: Synchronized Euro-Area-Wide Structural Reform—Long-Run Impact
(Deviations from baseline in percent)

	Real GDP	Consumption	Hours Worked	Capital Stock
France ¹				
Labor market	6.8	6.7	6.9	6.7
Services	7.6	5.4	6.3	10.5
Goods	2.0	1.7	1.5	5.5
All markets	17.3	14.5	15.2	24.4
<i>Of which: spillover from Euro area</i>	1.3	1.4	0.2	1.9

Source: Everaert, L. and Schule, W. (2006).

¹ Markups were reduced in France by 22 percentage points in labor markets, 17 percentage points in nontradables, and 7 percentage points in tradables. The markup reductions in the Euro area were 22, 16, and 7 percentage points, respectively.

Table 4. GEM: Benign Global Rebalancing Scenario: Implications for the Euro Area¹
(Deviation from baseline; in percent)

	Years After The Shock				
	$t = 1$	2	3	4	5
Real GDP	-0.2	0.8	1.1	0.5	0.0
<i>Contribution of</i>					
Domestic Demand	0.4	0.9	1.0	0.8	0.6
Net Exports	-0.6	-0.1	0.1	-0.3	-0.6
CPI Inflation ²	-0.1	-0.2	-0.2	-0.1	-0.1
CA/GDP ²	-0.6	-0.1	0.1	-0.4	-0.8
Nominal Interest Rates ²	-0.3	-0.5	-0.4	-0.4	-0.5
Nominal Effective Exchange Rate ³	8.6	6.9	3.7	0.6	-1.1
Real Effective Exchange Rate ³	8.6	6.9	3.6	0.2	-1.9
Bilateral Real Rate v. RW ³	2.3	2.0	1.1	-0.1	-1.1
Bilateral Real Rate v. \$ ³	20.4	16.0	8.3	0.9	-3.4
<i>memorandum item</i>					
U.S. CA/GDP ²	3.3	4.2	4.4	4.1	3.1

Source: Faruqee (2004).

¹Table reports the simulated effects of a 7 percent increase in TFP in the Euro area and rest of the world, and persistent 0.75 percentage point decline in risk premia on nondollar assets.

²In percentage points.

³A - (minus) indicates a depreciation of the euro.

Table 5. GFM: Two-Region Calibration of GFM
 One Percentage-Point of GDP Tax Cut in the United States for 10 Years
Sensitivity Analysis

Scenario	Variable	United States			Rest of the World		
		Impact	First 10 years (average)	Long run	Impact	First 10 years (average)	Long run
Baseline	GDP	0.2	—	-1.0	—	-0.1	-0.8
	Consumption	0.9	0.9	-1.3	-0.3	-0.1	-0.1
	Real interest rate	-0.1	0.1	0.2	-0.1	—	0.2
Strengthening supply-side effects ¹	GDP	0.6	0.6	-1.9	0.1	-0.1	-1.4
	Consumption	0.8	1.2	-2.2	-0.1	-0.1	-0.4
	Real interest rate	-0.1	—	0.3	-0.1	—	0.3
Increasing the effects of deficits on interest rates ²	GDP	0.2	-0.1	-1.7	-0.1	-0.2	-1.4
	Consumption	1.2	1.0	-1.6	-0.2	—	-0.3
	Real interest rate	0.1	0.1	0.4	-0.1	0.1	0.4
Making the savings rate more sensitive to future tax increases ³	GDP	0.1	—	-0.3	—	0.0	0.0
	Consumption	0.3	0.2	-0.9	—	-0.1	0.3
	Real interest rate	—	0.0	—	0.0	—	0.0

Source: IMF staff estimates; Botman and Laxton, 2004, World Economic Outlook (April).

¹Base-case model, but the labor supply is elastic.

²Base-case model, but the intertemporal elasticity of substitution is lower.

³Base-case model, but consumers have a longer planning horizon

Figure 1. Global Economy Model: Structure

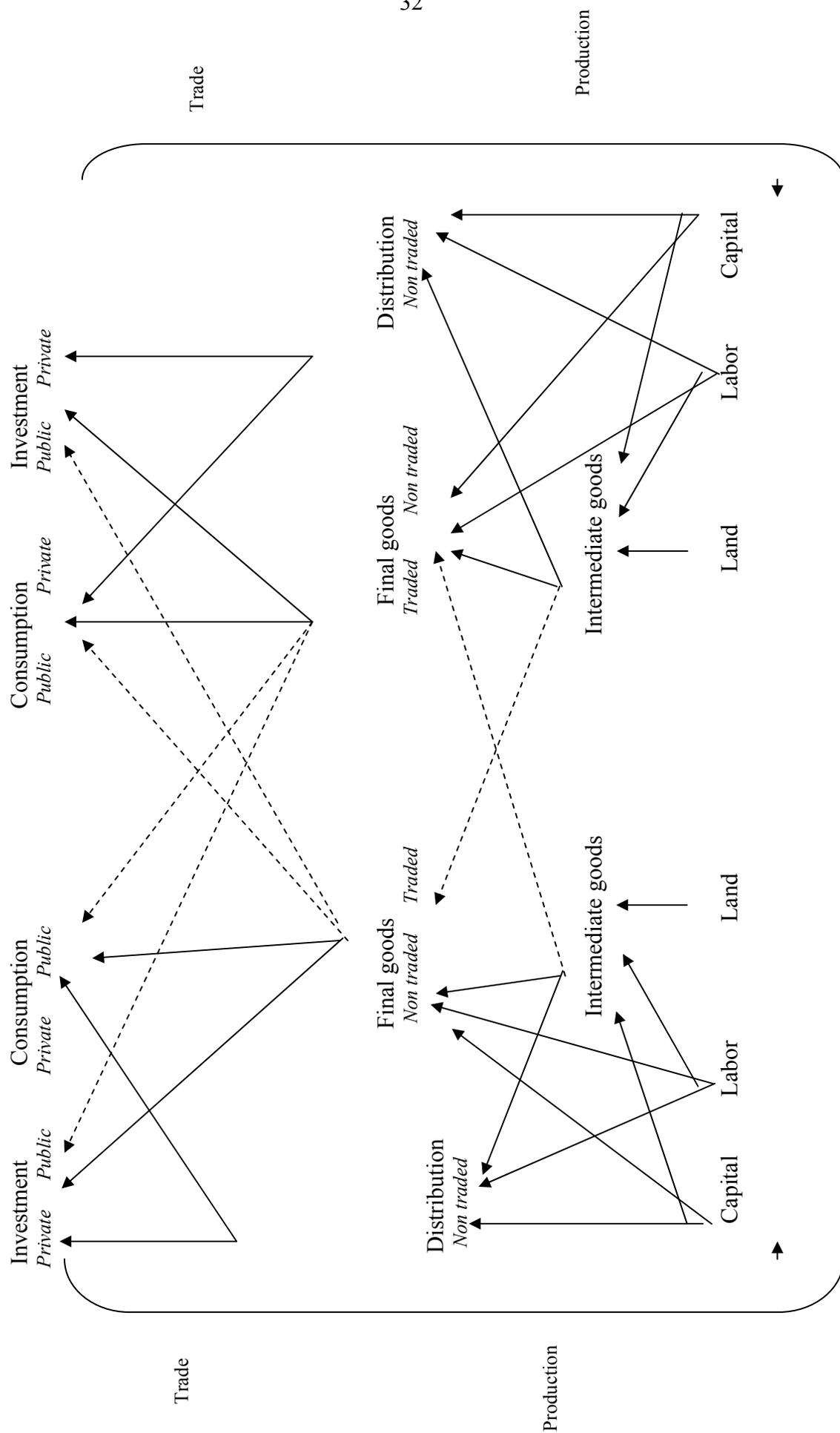
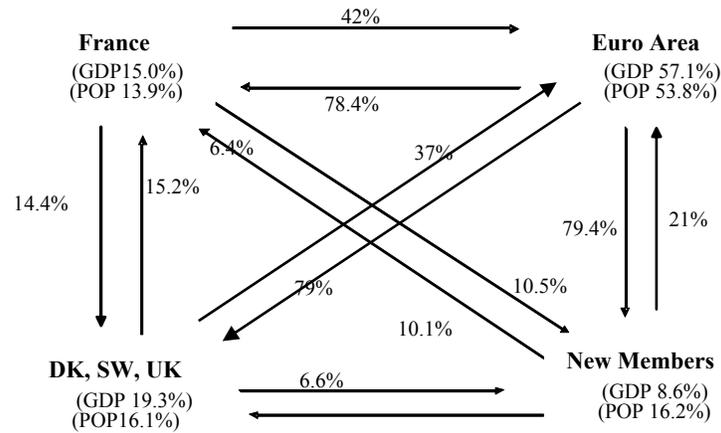


Figure 2. GEM Calibrated on 4 Blocks:
GDP and Intra-EU Trade Flows (imports)

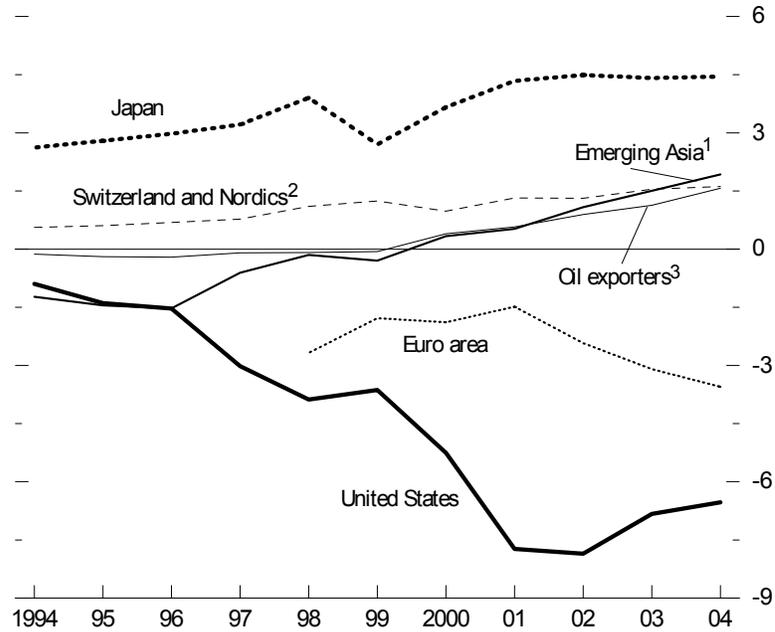


Sources: Eurostat, ECB, COMTRADE.

Notes: DK = Denmark; SW = Sweden; UK = United Kingdom.

This figure shows country sizes by population and real GDP and bilateral trade flows in percent of GDP. The population and GDP shares add up to 'world' population and income, respectively and are normalized at one. Trade covers intra-EU flows only.

Figure 3. Dispersion in Net Foreign Assets in Response to Widening Global Current Account Imbalances
(Percent of world GDP)



Source: Lane and Milesi-Ferretti (2005).

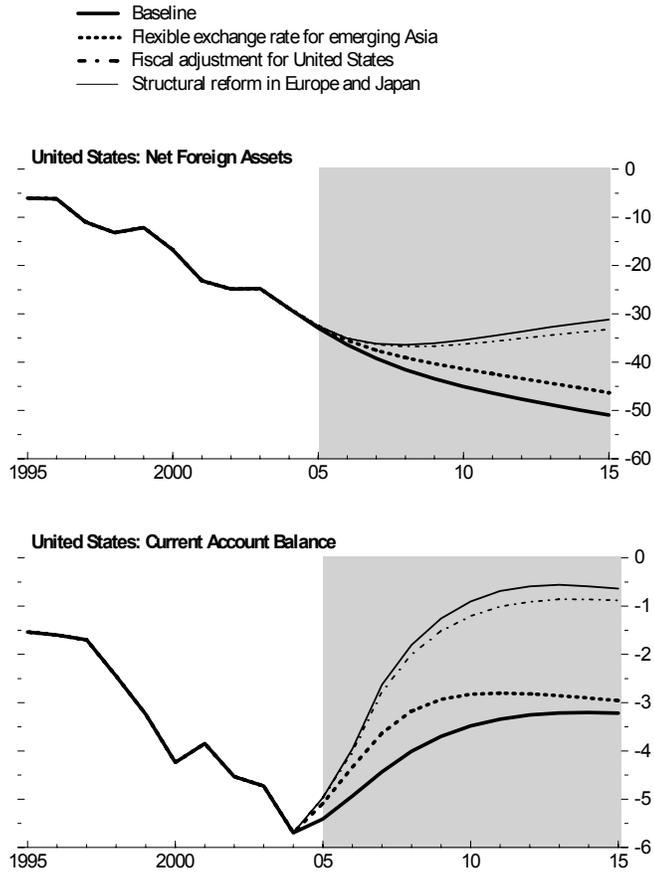
¹ China, Hong Kong SAR, Korea, Malaysia, Singapore, Taiwan Province of China, and Thailand.

² Norway, Sweden, and Switzerland.

³ Algeria, Bahrain, Egypt, I. R. of Iran, Jordan, Kuwait, Libya, Saudi Arabia, Syrian Arab Republic, United Arab Emirates, Yemen, and Russia.

Figure 4. GEM: Scenarios for Global Adjustments of Current Account Imbalances
 The Case of the United States
(Percent of GDP)

Combined policy action—with the effects of individual measures on the baseline shown cumulatively in the figure—could significantly reduce global imbalances.



Source: IMF staff estimates.

Figure 5. Global Fiscal Model Structure

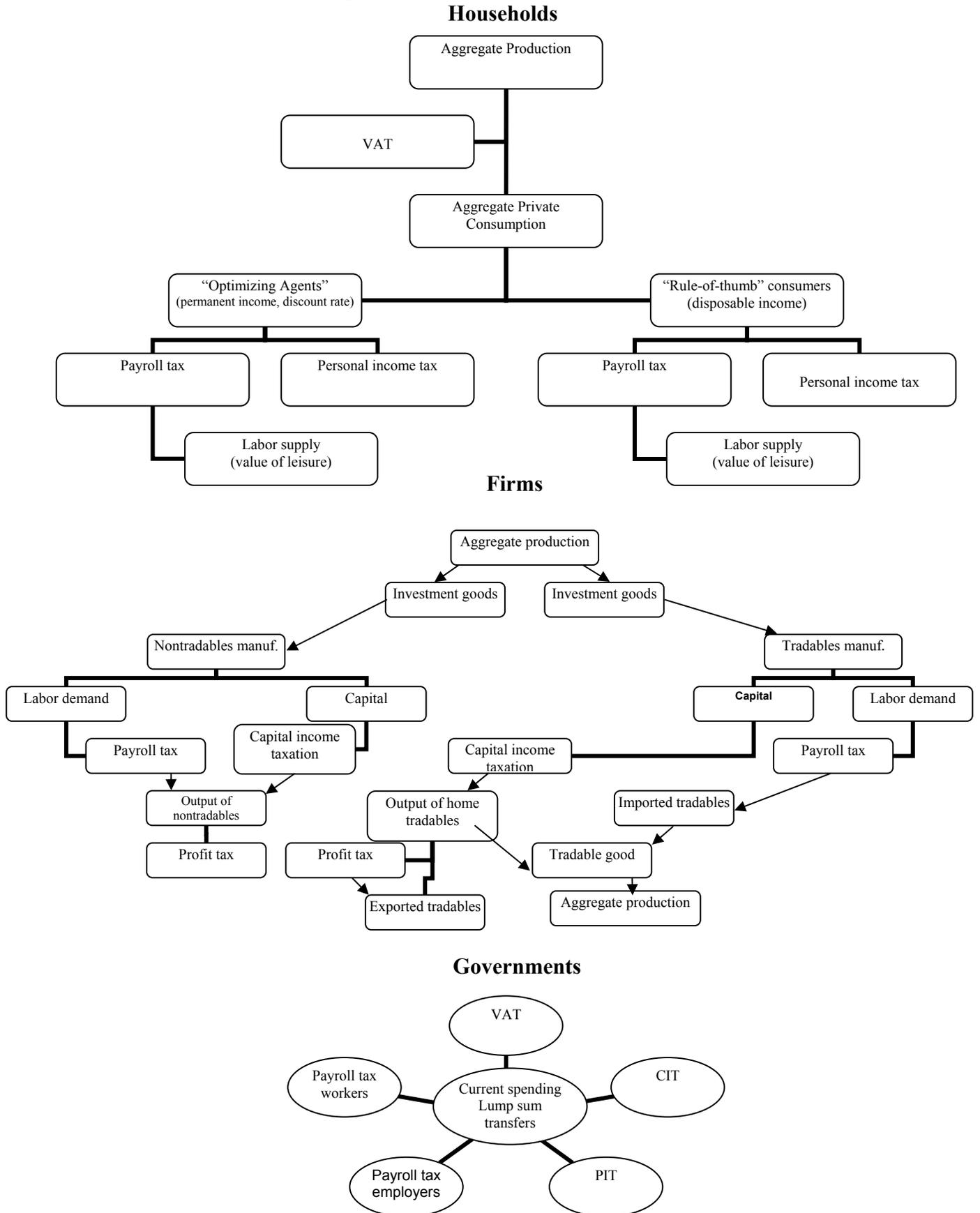
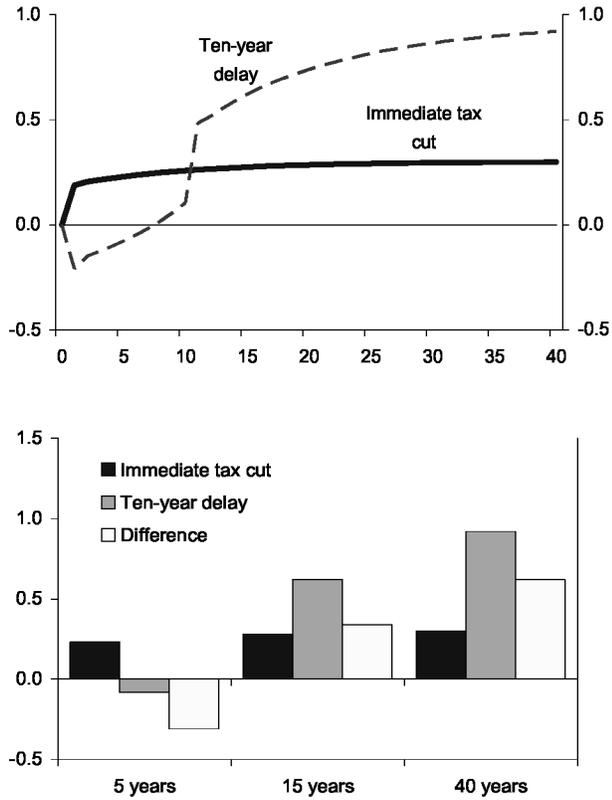


Figure 6. GFM: Effects on Real GDP of Reducing Transfers and Cutting Wage Tax Immediately and with a Delay
(percent deviation from baseline)



Source: Fund staff calculations.

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