Global Effects of Fiscal Stimulus During the Crisis

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Received November 4, 2009; Received in Revised Form February 25, 2010; Accepted Date

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Abstract

The IMF's Global Integrated Monetary and Fiscal Model is used to compute short-run multipliers of fiscal stimulus measures and long-run crowding-out effects of higher debt. Multipliers of two-year stimulus range from 0.2 to 2.2 depending on the fiscal instrument, the extent of monetary accommodation and the presence of a financial accelerator mechanism. A permanent 10 percentage point increase in the U.S. debt to GDP ratio raises the U.S. tax burden and world real interest rates in the long run, thereby reducing U.S. and rest of the world output by 0.3 to 0.6 percent and 0.2 to 0.3 percent, respectively.

Keywords: Fiscal Stimulus; Crowding-Out; Financial Crisis; Non-Ricardian Households; Government Deficits; Government Debt; Macro-Financial Linkages

JEL classification: E62; F41; F42; H30; H63

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1. Introduction

During the last two years, the global economy has experienced large negative shocks to growth that resulted from sharp declines in house and stock prices and from a tightening of financial conditions. The economic downturn and the financial crisis fed on each other. Output contracted sharply at the beginning of the crisis, and there were sizeable downward revisions to potential growth rates. Due to a decline in the value of housing and business net worth, leverage and spreads increased sharply between early 2006 and mid-2009.

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†We thank Olivier Blanchard, Charles Collyns and Jorg Decressin for encouraging us to do this work. The views expressed in this paper are those of the authors and should not be attributed to the International Monetary Fund, IMF policy, its Executive Board, its management, or any member government.

Governments and central banks responded to financial sector difficulties by introducing a number of measures to deal with liquidity and solvency problems in financial institutions. Central banks reduced interest rates to unprecedented levels to offset the increase in private sector risk premia and to underpin aggregate demand, and used nonconventional measures in the form of quantitative easing and qualitative or credit easing to bring about reductions in risk premia and to provide liquidity to markets in difficulty. In spite of these efforts, credit remained tight and aggregate demand in many countries weakened rapidly. There were negative spillovers from the weakening economies to those that had appeared to be more robust, and increased concern that the global economy might be moving into a period of deep and prolonged recession (IMF, 2009).

Governments around the world therefore went beyond monetary policy measures by introducing large stimulative fiscal packages. In this context, questions were raised both about the effectiveness of temporary fiscal policy actions in lessening the depth and duration of the slowdown, and about the potential long-run negative effects on the economy of the debt accumulation resulting from the fiscal stimulus.

In this paper, we use the IMF's Global Integrated Monetary and Fiscal (GIMF) model, a dynamic general equilibrium model, to simulate the joint effects of fiscal and monetary stimulus measures. GIMF is a multi-region model of the world economy, with 5 regions in this paper's application. For the effects of fiscal stimulus the critical aspect of GIMF is the household sector, which has two non-Ricardian features that affect both the short-run effectiveness of stimulus and the extent of long-run crowding-out due to increases in government debt. First, a share of households is liquidity-constrained as in Galí et al. (2007), that is, these households are constrained to consume their after-tax income in every period. This has a strong impact on the short-run effects of tax and transfer based stimulus measures. Second, the remaining households have finite horizons as in Blanchard (1985). This implies that government debt has a non-zero net worth, so that additional government debt will crowd out physical capital and foreign asset holdings in the long run.

There are several advantages to using a fully structural model such as GIMF to analyze the effects of the current set of policy measures. First, it can be used to highlight how the effectiveness of fiscal stimulus depends on the fiscal instrument used and on key structural characteristics of the economy.[1] Second, it allows for the short-run interaction of fiscal and monetary policy actions, especially the implications of the economy being at the zero interest rate floor in the presence of fiscal stimulus. Third, it allows for an analysis of the long-run implications of policy actions, and of the dynamics between the short run and the long run.

The paper is structured as follows. Section 2 presents a brief literature review. Section 3 presents an overview of GIMF. Section 4 compares the results of two contractionary shocks in two versions of GIMF, one with a financial accelerator and the other without. Section 5 uses the model, again with and without a financial accelerator, to examine the short-run multipliers of various types of stimulative fiscal measures. Section 6 presents the simulated effects on the world economy of the actually announced G20 fiscal stimulus measures for 2009 and 2010. Section 7 sets out the long-run effects of a permanent increase in the ratio of government debt to GDP, and discusses the transition between the short run and the long run. Section 8 provides concluding remarks.

2. Literature review

The recent debate on fiscal stimulus has to be seen against the background of a long debate in economics on the virtues or otherwise of fiscal activism. That debate centered mostly on the desirability of ongoing fine-tuning of the business cycle, while the current debate is taking place against the background of an exceptionally severe financial and economic crisis, where even many staunch opponents of the active and continuous use of fiscal policy have suggested that fiscal stimulus should be used as a one-off emergency measure.

Keynesian demand management through fine-tuning of fiscal policy was popular among economists of the 1950s and 1960s.[2] But it started to be challenged by the emerging neo-

[1] See, for example, Freedman et al. (2009, 2010).
[2] See Phillips (1954), Musgrave (1959) and Tobin (1972), and also Seidman (2003).

classical school in the 1960s.[3] There was a simultaneous challenge to the systematic use of monetary policy (Lucas, 1972), but here the pendulum started to swing back in favor of activism in the early 1980s, based on much improved theoretical[4] and empirical foundations. But the presumption was still that policy activism should be left to monetary policy. It was argued (Gramlich, 1999) that it is difficult for fiscal policy to deliver its stimulus in a "timely, targeted and temporary" manner. But Solow (2005) and Wyplosz (2005) argue that this problem can be overcome through institutions and procedures that would allow fiscal policy to adopt the core principles of monetary policy.

Fiscal rules are one way to formalize the use of fiscal policy for fine-tuning the business cycle. Taylor (2000) discusses the desirability of a fiscal rule in which the budget surplus depends on the output gap, but he argues against its use because the Fed would only suffer from having to forecast the fiscal stance. He therefore argues, along with many other commentators at that time, that the role of fiscal policy should be limited to minimizing distortions and to "letting automatic stabilizers work". Automatic stabilizers describe the channels through which fiscal policy can be mildly countercyclical even if fiscal instruments are not varied in any discretionary way in response to the business cycle.

Crucially, however, Taylor (2000) makes two exceptions to this assessment. The first is fixed exchange rate regimes, where monetary policy deliberately gives up its stabilizing role. The second is the type of situation that the world economy has been facing during the crisis, where nominal interest rates are very close to their zero lower bound so that further conventional discretionary monetary policy is much more problematic. This, and the exceptional gravity of the current crisis, are the major reasons for the renewed interest in fiscal policy.[5]

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[3] See Eisner (1969), which was based on Friedman (1957), and Barro (1974).

[4] See Taylor (1980), Rotemberg (1982), Calvo (1983), Taylor (1993) and Bernanke and Mishkin (1997).

[5] We would add that in an economy with many liquidity-constrained agents fiscal activism may be desirable even away from the zero bound under flexible exchange rates. This is because monetary policy operates mainly through an intertemporal substitution channel that is absent for liquidity-constrained agents, while fiscal policy can directly affect these agents' income. See Kumhof and Laxton (2009a).

The question then turns to how we should think about the short-run and long-run effects of the current fiscal stimulus packages in terms of a rigorous theoretical model. Until recently progress with the development, and even more the acceptance, of models that admit a meaningful role for fiscal policy has been slow. Theoretical work in the 1990s[6] and even more recently focused almost exclusively on the study of optimal taxation that minimizes tax wedges in models with few or no rigidities. Not surprisingly, this analysis finds little benefit from time variation in taxes and spending. Any attempt to go beyond this should start from the new generation of open economy monetary business cycle models. However, as argued in several important papers, these models face difficulties in adequately replicating the dynamic short-run effects of fiscal policy.[7] They also have serious shortcomings when applied to the analysis of longer-run fiscal issues such as the crowding-out effects of a permanent increase in fiscal deficits and public debt.[8] Therefore, to design a model that at least allows for the possibility of non-trivial stimulus and crowding-out effects, a critical departure from much of the existing literature has to be the incorporation of non-Ricardian household (and firm) behavior into a monetary business cycle model. We do so in this paper.

3. The model

This section, to conserve space, contains only a brief overview of the model, followed by some details that are critical to understanding its fiscal policy implication. A complete description can be found in Kumhof, Laxton, Muir and Mursula (2010), henceforth KLMM.[9] Time periods represent years. To simplify the exposition we present the perfect foresight version of the model.

[6] This work is surveyed in Chari and Kehoe (1999).
[7] See Fatas and Mihov (2001), Blanchard and Perotti (2002), and Galí et al. (2007).
[8] See Kumhof and Laxton (2009b).
[9] This paper is available at http://www.imf.org/external/pubs/cat/longres.cfm?sk=23615.0.

3.1. Overview

The world consists of 5 regions, the United States (US), the euro area (EU), Japan (JA), emerging Asia (AS)[10] and remaining countries (RC). The regions trade with each other at the levels of intermediate and final goods. International asset trade is limited to nominal non-contingent bonds denominated in U.S. dollars. We refer to U.S. variables by a superscript asterisk. The world economy's technology grows at the constant rate $g = T_t/T_{t-1}$, where T_t is the level of labor augmenting world technology, and world population grows at the constant rate n.

Each country is populated by two types of households, both of which consume final retailed output and supply labor to unions. Liquidity-constrained households are limited to consuming their after-tax income in every period, as in Galí et al. (2007).[11] The share of these agents in the population equals ψ. Overlapping generations households have finite planning horizons as in Blanchard (1985). Each of these agents faces a constant probability of death $(1-\theta)$ in each period, which implies an average planning horizon of $1/(1-\theta)$.[12] In addition to the probability of death, households also experience labor productivity that declines at a constant rate $\chi < 1$ over their lifetimes.[13] Households of both types are subject to uniform labor income, consumption and lump-sum taxes. We will denote variables pertaining to these two groups of households by OLG and LIQ.

Firms are managed in accordance with the preferences of their owners, finitely-lived OLG households, and they therefore also have finite planning horizons. Except for capital goods producers, entrepreneurs and retailers, they are monopolistically competitive and subject

[10] For calibration purposes, AS comprises China, Hong Kong S.A.R. of China, India, Indonesia, Korea, Malaysia, Philippines, Singapore, and Thailand.

[11] We follow Galí et al. (2007) in referring to these households as liquidity-constrained. Other terms used in the literature are rule-of-thumb or hand-to-mouth agents.

[12] Galí et al. (2007) interpret the complete inability to smooth consumption of their model's liquidity-constrained households as (among other possible interpretations) extreme myopia, or a planning horizon of zero. We adopt the same interpretation for the average planning horizon of the finite-horizon model. We therefore allow for the possibility that agents may have a shorter planning horizon than what would be suggested by their biological probability of death. See KLMM for a more detailed discussion.

[13] Due to the absence of explicit demographics in our model, we only need the assumption of declining labor productivity to be correct for the average worker.

to nominal rigidities in price setting.[14] Each country's primary production is carried out by manufacturers producing tradable and nontradable goods. Manufacturers buy capital services from entrepreneurs and labor from unions. Unions buy labor from households. Entrepreneurs buy capital from capital goods producers. They are subject to an external financing constraint and a capital income tax. Capital goods producers are subject to investment adjustment costs. Manufacturers sell to domestic and foreign distributors, the latter via import agents located abroad that price to their respective markets. Distributors combine a public capital stock with nontradable goods and domestic and foreign tradable goods, subject to an import adjustment cost. Distributors sell to domestic and foreign consumption and investment goods producers, via import agents for foreign sales. Consumption and investment goods producers combine domestic and foreign output, again subject to an import adjustment cost. Consumption goods are sold to retailers and the government, while investment goods are sold to capital goods producers and the government. Retailers face real sales adjustment costs, which together with habit persistence in preferences generate inertial consumption dynamics.

Asset markets are incomplete. There is complete home bias in domestic government debt and in ownership of domestic firms. Equity is not traded, instead households receive lump-sum dividend payments.

In our derivations, per capita variables are only considered at the level of disaggregated households. When the model's real aggregate variables, say x_t, are rescaled, we divide by the level of technology and by population to obtain $\check{x}_t$, with the steady state of $\check{x}_t$ denoted by $\bar{x}$.

[14] We assume quadratic inflation adjustment costs as in Ireland (2001) and Laxton and Pesenti (2003), meaning that inflation rather than the price (or wage) level is sticky.

3.2. Overlapping Generations (OLG) Households

A representative OLG household of age a derives utility at time t from consumption $c_{a,t}^{OLG}$ relative to the consumption habit $h_{a,t}^{OLG}$, and from leisure $(1-\ell_{a,t}^{OLG})$ (where 1 is the time endowment). The lifetime expected utility of a representative household has the form

$$\sum_{s=0}^{\infty}(\beta\theta)^s\left[\frac{1}{1-\gamma}\left(\left(\frac{c_{a+s,t+s}^{OLG}}{h_{a+s,t+s}^{OLG}}\right)^{\eta^{OLG}}\left(1-\ell_{a+s,t+s}^{OLG}\right)^{1-\eta^{OLG}}\right)^{1-\gamma}\right], \tag{1}$$

where β is the discount factor, $\theta<1$ determines the planning horizon, $\gamma>0$ is the coefficient of relative risk aversion, and $0<\eta^{OLG}<1$. As for money, we assume the cashless limit advocated by Woodford (2003). Consumption $c_{a,t}^{OLG}$ is given by a Dixit-Stiglitz CES aggregate over retailed consumption goods varieties. The (external) consumption habit is given by lagged per capita consumption of OLG households.

A household can hold domestic currency bonds, which are either issued by the domestic government, $B_{a,t}$, or by banks lending to nontradables and tradables entrepreneurs, $B_{a,t}^N+B_{a,t}^T$. They can also hold U.S. dollar denominated foreign bonds $F_{a,t}$. The nominal exchange rate vis-a-vis the U.S. dollar is E_t, and the corresponding gross depreciation rate is ε_t. Gross nominal interest rates on domestic and foreign currency denominated assets held from t to $t+1$ are i_t and $i_t^*(1+\xi_t^f)$, where i_t^* is the U.S. dollar nominal interest rate and ξ_t^f is a foreign exchange risk premium.

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.[15]

OLG households' pre-tax nominal labor income is $W_t\Phi_{a,t}\ell_{a,t}$. The productivity $\Phi_{a,t}$ of an individual household's labor declines throughout his lifetime, with $\Phi_{a,t}=\kappa\chi^a$ and $\chi<1$. OLG households also receive lump-sum remuneration for their services in the bankruptcy

[15] The turnover in the population is assumed to be large enough that the income receipts of the insurance companies exactly equal their payouts.

monitoring of entrepreneurs, $P_t rbr_{a,t}$. Lump-sum after-tax nominal dividend income received from firms/unions in sector j is denoted by $D^j_{a,t}$. OLG households' labor income and consumption are taxed at the rates $\tau_{L,t}$ and $\tau_{c,t}$. In addition there are lump-sum taxes $\tau^{ls,OLG}_{a,t}$, and transfers $\Upsilon^{OLG}_{a,t}$ paid to/from the government.[16] The consumption tax $\tau_{c,t}$ is payable on the price P_t at which retailers purchase final consumption goods from distributors.

We choose P_t as our numeraire. Gross inflation is given by $\pi_t = P_t/P_{t-1}$, the real interest rate is $r_t = i_t/\pi_{t+1}$, the real wage is $w_t = W_t/P_t$, and retailers' real sales price is $p^R_t = P^R_t/P_t$. Real domestic bonds are $b_t = B_t/P_t$, real internationally traded bonds are $f_t = F_t/P^*_t$, and the real exchange rate vis-a-vis the United States is $e_t = (E_t P^*_t)/P_t$. The household's budget constraint in nominal terms is

$$P^R_t c^{OLG}_{a,t} + P_t c^{OLG}_{a,t}\tau_{c,t} + P_t\tau^{ls}_{a,t} + B_{a,t} + B^N_{a,t} + B^T_{a,t} + E_t F_{a,t} \tag{2}$$

$$= \frac{1}{\theta}\left[i_{t-1}\left(B_{a-1,t-1} + B^N_{a-1,t-1} + B^T_{a-1,t-1}\right) + i^*_{t-1}E_t F_{a-1,t-1}\left(1+\xi^f_{t-1}\right)\right]$$

$$+W_t\Phi_{a,t}\ell^{OLG}_{a,t}(1-\tau_{L,t}) + \sum_j D^j_{a,t} + P_t rbr_{a,t} + P_t\Upsilon^{OLG}_{a,t}\ .$$

The household maximizes (1) subject to (2). We obtain a standard first-order condition for the consumption/leisure choice. Uncovered interest parity is given by $i_t = i^*_t\xi_t\varepsilon_{t+1}$.

A key condition of the model is the optimal aggregate consumption rule of OLG households.[17] Consumption is a function of real aggregate financial wealth fw_t and human wealth $hw^L_t + hw^K_t$, with the marginal propensity to consume of out of wealth given by $1/\Theta_t$, with hw^L_t representing the present discounted value of households' time endowments evaluated at the after-tax real wage, and hw^K_t representing the present discounted value of dividend income net of lump-sum government transfers. After rescaling by technology we have

$$\check{c}^{OLG}_t\Theta_t = \check{f}w_t + \check{h}w^L_t + \check{h}w^K_t\ , \tag{3}$$

[16] It is convenient to keep these two items separate in order to account for a country's overall fiscal accounts, and to distinguish targeted and untargeted transfers.

[17] Aggregation takes account of the initial size of each age cohort and the remaining size of each generation.

where

$$\check{f}w_t = \frac{1}{\pi_t g n}\left[i_{t-1}\left(\check{b}_{t-1}+\check{b}^N_{t-1}+\check{b}^T_{t-1}\right)+i^*_{t-1}\varepsilon_t(1+\xi^f_{t-1})\check{f}_{t-1}e_{t-1}\right] , \tag{4}$$

$$\check{h}w^L_t = (N(1-\psi)(\check{w}_t(1-\tau_{L,t}))) + \frac{\theta\chi g}{r_t}\check{h}w^L_{t+1} , \tag{5}$$

$$\check{h}w^K_t = \left(\Sigma_j \check{d}^j_t + r\check{b}r_t - \check{\tau}^{ls,OLG}_t + \check{\Upsilon}^{OLG}_t\right) + \frac{\theta g}{r_t}\check{h}w^K_{t+1} , \tag{6}$$

$$\Theta_t = \frac{p^R_t+\tau_{c,t}}{\eta^{OLG}} + \frac{\theta j_t}{r_t}\Theta_{t+1} , \tag{7}$$

and where j_t is discussed in KLMM. The intuition is as follows:

Financial wealth depends on the government's current financial liabilities, which are serviced through different forms of taxation. These future taxes are reflected in the different components of human wealth, as well as in the marginal propensity to consume. But unlike the government, which has an infinite horizon, a household with finite planning horizon attaches less importance to higher tax payments in the distant future, by discounting future tax liabilities at the rates r_t/θ and $r_t/\theta\chi$, which are higher than the market rate r_t. Government debt is therefore net wealth to the extent that households, due to short planning horizons, disregard the future taxes necessary to service that debt.

A fiscal stimulus through initially lower taxes, and accompanied by a permanent increase in debt, represents a tilting of the tax payment profile from the near future to the more distant future. The present discounted value of the government's future primary deficits has to remain equal to the current debt $i_{t-1}b_{t-1}/\pi_t$ when future deficits are discounted at the market interest rate r_t. But for households the same tilting of the tax profile represents an increase in human wealth because an increasing share of future taxes becomes payable beyond the household's planning horizon. For a given marginal propensity to consume, this increase in human wealth leads to an increase in consumption.

3.3. Liquidity-Constrained (LIQ) Households and Aggregate Households

The objective function of liquidity-constrained households is assumed to be identical to that of OLG households. These agents can consume at most their current income, which consists of their after-tax wage income plus net government transfers. After rescaling by technology, their budget constraint is given by

$$\check{c}_t^{LIQ}(p_t^R + \tau_{c,t}) = \check{w}_t \ell_t^{LIQ}(1 - \tau_{L,t}) + \check{\Upsilon}_t^{LIQ} - \check{\tau}_t^{ls,LIQ} \; . \tag{8}$$

This group of households has a very high marginal propensity to consume out of income (equal to one), so that fiscal multipliers of revenue based stimulus measures (taxes and transfers) are particularly high whenever such agents have a high population share. Aggregate consumption and labor supply are given by $\check{C}_t = \check{c}_t^{OLG} + \check{c}_t^{LIQ}$ and $\check{L}_t = \check{\ell}_t^{OLG} + \check{\ell}_t^{LIQ}$.

3.4. Firms

To conserve space we only describe here the financial accelerator or entrepreneur/bank sector. KLMM contains the complete details for the other sectors. Each firm in each sector maximizes the present discounted value of net cash flow or dividends. The discount rate it applies 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, OLG households. The first-order conditions for optimal price setting and input choices are standard.

The entrepreneur/bank sector is based on the models of Bernanke et al. (1999) and Christiano et al. (2009). Entrepreneurs rent capital stocks to manufacturers. Each entrepreneur finances his capital with a combination of his net worth and bank loans. Loans are risky because the productivity of an entrepreneur's capital is subject to idiosyncratic risk. The entrepreneur is risk-neutral and therefore bears all aggregate risk. The loan contract specifies a loan amount and a state-contingent schedule of gross interest rates to be paid if productivity is above a cut-off level. Entrepreneurs below the cut-off go bankrupt and must hand over their entire capital stock to the bank. Due to bankruptcy monitoring costs rbr_t the bank can only recover a fraction of the value of such firms. The bank finances its loans to entrepreneurs by borrowing from households. It pays households a nominal rate of return i_t that is not state-contingent. The parameters of the entrepreneur's debt contract are chosen to maximize entrepreneurial profits, subject to zero bank profits in each state of nature. Due to the costs of bankruptcy, entrepreneurs must pay an external finance premium, which equals the difference between the rate paid by entrepreneurs to banks and the rate paid by banks to households. There is an upward-sloping and convex relationship between entrepreneurs' leverage and the external finance premium. Entrepreneurs accumulate profits over time. To rule out net worth accumulation to the point that entrepreneurs no longer need loans, we assume that they regularly pay out dividends to households according to a fixed dividend policy.

3.5. Government

Fiscal policy consists of a specification of consumption and investment spending $G_t = G_t^{cons} + G_t^{inv}$, lump-sum taxes $\tau_{ls,t} = \tau_t^{ls,OLG} + \tau_t^{ls,LIQ}$, lump-sum transfers $\Upsilon_t = \Upsilon_t^{OLG} + \Upsilon_t^{LIQ}$, and tax rates $\tau_{L,t}$, $\tau_{c,t}$ and $\tau_{k,t}$, while monetary policy is described by an interest rate rule.

Government consumption spending is unproductive, while government investment spending augments a stock of publicly provided infrastructure capital that depreciates at the rate δ_G. Tax revenue τ_t is endogenous and given by the sum of labor, consumption, capital and lump-sum taxes. Denoting the primary surplus by $\check{s}_t$, the government budget constraint is

$$\check{b}_t = \frac{i_{t-1}}{\pi_t gn}\check{b}_{t-1} + \check{G}_t + \check{\Upsilon}_t - \check{\tau}_t = \frac{i_{t-1}}{\pi_t gn}\check{b}_{t-1} - \check{s}_t \ . \tag{9}$$

A fiscal policy rule stabilizes deficits and the business cycle. First, it stabilizes the interest inclusive government-deficit-to-GDP ratio gd_t^{rat} at a long-run level $gdss^{rat}$. Second, it stabilizes the business cycle by letting the deficit fall with the output gap. We have

$$gd_t^{rat} = gdss_t^{rat} - d^{gdp} \ln \left(\frac{g\check{d}p_t}{g\check{d}p_{pot}} \right) \quad . \tag{10}$$

Here $d^{gdp} \geq 0$, gd_t^{rat} is given by

$$gd_t^{rat} = 100 \frac{\frac{(i_{t-1}-1)\check{b}_{t-1}}{\pi_t gn} - \check{s}_t}{g\check{d}p_t} = 100 \frac{\check{b}_t - \frac{\check{b}_{t-1}}{\pi_t gn}}{g\check{d}p_t} \quad , \tag{11}$$

and $gdss_t^{rat}$ is the long-run target (structural) government-deficit-to-GDP ratio. We denote the current value and the long-run target of the government-debt-to-GDP ratio by $\check{b}_t^{rat}$ and $\check{b}ss_t^{rat}$. The relationship between bss_t^{rat} and $gdss_t^{rat}$ follows directly from the government's budget constraint as

$$bss_t^{rat} = \frac{\bar{\pi} gn}{\bar{\pi} gn - 1} gdss_t^{rat} \ , \tag{12}$$

where $\bar{\pi}$ is the inflation target of the central bank. In other words, for a given trend nominal growth rate, choosing a deficit target $gdss_t^{rat}$ implies a debt target bss_t^{rat} and therefore keeps debt from exploding. We note that the implied long-run autoregressive coefficient on debt, at $1/(\bar{\pi} gn)$, is close to one.

Our model allows for permanent saving and technology shocks, which have permanent effects on potential output $g\check{d}p_{pot}$. The latter is therefore modeled as an arithmetic moving average of past actual values of GDP to allow for the gap to close over time. Fiscal policy can be characterized by the degree to which automatic stabilizers work. This has been quantified by the OECD, who have produced estimates of d^{gdp} for a number of countries.[18]

The rule (10) is not an instrument rule but rather a targeting rule. Any of the available tax and spending instruments can be used to make sure the rule holds. The default setting in this paper is that this instrument is general transfers $\check{\Upsilon}_t$, meaning transfers that are not specifically targeted at one of the two household groups.

[18] See Girouard and André (2005).

Monetary policy uses an interest rate rule to stabilize inflation. The rule is similar to a conventional inflation forecast based rule that responds to one-year-ahead inflation, but with the important exception that the equilibrium real interest rate needs to be formulated as a (geometric) moving average, similar to potential output above.

3.6. Calibration

Detailed calibration tables are presented in KLMM. Here we comment only on the most important features. The real per capita growth rate is 1.5 percent, the world population growth rate is 1 percent, and the long-run real interest rate is 3 percent.

Household utility functions are equal across countries. The intertemporal elasticity of substitution is 0.25, or $\gamma = 4$, and the wage elasticity of labor supply is 0.5. The parameters ψ, θ and χ are critical for the non-Ricardian behavior of the model. The shares of liquidity-constrained agents ψ are 25 percent in US, EU and JA, and 50 percent in AS and RC, reflecting less developed financial markets in the latter two regions. The average remaining time at work is 20 years, or $\chi = 0.95$. The planning horizon is also equal to 20 years, or $\theta = 0.95$. The main criterion used in choosing θ and χ is the empirical evidence of Laubach (2003), Engen and Hubbard (2004) and Gale and Orszag (2004). They find that a one percentage point increase in the government-debt-to-GDP ratio in the U.S. leads to an approximately one to six basis points long-run increase in the U.S. (and therefore world) real interest rate. Our calibration is at the lower end of that range, at around one basis point. Our estimates of the long-run crowding-out effects of higher fiscal deficits and debt are therefore conservative.

As for technologies, elasticities of substitution equal 1 between capital and labor, 0.75 between domestic and foreign goods, and 0.5 between tradables and nontradables. Steady state gross markups equal 1.1 in manufacturing and wage setting, 1.05 in retailing, investment and consumption goods production, and 1.025 for import agents.

Steady state GDP decompositions, trade flows and debt ratios are based on recent historical averages. For the public capital stock accumulation we adopt Kamps' (2004) 4 percent per year estimate of δ_G. Ligthart and Suárez (2005) estimate the elasticity of aggregate output with respect to public capital at 0.14. This is reproduced by our model through specifying the productivity of public capital in the distribution sector's technology.

The calibration of monetary rule parameters is based on our own estimates using annual data. For fiscal rule parameters the calibration assumes target deficit-to-GDP ratios consistent with historically observed government-debt-to-GDP ratios. We use OECD estimates of output gap coefficients d^{gdp}.

This paper compares, throughout its discussion of the simulation results, a version of GIMF without and with a financial accelerator. The structure and calibration of the two model variants are kept identical in all but the entrepreneur/bank sector. The key step in the calibration of the latter is to fix two magnitudes. First, leverage, defined as the ratio of corporate debt to corporate equity, equals 100 percent in all sectors and regions. Second, the steady state external finance premium equals 2.5 percent. These ratios are fixed by setting the steady state values of entrepreneurs' annual dividend distributions, of firm riskiness, and of the fraction of bankrupt firms' assets lost to bankruptcy monitoring costs. The model version without a financial accelerator can be thought of as an otherwise identical model where bankruptcy monitoring costs are zero.

4. Two Contractionary Shocks and the Financial Accelerator

We begin by illustrating the importance of including a financial accelerator mechanism in the model. We do so by simulating[19] two shocks that in our view reflect important aspects of recent economic events, a decline in the U.S. potential growth rate and an increase in the project riskiness of the U.S. corporate sector. The latter shock is only present in the

[19] All programs used to generate the results in this paper are available at www.douglaslaxton.org. The programs use TROLL to generate the model structure and simulations. A temporary version of TROLL can be obtained from Peter Hollinger at INTEX Solutions at <troll@intex.com>.

model with a financial accelerator. We assume that both shocks are temporary but highly persistent.

The key feature of the financial accelerator is that when net worth declines, the real interest rate faced by the corporate sector increases. Also, shocks to net worth have persistent effects because it takes several years to rebuild lost net worth. During this time dividend distributions are reduced, which negatively affects consumption. Corporate net worth is equal to the market value of the firm's physical capital minus the value of the firm's financial liabilities. The former falls in the presence of negative technology shocks and of higher riskiness of corporate borrowers. The latter rises when there is a decline in the price level.

The monetary policy response to adverse shocks, and also to the fiscal stimulus response to such shocks, has played a key role in the recent policy debate.[20] Several of the world's main central banks have reached the zero lower bound on nominal interest rates during the course of the financial crisis, and are therefore unable to respond to negative shocks through lower rates. This means that further falls in inflation cause real interest rates to rise far more quickly than in ordinary circumstances. Our simulations, in this section and throughout the paper, reflect these circumstances by comparing three sets of environments, ranging from an ordinary monetary policy response that follows an interest rate reaction function, to a situation where the central bank keeps nominal interest rates unchanged for one or two years.

4.1. Decline in Productivity Growth

Figure 1 illustrates the simulated effects on the U.S. and rest of the world economies of a temporary but persistent reduction in U.S. productivity growth. The shock involves a reduction in the rate of productivity growth of 0.25 percentage points for 10 years in both the tradables and non-tradables sectors.

In figure 1 and in all subsequent figures, the dotted line shows the effects of the shock when the policy interest rate can drop immediately, in line with the monetary policy reaction

[20] See, for example, Freedman et al. (2009).

function. The dashed line scenario leaves policy rates unchanged for one year following the shock, either because the rate is at the zero interest rate floor (ZIF) or because of a delay in the policy response. The solid line scenario leaves policy rates unchanged for two years.

We first discuss the model without a financial accelerator. The short-run to medium-run effects of the decline in productivity growth are a reduction in real GDP and a decline in inflation. The latter indicates that aggregate demand falls by more than aggregate supply over the time period shown, as households consume less in anticipation of lower lifetime income, and as businesses reduce investment in response to anticipated lower growth. The central bank, if it follows its reaction function (dotted line), gradually reduces the policy interest rate, and the real interest rate eventually falls below baseline. If interest rates are left unchanged for one year (dashed line), real interest rates in the first year are above those in the previous case, so that real GDP, inflation, consumption and investment are slightly lower than in the previous case. If interest rates are held fixed for two years (solid line), we observe considerably larger declines in real GDP, inflation, consumption and investment. There are only limited spillovers from the U.S. shock to the rest the world, even in the case of unchanged nominal interest rates for two years.

Now consider the model with a financial accelerator. For the cases in which interest rates are able to adjust or are fixed for only one year, introducing the financial accelerator causes the negative effects of the shock to be only slightly larger. But in the case of interest rates fixed for two years, the differences are much more substantial. Two principal mechanisms are responsible for this outcome.

First, there is a substantial increase in the external finance premium. The reason is that leverage increases due to lower net worth, which in turn results from a combination of the negative effect of lower productivity growth on the market value of physical capital with the positive effect of the unanticipated fall in the price level on the real value of outstanding debt. Investment is negatively affected by the higher external finance premium, while consumption falls in response to lower dividend distributions from the corporate sector, due to both lower earnings and the effort to rebuild lost net worth.

Second, the larger decline in investment and consumption results in a larger decline in inflation, which raises the riskless real interest rate still further, especially for the case of nominal interest rates fixed for two years. This further reduces investment and consumption.

The interaction of these factors results, for the case of interest rates unchanged for two years, in a maximum decline (in year two) in consumption of about 2.5 percent in the model with a financial accelerator versus 1.3 percent in the model without a financial accelerator, and a reduction of 4.5 percent versus 2.3 percent in investment. The corresponding GDP contractions are 2.7 percent versus 1.6 percent.

In the case of interest rates held fixed for two years, the spillovers to the rest of the world are considerably higher than in the model without a financial accelerator. This is not the direct result of demand spillovers from lower spending in the United States, which are fairly small, as is common in this type of model. Rather, they are the result of much stronger propagation through real financing costs. Specifically, the decline in U.S. demand reduces inflation not only in the United States but also in RW. With interest rates held unchanged, this drives up RW real interest rates, thereby negatively affecting corporate balance sheets and the external finance premium.

4.2. Increase in Borrower Riskiness

Figure 2 presents the simulated effects of a temporary but persistent increase in the idiosyncratic project risk of U.S. corporate borrowers, in both the tradables and non-tradables sectors. The shock gradually phases out over time, with an annual decay factor of 0.95.

Given the model's calibration, the shock results in an increase of between 70 and 90 basis points in the external finance premium in year one, depending on the ability of nominal interest rates to adjust to the shock. While this increase has some effect on consumption, and a very considerable and persistent effect on investment, even in the cases of interest rates that are able to adjust or are fixed for one year (GDP drops by around 0.5 percent), the effects are much larger (over 1 percent) in the case of unchanged interest rates for two years. Part of the larger effects in the latter case can be attributed to the larger initial movement in the external finance premium, but most is attributable to the much greater increase in the riskless real interest rate. For this shock, spillovers to RW are miniscule for the cases of interest rates able to adjust or fixed for one year, but very significant (over 0.3 percent) for the case of interest rates unchanged for two years, for the same reasons discussed in the previous subsection.

5. Short-Run Fiscal Multipliers

This section turns to a simulation-based evaluation of one of the two key aspects of the recently adopted fiscal policy measures, their effectiveness at stimulating aggregate demand and output in the short run. Section 7 will consider the other key aspect, the possibility that a large run-up in government debt can have harmful effects in the longer run.

We discuss simulations for four types of temporary fiscal stimulus measures—(i) an increase in government investment; (ii) an increase in general lump-sum transfers to all households; (iii) an increase in lump-sum transfers targeted specifically at liquidity-constrained households; and (iv) a decrease in the tax rate on labor income.[21] In all cases, the fiscal shock involves discretionary stimulative actions equal to 1 percent of pre-shock GDP for two years. The resulting government deficits are smaller than the size of the shock because automatic stabilizers ($d^{gdp} > 0$) react to the positive movements of GDP that result from the discretionary fiscal actions.

In our discussions of the results we will use the terminology "fiscal multiplier" to describe the sizes of the GDP effects of the four stimulus measures. Given that the stimulus equals exactly one percent of baseline GDP in the first two years, the fiscal multiplier equals simply the percentage change in GDP for those same years.

[21] See Freedman et al. (2010) for a more detailed discussion of fiscal multipliers that also includes government consumption, consumption taxes and corporate income taxes.

Fiscal stimulus has effects on both the demand and supply sides of the economy. The demand effects come from the fiscal action feeding directly into aggregate demand (in the case of government investment), or from increasing real disposable incomes that are partly used to increase spending (in the case of increases in general or targeted transfers and decreases in labor income taxes). Demand effects have the usual secondary multiplier effects, as higher spending increases labor incomes and dividends, and the recipients in turn increase their own spending. For some stimulus measures there are important supply-side effects. Specifically, higher government investment and lower labor income taxes increase potential output, thereby reducing the inflationary effects of fiscal stimulus.

For the expansionary fiscal measures discussed in this section, we will refer to the cases of interest rates held constant for one or two years as monetary accommodation. Accommodation plays a critical supportive role for fiscal policy. Stimulus increases inflationary pressures (or at least reduces deflationary pressures), which under constant nominal interest rates lowers the real interest rate, thereby giving rise to further increases in consumption and investment.

5.1. Increase in Government Investment

Figure 3 shows the simulated effects of an increase in government investment. The average effects on U.S. GDP over the two years of fiscal stimulus in the model without a financial accelerator are sizeable, ranging from a 1.2 percent increase in GDP without monetary accommodation, to 1.4 percent for one year of monetary accommodation, to 1.8 percent for two years of monetary accommodation. The corresponding effects in the model with a financial accelerator are 1.3 percent, 1.5 percent, and 2.2 percent.

There are a number of reasons for these relatively large multipliers. First, government investment feeds directly into aggregate demand. Second, it has a small but not insignificant effect on aggregate supply, by making private production more efficient. Third, under monetary accommodation, the substantial increase in inflation leads to a substantial decline in real interest rates. For example, with two-year monetary accommodation and a financial accelerator, riskless real interest rates are below baseline by around 1.2 percentage points in years 1 and 2. This supports and greatly increases, by more than 50 percent, the direct effects of the fiscal action on GDP.

With a financial accelerator, corporate net worth increases as the strengthening economy raises the market value of physical capital, and as higher inflation reduces the real value of corporate debt, thereby causing a reduction in the external finance premium, especially in the case of two-year monetary accommodation. This leads to an additional reduction in interest rates faced by corporate borrowers, beyond that from the decline in the riskless real interest rate, and therefore to even larger investment.

A notable feature of figure 3 is that the effect of the shock on GDP nearly dies out as soon as the shock ends. The main reason is the highly temporary nature of the stimulus measure.[22] This implies that OLG households will largely, although not completely, smooth their consumption by saving the additional income, while investors have no incentive to engage in sustained higher investment because the effect of temporarily higher demand is more than outweighed by the anticipation of higher real interest rates. In the absence of a sustained increase in demand from these sources, wage income does not increase significantly beyond the stimulus period, and therefore neither does LIQ households' post-stimulus consumption.

Another reason for the rapid drop in output following the stimulus could be that annual averaging in GIMF can give the appearance of less dynamics. But quarterly models do in fact produce very similar impulse responses around the end of the stimulus period. This is shown in Coenen et al. (2010), which compares fiscal multipliers for temporary stimulus measures across seven large DSGE models (five of which are quarterly) used by policymaking institutions. In fact, in that comparison GIMF typically generates as much or more persistence than estimated models such as the Federal Reserve's FRB-US and the European Central Bank's NAWM.

[22] See Section 5.5 for the case of a permanent increase in the fiscal instrument, which does generate a more persistent response of output.

The effects of fiscal stimulus on realized fiscal deficits are of course also a matter of great interest to policymakers. We find that the direct effects are offset to a considerable extent by automatic stabilizers. For example, for two years of monetary accommodation and a financial accelerator, the fiscal accounts move back into balance in year 3, and the government-debt-to-GDP ratio is below baseline for several years, as the effect of the relatively small deficits in the first two years is offset by the increase in real GDP, and by the effect of the rise in prices on the real value of government debt.

The effects on the rest of the world of the U.S. fiscal stimulus are generally small, except for the case of two years of monetary accommodation, where real interest rate effects result in a large increase in real GDP (about 0.6 percent on average over the two years) in the model with a financial accelerator, which is roughly twice as large as in the model without a financial accelerator.

5.2. Increase in General Lump-Sum Transfers

The simulated effects on GDP of an increase in general lump-sum transfers (figure 4) are small, even in the case of monetary accommodation. In the model without a financial accelerator and without monetary accommodation, GDP increases by less than 0.2 percent. With two-year monetary accommodation, the results are somewhat larger, with real GDP rising by about 0.3 percent. There are virtually no spillovers to the rest of the world.

The main reason for these small multipliers is that the increase in general lump-sum transfers only has a significant effect on the spending of liquidity-constrained households, who comprise only one quarter of the U.S. household population. The remaining households treat most of the increase in income as a windfall, and spend only a small proportion. The indirect effect from the decline in real interest rates under monetary accommodation is minimal since the increase in inflation is small.

Adding a financial accelerator generally results in only small increases in the multiplier. In the case of two-year monetary accommodation, there are somewhat larger effects on corporate net worth and the external finance premium, and real GDP rises by about 0.4 percent on average over two years. Spillovers to the rest of the world are also more noticeable in this case.

5.3. Increase in Targeted Lump-Sum Transfers

Targeted transfers are aimed directly at liquidity-constrained households, who have a marginal propensity to consume out of current income of one. When the one quarter of such households in the United States receive 100 percent of the increase in transfers, the aggregate increase in consumption is much higher than when they receive only 25 percent.

Figure 5 shows the simulated results. The effects on U.S. GDP are almost four times larger than the effects of an increase in untargeted lump-sum transfers. In the case of two-year monetary accommodation, they equal 1.1 percent compared with 0.3 percent in the model without a financial accelerator, and 1.5 percent compared with 0.4 percent in the model with a financial accelerator. The larger increase in U.S. demand results in significantly higher inflation not only in the United States but also in RW. This relatively limited spillover is however propagated much more strongly in the presence of monetary accommodation and financial accelerator effects, as higher RW inflation drives down the riskless real interest rate, which in turn positively affects corporate balance sheets and external finance premia. The result is a four times larger increase in GDP in the rest of the world than in the case of general lump-sum transfers.

5.4. Decrease of the Labor Income Tax Rate

The simulation results for fiscal stimulus implemented via lower labor income taxes are presented in figure 6.[23] The effect on U.S. GDP is slightly larger than in the case of general lump-sum transfers for no monetary accommodation and one-year monetary accommodation, and slightly smaller in the case of two-year monetary accommodation. The reduction in

[23] A reduction of about 1.7 percentage points in the tax rate on labor income is needed to achieve an increase of 1 percent in the government-deficit-to-GDP ratio.

labor income taxes increases households' labor supply. This has two effects that operate in opposite directions. First, the increase in labor supply directly increases potential and actual output, and by more than in the case of general transfers. Second, as a result of the increase in potential GDP, there is less upward pressure on inflation and therefore less downward pressure on the real interest rate in the presence of monetary accommodation, which implies less monetary stimulus to aggregate demand than in the case of general transfers. For example, in the case of two-year monetary accommodation and no financial accelerator, U.S. real interest rates fall on average by about 0.3 percentage points over the two years when the fiscal instrument is general lump-sum transfers, but they are virtually unchanged in the case of a reduction in labor income taxes. A similar result holds in the model with a financial accelerator and two-year monetary accommodation. Given the much smaller changes in real interest rates, there is also less propagation due to financial accelerator effects.

5.5. Temporary versus Permanent Fiscal Shocks

Our simulations have so far focused on temporary fiscal shocks, because most of the stimulus measures currently being implemented worldwide are intended to be strictly temporary. But in the economics literature the most common canonical shock has been a permanent change in a fiscal instrument. Therefore, to make our simulations comparable to that literature, such as the Brookings comparison of global models in Bryant, Hooper and Mann (1993), we now turn to a comparison of the short-run effects of temporary versus permanent increases in spending, deficits and debt.

Figure 7 illustrates the differences in multipliers between a one-year fiscal stimulus[24] using government consumption, and a permanent change in government consumption of the same size, one percent of baseline GDP. For the latter we assume that the government's deficit-to-GDP ratio also increases permanently by one percentage point, which leads to a 20 percentage point long-run increase in the debt-to-GDP ratio. Higher long-run debt implies

[24] We use a one-year stimulus, rather than a two-year stimulus as in the other simulations of Section 5, to maximize the contrast between temporary and permanent fiscal shocks.

that additional interest charges will eventually exceed the increase in the deficit ratio. We assume that labor income taxes are increased to service these interest charges as well as to pay for the higher government spending in the long run. Because this is a long-run scenario, we assume that there is no monetary accommodation.

Figure 7 shows that the temporary fiscal stimulus has a first-year multiplier of about 1.05 that goes to zero in year 2 (top panel)[25], while a permanent change in government consumption has a first-year multiplier of 0.7 that declines much more gradually thereafter (bottom panel).[26] To understand these differences, we return to the fact that our permanent stimulus experiment involves higher labor income taxes and debt in the long run. This has three effects. First, the large increase in the present discounted value of taxes leads to a negative wealth effect that immediately starts to crowd out private demand. Second, if taxes are distortionary, this exacerbates the crowding-out effects. The more distortionary is the tax, the greater will be the effect on GDP. Third, due to finitely-lived households, part of the increase in government debt is perceived as net wealth, and therefore crowds out alternative investments, specifically physical capital and (net) foreign assets, as well as resulting in a permanent increase in the world real interest rate. This further reduces the short-run multiplier. We will revisit long-run issues in Section 7.

6. Effects of Announced G20 Fiscal Stimulus Packages

Table 1 sets out the simulated effects on regional and global GDP of the actually announced G20 fiscal stimulus packages that are being implemented over 2009 and 2010.[27] We make what appears from the current vantage point to be the most realistic assumption about monetary policy, namely two years of accommodation. We emphasize that these simulations

[25]Following the withdrawal of fiscal stimulus, GDP remains slightly below its baseline value for some period of time as inflation is brought back to baseline.

[26]We note that the multipliers reported by Cogan et al. (2009), who express skepticism about the effectiveness of fiscal stimulus, are very similar to those in the bottom panel of figure 7. Part of their skepticism can therefore be attributed to the fact that they concentrate on permanent rather than temporary increases in spending.

[27]Regional decompositions of stimulus measures are based on data collected by IMF staff, as of April 20, 2009.

do not represent an ex-post evaluation of the actual impacts of the policy packages, but rather an ex-ante simulation of what the model predicts for their effectiveness.

Japan, emerging Asia and the United States have announced the largest fiscal packages, while the G20 countries in the euro area, Africa and Latin America have smaller packages. In terms of their composition, general and targeted transfers dominate in Japan, government investment dominates in emerging Asia, general and targeted transfers and labor income taxes dominate in the United States, while in the euro area and other countries there is a relatively large role for corporate income tax cuts in 2010.[28] It is interesting to note that increases in government consumption do not play a predominant role in any of the regions.

Simulations of both versions of the model show a considerable impact on GDP of the announced packages. The regional differences reflect both the different sizes of the announced packages and the higher multipliers of government investment and targeted transfers based measures. Consistent with the earlier results on fiscal multipliers, the effects in the model with a financial accelerator are up to 50 percent larger.

Furthermore, each region benefits from spillovers due to simultaneously implemented worldwide stimulus. But at the same time, the multiplier for simultaneous worldwide stimulus is smaller than the sum of the multipliers for stimulus in each region at a time. The reason is that stimulus in one region can expand output at a comparatively low cost by drawing on foreign output and therefore labor. The world as a whole faces a much less elastic labor supply curve.

7. Long-Run Effects of the Accumulation of Public Debt

In this section, we assess the risks to the regional and global economies if the deficits associated with the fiscal stimulus measures should become chronic and therefore lead to permanently higher debt. Specifically, we consider the effects of a permanent 0.5 percentage point increase in the U.S. government-deficit-to-GDP ratio, which ultimately results in a 10

[28] Transfers that fall under the social safety net heading are treated as targeted transfers for simulation purposes.

percentage point increase in the U.S. government-debt-to-GDP ratio.[29] Table 2 and figure 8 illustrate. We assume that the deficits are initially driven up by stimulus measures based on higher lump-sum transfers or lower labor income, capital income or consumption taxes. As debt and real interest rates increase, the same transfers are lowered or taxes increased to service the growing interest charges on government debt. We restrict attention to the version of the model with a financial accelerator.

Figure 8 illustrates the dynamic transition paths of key U.S. variables for the case of stimulus based on initially lower labor income tax rates. Automatic stabilizers are allowed to operate during the transition, but their effect is small because the government is assumed to quickly update its estimate of potential output following the shock. In the first 10 years following the increase in deficits, U.S. GDP, consumption, investment and inflation increase.[30] So do real interest rates, except for the first two periods (due to interest rate smoothing). During this initial phase, higher real interest rates are mostly associated with the monetary policy response to higher inflation.

In subsequent decades real GDP declines relative to baseline, ultimately by about 0.4 percent. There are two interrelated reasons, one connected with tax rates and the other with real interest rates. First is the evolution of U.S. distortionary labor income taxes. While they fall initially to cause the short-run stimulus effect on GDP, in the longer run they must rise above the baseline to service a larger stock of public debt that carries a higher real interest rate. Second, higher fiscal deficits lead to lower U.S. saving and therefore, given the size of the U.S. economy, significantly lower world saving. Given the non-Ricardian behavior of households, private saving does not offset the decline of public saving. The result is an increase in the world real interest rate that crowds out investment in U.S. physical capital and therefore real output. It also crowds out U.S. investment in net foreign assets, and

[29] We choose the United States for illustrative purposes only. An identical increase in deficits in another region that accounts for a similar share of world GDP would have very similar effects on the world economy.

[30] Note that the short-run multipliers are not directly comparable to those in our earlier exercises. In those simulations the size of the stimulus was expressed as a fraction of pre-stimulus GDP, while here deficits are expressed as a fraction of actual post-stimulus GDP, which is larger.

because the current account and the net foreign asset position exhibit the same type of long-run relationship as government deficits and government debt in equation (12), it leads to a progressive deterioration in U.S. current account imbalances with the rest of the world.[31] The rising interest payments to foreigners ultimately require a reversal of the initially negative trade balance. In the long run, the U.S. fiscal actions have a significant negative effect on GDP in the other regions, as higher world real interest rates result in lower capital ratios and hence lower GDP in all regions. We note that these transitions, because they are driven by stock-flow dynamics, take decades rather than years to play out.

While figure 8 focuses on the transitional dynamics of higher deficits and debt, Table 2 concentrates only on the long-run GDP effects. Higher debt results in a permanent decline in long-run U.S. real GDP of 0.27 percent for general transfers, 0.34 percent for consumption taxes, 0.43 percent for labor income taxes and 0.64 percent for taxes on capital income. The corresponding figures for global real GDP are 0.21 percent, 0.24 percent, 0.28 percent and 0.34 percent. The latter is due to higher world real interest rates. U.S. results are worse for all instruments because it has to finance a higher debt stock from higher distortionary taxes.[32] The more distortionary the tax, the greater the effect on potential GDP.

We conclude that if fiscal stimulus should lead to permanently higher deficits and therefore debt, the consequences may look favorable for the domestic economy in the short run and even in the medium run, but at the expense of unfavorable long-run consequences.

8. Concluding Remarks

This paper uses the IMF's DSGE model, GIMF, to analyze two key questions that have arisen during the recent policy debate on fiscal stimulus. First, how effective is fiscal stimulus in the short run? In other words, what is the *multiplier* of fiscal stimulus on GDP? Second, how damaging is fiscal stimulus in the long run if it becomes permanent? In other words,

[31] See Kumhof and Laxton (2009b) for a more detailed treatment of this issue.

[32] The U.S. contraction is also larger for general transfers, because their eventual reduction has a greater proportionate effect on LIQ than on OLG households.

what are the long-run *crowding-out* effects of higher debt on GDP?

GIMF has been developed for several years precisely with questions of this nature in mind. It features non-Ricardian households, which implies that fiscal policy can have significant real effects in both the short run and the long run, and its specification allows for many different fiscal instruments. It embeds this in a monetary business cycle framework that allows for an analysis of the interaction of monetary and fiscal policies. And it adds a financial accelerator mechanism that gives an important role to macro-financial shocks and transmission channels, a critical aspect of the recent financial crisis.

The comprehensive nature of the model has a major advantage for the type of policy analysis undertaken in this paper – it allows us to explore the sensitivity of our conclusions to many different combinations of policies and structural features. Most importantly, unlike monetary policy, fiscal policy can use a large number of different instruments, and there is no substitute for exploring them one at a time.

We find that the multipliers of a two-year fiscal stimulus package with no monetary accommodation and no financial accelerator mechanism range from 1.2 for government investment to 0.2 for general transfers, with targeted transfers closer to the upper end of that range and tax cuts closer to the lower end. In the presence of monetary accommodation and a financial accelerator mechanism multipliers are up to twice as large, as accommodation lowers real interest rates, which in turn has a favorable effect on corporate balance sheets and therefore on firms' external finance premium.

As for crowding-out, a permanent 0.5 percentage point increase in the U.S. deficit-to-GDP ratio leads to a 10 percentage point increase in the U.S. debt-to-GDP ratio in the long run. Servicing this higher debt raises the U.S. tax burden and world real interest rates in the long run, thereby eventually permanently reducing U.S. output by between 0.3 and 0.6 percent, with the size of the output loss depending on the distortionary effects of the fiscal instrument. The real interest rate movement (but not the change in the tax burden) affects the rest of the world equally and accounts for non-U.S. output losses of around 0.2 percent.

The foregoing suggests that a carefully chosen package of fiscal and supporting monetary stimulus measures can provide a significant contribution to supporting domestic and global economies during a period of acute stress. But such measures should also be embedded in a conservative medium-term fiscal framework that ensures that deficits and debt do not drift upwards permanently when the economy recovers. In the absence of such a framework the long-run costs could exceed the short-run benefits.

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Figure 1: U.S. Persistent Productivity Growth Shock (Deviation from Baseline)

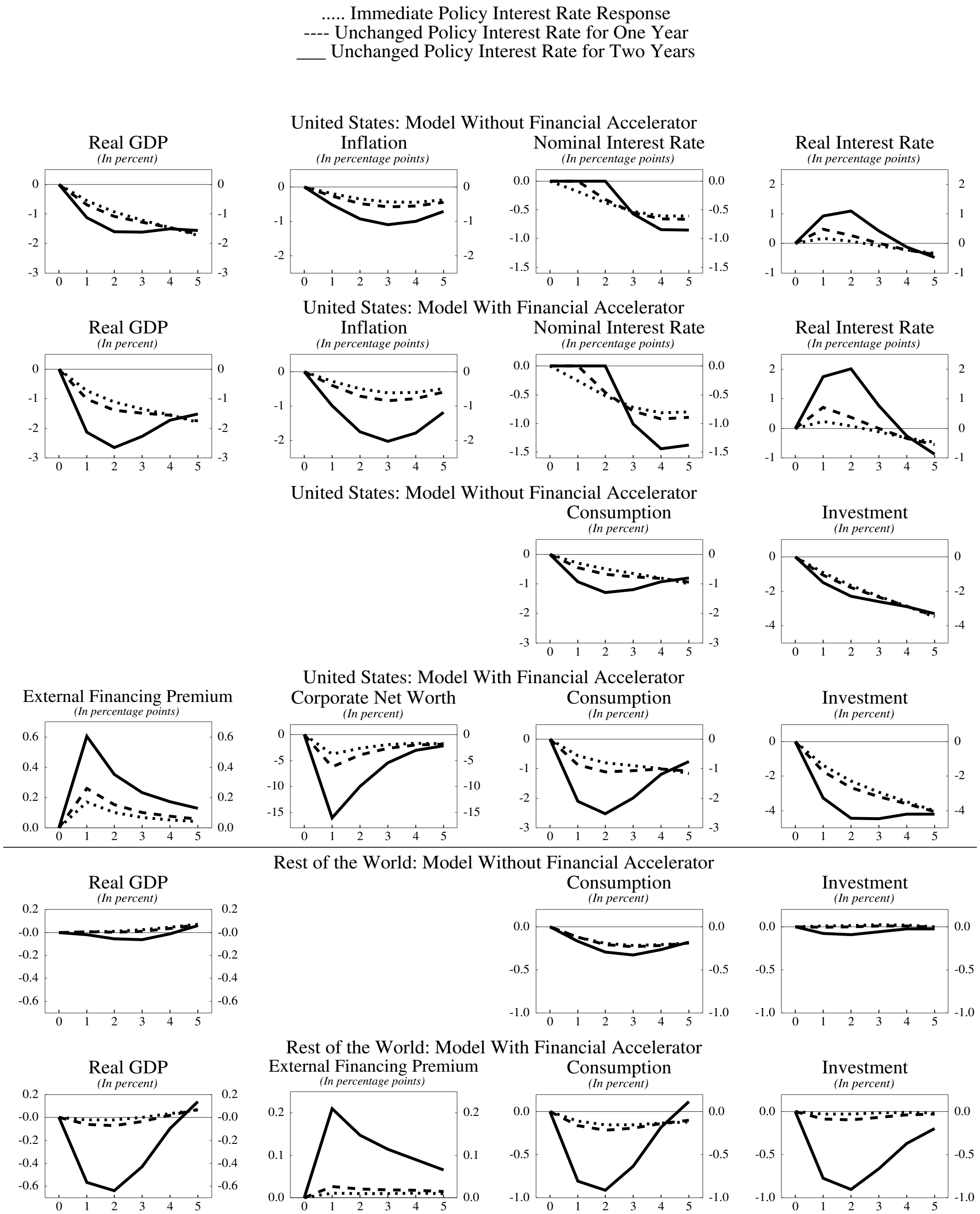

Figure 2: U.S. Persistent Increase in Borrower Riskiness (Deviation from Baseline)

Figure 3: U.S. Fiscal Stimulus, Instrument=Gov't Investment (Deviation from Baseline)

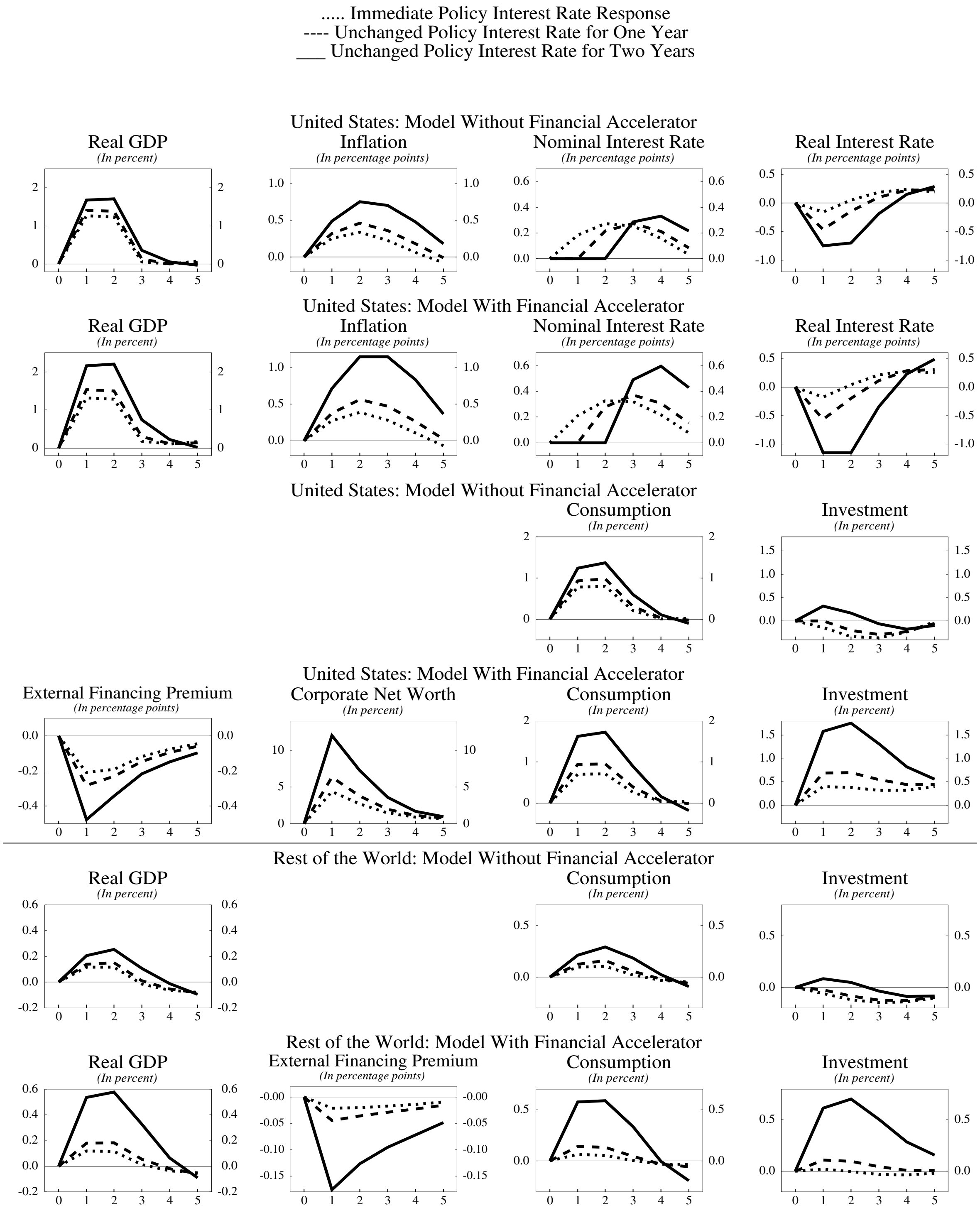

Figure 4: U.S. Fiscal Stimulus, Instrument=General Transfers (Deviation from Baseline)

..... Immediate Policy Interest Rate Response
---- Unchanged Policy Interest Rate for One Year
___ Unchanged Policy Interest Rate for Two Years

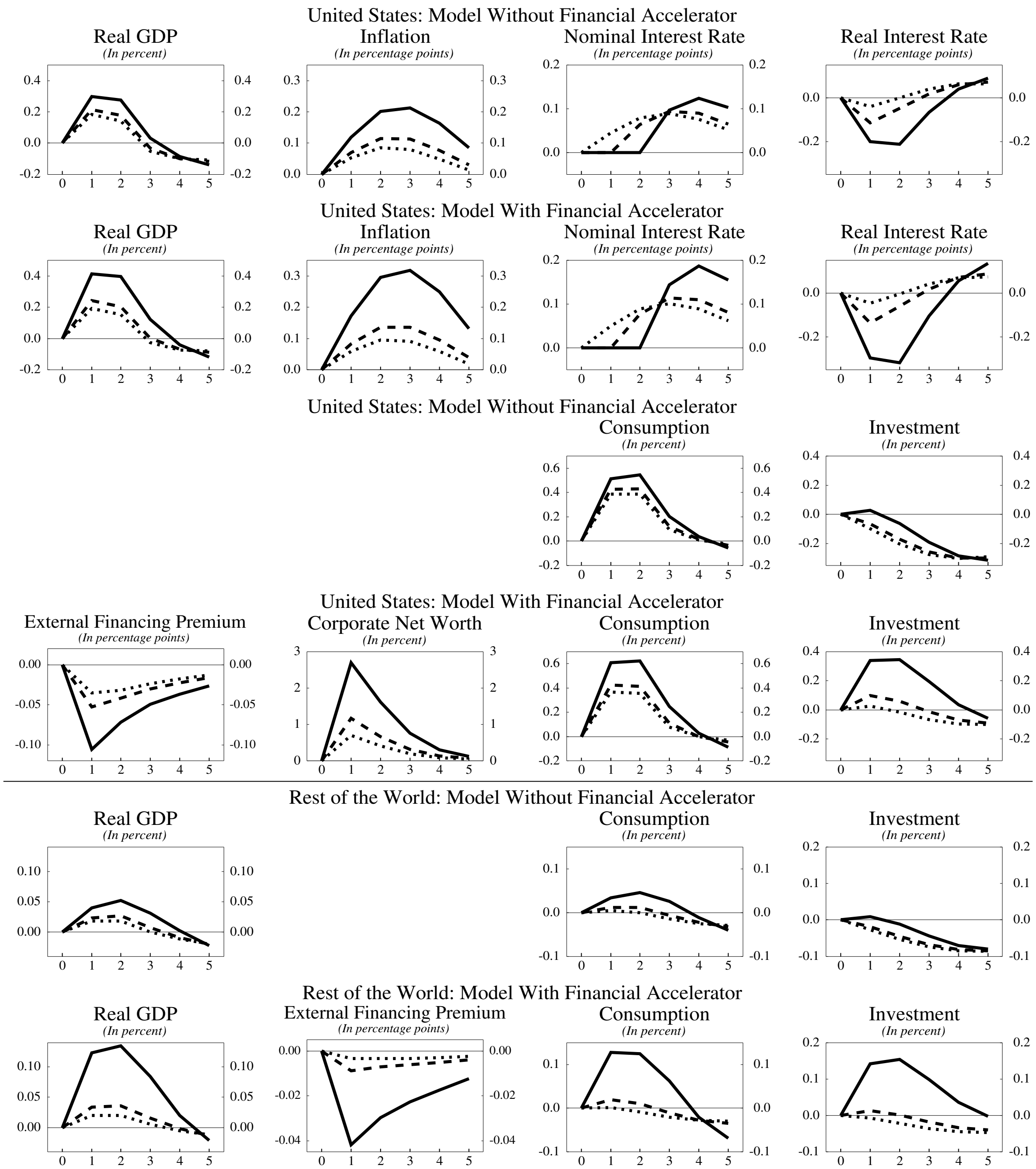

Figure 5: U.S. Fiscal Stimulus, Instrument=Targeted Transfers (Deviation from Baseline)

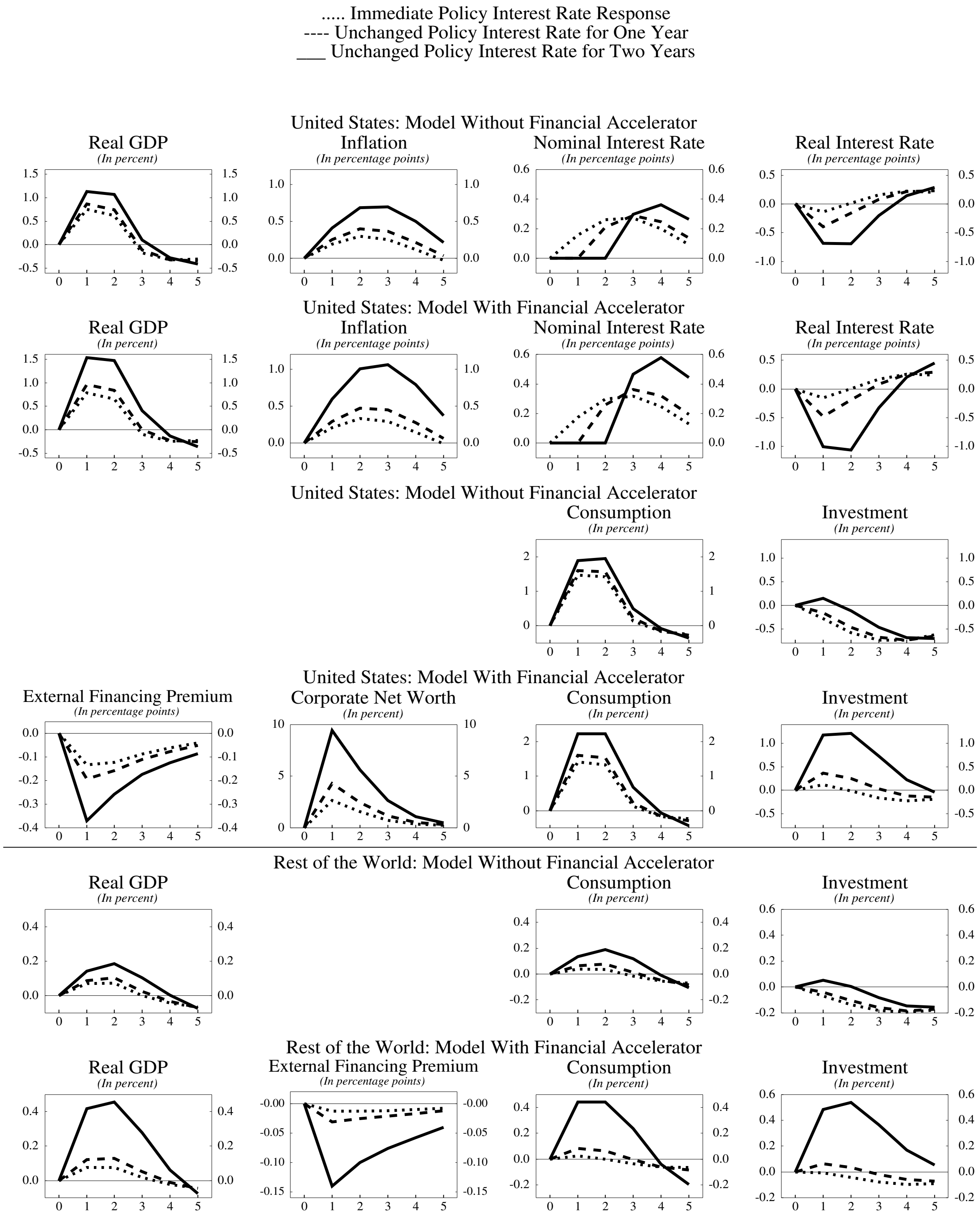

Figure 6: U.S. Fiscal Stimulus, Instrument=Labor Income Tax (Deviation from Baseline)

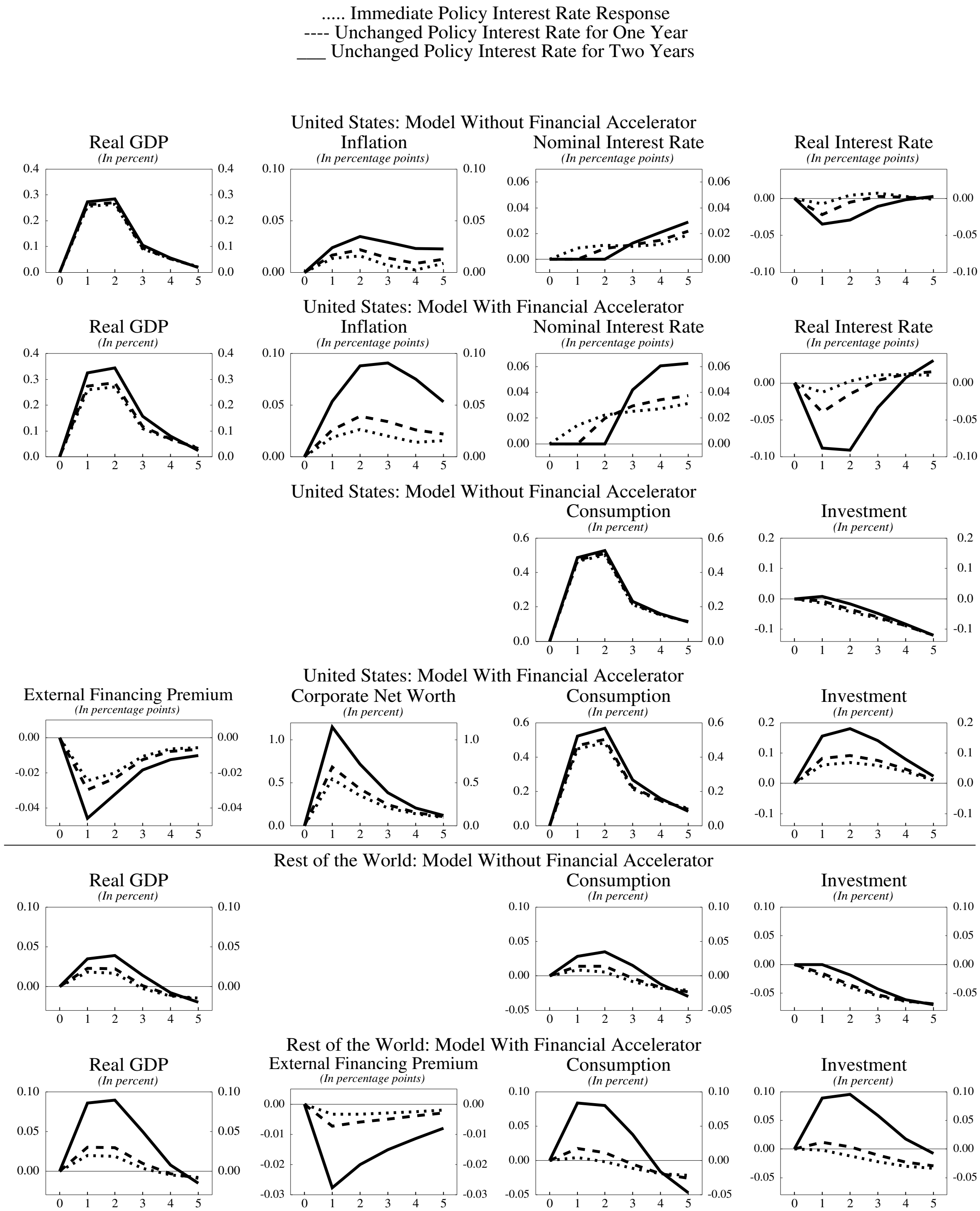

Figure 7: Effect of 1 Year U.S. Fiscal Stimulus and of Permanent Change in the U.S. Fiscal Instrument on GDP (in percent), Instrument = Government Consumption

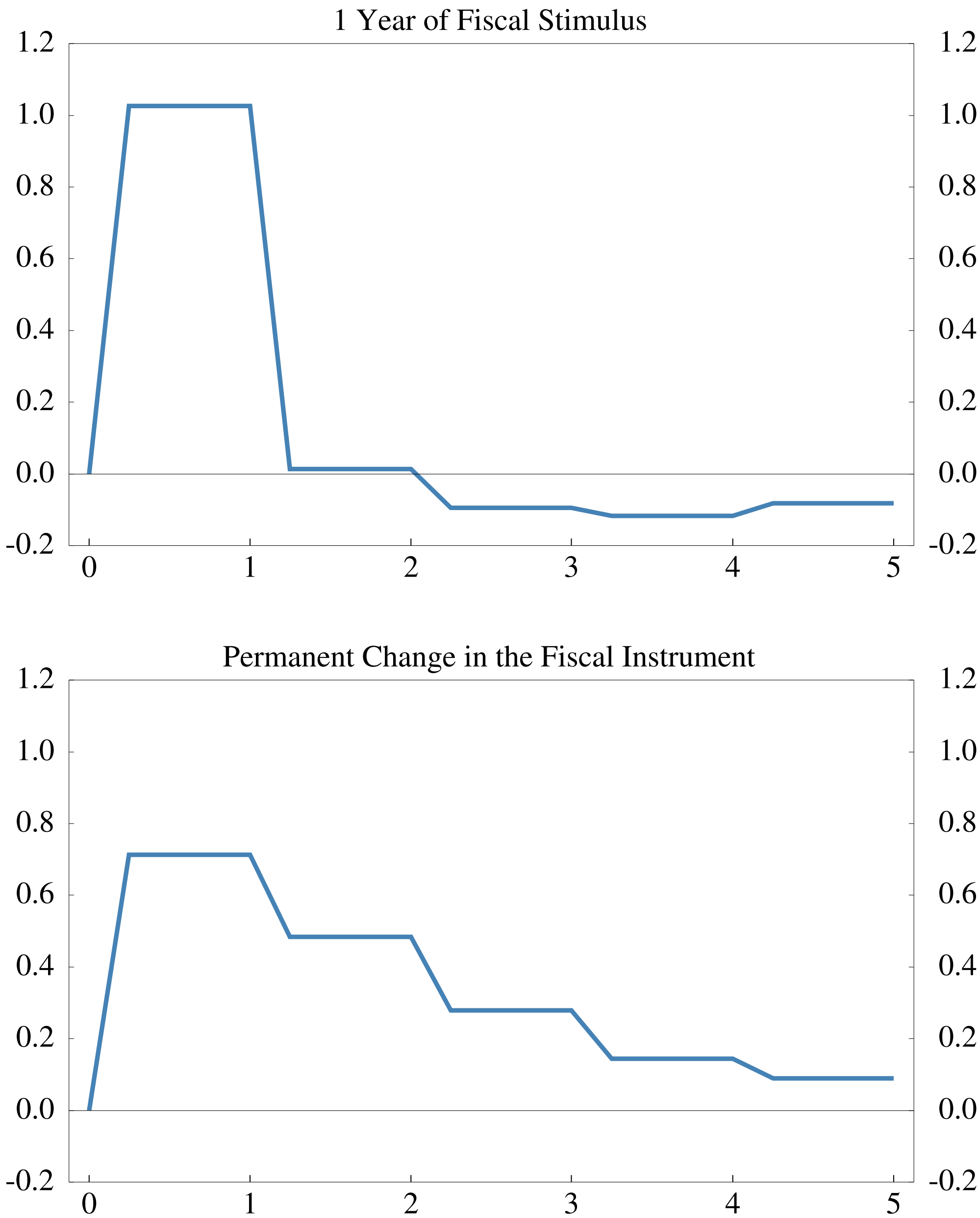

Figure 8: Dynamic Effects of a 10 Percentage Point Increase in the U.S. Debt-to-GDP Ratio, Instrument=Labor Income Tax

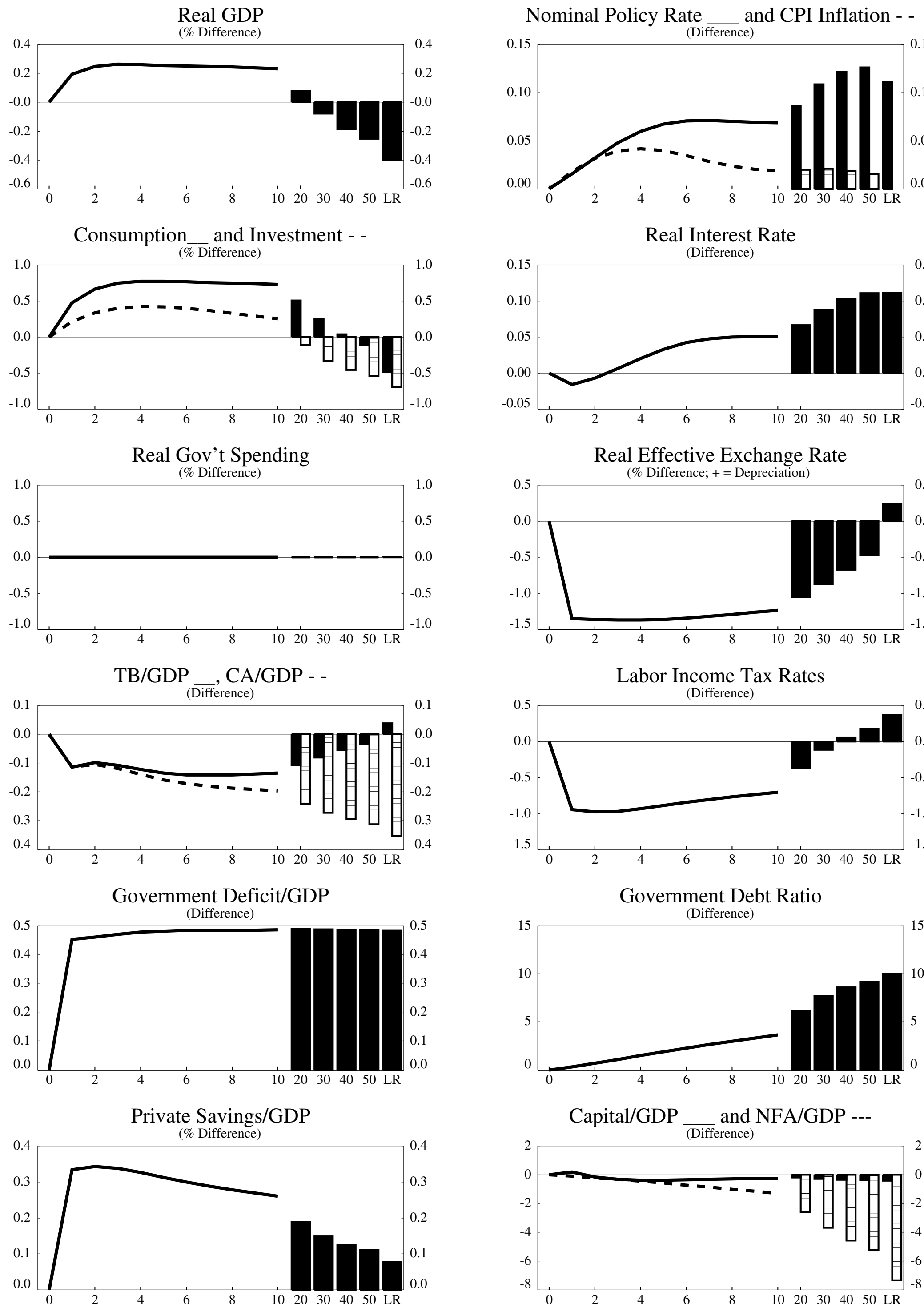

Table 1: Simulated Effects on GDP of G-20 Fiscal Stimulus (Percent Deviation from Baseline)

	Stimulus in:					
	All	U.S.	Euro Area	Japan	Em.Asia	RoW
			Model without Financial Accelerator			
Effects on GDP Level in 2009						
World	1.6	0.4	0.1	0.1	0.7	0.3
United States	1.4	**1.1**	0.0	0.0	0.2	0.1
Euro Area	0.7	0.0	**0.5**	0.0	0.1	0.1
Japan	1.8	0.1	0.0	**1.5**	0.2	0.0
Emerging Asia	2.6	0.4	0.1	0.1	**2.0**	0.2
Remaining Countries	1.4	0.2	0.1	0.1	0.4	**0.8**
Effects on GDP Level in 2010						
World	1.3	0.4	0.1	0.1	0.6	0.2
United States	1.2	**1.0**	0.0	0.0	0.2	0.1
Euro Area	0.6	0.0	**0.3**	0.0	0.1	0.1
Japan	1.6	0.1	0.0	**1.3**	0.3	0.0
Emerging Asia	2.2	0.4	0.1	0.1	**1.7**	0.1
Remaining Countries	1.1	0.2	0.1	0.1	0.5	**0.5**
			Model with Financial Accelerator			
Effects on GDP Level in 2009						
World	2.1	0.7	0.2	0.2	0.8	0.5
United States	1.9	**1.5**	0.1	0.1	0.3	0.2
Euro Area	0.9	0.1	**0.6**	0.0	0.2	0.2
Japan	2.4	0.2	0.0	**1.8**	0.4	0.1
Emerging Asia	3.1	0.8	0.1	0.1	**2.1**	0.3
Remaining Countries	2.0	0.5	0.2	0.1	0.7	**1.0**
Effects on GDP Level in 2010						
World	1.9	0.7	0.2	0.2	0.8	0.4
United States	1.8	**1.4**	0.1	0.1	0.3	0.2
Euro Area	0.7	0.1	**0.4**	0.0	0.2	0.1
Japan	2.2	0.2	0.1	**1.6**	0.4	0.1
Emerging Asia	2.7	0.8	0.1	0.1	**1.7**	0.2
Remaining Countries	1.8	0.5	0.2	0.1	0.7	**0.7**

Table 2: Effects of a Permanent 10 Percentage Point Increase in the U.S. Government Debt to GDP Ratio (Deviation from Baseline)

	U.S.	RoW	Global
Financed by a Cut in General Transfers			
Real GDP (Percent)	-0.27	-0.20	-0.21
Real Interest Rate (Percentage points)	0.10	0.10	0.10
Current Account to GDP (Percentage points)	-0.32	0.10	
Investment (Percent)	-0.54	-0.47	-0.48
Government Deficit to GDP (Percentage points)	0.48	0.00	0.11
Private Saving to GDP (Percentage points)	0.12	0.05	0.06
Financed by an Increase in Labor Income Taxes			
Real GDP (Percent)	-0.43	-0.24	-0.28
Real Interest Rate (Percentage points)	0.11	0.11	0.11
Current Account to GDP (Percentage points)	-0.36	0.12	
Investment (Percent)	-0.73	-0.54	-0.58
Government Deficit to GDP (Percentage points)	0.48	0.00	0.11
Private Saving to GDP (Percentage points)	0.07	0.05	0.06
Labor Income Tax Rate (Percentage points)	0.41	0.00	0.09
Financed by an Increase in Capital Taxes			
Real GDP (Percent)	-0.64	-0.25	-0.34
Real Interest Rate (Percentage points)	0.10	0.10	0.10
Current Account to GDP (Percentage points)	-0.30	0.10	
Investment (Percent)	-1.80	-0.50	-0.79
Government Deficit to GDP (Percentage points)	0.48	-0.00	0.11
Private Saving to GDP (Percentage points)	-0.02	0.05	0.03
Capital Tax Rate (Percentage points)	1.25	0.00	0.28
Financed by an Increase in Consumption Taxes			
Real GDP (Percent)	-0.34	-0.21	-0.24
Real Interest Rate (Percentage points)	0.10	0.10	0.10
Current Account to GDP (Percentage points)	-0.33	0.11	
Investment (Percent)	-0.61	-0.49	-0.51
Government Deficit to GDP (Percentage points)	0.48	-0.00	0.11
Private Saving to GDP (Percentage points)	0.11	0.05	0.06
Consumption Tax Rate (Percentage points)	0.32	0.00	0.07