Fiscal Deficits and Current Account Deficits [*]

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Abstract

Recent fiscal stimulus packages significantly depend for their effectiveness on the assumption of non-Ricardian savings behavior. We show that, under the same assumption, higher fiscal deficits can have worrisome implications for world real interest rates and global current account imbalances if they turn out to be permanent. First, if they occur in large countries they significantly raise the world real interest rate. Second, they cause a short run current account deterioration equal to around 50 percent of the fiscal deficit deterioration. Third, the longer run current account deterioration equals almost 75 percent for a large economy such as the United States, and almost 100 percent for a small open economy.

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"As the global economy recovers and trade volumes rebound, however, global imbalances may reassert themselves. As national leaders have emphasized in recent meetings of the G-20, policymakers around the world must guard against such an outcome. We understand, at least in principle, how to do this. The United States must increase its national saving rate. Although we should deploy, as best we can, tools to increase private saving, the most effective way to accomplish this goal is by establishing a sustainable fiscal trajectory, anchored by a clear commitment to substantially reduce federal deficits over time."

Ben Bernanke, October 19, 2009, Federal Reserve Bank of San Francisco's Conference on Asia and the Global Financial Crisis, Santa Barbara, California

I.   Introduction

In response to the recent financial crisis many governments have announced sizeable expansionary fiscal stimulus packages. As documented in Freedman et al. (2009), the sizes and compositions of these packages differ greatly across countries, but almost all of them are large as a share of GDP. The policy debate has mainly concentrated on their short-run efficacy at stimulating output and preventing the tax base from collapsing, with much less attention devoted to long-run fiscal sustainability issues. But it is becoming increasingly clear that sustainability will be a real concern.[1] Specifically, a significant share of the now envisaged increases in government deficits may represent not just a temporary spike to cope with the crisis, but rather a permanent drifting up to what are perceived to be unsustainable levels. The consequences of these permanent deficit changes are the main concern of this paper.

A prominent example is the United States, whose fiscal outlook is examined in detail in Auerbach and Gale (2009). One of their main concerns is that the current baseline fiscal projection in Congressional Budget Office (2009) may be far too optimistic because it assumes that the provisions of the recent stimulus package are allowed to expire even though the Administration would like to make many of them permanent. For example, "the Make Work Pay credit ... was originally proposed as a permanent policy change",

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[1]See for example the recent warning of ECB President Trichet to fiscal policymakers: "There is a moment where you can't spend anymore and you can't accumulate any more debt. I think we are at that moment." (Reuters (2009))

and "provisions for health care, education, infrastructure and energy ... are items that the Administration would like to promote in the long-term, not just as stimulus". The authors emphasize that this drift towards making higher deficits permanent would not be at all unprecedented, in that the major share of the current decade's deficit deterioration relative to the very favorable 2001 CBO baseline projection can be attributed to the extension of Bush tax cuts that were originally billed as temporary. Finally, Obama's expensive health care reform proposals, which are not part of CBO's baseline projection, are also likely to be of a long-term nature. Auerbach and Gale (2009) find that the combined effects of further extending the Bush tax cuts and of including the stimulus package would result in deficits that by 2019 would be worse than the official CBO baseline deficit projection (2% of GDP) by almost 5% of GDP, and that even this may be too optimistic. This view is even more pessimistic than the baseline projection in the IMF's latest World Economic Outlook (4.9% deficit by 2019) and with the CBO projection of the President's 2010 budget proposal (5.5% deficit by 2019), which are both shown in Figure 1. That figure also shows that according to the IMF WEO projection the U.S. debt-to-GDP ratio is expected to reach 100 percent over the next decade[2].

All of the more recent problems are of course in addition to longer-run concerns such as demographics and medical costs that have been emphasized for years, and which meant that the United States faced the prospect of large and persistent future deficits even before the onset of the crisis. Figure 2 shows longer term CBO projections of deficit and debt dynamics until 2080. They are highly unstable, with debt reaching between 300% and 700% of GDP depending on assumptions.[3] Finally, it should be emphasized that since the onset of the crisis debt projections have also become subject to another serious risk, increased uncertainty about the long-run sustainable growth rate of potential output.[4]

In an age of increasing macroeconomic interdependence across countries, the interest in the longer-run consequences of fiscal deficits is no longer exclusively motivated by the study of individual economies, but also by spillovers between multiple economies, specifically by global

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[2]See Kamenik et al. (2009).

[3]Government Accountability Office (2009) and Auerbach and Gale (2009) contain similar projections.

[4]Congressional Budget Office (2009) assumes potential output growth of 2.5 percent from 2009-2014 and an output gap of -7.4 percent in 2009. By contrast several institutions (IMF, OECD, European Commission, San Francisco Fed) have been making fairly dramatic downward revisions to the level of potential output arguing that low investment and the destruction of capacity has had important consequences for medium-term growth prospects. See, for example, Weidner and Williams (2009).

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current account imbalances. The concern with U.S. fiscal deficits has probably been the most pressing example until recently, but there are now numerous other examples of smaller open economies proposing very sizeable increases in fiscal deficits. The question we ask in this paper is whether such deteriorations in fiscal deficits can be a major contributing factor to deteriorations in their current account deficits. Or conversely, would an eventual fiscal consolidation among major deficit spenders make a sizeable contribution to the resolution of global current account imbalances?

The empirical literature on the link between fiscal and external deficits has produced very mixed and inconclusive results.[5] One problem faced by this literature is highlighted by our work. While fiscal deficits may have some immediate impact on the current account, the full effect of permanent deficit shocks may take years or even decades to arrive, making it difficult to correctly capture and distinguish it from other factors in reduced-form empirical work. We therefore follow the same approach as Erceg et al. (2005a), by using an open economy dynamic general equilibrium model to simulate the effects of fiscal deficit shocks, and by exploring the sensitivity of our simulations to key model assumptions.

But this raises an important question. Do we have appropriate model tools to study the implications of permanent saving shocks? In general the appropriate tool for studying open economy business cycle issues is the new generation of open economy monetary business cycle models with both nominal and real rigidities, which are being constantly refined in academia, and are being deployed rapidly in policymaking institutions to replace the previous generation of models, which were not completely based on microfoundations. Such models are well suited to address many monetary business cycle issues, but as argued in several important papers they face difficulties in adequately replicating the dynamic *short-run* effects of fiscal policy.[6] More importantly for this paper, 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. For example, the prediction of standard monetary business cycle models such as the Fed's SIGMA and the IMF's GEM[7] is that fiscal deficits

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[5]See Bernheim (1987), Roubini (1988), Bussière et al. (2005), Chinn (2005), Chinn and Ito (2005), Chinn and Lee (2005), Chinn and Steil (2006) and Kopcke et al. (2006).

[6]See Fatas and Mihov (2001), Blanchard and Perotti (2002), Gali et al. (2007).

[7]For documentation on SIGMA see Erceg et al. (2005b) and for GEM see Faruqee et al. (2005). Both are medium to large scale models, and take many of their modeling elements from benchmark closed economy models such as Christiano et al. (2005).

should have very small medium-run and zero long-run effects on the current account balance. The critical assumption behind this result is that all households have infinite planning horizons, augmented by an *economically* essentially arbitrary assumption that the economy's net foreign assets have to return to their original value in the very long run.[8] While these assumptions are generally considered innocuous for temporary shocks, their implications for permanent saving shocks may be too extreme. For example, they imply that when a government issues additional debt due to higher deficits, exactly 100% of this debt will eventually be acquired by domestic residents without recourse to foreign financing, even if the country is extremely small and perfectly integrated into world financial markets. We will show in this paper that if the assumption of infinite horizons is replaced with finite horizons, even if they are as long as 50 years, radically different results are obtained.

In this context it is important to point out that the fiscal stimulus packages that motivate this study are themselves based on the notion that households exhibit significant non-Ricardian saving behavior, in other words that they do not behave as though they were infinitely lived. Many of the measures announced up to this point consist of reducing government revenue by lowering taxes, rather than increasing government spending on goods and services. For their efficacy such measures depend critically on the assumption that households will not raise their saving rates to fully offset lower government saving rates. A study of the long-run implications of permanently higher deficits should therefore also allow for the possibility of non-Ricardian saving behavior.

In view of the current importance of fiscal policy problems, the idea of bringing models with microfoundations as rigorous as those of the open economy monetary business cycle literature to the analysis of fiscal policy is very appealing.[9] But to do so in a way that neither destroys the strengths nor ignores the weaknesses of existing models, the microfoundations of non-Ricardian household and firm behavior need to be integrated into existing models while maintaining their monetary policy specifications and their nominal and real rigidities. We attempt to do so in this paper.

The candidate non-Ricardian features known from the literature are finite-horizon (overlapping generations) models following Blanchard (1985) and infinite-horizon models with

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[8]This assumption is typically used only for *technical* reasons, to insure that the linearized model is dynamically stable and can therefore be solved with standard perturbation methods.

[9]See Ganelli and Lane (2002) for a discussion of the need to give a greater role to fiscal policy.

a subset of liquidity-constrained agents (who have a horizon of zero) following Gali et al. (2007). Both model classes are capable of producing powerful short-run effects of fiscal policy, and Kumhof and Laxton (2007) have shown that their short-run behavior can be very similar for purely temporary deficit shocks.[10] But only a finite-horizon setup allows for longer-run crowding-out effects of permanent increases in the stock of government debt, including an endogenous determination of the stock of net foreign liabilities. This behavior of stocks is critical to understanding the longer-run connections between the corresponding flows, fiscal deficits and current account deficits, that are the object of our study. A finite-horizon setting is therefore a key ingredient of this paper.

Gali 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. As we will discuss below in more detail, the finite-horizon model can then be seen as the intermediate case that spans all planning horizons between those of the liquidity-constrained households and infinite-horizon models.

Bringing a finite-horizon setting into an open economy monetary business cycle model has been undertaken by Ghironi (2000a,b) and by Ganelli (2005). The former does not consider the effects of government debt, but shows that a finite-horizon setup following Blanchard (1985) ensures the existence of a well-defined steady state for net foreign liability positions (see also Buiter (1981)). Our model is closer to Ganelli (2005), which is in turn related to the work of Frenkel and Razin (1992). Our model differs from these studies in that it embeds the finite-horizon setup in a fully-specified monetary and fiscal business cycle model.[11] This includes a very general specification of preferences and technologies and a number of nominal and real rigidities. We show that the resulting model, which is built on complete optimizing foundations, nests the extreme long-run Ricardian predictions of conventional models when the planning horizon approaches infinity. But when horizons are even moderately finite, any permanent change in deficits and debt has very significant immediate effects on the current

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[10]In general however the liquidity constrained agents model implies far more volatile short-run consumption behavior for the non-Ricardian group of agents than the overlapping generations model.

[11]An expanded version of this model is now widely used within the IMF for analytical work and policy analysis. See Kumhof et al. (2009).

account, and even larger effects in the long run.

The model has several features that are standard in the monetary business cycle literature, but which have so far not been incorporated into finite-horizon models due to difficulties in aggregating over generations. This includes a CRRA utility function that allows us to highlight the critical role of the intertemporal elasticity of substitution in the propagation of fiscal shocks, and which allows for endogenous labor supply. Capital formation is also endogenous, and provides a key channel through which government debt crowds out economic activity. There are nominal rigidities in price setting, and real rigidities in consumption, investment and imports.

The combination of non-Ricardian features and rigidities allows us to introduce specifications of fiscal and monetary policies that interact with one another. A monetary policy reaction function familiar from state-of-the-art monetary theory stabilizes inflation, while fiscal policy stabilizes the government deficit and therefore government debt. The short-run dynamics of the model are determined by the interaction of both of these policies, while the longer-run dynamics depend only on fiscal policy.

We find that a permanent increase in a country's fiscal deficit equal to 1% of its GDP leads to a short-run current account deterioration of around 0.5% of GDP, and to a long-run deterioration of between 0.75% for a country the size of the United States, and 1% for a small open economy. The long-run effects are independent of whether lump-sum taxes or government spending are used as the fiscal instrument. These results are in striking contrast to the infinite-horizon model. In a version of our model that replaces finite-horizon agents with 50% infinitely lived agents and 50% liquidity-constrained agents, but that is otherwise identical to our baseline, the same shock causes a short-run current account deterioration of only around 0.1% of GDP for lump-sum tax cuts and 0.4% of GDP for spending increases, while in the long run, by assumption, the increase is zero. The results for this model version are similar to those of Erceg et al. (2005a), who employ a closely related setup. But the focus of that paper is entirely on the short run. We find that the assumptions of this model class make its predictions for the long-run stock-flow dynamics of permanent saving shocks too rigid. We view our contribution as offering a more general and flexible framework to look at longer-run issues, and as demonstrating that it obtains strikingly different results even for very small deviations from the infinite-horizon paradigm.

The remainder of the paper is organized as follows. Section II summarizes the theoretical structure of the model, leaving some of the details to a Technical Appendix. Section III discusses calibration. Section IV analyzes the model's predictions for the consequences of permanently higher government deficits. Section V concludes.

II.   The Model

The world consists of 2 countries, Home (HO) and the rest of the world (RW). When the interaction between two countries is discussed we identify HO by an asterisk. Our main tool of analysis is a finite-horizon model (henceforth FIN). But for comparison with the recent literature we will also consider an infinite-horizon model (henceforth INF) with a subset of liquidity-constrained agents. Because the critical effects of permanent saving shocks stressed in this model arise over the longer run, we work with an annual version of the model.

In the FIN model each country is populated by households with finite planning horizons as in Blanchard (1985) who consume final retailed output and supply labor. In each period, $N(1-\theta)$ and $N^*(1-\theta)$ of such individuals are born in RW and HO, where N and N^* are population sizes and $(1-\theta)$ is the constant probability of death faced by each agent in each period. The latter implies an average planning horizon of $1/(1-\theta)$.

Firms are managed in accordance with the preferences of households, and they therefore also have finite planning horizons. Each country's primary production is carried out by manufacturers who produce tradable goods using inputs of labor and capital, and who accumulate capital subject to investment adjustment costs. Their sales go to distributors, who assemble domestic and foreign manufactured goods subject to an import adjustment cost. Final output is sold to consumption goods retailers, investors and the government. Distributors are subject to nominal rigidities in price setting. Retailers' output prices are flexible but they find it costly to rapidly adjust their sales volume. This feature generates inertial short-run consumption dynamics.

Asset markets are incomplete. There is complete home bias in the ownership of domestic firms. Households receive firms' cashflow distributions by way of lump-sum dividend payments. There is also complete home bias in government debt, which takes the form of nominally non-contingent one-period bonds denominated in domestic currency. The only

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assets traded internationally are nominally non-contingent one-period bonds denominated in the currency of HO.

In our derivations per capita variables are only considered at the level of disaggregated households. All aggregate variables represent absolute quantities normalized by the level of labor-augmenting world technology T_t, which grows at the constant rate $g = T_t/T_{t-1}$. For any growing variable x, we use the notation $\check{x}_t = x_t/T_t$, with the steady state of $\check{x}_t$ denoted by $\bar{x}$.

We consider the consequences of a single policy shock, a permanent 1 percentage point increase in the government-deficit-to-GDP ratio. We use the perfect foresight rather than the log-linearized stochastic version of the model to do so.[12]

A. Households

A representative household of age a derives utility at time t from consumption $C_{a,t}$, leisure $(1 - L_{a,t})$ (where 1 is the time endowment), and real balances $(M_{a,t}/P_t^R)$ (where P_t^R is the retail price index). The lifetime expected utility of a representative household of age a at time t has the form

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

where β is the discount factor, $\theta < 1$ determines the planning horizon, $\gamma > 0$ is the coefficient of relative risk aversion, and $0 < \eta < 1$. As for money demand, in the following analysis we will only consider the case of the cashless limit advocated by Woodford (2003), where $u^m \longrightarrow 0$. Preferences (1) satisfy the two essential requirements of being consistent with balanced growth and of allowing aggregation across generations of households.[13] To generate reasonable short-run consumption dynamics it has also become common to introduce habit persistence. However, for aggregation reasons this can only be incorporated into (1) in a form that generates very little inertia in consumption. We therefore adopt an alternative specification that yields the same result, quantity adjustment costs in a retail sector (see

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[12]See Armstrong et al. (1998).

[13]There are several other preference specifications that are consistent with balanced growth. But none of them allows for the aggregation of optimality conditions across generations.

subsection B.3). Consumption $C_{a,t}$ is given by a CES aggregate over retailed consumption goods varieties $C_{a,t}(i)$, with elasticity of substitution σ_R:

$$C_{a,t} = \left(\int_0^1 (C_{a,t}(i))^{\frac{\sigma_R-1}{\sigma_R}} \, di \right)^{\frac{\sigma_R}{\sigma_R-1}} . \tag{2}$$

This gives rise to a demand for individual varieties

$$C_{a,t}(i) = \left(\frac{P_t^R(i)}{P_t^R} \right)^{-\sigma_R} C_{a,t} , \tag{3}$$

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

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

A household can hold domestic government bonds $B_{a,t}$ denominated in domestic currency, and foreign bonds denominated in the currency of HO. The nominal exchange rate vis-a-vis HO is denoted by $\mathcal{E}_t$, and $\mathcal{E}_t F_{a,t}$ are nominal net foreign asset holdings in terms of domestic currency. In each case the time subscript t denotes financial claims held from period t to period $t+1$. Gross nominal interest rates on RW and HO currency denominated assets held from t to $t+1$ are i_t and $i_t^* \xi_t$, where ξ_t is a foreign exchange risk premium that is external to the household's asset accumulation decision. This term is assumed to equal one in the FIN model, while it depends on the level of net foreign liabilities in the INF model (see below). 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.[14]

Apart from returns on financial assets, households also receive labor and dividend income. Nominal labor income equals $W_t L_{a,t}$. Dividends are received in a lump-sum fashion from all firms in the manufacturing (H), distribution (D) and retail (R) sectors, with after-tax nominal dividends received from firm/union i denoted by $D_{a,t}^j(i)$, $j = H, D, R$. Finally, households are subject to nominal lump-sum taxes $P_t \tau_{a,t}$.

We choose the final goods price charged by distributors P_t as our numeraire. Then the real wage is denoted by $w_t = W_t/P_t$, the price level, relative price and gross inflation rate of

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

any good x by P_t^x, $p_t^x = P_t^x/P_t$ and $\pi_t^x = P_t^x/P_{t-1}^x$, gross final goods inflation by $\pi_t = P_t/P_{t-1}$, and gross nominal exchange rate depreciation by $\varepsilon_t = \mathcal{E}_t/\mathcal{E}_{t-1}$. The real exchange rate vis-a-vis HO is $e_t = (\mathcal{E}_t P_t^*)/P_t$. Each nominal asset is deflated by the final output price index of the currency of its denomination, so that real domestic bonds are $b_t = B_t/P_t$ and real internationally traded bonds are $f_t = F_t/P_t^*$. The real interest rate in terms of final output is $r_t = i_t/\pi_{t+1}$. The household's budget constraint in nominal terms is

$$P_t^R C_{a,t} + B_{a,t} + \mathcal{E}_t F_{a,t} = \frac{1}{\theta} \left[i_{t-1} B_{a-1,t-1} + i_{t-1}^* \xi_{t-1} \mathcal{E}_t F_{a-1,t-1} \right] \tag{5}$$

$$+ W_t L_{a,t} + \sum_{j=H,D,R} \int_0^1 D_{a,t}^j(i) di - P_t \tau_{a,t} \ .$$

For future reference, the multiplier of the budget constraint (5) in the household's optimization problem is $\lambda_{a,t}/P_t$. The household maximizes (1) subject to (2) and (5). The derivation of the first-order conditions for each generation, and aggregation across generations, is discussed in the Technical Appendix. Aggregation takes account of the size of each age cohort at the time of birth, and of the remaining size of each generation. For consumption we have

$$C_t = N(1-\theta) \Sigma_{a=0}^{\infty} \theta^a C_{a,t} \ . \tag{6}$$

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

$$\check{C}_t(i) = \left(\frac{P_t^R(i)}{P_t^R} \right)^{-\sigma_R} \check{C}_t \ , \tag{7}$$

$$\frac{\check{C}_t}{N - L_t} = \frac{\eta}{1-\eta} \frac{\check{w}_t}{p_t^R} \ . \tag{8}$$

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

$$i_t = i_t^* \xi_t \varepsilon_{t+1} \ . \tag{9}$$

Optimal aggregate consumption $\check{C}_t$ is a function of households' real aggregate financial wealth fw_t and human wealth hw_t, with the marginal propensity to consume of out of wealth given by $1/\Theta_t$. Human wealth is composed of the expected present discounted value of households' time endowments evaluated at the real wage plus the expected present discounted value of dividend income minus lump-sum taxes. After normalizing by technology we have

$$\check{C}_t \Theta_t = \check{f}w_t + \check{h}w_t \,, \tag{10}$$

where

$$\Theta_t = \frac{p_t^R}{\eta} + \frac{\theta j_t}{r_t}\Theta_{t+1} \,, \tag{11}$$

$$\check{f}w_t = \frac{1}{\pi_t g}\left[i_{t-1}\check{b}_{t-1} + i_{t-1}^*\xi_{t-1}\varepsilon_t\check{f}_{t-1}e_{t-1}\right] \,, \tag{12}$$

$$\check{h}w_t = \left(N\check{w}_t + \check{d}_t^H + \check{d}_t^D + \check{d}_t^R - \check{\tau}_t\right) + \frac{\theta g}{r_t}\check{h}w_{t+1} \,, \tag{13}$$

$$j_t = (\beta r_t)^{\frac{1}{\gamma}}\left(\frac{p_t^R}{p_{t+1}^R}\right)^{\frac{1}{\gamma}}\left(\frac{\check{w}_{t+1}p_t^R}{\check{w}_t p_{t+1}^R}g\right)^{(1-\eta)(1-\frac{1}{\gamma})} \,. \tag{14}$$

The implication of this set of equations is that government debt adds to agents' net worth, and that the timing of tax changes affects consumption. The intuition is as follows.

Financial wealth (12) is equal to the domestic government's and foreign households' *current* financial liabilities. For the government debt portion, the government services these liabilities through taxation, and these *future* taxes are reflected in human wealth (13). But unlike the government, which is infinitely lived, an individual household's planning horizon is finite, so that he attaches less importance to tax payments that fall due in the distant future. Hence *a household discounts future tax liabilities by a rate of r_t/θ, which is higher than the market rate r_t*, as reflected in the discount factor in (13). The implication is that government debt is net wealth to the extent that households do not expect to become responsible for the taxes necessary to service that debt. The shorter households' planning horizon, the greater the portion of outstanding government debt that they consider to be net wealth.

A permanent increase in the fiscal deficit through initially lower taxes represents a tilting of the tax payment profile from the near future to the more distant future, so as to effect an increase in the debt stock. The government has to respect its intertemporal budget constraint in affecting this tilting, and this means that the expected present discounted value of its 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 when individual households discount future taxes at a higher rate than the government, the same tilting of the tax profile represents an increase in human wealth because it decreases the value of future taxes for which the household expects to be responsible. For a given marginal propensity to consume, this increase in human wealth leads to an increase in consumption.

The marginal propensity to consume $mpc_t = 1/\Theta_t$ is, in the simplest case of logarithmic utility and exogenous labor supply, equal to $(1-\beta\theta)$. For the case of endogenous labor supply, household wealth can be used to either enjoy leisure or to buy goods. The main determinant of the split between consumption and leisure is the consumption share parameter η, which explains its presence in the marginal propensity to consume (11).

Two parameters, the intertemporal elasticity of substitution $1/\gamma$ and the planning horizon parameter θ, are critical for the long-run interest rate response to higher deficits. By combining (11) with (14), we obtain the following steady state relationship between $\overline{mpc}$, $\bar{r}$ and θ:

$$\overline{mpc} = \frac{\eta}{\bar{p}^R}\left(1 - \theta\beta^{\frac{1}{\gamma}}g^{(1-\eta)(1-\frac{1}{\gamma})}\bar{r}^{\left(\frac{1}{\gamma}-1\right)}\right) . \tag{15}$$

A higher real interest rate has a substitution and an income effect, the former reducing the marginal propensity to consume and the latter increasing it, with the two exactly offsetting each other for the log utility case of $\gamma = 1$. The conventional assumption is that $\gamma > 1$, and we will consider a benchmark of $\gamma = 4$. In that case the income effect is stronger, and the increase in the marginal propensity to consume due to a higher r partly offsets the contractionary consumption effect of a higher r on human wealth $\check{hw}_t$ in (13). The consequence is that for high γ real interest rates have to increase by more to clear markets following an increase in deficits.

A shorter planning horizon, or lower θ, increases the level of the marginal propensity to consume. But it also decreases its sensitivity to the real interest rate, because agents with a short planning horizon care less about the future effects of real interest rate changes. This is illustrated in Figure 3, which for simplicity depicts the closed economy case. Starting at a saving-investment equilibrium at point A, the government exogenously reduces its saving to take the economy to point A'. When households have long planning horizons (the dashed saving schedules), their saving is highly sensitive to the real interest rate. As a consequence the economy ends up at point B, with an only slightly higher real interest rate and only slightly lower saving and investment. The infinite-horizon model is the limiting case, where the savings schedule becomes horizontal and the economy returns to point A. When households have short planning horizons (the solid saving schedules), their saving is not highly sensitive to the real interest rate. The economy therefore ends up at point C, with much higher real interest rates and much lower saving and investment. If in addition leftward shifts in the investment schedule due to non-interest factors, such as lower aggregate demand, are

taken into account, the overall equilibrium reduction in saving could well exceed the government's own reduction in saving. We will in fact observe this for sufficiently low values of θ. The liquidity-constrained agents model is the limiting case of short planning horizons, where the savings schedule for this group of agents becomes vertical. This illustrates that the finite-horizon model spans all possible planning horizons between the two limiting cases.

In our policy simulations we will compare the finite-horizon (FIN) model to an infinite-horizon (INF) representative agent alternative that is identical in all but three respects. First, the parameter θ is assumed to be equal to one for one subgroup of households that is therefore infinitely lived. Second, in order to nevertheless generate non-Ricardian behavior in the short run, another subgroup of households is liquidity constrained. Specifically, they are limited to consuming their after tax income in each period, while still optimizing their consumption-leisure trade-off intratemporally. To generate a sufficiently non-Ricardian behavior the share of these agents is set at 50%. Details of this model specification are contained in the Technical Appendix. As is well known, in this alternative model class it is not possible to determine the steady state level of net foreign assets in log-linearized or perfect foresight environments. This calls for a third specification change whereby negative deviations from a long-run net-foreign-assets-to-GDP ratio $\overline{nfa}$ raise the external interest rate faced by the country. We assume the following simple specification for this risk premium ξ_t,

$$\xi_t = -\zeta \left(\frac{e_t \check{f}_t}{g\check{d}p_t} - \overline{nfa} \right) , \tag{16}$$

where ζ is very small. The alternative model gives rise to an identical system of equations except for a (numerically small) modification of the uncovered interest rate parity condition, and more importantly to a replacement of the consumption system (10)-(14) with the equation

$$\check{C}_{t+1} = \frac{j_t}{g}\check{C}_t . \tag{17}$$

B.   Firms

In the manufacturing, distribution and retail sectors there is a continuum of agents that are perfectly competitive in their input markets. In their output markets manufacturers are perfectly competitive, while distributors and retailers are monopolistically competitive, and indexed by $i \in [0, 1]$. Distributors face a fixed cost of production. Each sector pays out

each period's net cash flow as dividends to households and maximizes the present discounted value of these dividends. In the FIN model the discount rate it applies in this maximization includes the parameter θ so as to equate the discount factor of firms θ/r_t with the pricing kernel for nonfinancial income streams of households, which equals $\beta\theta\left(\lambda_{a+1,t+1}/\lambda_{a,t}\right)$. This equality follows directly from households' Euler equation $\lambda_{a,t} = \beta\left(\lambda_{a+1,t+1}r_t\right)$.

B.1 Manufacturers

Manufacturers produce homogenous output Z_t^H and sell it at the price P_t^H. The technology of each manufacturer is given by a Cobb-Douglas production function in capital K_t and labor L_t, with labor share parameter α_L:

$$Z_t^H = (K_t)^{(1-\alpha_L)}\left(T_t L_t\right)^{\alpha_L} \ . \tag{18}$$

The law of motion of capital is given by

$$K_{t+1} = (1-\delta)K_t + I_t \ , \tag{19}$$

where δ is the depreciation rate of capital. Capital accumulation is subject to quadratic adjustment costs $G_{I,t}$ in gross investment I_t:

$$G_{I,t} = \frac{\phi_I}{2}I_t\left(\frac{(I_t/g)-I_{t-1}}{I_{t-1}}\right)^2 \ . \tag{20}$$

Nominal dividends D_t^H equal nominal revenue $P_t^H Z_t^H$ minus nominal cash outflows. The latter include the wage bill $W_t L_t$, investment $P_t I_t$ and investment adjustment costs $P_t G_{I,t}$. The optimization problem of each manufacturing firm is given by

$$\underset{\left\{P_{t+s}^H, L_{t+s}, I_{t+s}, K_{t+s+1}\right\}_{s=0}^{\infty}}{Max} \Sigma_{s=0}^{\infty}\tilde{R}_{t,s}D_{t+s}^H, \tag{21}$$

where

$$\tilde{R}_{t,s} = \Pi_{l=1}^s \frac{\theta}{i_{t+l-1}} \text{ for } s>0 \ (=1 \text{ for } s=0) \ , \tag{22}$$

and subject to (18)-(20). The first-order conditions for the optimal choice of labor, investment and capital are standard except for the presence of the term θ in the discount factor. They are derived in the Technical Appendix.

B.2   Distributors

This sector produces final output. Distributors' customers demand a CES aggregate of distributed varieties, with elasticity of substitution σ_D. The aggregate demand for variety i is

$$Z_t^D(i) = \left(\frac{P_t(i)}{P_t}\right)^{-\sigma_D} Z_t^D , \tag{23}$$

where the numeraire price index P_t is defined similarly to (4), and where $Z_t^D(i)$ and Z_t^D remain to be specified by way of market-clearing conditions. Each distributor's technology is given by a CES production function in domestic and foreign manufactures $Y_t^H(i)$ and $Y_t^F(i)$, with elasticity of substitution ξ_D, domestic goods quasi-share parameter α_H, and subject to an adjustment cost $G_{F,t}(i)$ that makes rapid changes in the share of foreign tradables costly:[15]

$$Z_t^D(i) = \left((\alpha_{H_t})^{\frac{1}{\xi_D}}\left(Y_t^H(i)\right)^{\frac{\xi_D-1}{\xi_D}} + (1-\alpha_{H_t})^{\frac{1}{\xi_D}}\left(Y_t^F(i)(1-G_{F,t}(i))\right)^{\frac{\xi_D-1}{\xi_D}}\right)^{\frac{\xi_D}{\xi_D-1}}, \tag{24}$$

$$G_{F,t}(i) = \frac{\phi_F}{2}\frac{(\mathcal{R}_t-1)^2}{1+(\mathcal{R}_t-1)^2} , \quad \mathcal{R}_t = \frac{Y_t^F(i)/Z_t^D(i)}{Y_{t-1}^F/Z_{t-1}^D} . \tag{25}$$

The prices of $Y_t^H(i)$ and $Y_t^F(i)$, and the marginal cost of producing $Z_t^D(i)$, are given by P_t^H, P_t^F and P_t^D. Distributors are subject to inflation adjustment costs $G_{P,t}(i)$. Following Ireland (2001) and Laxton and Pesenti (2003), these are quadratic in changes in the rate of inflation rather than in price levels, which helps to generate realistic inflation dynamics:

$$G_{P,t}(i) = \frac{\phi_P}{2}Z_t^D\left(\frac{\frac{P_t(i)}{P_{t-1}(i)}}{\frac{P_{t-1}}{P_{t-2}}}-1\right)^2 . \tag{26}$$

Nominal dividends $D_t^D(i)$ equal nominal revenue $P_t(i)Z_t^D(i)$ minus nominal input costs $P_t^H Y_t^H(i) + P_t^F Y_t^F(i)$, inflation adjustment costs $P_t G_{P,t}(i)$, and a fixed resource cost $P_t T_t \omega^D$. The latter arises as long as the firm chooses to produce positive output. Net output is therefore equal to $\max(0, Z_t^D(i) - T_t \omega^D)$. The price of foreign inputs is given by purchasing power parity as

$$P_t^F = P_t^{H*}\mathcal{E}_t . \tag{27}$$

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[15]This assumption is now widely used. It addresses a key concern in open economy DSGE models, the potential for an excessive short-term responsiveness of international trade to the real exchange rate.

First-order conditions for input demands are listed in the Technical Appendix. The Phillips curve for final goods inflation π_t is

$$
\begin{aligned}
\mu p_t^D - 1 = {} & \phi_P \left(\mu - 1 \right) \left(\frac{\pi_t}{\pi_{t-1}} \right) \left(\frac{\pi_t}{\pi_{t-1}} - 1 \right) \\
& - \frac{\theta g}{r_t} \phi_P \left(\mu - 1 \right) \frac{\check{Z}_{t+1}^D}{\check{Z}_t^D} \left(\frac{\pi_{t+1}}{\pi_t} \right) \left(\frac{\pi_{t+1}}{\pi_t} - 1 \right) ,
\end{aligned}
\tag{28}
$$

where μ is the markup of price over marginal cost $\mu = \sigma_D / (\sigma_D - 1)$.

B.3   Retailers

Household demand for the output varieties supplied by retailers $C_t(i)$ is given by (7). The optimization problem of retailers consists of maximizing the present discounted value of nominal revenue $P_t^R(i)C_t(i)$ minus nominal input costs $P_t C_t(i)$, minus nominal quantity adjustment costs $P_t G_{C,t}(i)$. The latter are assumed to take the form

$$
G_{C,t}(i) = \frac{\phi_C}{2} C_t \left(\frac{(C_t(i)/g) - C_{t-1}(i)}{C_{t-1}(i)} \right)^2 .
\tag{29}
$$

The normalized first-order condition for the retailer's problem has the form

$$
\begin{aligned}
\frac{\sigma_R - 1}{\sigma_R} p_t^R - 1 = {} & \phi_C \left(\frac{\check{C}_t - \check{C}_{t-1}}{\check{C}_{t-1}} \right) \frac{\check{C}_t}{\check{C}_{t-1}} \\
& - \frac{\theta g}{r_t} \phi_C \left(\frac{\check{C}_{t+1} - \check{C}_t}{\check{C}_t} \right) \left(\frac{\check{C}_{t+1}}{\check{C}_t} \right)^2 .
\end{aligned}
\tag{30}
$$

We note that this specification only has a significant effect on consumption dynamics in the first two to three years following the shock, while leaving the longer-run results that are of most interest to this paper unaffected.

C.   Government

C.1   Budget Constraint

The government issues nominally non-contingent one-period debt B_t at the gross nominal interest rate i_t, levies lump-sum taxes τ_t, and determines government spending G_t. Letting $\check{b}_t = B_t/P_t T_t$, the real government budget constraint therefore takes the form

$$
\check{b}_t = \frac{i_{t-1}}{\pi_t g} \check{b}_{t-1} + \check{G}_t - \check{\tau}_t .
\tag{31}
$$

C.2   Fiscal Policy

The government's fiscal policy specifies a target $\check{g}d_{tgt}^{rat}$ for the government-deficit-to-GDP ratio $\check{g}d_t^{rat}$:

$$\check{g}d_t^{rat} = 100\frac{\frac{(i_{t-1}-1)\check{b}_{t-1}}{\pi_t g} + \check{G}_t - \check{\tau}_t}{\check{g}dp_t} = 100\frac{\check{b}_t - \frac{\check{b}_{t-1}}{\pi_t g}}{\check{g}dp_t} = \check{g}d_{tgt}^{rat} \quad , \tag{32}$$

where $\check{g}dp_t$ will be defined below. Either lump-sum taxes or government spending adjust endogenously to ensure that the deficit target is met. Equation (32) implies the following relationship between $\check{g}d_{tgt}^{rat}$ and the long-run government-debt-to-GDP ratio $\check{b}_{tgt}^{rat}$:

$$\check{b}_{tgt}^{rat} = \check{g}d_{tgt}^{rat}\frac{\pi^{tgt}g}{\pi^{tgt}g - 1} \quad , \tag{33}$$

where π^{tgt} is the central bank's inflation target. This implies that a target for the government-deficit ratio automatically ensures a non-explosive government debt ratio, with the ratio between the two given by the economy's nominal growth rate. But the autoregressive coefficient on debt, at $1/(\pi^{tgt}g)$, is very close to one, which implies that following a permanent change in the deficit target debt takes several *decades* to reach its long-run value.

C.3   Monetary Policy

Monetary policy relies on an interest rate rule to stabilize inflation. The rule is similar to conventional inflation-forecast-based rules, but with the important exception that the "steady state" value of the real interest rate needs to be proxied by a moving average of past actual real interest rates. The reason is that the permanent saving shocks considered in this paper lead to permanent changes in equilibrium real interest rates, and the monetary policy rule needs to reflect those changes over time to avoid policy biases. The targeted inflation rate is assumed to be a geometric weighted average of current year and one-year-ahead inflation, while the target itself is π_t^{tgt}. We have

$$i_t = (i_{t-1})^{\delta_i}\left(r_t^{filt}\pi_t^{avg}\right)^{1-\delta_i}\left(\frac{\pi_t^{avg}}{\pi_t^{tgt}}\right)^{(1-\delta_i)\delta_\pi} \quad , \tag{34}$$

$$r_t^{filt} = \Pi_{j=0}^{\kappa}\left(r_{t-j}\right)^{\frac{1}{\kappa+1}} \quad , \tag{35}$$

$$\pi_t^{avg} = \pi_t^{\iota}\pi_{t+1}^{1-\iota} \quad . \tag{36}$$

D. Equilibrium and Balance of Payments

In equilibrium households maximize lifetime utility, firms maximize the present discounted value of their cash flows, the government follows its monetary and fiscal rules, and the following market clearing conditions for manufacturing output and final output hold:[16]

$$\check{Z}_t^H = \check{Y}_t^H + \check{Y}_t^{F^*} , \tag{37}$$

$$\check{Z}_t^D = \check{C}_t + \check{I}_t + \check{G}_t + \omega^D + \check{G}_{I,t} + \check{G}_{P,t} + \check{G}_{C,t} . \tag{38}$$

Furthermore, the net foreign asset evolution is given by

$$e_t \check{f}_t = \frac{i_{t-1}^* \xi_{t-1} \varepsilon_t}{\pi_t g} e_{t-1} \check{f}_{t-1} + p_t^H \check{Y}_t^{F^*} - p_t^F \check{Y}_t^F , \tag{39}$$

the market clearing condition for international bonds is

$$\check{f}_t + \check{f}_t^* = 0 , \tag{40}$$

and the level of GDP is given by

$$g\check{d}p_t = \check{C}_t + \check{I}_t + \check{G}_t + p_t^H \check{Y}_t^{F^*} - p_t^F \check{Y}_t^F . \tag{41}$$

We now derive a long-run relationship between the current-account-deficit-to-GDP ratio $\check{c}\check{a}d_t^{rat}$ and the net-foreign-liabilities-to-GDP ratio $n\check{f}l_t^{rat}$ that parallels the long-run relationship between fiscal deficits and public debt in equation (33). The current-account-deficit-to-GDP ratio is given by

$$\check{c}\check{a}d_t^{rat} = -100 \frac{\frac{\left(i_{t-1}^* \xi_{t-1} \varepsilon_t - 1\right) e_{t-1} \check{f}_{t-1}}{\pi_t g} + p_t^H \check{Y}_t^{F^*} - p_t^F \check{Y}_t^F}{g\check{d}p_t} = -100 \frac{e_t \check{f}_t - \frac{e_{t-1} \check{f}_{t-1}}{\pi_t g}}{g\check{d}p_t} , \tag{42}$$

and net foreign liabilities equal $n\check{f}l_t = -e_t \check{f}_t$. We replace the time subscript t with LR to denote long-run values. Then equation (42) implies the following relationship:

$$n\check{f}l_{LR}^{rat} = \check{c}\check{a}d_{LR}^{rat} \frac{\pi^{tgt} g}{\pi^{tgt} g - 1} . \tag{43}$$

---

[16] Only the market clearing conditions for RW are listed. HO conditions are symmetric.

III.   Calibration

In our baseline economy HO represents the United States and accounts for 25 percent of world GDP. In one of our alternative scenarios RW represents a small open economy and accounts for 0.5 percent of world GDP. Country sizes are calibrated by adjusting the population size parameters N and N^*. Time periods represent years.

The denomination of international bonds is in HO currency. In the baseline both countries have initial government-debt-to-GDP ratios of 60 percent, and the United States has an initial net-foreign-liabilities-to-GDP ratio of 40 percent. The trade share parameters α_H and α_H^* are set to produce a U.S. imports-to-GDP-ratio of 15 percent, which is in line with recent historical averages.

We fix the world technology trend growth rate g at 3% per annum, and the targeted inflation rate π^{tgt} in each country at 2% per annum. The long-run real interest rate $\bar{r}$ is equalized across countries, and we assume a value of 4% per annum. We find the values of β and β^* that are consistent with these and the following assumptions.

The planning horizon $1/(1-\theta)$ is critical for the non-Ricardian behavior of the model, and we therefore evaluate a number of alternatives for θ, ranging from $\theta = 0.8$ (5 year horizon) to $\theta = 0.98$ (50 year horizon). One possible criterion for choosing this parameter is the empirical evidence for the effect of government debt on real interest rates. A number of papers have found that a one percentage point increase in the U.S. government-debt-to-GDP ratio leads to an approximately one to six basis points increase in the U.S. real interest rate, see Laubach (2003), Engen and Hubbard (2004) and Gale and Orszag (2004). We will show that our model, to be consistent with those results, would require a value of θ between 0.8 and 0.9.[17]

Household preferences are further characterized by an intertemporal elasticity of substitution of 0.25, or $\gamma = 4$. We will also consider $\gamma = 2$ in our sensitivity analysis. With preferences (1) the labor supply elasticity depends on the steady state value of labor supply, which is in turn determined by the leisure share parameter η. We adjust this parameter to

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[17]This is also consistent with the evidence of Bayoumi and Sgherri (2006). Based on U.S. annual data starting in 1955 they decisively reject the infinite horizon model and estimate a planning horizon that is significantly shorter than 10 years.

obtain an elasticity of 1, in line with much of the business cycle literature.

The elasticity of substitution between domestic and foreign goods, ξ_D, which corresponds to the long-run price elasticity of demand for imports, is assumed to be equal to 1.5. The elasticities of substitution between varieties in the distribution and retail sectors equal 6 and 11. The real and inflation adjustment cost parameters are chosen to yield reasonable dynamics over the first few years following the shock.[18] We calibrate the technology share parameter α_L, the fixed cost parameter ω^D, and the initial level of government spending to obtain initial shares of labor income, investment spending and government spending in GDP of 60 percent, 19 percent and 18 percent, respectively. The annual depreciation rate is 10 percent.

For the monetary policy rules in each country we assume relatively small interest rate smoothing parameters, $\delta_i = \delta_i^* = 0.4$, given that this is an annual model. The coefficients on inflation are $\delta_\pi = 1.0$, which results in overall inflation-feedback coefficients of 2. The targeted inflation rate puts an equal weight on current and one-year-ahead inflation, $\iota = 0.5$. The equilibrium real interest rate is proxied by a four year moving average. Monetary policy, like adjustment costs, only affects the short run of our simulations.

Calibration for the INF model is almost identical. The three differences are the assumption $\theta = 1$, a 50% share of liquidity-constrained agents, and a foreign exchange risk premium function for RW with $\zeta = 0.01$ and $\overline{nfa} = 0.1333$, corresponding to the assumed 40% U.S. net-foreign-liabilities-to-GDP ratio. We also assume that liquidity-constrained agents receive a 25% share of aggregate dividends by way of a lump-sum tax on INF agents that is redistributed by the government. This is to avoid the extreme assumption that liquidity-constrained agents derive no benefit at all from corporate profits.

The small open economy version of the model is also almost identical. Here we assume that the size of RW is 0.5% of the world economy, with international debt continuing to be denominated in the currency of HO. We also assume that the small open economy has zero net foreign liabilities and a 30% imports-to-GDP ratio.

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[18]Their calibrated values are $\phi_P = 20$, $\phi_C = 5$, $\phi_I = 10$ and $\phi_F = 2$.

IV.   Permanent Increases in Fiscal Deficits

In this section we simulate the effects of a permanent 1% increase in the targeted fiscal-deficit-to-GDP ratio $\breve{g}d_{tgt}^{rat}$. For each impulse response presented we compare (i) the INF model with 50% liquidity-constrained agents, (ii) the FIN model with a 10-year planning horizon, and (iii) the FIN model with a 5-year planning horizon. To generalize our results we will also present current account and real interest rate responses for a broader range of planning horizons up to 50 years.

By equations (33) and (43), and under our assumption of a 5% annual nominal growth rate, a permanent 1% increase in the fiscal-deficit-/current-account-deficit-to-GDP ratio corresponds to a 20% increase in the long-run government-debt-/net-foreign-liabilities-to-GDP ratio. The key difference between FIN models and INF models is that in the former, but not in the latter, there is also a long-run positive causal relationship from higher government debt to higher net foreign liabilities, due to crowding-out.

INF models assume that in the long run the additional saving of consumers who are not liquidity constrained perfectly offsets reduced government saving, with zero effects on national saving. Fiscal deficits can therefore have short-run effects on current account deficits, but by design they are much smaller, and they must die out over time. One implication is that the long-run net foreign liabilities position in such models must be specified independently of the level of government debt. By contrast, in FIN models all consumers are disconnected from future generations and do not save sufficiently to offset fiscal deficits. Instead their increased investment in government debt is partly financed by liquidating (crowding out) other forms of investment, specifically physical capital and, crucially for this paper, foreign assets. And because of the stock-flow relationships (33) and (43), the latter directly implies a long-run causal relationship from higher fiscal deficits to higher current account deficits.

Another important difference between FIN and INF models concerns the long-run equilibrium real interest rate. In the INF model this rate is tied down by the rate of time preference β and trend productivity growth g, while in the FIN model it is related to the same fundamental parameters that affect the saving-investment relationship. These include not only β and g but also government debt, the planning horizon, the intertemporal elasticity of substitution, and the manufacturing technology.

A. U.S. Fiscal Deficits

We start with our baseline calibration for the U.S. economy, and assume that the increase in the fiscal deficit is accomplished by reducing lump-sum taxes τ. Figures 4 to 6 illustrate. In each case we show simulations for 50 years, because changes in deficits affect debt stocks with very long lags, so that the new long-run equilibrium takes several decades to be reached.

Figure 4 shows the fiscal accounts. On impact tax revenues are reduced by 1% of GDP without simultaneous adjustments in government spending. The primary and overall deficits therefore also increase by 1% of GDP. This begins to drive up debt, so that interest expenditure on government debt starts to rise over time. As we will see the deficits also increase because of a higher real interest rate, but the main effect on interest expenditure can be shown to come from the higher stock of debt. To finance the interest charges while remaining within the targeted increase in the overall fiscal-deficit-to-GDP ratio, the primary deficit has to start falling. In the long run, that is after more than 20 years, the additional interest charges exceed one percent of GDP and the primary deficit has to contract below its initial value. Debt keeps rising until it reaches its long-run value of 80% of GDP, which represents an increase of 20 percentage points (60% to 80%).

Figure 5 shows how this profile of taxes affects the main macroeconomic variables. For the INF model the effect in the first few years is very small, with overall consumption rising by only around 0.2%. Liquidity-constrained agents respond to the increased after tax income partly by increasing their demand for leisure, which limits their initial increase in consumption to 0.6%. Furthermore, lower taxes do not directly affect infinitely lived agents' lifetime income, and therefore their consumption, while the indirect effect, through monetary policy, is negative. This is because monetary policy responds to the additional demand pressure generated by liquidity-constrained agents by raising the real interest rate, which reduces the consumption of infinitely lived agents by around 0.2% initially. Output drops slightly on impact because the real appreciation accompanying higher real interest rates crowds out exports and crowds in imports. The latter in turn implies a small current account deficit of around 0.1% of GDP. The assumption of this model is that the resulting slight deterioration in the net foreign liabilities position, and therefore in the current account, will be reversed very gradually over time. Critically, the long-run effect on either the real interest rate or the current account is zero, but with some redistribution from liquidity-constrained

to infinitely-lived agents, as the former pay higher taxes that allow the government to service the higher debt owed to the latter. These very small effects, both in the short and the long run, are obtained despite the fact that the deficit change, being permanent, is very large in present discounted value terms. This is because infinitely-lived agents do not respond directly to any change in the profile of taxes.

In the FIN model however all households respond to the entire profile of future deficits. Given that taxes drop on impact, they increase consumption over the first years of the tax cut. The extent to which lower taxes correspond to higher net wealth and therefore higher desired consumption depends on the planning horizon. Figure 5 shows that if households' planning horizon is short enough (5 years instead of 10), the initial increase in consumption demand is strong enough (2.2% instead of 0.7%) to lift output, in this case by 0.5%. But the initial increase in consumption demand and therefore inflation also causes a much larger initial increase in the real interest rate due to the monetary policy response, and therefore a much stronger real appreciation that increases imports and depresses exports. As a consequence the current account deteriorates by between 0.3% and 0.5% of GDP starting in year two, after a brief and small improvement in year one due to the J-curve effects of cheaper imports. The subsequent evolution of the current account and the real interest rate however is not driven by monetary policy but by saving and investment dynamics. For that we turn to figure 6.

The left column of panels in figure 6 shows the sources and uses of saving, namely public saving, private saving, investment and the current account deficit as shares of GDP, while the right column of panels shows how these flows cumulate into stocks of government debt, financial wealth (government debt minus net foreign liabilities), physical capital and net foreign liabilities, again shown as shares of GDP. We observe that in the INF model an increase in the private saving ratio offsets the decrease in the public saving ratio almost completely in the short run, and exactly in the long run. This is, of course, Ricardian behavior. In the FIN model the offset is approximately complete only in year 1 as consumption increases by much less than the increase in after-tax income. Thereafter the private saving ratio declines rapidly as higher real interest rates start to raise the marginal propensity to consume out of wealth. For the longer planning horizon of 10 years the long-run private saving ratio is only 0.1 percentage points above its initial level, while for the shorter planning horizon of 5 years it is 0.4 percentage points below. The reason for this difference is the lower interest sensitiv-

ity of saving under short planning horizons, as discussed in connection with figure 3 above. That figure also shows why under the five-year horizon long-run interest rates increase by far more (90 basis points instead of 20 basis points) and investment declines by far more (0.7% of GDP instead of 0.2% of GDP). But our model, unlike figure 3, is of an open economy, where saving and investment differ by the current account. And here we observe that the reduction in saving in the FIN model is so much larger than the reduction in investment that the current account, following its initial drop by 0.3% to 0.5% of GDP, deteriorates by around 0.75% of GDP in the long run. As a share of the fiscal deficit this deterioration is almost exactly equal to the share of the rest of the world in world GDP.

The right column of panels in figure 6 shows how higher government debt, through higher real interest rates, crowds out other forms of household investment. First, it crowds out domestic private capital, especially if planning horizons are short. For a five-year horizon the capital stock drops by almost 5% of GDP. And second, it crowds out net holdings of foreign assets equal to around 15% of GDP, the stock counterpart of the 0.75% of GDP current account deterioration.

Figure 7 illustrates that as far as the current account is concerned this result is very robust to varying the length of the planning horizon. It plots the current-account-to-GDP ratio at five different time horizons between the very short run (2 years) and the very long run (50 years), and for seven different planning horizons. The long-run current account deficit does drop as the planning horizons lengthens, but even at a very long 50-year horizon it still equals around 0.4% of GDP. From this perspective the infinite-horizon model is extreme, as only planning horizons equal to hundreds of years get close to replicating its predictions.

One criterion by which to judge a realistic length of the planning horizon is the implied prediction for real interest rates. The above mentioned empirical literature implies that a 20 percentage point increase in the U.S. government-debt-to-GDP ratio should lead to a 20 - 120 basis points increase in real interest rates, and correspondingly less for the shorter run while debt builds up to its long run level. Figure 8 shows that the 10-year planning horizon is precisely at the lower end of that range, and the 5-year planning horizon close to the upper end. Longer planning horizons imply negligible real interest rate effects.[19] It is for this reason that we have chosen the 5- and 10-year horizons for our exposition.

[19]This result, as mentioned above, is somewhat sensitive to the assumption about γ, the inverse of the intertemporal elasticity of substitution. We will return to this issue in the next subsection.

B. Sensitivity Analysis

The short-run response of real GDP to the fiscal stimulus generated by a higher deficit may seem small and inconsistent with the effects estimated in historical episodes when monetary policy accommodated shocks to aggregate demand. It is important to understand that the monetary policy rule used in our model has been designed to keep inflation close to the target, so that the short-run expansionary effects of any positive aggregate demand shock are constrained by a rise in the real interest rate. Obviously, a policy that accommodated the expansion in demand by delaying hikes in nominal interest rates would generate a much larger short-run multiplier.

We have discussed that in the FIN model the magnitude of real interest rate changes and therefore of crowding-out effects on capital depends critically on how sensitive saving is to the real interest rate. This sensitivity is increasing in the planning horizon θ and decreasing in the intertemporal elasticity of substitution $1/\gamma$. We have already analyzed the implications of varying θ. We know from our previous discussion that as the intertemporal elasticity increases (lower γ), saving become more sensitive to the real interest rate, so that changes in real interest rates and crowding-out effects diminish. To confirm this we resimulate the government deficit shock under the assumption $\gamma = 2$. We find that the increase in the real interest rate is roughly half of the baseline, and likewise for the drop in investment. But, at least at the 5-year and 10-year planning horizons, the change in the current-account-to-GDP ratio is virtually identical to that of the baseline.

By contrast, the long-run predictions of INF models for real interest rates and real activity are not sensitive at all to assumptions about parameters such as γ, since the basic long-run predictions are fixed by the assumption that net foreign liabilities positions and world real interest rates are independent of government debt.

We have also explored the sensitivity of our results to using government spending G rather than taxation as the fiscal instrument. There are some differences, notably a larger stimulus effect on GDP on impact, which lies between 0.5% for the INF model and 1.0% for the FIN model with 5-year planning horizon. But longer-run real interest rates and current accounts in the FIN model behave virtually identically to the baseline case. The main change is in the current account behavior of the INF model, where the current account now deteriorates by 0.4% of GDP on impact, with a very slow reversion to zero.

Of considerable practical relevance at the present juncture is a scenario of worldwide coordinated fiscal stimulus. We therefore simulate a scenario where both the HO and the RW governments increase their fiscal deficits by 1% of GDP. Of course in the FIN model the short-run stimulus effect of such a measure on GDP is very much stronger, especially when the fiscal instrument is government spending. But because the reduction in worldwide saving is four times larger, the longer-run increase in world real interest rates, and the decrease in worldwide investment and GDP, is also roughly four times larger. The current account effects are of course very much smaller when all countries run equal fiscal deficits. It turns out that a net international debtor, such as the United States, experiences a small improvement in the current-account-to-GDP ratio, by between 0.1 percentage points (10-year horizon) and 0.2 percentage points (5-year horizon), as a depreciation and trade balance improvement more than compensates for the higher interest costs of international debt.

C.   Small Open Economies

Many smaller countries are also considering or implementing large fiscal stimulus packages. Here we explore the implications of a stimulus equal to 1% of GDP if the country accounts for 0.5% of world GDP, has zero net foreign assets, and an imports-to-GDP ratio of 30%.

Figure 9 illustrates. Because the country is very small, its effect on the world real interest rate is negligible. In the FIN model, initially real rates rise by around 5-10 basis points as monetary policy responds to inflation, but in the longer-run the real interest rate effect is virtually zero because the saving-investment balance is the sole driver of results. Consumption rises on impact, but because this country imports a larger share of its consumption than in our baseline example, the diversion of domestic purchasing power away from domestic goods also leads to a 0.3%-0.4% contraction in GDP.

The most striking result however is the behavior of the current account balance. In the short run the current account deteriorates by very similar magnitudes to the baseline case. But in the long run the current account deterioration equals almost exactly 1% of GDP, that is it is equal to the fiscal deficit deterioration. The main reason is that the real interest rate does not change significantly in the long run, which means that the marginal propensity to consume out of wealth does not change significantly. Human wealth is similarly almost unaffected, with GDP returning to the baseline in the long run. This means that

the private saving ratio does not change in the long run, and neither does investment, given the behavior of real interest rates. The fiscal deficit therefore translates virtually one for one into a current account deficit. In other words, foreigners acquire practically all of the additional government debt. This reflects the fact that foreigners account for 99.5% of the world's population, and world capital markets are assumed to be perfectly integrated.

The results would therefore change if there were frictions in international capital flows whereby changes in net foreign liabilities positions led to sizeable changes in foreign borrowing interest rates.[20] In that case higher fiscal deficits would increase domestic real interest rates, which would raise private saving and reduce investment, thereby reducing the current account deficit. We do not pursue this alternative here.

Figures 10 and 11 illustrate the difference between large and small open economies in stylized form. The world real interest rate is established, as per the right-most panel in each figure, by the equilibrium between world saving and world investment. We assume that in the initial equilibrium the saving-investment balance of HO and RW is also zero, meaning that current accounts equal zero. Now HO reduces its saving due to fiscal stimulus. If HO is large, this has a significant effect on world saving, and the world real interest rate rises. That in turn reduces the current account effects of the drop in HO saving. If HO is very small however, its lower saving rate has a virtually no effect on the world real interest rate. For the same proportional reduction in saving, the current account therefore deteriorates by far more. In other words, for the current account deficit to be smaller than the fiscal deficit there has to be a positive private saving response (and/or a negative investment response). This however requires, by the positive slope of the saving schedule, an increase in world real interest rates, which can only happen if the country in question is large enough to affect world real interest rates.

In the FIN model the saving schedule is assumed to be infinitely elastic with respect to real interest rates, so that domestic households absorb the entire stock of newly issued government debt, except for a small and slowly mean-reverting net foreign liability incurred during the initial period of trade deficits. The real effects of fiscal deficits are therefore again very much smaller than in the FIN model, and the initial current account deficit again equals only around 0.1% of GDP.

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[20]We reiterate that our model's foreign exchange risk premium (16) is not operative in the FIN model, and extremely small in the INF model.

V.   Conclusion

This paper discusses the potential current account implications of the fiscal stimulus packages recently announced in many major regions of the world economy. Our main concern is not with temporary and quickly reversed stimulus measures, but with the potential for a significant share of the increases in deficits to remain permanent. Given this primary concern with the longer run behavior of fiscal deficits, we analyze their current account implications not just at short horizons but also at medium and very long horizons, because the stock-flow dynamics of permanent changes in fiscal deficits take several decades to take the economy to a new steady state.

To address these issues we develop an open economy business cycle model that is suitable for the joint analysis of fiscal and monetary policies. The model combines the rigorous foundations of recent analytical frameworks developed for short-run monetary policy analysis with a finite-horizon model that can be used to study both the short-run and the longer-run effects of fiscal policy. The benefit of this feature has been most apparent in our study of real interest rates, which are mostly driven by monetary policy in the short run, but exclusively by the saving-investment balance in the longer run.

We find that a permanent increase in fiscal deficits equal to 1% of GDP, if it is not accompanied by equal fiscal deficit increases in the rest of the world, leads to a current account deterioration of around 0.5% of GDP in the short run, and to a long-run deterioration of between 0.75% for a country the size of the United States, and 1% for a small open economy. This is in striking contrast to the conventional infinite-horizon model, even if that model is augmented by a 50% share of liquidity-constrained agents. In that model the short-run current account deficit increases by between 0.1% of GDP for tax cuts and 0.4% of GDP for spending increases, while in the long run - by assumption - the increase is zero. This inability to deal with the long-run stock-flow dynamics of permanent saving shocks is, in our view, a serious shortcoming of the conventional model.

We present results that interpret the infinite-horizon model as a limiting case of the finite-horizon model. Two findings stand out. First, to obtain current account implications even close to those of the infinite-horizon model, the planning horizon of households in the finite-horizon model would have to equal several hundred years. Second, real interest rates in the infinite-horizon model do not change at all in the long run, while several papers in the

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empirical literature have found that real U.S. interest rates rise by between 1 and 6 basis points for every one percentage points increase in the U.S. government-debt-to-GDP ratio. While we recognize that there are other theoretical models that can generate this result, the ability of the finite-horizon model to generate this result with plausible planning horizons of between 5 and 10 years is one of its attractive features.

The short-run expansionary effect of fiscal stimulus in the infinite-horizon model with liquidity-constrained agents is also significantly weaker than in the finite-horizon model. But that does not need to be the case. In Kumhof and Laxton (2007) we show that when stimulus is highly front-loaded, with much larger initial deficits followed by a smaller permanent deterioration, the two models can behave almost identically *in the short run*. This is because liquidity-constrained agents in the infinite-horizon model have a marginal propensity to consume out of income of 100%, so that their response to temporary tax cuts is larger than that of finite-horizon agents. This can offset the infinite-horizon model's smaller response to the permanent component of deficit changes. The infinite-horizon model may therefore be perfectly adequate to analyze temporary stimulus measures.

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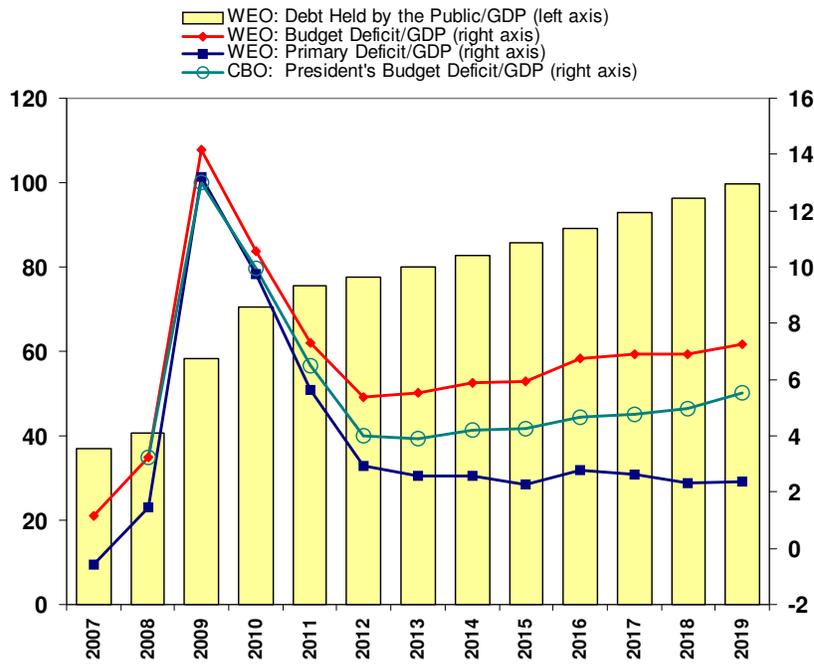Figure 1: IMF WEO and CBO Baseline Deficit and Debt Projections for the United States

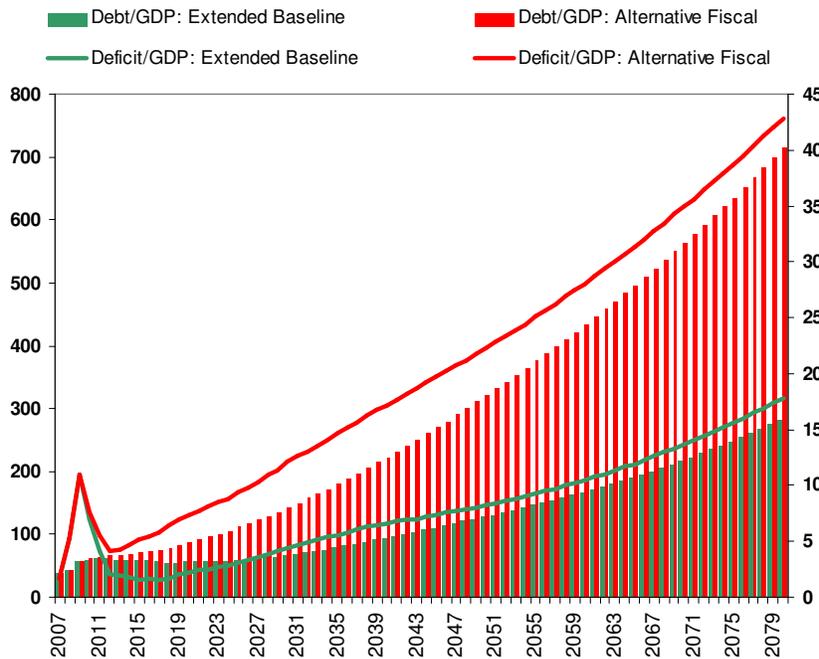Figure 2: CBO Long-Term Projections for U.S. Fiscal Deficits and Debt

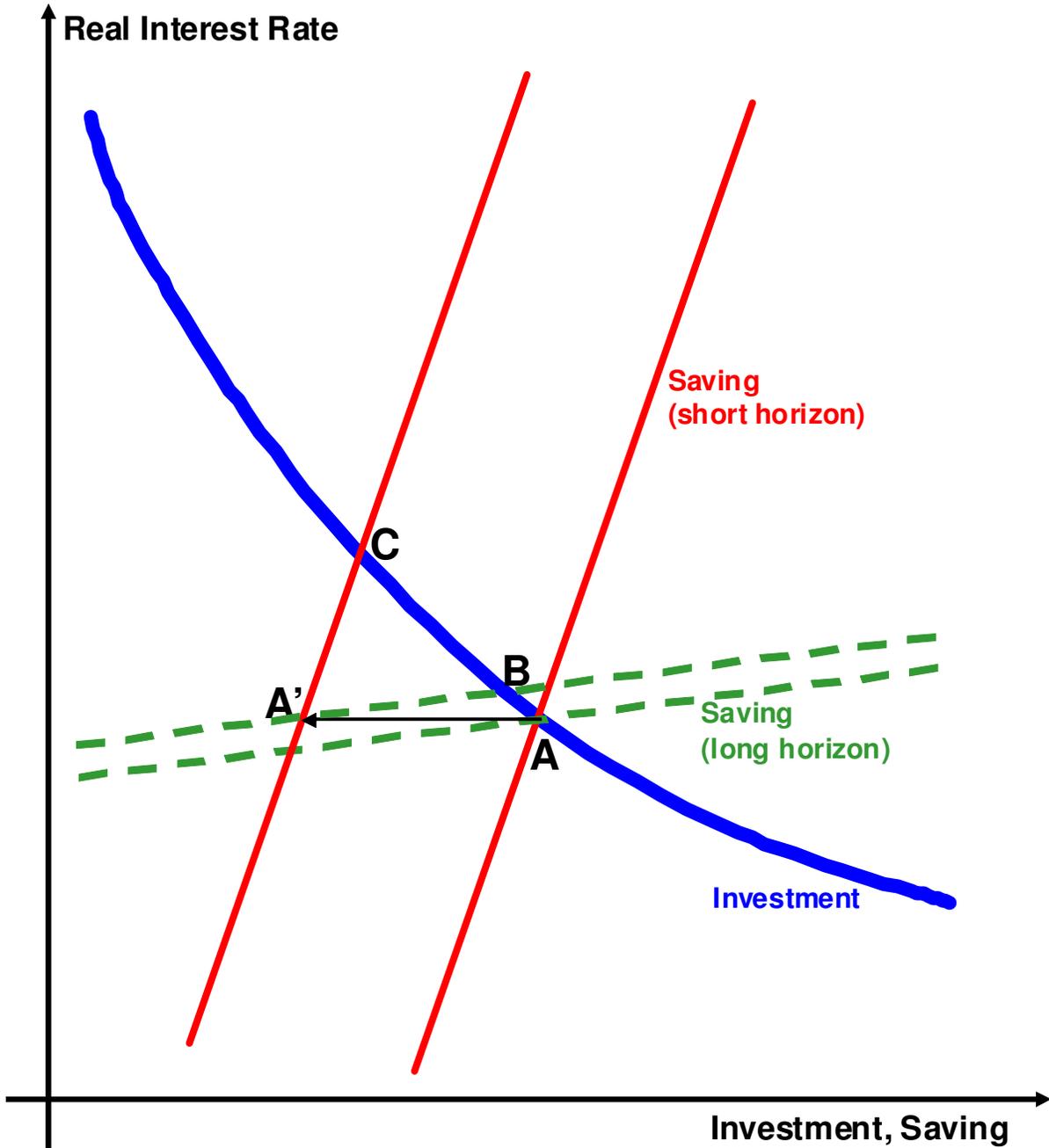Figure 3: Dissaving and the Role of the Planning Horizon

Figure 4: One Percentage Point Deficit Shock, Instrument = Taxation

Fiscal Accounts
Planning Horizon: Infinite = . . ., 10-years = ___, 5-years = - - -

Tax Revenue/GDP
(Difference)

Gov. Spending/GDP
(Difference)

Primary Deficit/GDP
(Difference)

Interest Expenditure/GDP
(Difference)

Government Deficit/GDP
(Difference)

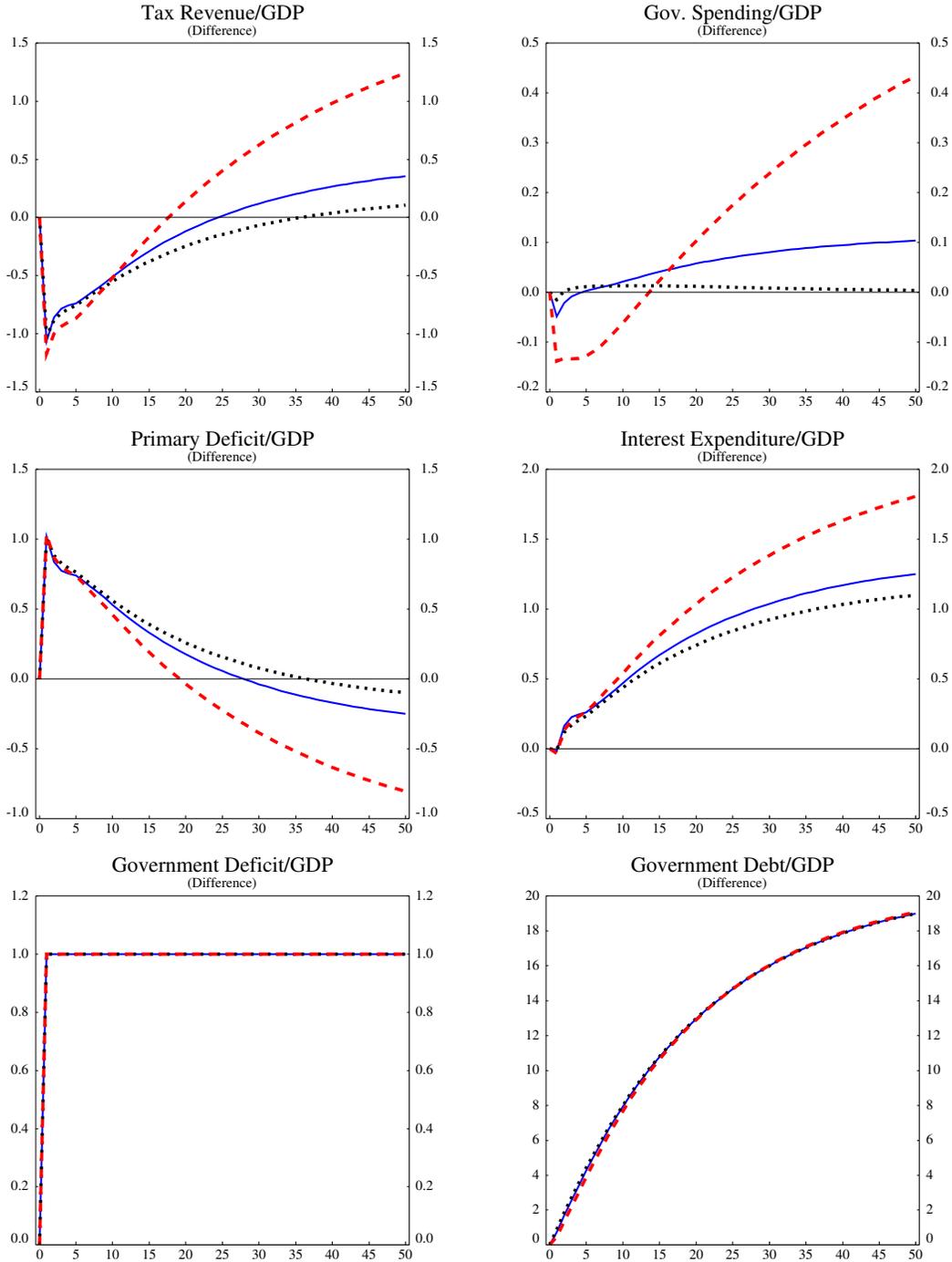### Government Debt/GDP
(Difference)

Figure 5: One Percentage Point Deficit Shock, Instrument = Taxation

Macroeconomic Aggregates
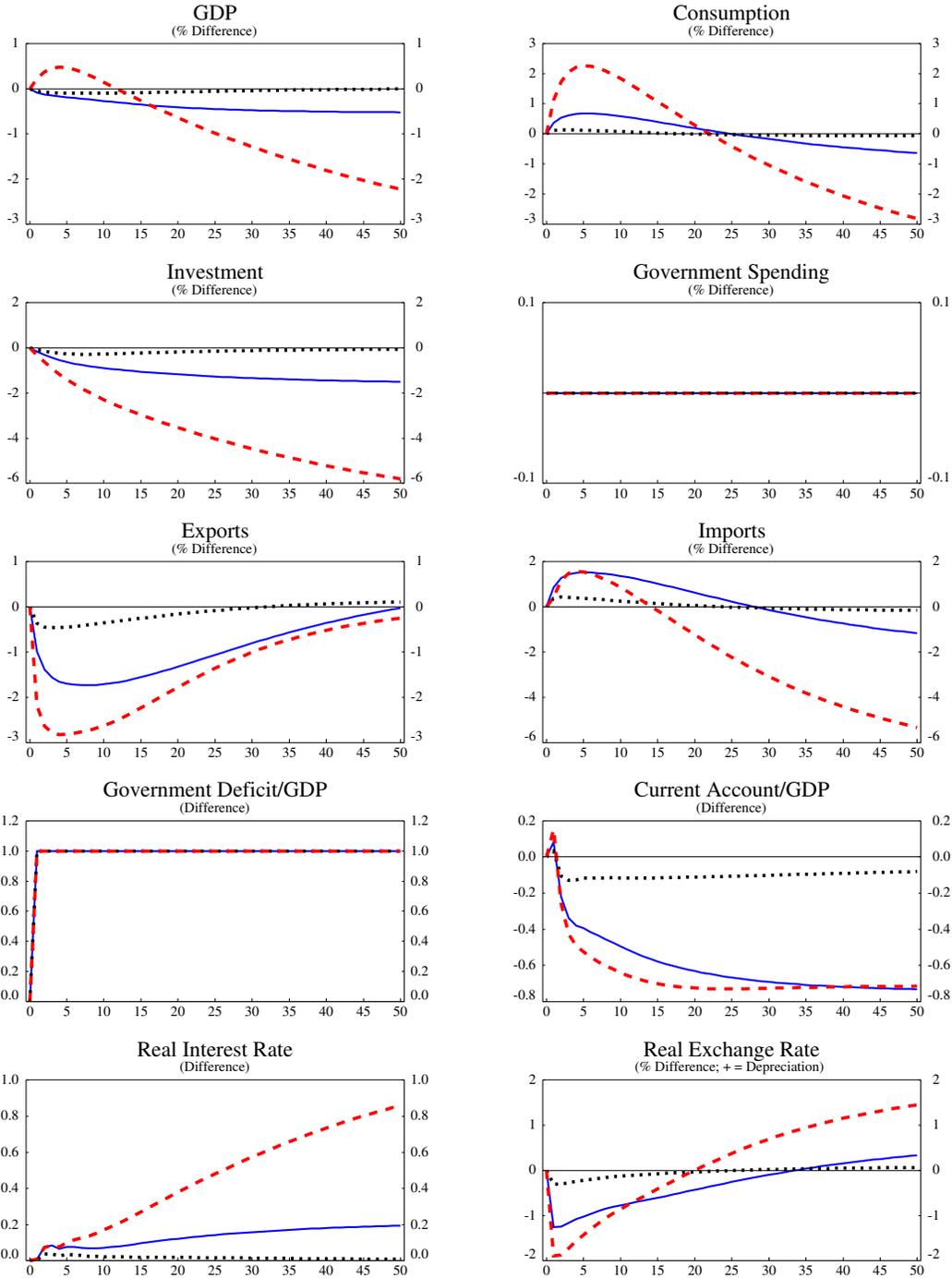Planning Horizon: Infinite = . . ., 10-years = ___, 5-years = - - -

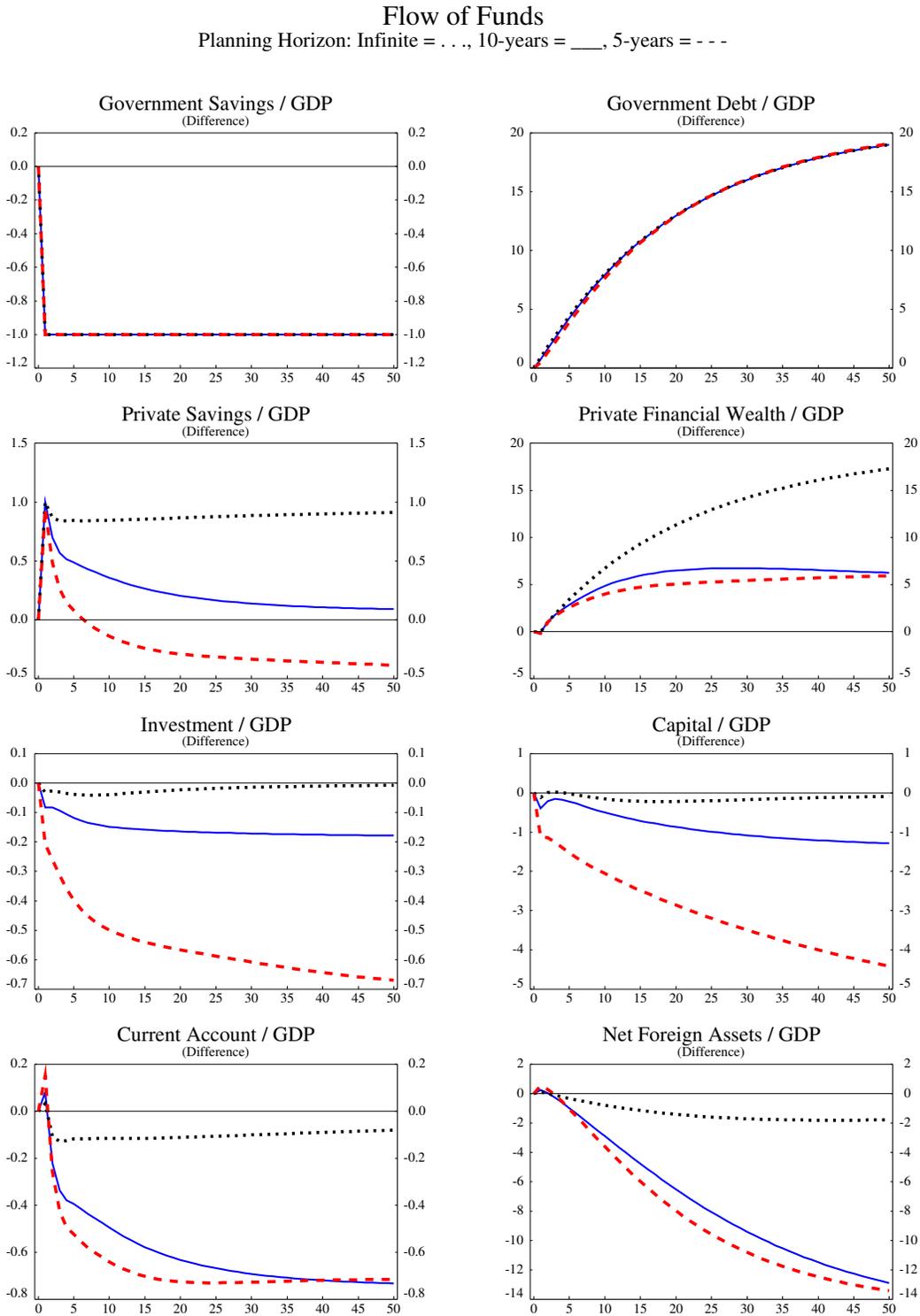Figure 6: One Percentage Point Deficit Shock, Instrument = Taxation

Flow of Funds
Planning Horizon: Infinite = . . ., 10-years = ___, 5-years = - - -

Government Savings / GDP
(Difference)

Government Debt / GDP
(Difference)

Private Savings / GDP
(Difference)

Private Financial Wealth / GDP
(Difference)

Investment / GDP
(Difference)

Capital / GDP
(Difference)

Current Account / GDP
(Difference)

Net Foreign Assets / GDP
(Difference)
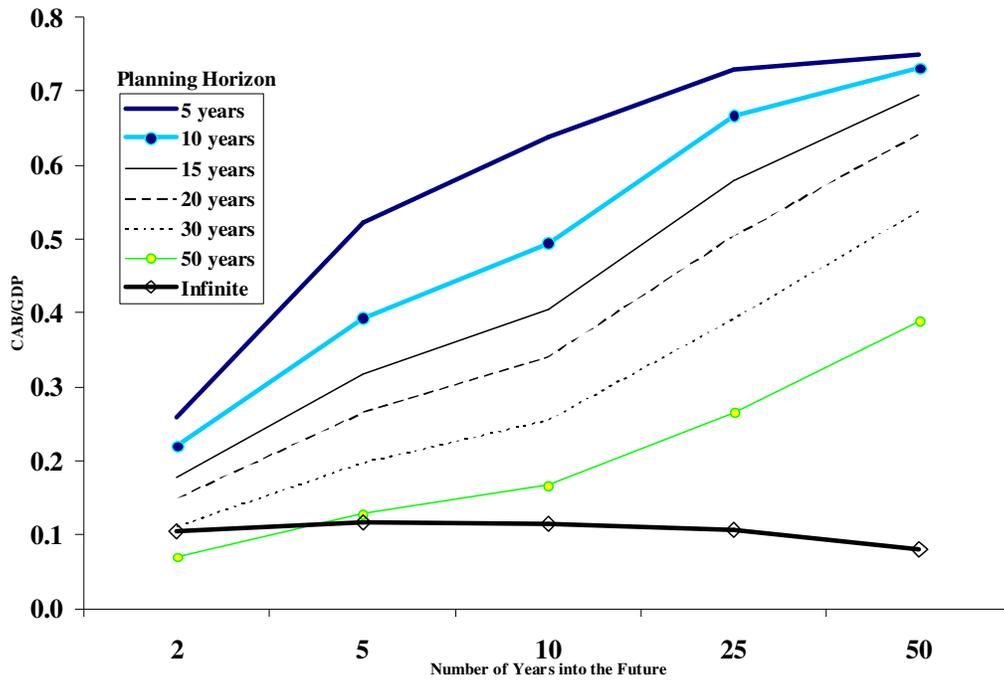
Figure 7: Current Account Deficit and the Planning Horizon

Figure 8: Real Interest Rate and the Planning Horizon

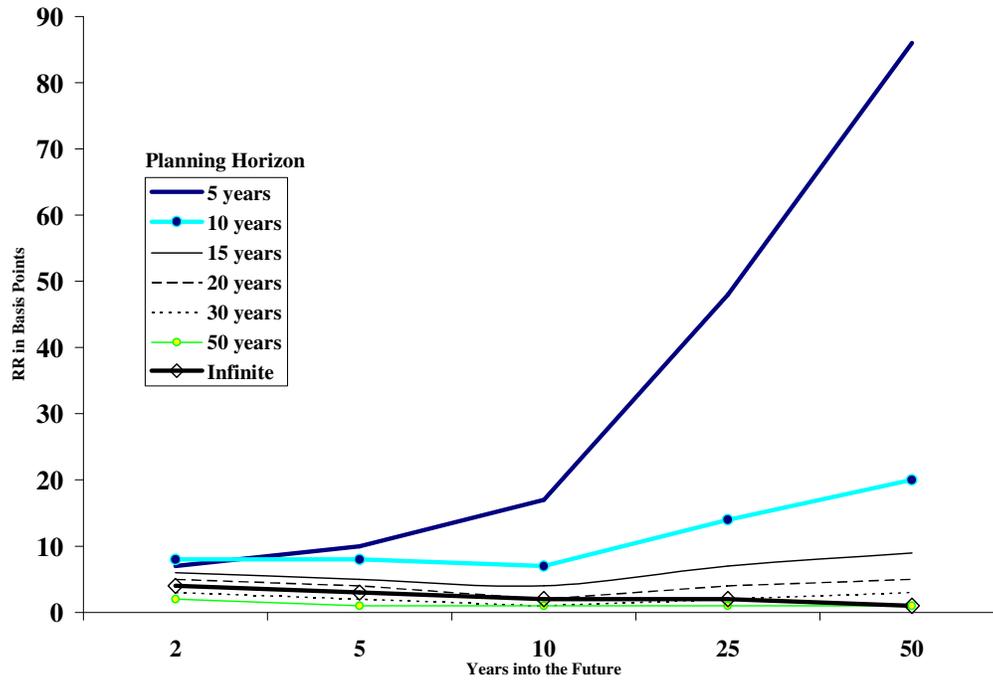# Figure 9: One Percentage Point Deficit Shock in a Small Open Economy

Macroeconomic Aggregates
Planning Horizon: Infinite = . . ., 10-years = ___, 5-years = - - -

GDP
(% Difference)

Consumption
(% Difference)

Investment
(% Difference)

Government Spending
(% Difference)

Exports
(% Difference)

Imports
(% Difference)

Government Deficit/GDP
(Difference)

Current Account/GDP
(Difference)

Real Interest Rate
(Difference)

Real Exchange Rate
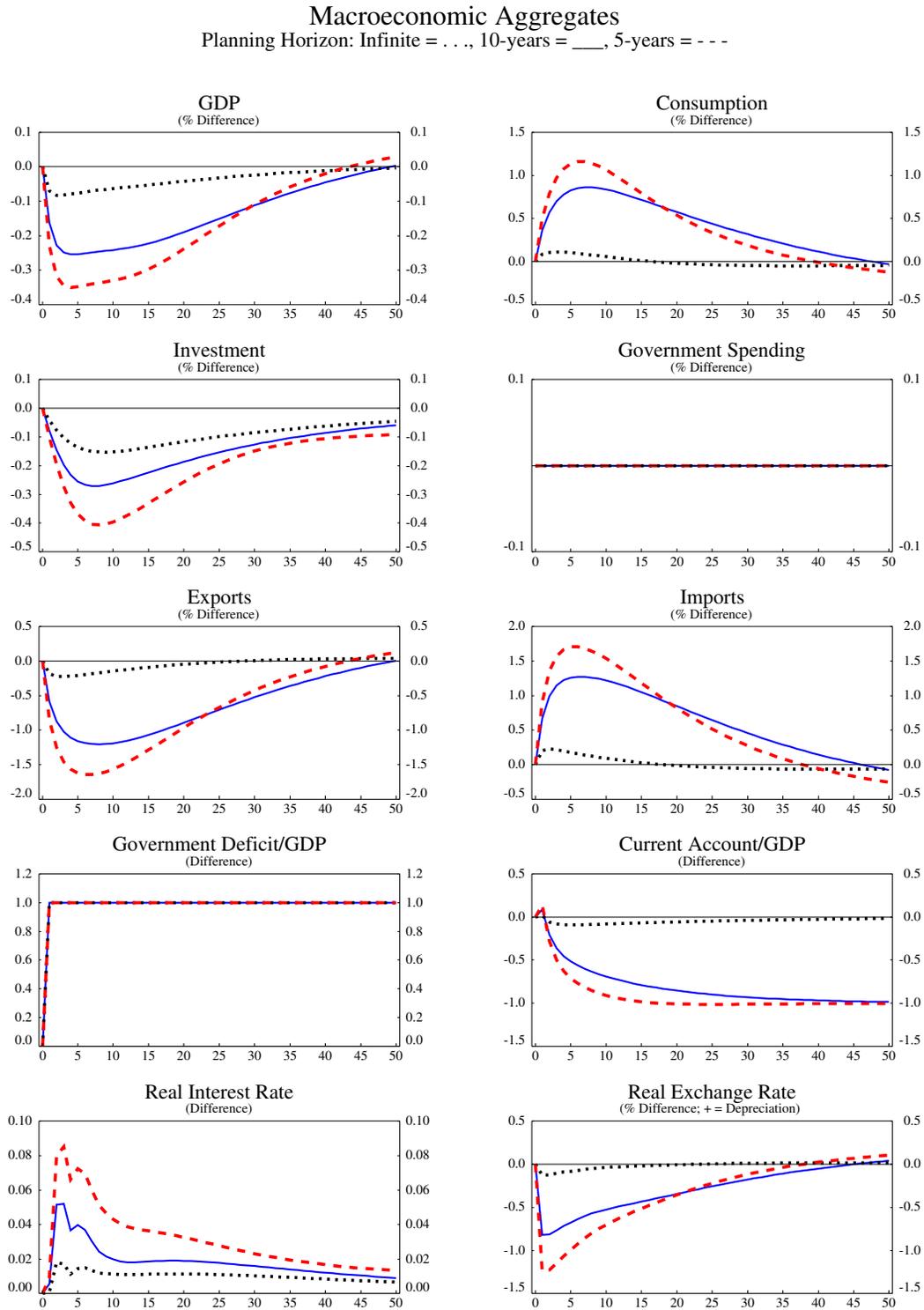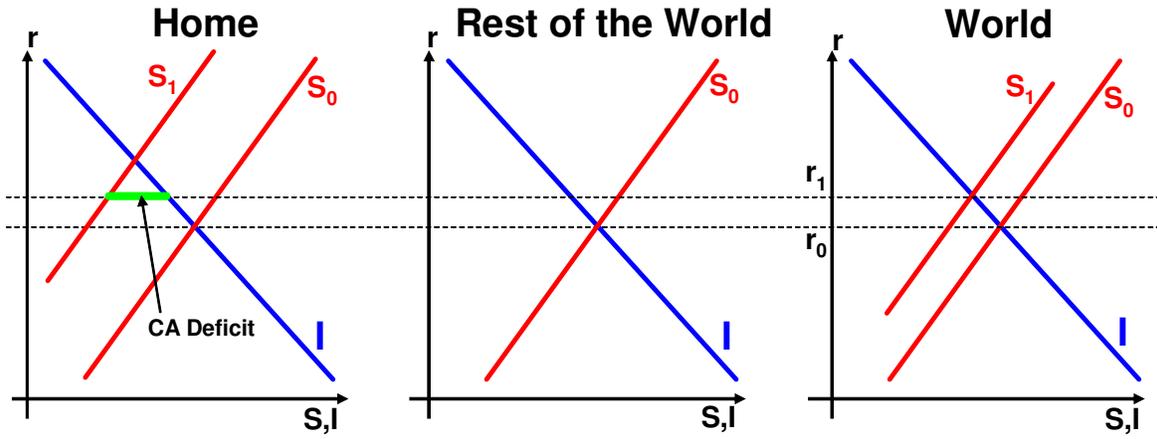(% Difference; + = Depreciation)

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Figure 10: Large Open Economy Dissaving

Figure 11: Small Open Economy Dissaving