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The Public Debt Crisis of the United States

by

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Abstract

Since the birth of the Republic, the United States has gone through five debt-crisis episodes defined as year-on-year increases in net federal debt in the 95-percentile. The Great Recession is the second largest, and the only one in which primary deficits continue six years later and are expected to persist at least through 2026. Persistent deficits are also sharply at odds with the surpluses that contributed to the reversal of all major debt surges in U.S. history. There is a view that high debt is not a concern and more debt is needed for fiscal stimulus and/or strong global demand for "safe assets." This paper makes four points to the contrary based on findings from the literature: First, empirical work shows that debt sustainability conditions display a significant break after 2008 and fiscal stimulus fails when debt is high. Second, a dynamic general equilibrium model predicts that tax adjustments may not make the debt sustainable and will have adverse effects on macro aggregates and social welfare. Third, the strong appetite for U.S. public debt worldwide can be a slow-moving, transitory result from financial globalization in an environment in which U.S. financial markets are relatively more developed and the expected financing needs of the U.S. government are large. Fourth, domestic sovereign default could become optimal if the cost of regressive redistribution in order to make debt payments outweighs default costs related to the social value of debt for liquidity provision, self-insurance and risk-sharing.

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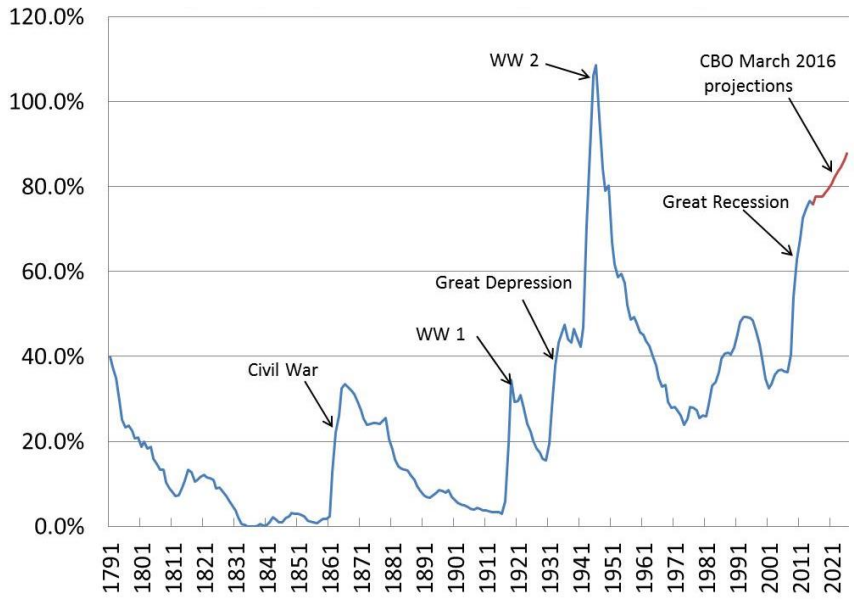
I. Introduction

Ongoing discussions of economic policies in advanced economies, and in the United States in particular, often fail to recognize the unprecedented nature of the current fiscal situation. Data on the U.S. net federal debt since the birth of the Republic show five debt-crisis episodes, defined as those in the 95 percentile of year-on-year increases in the debt-GDP ratio (see Figure 1). These are well-known watershed episodes: The two World Wars, the Civil War, the Great Depression and the Great Recession. Of the five, the Great Recession ranks second, next only next to World War II, and if the April, 2016 projections of the Congressional Budget Office turn out to be correct, the debt ratio could come close or surpass the World War II peak.

Figure 1: U.S. Debt-to-GDP Ratios

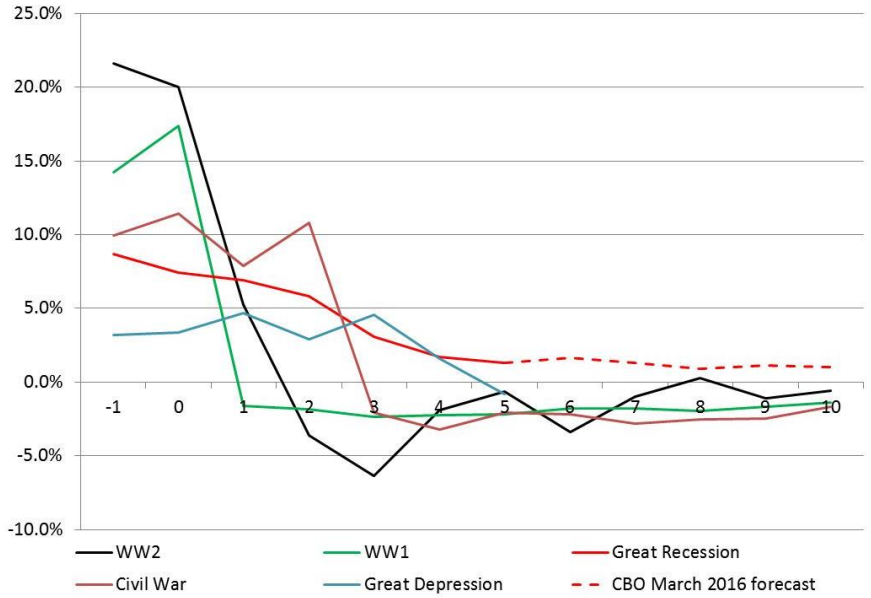


Sources: 1791-2012 from Bohn (2008) and the updated dataset in http://econ.ucsb.edu/~bohn/data.html . 2013-2026 from the March, 2016 *Updated Budget Projections* of the Congressional Budget Office, spliced with the Bohn data set using the annual changes in the debt-GDP ratio.

The pattern of U.S. fiscal adjustment (or the lack thereof) in the aftermath of the Great Recession debt spike is also unprecedented. As Figure 2 shows, in all previous U.S. debt crises, the primary balance switched into surplus within six years, while in the current episode we still observe primary deficits, and the CBO projects that under unchanged policies primary deficits will persist at least through 2026. Moreover, these figures include only the federal government's standard accounts, and hence do not take into account the large unfunded liabilities of Social Security, Medicare and states and municipalities, which did not exist in previous debt crises. Lutz and Sheiner (2014) report estimates of the state-and-local actuarial accrued pension and healthcare liabilities of about $3 trillion using fiscal year data for 2010-2012, which is equivalent to 100 percent of state and local revenues those years, 20 percent of U.S. GDP in 2010, or roughly 1/4th of the 2015 net federal debt-GDP ratio. Moody's estimates

the federal unfunded liabilities of Social Security and the hospital insurance component of Medicare at 75 and 18 percent of GDP respectively.[2]

Figure 2: U.S. Primary Balance Deficits After Debt Crises



Source: Primary balance data from Bohn (2008), except post 2012 the data are spliced with data from the March, 2016 CBO projections.

The persistence of primary deficits is also strikingly at odds with the historical record showing that primary surpluses have been an important driving force making U.S. debt sustainable. Table 1 provides a breakdown of the factors contributing to the five largest episodes of debt reduction in U.S. history (the five largest peak-to-trough phases in Figure 1). The Table shows the peak and trough debt ratios of each, the change from peak to trough, and the cumulative contributions of the following factors to each debt-reduction episode: The overall deficit, the growth effect, the primary deficit, debt service, and debt service net of the growth effect.[3] The overall balance has played a minor role, because only in the first two cases overall surpluses contributed to lowering the debt, and in the other three in fact we observed overall deficits. From this perspective, one could conclude that the overall balance is of little relevance and the big debt reductions have been mainly a "growth dividend," of as much as 103 percentage points of GDP for the post-World-War II case. This is misleading, however, because decomposing the overall balance into primary balance and debt service shows that primary surpluses played a role in all cases, with cumulative contributions from 2.7 to 45 percentage points of GDP and annual surpluses that averaged as much as 3.1 percent of GDP for the 1994-2001 episode. None of the

[2] Moody's report, available at https://www.moodys.com/research/Moodys-US-government-pension-shortfall-overshadowed-by-Social-Security-Medicare--PR_346878 .

[3] This decomposition is based on the government's accounting identities. Since debt is measured as a ratio to GDP, the change in the debt is equal to the overall fiscal balance plus a term that depends on the growth rate of nominal GDP, which is given by g/[(1+g)b], where g is nominal GDP growth and b is the beginning-of-period debt ratio. Since the overall balance is the sum of the primary balance and debt service, the decomposition can be made using the contributions of these two instead of the overall balance.

large debt reductions occurred without large average and cumulative primary surpluses. The growth dividend was important too. It paid for a large fraction of the debt service, and in three cases exceeded what was needed to pay the interest on the debt to yield net cumulative contributions to the decline in debt ranging from 5 to 60 percent of GDP (the latter for the post-World-War II case).[4]

Table 1: Accounting of Large Debt Reductions During U.S. Debt Crises

	Initial Debt Ratio	Final Debt Ratio	Cumulated contribution of						Annualized Rates		
			Change in Debt Ratio	Overall Deficit	Growth Effect	Primary Deficit	Debt Service	Net debt Service	Nominal Growth	Inflation	Real Growth
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
			I. Peak to Trough								
a) 1792-1812	37.5%	7.2%	-30.3%	-7.2%	-23.1%	-25.2%	18.0%	-5.1%	5.8%	1.4%	4.3%
b) 1866-1916	33.5%	3.0%	-30.5%	-16.7%	-13.8%	-45.0%	28.3%	14.5%	3.3%	-0.6%	3.9%
c) 1919-1930	34.6%	15.6%	-19.0%	8.8%	-27.8%	-2.7%	11.6%	-16.3%	2.6%	0.1%	2.5%
d) 1946-1974	108.7%	23.9%	-84.8%	18.5%	-103.3%	-24.1%	42.6%	-60.7%	6.9%	3.3%	3.5%
e) 1994-2001	49.2%	32.5%	-16.7%	1.0%	-17.7%	-21.5%	22.4%	4.8%	5.6%	1.8%	3.7%
			II. Per-year Average								
a) 1792-1812			-1.5%	-0.4%	-1.2%	-1.3%	0.9%	-0.3%			
b) 1866-1916			-0.6%	-0.3%	-0.3%	-0.9%	0.6%	0.3%			
c) 1919-1930			-1.7%	0.8%	-2.5%	-0.2%	1.1%	-1.5%			
d) 1946-1974			-3.0%	0.7%	-3.7%	-0.9%	1.5%	-2.2%			
e) 1994-2001			-2.4%	0.1%	-2.5%	-3.1%	3.2%	0.7%			

Source: Author's calculations. See footnote 4 for details. Data in columns (1), (2), (4), (6), (7), (9) and (10) are from Bohn (2008).

A canonical view of this dire fiscal situation would raise concerns about U.S. public debt sustainability and advocate for fiscal austerity, fearing the adverse effects caused by the need to raise revenues and/or reduce expenditures to repay the debt, or warning about the potential risk of de-facto or de-jure default in the absence of fiscal austerity.[5] Contrary to this view, however, several economists and international organizations have argued that these are unwarranted concerns, and additional public debt is actually needed and/or desirable for two reasons: First, to finance fiscal expansions so that advanced economies can take advantage of fiscal multipliers and recover. Second, to meet strong global demand for so-called "safe assets." After all, strong demand has driven prices of government securities sharply lower and produced negative yields in several advanced economies, so this seems a very good time to take on even more debt.

This paper provides four arguments that raise doubts about the above arguments in favor of increasing public debt further and validate some of the concerns behind the canonical view.

(1) Evidence from empirical studies on fiscal multipliers and debt sustainability shows that (a) in highly indebted countries, fiscal multipliers are zero on impact and significantly negative in the

[4] This poses the question of whether it would have been preferable to run smaller primary surpluses in these cases, but at least judging by the annualized growth rates of the five episodes, it is not the case that the ones with smaller surpluses always had the highest growth rates.

[5] A temporary increase in inflation and dollar depreciation would be akin to a partial de-facto default on U.S. dollar-denominated public debt. De-jure defaults are much less likely, but not unprecedented, even in U.S. history (see Hall and Sargent (2014) and Reinhart and Rogoff (2011)).

long run (see Ilzetzki, Mendoza and Vegh (2013)); and (b) there has been a statistically significant break in debt sustainability conditions since 2008 (see D'Erasmo, Mendoza and Zhang (2016)) which is harbinger of a transition to much higher long-run debt levels.

(2) A structural dynamic general equilibrium model proposed by Mendoza, Tesar and Zhang (2014) shows that making higher debt sustainable will be difficult if not impossible, because traditional adjustments in tax rates may not generate enough revenue to restore fiscal solvency given the sharp increase in public debt that has taken place, the already high rates of distortionary taxation, and the integration of global markets that creates large spillovers when domestic tax rates change.

(3) It is risky to treat the strong demand for liquid assets as a permanent phenomenon anchoring debt sustainability, because the profession still has a limited understanding of what is driving it and how it will evolve in the future. An extension of the frameworks proposed by Mendoza, Quadrini and Rios-Rull (2009) and Azzimonti, de Francisco and Quadrini (2014) shows that this phenomenon could have been the result of slow-moving transitional dynamics caused by the integration of capital markets amongst financially heterogeneous countries, with the United States as the most financially developed and the one with the larger public debt needs. Convergence of these dynamics would weaken the growth in demand for safe assets, and a potential reversal would trigger adjustments in the opposite direction. World markets would be exposed to a sharp drop in government bond prices and a sudden reversal of fortunes in the ability of governments to sustain high debt ratios without fiscal adjustment.

(4) In light of the previous three arguments, the risk of a default on domestic public debt, even an outright default, should not be ignored. Recent work by D'Erasmo and Mendoza (2016a,b) shows that a utilitarian government may choose to default if the social cost of the regressive redistribution imposed by repaying exceeds the social value of public debt as a financial asset that provides liquidity, a vehicle for self-insurance, and a mechanism for sharing of idiosyncratic risk across agents.

This paper draws from several findings in the literature, particularly form the above-cited studies. More broadly, the paper is related to three strands of the literature: Empirical studies on fiscal multipliers and public debt sustainability, fiscal policy assessments based on quantitative dynamic general equilibrium models, and studies on global imbalances and the demand for liquid assets. Chinn (2013) provides a comprehensive survey of the literature on fiscal multipliers, D'Erasmo et al. (2016) survey the literature on public debt sustainability and quantitative macro models of fiscal policy, and Mendoza and Quadrini (2012) review the literature on global demand for liquid assets driven by financial underdevelopment.

The rest of this paper proceeds as follows. Section II discusses the empirical findings on fiscal multipliers for high-debt countries and breaks in public debt sustainability tests. Section III shows the structure and findings of the dynamic general equilibrium model. Section IV discusses the framework relating demand for public debt to globalization of capital markets, financial underdevelopment, and the government's financing needs. Section V describes a model of default on domestic public debt and what

are the determinants that make domestic default an optimal decision for the sovereign. Section VI concludes.

II. Empirical Evidence on Fiscal Multipliers and Fiscal Solvency

The fiscal multiplier, namely the multiple by which a given macro aggregate, usually GDP or investment, changes for a unit change in a fiscal policy instrument, such as government spending or tax rates, has been exhaustively studied. It regained critical relevance during the Great Recession, as expansionary fiscal policy was considered and then used in frantic efforts to halt the rapid contraction of economic activity (e.g. the $800 billion fiscal stimulus provided by the 2009 American Recovery and Reinvestment Act). Unfortunately, the effectiveness of fiscal expansions is a subject of heated debate because empirical estimates of the size of the fiscal multiplier vary widely. In a survey paper, Chinn (2013) documents that estimates of the U.S. fiscal multiplier range between 0.1 and 2.5, depending on the type of fiscal instrument and the macro aggregate to which it applies.

The uncertainty surrounding the effectiveness of fiscal expansions is even larger when high levels of public debt are considered. Research has not focused much on how fiscal multipliers vary as debt rises, but the results that exist provide striking findings. In particular, Ilzetzki et al. (2013) found that multipliers for government expenditures range from non-existent to sharply negative at sufficiently high public debt ratios. For countries where the public debt ratio exceeds 60%, the fiscal multiplier is 0 on impact and -3 (and statistically significant) in the long run, while for countries with lower debt ratios the impact multiplier is positive.[6] Hence, at high debt ratios fiscal expansions are not just ineffective, they are contractionary! Given that the United States is far above the 60% threshold, one should be pessimistic about the prospects that debt-financed fiscal expansions will yield significant output gains, and should consider the possibility that in fact they could have the opposite effect.

Empirical analysis is also very useful for shedding light on the key question of whether the recent U.S. public debt dynamics are consistent with debt sustainability (i.e. with the intertemporal government budget constraint, IGBC). The seminal work of Bohn (1998, 2008) yields key results for specifying and estimating empirical tests of debt sustainability, one of which is a sufficiency condition in the form of the following fiscal reaction function (FRF):

$$pb_t = \mu_t + \rho b_{t-1} + \varepsilon_t \tag{1}$$

where pb_t corresponds to the primary balance to GDP ratio in period t and b_{t-1} is the beginning-of-period debt ratio. As shown by Bohn (2008), a sufficient condition for the IGBC to hold is a positive

[6] These results are consistent with previous theoretical and empirical work on "expansionary austerity" (e.g. Blanchard (1990), Alessina and Perotti (1995)), which applies Ricardian-equivalence arguments to conclude that higher debt in the present generate expectations of low solvency and higher taxes in the future, which in turn have negative effects on economic activity.

response of the primary balance with respect to debt (i.e., $\rho > 0$).[7] Interestingly, debt is stationary if $\rho > r$ where *r* is the net interest rate on public debt adjusted for the rate of output growth, and for $0 < \rho < r$ debt follows an explosive trajectory but still satisfies the IGBC. These results follow from replacing the definition of the primary fiscal balance ($pb_t = (1+r_t)b_{t-1} - b_t$) in equation (1):[8]

$$b_t = -\mu_t + (1+r_t-\rho)b_{t-1} - \varepsilon_t \tag{2}$$

where μ_t is a vector of variables that are additional determinants of the debt ratio (e.g. the output gap and the cyclical component of government expenditures) and ε_t is an iid error. For $\rho > r$, the autoregressive coefficient on debt is lower than 1, implying a stationary trajectory, but for $0 < \rho < r$ the opposite is true. Notice also that when debt is stationary, a lower value of ρ implies that the IGBC holds for the same initial condition of debt (i.e. the same initial debt ratio b_0), but implies larger primary deficits and higher long-run debt on average.

D'Erasmo et al. (2016) estimate updated FRFs for the United States using data for the period 1792-2014 and find point estimates of ρ that range between 0.078 and 0.105 and are statistically significant. This could be viewed as good news, because it suggests that the IGBC is satisfied and with a stationarity debt ratio. But upon closer scrutiny the data also reveal a large, statistically significant structural break around 2008. For a sample that ends in 2008, before the Great Recession, the value of ρ is close to 0.102, which is also very similar to a previous estimate obtained by Bohn (2008) using data ending in 2003, while for the sample that runs until 2014 the point estimate falls to 0.078.

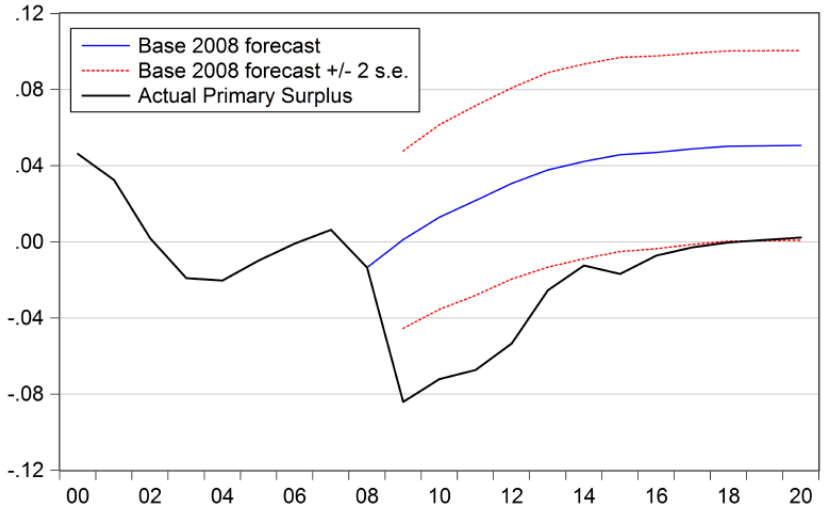
Although the fiscal solvency condition still cannot be rejected by the data, these new FRF implies an adjustment of the primary balance with respect to debt that is roughly 25% smaller, and this has effects on both the short- and long-run dynamics of the debt ratio. In order to illustrate these effects, Figure 3 presents a comparison of the forecast of the U.S. primary surplus produced by the regression that ends in 2008 v. the actual observations for 2009-2014 and the projections for 2015-2020 in the *President's Budget* for 2016. In line with the evidence of a large structural break, the predicted primary balance produces a small deficit in 2009 and a growing surplus that settles around 4 percent of GDP by 2020. This contrasts sharply with the large deficits of as much as 8% of GDP observed in 2009-2014 and the President's Budget projected smaller but continued deficits for much of the rest of the period. In fact, the 2009-2014 observed deficits are significantly outside the two-standard-error bands of the regression forecast, and the 2015-2020 projections just barely reach the minus-two-standard-error boundary by 2020. Moreover, the President's Budget projections are optimistic when contrasted with those in the March 2016 report of the Congressional Budget Office, which project continued deficits through 2016. Note also that the regression forecast already makes allowance for the large output gap

[7] Notice that this is only a sufficiency condition. Bohn (2007) shows that the IGBC holds under the much weaker condition that the debt ratio is stationary of *any* finite order, because the exponential growth in the discounting of future debt dominates the polynomial growth of the debt itself when debt is stationary of finite order.

[8] Since both debt and the primary balance are ratios of GDP, the gross interest rate in this equation is actually the gross nominal interest rate divided by the gross rate of nominal GDP growth

and cyclical increase in government purchases during 2009-2011. In short, the observed deficits are much larger than what they should have been under the pre-2008 FRF, which is in line with the point noted earlier about the recent pattern on persistent deficits being unprecedented relative to previous reversals of high U.S. public debt ratios in historical data.

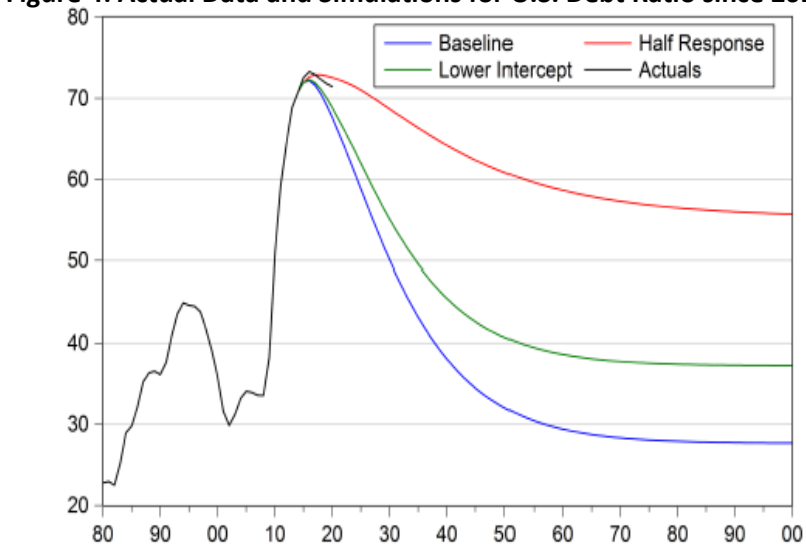
Figure 3: Actual and 2008 Based Forecast Values, U.S. Primary Surplus



Note: Out-of-sample forecast uses actual values for the independent variables for 2009-2014 and 2016 President's Budget for 2015-2020.

Figure 4 illustrates the effects of changes in the FRF parameters for debt dynamics. Recall that as mentioned earlier, the IGBC holds for the same initial debt as this parameter changes. The Figure shows the evolution of the U.S. public debt ratio for the estimated FRF (with 1792-2014 data), and for two alternatives, one with a lower regression intercept and one with a response coefficient equal to half of the estimated value of ρ. All three projections use the actual 2014 debt ratio as initial condition.

Figure 4: Actual Data and Simulations for U.S. Debt Ratio since 2014



As suggested earlier, the changes in the FRF parameters have significant short- and long-run effects on the debt GDP ratio. In the scenario in which the response coefficient is halved, the debt ratio actually continues to rise in the early years after 2014 (which shows also how this allows for larger primary deficits initially), and only starts to fall after 2020, but converges to a much higher debt ratio than under the other two alternatives. The predicted long-run average of the debt ratio is about 58%, nearly double the ratio predicted under the estimated FRF. Note also that the debt ratio remains above the negative-multiplier threshold of 60% until 2053!

In summary, the results of empirical work have two key implications for the U.S. fiscal situation. First, at its current and predicted public debt ratios, the United States will remain in the range in which fiscal multipliers have insignificant impact effects and large, negative long-run effects. Second, while the hypothesis that the debt is consistent with the IGBC cannot be rejected by the data, there has been a major structural break in the fiscal reaction function, evidenced by much larger primary deficits than have been observed, and the systematically weakened primary balance adjustment points to a doubling of the long-run debt ratio.

III. Dynamic General Equilibrium Model

The main limitation of the fiscal sustainability analysis based on the FRF is that, while it can test for the hypothesis that IGBC holds and provide informative insights into the historical and projected adjustments of debt and the primary balance under alternative parameterizations, it cannot say anything about the broader macroeconomic and welfare effects of alternative paths of fiscal adjustment. For a given initial debt ratio, any positive response coefficient satisfies the IGBC, but it implies different short- and run dynamics for debt and primary balances (see, for example, Figure 4), which in turn have associated with them different dynamics for macro variables and different welfare levels. The FRF is not a useful tool for comparing these, and hence for deciding which fiscal policy strategies are more or less desirable to make the debt sustainable. Making these comparisons requires a structural approach.

In this Section, we discuss the results obtained by D'Erasmo et al. (2016) using a two-country dynamic general equilibrium model calibrated to actual data to compare fiscal adjustment policies. The structure of the model is based on Mendoza and Tesar's (1998) two-country version of the workhorse neoclassical model with exogenous balanced growth driven by labor augmenting technological change (as in King, Plosser and Rebelo (1988)). The interested reader should consult these references for a detailed description of the model, but a brief description of its key elements is presented below. The main difference relative to the Mendoza-Tesar setup is in that, following Mendoza et al. (2016), D'Erasmo et al. use endogenous capacity utilization and a limited depreciation tax allowance so that the model can match the observed elasticity of capital tax revenues.

The first key element consists of a fiscal sector that has three components. First, fiscal policy includes unproductive government purchases (g) and transfer payments (e) to households, both as shares of output. The second component involves the tax structure, which consists of time-invariant tax rates on consumption (τ_C), labor income (τ_L) and capital income (τ_K). The third component is the public debt ratio (d), which is one-period debt denominated in units of goods. Also, the government is committed to its debt and tax policies.

A second key element consists of the features that Mendoza et al. (2016) added to the standard two-country neoclassical model of tax policy: A depreciation tax allowance limited to the fraction θ of the book value of depreciated capital ($\theta\tau_K\bar{\delta}k$) and an endogenous choice of capacity utilization rate (m) of the installed capital (k), so that effective capital used in production is mk and the rate of physical depreciation of capital is an increasing function of m. Standard neoclassical models of tax policy assume that 100% of actual physical depreciation is deductible and assume also full utilization of capital, and as a result they yield unrealistic predictions for the elasticity of the capital tax base. In particular, the capital tax base cannot fall on impact when the capital tax increases, because the capital stock is pre-determined, while in the data the short-run elasticity of the capital base is estimated in the [0.1, 0.5] interval. With endogenous utilization, a higher capital tax rate lowers the utilization rate contemporaneously, allowing the capital tax base to respond (since governments generally tax income derived from capital, which depends on mk). The limited depreciation allowance introduces the realistic feature that typical depreciation tax allowances apply only to corporate income taxes and/or nonresidential capital structures, and they are set relative to the book value of assets.

The third key element is that the model assumes a residence-based taxation system on capital income, which is in line with the tax systems in the U.S. and Europe, and allows countries to tax capital differently. In principle, most tax systems are source-based, but widely used bilateral tax treaties provide credits for taxes paid abroad, effectively resulting in a residence-based tax system. It is important to mention that, in order to prevent the equalization of pre- and post-tax returns on capital due to cross-country arbitrage, capital is owned by domestic residents. Given the latter, bond payments are taxed at a uniform world rate, which is normalized to 0 for simplicity. Although capital is immobile across countries, differences in taxes between countries induces reallocation of resources and changes in capital accumulation, which over time result in results equivalent to the case in which physical capital is mobile. Via this effective relocation of capital, and its general equilibrium effects on allocations and prices, a unilateral change in capital taxation by one country generates cross-country externalities by affecting relative prices, tax revenues and the wealth distribution among them.

In the two-country model simulated by D'Erasmo et al. (2016), the period-by-period budget constraint of the government in the home country is:

$$d_t - (1+\gamma)q_t^g d_{t+1} = pb_t \equiv \tau_C c_t + \tau_L w_t l_t + \tau_K (r_t m_t - \theta\bar{\delta})k_t - (g_t - e_t) \tag{3}$$

where γ is the exogenous growth rate of the economy, q_t^g is the price of public debt, and pb_t denotes the primary balance as a share of GDP. Imposing the standard No-Ponzi-game condition, the above constraint results in an IGBC of the following form:

$$\frac{d_0}{y_{-1}} = \psi_0 \left[\frac{pb_0}{y_0} + \sum_{t=1}^{\infty} \left(\left[\prod_{i=0}^{t-1} \nu_i \right] \frac{pb_t}{y_t} \right) \right] \tag{4}$$

where $\psi_i = y_{i+1} / y_i$, y is output, and $\nu_i = (1+\gamma)\psi_i q_i^g$. In this expression, the discount factors applied to the stream of primary balances combine the long-run growth rate, transitional growth towards the balanced growth path, and the rate of interest on the public debt (which is the reciprocal of its price).

D'Erasmo et al. (2016) use model simulations to construct dynamic Laffer curves. These curves plot the implied change in the right-hand-side of the above IGBC that result from varying either the capital or labor tax rates, taking into account that all the prices and allocations in the IGBC are equilibrium intertemporal sequences that change as tax rates change. By expressing the results in terms of changes in the present value of the primary balance, the goal is to show how the *sustainable debt* changes as tax rates change.

The tax structure of each country has well-known distortionary effects on world equilibrium conditions, which in turn result in the cross-country externalities of domestic tax policy noted earlier and discussed in Mendoza and Tesar (1998). The main channel for these externalities operates via capital income taxation and the arbitrage conditions that connect the world market of bonds, b, with domestic physical capital markets. These arbitrage conditions can be expressed as follows (the model assumes capital adjustment costs, but these are omitted below for simplicity):

$$\begin{aligned}
&\frac{(1+\gamma)u_1(c_t,1-l_t)}{\tilde{\beta}u_1(c_{t+1},1-l_{t+1})} = (1-\tau_K)F_1(m_{t+1}k_{t+1},l_{t+1})m_{t+1} + 1-\delta(m_{t+1}) + \tau_K\theta\bar{\delta} = \frac{1}{q_t^g} = \frac{1}{q_t}, \\
&\frac{(1+\gamma)u_1(c_t^*,1-l_t^*)}{\tilde{\beta}u_1(c_{t+1}^*,1-l_{t+1}^*)} = (1-\tau_K^*)F_1(m_{t+1}^*k_{t+1}^*,l_{t+1}^*)m_{t+1}^* + 1-\delta(m_{t+1}^*) + \tau_K^*\theta\bar{\delta} = \frac{1}{q_t^{g*}} = \frac{1}{q_t}
\end{aligned} \tag{5}$$

where variables with (without) an asterisk denote the foreign (home) country variables. The first ratios, starting from the left, in these two conditions are the intertemporal marginal rates of substitution of households in each country. At equilibrium, these must equal the terms in the right-hand-side of the first equality of each condition, which correspond to the marginal returns on investments into domestic and foreign physical capital. In turn, these two must equal the return on each country's public debt, which are the reciprocals of the corresponding bond prices. Finally, the return on public debt in each country must equal the common return on the internationally traded bond, $1/q_t$.

The cross-country externalities of unilateral capital tax changes are embodied in the above arbitrage conditions, and are the engine of the mechanism driving the well-known strategic incentives behind international tax competition. If the home country lowers its capital tax rate, the higher post-tax marginal return on its capital incentivizes home-country households to invest more, and the resulting rebalancing effect lowering demand for domestic public debt and international bonds lowers both of their prices, so that their returns rise to match the higher post-tax return on domestic capital. The fall in the price of international bonds is the vehicle of transmission to the foreign country, because it triggers a rebalancing of the portfolio of foreign households, who reduce investment in the foreign capital stock and reduce demand for foreign public debt, lowering its price and increasing its return. Foreign intertemporal plans for consumption, labor, capital accumulation, and capital utilization are therefore affected by the change in the home country tax rate, and in particular the foreign capital stock falls. Foreign factor prices also change accordingly, responding to general equilibrium effects, and thus the capacity of the foreign government to raise revenues is adversely affected as both allocations of foreign consumption, capital and labor and foreign factor prices adjust.

The labor market equilibrium condition is given by:

$$\frac{u_2(c_t, 1-l_t)}{u_1(c_t, 1-l_t)} = \frac{1-\tau_L}{1+\tau_C} F_2(k_t, l_t) \tag{6}$$

This condition states that the marginal rate of substitution between consumption and leisure must equal the post-tax wage rate, which at equilibrium is determined by the effective labor tax (i.e. the tax wedge $(1-\tau_L)/(1+\tau_C)$) applied to the marginal product of labor. Higher labor or consumption taxes thus reduce the post-tax wage rate and lead households to increase leisure and reduce labor supply.

Finally, the optimality condition for utilization is:

$$F_1(m_t k_t, l_t) = \frac{1+\Phi_t}{1-\tau_K} \delta'(m_t) \tag{7}$$

where Φ_t is a Tobin's Q term that represents the effects of capital adjustment costs. This condition equates the marginal product of capital utilization with its post-tax marginal cost (recall that higher utilization increases the rate of capital depreciation). An increase in the capital tax rate reduces the utilization rate (given the concavity of the production function with respect to capital). Moreover, adjustment costs also affect capacity utilization, depending on whether Tobin's Q is above or below 1.

D'Erasmo et al. calibrate the model to match key macro and fiscal features as of 2008 for the United States as the home country (denoted US) and a GDP-weighted average of the 15 largest European countries as the foreign region (denoted EU15). Table 2 lists the main calibration targets and fiscal parameters.

Table 2: Main Statistics for the U.S. and Europe

	GDP-weighted	
	EU15	US
(a) Macro Aggregates		
τ_C	0.17	0.04
τ_L	0.41	0.27
τ_K	0.32	0.37
c/y	0.57	0.68
x/y	0.21	0.21
g/y	0.21	0.16
tb/y	0.00	−0.05
Rev$/y$	0.45	0.32
Total Exp$/y$	0.47	0.39
(b) Debt Shocks		
d_{2007}/y_{2007}	0.38	0.43
d_{2011}/y_{2011}	0.58	0.74
$\Delta d/y$	0.20	0.31

Source: D'Erasmo et al. (2016).

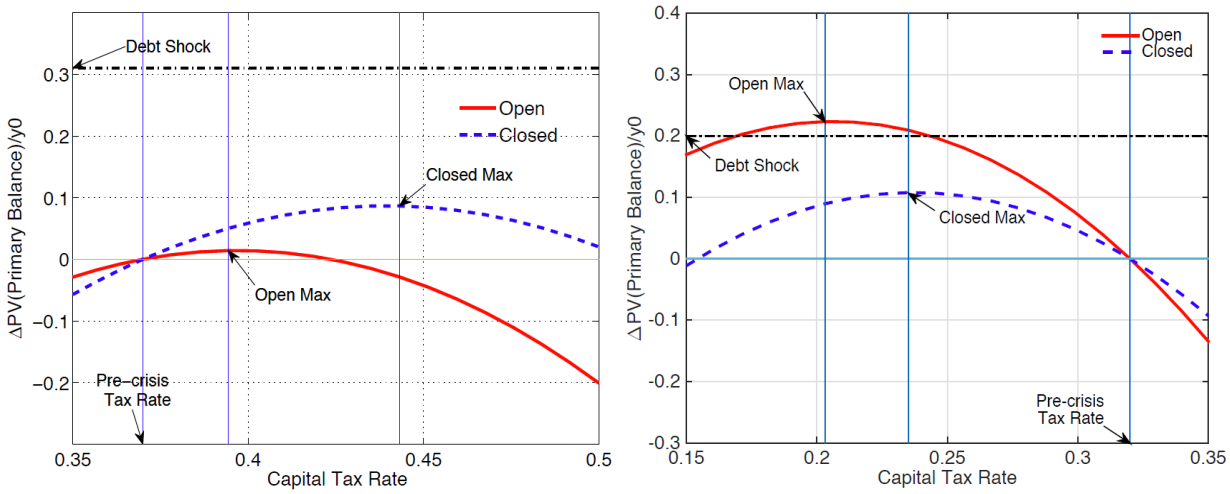
The tax rates shown in the Table correspond to updated estimates of effective tax rates computed with a revised version of the Mendoza-Tesar-Razin method by Mendoza et al. (2016). These estimates show important differences in tax rates between the U.S. and Europe. The consumption tax rate is 17% in EU15 v. 4% in US, the labor tax rate is 41% in EU15 v. 27% in US, and the capital tax rate is 32% in EU15 v. 37% in US. The effective labor tax wedge is 50% in EU15 v. 30% in US. Hence, relative to Europe, the United States taxes capital more and labor much less. Regarding expenditure ratios relative to GDP, the United States has a consumption ratio about 11 percentage points higher than Europe, while the U.S. government expenditures share is about 5 percentage points lower. Net exports are about zero in EU15, v. a 5% trade deficit in US. In terms of fiscal ratios, both total revenues and total non-interest expenditures (i.e. government purchases plus transfer payments) as shares of GDP are higher in EU15 than in US, 45% v. 32% for revenues and 47% v. 39% for expenditures. The differences in total expenditures minus government purchases indicates that transfer payments are also higher in EU15, 26% v. 23% in US. In the model simulations, government purchases and transfers are kept at these 2008 "initial" shares of GDP, and hence the calculations are conservative in that they do not include the expansionary fiscal policies since the 2008 crisis nor the creation of new entitlement programs like "Obamacare." Finally, the bottom section of Table 2 shows the changes in the public debt ratios between 2007 and 2011. These debt ratios correspond to general government net financial liabilities as a share of GDP as reported in Eurostat. The debt ratio increased in both regions, but the increase was larger in US than in EU15 (31 v. 20 percentage points). For additional details of the model calibration see D'Erasmo et al. (2016).

The data reviewed above suggest that while the United States experienced a larger increase in debt than in Europe, and therefore needs to increase the present discounted value of its primary fiscal balance by more, it has a "fiscal advantage" because of its much lower effective labor tax rate and higher capital tax rate. In particular, one could infer from the previous discussion of the model's tax distortions and international spillovers that the United States could "beg its neighbor" by lowering its capital tax rate and raising its effective labor tax wedge if needed to offset revenue loses. The former would move the international tax spillovers in favor of the United States, and the latter would allow it to "defend" that strategy by raising a tax distortion on which it has much more room to compete than Europe, given the much lower effective labor tax wedge of the United States. This does not, however, look like a politically feasible strategy, since the U.S. political climate is very much against any kind of tax increases.

Figure 5 reproduces the Dynamic Laffer curves (DLCs) with respect to changes in the capital tax, for the U.S. and Europe constructed by D'Erasmo et al. (2016). In order to highlight the role of the international spillovers, the plots include scenarios in which the countries are open or closed economies. The vertical axis corresponds to the change in the present discounted value of the primary balance with respect to 2007 public debt to GDP ratio. The horizontal axis is the value of the capital tax rate. These DLC plots can be read as follows. Take the DLC for the U.S. in the left side of the plot. At its calibrated pre-crisis capital tax rate of 37%, the change in the present discounted value of the U.S. primary balance as an open economy is 0 by construction, because this represents the baseline calibration relative to which the changes in the present value of the primary balance are measured. The rest of the red,

continuous curve shows how the present value of the primary balance would change for different U.S. capital tax rates, taking into account all general equilibrium effects, including the transition from the initial conditions to the new stationary equilibrium and assuming the foreign tax rates are unchanged. The blue, dashed curve has the same interpretation, but solving the model treating the U.S. as a closed economy. The two curves in the plot in the right side of Figure 5 are the analogous curves for the EU15.

Figure 5: Capital Tax and Dynamic Laffer Curves



(a) US (b) EU15

Source: D'Erasmo et al. (2016).

The main lesson to draw from Figure 5 is that capital tax changes will not be a feasible strategy for making the observed increases in debt sustainable. On the side of the United States, clearly the DLCs for the closed- and open-economy cases are always below the required increased in the present value of the primary balance of about 31 percentage points of GDP that would make the 2011 debt ratio sustainable. At the maximum value of the U.S. open-economy DLC, the sustainable debt increases only by 2 percentage points of GDP. The international spillovers of capital income taxation are significant, because the U.S. can produce much larger increases in the present value of its primary balance under financial autarky than as an economy that is fully integrated to world capital markets (i.e. the closed economy DLC is above the open economy DLC for capital taxes above the pre-crisis rate), and the gap between the two grows larger as the U.S. capital tax rises. At the maximum value of the U.S. closed-economy DLC, the sustainable debt increases by almost 10 percentage points of GDP, nearly five times more than in the open-economy case.

For Europe, the DLCs in the right side of Figure 5 show that at the pre-crisis tax rates EU15 is in the inefficient side of both Laffer curves. Hence, in this case, the policy adjustment that would be desirable is a cut in capital tax rates, not a hike (keeping labor and consumption taxes constant, which is unlikely to be politically viable). But the strategy would still not make the debt sustainable. Under financial autarky, this is the case because again the corresponding DLC is always below the increase in

the present value of the primary balance required to make the debt sustainable, and at its maximum it yields at most an increase of 10 percentage points in the sustainable debt ratio by reducing the capital tax rate by about 9 percentage points. In the open-economy case, the DLC suggests that an European tax cut down to nearly 20 percent (a cut of more than 12 percentage points relative to the pre-crisis tax rate) could make the debt sustainable. But notice that at the same tax rate under financial autarky the present value of the primary balance is more than 10 percentage points below what is required to make the debt sustainable. Therefore, debt sustainability in this scenario is being attained solely by exploiting the large international tax spillovers that favor EU15 if it can cut its capital tax rate that much while counting on the U.S. to keep its much higher capital tax rate unchanged. This is very unlikely to happen, because the U.S. would have very strong incentives to cuts its tax rate both in order to respond to the negative international spillovers and to reduce the large domestic inefficiencies produced as a result. The European Union has experience with this phenomenon, as evidenced by the rounds of international corporate tax competition it has gone through and the fear of consumption tax competition that led to the VAT harmonization directives.

The international spillovers of unilateral capital tax rate changes can be illustrated further by studying their effects on social welfare and steady-state output. Table 3 documents these effects for a hypothetical increase in the U.S. capital tax rate to the rate that yields the maximum value of the open-economy DLC for US in the model, $\tau_K = 0.402$. The spillovers that favor the EU15 region can be allocated to lower taxes or higher transfers while maintaining revenue neutrality (i.e. without changing the present discounted value of its primary balances). In Table 3 they are allocated to reduced labor taxation (from 0.41 to 0.4).

Table 3: Macroeconomic Effects from Unilateral Capital Increases in the U.S.

	Open Economy			
	Home		Foreign	
Tax rates	Old	New	Old	New
τ_K	0.37	0.40	0.32	0.32
τ_C	0.04	0.04	0.17	0.17
τ_L	0.27	0.27	0.41	0.40
ΔPV(Primary Bal.)/y_0		0.014		0.00
Welfare Impact		−2.19		0.74
Δy_{ss}		−3.87		1.25

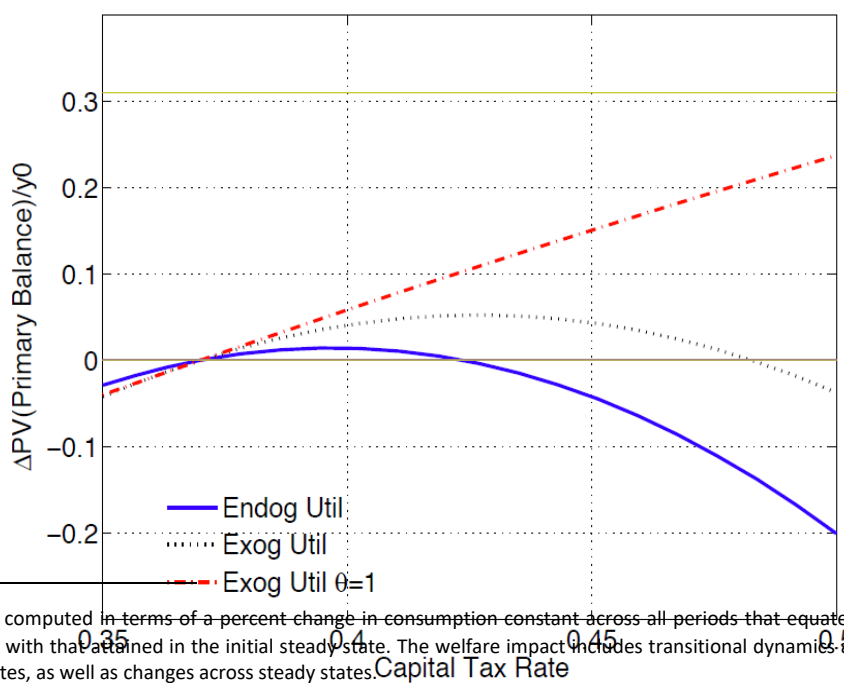
Source: D'Erasmo et al. (2016).

The increase in the capital tax increases the U.S. present discounted value of the primary balance by roughly 1.4 percentage points of GDP, decreases welfare by nearly 2.2%, and decreases

output in the long run by approximately 3.9%.[9] Hence, a small increase of 140 basis points in the sustainable debt ratio is attained at the very heavy cost of a large welfare cost and a significant reduction in long-run output. On the other hand, EU15 enjoys positive spillovers that allow it to cut its labor tax by just one percentage point, but at such initial effective labor tax wedge this small tax cut yields a non-trivial welfare gain of 0.74% and a 1.25% increase in long-run output.

It is critical to keep in mind that the limited depreciation tax allowance and endogenous capacity utilization play a key role in these results, because they are the mechanisms used to ensure that the model approximates well the empirical estimates of the capital income tax base short-run elasticity. In the data, the estimates range from 0.1 to 0.5, and in the calibrated model the elasticity is 0.29 (see Mendoza et al. (2016)). Without these features the elasticity is around -0.09! This also plays a key role in the shape of the DLCs and their implications. Figure 6 compares the open-economy DLCs for three cases (i) exogenous capacity utilization and full depreciation tax allowance, (ii) exogenous capacity utilization and limited depreciation tax allowance, and (iii) endogenous utilization and limited depreciation tax allowance, which is the baseline case. In case (i), the results are radically different. The DLC is an almost linear, upward sloping curve, which indicates that both raising revenue with tax hikes and making debt sustainable is very easy. Clearly models that assume full depreciation allowance and no capital utilization choice, which are fairly common assumptions in quantitative macro models of the effects of taxes, grossly overestimate both items (and do so because they embody a highly unrealistic elasticity of the capital tax base, with the wrong sign!). Comparing case (i) with (ii) shows that just by introducing the limited depreciation allowance, the DLC becomes bell-shaped, because with the limited tax allowance capital taxes are more distortionary, and hence have more pronounced Laffer curves. Finally, comparing curves (i) and (ii) with (iii) shows how endogenous utilization choice makes raising revenue via capital taxes even more difficult, because utilization rates drop as capital taxes increase.

Figure 6: Dynamic Laffer Curves, Capacity Utilization and Depreciation Tax Allowance for the U.S.



[9] Welfare effects are computed in terms of a percent change in consumption constant across all periods that equates lifetime utility under a given tax rate change with that attained in the initial steady state. The welfare impact includes transitional dynamics across the pre- and post-tax-change steady states, as well as changes across steady states.

(a) US

Source: D'Erasmo et al. (2016).

In summary, the quantitative predictions of the dynamic general equilibrium model indicate that standard tax adjustments in both the United States and Europe are unlikely to make the post-2008 surge in public debt sustainable. In particular, increases in capital income taxes cannot yield sufficiently large increases in the present discounted value of the primary fiscal balance to match the observed debt increases. The exception is if a country could count on its relevant economic partners to maintain their capital taxes high while it cuts its own capital tax rate significantly. Then, large spillovers favoring the country with the lower capital tax rate expand its tax bases by enough to make the observed debt increases sustainable. But since the incentives of the neighbors to respond by lowering their own taxes would be very strong (i.e. both welfare and output of the tax-disadvantaged countries fall sharply), this is not a viable solution. Moreover, these calculations are in fact "optimistic," because the revenue requirements of governments are understated, since the large unfunded liabilities of various entitlement programs are excluded.

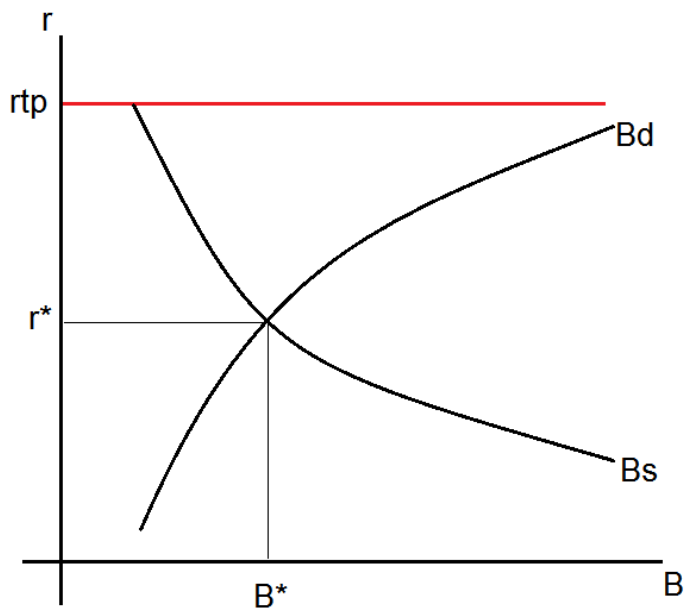
IV. Public Debt Demand Instability

The dire situation reflected in the findings reviewed in the previous two Sections is in sharp contrast with the very high prices that public debt of advanced economies, including the United States, command these days. In fact, some public debt instruments have sold at negative yields in recent years in France, Germany and Japan, for example. Against this background, it would seem that public debt sustainability is a non-issue. The other side of this situation is the very strong demand for liquidty or so-called "safe assets" across the globe that started since the 1990s with the surge in accumulation of reserves in many emerging markets and the global imbalances phenomenon. These are issues that are widely studied in economic research and debated in policy circles, but they are very far from being well understood or resolved. It is not clear whether this is a temporary phenomenon, or a feature of transitional dynamics of the evolution of financial markets, or a permanent change. It is also not clear whether it is an efficient outcome or the result of distortions that should be tackled (i.e. it is not clear whether it is a welfare-improving or welfare-reducing situation). Hence, pinning down the sustainability of U.S. public debt on the belief that it will remain a heavily demanded instrument in the long run, and without knowing if it is a desirable outcome, is a dangerous bet. In particular, arguments already exposed in the literature on financial globalization suggest that it can be a transitional phenomenon and one that reflects financial market imperfections.

The work of Mendoza, Quadrini and Rios-Rull (2009) argues that, if insurance markets are incomplete, the surge in demand for safe assets can be a feature of the transitional dynamics produced by financial integration among countries that differ in their degree of financial development (i.e. their degree of "market completeness"). To explain their point graphically, consider first the canonical closed-

economy Bewley-style heterogeneous agents model of the wealth distribution under incomplete markets as formulated by Aiyagari (1993) and illustrated in Figure 7. The aggregate demand for risk-free bonds is a concave, upward-sloping function that reflects the stronger incentive to self-insure (accumulate precautionary savings) as the risk-free interest rate rises, or the price of bonds falls. In the limit, as the interest rate approaches the rate of time preference (rtp), the demand for bonds diverges to infinity because agents desire to maintain the expected marginal utility of consumption constant over time, and that requires an infinitely large stock of precautionary savings. The supply of bonds (assumed to be provided by the government) is determined by the budget constraint of the government $pb_t = (1+r_t)b_{t-1} - b_t$ evaluated at steady state, so that $b = pb / r$. As the interest rate rises, the annuity value of an exogenously-given, long-run primary balance surplus falls, and thus the steady-state supply of public debt falls. The closed-economy equilibrium of the market for safe assets is the intersection of the supply and demand curves, (B*,r*).

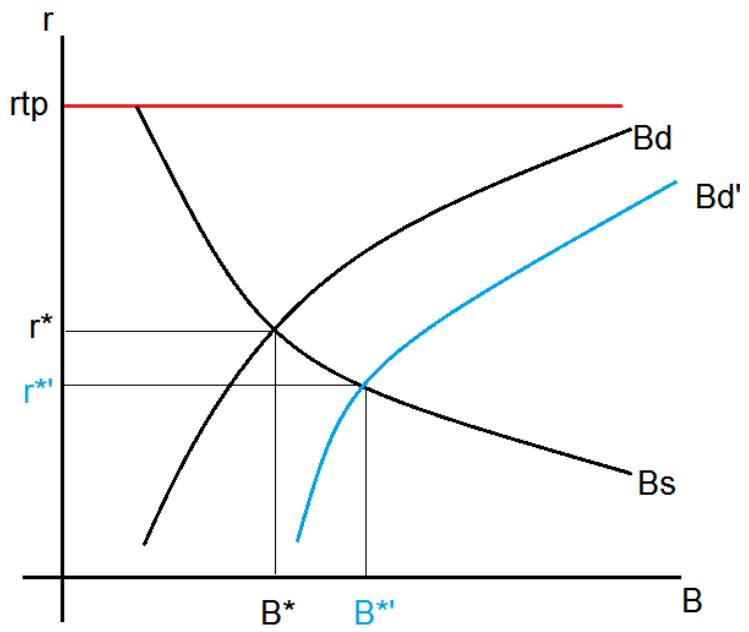
Figure 7: Bewley-Aiyagari Model of the Market of Safe Assets in a Closed Economy



Before introducing the open-economy version of this framework, it is worth noting that this setup can also deliver an explanation for the surge in demand for public debt resulting from an increase in actual or perceived individual (not national) income volatility. The asset demand curve shifts to the right as the variability of the income process of individuals rises (see Figure 8), because higher volatility incentivizes stronger precautionary savings, resulting in a lower risk-free rate and a larger public debt ratio. This happens if actual volatility rises (e.g. if unemployment spells grow larger or if there is a structural shift making the pool of jobs shift to jobs with higher risk of unemployment as with “temp” positions), but also if perceived volatility rises, as it would with “news” shocks related to individual income or large structural changes that may require learning and can lead to optimistic or pessimistic beliefs (as in the equity premium model of Cogley and Sargent (2008) or the model of credit booms and crashes by Boz and Mendoza (2014)). The difference is that if the uncertainty leading to higher

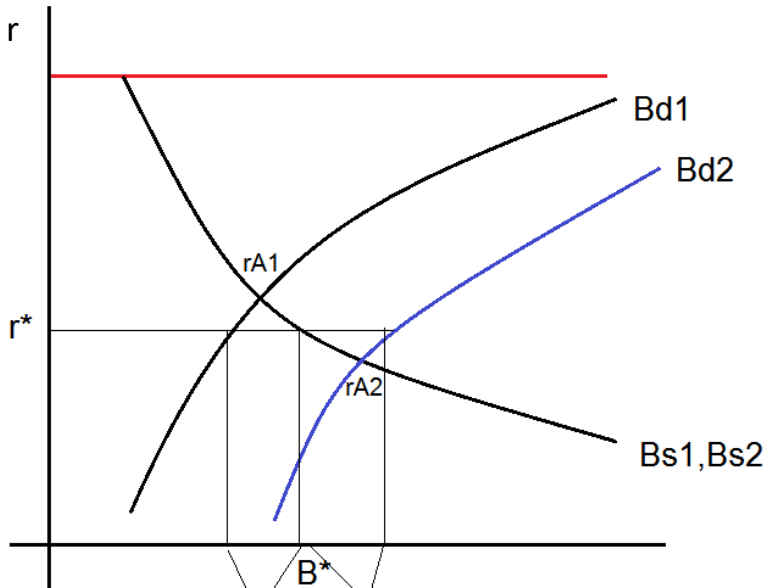
perceived volatility is resolved, the demand for assets may shift back to the position that reflects accurately the probabilistic process of individual income, and hence the demand for risk free assets will only be temporarily high. There is also the possibility that the equilibrium may be subject to self-fulfilling expectations. For example, individuals may believe that volatility is higher, therefore demand for risk-free asset assets shifts and interest rates fall, but very low interest rates can result in financial instability, a crisis may occur justifying the belief that volatility is high. This is an argument that as of now stands only as a conjecture, but worth pursuing in further research.

Figure 8: Demand for Safe Assets and Increased Volatility



Mendoza et al. (2009) extended the Bewley-Aiyagari model to an open-economy framework by introducing a second ("foreign") country with a similar demand curve, which seats higher or lower than the first (home) country's demand curve depending on its level of relative financial development. The more financially developed, the closer to the horizontal rtp line, which is the complete-markets case. In Figure 9, Country 1 has a higher level of financial development than Country 2.

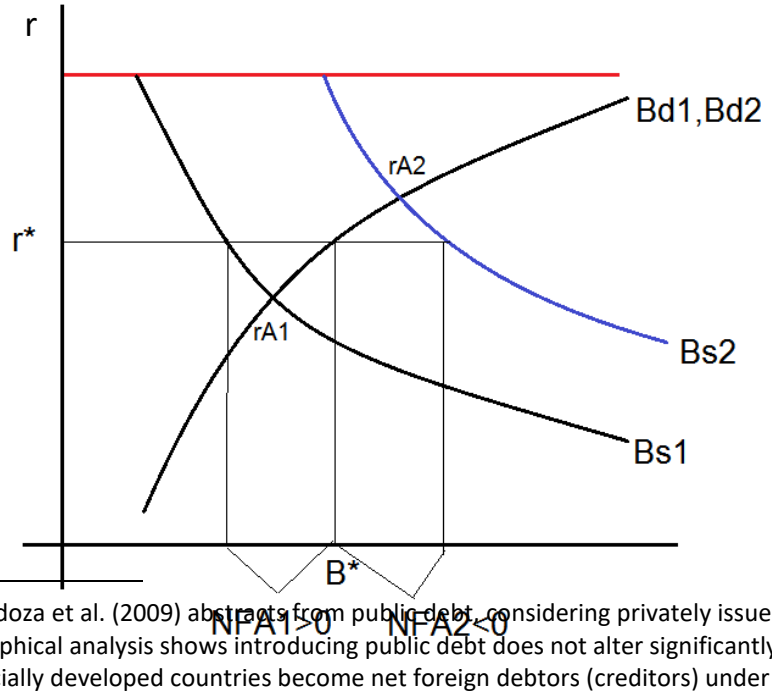
Figure 9: Financial Integration with Countries that Differ in Financial Development



B

Figure 9 can be used to examine the effects of financial integration between two countries with different levels of financial development. Notice the Figure also assumes that in terms of fiscal conditions both countries are identical (i.e. they have the same long-run primary fiscal balance), so the world supply of public debt is the single curve denoted Bs1,Bs2.[10] The autarky rates are denoted rA1 and rA2, and they correspond to the closed-economy equilibrium that each country would attain under financial autarky. When the countries join a common world financial market, equilibrium requires an interest rate r* at which the global net foreign asset position adds up to zero. Hence, as Figure 9 shows, the interest rate falls relative to autarky for the most financially developed country, its net foreign asset position becomes negative (staring from zero by definition under autarky), and its government issues more public debt. The opposite occurs in the less financially developed country. Hence, this experiment captures well important qualitative features of the actual experience since financial globalization started in the 1990s. In particular, it can explain the "Greenspan conundrum" of falling interest rates coexisting with growing debt of the U.S. economy. Mendoza et al. (2009) show that in fact, enriching the model with trade in risky assets and limited insurance markets, the model can provide a quantitatively plausible explanation for the large decline in the U.S. NFA position, the fall in U.S. interest rates, and the composition of the U.S. foreign asset portfolio long in risky and short in risk-less assets.

Figure 10: Financial Integration with Countries that Differ in Long-run Primary Surplus



[10] The analysis in Mendoza et al. (2009) abstracts from public debt, considering privately issued risk-free bonds instead, but as the graphical analysis shows introducing public debt does not alter significantly their main point that more (less) financially developed countries become net foreign debtors (creditors) under financial integration.

B

One can also ask from this framework the question of what does financial integration do if countries are actually homogeneous in financial development but heterogeneous in their fiscal stance. This scenario is illustrated in Figure 10. In this Figure, Country 2 has a larger long-run primary surplus, so at each value of the interest rate it can sustain a higher debt ratio, and thus its supply-of-bonds curve is to the right of that for Country 1. In this case, for the country with stronger fiscal stance (Country 2) the effects are qualitatively similar as for the country with higher financial development in Figure 9: interest rate falls relative to autarky, the net foreign asset position becomes negative and the country issues more public debt. So again, financial integration can explain higher public debt ratios at the same time as yields fall (bond prices rise).

The central point for the analysis of the U.S. public debt situation is that, in the scenarios illustrated in Figures 9 and 10, the global growth in demand for risk-free public debt is a feature of the transitional dynamics from autarky to financial integration. As that process converges, demand *growth* tapers off until it converges to zero (see Mendoza et al. (2009) for quantitative simulations of the dynamics of NFA). Moreover, if gaps in financial development or fiscal stance narrow (either because weaker countries become stronger or vice versa), the transitional dynamics move in reverse, narrowing the gaps in NFA positions, which would then mean a decline in demand for risk-free assets. The same would occur if countries engage in a "financial trade war," by which the widespread imposition of capital controls return the world financial system to a pre-1990s status, both of which have become more likely scenarios of recently. In short, while the jury is still out on what explains the surge in demand for safe assets and high public debt prices, some of the theories that can provide plausible explanations indicate that we should not count on strong growth in demand for safe assets and high bond prices to be permanent features of world capital markets on which to base the sustainability of U.S. debt.

V. Domestic Default Risk

Up to this point, we have focused on empirical and theoretical arguments that implicitly assume the government is committed to repay its debt. This assumption, however, seems questionable in light of the findings documented in the previous three sections. Hence, in this Section we explore the implications of relaxing this assumption following the work by D'Erasmo and Mendoza (2015a,b) which studies conditions under which a government chooses optimally to default on its *domestic* public debt. The interest on this issue stems also from the seminal work by Reinhart and Rogoff (2011), which documents episodes of de-jure (or outright) domestic defaults in a cross-country historical dataset including advanced and developing countries. In addition, for the case of the United States, Hall and Sargent (2014) describe in detail the domestic default episode in the aftermath of the Revolutionary War. Hence, historically (and albeit infrequently), we have seen governments of all kinds default on domestic debt obligations, so it seems logical to ponder if this U.S. debt crisis may not be a preamble to one of these rare domestic sovereign defaults.

D'Erasmo and Mendoza (2016a,b) study optimal domestic debt issuance and default decisions of a utilitarian government that cannot commit to repay its debt. The government faces a stochastic process of government expenditures and levies an income tax paid at the same rate by all individuals. Unlike traditional models of external sovereign default, in this framework the government considers the utility of both bondholders (BH) and non-bondholders (NBH), and in particular it cares about the distributional implications across BH and NBH agents of both retaining borrowing capacity to issue debt and defaulting on the outstanding debt. Without considering default, issuing new debt re-distributes resources from the BH to the NBH group (i.e. it induces "progressive redistribution"), because it allows the government to generate the resources needed to finance its outlays without having to increase taxes, while repaying outstanding debt re-distributes in the opposite direction (i.e. it induces "regressive redistribution"), because repaying the debt requires raising tax revenue at a tax rate that is the same for all agents. Adding the option to default provides a mechanism for additional progressive redistribution, because it pre-empts the regressive redistribution that would be needed in order to repay. But redistribution alone would not be sufficient to support debt markets, because the BH group would know that the government will default for sure in the future on newly issued debt, and thus that new debt would not be bought. For public debt markets to exist, it must be that default only becomes optimal when the social cost of the regressive re-distribution implied by repayment exceeds the social benefits of government debt, both measured by a utilitarian social welfare function that aggregates the welfare of BH and NBH groups. With the probability of default at t+1 on debt issued at t being less than 1, markets can charge a well-defined risk premium, and the debt market can function.

Notice that in this setup we obtain an alternative notion of debt sustainability, which is not related to fiscal solvency. The amount of debt that is sustainable in this environment is the optimal quantity that the government can sell at a well-defined price that takes into account the risk of a future default. When the default probability is high, the price of government debt is low and the amount of additional debt that can be sold at equilibrium (i.e. the sustainable debt) is small, regardless of the future prospects of the primary fiscal balance or the estimated coefficient of the fiscal reaction function. Moreover, for given welfare weights and a particular realization of government expenditures at date t, there is always a maximum amount of debt the government can issue, which is defined by the amount for which the government would find it optimal to default at t+1 not matter how low the realization of government expenditures is in that period. The key issue here is that debt sustainability is defined by willingness to pay, not by ability to pay.

D'Erasmo and Mendoza argue that the reason domestic defaults are rare is because the social value of debt is high, so for default to become optimal debt must grow sufficiently large and large debt must coincide with high realizations of government outlays. In turn, the social value of debt is high because in their analysis public debt is a vehicle that provides three key benefits to society: liquidity, self-insurance and risk-sharing.[11] The issuance of government debt provides liquidity by effectively providing resources that relax the credit constraints of a fraction of agents in the NBH group who are hitting borrowing constraints (endogenously, in the context of a Bewley-Aiyagari model of

[11] They adapted this approach to model the social benefits of public debt from the Bewley-Aiyagari models of heterogeneous agents with incomplete markets and public debt (e.g. Aiyagari and McGrattan (1998)).

heterogeneous agents similar to the ones discussed in the previous Section). The self-insurance benefit is present because, given that asset markets are incomplete, agents use government debt to build precautionary savings to partially insure against the fluctuations of their income. The risk-sharing benefit follows from the progressive redistribution attained by issuing debt, which allows the government to improve risk-sharing by transferring resources across agents.

We describe next some of the key elements of the D'Erasmo-Mendoza setup to clarify the above arguments. The complete analysis can be found in D'Erasmo and Mendoza (2016a,b). There is a continuum of agents in the economy that face idiosyncratic income shocks (y) and an aggregate government expenditure shock (g). Agents pay proportional income taxes (τ^y), collect transfers from the government (τ) and can save by accumulating domestic public debt (b) purchased at a price q . As is typical in Bewley-Aiyagari models with incomplete markets, agents face a borrowing constraint, in the sense that they cannot take short positions on domestic public debt.

If the government repays, the budget constraint of an individual agent is given by:

$$\begin{aligned} &c_t + q_t b_{t+1} = y_t(1-\tau^y) + b_t + \tau_t \\ &b_{t+1} \geq 0 \end{aligned} \tag{8}$$

and if the government defaults, it is given by:

$$c_t = y_t(1-\tau^y) - \phi(g_t) + \tau_t \tag{9}$$

where $\phi(g)$ represents a default cost in terms of disposable income that is a decreasing function of g , so that default costs are higher when income is higher. This feature of the model is introduced to make the model comparable with standard external default models, which also impose income costs of default that are higher when income is higher, and also because without default costs the gains from default can be so large as to make debt markets unsustainable because the government would always find it optimal to default. D'Erasmo and Mendoza (2016a) prove that this is indeed the case in a two-period model in which the distribution of agents in terms of BH and NBH types is pre-determined. In this case, the social benefit of default in the second period always exceeds that of repayment, and in fact defaulting on debt (assuming any debt could be sold in the first period) attains the perfect risk-sharing solution. They also show that if default is costly, or if the government has preferences biased in favor of the NBH group, the government may not always default and debt can be sustained. Moreover, it is possible that an economy with a majority of NBH types prefers the government to be biased in favor of BH types, because that allows the government to sustain more debt, and the larger debt provides more liquidity for NBH agents.

The government budget constraint when it repays is given by:

$$\tau_t = \tau^y Y - g_t - B_t + q_t B_{t+1} \tag{10}$$

where Y denotes the aggregate (non-stochastic) income of the economy and B is the supply of government debt. Alternatively, if the government defaults its budget constraint is:

$$\tau_t = \tau^y Y - g_t \tag{11}$$

Replacing government transfers in the agent's budget constraint using the above expressions, we can rewrite the constraints of individual agent as:

$$\begin{aligned} c_t &= y_t + \tilde{b}_t - q(B_{t+1}, g_t)\tilde{b}_{t+1} - \tau^y (y_t - Y) - g_t \\ \tilde{b}_{t+1} &\geq -B_{t+1} \end{aligned} \tag{12}$$

where $\tilde{b} \equiv b - B$. This variable corresponds to an agent's debt holdings relative to the supply of debt, which by market clearing equals "average debt," in the sense of the average taken with the distribution of bond holdings across agents. The price of debt depends on two aggregate variables, the amount of new public debt the government issues and the observed government expenditure shock. As D'Erasmo and Mendoza show, the price of debt falls as the debt issuance rises, because higher debt today implies higher risk of default tomorrow.

Expression (12) is helpful for illustrating the three social benefits of debt mentioned earlier. First, looking at the reformulation of the no-borrowing constraint, it is clear that the issuance of public debt provides liquidity (i.e. resources available for consumption) to credit-constrained agents via the progressive redistribution that issuing debt attains. Second, public debt provides a self-insurance vehicle. Agents with above-average income ($y_t > Y$) would like to acquire more debt as a buffer stock from which to draw in future periods in which they draw below-average income ($y_t < Y$), and agents with below-average income would sell some of their debt holdings to self-insure using their accumulated precautionary savings. Third, risk-sharing across agents improves when new debt is sold because the cross-sectional dispersion of consumption falls, since consumption of agents with $\tilde{b}_{t+1} > 0$ ($\tilde{b}_{t+1} < 0$) falls (rises) again as a result of the progressive redistribution attained by issuing debt. Repayment of the debt, on the other hand, has the drawback that it implies higher consumption dispersion, and this is a key driver of the government's distributional default incentives. Note that in D'Erasmo and Mendoza (2016b), the magnitude and cross-sectional dispersion of these two forces changes over time, as the distribution of debt holdings evolves endogenously.

The budget constraint in (12) also shows how income taxation works as an alternative mechanism to improve risk-sharing of idiosyncratic income shocks, because agents with below-average income effectively receive a subsidy, while those above the average pay taxes. Notice that by setting the income tax rate to 100 percent and rebating the revenues with a lump-sum transfer equal to average income to all agents, the government could provide full insurance against idiosyncratic income shocks. Of course this is not a realistic scenario, but the observation is important because it highlights that the D'Erasmo-Mendoza setup is best viewed as representing a situation in which other (perhaps more efficient) mechanisms to provide the three social benefits that public debt offers have been exhausted or are unavailable by construction.

The dynamics of the government's decision on debt issuance and default reflect a tight intertemporal connection between the progressive redistribution of issuing more debt today v. the regressive redistribution of repaying that debt tomorrow with the option of avoiding it by defaulting.

The inability of the government to commit to repay tomorrow in fact dampens the magnitude of the progressive redistribution that can be attained today, because the amount of resources that can be raised by borrowing ($q(B_{t+1}, g_t)B_{t+1}$) follows a Laffer-curve pattern. As debt increases, it reaches a point at which issuing more debt actually induces less progressive redistribution than issuing less debt, because a higher amount increases default risk sufficiently to make the price of debt fall by enough for the resources generated by debt to actually fall. In each period, the government weighs the distributional implications of repaying v. defaulting taking this intertemporal feedback into account, and trading it off against the endogenous costs of defaulting that are incurred, because when default occurs the liquidity, self-insurance and risk-sharing benefits of debt issuance are wiped out.

The endogenous evolution of the distribution of bond holdings across agents in the economy also plays an important role in the setup of D'Erasmo and Mendoza (2016b). The government, at the moment of deciding whether to default or not, aggregates the individual utility gains and losses caused by a government default across all agents, and hence default becomes more likely the larger the fraction of agents who have a utility gain instead of a loss, which is larger the larger the fraction of agents in the economy with $\tilde{b}_t < 0$, and in particular the larger the subset of these agents who is hitting the liquidity constraint. Hence, default incentives are stronger the more concentrated is the ownership of government bonds. But these stronger incentives increase default risk, lower the price of debt that can be issued before defaulting, and thus reduce the size of the progressive redistribution that issuing debt can attain. In addition, the agents' debt demand choices react to changes in the price, altering the distribution of gainers and losers from a default. As a result, at equilibrium the size of the progressive redistribution that debt can attain today is not only affected by the size of government debt but also by the distribution of bond holdings. However, this distribution is itself affected by debt and repayment policies, creating a rich feedback mechanism connecting the dynamics of the distribution of bond holdings, the government debt, default incentives and the price and risk premium paid on public debt.

D'Erasmo and Mendoza (2016a,b) conduct quantitative experiments calibrating the model to data for Spain, motivated by the idea that to some extent the European debt crisis shares several features of a domestic sovereign default. The model predicts protracted fluctuations in government debt, with average debt ratios in line with those observed for Spain and with a very low frequency of default (1%), which is indicative of high endogenous costs of default (i.e. high social benefits of public debt). Interestingly, in a time-series simulation, defaults occur with what seems a rapid, sudden surge in debt and spreads from low, stable levels. Moreover, in most periods public debt is sold as a risk-free asset (i.e. with zero default probability one period ahead as an equilibrium outcome).

Spain is very different from the United States, and Spanish debt does not play the central role in world capital markets that U.S. public debt plays. Still, we can infer from these results that distributional incentives to default are getting stronger in the United States, given the large stock of outstanding debt and increasing wealth inequality, and that to the extent that more of the debt is being placed abroad, the social benefits of that debt accrue to agents that are not part of the sovereign's social welfare function, which also make default more attractive. On the other hand, the stylized nature of this model has its drawbacks. In particular, it misses two important features of U.S. debt, one that is nominal debt, so that inflation as a de-facto partial default can provide some relief, and also that dollar depreciation has a similar effect via capital loses that foreign debt holders would experience.

VI. Conclusions

The United States is going through the second-largest public debt crisis since the birth of the republic (defining a debt crisis as the largest 5 percent of the year-on-year changes in the public debt ratio). This crisis is also unique in that six years after it hit the primary fiscal balance remains in deficit, and primary deficits are projected to persist at least through 2026. The U.S. debt ratio has never reversed from its historical peaks without a sizable contribution from primary surpluses. It is even more unprecedented if one were to add to the standard measure of net federal debt the large unfunded liabilities of entitlement programs at the federal, state, and local levels. While there are opinions suggesting that the high U.S. public debt should not be a concern, and in fact additional borrowing is desirable to stimulate the economy and meet strong global demand for safe assets, this paper reviewed four arguments to the contrary that highlight the fragility of U.S. fiscal prospects.

First, from an empirical standpoint, government expenditure multipliers in highly indebted economies are zero on impact and negative in the long run, and estimates of the U.S. fiscal reaction function show a large structural break after the 2008 crisis, resulting in much larger primary deficits than the pre-2008 fiscal reaction function predicted. Second, a two-country dynamic general equilibrium model calibrated to the U.S. and Europe and to the observed elasticity of capital tax revenues predicts that capital tax adjustments cannot restore fiscal solvency. For the United States, the dynamic Laffer curve of capital income taxes peaks well below the amount that would be required to restore solvency. Third, growth in the world demand for safe assets is an issue that is in need of further research, but theories that can provide a quantitatively plausible explanation for it suggest that it is a temporary phenomenon that is part of the transitional dynamics of financial integration, and as such sustained growth in world demand for safe assets should not be counted on as the basis to keep U.S. debt sustainable. Fourth, in light of these previous three arguments, and of the increased concentration in debt ownership inside the United States and the larger fraction of the debt held abroad, the risk of a default on public debt should not be ignored. Here again, quantitatively plausible models suggest that a sovereign that cares for all of its domestic constituency, bond holders and non-bondholders alike, can find it optimal to default outright if the distributional incentives to default exceed the social benefits of public debt as a vehicle that provides liquidity, self-insurance and risk-sharing.

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