Crunch Time: Fiscal Crises and the Role of Monetary Policy*

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February 22, 2013
Revised July 29, 2013

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* This paper was written for the U.S. Monetary Policy Forum, New York City, February 22, 2013. We thank Anil Kashyap for helpful comments. We also thank Matthew Luzzetti, Rumki Majumdar, and John Abraham for their substantive contributions to our analysis and Richard Cunniff for editorial assistance. The views expressed here are ours alone and do not necessarily reflect those of the institutions with which we are affiliated. Author affiliations and email addresses: Greenlaw: Managing Director and Chief U.S. Fixed Income Economist, Morgan Stanley (David.Greenlaw@morganstanley.com); Hamilton: Professor of Economics, University of California at San Diego (jhamilton@ucsd.edu) and Research Associate of the National Bureau of Economic Research; Hooper: Managing Director and Chief Economist, Deutsche Bank Securities Inc. (peter.hooper@db.com); Mishkin: Alfred Lerner Professor of Banking and Financial Institutions, Graduate School of Business, Columbia University (fsm3@columbia.edu) and Research Associate of the National Bureau of Economic Research. Disclosure of Mishkin's outside compensated activities can be found on his website at http://www0.gsb.columbia.edu/faculty/fmishkin/

ABSTRACT

Countries with high debt loads are vulnerable to an adverse feedback loop in which doubts by lenders lead to higher sovereign interest rates which in turn make the debt problems more severe. We analyze the recent experience of advanced economies using both econometric methods and case studies and conclude that countries with debt above 80% of GDP and persistent current-account deficits are vulnerable to a rapid fiscal deterioration as a result of these tipping-point dynamics. Such feedback is left out of current long-term U.S. budget projections and could make it much more difficult for the U.S. to maintain a sustainable budget course. A potential fiscal crunch also puts fundamental limits on what monetary policy is able to achieve. In simulations of the Federal Reserve's balance sheet, we find that under our baseline assumptions, in 2017-18 the Fed will be running sizable income losses on its portfolio net of operating and other expenses and therefore for a time will be unable to make remittances to the U.S. Treasury. Under alternative scenarios that allow for an emergence of fiscal concerns, the Fed's net losses would be more substantial.

1 Introduction.

As recently as the 1990s, the United States government was running budget surpluses and there was serious discussion of what would happen if the federal government was able to retire its debt. Although the fiscal situation deteriorated somewhat in the United States after 2000, countries in Europe, especially Ireland and Spain, were able to reduce the level of their government debt relative to national income up until 2007. However, when the global financial crisis turned virulent in 2008, everything changed. The subsequent sharp economic downturn in advanced countries reduced fiscal revenues and led to increased government spending, with the result that government debt has grown dramatically for most developed economies since 2008. At the same time, central banks have sought to stimulate their weak economies with unprecedented expansions of their balance sheets.

The challenges for policy entered a new phase in 2010 when several European countries suddenly faced rapid increases in borrowing rates on sovereign debt that rendered their current fiscal policies unsustainable. But a fiscal contraction in these circumstances had the potential to make the economic situation even worse by contracting aggregate spending, while further monetary accommodation could lead to a tipping point in inflation and currency flight. Given the suddenness with which these problems have become manifest, it is critical to understand the circumstances that give rise to tipping points in sovereign debt markets and examine the implications for monetary policy.

We start our analysis in Section 2 by sketching a simple model of debt dynamics to explore the relationship between sovereign debt loads and interest rates. Based on the mechanics of debt accumulation and economic growth, we calculate the level of the primary government surplus that would be necessary to keep debt from continually growing as a percentage of GDP. We argue that if this required surplus is sufficiently far from a country's historical experience and politically plausible levels, the government will begin to pay a premium to international lenders as compensation for default or inflation risk. This higher interest rate in turn feeds back to make fiscal sustainability even harder to achieve, possibly leading to a fiscal crunch -- a tipping point in which sovereign interest rates shoot up and a funding crisis ensues.

Section 3 then conducts an empirical examination of the recent experience of advanced economies. We look at statistical predictors of sovereign borrowing costs in a panel of 20 advanced countries over the last 12 years. We find a significant relation between debt loads and borrowing costs, with a one-percentage-point increase in debt as a percent of GDP being associated with a 4.5-basis-point increase in the yield on 10-year government bonds in a linear specification. We also find strong evidence of nonlinearities. Interest rates rise much more quickly at higher debt levels, and there is a strong interaction between debt levels and a country's longer-term current-account balance. In countries with large current-account deficits, the borrowing cost is much more sensitive to the level of debt. We then explore case studies of a number of individual countries, identifying the specific news developments that seemed to trigger market reactions as well as the underlying fundamentals that have allowed other countries to continue to borrow at very low interest rates. We focus, in particular, on the U.S. and attempt to use our model to quantify feedback effects in the debt dynamics that are not captured in official budget projections.

In Section 4 we turn our attention to the impact of fiscal crises on monetary policy. We first discuss the role of monetary policy in promoting successful fiscal consolidations and the challenges confronting policymakers, noting that the political and logistical capability of the central bank to control inflation is directly tied to whether the government can achieve a sustainable path for fiscal policy. We then conduct a detailed analysis of the Federal Reserve's balance sheet and the implications for the Fed's future cash flow of a realistic exit strategy from its current expanded balance sheet. As interest rates rise, the Fed will need to pay more to persuade banks to hold any remaining large balances of excess reserves. And, should it sell assets to shrink its balance sheet as it once indicated was likely, the Fed would realize a capital loss on long-term securities that it bought when interest rates were lower. In our baseline assumptions, these forces would result in losses equal to a significant portion of Fed capital by 2018, after which these losses could gradually be worked off. But departures from the baseline, such as large-scale purchases continuing past 2013, or a more rapid rise of interest rates (a distinct possibility given the analysis presented in Section 3) would saddle the Fed with losses beginning as early as 2016, and losses that in some cases could substantially exceed the Fed's capital. Such a scenario would at very least present public relations challenges for the Fed and could very well impact the conduct of monetary policy.

Section 5 briefly summarizes our conclusions.

2 Understanding fiscal crises.

To understand fiscal crises, we first discuss the debt dynamics of sustainable fiscal paths and then go on to analyze instability and tipping points.

2.1 Sustainable fiscal paths.

Consider a country with nominal GDP in year t of Y_t and nominal sovereign debt of B_t. Let S_t denote the nominal primary surplus, that is, government revenue less spending on all categories other than interest expense, with a primary deficit corresponding to a negative value of S_t. If R_t is the average nominal interest rate on outstanding government debt, we have the accounting identity[1]

$$B_{t+1} = (1+R_t)(B_t - S_t). \tag{1}$$

Dividing both sides of (1) by GDP in year $t+1$ gives

$$\frac{B_{t+1}}{Y_{t+1}} = \frac{Y_t}{Y_{t+1}} \frac{1}{Y_t}(1+R_t)(B_t - S_t). \tag{2}$$

Let lower-case symbols denote magnitudes as a fraction of GDP,

$$b_t = B_t/Y_t$$

$$s_t = S_t/Y_t,$$

and let r_t be defined by

$$1+r_t = \frac{(1+R_t)Y_t}{Y_{t+1}}, \tag{3}$$

so that (2) can be written

$$b_{t+1} = (1+r_t)(b_t - s_t). \tag{4}$$

If g_t denotes the nominal GDP growth rate between t and $t+1$,

$$Y_{t+1} = (1+g_t)Y_t, \tag{5}$$

then notice that r_t in (3) is approximately the nominal interest rate R_t minus the nominal

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[1] If R_t is interpreted as the weighted average interest rate on all outstanding government debt, equation (1) holds exactly as an accounting identity. In our empirical work, we will focus on 10-year bond yields as the key indicator of long-run concerns. Our dynamic simulations for U.S. data are based on estimates of the actual maturity structure of outstanding debt.

GDP growth rate:

$$r_t \approx R_t - g_t. \tag{6}$$

Suppose that a country faces a constant net borrowing cost r^* and wants to maintain a constant debt-to-GDP ratio b^*. Then (4) implies that this would require a primary surplus s^* satisfying[2]

$$b^* = (1+r^*)(b^* - s^*) \tag{7}$$

$$s^* = \frac{r^* b^*}{1+r^*}. \tag{8}$$

To understand the implications of this condition, it is useful to consider two separate cases.

2.1.1 Case 1: $R_t > g_t$.

First suppose that the steady-state nominal interest rate is greater than the nominal GDP growth rate, so that r^* is positive. In this case, equation (8) says that the primary surplus must be sufficient to cover the steady-state interest payments on the outstanding stock of government debt b^*. Note that with a constant positive value for r^*, the difference equation associated with (4) is explosive:

$$b_{t+1} = (1+r^*)(b_t - s^*). \tag{9}$$

If the government were to maintain a constant value for the primary surplus equal to s^* and if the debt-GDP ratio were ever to rise to some $b' > b^*$, then debt would continue to grow from that point without bound relative to GDP. The government would ultimately either need to use fiscal reform (tax increases or spending cuts) to get to a new higher

[2] See Hall (2012) for a more general characterization of ergodic distributions for the surplus and debt in a stochastic setting.

primary surplus s' given by $s' = r^* b'/(1+r^*)$, or else default on some of the outstanding debt to bring it back down to the level b^* that is sustainable given the steady-state primary surplus s^* that the country is actually capable of maintaining. As Reinhart and Rogoff (2009) extensively documented, historically partial defaults have often been implemented at least in part by means of unanticipated inflation. This could achieve a reduction in the debt burden by raising the realized nominal growth rate g_t relative to the ex ante nominal interest rate R_t. Of course, if there is any anticipation of default or inflation, it would be expected to affect the interest rate R_t, a point to which we will turn in Section 2.2.

2.1.2 Case 2: $R_t < g_t$.

Suppose instead that the nominal interest rate on government debt is less than the nominal growth rate of the economy. In this case, r^* is negative and (8) indicates that the government could maintain a primary deficit in perpetuity ($s^* < 0$) without increasing the ratio of debt to GDP. For example, if the borrowing cost is $R_t = 2\%$ and GDP is growing at rate $g_t = 3\%$, government spending could exceed revenues in perpetuity by about 1% of the outstanding debt b^* without increasing the ratio of debt to GDP.

Moreover, in this case when $r^* < 0$, the difference equation (9) is stable. If the country started with steady-state values s^*, r^*, and b^* satisfying (8) and then moved to a permanently larger deficit (that is, a more negative value $s' < s^*$), the result would be an increase over time in the debt-to-GDP ratio from the initial b^*. But the path is not explosive and would eventually stabilize at a new value $b' = s'(1+r^*)/r^*$.

If R_t corresponded to the nominal return to capital, the case when $R_t < g_t$ would be a violation of basic conditions for dynamic efficiency (see for example Blanchard and Fischer, 1989, pp. 103-104). Note, however, that in the present instance R_t refers to the government borrowing cost, which could be much less than the marginal product of capital as a result of favorable risk and liquidity properties perceived to be associated with government debt. For example, one form of government debt (money) pays no interest, and yet the asset is nonetheless valued in equilibrium in a growing economy.

However, these advantages of government debt cannot be assumed to hold independently of how large debt becomes relative to GDP. A number of previous studies,[3] as well as our own empirical investigations below, establish that as the ratio of government debt to GDP rises, the government's borrowing cost R_t likely rises with it. Insofar as this is the case, it means that while there may be a range of values for the steady-state primary surplus s that could be consistent with long-run fiscal sustainability, once government debt becomes so large as to result in a positive value for r^*, sustainability of the fiscal path will once again come back to requiring that (8) be satisfied.

2.2 Instability and tipping points.

We next examine a dynamic model in which expectations of the future play a role.[4] Consider a government that begins period t owing outstanding debt as a fraction of GDP given by b_t, faces a net borrowing cost r_t, and then runs a primary surplus relative to GDP given by s_t. This would imply a debt-to-GDP ratio for period $t+1$ given

[3] See for example Bayoumi, Goldstein, and Woglom (1995), Engen and Hubbard (2005), Laubach (2009), Gruber and Kamin (2012), and International Monetary Fund (2012).
[4] For more detailed optimizing models incorporating features similar to those discussed here, see Calvo (1988) and Bi and Traum (2012).

by equation (4). Suppose that from period $t+1$ forward the government will be on a sustainable path and face a steady-state net borrowing cost given by r^*. Suppose also that, based on the past history of the country and its politics, creditors believe that a long-run primary surplus of s^* could quite credibly be maintained, implying a sustainable debt-to-GDP ratio given by $b^* = s^*(1+r^*)/r^*$. The question we consider is, what happens if the value of b_{t+1} implied by equation (4) is greater than b^*, that is, what happens if

$$(1+r_t)(b_t - s_t) > b^*? \qquad (10)$$

One possibility is that the country will succeed in implementing permanent fiscal reform, increasing taxes or lowering spending so as to bring the permanent surplus up to the value s' that would be necessary to service the debt that would be owed next period according to the left-hand side of (10):

$$(1+r_t)(b_t - s_t) = s'(1+r^*)/r^*.$$

In this case, the government's creditors would indeed receive the promised nominal return R_t. But an alternative that creditors may contemplate is that there could be a partial default or surprise inflation on government debt, with fiscal sustainability restored by bringing the debt burden down to one that can be serviced without increasing the surplus above the current value of s^*, that is, a default or surprise inflation that brings the debt-to-GDP ratio next period back down to the sustainable value b^*. In the latter case, the post-default value of outstanding debt as of the start of period $t+1$ is given by $\widetilde{B}_{t+1}$,

$$\widetilde{B}_{t+1} = b^* Y_{t+1} = b^*(1+g_t)Y_t. \qquad (11)$$

In the case of an outright default of this magnitude, investors would end up earning a nominal return of $\widetilde{R}_t$ instead of the promised R_t, where $\widetilde{R}_t$ is characterized by

$$\widetilde{B}_{t+1} = (1+\widetilde{R}_t)(B_t - S_t). \tag{12}$$

If π_t denotes creditors' perceived probability of successful reform, then the sovereign bonds yield an expected return R_t^e given by

$$1 + R_t^e = \pi_t(1+R_t) + (1-\pi_t)(1+\widetilde{R}_t). \tag{13}$$

Substituting (11) and (12) into (13),

$$1 + R_t^e = \pi_t(1+R_t) + (1-\pi_t)\frac{b^*(1+g_t)}{b_t - s_t}. \tag{14}$$

Dividing both sides of (14) by $1+g_t$ allows us to express this condition in terms of the interest rate net of the growth rate:

$$1 + r_t^e = \pi_t(1+r_t) + (1-\pi_t)\frac{b^*}{b_t - s_t}. \tag{15}$$

Given a required expected return on sovereign debt net of the growth rate (r_t^e), a perceived probability of successful fiscal reform π_t, sustainable debt-to-GDP level b^*, and current fiscal situation as summarized by $b_t - s_t$, equation (15) determines r_t, the net interest rate that the government is required to promise on its sovereign debt. For example, if the expected return is the long-run sustainable rate ($r_t^e = r^*$) and if the current fiscal situation is consistent with long-run sustainability (which from (7) requires $b^*/(b_t - s_t) = 1 + r^*$), then (15) states that the net interest rate r_t would be characterized by

$$1 + r^* = \pi_t(1+r_t) + (1-\pi_t)(1+r^*)$$

or $r_t = r^*$. In other words, under the specified conditions, the government can borrow at its long-run sustainable rate. However, as $b_t - s_t$ grows relative to b^* so that $b^*/(b_t - s_t) < 1 + r^*$, condition (15) means that the government's current borrowing rate r_t

will exceed r^* as compensation to creditors for uncertainty about a successful fiscal reform.

Condition (15) thus characterizes the slippery slope on which governments may find themselves as debt levels rise relative to GDP. If creditors are not certain that the primary surplus will be increased sufficiently to cover the growing interest expense, they may demand a higher interest rate in compensation for the possibility of default or inflation. However, from (4), the higher interest rate r_t means that next period the debt situation will be even more tenuous than it would have been with a lower interest rate.

The above analysis assumed risk-neutral evaluation of sovereign debt, but it is straightforward to modify it to allow for risk premia.[5] Let $\overline{R}_t$ denote the risk-neutral nominal interest rate and π_t^Q denote the market price at time t of a state-contingent security that promises to pay $1+\overline{R}_t$ dollars in year $t+1$ if and only if the country repays creditors exactly what they were promised. If investors were risk neutral, π_t^Q would just equal the objective probability of reform π_t. More generally, the value of π_t^Q would reflect both the objective probability of reform π_t as well as any risk premium the market requires, and is sometimes referred to as the Q-measure probability of reform. For example, if creditors have as their objective function

$$E_t \sum_{j=0}^{\infty} \beta^j U(C_{t+j}),$$

where β is a personal discount factor and C_{t+j} is future real consumption, then in equilibrium

[5] For further discussion see Caceres, Guzzo and Segoviano (2010) and Borri and Verdelhan (2011).

$$\pi_t^Q = \pi_t(1+\overline{R}_t)E\left[\frac{\beta U'(C_{t+1})P_t}{U'(C_t)/P_{t+1}}\middle|\Omega_t, Z_{t+1}=1\right]$$

where P_t is the dollar price of the consumption good and the objective expectation is taken conditional on the information set available at date t (Ω_t) augmented by knowledge that there will be no default at $t+1$ (denoted by $Z_{t+1}=1$). In this case the growth-adjusted return on sovereign debt r_t would need to satisfy

$$1+\overline{r}_t = \pi_t^Q(1+r_t)+(1-\pi_t^Q)\frac{b^*}{b_t - s_t}, \tag{16}$$

which simply replaces the objective probability π_t in (15) with the Q-measure probability π_t^Q.

This analysis identifies three factors that could lead to a sudden increase in a country's borrowing cost r_t: (1) news that conveys a significant deterioration of the country's fiscal situation, that is, increase in $b_t - s_t$; (2) a decrease in the objective probability that the country will successfully complete the fiscal reforms necessary to return to a sustainable path, that is, a decrease in π_t; (3) an increase in the risk premium on the sovereign debt, that is, a decline in π_t^Q relative to π_t.

3 Recent experience in advanced economies.

A large literature has looked at the determinants of currency and sovereign debt crises, much of it focusing on the experience of developing economies. Reinhart, Savastano and Rogoff (2003) found that emerging-market economies have a lower tolerance for sovereign debt, with defaults at much lower levels of debt to GDP. Reinhart and Rogoff (2010) provided further evidence that emerging markets are different in that higher debt levels are associated with higher levels of inflation, while this has not been the case (so far) in advanced economies. Mishkin (1996, 1999) attributed the lower debt tolerance of emerging-market economies to their weaker financial institutions and greater vulnerability to international capital flows. Eichengreen, Hausman and Panizza (2005) described the inability of emerging market countries to borrow in their own currencies as "original sin". The denomination of debt in foreign currencies implies that a currency depreciation increases the debt burden, which can lead to financial crises, a collapse in the economy and further exchange rate depreciation. The possibility of this vicious cycle puts limits on the amount of debt that a country can issue and constrains monetary policy options.

Unfortunately, the recent experience has shown that more advanced economies are not immune to potential sovereign-debt problems similar to those widely observed in less developed economies. Our analysis will focus exclusively on the recent data for advanced economies.

3.1 Cross-section and time-series evidence.

We constructed an annual panel data set from IMF databases on 20 advanced economies in order to study the statistical predictors of R_{it}, the average nominal yield on long-term government debt for country i in year t. Note that in our empirical regressions we measure R_{it} in percentage points, which would correspond to 100 times the value of R_t appearing in the formulas in the previous section.

Most of the literature on debt crises has used gross government debt, in part because this was the only series available. In our case, the data are also available for net government debt. There are arguments for using either measure. When government debt is held as an asset of separate government-run accounts such as the U.S. Social Security Trust Fund, these accounts are typically associated with off-balance-sheet liabilities whose present value could significantly exceed the value of Treasury securities counted as assets of the trust fund. For example, the trustees of the Social Security Trust Fund estimated that the present value of future benefits to be paid to current program participants exceeds the value of targeted tax receipts by $26.5 trillion dollars.[6] Perception of these future Treasury obligations could be an independent factor contributing to doubts about government solvency. For this reason, the gross debt (which includes the $2.6 trillion in Treasury securities owed to the Social Security Trust Fund) might be a more appropriate measure of the U.S. government's fiscal health than the net measure (which acts as if there are zero net future liabilities associated with current program participants). We propose to treat as an empirical question which measure, gross or net debt, is more important for determining the cost of government borrowing. We let b_{it} denote the gross government debt for country i in year t as a percentage of GDP (so that $b_{it} = 100$ denotes gross debt equal to GDP),[7] and b_{it}^n the net government debt.

Another important determinant of a country's borrowing cost could be the current-account deficit. Busierre and Fratzscher (2006) and Busierre (2013) found this to be a key predictor of financial crises in emerging economies. Government deficits and current-account deficits often appear together, with the government effectively funding its shortfall by borrowing from abroad. The more government debt is held by foreigners,

[6] See Table IV.B7, 2013 Annual Report of the Board of Trustees of the Federal Old-Age and Survivors Insurance and Federal Disability Insurance Funds.

[7] Again in the previous section b_t was measured as a fraction of 1 whereas this section reports empirical results for b_{it} measured in percentage points.

the greater the political incentives for the government to default on that debt. In a rational market, this would translate into a higher sovereign borrowing cost. Alternatively, if the government borrows from domestic banks who in turn are largely capitalized by foreign lending, the public debt may be domestically held but the political economy could work out similarly to the case when the sovereign debt is held directly by foreigners. Furthermore, a higher overall foreign debt load (both public and private) may make it more difficult for a country to continue to make interest payments on its sovereign debt. For these reasons we also explore the relation between the interest rate R_{it} and c_{it}, which denotes the average of the ratio of the current-account surplus to GDP for country i for the five years ending in year t; like the other empirical variables, c_{it} is expressed in units of percentage points, with $c_{it} = -1$ signifying a current-account deficit equal to 1% of GDP.

We begin with a regression that tries to predict R_{it}, the interest rate for country i in year t, on the basis of the previous year's gross debt ($b_{i,t-1}$), net debt ($b^n_{i,t-1}$), and current-account deficit ($c_{i,t-1}$). All our panel regressions also include both country and time fixed effects, and t statistics are in parentheses:

$$R_{it} = \hat{\alpha}_i + \hat{\gamma}_t + \underset{(3.95)}{0.0313}\, b_{i,t-1} + \underset{(2.30)}{0.0142}\, b^n_{i,t-1} - \underset{(5.16)}{0.184}\, c_{i,t-1} + e_{it} \tag{17}$$

$$R^2 = 0.69 \qquad \text{log likelihood} = -288.32.$$

The regression covers 20 countries for years $t = 2000-2011$ for a total of 240 observations. Interestingly, the coefficients on gross and net debt are both highly statistically significant. The regression suggests that if the country's primary deficit increases by 1% of GDP (causing both gross and net debt to increase by one percentage point relative to GDP), the borrowing cost would increase by $0.0313 + 0.0142 = 0.0455$ or 4.5 basis points. The current-account deficit also is highly significant. A country that increases its 5-year-average current-account deficit by one percent of GDP would be expected to face an interest rate that is 18 basis points higher. We also tried including the previous year's primary surplus as a separate explanatory variable, but it did not enter significantly in any of our regressions.

The coefficients in (17) are consistent with those found by previous researchers using other data sets. The general findings in Gale and Orszag (2002), Reinhart and Sack (2000), Kinoshita (2006), Laubach (2009), Baldacci and Kumar (2010), and Ichiue and Shimizu (2013) are that a one-percentage-point increase in the actual or projected debt-to-GDP ratio raises the long rate by 3-7 basis points. However, these authors generally found much larger separate contributions from the deficit itself, with an increase in the deficit of 1% of GDP raising long-term interest rates by 20-60 basis points, an effect that does not show up in our data set when estimated as a prediction equation (all explanatory variables lagged). However, the separate contribution of the budget deficit over and above that of the debt itself that was found by other researchers may also be related to the issue of tipping points, to which we now turn.

The discussion of instability and tipping points in Section 2.2 suggests the possibility of nonlinearities in these relations. For advanced economies, a separate literature has looked at the relation between debt burdens and economic growth rates, and it also finds substantial empirical evidence of nonlinearities or tipping points. Reinhart and Rogoff (2010) and Reinhart, Reinhart and Rogoff (2012) documented that in advanced countries, levels of sovereign debt above 90% of GDP lead to a decline in economic growth, while Cecchetti, Mohanty and Zampolli (2011) found a threshold of around 85% for the debt-to-GDP ratio at which sovereign debt retards growth. Checherita and Rother (2010) instead looked for a possible nonlinear hump-shaped effect of debt on growth and found that debt-to-GDP levels above 90-100% have serious negative effects on growth, but confidence intervals suggest that the negative impact of debt on growth may start at levels around 70-80% of GDP. With a case study approach, the IMF (2012) came to similar conclusions using a 90-100% threshold, but noted that it matters whether a country's debt level is increasing or decreasing. Growth is higher over the fifteen years after the threshold is crossed when the debt level is falling rather than rising.

The above considerations led us to add squared and cross-product terms to the regression (17). To keep the representations parsimonious, we report regressions based on gross debt and net debt separately rather than try to include both together as we did in (17). In a regression based on gross debt, all of the second-order terms turn out to be highly statistically significant:

$$R_{it} = \hat{\alpha}_i + \hat{\gamma}_t + \underset{(0.30)}{0.0029}\, b_{i,t-1} + \underset{(4.29)}{0.245}\, c_{i,t-1} + \underset{(4.81)}{0.000203}\, b_{i,t-1}^2 \tag{18}$$

$$+ \underset{(2.98)}{0.00793}\, c_{i,t-1}^2 - \underset{(10.18)}{0.00636}\, c_{i,t-1} b_{i,t-1} + e_{it}$$

$$R^2 = 0.82 \qquad \log \text{likelihood} = -224.28.$$

Nonlinear terms are also extremely significant as a group in the analogous regression using net debt. A test of the hypothesis that the coefficients on the three nonlinear terms in the regression below are all zero produces an F(3,204) statistic of 24.81, leading to rejection with a p-value below 10^{-8}:

$$R_{it} = \hat{\alpha}_i + \hat{\gamma}_t + \underset{(7.14)}{0.0370}\, b_{i,t-1}^n - \underset{(3.65)}{0.157}\, c_{i,t-1} + \underset{(0.89)}{0.0000365}(b_{i,t-1}^n)^2 \tag{19}$$

$$+ \underset{(2.35)}{0.0101} c_{i,t-1}^2 - \underset{(2.10)}{0.00124} c_{i,t-1} b_{i,t-1}^n + e_{it}$$

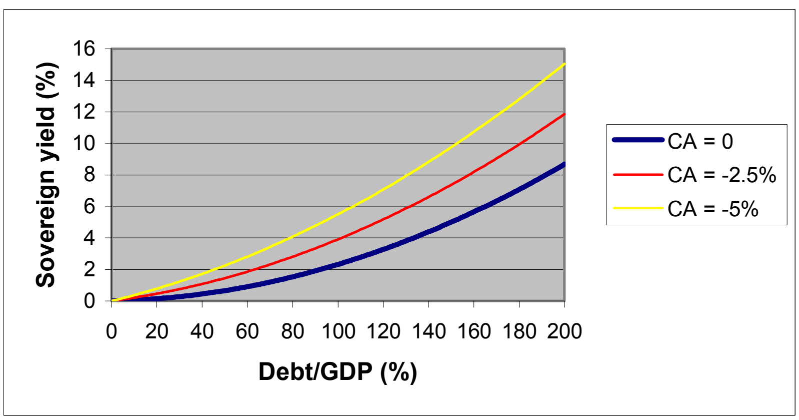
$$R^2 = 0.76 \qquad \log \text{likelihood} = -259.74.$$

Note that the gross debt regression (18) has better predictive power than the net debt regression (19). This might be due to the importance of off-balance sheet liabilities, which are implicitly reflected in the component of gross debt that is owed to government trust funds but excluded from net debt, and to the possibility of added judgmental or political manipulation of net debt relative to gross debt measures. We find for example in our data that net debt exhibits more volatility than gross debt.

Again our finding of significant nonlinearities is consistent with previous studies of the relation between debt loads and sovereign interest rates. Ardagna (2009) found that large increases in the deficit (over 1½% of GDP) are associated with larger increases in interest rates (180 basis points). Baldacci and Kumar (2010) also found a larger impact of deficits on interest rates when deficits are greater than 2% of GDP, with the impact of a one-percentage-point increase in the deficit rising by 14 basis points. They also found that in their sample, which includes advanced as well as emerging-market countries, initial debt levels above 60% of GDP add about 6 basis points to the impact of a one-percentage-point increase in the deficit.

To understand the nature of the nonlinearities in the gross debt regression (18), consider first a country whose current account is exactly balanced ($c_{i,t-1} = 0$). The blue line in Figure 3.1 plots how much higher the interest rate that the country would face in year t if it had gross debt/GDP in $t-1$ equal to b (represented by a distance on the horizontal axis) compared to what it would pay if $b_{i,t-1} = 0$.[8] Taking the debt level from 0 to 40% of GDP for such a country would only raise its borrowing cost by 44 basis points. However, going from 40% to 80% would raise its borrowing cost an additional 109 basis points, and another 40% increase from there would raise the rate by an additional 174 basis points. Values of the blue line in Figure 3.1 for selected debt levels are reported in the first column of Table 3.1

Figure 3.1 Response of Sovereign yields to Debt Ratios under alternative current account balances



Note: CA is current account balance as % of GDP. Horizontal axis: gross debt as a percent of GDP in year t - 1. Vertical axis: amount by which a country's interest rate in year t would be predicted to be higher (measured in annual percentage points) compared to what the interest rate would be if debt in year t - 1 were equal to 0 for indicated levels of the current-account balance.

Source: authors' calculations.

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[8] Specifically, the lines in Figure 3.1 plot $\hat{\beta}_1 b + \hat{\beta}_3 b^2 + \hat{\beta}_5 cb$ for $\hat{\beta}_j$ the coefficients in equation (18), b the value on the horizontal axis, and c the indicated assumption about the 5-year average current-account balance, where b and c are both expressed as percentages of GDP.

Table 3.1 Estimated Response of Sovereign Yields (%) to Alternative Changes in Debt Ratios at Alternative Current Account Balances

	(1)	(2)	(3)	(4)	(5)	(6)
debt/GDP	*c* = 0	(std err)	*c* = -2.5	(std err)	*c* = -5	(std err)
0	0.00	(0.00)	0.00	(0.00)	0.00	(0.00)
20	0.14	(0.18)	0.46	(0.18)	0.77	(0.17)
40	0.44	(0.33)	1.08	(0.33)	1.71	(0.32)
60	0.90	(0.45)	1.86	(0.45)	2.81	(0.44)
80	1.53	(0.55)	2.80	(0.55)	4.07	(0.55)
100	2.32	(0.64)	3.91	(0.64)	5.50	(0.64)
120	3.27	(0.70)	5.17	(0.71)	7.08	(0.72)
140	4.38	(0.76)	6.60	(0.77)	8.83	(0.80)
160	5.65	(0.83)	8.19	(0.84)	10.74	(0.88)
180	7.09	(0.90)	9.95	(0.92)	12.81	(0.98)
200	8.68	(0.99)	11.86	(1.02)	15.04	(1.10)

Source: authors' calculations

A country with a current-account deficit is predicted by the regression to run into these problems much more quickly. For example, if the current-account deficit has averaged 2.5% of GDP over the last 5 years, going from 0% to 40% debt would raise borrowing costs by 108 basis points, and going from 0% to 120% debt would raise the interest rate by 517 basis points (see the red line in Figure 3.1 or column 3 in Table 3.1). A country with large and persistent current-account deficits (e.g., $c = -5\%$) could end up paying a very high price for running up more debt, as seen in the yellow line in Figure 3.1 or column 5 of Table 3.1.

Table 3.1 also reports standard errors for these calculations. It should be emphasized that these summarize only the uncertainty associated with the regression coefficients themselves. A considerably larger error is involved if the task is to predict the interest rate that a particular country facing specified circumstances would actually pay. For one thing, there is a substantial deviation between the interest rate actually paid by country i in year t and the value predicted by the regression, as represented by the error term e_{it} in equation (18). The error e_{it} has a standard error of 67 basis points across countries and across time. There are further significant differences in the average experience across countries, as represented by the country-specific coefficient α_i. This has a standard deviation of 186 basis points across countries. Finally, there are important differences in the average experience across different years in the sample. This is captured by the time-specific coefficient γ_t, which has a standard deviation of 82 basis points across different years in the sample. Thus, for modest levels of debt and current-account deficits, the change in yield associated with a small change in the explanatory variables is going to be swamped by other factors influencing the interest rate. On the other hand, the regressions capture a clear feature of the data: problems can arrive quickly and dramatically once the debt loads and current-account deficits get sufficiently high. For example, a country with a debt load in excess of 120% and current-account deficit of 5% or more is very likely to run into trouble.

It should be noted that the evidence for nonlinearities in our data set comes entirely from countries that are members of the European Monetary Union.[9] De Grauwe (2011) argued that the periphery countries of the union are in a similar situation to emerging economies, forced to borrow in a currency (the euro) whose supply they do not control. However, the loss to creditors in this situation could come in a variety of forms, a leading possibility being withdrawal from the union and repayment of creditors in, for example, "Greek euros," which ultimately is an inflation risk. Either outright default or exit from the euro could be associated with substantially greater real costs than those

[9] Iceland is an interesting example of a non-euro advanced economy that recently encountered its fiscal tipping point. When Iceland is included in our regressions, we obtained similar results as for the group of countries listed in Table 3.2. We ended up excluding Iceland from the estimates reported here, however, because of discrepancies across different data sets in the interest rate figures reported for Iceland.

sustained by a country that had borrowed from the beginning in its own currency and simply engineered an unanticipated inflation. This could make the threshold for a tipping point lower for periphery countries of the eurozone than for other advanced economies.

Nevertheless, the fundamental constraints on sovereign borrowing that we described in Section 2 are real, not monetary. Countries may differ in the point at which those constraints start to matter, and we allow for this in our empirical estimates through the country fixed effects in equation (18). Countries may also differ in terms of whether the resolution of an unsustainable situation comes in the form of currency reform, unanticipated inflation, or outright default. But they do not differ to the extent that any country can consider itself immune from the need to adhere to a sustainable fiscal path, as we explore further in the following section.

3.2 Implications for fiscal sustainability.

Table 3.2 reports each country's average interest rate during 2012 for our sample of 20 advanced economies along with the 2011 gross debt-to-GDP ratio, net debt-to-GDP, and the average over 2007-2011 in the ratio of the current-account surplus to GDP. Note that these observations were not used in the preceding empirical analysis, since the yield for the full year 2012 was not known at the time of our study. The first question asked in this subsection is, suppose that each country had implemented in 2012 an immediate fiscal reform, raising taxes or lowering spending by an amount sufficient to stabilize the debt-to-GDP ratio at 2011 levels. By how much would each country have to increase its primary government surplus in order to achieve this?

.

Table 3.2. Key Fiscal Indicators for 20 advanced economies.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Country	2012 10-year yield (%)	2011 debt/GDP (%)	2011 net debt/GDP (%)	2007-11 current acct/GDP (%)	Nominal GDP growth (%)	2011 surplus (% of GDP)	necessary surplus (% of GDP)
Australia	3.4	24.2	8.2	-4.0	6.7	-4.0	-0.8
Austria	2.4	72.3	52.1	3.2	3.4	-0.4	-0.7
Belgium	3.0	97.8	81.4	-0.2	3.4	-0.6	-0.4
Canada	1.9	85.4	33.1	-1.6	4.2	-3.9	-2.0
Denmark	1.5	44.1	0.2	4.0	2.6	-1.4	-0.5
Finland	1.9	49.1	-54.1	1.8	3.0	-1.0	-0.5
France	2.6	86.0	78.8	-1.5	2.7	-2.7	-0.1
Germany	1.5	80.6	55.3	6.3	2.2	0.9	-0.6
Greece	22.9	165.4	165.4	-12.1	2.6	-2.2	28.0
Ireland	6.0	106.5	94.9	-2.2	1.6	-9.6	4.5
Italy	5.5	120.1	99.6	-2.6	2.0	0.8	4.1
Japan	0.8	229.6	126.4	3.4	-1.0	-8.9	4.1
Netherlands	2.0	65.2	31.7	6.1	2.7	-3.1	-0.5
Norway	2.1	49.6	-168.2	13.2	5.6	11.6	-1.8
Portugal	11.0	107.8	97.3	-10.0	2.0	-0.6	9.0
Spain	5.9	69.1	57.5	-6.5	3.6	-7.0	1.6
Sweden	1.5	37.9	-18.2	7.7	3.9	-0.8	-0.9
Switzerland	0.7	46.8	25.9	9.2	2.8	0.8	-1.0
U.K.	1.9	81.8	76.6	-1.8	3.6	-5.7	-1.5
U.S.	1.8	102.9	80.3	-3.7	3.5	-7.8	-1.8

Source: Haver Analytics, IMF, authors' calculations

This question can be answered from equation (8) if we know the value of r^*, the difference between the country's steady-state nominal borrowing cost R^* and steady-state nominal growth rate g^*. To get an estimate of the latter, we applied exponential smoothing to the ten most recent observations on g_t using a decay factor of 0.9. This constructs an estimated long-run growth rate from a weighted average of the most recent decade's observed annual growth rates g_t, with more recent years receiving a greater weight, and is reported in column 5 of Table 3.2. Specifically, column 5 reports

$$g_{iT}^* = \frac{1-\delta}{1-\delta^{10}} \sum_{j=0}^{9} \delta^j g_{i,T-j} \tag{20}$$

for $\delta = 0.9$.[10] To illustrate the nature of the trap that countries get into when the sovereign yield rises, we first explore the implications if the current interest rate for each country were to continue forever. Column 7 of Table 3.2 reports the primary surplus (expressed as a percentage of GDP) that would be necessary to hold the debt constant at its current value if the interest rate were to remain at its current value[11], while column 6 reports the primary surplus actually achieved in 2011.

If Greece were required to continue to pay a 23% interest rate on its outstanding debt, stabilizing debt at 2011 levels would be an essentially impossible task. The reason is that with debt already at 165% of GDP, 23% interest on this debt would require $(0.23)(165)/(1.23) = 31\%$ of GDP each year just to make the interest payments. Similarly, a continuation of Portugal's borrowing cost near 11%, given its debt well above 100% of GDP, would also require a primary surplus close to 9% of GDP each year to keep debt from growing further. Ireland, Italy and Japan would need primary surpluses in excess of 4%. For Italy, this is not too big a change from its current primary surplus near 1%, but Japan had a primary deficit in 2011 of -8.9% and Ireland faced -9.6%. Interestingly, in Japan's case the need for a large primary surplus in steady state is not caused by a currently high borrowing cost. Indeed, Japan faced one of the lowest borrowing costs in 2012 (0.8%) of any country in our sample. Japan's problem instead comes from a huge accumulated debt and a very slow growth rate; the country's weighted average annual

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[10] This does not differ much from the simple average $\overline{g}_{iT} = (g_{iT} + g_{i,T-1} + \cdots + g_{i,T-9})/10,$ though we feel the weighted average is slightly preferable.

[11] That is, column 7 reports the value of

$$b_{iT} \frac{(R_{iT} - g_{iT}^{*})}{(100 + R_{iT} - g_{iT}^{*})}.$$

nominal GDP growth rate over the last decade is -1%. If this unfortunate record were to continue, it would imply a net annual borrowing cost for Japan of $r^* = 0.8 - (-1.0) = 1.8\%$. If we apply that net interest factor to a debt load representing 230% of GDP, we calculate that the country would require a steady-state primary surplus of $(0.018)230/(1.018) = 4.1\%$ of GDP. Moving to such a surplus would require higher tax revenues or spending cuts relative to current levels on the order of 13% of GDP. Pessimism about the sustainability of the Japanese situation has also been the conclusion of a number of other studies using different assumptions and methods, including Doi and Ihori (2009), Ostry et al. (2011), Doi, Hoshi, and Okimoto (2011), Ito (2011), Ito, Watanabe, and Yabu (2011), Sakuragawa and Hosono (2012), and Hoshi and Ito (2012).

By contrast, the fiscal policies of many other countries in our sample appear to be easily sustainable without any change in current conditions. Favorably situated countries include Austria, Finland, Germany, Denmark, Norway, Sweden, Canada, and Switzerland.

However, our nonlinear regression results imply that a country can quickly move from the group without problems to the group that faces nearly insurmountable problems if its debt rises significantly above 80% of GDP, particularly if it is running a large current-account deficit. For example, the numbers in column 5 of Table 3.1 imply that if a country with a current-account deficit of 5% of GDP were to increase its debt load from 80% to 120% of GDP, its borrowing cost would rise by about 3 percentage points. Because this higher interest rate eventually will apply to all of the country's outstanding debt, it means that if the debt level rises from 80% to 120% of GDP, an additional primary surplus of around $(0.03)(120) = 3.6\%$ of GDP will be necessary just to cover the higher interest rate applied to all of its debt.

The linear specification (17) is more forgiving of added debt. On the basis of the linear specification, increasing both gross debt and net debt by 40 percentage points relative to GDP would raise the country's borrowing cost by $(0.0313+0.01420)(40)=1.8$ percentage points, requiring permanently increasing the primary surplus by about 2.1 percent of GDP in order to cope with the burden of having to borrow at a higher interest rate.

The "good" news is that if Greece were somehow able to move its primary surplus anywhere close to 28% of GDP, its borrowing cost would fall dramatically, and the assumption that Greek debt would always have to offer the very high yields of 2012 would not be appropriate. According to the theoretical model presented in Section 2.2, the factor driving Greece's high borrowing cost in 2012 was lenders' belief that a substantial increase in the country's primary surplus is unlikely to occur. Our panel regressions are simply summarizing the average historical correlations in the data, which are a combination of any possible dependence of the steady-state yield R^* on debt levels plus the fact that actual yields R_t will exceed R^* whenever lenders have doubts about the likelihood of a successful fiscal reform. Still, even if Greece were able to lower its nominal borrowing cost to 5%, maintaining debt at 165% of GDP would require it permanently to maintain a primary surplus of $165(5-2.6)/(100+5-2.6)=3.9\%$ of GDP.

However, trying to deal with the problem purely by fiscal reform can put the country on a separate slippery slope. Dramatic cuts in planned spending or increases in tax rates are contractionary and will lead to a drop in GDP. This in turn aggravates the country's fiscal challenges. Lower GDP means less tax revenue collected for any given rate, more expenditures on social-safety-net items, and a smaller denominator from which the debt-to-GDP ratio is calculated. Slower future growth g further aggravates all the calculations of what would be necessary to restore sustainability. In a problem as big as that facing Greece, trying to change the situation with fiscal reform alone may be logistically extremely difficult, even if there were a political will to do so.

One way to have a more attractive set of policy options is to avoid getting into such a situation in the first place. A country with debt below 60% of GDP that can borrow at a nominal interest rate less than its growth rate may see little harm in allowing debt levels to climb relative to GDP. And if all continues as planned, there may indeed be little or no drawbacks to doing so. The difficulty arises if the country for other reasons is unexpectedly subjected to a severe economic downturn or large unavoidable fiscal shock. In response to such a situation, any country would want to allow debt to accumulate in the short run as it tries to resolve the difficulties. If the country entered the crisis with government debt at 60% of GDP, it should be able to respond appropriately without having to worry about the slippery slope of rising sovereign debt costs. However, if the country started with debt at 100% of GDP, it may find itself with few good options in such a situation.

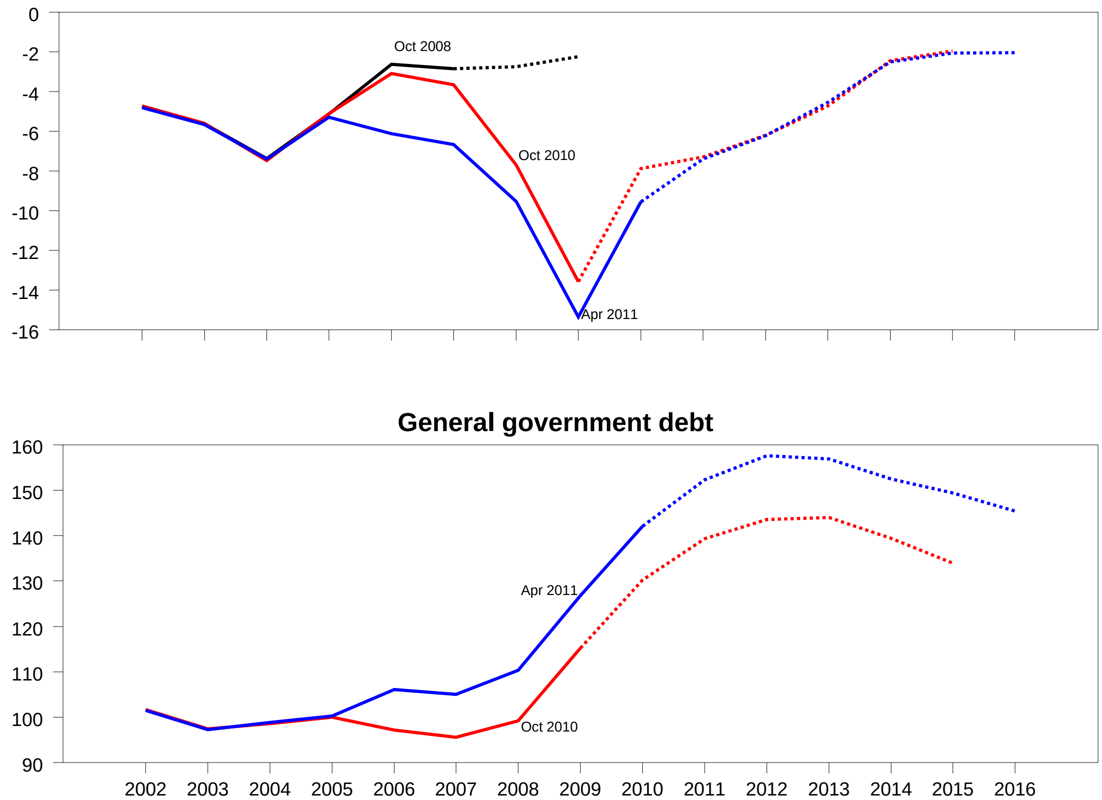
3.3 Case studies.

The statistical models in Section 3.2 were based on year-ahead forecasts using annual data. By contrast, events over the last several years have sometimes unfolded extremely quickly, with dramatic changes in yields over the space of a few weeks or even days. In this section we review high frequency data, trying to relate it to specific news developments and the general framework developed in the preceding sections for a number of key countries.

3.3.1 Greece.

We begin by summarizing the Greek situation prior to the crash of Lehman Brothers in the fall of 2008. The black line in the top panel of Figure 3.2 displays the general government balance for Greece as a percent of GDP as reported in the database for the IMF October 2008 *World Economic Outlook* (http://www.imf.org/external/ns/cs.aspx?id=28). The solid black line depicts historical values through 2007 as reported at that time, and the dashed line gives forecasts for 2008 and 2009. According to these figures, Greece was expected to maintain a deficit less than 3% of GDP. Note that this reported deficit figure includes interest payments. With debt at about 100% of GDP at the time and an interest rate of 5%, a 3% total deficit would roughly correspond to a 2% primary surplus. Moreover, Greece's nominal GDP over the 10 years ending in 2008 grew at a weighted average rate of 6.6% per year. The official projections prior to the fall of 2008 are thus quite consistent with a sustainable fiscal path.

Figure 3.2 Greek Government Budget Balance and Debt Reported and Projected at Alternative Dates (% of GDP)



Source: IMF World Economic Outlook

The weakening economy brought on by the recession reduced government revenue and increased spending demands. By September of 2009, Greece was projecting a deficit for the year of 6% of GDP. Prime Minister Kostas Karamanlis campaigned on the basis of a proposed wage and hiring freeze and possible tax increase. Karamanlis was soundly defeated in the October 4 election. New Prime Minister George Papandreou charged that the government had been underreporting the deficit, and shortly after his inauguration, projections were for a 2009 deficit in excess of 12% of GDP.[12] On January 12, 2010, a report from the European Commission condemned the official Greek deficit

[12] "Greece's Papandreou May Have to Ditch Fiscal Pledges (Update1)", Bloomberg News, Dec 7 2009 (http://www.bloomberg.com/apps/ news?pid=newsarchive&sid=abWn.72Zt8Dpk).

and debt figures as unreliable.[13]

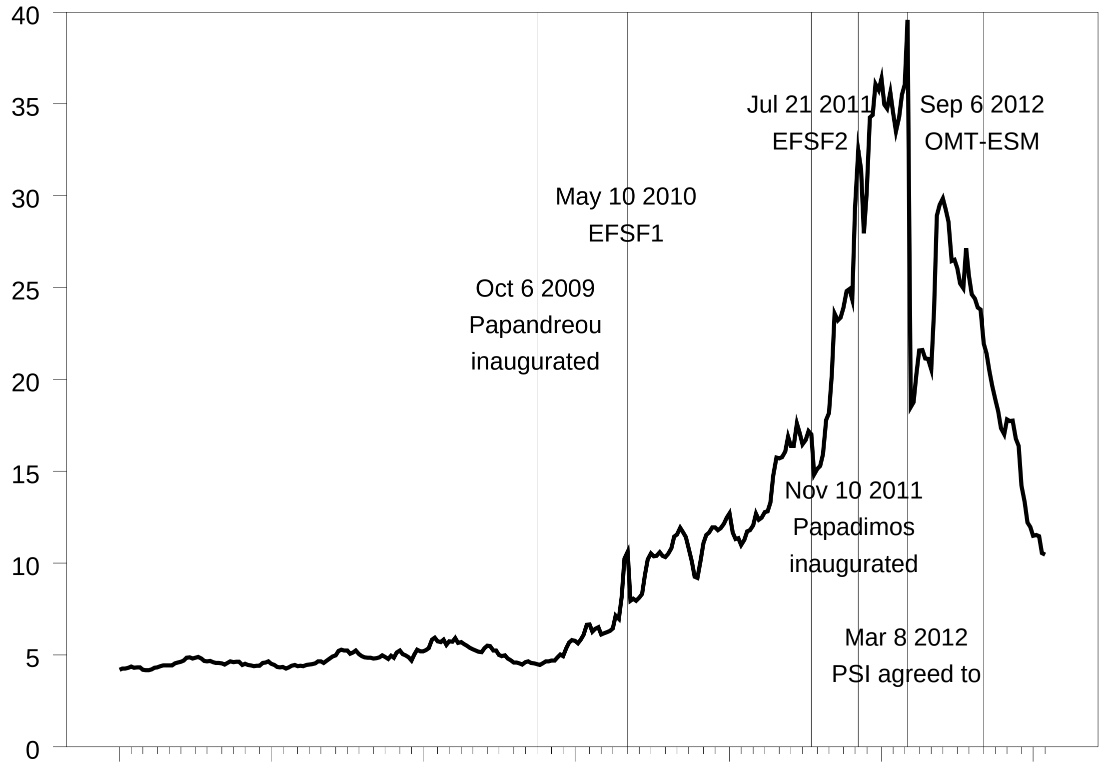
The solid red line in the top panel Figure 3.2 plots the historical values for the Greek deficit as reported in October 2010. There had been a minor revision as of that date in the historical figures for the deficits reported for 2006 and 2007. But the biggest difference is in the deficits for 2008 and 2009, which were initially projected to come in at 2.8% and 2.3% of GDP, respectively. As of October 2010, these deficits were instead being reported to have been 7.7% and 13.6%. The cumulative difference over 2006-2009 in the deficit between the initial reports/projections and the values as reported in 2010 comes to 17.5% of GDP. According to equation (18), with a debt level around 100% and current account of -11.9%, this news might be expected to result in an increase in the interest rate given by

$$(0.0029)(117.5-100)+(0.000203)(117.5^2-100^2)+(0.00636)(11.9)(117.5-100)=2.1\%.$$

Figure 3.3 plots weekly yields on 10-year Greek sovereign debt from January 2007 through January 2013. These began to rise with some modest bond downgrades in December 2009, culminating in a sharp spike associated with a downgrade to junk bond status on April 27, 2010. Between October 2, 2009 and May 7, 2010, the yield rose 6.1%

[13] "EU report slams Greece over false statistics," EUObserver, Jan 13 2010 (http://euobserver.com/ economic/29258).

Figure 3.3. Greek 10-year government bond yields (%)



Source: Haver Analytics and Financial Times

In response to the spike in Greek yields, on May 2, 2010, the International Monetary Fund and finance ministers of other European countries announced their intention to implement a €110 B rescue package in the form of new loans to Greece.[14] When this failed to have the desired effect on markets, it was followed by an announcement on May 10 of creation of a European Financial Stability Facility (EFSF) to provide €440 B in loan guarantees available to a number of European countries plus additional European Commission and International Monetary Fund Loans totalling €310 B.[15] If the problem was simply that Greece had accumulated a debt load that it was not

[14] "EU debt crisis: Greece granted €110bn aid to avert meltdown," *Guardian* May 2 2010 (http://www.guardian.co.uk/world/2010/may/02/eu-debt-crisis-greece-aid-meltdown).

[15] "EU ministers offer 750bn-euro plan to support currency," BBC News, May 10 2010 (http://news.bbc.co.uk/2/hi/business/8671632.stm).

going to be able to repay, new loans would not seem to be of much help. Nevertheless, the framework of Section 2 raises three potential mechanisms by which such a rescue program might have an effect. First, if, as Bolton and Jeanne (2011) and Park (2012) suggest, rising default risk undermines the collateral of the limited number of potential buyers of sovereign debt, the deteriorating Greek budget picture may have resulted in an increase in the risk premium on Greek debt as represented by the difference between π_t and π_t^Q in equation (16). To the extent that market rates reflected this risk premium rather than an objective probability of default, the willingness of other sovereign countries or institutions like the IMF to take the place of private lenders could potentially bring the interest rate down and move the country back into a region of sustainability.

A second possible mechanism could operate if the new institutional lenders force the country to adopt fiscal reforms leading to a credible commitment to increase the country's steady-state primary surplus. The May 2, 2010 announcement of the rescue package reported that Greece would be required to cut its 2010 deficit in half as part of the deal.

Third, the model of default in Section 2 assumed that costs would be borne by some combination of losses by creditors, increases in domestic taxes, or reduction in government spending. Another possible outcome is that other sovereign countries might be prepared to absorb some of the losses out of a desire to limit the consequences of a default by a country like Greece. If a third-party rescue package is interpreted by lenders as increasing the likelihood that other sovereign governments will absorb some of the future losses, that could be a third mechanism by which such measures could result in lower Greek borrowing costs.

The yield on Greek 10-year bonds fell by 270 basis points following the initial EFSF announcement on May 10, 2010. Unfortunately, the fundamentals in Greece continued to deteriorate and within a few months the interest rate was back above its May 10 value. One important news development was the acknowledgement that Greece's historical deficits were significantly larger than the country had been claiming. The blue line in the top panel of Figure 3.2 shows the deficits as reported in the IMF April 2011 WEO database. This shows that the cumulative actual deficits (not the forecasts) over 2006-2008 were 10% higher as a percent of GDP than they had been reported to be the previous fall, news which immediately added 10 percentage points to the baseline debt/GDP (bottom panel), and by itself would be predicted to lead to an additional 1.3% increase in Greek's borrowing costs.[16] The actual deficit for 2009 turned out to be 15.4% of GDP, and the forecast debt/GDP for the end of 2011 was 152%. This again proved to be too optimistic, with the figure now given as 165%, compared with an assumed value of 100% just two years earlier.

Several additional interventions were attempted, though these only produced temporary jags down in a longer upward climb in Greek borrowing costs, as seen in Figure 3.3. The European Central Bank provided assistance and was estimated to have purchased €47 B in Greek bonds between May 2010 and June 2011, and to have accepted as collateral an additional €98 B from Greek banks (Nelson, Belkin, and Mix, 2011). To put these numbers in perspective, the €145 B in ECB notional exposure corresponds to 64% of Greece's 2010 GDP (€227 B) and 44% of its 2010 sovereign debt (€330 B).

[16] $(0.0029)(127.5-117.5)+(0.000203)(127.5^2-117.5^2)+(0.00636)(11.9)(127.5-117.5)=1.3\%$.

A summit of European leaders and financial institutions announced on July 21, 2011 that EFSF loan guarantees would be increased to €780 B (European Financial Stability Facility, 2012) along with an agreement from private banks to contribute €50 B through 2014 in the form of losses on Greek bond exchanges, rollovers, and debt buybacks (Nelson, Belkin, and Mix, 2011). However, strikes protesting the austerity measures in September raised new doubts about the willingness of the Greek public to participate in the plan.[17] The yield on Greek debt rose from 18.2% on September 2 to 24.4% on October 28. On November 1, Prime Minister Papandreou proposed that Greek citizens should hold a referendum on whether they approved of the proposed austerity measures, after which the borrowing cost shot up another 800 basis points. Given this reaction, Papandreou resigned, and a new prime minister was inaugurated November 10.

Once again, any relief from the change in leadership was only temporary, and the yield on Greek sovereign debt reached almost 40% at the beginning of March 2012. On March 8, Greek Finance Minister Venizelos announced that a majority of private holders of the country's sovereign debt had agreed to accept "PSI" notes from EFSF or new Greek debt at a 53.5% haircut on outstanding bonds.[18] This represents the key measure that would actually make a difference for the underlying core problem. Venizelos expected the agreement to reduce outstanding debt by €105 B, which would reduce the 2011 debt/GDP from 165% to 117%. Equation (18) predicts that such a measure would lead to a drop in the interest rate of almost 700 basis points.[19] In fact, the Greek interest rate fell by over 2100 basis points, from 39.6% on March 9 to 18.5% on March 16.

[17] "Greek taxis, doctors, dentists on strike," *Business Week,* September 8, 2011 (http:// www.businessweek.com/ap/financialnews/D9PKBVE00.htm).

[18] "Greece Readies Record Debt Swap," Bloomberg News, March 8, 2012 (http:// www.bloomberg.com/ news/ 2012-03-07/ investors-with-39-of-greek-debt-agree-to-join-in-swap-iif-says.html).

[19] $(0.0029)(165-117)+(0.000203)(165^2-117^2)+(0.00636)(12.1)(165-117)=6.58\%.$

However, by June it had drifted back up above 29%, about a thousand basis points below its peak.

Two further important measures came later in the year. On September 6, 2012, the European Central Bank indicated its willingness to conduct outright monetary transactions to buy troubled sovereign debt on the secondary bond market, doing "whatever it takes" to redress "unfounded fears on the part of investors."[20] A week later, the German Constitutional Court ruled on September 12 that it would be lawful for Germany to ratify the European Stability Mechanism, which would provide up to €500 B in loans to European countries. The yield on Greek debt declined substantially after these announcements and the full German ratification of the ESM which followed shortly after (see Figure 3.3).

However, our framework suggests that the underlying problems could hardly be described as "unfounded fears on the part of investors." Equation (8) implies that if Greece were to reduce its outstanding debt by another third (to get debt/GDP back to 80%) and move to a permanent primary surplus of 2% of GDP, it would be able to borrow again at 5% and sustain the situation indefinitely, even if Greek's nominal growth rate does not recover from its recent low 2.5% recent trend. With faster growth, a more modest primary surplus would be needed to achieve sustainability. But such scenarios seem optimistic. A more important contribution of the OMT and ESM might be their signal that significant resources from broader Europe will be available to Greece to cover the primary surplus shortfall. Even with these, it is very easy to imagine that Greek yields could climb again to 2012 levels if there is no satisfactory resolution of Greek's

[20] "ECB outlines bond-buying program," *CNNMoney,* September 6, 2012 (http://money.cnn.com/2012/09/06/investing/ecb-draghi/index.html).

longer-run fiscal challenges.

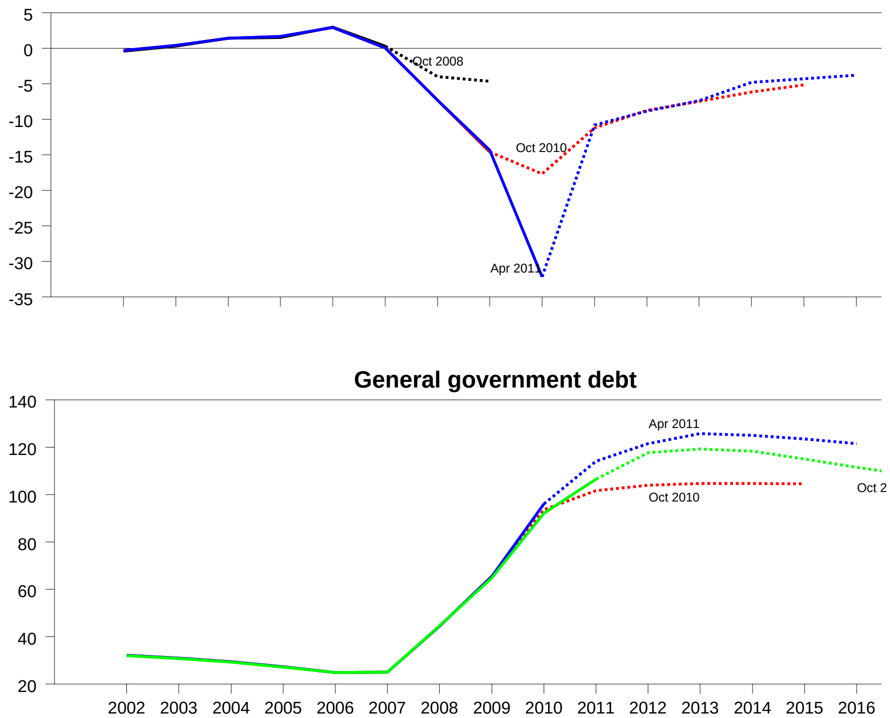
3.3.2 Ireland.

The black line in the top panel of Figure 3.4 shows the historical and projected Irish budget surplus as of October 2008. An economic downturn is reflected in these projections, with deficits of 4 to 5% of GDP anticipated for 2008 and 2009. With debt in 2007 at only 25% of GDP, one would hardly have expected Ireland shortly to be added to the list of countries whose sovereign debt would be questioned.

After the stresses associated with the failure of Lehman, Irish banks started to face problems obtaining financing. The Irish government responded on September 30, 2008 by guaranteeing "all deposits (retail, commercial, institutional and interbank), covered bonds, senior debt and dated subordinated debt"[21] of the 6 major banks, a potential liability estimated by Cussen and Lucey (2011) at €352 B. Underappreciated at the time was the fact that, like the United States, Ireland had experienced its own real estate price bubble that was about to collapse. During 2009, Irish house prices fell by 19%, ending the year 29% below their 2007 peak and ending 2010 37% below the peak (see Figure 3.5). By the end of 2009, impaired loans for the top 3 banks were up to €59 B and criticised loans at €102 B.[22]

[21] Irish Department of Finance (http://www.finance.gov.ie/viewdoc.asp?DocID=5475).
[22] Data source: annual reports for Allied Irish Banks, Bank of Ireland, and Anglo Irish Bank.

Figure 3.4 Irish Government Budget Balance and Debt Reported and Projected at Alternative Dates (% of GDP)



Source: IMF Word Economic Outlook

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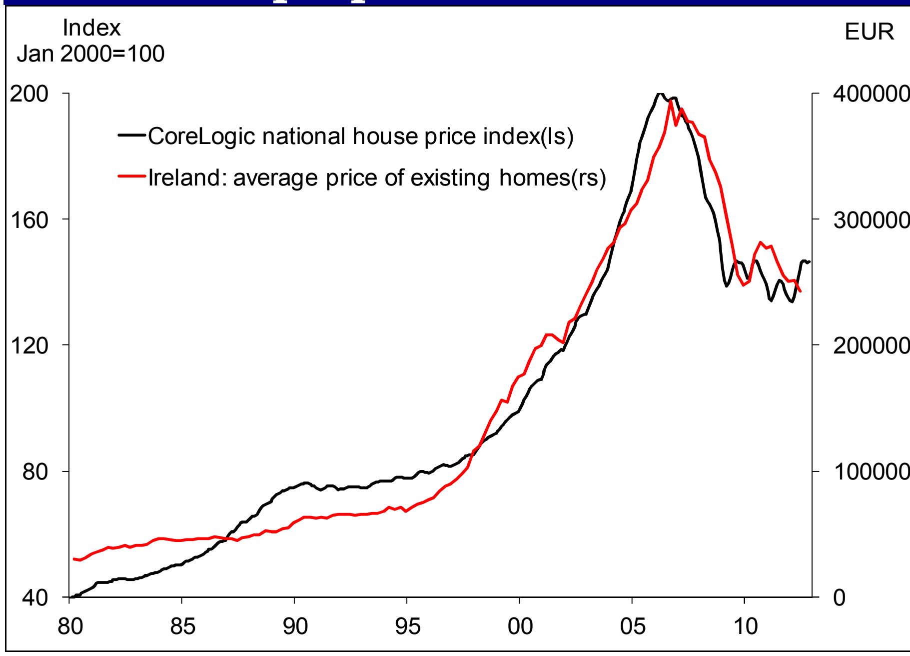
Figure 3.5 Price index for Irish residential properties



Source: Haver, Ireland Dept of Environment, Heritage, and Local Government; Core Logic

As bank losses mounted, the government nationalized Anglo Irish Bank in 2009 and set up the National Asset Management Agency (NAMA) in December of 2009, which was to issue government debt and use the proceeds to purchase troubled assets at a discounted price. In addition, Anglo Irish Bank and Irish Nationwide Building Society received €30.6 B (20% of Ireland's 2010 GDP) in emergency lending from the Central Bank of Ireland, whose monetary effects were sterilized through issue of "promissory notes" by the fiscal authority. An interesting feature of the budget numbers as of October 2010 (red lines in Figure 3.4) is that while the 2010 budget deficit was projected at only 14% of GDP in the IMF's October 2010 database, that same projection called for gross government debt to grow from 65% of GDP in 2009 to 94% in 2010. The discrepancy between the anticipated size of the 2010 deficit and anticipated value for 2010 debt appears to come from the fact that while the promissory notes were included in the gross debt figures, they were mostly excluded from the reported deficit. By April 2011, the deficit estimate for 2010 followed the Eurostat convention of counting the new notes as part of the deficit, which was revised up to 32% of GDP (see the blue lines in Figure 3.4).

Again quick calculations using (18) suggest that if perceptions of true net government debt/GDP grew by 20 percentage points as a result of this news in the fall of 2010, the country would have expected to see its borrowing cost rise by 1.2%.[23] The yield on 10-year Irish sovereigns rose from 5.0% on August 6, 2010 to 9.0% on November 26. On November 28, the EU approved €85 B in loans to Ireland,[24] which temporarily stabilized the upward trajectory of borrowing costs (see Figure 3.6).

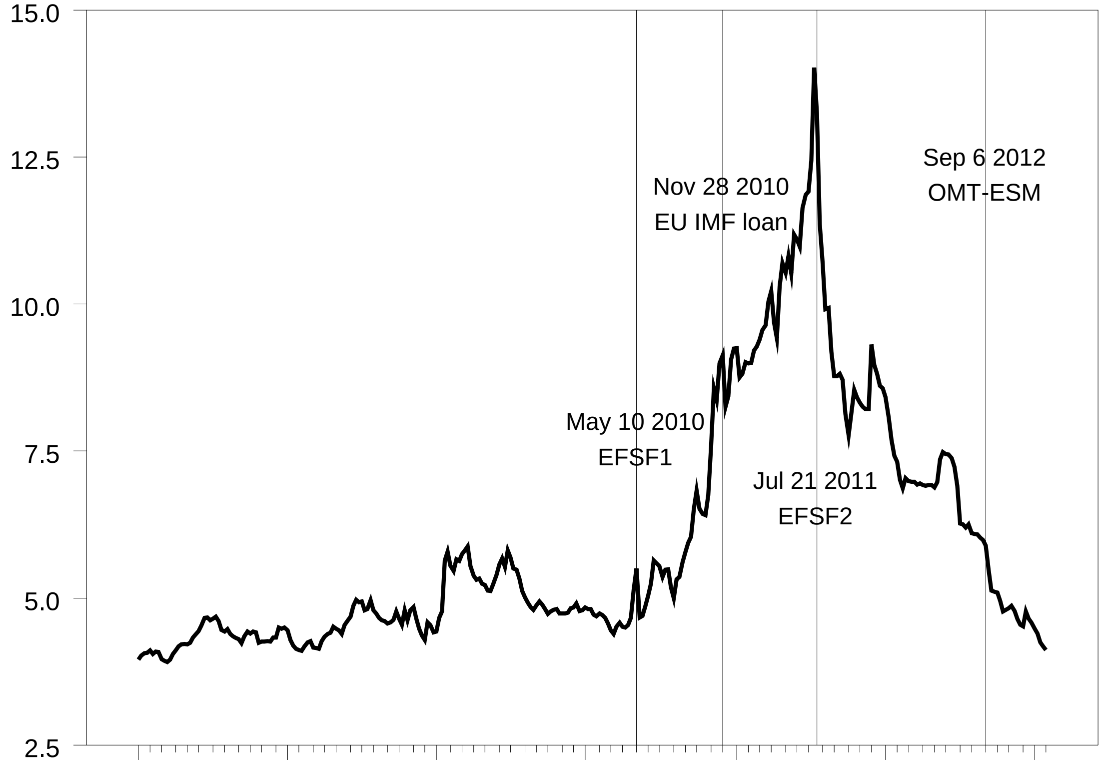
Unfortunately, house prices in Ireland fell an additional 17% during 2011. In July the government injected an additional €16.5 B (11% of GDP) into the banking system,[25] and on July 12 Moody's downgraded Irish debt to junk status. The yield peaked at 14% on July 15, but fell sharply following EFSF2.

[23] $(0.0029)(85-65)+(0.000203)(85^2-65^2)+(0.00636)(4.1)(85-65)=1.2\%$.

[24] "EU approves bailout deal for Ireland," *Bloomberg Businessweek,* Nov 28 2010 (http://www.businessweek.com/ ap/financialnews/D9JP9VUO1.htm).

[25] "ESA95 accounting treatment of July 2011 capital injections into Irish banks," Central Statistics Office, March 2012 (http://epp.eurostat.ec.europa.eu/portal/page/portal/government_finance_statistics/ documents/Ireland-Annex_2-CSO_note_to_Eurostat_on_accounting_treat.pdf).

Figure 3.6. Irish 10-year government bond yield



Source: Haver Analytics and Financial Times

Although the rescue of Irish banks entailed a huge debt issuance by the government, in the process the government also acquired and preserved the value of an asset, namely the ongoing enterprise value of the banks themselves. Should these expenditures be viewed as pouring money down a hole? One perspective is provided by noting that Ireland's 6 largest banks held €400 B in customer loans in 2009, about half of which were for property and construction or mortgages.[26] If all of the property loans had been made at the peak of house prices, and if all of the 50% decline in house prices from the peak were absorbed as a loss to the banking system (rather extreme assumptions), one arrives at an upper bound on the loss of €100 B. For comparison, Cussen and Lucey

[26]Section 5, Supplementary Documentation, National Asset Management Agency, September 16, 2009 (http://www.finance.gov.ie/documents/speeches2009/sfbl034suppfinaldoc.pdf).

(2011) calculated injections of funds into the banking system in 2010 and 2011 at €64 B. This simple calculation suggests that the convention of regarding all of this sum as "government spending" is overly conservative, and that there is some compensation in the form of acquisition of a positively valued asset.

Moreover, Irish property prices appear to have stabilized in 2012, and in December 2010 the Irish government agreed to €4 B in spending cuts and €2 B in tax increases as terms of the EU assistance.[27] The most recent projections of future Irish debt are more optimistic than those of a year ago (see the green line in Figure 3.4). We thus conclude that although the effective nationalization of property losses put a huge fiscal strain on Ireland, there is reason to believe that the country has turned the corner and will emerge with a sustainable situation.

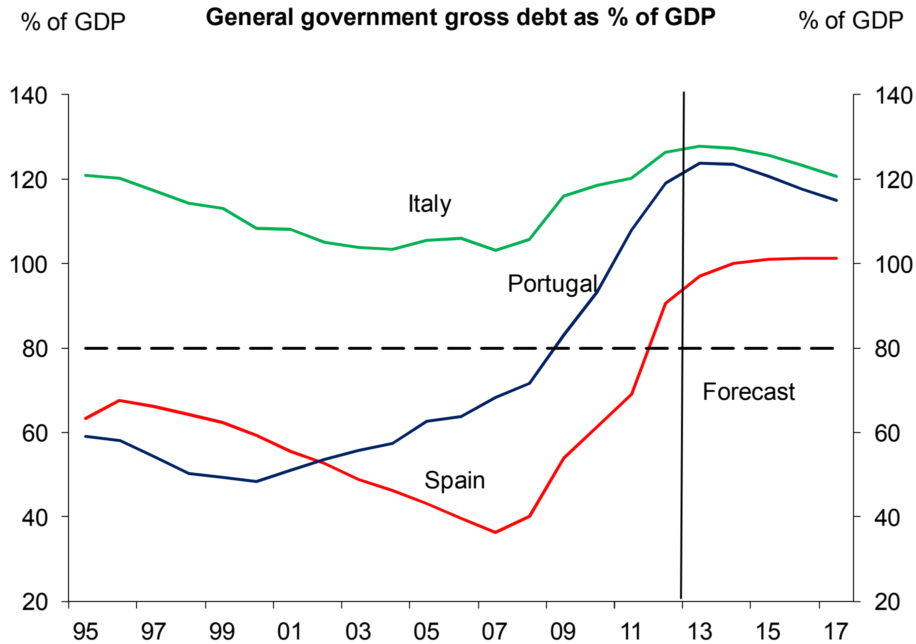
3.3.3 Other European countries.

Figure 3.7 plots debt levels for three other countries that have seen significant increases in borrowing rates. Spain's situation is similar to Ireland, having started from a low debt level but experiencing a very significant decline in property values. The key unresolved question is how much of the loss in property values will ultimately end up as a direct fiscal charge to the Spanish government. Portugal seems to involve a mix of the issues facing Spain and Greece (Maior, 2011).

Italy presents an interesting case, having maintained debt levels above 100% of GDP for a quarter century. Why should debt levels be raising concerns about Italy today that were not present a decade ago? One answer is suggested by the second panel

[27] "Irish lawmakers approve EU-IMF bailout loans," *Bloomberg Businessweek* December 15, 2010 (http://www.businessweek.com/ ap/financialnews/D9K4DOO81.htm).

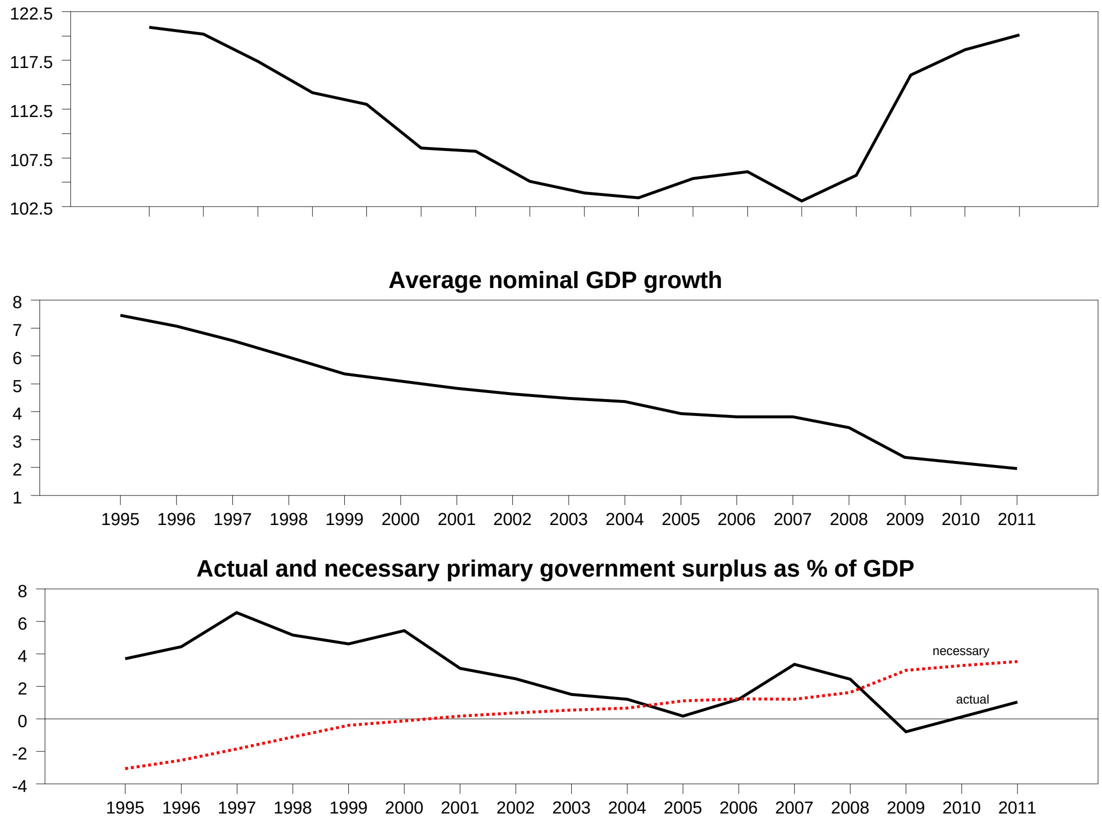
Figure 3.7. Historical and forecast debt/GDP for Spain, Portugal, and Italy



Source: IMF October 2012 World Economic Outlook

of Figure 3.8, which shows that the nominal growth rate in Italy has been steadily falling over this period. Slower growth g means a higher net borrowing cost r from equation (6). From equation (8), that in turn means that a higher primary surplus would be necessary to maintain any given level of debt. To illustrate the implications of this, the dashed red line in the bottom panel of Figure 3.8 plots the primary surplus that Italy

Figure 3.8. Italy: Debt, GDP growth, and Budget surplus

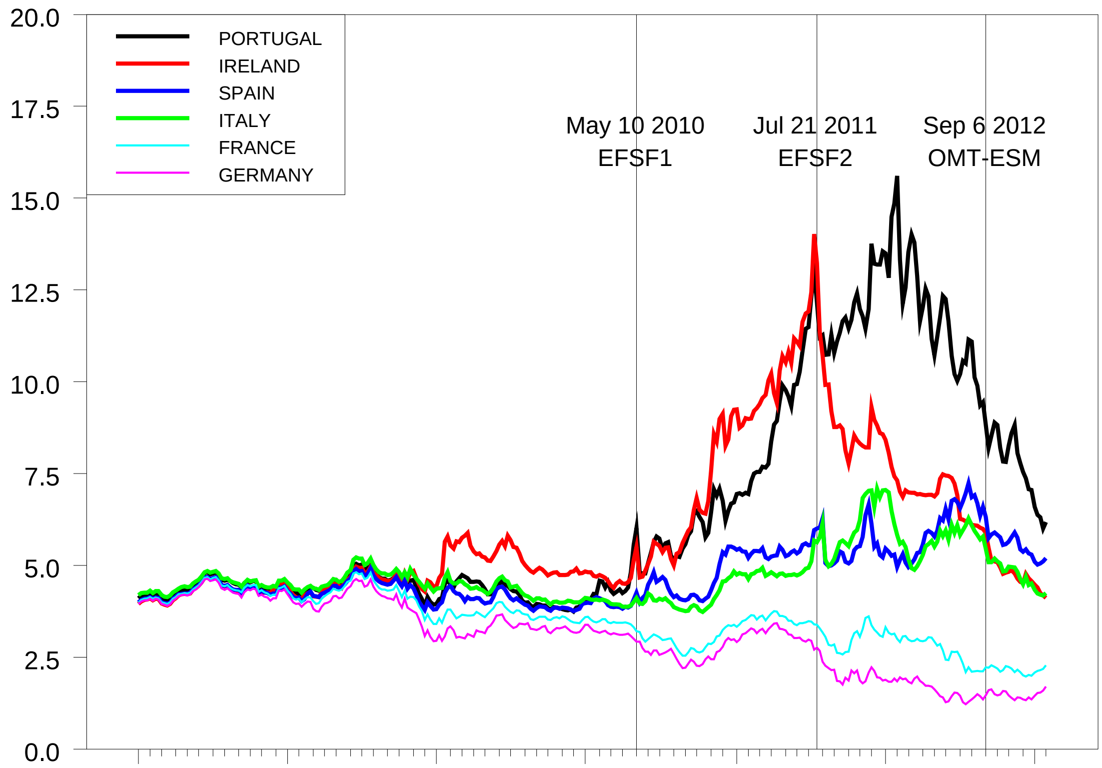


Note: Second panel: shows weighted average of previous decade's nominal GDP growth from equation (20). Third panel: solid black indicates primary surplus (excluding interest payments) as percent of GDP; dashed blue shows the primary surplus that would be necessary to hold debt steady at the value given in the top panel if the nominal interest rate is 5% and the long-term growth rate is as given in the second panel.
Source: Haver Analytics, IMF, and authors' calculations

would have needed in each year in order to hold debt/GDP constant at its observed value for that year under the assumption that it could borrow at a nominal interest rate of 5% and that its long-run nominal GDP growth rate would continue at the weighted average seen over the previous decade. With the solid growth of the 1990s, Italy could have run a small primary deficit and still reduced its debt/GDP ratio. Given that it actually realized a significant primary surplus, debt fell significantly as a percentage of GDP in the 1990s. But with slowing growth rates, by 2000 it would have been necessary to run a primary surplus to stabilize debt even at its new lower levels. If Italy's recent slow growth is projected forward, a primary surplus of 4% of GDP would be necessary for a stable path.

Figure 3.9 plots weekly interest rates for 6 different European countries. One of the striking features of these high-frequency data is that the yields of the 5 troubled countries (Greece, Ireland, Portugal, Spain and Italy) often moved together in response to the same news events. For example, the interest rates for Ireland and Portugal followed very similar paths in the early part of 2010. Although news of deteriorating economic fundamentals such as falling real-estate prices are doubtless correlated across countries, something else is clearly going on in the data. One interpretation is that news was affecting not just the objective probability of default π_t but also the market price of default risk π_t^Q in equation (16), and that this risk premium was highly correlated across countries. Bolton and Jeanne (2011) and Park (2012) suggested that this could arise if there is a single set of investors who are willing to hold the sovereign debt of risky countries, and that deteriorating fiscal fundamentals in one country erode the investors' working capital and cause them to seek higher risk compensation for holding similar assets. Another possibility is that a key determinant of sustainability would be outside financial assistance for the country. News that such assistance would be forthcoming (for example, EFSF1 and EFSF2) would bring yields down together, while doubts about the funds' adequacy, brought about for example by deteriorating fundamentals in any one of the countries, would result in higher borrowing costs for all.

Figure 3.9. 10-year government bond yields (%)



Source: Haver Analytics and Financial Times

But note that despite the high-frequency correlation, ultimately the rates facing different countries diverged significantly. For example, Ireland's interest rate has now pulled dramatically below those of Greece or Portugal. We conclude that, despite the strong comovement of yields across countries and possible correlated risk premia, the basic framework for thinking about debt sustainability and tipping points presented in Section 2 appears to be the correct way to interpret recent European experience. Additional evidence supporting this conclusion was provided by Caceres, Guzzo and Segoviano (2010) and Caporin et al. (2012).

3.3.4 Japan.

The most dramatic outlier in our data set is Japan, whose gross debt is now 230%

of GDP but whose borrowing cost is below 1%. Our regression (18) would attribute this low interest rate to the fact that Japan maintains a significant current-account surplus (with $c_{iT} = +3.4\%$) and enjoys a country fixed effect that implies there is something very special about Japan. In fact, the sum $\hat{\alpha}_{\text{Japan}} + \hat{\gamma}_T$, which gives the predicted nominal interest rate from the quadratic specification if Japan had zero debt and zero current-account balance, is -3.7%.

Hoshi and Ito (2012) argue that a key feature that makes Japan special is its very high domestic saving rate coupled with extreme home bias. They report that 95% of the Japanese sovereign debt is domestically held by institutions such as banks, insurance companies and pension funds. Our measure of Japanese government debt after netting out that owed to other Japanese government entities is only 126% of GDP, and the difference between gross and net debt certainly accounts for some of Japan's "specialness" in the gross debt regression; for example the sum $\hat{\alpha}_{\text{Japan}} + \hat{\gamma}_T$ from the net-debt regression (19) is just -1.2%.

Nevertheless, Hoshi and Ito argue that, given Japan's aging population, its private saving rate is likely to fall significantly over the next decade. Once Japan is forced to sell its debt to international investors and not just domestic institutions, the yield on Japanese debt should start to behave much more like that of other countries. Given its high debt load, even modest increases in its borrowing cost could quickly make the sustainability issues we have been discussing become much more significant. Hoshi and Ito conclude that policy-makers should not be reassured by Japan's current low borrowing costs, and argue that Japan will need to adopt significant fiscal reforms if it is to avoid a future fiscal crisis.

3.3.5 United States.

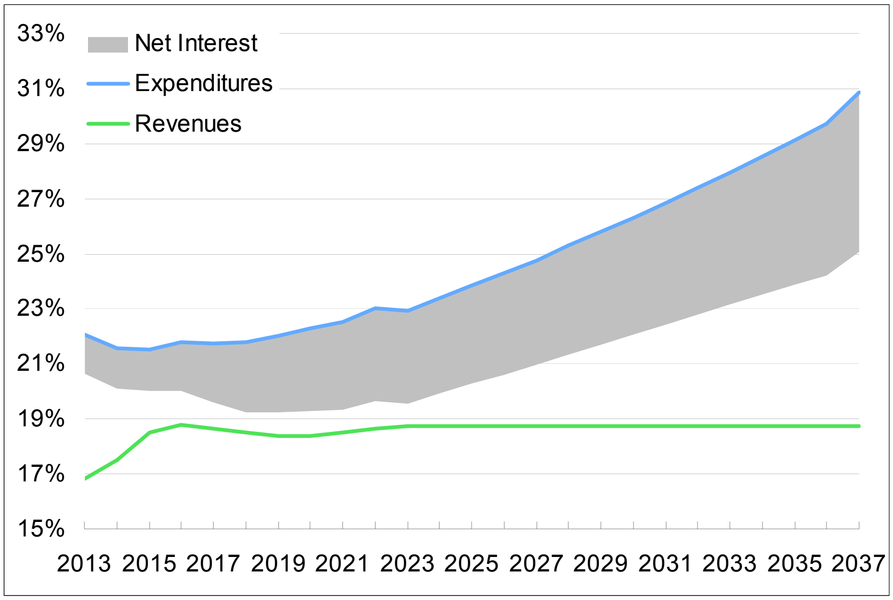
The United States is another country with a significant debt load (with gross debt at 103% of GDP in 2011) but still a very low interest rate. The country-fixed-effects term in (18) imputes special borrowing privileges for the United States that would allow it to enjoy a borrowing cost of only $\hat{\alpha}_{\text{US}} + \hat{\gamma}_T = +1.1\%$ if it had zero debt and a balanced current account. Again an important portion of the U.S. debt is held by government institutions such as the Social Security Trust Fund, leaving the net debt load in 2011 at only 80%. Another key reason that U.S. rates have historically been low is that the use of the U.S. dollar as the world's reserve currency creates a special demand for U.S. Treasury securities. We note, for example, that although public debt of the United Kingdom was never below 170% of GDP between 1922 and 1936 (Abbas et al., 2010), the annual average yield on British consoles (infinite-maturity sovereign debt) was never above 4.6% over those same years (Homer and Sylla, 2005, Table 59).

Recent projection from the Congressional Budget Office (2013) called for U.S. gross debt/GDP to rise to 107% by 2014 and decline modestly for the next several years before resuming a gradual upward ascent.[28] The underlying revenue and outlay assumptions behind these projections are detailed in Figure 3.10. We show the standard CBO (2013) baseline through 2023, with an adjustment for some relatively minor items (such as the so-called doc fix and tax extenders). The data beyond 2023 reflect our own efforts to reproduce the methodology that CBO used in their most recent long-term

[28] In order to allow for cross country comparisons, we have used IMF data on public debt to this point in the paper. In the remainder of this section, we refer to the standard US definitions for gross debt and debt held by the public. However, it's important to note that the IMF figure of 103% for US gross public debt at the end of 2011 is very close to the CBO reported value of 99%.

projections (see Congressional Budget Office, 2012) to allow for significant changes in policy that have occurred in the interim. On the revenue side, note that tax receipts only amounted to 15.8% of GDP in 2012. That's quite low by historical standards. However, tax revenues are low for understandable reasons. The U.S. economy has suffered through a severe recession, and a considerable amount of slack still exists. Moreover, there have been a number of tax cuts over the last decade or so—specifically, the Bush era tax cuts in 2001 and 2003 as well as the payroll tax cut that was in place during 2011 and 2012. But, if the U.S. economy fully recovers over the next several years and the unemployment rate eventually gets all the way back down to 5.25%, as the CBO (2013) assessment assumed, then tax receipts should gradually rise to about 19% of GDP -- slightly above the long-run average of 18.5% seen during the post-war period in the U.S.

Figure 3.10. Adjusted CBO assumptions for Federal government revenues and expenditures (percent of GDP).



Source: Congressional Budget Office (CBO) and authors' calculations.

Next, let's take a look at the spending side. Figure 3.10 also shows our adjusted CBO outlook for federal government expenditures as a share of GDP.[29] In 2012, federal spending amounted to 22.7% of GDP. However, a number of factors should lead to higher spending levels in coming decades. Take, for example, outlays for Social Security, which are now about 5% of GDP. The aging of the population will help to push Social Security benefits up to about 6% of GDP as we approach the middle of the century (by the way, the COLA change that has recently been under consideration would cut that only slightly – to 5.8% of GDP). Some of this pickup is expected to be offset by a decline in defense and nondefense discretionary spending. However, health-care-related expenditures are slated to explode if no policy action is taken. For example, CBO (2012) baseline estimates

[29] Again, we have used CBO (2013) projections through 2023 and have attempted to adapt CBO (2012) assumptions to recent legislation in order to extend these projections through 2037.

show federal government spending for Medicare and Medicaid rising from 5.5% of GDP in 2010 to more than 9% of GDP by 2030. The dramatic escalation in projected Medicare and Medicaid outlays is being driven by two factors -- demographics and rising per patient expenses.

Finally, let's factor in interest costs. In 2012, debt service was quite low (less than 1.4% of GDP) because interest rates were so low. Roughly one-quarter of the Treasury debt outstanding is in the bill sector (meaning an original maturity of 1 year or less) and borrowing costs at the short end of the yield curve have been close to zero for the past several years. Even longer-term notes and bonds issued by the Treasury in recent years have had a very low coupon. But, if the U.S. continues to pile on more debt and if we assume – as CBO (2013) does – a normalization of interest rates over the course of coming years (to roughly 4.0% for 3-month T-bills and 5.2% for 10-year notes), then debt service costs will eventually skyrocket.

The bottom line is that a CBO-type baseline forecast shows large structural primary budget deficits and an escalation in debt service leading to higher debt levels in the future even if the economy achieves full employment.

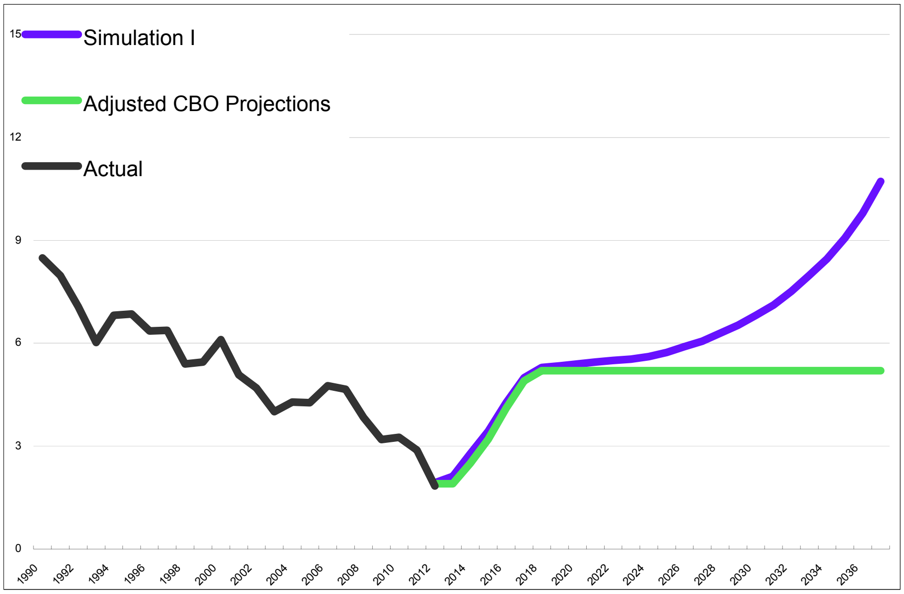
Given an initial debt level, an assumed path for revenue and non-interest expenditures, and an assumed path for interest rates, one can then calculate a path for the debt/GDP ratio. The CBO's baseline estimates (and similar projections produced by the White House Office of Management and Budget) assume that long-term interest rates rise gradually to reach a level of 5.2% in 2018 and then remain constant at that level despite a continued escalation in the amount of public debt outstanding. The theoretical analysis and historical experience reviewed in

Sections 2 and 3 suggest that this assumption could lead to a significant understatement of the potential deterioration in the budget picture because yields are assumed to hold steady at normalized levels as debt continues to accumulate.

If we instead allow yields to adjust as implied by the model specified in Section 3.1, then debt service -- and public debt outstanding -- would rise even more than in the CBO projections. The green line in Figure 3.11 plots the 10-year yield assumed in our adjusted CBO simulations, whereas the blue line (labeled Simulation I) gives a predicted yield from a dynamic simulation in which changes in debt feed back into changes in the interest rate. To calculate the latter, we used equation (18) to predict how much higher the interest rate would be if the gross debt/GDP were at the level implied by the simulation relative to what the interest rate would be predicted to be if debt remained at 103%, the level in 2011. We then added this predicted premium to the CBO's assumed interest rate for the year, made a calculation of how that higher interest rate would change the debt load the following year, and continued in a dynamic simulation.

According to our model, one key determinant of the effect of debt on the interest rate is the current-account balance. The U.S. has run an average current-account deficit of 3.7% over the last 5 years and 4.3% on average since 2000. However, favorable trends in U.S. energy production and consumption helped narrow the deficit to 2.8% of GDP in 2012. Our baseline simulations shown in Figure 3.11 assume that the U.S. will maintain an average current-account deficit of only 2.5% of GDP over the next several decades.

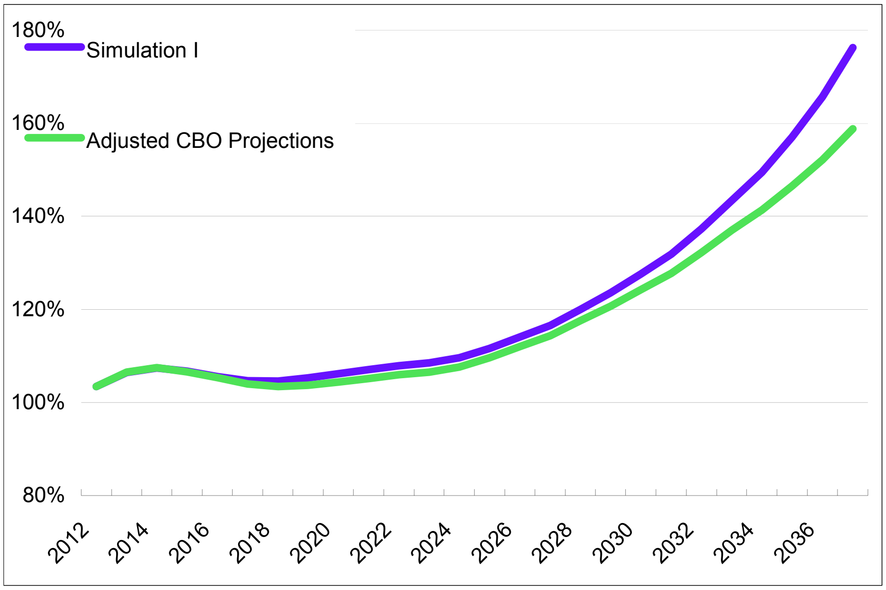
Figure 3.11. Actual and projected 10-year bond yields under adjusted CBO assumptions and our baseline simulations



Source: Haver Analytics, CBO and authors' calculations

Our dynamic simulation then used this sequence of predicted yields and the maturity structure of gross federal debt to calculate the interest-inclusive deficit for each year and the level of debt for the following year that it would imply. As seen in Figure 3.12, debt levels are much higher in our simulation than in the adjusted CBO baseline by the end of the 25-year forecast horizon (176% vs. 159%).

Figure 3.12. Gross debt as percent of GDP under adjusted CBO projections and our baseline simulation.

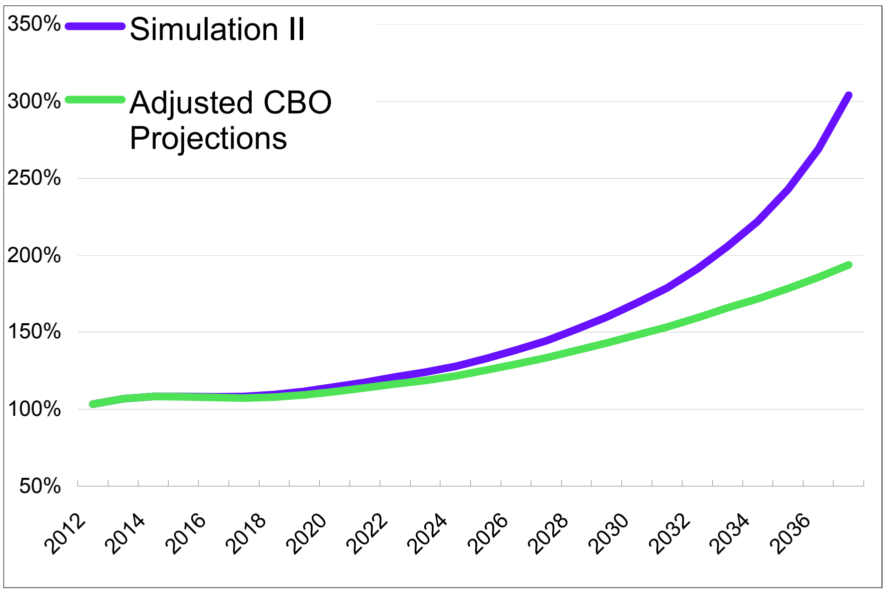


Source: CBO and authors' calculations

As mentioned, we have assumed the U.S. current account deficit holds at 2.5% of GDP-- a level that matches the best result seen in the past decade and is slightly narrower than the 2.8% of GDP recorded in 2012. If, instead, we assume that the current account deficit reverted to the 3.7% of GDP average seen over the prior five years, then the projected debt burden would reach 180% of GDP in 2037.

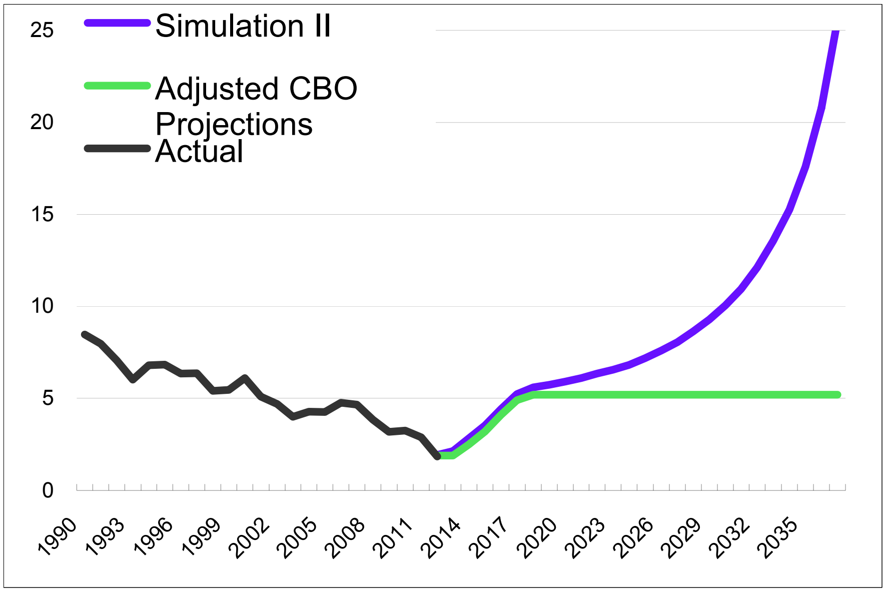
We can also examine a scenario in which policy actions and economic outcomes produce a less favorable path for the primary budget deficit (using our baseline current account deficit assumption of 2.5% of GDP). For example, suppose that the budget sequester that went into effect on March 1 was cancelled and that the steady-state unemployment rate turns out to be 6% (as opposed to the 5.25% in our adjusted CBO simulations). In this case (which we refer to as Simulation II), the budget deficit would be quite a bit higher than in the initial scenario. The debt/GDP ratio would rise much more rapidly, hitting 304% of GDP by 2037 (Figure 3.13) and bond yields would skyrocket, eventually getting above 25% (see Figure 3.14).

Figure 3.13. Gross debt as percent of GDP under adjusted CBO assumptions and our simulation with budget sequester cancelled and higher unemployment.



Source: CBO and authors' calculations

Figure 3.14. Ten-year yields under adjusted CBO assumptions and our simulation with budget sequester cancelled and higher unemployment.

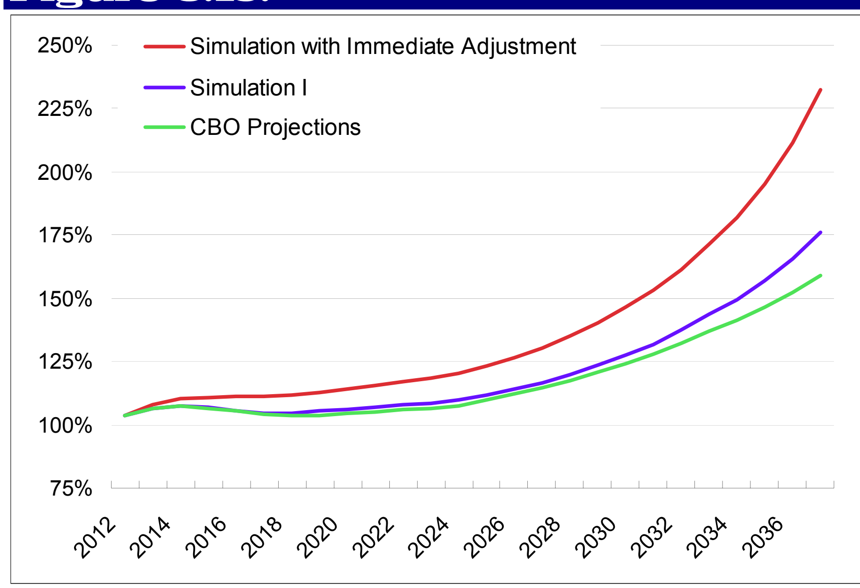


Source: Haver Analytics, CBO and authors' calculations

Finally, note that the above simulations were all based on a first-difference approach -- we used equation (18) only to predict the change in the interest rate premium, rather than its prediction for the overall level. One reason for this conservative approach is that our levels model would already be predicting an interest rate for the United States for 2012 that is higher than what we actually observed; the large-scale purchases by the Federal Reserve may be one factor that has helped keep interest rates down up to this point. For completeness, we display in Figure 3.15 the debt levels that would prevail if long-term yields were to rise immediately to the level predicted by our model as opposed to the adjusted CBO baseline assumptions and the gradual adjustment specified in our initial simulation.

We should emphasize that we are not presenting these alternative simulations as more realistic forecasts of what the U.S. experience will actually be. In a country like the United States, the debt premium presumably would arise from inflation fears rather than concerns about outright default. And if we are talking about a higher inflation rate, forecasts of nominal GDP should be adjusted as well. Instead, we view these simulations as illustrating the extent to which the path implied by baseline CBO projections could quickly become much more difficult to manage than some policy-makers may be assuming-- something dramatic will need to change well before U.S. interest rates reach double-digit rates. Our main conclusion is that higher debt levels can have a significant impact on the interest rate path and that feedback effects of higher rates on the level of indebtedness can lead to a more dramatic deterioration in long-run debt sustainability in the United States than is captured in official baseline estimates.

Figure 3.15.



Source: CBO and authors' calculations

4 Implications for monetary policy.

We turn now to the interaction between fiscal policy and monetary policy during periods of sovereign debt stress. Our ultimate objective here is to consider the practical implications of how rate increases induced by fiscal stress could affect the conduct of monetary policy, with an emphasis on the situation in the U.S. over the balance of this decade. The literature on fiscal and monetary interactions is vast. We focus on two strands in introducing this topic. If fiscal policy is shifting in a desirable direction, from an unsustainable path to a sustainable one, monetary policy can play an important role in ensuring a successful outcome. Here we review the debate over "tough love," or how accommodative monetary policy should be in the face of fiscal contraction in the next subsection. In doing so, we consider the potential implications for Fed policy of a "Grand Bargain" that would put the U.S. debt ratio on a sustainable downward trajectory, should such an agreement materialize.

However, given a still polarized political system in the U.S., a less favorable outcome seems more likely. So we turn next to the opposite case: the implications for monetary policy of a fiscal policy that remains unsustainable. In subsection 4.2 we briefly review the literature on fiscal dominance, where the central bank ultimately is forced to finance the fiscal deficit via inflation. While fiscal dominance is not an immediate risk, there are important elements in the current makeup of U.S. fiscal and monetary policy that suggest increasing attention will be paid to this risk in the years ahead.

The primary focus of our analysis in this section is then presented in subsection 4.3. Here we consider how a sovereign risk shock stemming from growing concern about the unsustainable U.S. debt trajectory under current policy could affect the Fed's exit from its ongoing extraordinary policy easing in the years ahead. In doing so, we focus on the growing importance of the Fed's own contributions to the fiscal picture, a heretofore minor item labeled "remittances to the Treasury"—one that has the potential to impinge on the flexibility of Fed policy given the growing size of its balance sheet and the undesirable trajectory of U.S. fiscal policy.

4.1 Fiscal Consolidations and Monetary Policy

Because fiscal consolidations are likely to be contractionary, the standard prescription for monetary policy, whose objectives are to minimize output and inflation gaps, is to ease when fiscal tightening is underway. A more contentious issue is whether tighter monetary policy, which Hellebrandt, Posen and Tolle (2012) characterize as a "tough love" policy, makes it more likely that there will be a successful fiscal consolidation.

One view supporting a "tough love" policy that is prominent in European policy circles and among critics of the Federal Reserve's quantitative easing is that expansionary monetary policy reduces the incentives for fiscal consolidation. Another argument for tighter monetary policy is that concerns about fiscal imbalances might unhinge inflation expectations, which could lead to a rise in interest rates that makes fiscal consolidation more difficult, and so tighter monetary policy is needed to anchor inflation expectations and keep interest rates low.

An alternative view is that easier monetary policy facilitates successful fiscal consolidations because it encourages higher nominal GDP growth, thereby raising the denominator of the debt-to-GDP ratio, and lowering this ratio. Furthermore, in contrast to the "tough love" view, anticipation of easier monetary policy which results in higher nominal GDP growth and lower interest rates may encourage fiscal authorities to implement a successful fiscal consolidation because it will have a higher likelihood of success.

Jeanne (2012) provides a simple model that suggests "tough love", which he describes as "hard monetary dominance", may reduce the probability of successful fiscal consolidations because it makes default more likely and fiscal adjustment harder to achieve. Using data from 1978-2009, Hellebrandt, Posen and Tolle (2012) find strong evidence that successful fiscal consolidations tend to be preceded by greater monetary easing (measured by lowering of policy rates). And Chapter 3 of the IMF World Economic Outlook (IMF, 2012) comes to a similar conclusion by examining one hundred years of public debt overhangs in advanced countries with a case study methodology.

The most striking example that casts doubt on the "tough love" policy is that of the United Kingdom in the interwar period. In the aftermath of World War I, the United Kingdom's debt-to-GDP ratio climbed to close to 140% of GDP, and the price level had doubled from prewar levels. The U.K. government then implemented a massive fiscal austerity, with primary surpluses in the 1920s of around 7% of GDP, while at the same time pursuing very tight monetary policy with policy rates raised to 7% to get back to prewar parity, despite ongoing deflation. The remarkable outcome of this monetary/fiscal policy mix was that instead of the debt-to-GDP ratio falling with the primary surpluses, it continued to rise, reaching 170% by 1930 and then rising further to 190% with the onset of the Great Depression.

Both theory and evidence suggest that a policy of “tough love” is counterproductive. This has important implications for the current situation in the Eurozone, which is pursuing short-run fiscal austerity and at the same time has a significantly tighter monetary policy than the United States or the United Kingdom. The key lesson as stated in IMF (2012) is that easier monetary policy is a necessary condition for successful fiscal consolidations.

The IMF (2012) case studies also indicate that successful fiscal consolidations do require a shift to primary surpluses, so some fiscal austerity is needed. However, the fiscal austerity needs to be permanent and structural. Successful debt reductions take a long time, with improvements greater than 10 percentage points over a ten-year period exceedingly rare. Fiscal consolidations involving temporary measures, as in Italy before 1992, do not seem to work. In addition, poorly designed fiscal consolidations, for example where spending is cut across the board (as in Canada in the 1980s), are typically short-lived because they do not engender sufficient political support and thus do not result in sustainable fiscal consolidation. At this juncture in the U.S., we expect that the surprise emergence of a grand bargain of entitlement and tax reforms that puts the debt ratio on a sustainable downward trajectory would be accompanied by Fed policy that would aim to slow the exit from extraordinary accommodation enough to offset much, if not all, of the associated fiscal drag. However, as we noted in Section 3, while some limited progress has been made toward stabilizing the debt ratio in the near term, U.S. fiscal policy remains on a clearly unsustainable trajectory for the longer term. The political polarization that has consistently stymied efforts to change this picture has hardly abated in the wake of the most recent election. Therefore, it seems safe to assume that sovereign risk remains alive and well in the U.S., and that it could very well intensify in the period ahead. One could easily imagine that the spending cuts called for under the Budget Control Act of 2011 (sequestration, etc.) will not be allowed to go through and that the prospective path of U.S. debt will exceed current expectations. This brings us to a more ominous branch of the literature.

4.2 Fiscal dominance and monetary policy

In the extreme, unsustainable fiscal policy means that the government's intertemporal budget constraint will have to be satisfied by issuing monetary liabilities, which is known as *fiscal dominance*, or, alternatively, by a default on the government debt. Fiscal dominance forces the central bank to pursue inflationary monetary policy even if it has a strong commitment to control inflation, say with an inflation target. As Sargent and Wallace (1981) pointed out in their famous paper on "unpleasant monetarist arithmetic," fiscal dominance at some point in the future forces the central bank to monetize the debt, so that despite tight monetary policy in the present, inflation will increase. Indeed, as Sargent and Wallace pointed out, tight monetary policy may result in inflation being even higher than it would be otherwise.

Ultimately, the central bank is without power to avoid the consequences of an unsustainable fiscal policy. As Reis (2013) noted, all that the central bank really brings to the unified fiscal-monetary government balance sheet is the ability to collect seigniorage or generate an unanticipated increase in inflation. If the central bank is paying for its open-market purchases of long-term government debt with newly created reserves, and if banks are induced to hold these reserves by payment from the central bank of a market interest rate, then ultimately all the open-market purchase does is exchange long-term government debt (in the form of the initial Treasury debt) for overnight government debt (in the form of interest-bearing reserves). It is well understood from the literature on sovereign debt crises[30] that any swap of long-term for short-term debt in fact makes the government more vulnerable to what we have described in this paper as a fiscal crunch, namely, more vulnerable to a self-fulfilling flight from government debt, or in the case of the U.S., to a self-fulfilling flight from the dollar.

To see how this would play out in practice, we need to recognize that fiscal dominance puts a central bank between a rock and a hard place. If the central bank does not monetize the debt, then interest rates on the government debt will rise sharply, causing the economy to contract. Indeed, without monetization, fiscal dominance may result in the government defaulting on its debt, which would lead to a severe financial disruption, producing an even more severe economic contraction. Hence, the central bank will in effect have little choice and will be forced to purchase the government debt and monetize it, eventually leading to a surge in inflation.

We could already be seeing the beginning of this scenario in Europe. The threat of defaults on sovereign debt in countries such as Ireland, Portugal, Spain and Italy has led the ECB to purchase individual countries' sovereign debt, with the latest manifestation being the announcement in September 2012 that it will engage in what it has called Outright Monetary Transactions (OMT). These OMT transactions involve

[30] See for example Jeanne (2009), Chatterjee and Eyigungor (2012), and Arellano and Ramarayanan (2012).

purchases of sovereign debt in the secondary markets of these countries, subject to their governments accepting a program of conditionality from the European Financial Stability Facility/European Stability Mechanism and the IMF. The ECB describes these transactions as monetary in nature because they "aim at safeguarding an appropriate monetary policy transmission," with the reasoning that they are "monetary" because low ECB policy rates are not translating into low interest rates in these countries. Nonetheless, these transactions are in effect monetization of individual countries' government debt (even if they are sterilized for the Eurosystem as a whole). The ECB's purchase of individual country's sovereign debt arises from the difficult position it faces. If the ECB does not do what ECB President Mario Draghi has described as "doing whatever it takes" to lower interest rates in these countries, the alternative is deep recessions in these countries or outright defaults on their debt, which would create another "Lehman moment" in which the resulting financial shock could send the Eurozone over the cliff.

It is true that the ECB's bond purchasing programs will not result in inflation *if* the sovereigns whose debt is being purchased get their fiscal house in order and fiscal dominance is avoided. However, this is an important *if*. Significant progress is being made on the fiscal front in some of these countries, but as noted in Section 3, much remains to be done in other cases. Indeed, there is still a danger that Europe may find itself with what we will refer to as the "Argentina problem". Argentina has had a long history of fiscal imbalances that have led to high inflation, and this continues to this day. The problem in Argentina is that its provinces overspend and are always bailed out by the central government. The result is a permanent fiscal imbalance for the central government, which then results in monetization of the debt by the central bank and high inflation. While the Euro area's overall fiscal path looks a good deal more benign than that of the US (with a smaller debt ratio that is on a downward trajectory going forward), significant risks remain. With bailouts of some sovereigns in the Eurozone, the incentive to keep fiscal policy sustainable in individual countries may have been weakened, leading to a significant moral hazard problem. Budget rules have been put in place to eliminate this moral hazard, but as the violation of the Stability and Growth Pact rules by Germany and France a number of years ago illustrates, budget rules can be very hard to enforce, even though we have seen success in some countries on this score, with Chile being a notable example.

Thus we see at least a risk that the Eurozone is on a path to become more like Argentina (which of course is why German central bankers are most concerned), with fiscal dominance a real possibility and high inflation the result. This possibility is a real one despite what the Maastricht Treaty specifies about the role of the ECB and what policymakers in the ECB want.

Although the US federal fiscal picture is bleaker than Europe's, the United States is not in as dire a situation on the state and local government front. This is because the no-bailout policy for state and local governments that has evolved over many years avoids significant elements of the "Argentina problem." Nevertheless, the possibility of fiscal dominance is real given the federal budget and debt situation. As we have noted, with sufficient political will, the U.S. government would be fully capable of avoiding fiscal dominance and achieving long-run fiscal sustainability by reining in spending on entitlements (Medicare/Medicaid and Social Security), while increasing tax revenue (but not necessarily tax rates). Indeed, a number of plans, including most famously by the majority recommendations of the Simpson-Bowles Commission, have already been laid out to show the way. Unfortunately, the political will is clearly not there yet, and the apparent gulf between the two political parties shows no signs of narrowing. If U.S. government finances are not put on a sustainable path, we could see the scenario outlined above, where markets lose confidence in U.S. government debt, so that bond prices fall and interest rates shoot up, and then the public might expect the Federal Reserve to be forced to monetize this debt. What would then unhinge inflation expectations would be the fear of fiscal dominance, which could then drive up inflation quickly. The bottom line is that no matter how strong the commitment of a central bank to an inflation target, fiscal dominance can override it. Without long-run fiscal sustainability, no central bank will be able to keep inflation low and stable.

Against this backdrop, there has been a great deal of attention paid to the Federal Reserve's quantitative easing policies as a potential threat to price stability in the United States. The concern is that the expansion of the Federal Reserve's balance sheet as a result of quantitative easing will unhinge inflation expectations and thus create inflation in the near future. However, as we will see in what follows, the Fed's greatly expanded balance sheet also introduces into the picture another channel through which sovereign risk can impinge on monetary policy and exacerbate inflation expectations—the heretofore little-noted Fed remittances to Treasury.

4.3. Possible implications for the Federal Reserve's exit strategy

An important issue raised by the possible emergence of concerns about U.S. fiscal sustainability is how it could affect the Fed's exit from the extraordinary policy easing it has undertaken since the onset of the financial crisis. Although Rudebusch (2011) concluded that the Fed's net interest income provided a substantial cushion against possible capital losses on its portfolio, much has changed since he performed those calculations. Many observers have expressed concern about the magnitude of balance sheet expansion that the Fed and other central banks have engaged in, noting the potential costs in terms of market interference, disruption to the markets upon exit, potential losses effectively resulting in a drain on the Treasury, and rising inflation expectations, eventually leading to rising inflation. Evidently, there is some concern within the Fed itself on these issues as well. The minutes to the December 2012 FOMC meeting indicated that such costs, including the potential effects of further balance sheet expansion on the Fed's remittances to Treasury when it comes time to exit, would have to be factored into upcoming decisions on how much further to push balance sheet expansion. A recent Fed staff paper by Carpenter, Ihrig, Klee, Quinn, and Boote (2013) has reported the implications of various Fed policy scenarios for the Fed's remittances to Treasury and found that under some conditions, the Fed could suffer substantial net income losses as it exits its current extraordinarily accommodative policy stance in the years to come. Given such concerns in what remains a remarkably calm fiscal environment (given near record-low Treasury yields), how much worse could the picture become if sovereign debt concerns heat up? And to what degree could U.S. monetary policy be constrained as a result?

To address this issue with respect to Fed policy, we begin by considering prospects for the Fed's balance sheet, income statement, and remittances to the Treasury under some plausible baseline expectations for Fed exit. We then consider alternative scenarios and, in particular, how the picture would be affected by a significant rise in inflation expectations originating in market concerns about fiscal sustainability and fiscal dominance of monetary policy. To produce these baseline and alternative projections, we have constructed a model of the Fed's balance sheet and income statement using detailed data made available to the public on the current composition of its balance sheet (down to the level of individual securities held) as well as the guidance the Fed has provided on both further expansion in the near term and on the exit process when the time comes. The model allows us to project the size and composition of both the asset and liability side of the Fed's balance sheet, as well as income, expenses and capital gains or losses booked on asset sales. It produces results very similar to those reported by Carpenter et al. (2013) when we use comparable assumptions.

4.3.1. Baseline simulations.

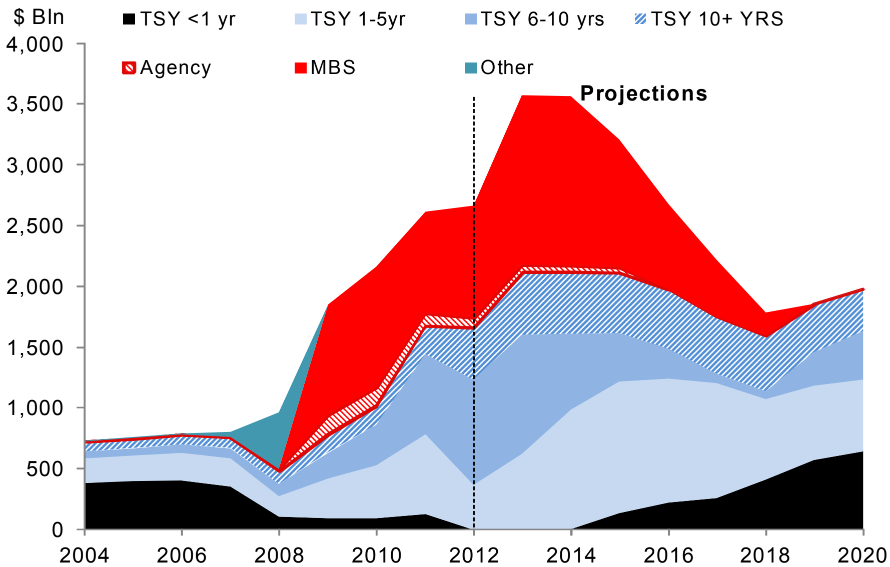
Our baseline projections of these variables are based on assumptions that are essentially the same as assumptions employed in the Carpenter et al. (2013) paper, with the exceptions of currency growth and bank capital. These assumptions are summarized in Table 4.1, discussed in more detail below, and illustrated in a sequence of figures as indicted in the right hand column of Table 4.1.

Table 4.1 Baseline assumptions for Fed's balance sheet and net income projections.

Variable	Assumed growth path	Figure
1. Asset purchases	Continue at current pace through December 2013, slow to maintenance levels (stock stable) through 2014, stop (stock declines) in 2015.	4.1
2. Asset sales	MBS sales start late 2015, completed in 2019	4.1
3. MBS prepayment	Follows market models	
4. Liabilities	Currency grows at 7% AR (2pp above Blue Chip forecast for nominal GDP growth per historical experience); required reserves grow at 4% AR	4.3
5. Interest rates	Driven by Blue Chip consensus forecast	4.4
6. Fed capital	Grows at 10% AR per historical average	4.5
7. Operating expenses	Grow on historical trend	4.5

Assets: As shown in Figure 4.1, we assume that the Fed's purchases of Treasury securities continue at a rate of $45 B per month and MBS purchases at a rate of $40 B per month through December 2013 (in the maturity buckets specified as of the December 2012 FOMC announcement) and are stopped thereafter. The Fed's principal reinvestment program is assumed to continue through 2014, after which assets are allowed to run off as they mature. Following Carpenter et al., we assume that the Fed's active selling of assets is limited to MBS and that these sales commence on a small scale in 2015, proceed more aggressively in 2016, and continue until 2019, by which time the Fed's portfolio is returned to its "normal" size (i.e., excess reserves have been run down to close to zero). The areas in different shades of blue in Figure 4.1 illustrate the shifting maturity composition of the Fed's Treasury holdings over time. Because MBS rates are projected to be higher when these assets are sold than they were when they were purchased, capital losses are recorded on these sales as discussed further below.

Figure 4.1. Baseline assets



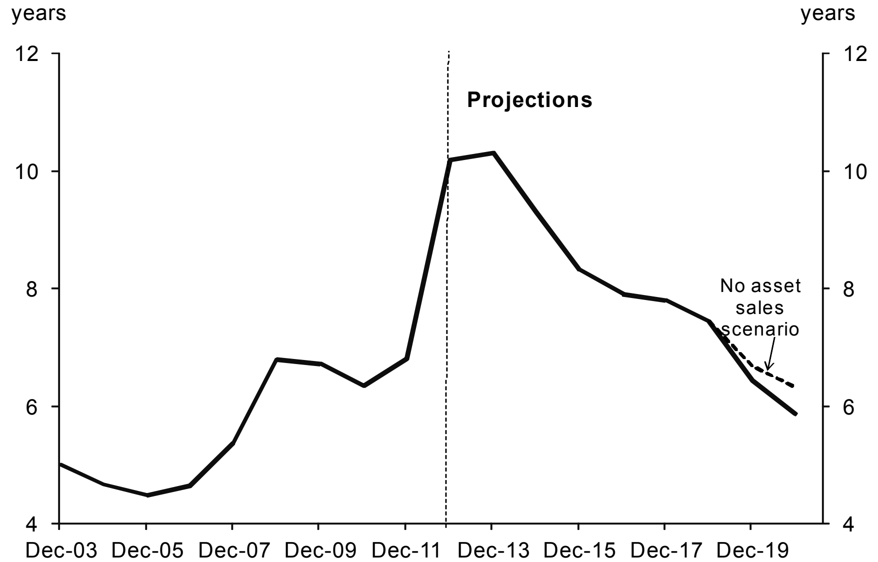
Source: FRB, Haver Analytics, authors' calculations

Under these assumptions, the duration (average term to maturity) of the Fed's portfolio peaks at nearly 11 years in 2013 with the end of new quantitative easing (Figure 4.2). The duration is important because as it rises, it increases the potential losses on the Fed's portfolio as the Fed strives to return its portfolio to a more normal level upon exit in a rising rate environment. It is worth noting that in comparison to the Fed, the Bank of Japan and ECB, both of which have expanded their balance sheets to several times their pre-crisis levels, have kept the duration of their portfolios much lower--on the order of three years.[31] Beyond 2013, the Fed's portfolio returns gradually toward a more normal composition under our baseline assumptions and the average duration recedes as securities held by the Fed mature over time, as the reinvestment program stops, as MBS sales proceed, and as the Fed begins to purchase shorter-term Treasury securities in 2019 once excess reserves have been run off. These assumptions return the average duration of the Fed's portfolio most of the way to its pre-crisis level by 2020. In the absence of

[31] The BOJ's portfolio is dominated by relatively short-term JGB's, and the ECB's by three-year LTROs. The ECB's holdings of sovereign debt account for less than 10% of its total assets.

outright asset sales, the reduction in average maturity declines a bit less—the effect here is small because the average maturity of the securities being sold is not much above the maturity of the overall portfolio at the time.

Figure 4.2 Average maturity of Treasury notes/bonds held by Fed



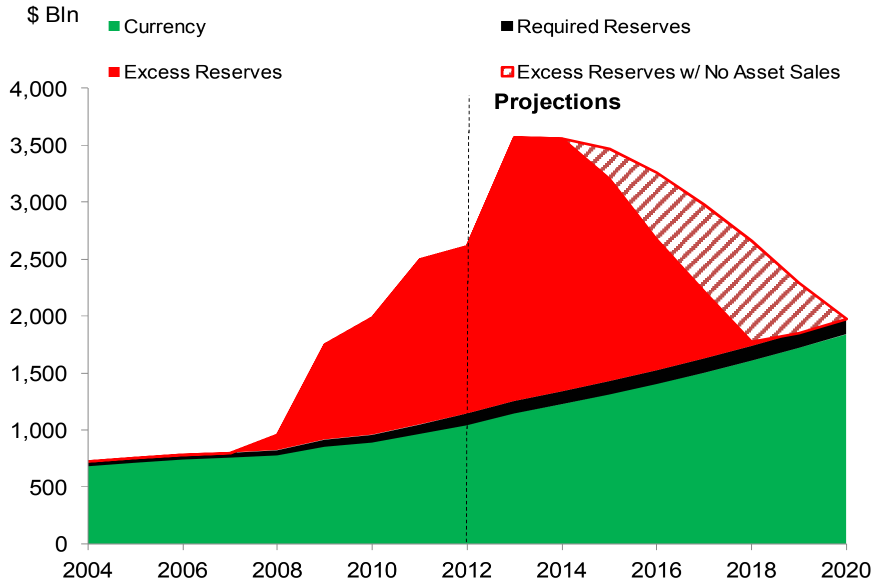
Source: FRB, Haver Analytics, authors' calculations

MBS prepayment: The rate at which the Fed's holdings of MBS run off is determined in part by assumptions about the rate of prepayment of mortgages, which varies with the level of interest rates. Our MBS prepayment assumptions were calibrated to match current market expectations about the sensitivity of prepayment rates to interest rates; in particular, prepayment rates are assumed to decline gradually to levels consistent with standard prepayment model assumptions over the next five years.

Liabilities: We assume that currency, the primary liability on the Fed's balance sheet in normal times, grows at a 7% annual rate—two percentage points faster than the Blue Chip/consensus forecast for nominal GDP growth over the next several years (Figure 4.3). This is in line with average experience over the past several decades; it is also a more favorable assumption than used by Carpenter et al., which assumed currency growth at 5% per year. The 7% assumption is more favorable in terms of its implications for the Fed's working capital position because the conversion of reserves into currency helps reduce the Fed's future costs associated with interest-bearing reserves. We also assume that bank deposits and required reserves grow roughly in line with their pre-crisis historical average of about 4%. The results of our analysis are not sensitive to this assumption, given the relatively small size of required reserves in the Fed's balance sheet. Excess reserves run down over time in line with the asset side of the balance sheet. We will also consider as an alternative scenario the possibility that the Fed avoids asset sales and just allows its holdings to run down as a result of mortgage repayment and prepayment, as well as the maturing of Treasury debt. This would delay the Fed's exit by two years, as indicated by the red and white shaded area in the chart.[32] Once excess reserves reach zero, asset purchases are driven by rising currency and required reserves.

[32] The corresponding change on the asset side, not shown in Figure 4.1, would entail a larger red area as MBS sales are dropped, and a smaller increase in the black area as purchases of Treasury bills to accommodate growth in currency during 2019-20s are dropped.

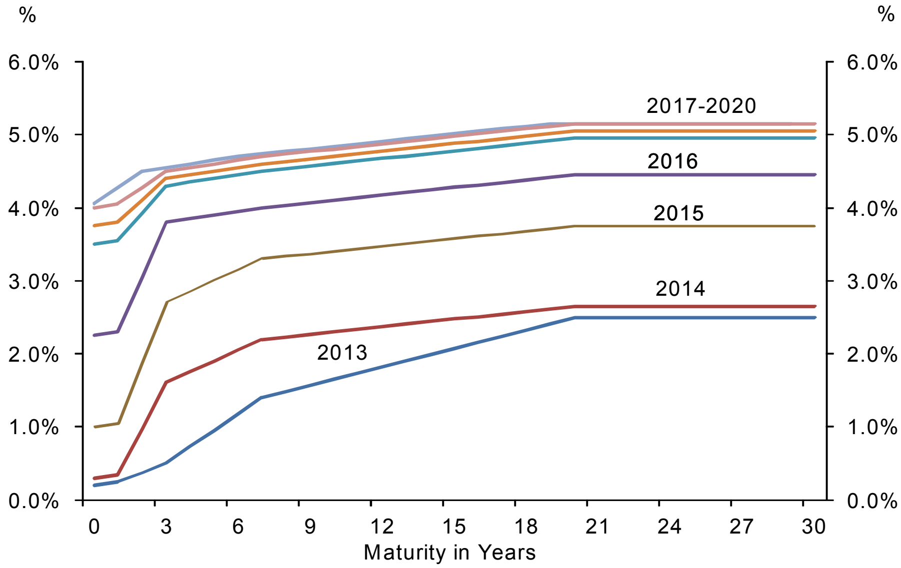
Figure 4.3 Baseline liabilities



Source: FRB, Haver Analytics, authors' calculations

Interest rate paths: To compute (1) interest income earned on the Fed's portfolio of assets, (2) interest paid to banks on reserve balances held at the Fed, and (3) capital gains or losses on securities that are sold, projected paths of policy rates and the Treasury yield curve are needed (Figure 4.4). Our baseline simulations assume that the 10-year Treasury yield evolves according to the most recent consensus forecast from the Blue Chip economic indicators and that spreads to the 10-year rate within the Treasury yield curve begin to normalize in 2014. In line with FOMC central-tendency and Blue Chip expectations, we assume that the fed funds rate and the rate paid on excess reserves begin to rise in 2015 and reach a "more normal" value of close to 4% beginning in 2018. From 2018 onward, these rates are near their longer-term values. In projecting the yield curve, as well as MBS yields, we assumed that the 1-year yield is tied to the fed funds rate and longer-term (including MBS) yields are tied to the 10-year Treasury yield via historical average spreads. Our driving assumptions about the fed funds and 10-year rates are roughly in line with those made in Carpenter et al.

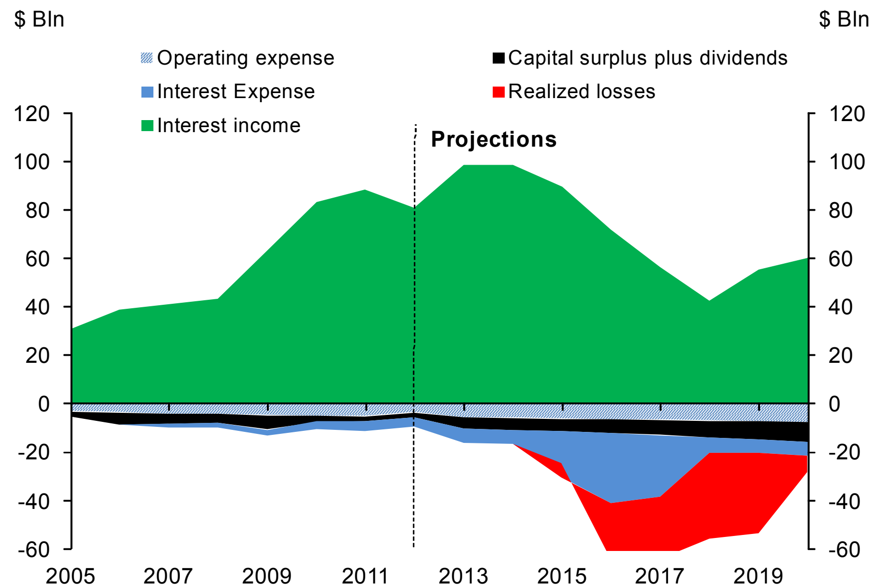
Figure 4.4 Interest rate assumptions



Source: Blue Chip and authors' calculations

Baseline net income statement. Based on these asset, liability, and interest rate assumptions, we can project much of the Fed's net income account, as outlined in Figure 4.5, and ultimately cumulative income gains or losses. The key components of the income statement are interest income on the Fed's portfolio net of premiums, interest payments on reserves and other liabilities, operating expenses, contributions to capital plus dividends paid on capital, and gains or losses on asset sales.

Figure 4.5 Baseline Income receipts and expenses



Source: FRB, authors' calculations

Dealing with net premiums: Because the Fed reports securities in its portfolio at par value, an adjustment must be made to projected interest income earned when the securities were originally purchased at a premium (or discount) relative to par. The premiums are amortized over the life of the security in the Fed's income statement. In the absence of comprehensive information about the magnitude of these premiums, we use an estimate reported by Carpenter et al. for net premiums at the end of 2012 and additional premiums associated with further securities purchases during 2013. Under these assumptions, the cumulative net premiums on the Fed's holdings of Treasuries and MBS have recently been on the order of $200 B, implying a downward adjustment to the Fed's earnings stream approaching $20 B per year relative to a par-value calculation of interest income. This amortization has been netted out of the income receipts shown in

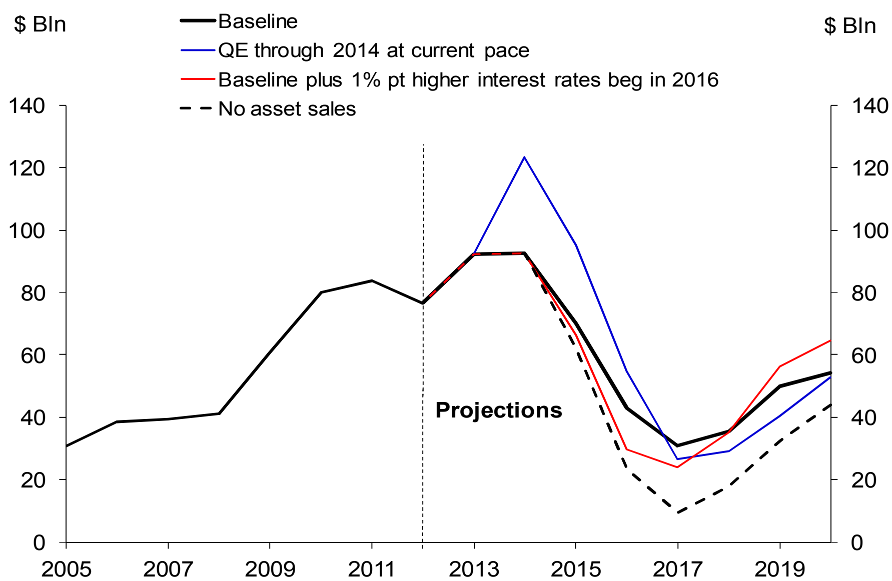
Figure 4.5. When assets are sold, remaining premiums are also subtracted from the computed proceeds of asset sales.

Other net expenses. We assume that "other expenses" including administration costs and so on grow on trend (as shown in Figure 4.5).

Capital and dividends. The Fed's contributions to capital surplus and dividends paid to member banks on their capital paid into the Fed are assumed to grow at 10% per year, roughly equal to the average annual growth of U.S. bank capital over the past decade. Carpenter et al. assume a higher 15% growth in capital, a less favorable assumption, but the results are not terribly sensitive to this assumption. The Fed's contributions to capital surplus are continually set equal to capital paid in by member banks. Private banks that are members of the Federal Reserve System are required to keep their capital held at the Fed equal to 6% of their own capital, and the Fed pays them a dividend of 6% on that capital each year. These capital contributions and dividends are taken out of net income before the balance is remitted to the Treasury.

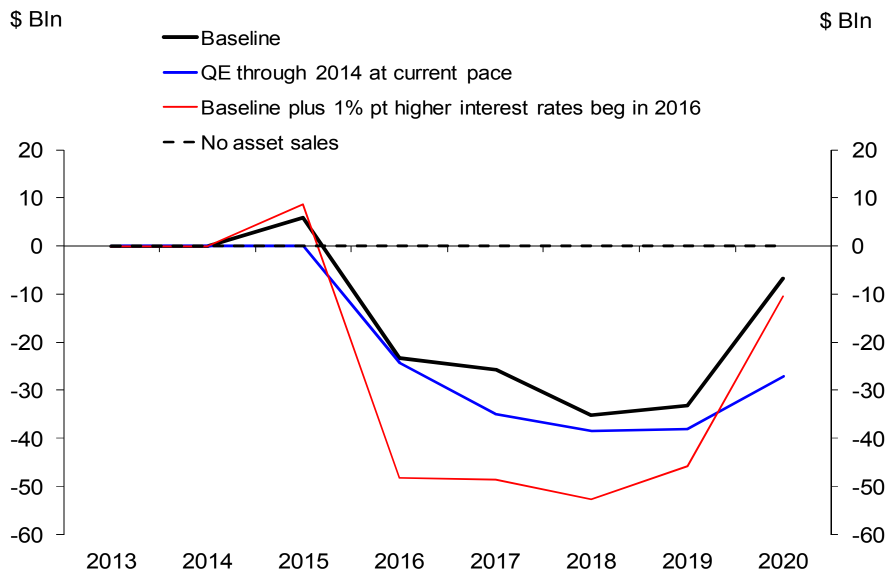
Baseline net interest income, net capital losses, and remittances to the Treasury. Net interest income (the difference between the green and blue areas in Figure 4.5) remains substantially positive in our baseline scenario, dipping to around pre-crisis levels in 2017 and rising thereafter (see also Figure 4.6 below). Under our baseline assumptions, capital losses on MBS sales (the red area in Figure 4.5 and black line in Figure 4.7) build to a peak rate of about $35 B in 2018. These losses are large enough to reduce net income available for remittance to Treasury to below zero in 2017-18 (Figure 4.8), after which that income gradually recovers toward more normal levels. (Recall that net income available for remittance to the Treasury is essentially equal to interest income minus the sum of interest payments on reserves, operating expenses, net capital losses, dividend payments on capital and contributions to capital surplus.)

Figure 4.6 Realized net interest income receipts



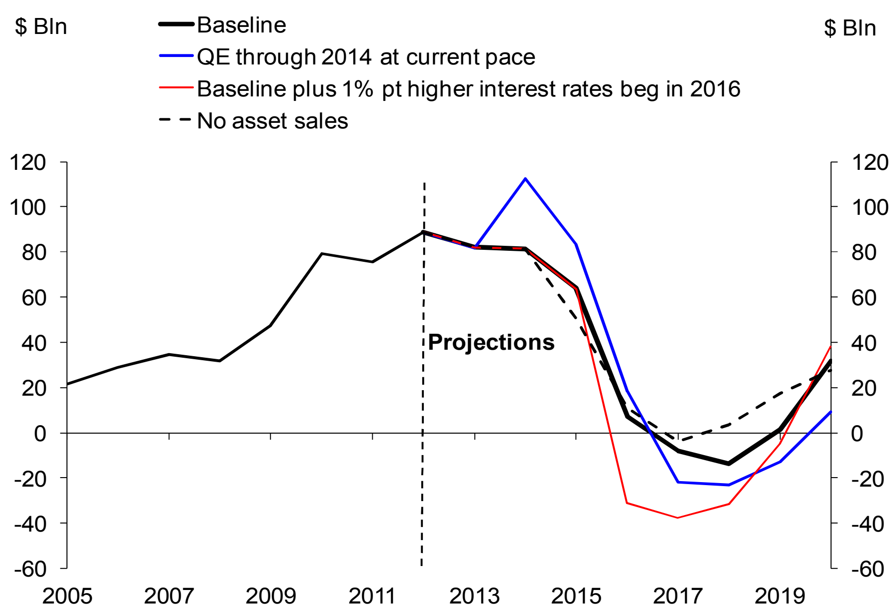
Source: FRB, authors' calculations

Figure 4.7 Net valuation gains or losses realized on asset sales



Source: Authors' calculations

Figure 4.8 Income before payments to Treasury

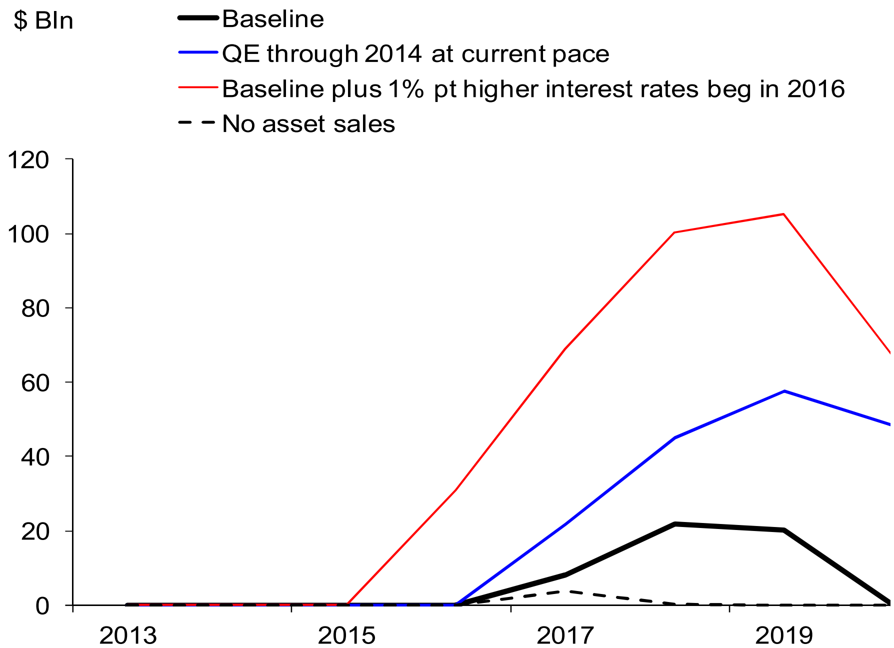


Source: FRB, authors' calculations

What would a negative remittance from the Treasury to the Fed look like? That is, if the Fed's net income fell below zero, how would it fund its interest payments on reserves, and its operating expenses? Would it have to draw down its capital or take out a loan from the Treasury, asking the Treasury to issue new debt to do so? No, under the Fed's new accounting practices adopted in January 2011, when net income available for remittance to Treasury falls below zero, this does not eat into the Fed's contributions to capital or threaten the Fed's operating expenses. Rather, the Fed would create new reserves against an item called the Fed's "***deferred asset***" account on the asset side of its balance sheet. For example, to pay interest on reserves, it would simply credit the payee bank's account at the Fed with the interest being paid, thus creating new reserves.[33] The deferred asset account being run up in the process would serve as a claim on future earnings or remittances to the Treasury. The idea is that when the Fed subsequently returns to earning a profit, rather than return that profit to the Treasury, it would use the funds to run down the deferred asset, and the extra reserves having been created in the process would be run down as well. In our baseline simulation, the deferred asset account would rise to a bit over $20 B by 2018, and it would run back down to zero by 2020.

[33] From a cash flow perspective, much the same could be done to deal with payment of dividends on member bank contributions to Fed capital and losses on asset sales. Fed contributions to surplus capital could simply be credited to the deferred asset account. And there would be more than enough interest income coming in to meet the Fed's operating expenses.

Figure 4.9 Deferred Asset Account

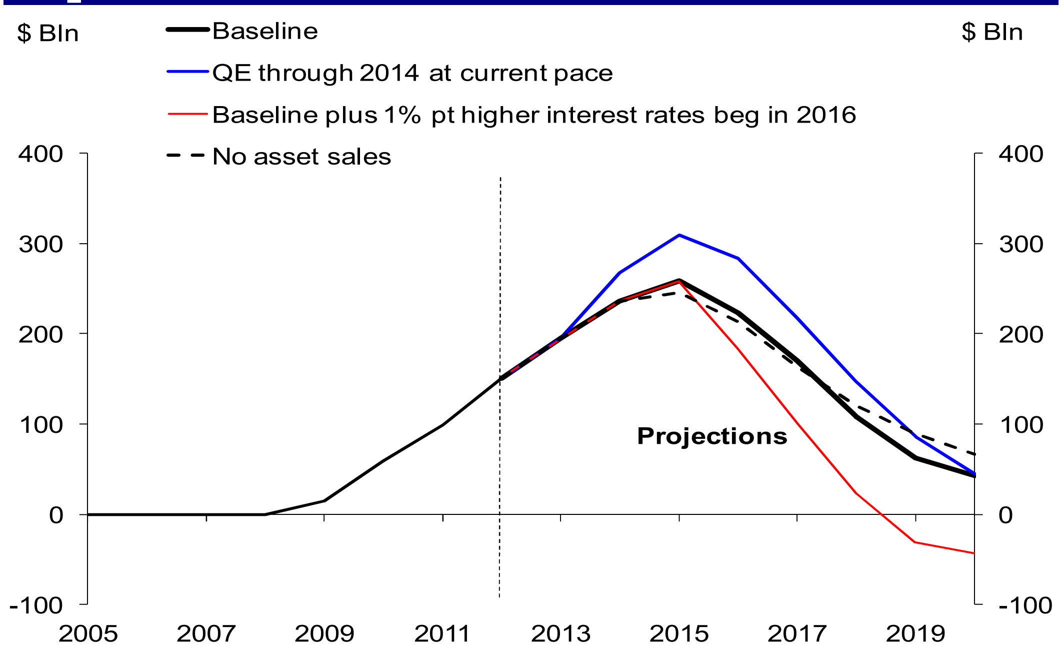


Source: Authors' calculations

In the present environment, when the demand for excess reserves is infinitely elastic, the creation of new reserves would not be a problem. But in the baseline exit scenario we are discussing, short-term assets have a positive yield and the demand for reserves would not be infinitely elastic. To persuade banks to hold a higher volume of excess reserves in such an environment, the Fed would need to increase the interest rate paid on excess reserves, otherwise the new reserve creation could, on the margin, become inflationary. It should be noted that this reserve creation is a second-order effect of the selling of assets by the Fed with the aim of running down excess reserves (and raising longer-term rates) in our baseline scenario. The capital losses incurred in this case would push up the deferred asset account enough to offset only a relatively small part of the intended reduction in reserves. However, even if the Fed were able to create additional reserves with no effects on the interest rate on those reserves, a cessation of positive interest payments from the Fed to the Treasury for a significant period could bring Fed policy decisions under greater public scrutiny, potentially leading to controversy that could even threaten central bank independence.

We also report an alternative gauge of remittances. Because the periods of reduced Fed income ahead will follow a period of "excess" Fed income, it is of interest to consider how the excess and losses will average out over time. Figure 4.10 shows the Fed's cumulative net remittances to Treasury relative to the pre-financial crisis trend in those remittances. A value of zero in this chart indicates that cumulative remittances have been in line with the pre-crisis trend. Under our baseline scenario, cumulative net remittances to Treasury remain higher than they would have been if they had followed the pre-crisis trend through 2020.

Figure 4.10 Cumulative net income relative to pre-crisis trend



Source: Authors' calculations

4.3.2. Alternative scenarios.

We consider a number of alternative scenarios, several of which are shown in Figures 4.6-4.10, and all of which are summarized in Table 4.1 in terms of the peak deferred asset level reached and the cumulative net income gain or loss (relative to pre-crisis trend) as of 2020. The first three alternatives shown in Table 4.1 reflect different assumptions on currency growth, asset purchases and sales. Reducing currency growth by two percentage points through 2020 (line 2) yields essentially the same deferred asset result as reported by Carpenter et al. as noted above. Cutting out asset sales and letting excess reserves run for another couple years (line 3) has a powerful positive effect on net income by eliminating capital losses (see also Figure 4.7). But to account for the increase in excess reserves that this scenario implies, we assume that supply would equal demand for reserves if the Fed raised the fed funds target by 100 basis points during 2016-18, and this has a significant negative effect on net interest income (Chart 4.6). Meanwhile, the deferred asset account is close to zero in the no asset sale scenario. Extending the current pace of asset purchases for another year through 2014 (line 4) is costly in terms of losses—it nearly triples the peak deferred asset relative to baseline. But the extended purchases do not affect cumulative gains/losses relative to trend by much because the higher purchases raise excess income relative to baseline initially (see Figure 4.8).

Table 4.2 Impact of alternative scenario on Fed's deferred asset and cumulative income gains/losses relative to pre-crisis trend.

	Peak deferred asset ($ Bn)	Cumulative excess gain/loss ($ Bn) 2007-2020
1. Baseline	22	43
2. Baseline with 2% pts slower currency growth	41	7
3. No asset sales	4	67
4. QE through 2014 at current pace	58	45
5. Baseline plus 1% pt higher interest rates begin 2016	105	-43
6. Baseline plus 2% pt higher interest rates begin 2016	194	-126
7. Baseline plus 2% pt higher interest rates beg in 2016 but no asset sales	67	-18
8. QE through 2014 at current pace and 2% pt higher interest rates begin 2016	372	-282

Source: Authors' calculations

The next four scenarios (lines 5-8) look at fiscal shocks, drawing in part on our analysis in Section 3. In particular, we consider how Fed exit would be affected by a sudden and sharp shift in market sentiment about U.S. Treasury debt. Our baseline U.S. fiscal simulation from Subsection 3.3.5 (the blue line in Figure 3.11) suggested that a rising debt load could produce a 100-basis-point premium relative to current values in the 10-year rate by 2021 and a 200-basis-point premium by 2027; effects of this magnitude could show up much sooner under some of our alternative scenarios. For a country such as the United States, we would interpret this premium as a compensation for the inflation risk that rises with higher debt levels, and would expect it to be manifest in an increase in both the long-term rate as well as the short-term rate necessary to equate supply and demand for excess reserves. We thus consider two alternative scenarios, one in which all yields are 100 basis points above our baseline balance-sheet simulation by 2016, and a second in which concerns about a fiscal crunch show up as a 200-basis-point increase relative to the baseline. In all of these scenarios, the risk premium shock is assumed to commence in 2016 and run through 2020 as markets look forward to ongoing failure of the U.S. political system to deal with its longer-term debt problems. Finally, we consider a "worst case" scenario that combines the extension of Fed asset purchases through 2014 with the 200-basis-point risk premium shock commencing in 2016.

As indicated in Table 4.1, three of these scenarios involving fiscal risk shocks (lines 5, 6, and 8) would have very large negative effects on the Fed's net income. Even in the smaller 100-basis-point case, the deferred asset account would rise to a level (in excess of $100 B) that significantly exceeded the likely level of Fed capital at the time (Fed capital is currently running at about $54 B). The losses relative to pre-crisis earnings trends would also more than wipe out the cumulative excess income that the Fed has returned to the Treasury in recent years. In all of these cases, net interest income would be hit by rising policy rates, and capital losses spurred by the premiums on longer-term rates. In the scenario where the Fed does not sell assets, the losses are reduced significantly.

4.3.2. Implications for Fed policy.

Our analysis and the analysis in Carpenter et al. (2013) have indicated that continued expansion of the Fed's balance sheet significantly raises the chances that the Fed will, for an extended period, cease to make positive remittances to the Treasury, especially if the Fed elects to sell some of its assets to speed up the runoff of excess reserves. In the presence of an unsustainable debt trajectory, political concerns surrounding any reduction in Fed remittances to the Treasury would be heightened. And the effect of fiscal imbalance on interest rates would exacerbate this problem. The magnitude of the Fed's cumulative net income losses could be increased substantially-- even approaching several times the size of Fed capital-- if failure to deal with an unsustainable U.S. fiscal position in the longer term results in a sizable increase in the inflation risk premium on U.S. national debt. This unfavorable fiscal arithmetic might tend to push the Fed toward delaying its exit from the extraordinary easing measures it has taken in recent years; it could even affect decisions this year about how much further to expand the Fed's holdings of longer-term government securities.

The Fed could cut its effective drain on the Treasury significantly by putting off asset sales and delaying policy rate increases. But such a response would presumably feed rising inflation expectations. In brief, the combination of a massively expanded central bank balance sheet and an unsustainable public debt trajectory is a mix that has the potential to substantially reduce the flexibility of monetary policy. This mix could induce a bias toward slower exit or easier policy, and be seen as the first step toward fiscal dominance. It could thereby be the cause of longer-term inflation expectations and raise the risk of inflation overall.

5 Conclusions.

In the aftermath of the global financial crisis, concerns about fiscal sustainability have come to the forefront in discussions of monetary policy. In this paper, we examined sovereign debt dynamics and concluded that countries with high debt relative to GDP cannot be complacent, even if they currently face low sovereign interest rates. Such countries are always vulnerable to an adverse feedback loop in which high debt leads to higher interest rates and hence higher debt loads, culminating in a tipping point-- or fiscal crunch -- in which the interest rate shoots up.

Recent sovereign debt crises among advanced economies have provided a rich data base for empirical analysis of the sensitivity of sovereign yields to debt levels and other aspects of fiscal risk. Our empirical work used both econometric analysis and event studies, and suggests that countries with debt above 80% of GDP and persistent current-account deficits are vulnerable to a rapid fiscal deterioration as a result of these tipping-point dynamics.

Many standard projections for the U.S. assume constant borrowing rates as debt loads rise. If there is instead some feedback, as historical experience suggests there could well be, the problems facing the U.S. in the next decade could easily escalate into an unmanageable situation.

The dangers of a fiscal crisis raise issues about the appropriate response of monetary policy. Overly tight monetary policy may make fiscal consolidations harder to achieve, while unsustainable fiscal policy could lead to a situation of fiscal dominance in which the central bank is no longer able to keep inflation under control. A fiscal risk shock occurring within the next five years would complicate matters greatly for a Fed that will be in the process of exiting from its massive balance sheet expansion. Unsustainable fiscal policy could result in a large increase in the inflation risk premium for U.S. government debt, leading to possible substantial losses on the Fed's balance sheet. This could further feed back into rising longer-term inflation expectations, raising the risk of an unwelcome surge in inflation.

If long-run fiscal policy consolidation occurs, consistent with a gradual decline in the debt burden, accommodative monetary policy would help counter any potential weakness in the economy. If long-run fiscal policy were shifting in the right direction, consistent with a gradual decline in the debt burden, accommodative monetary policy would be the appropriate response to a weak economy. Unfortunately, such a shift in U.S. fiscal policy is still far from apparent, complicating significantly the choices for monetary policy makers.

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