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Sovereign Debt Sustainability in Italy and Spain: A Probabilistic Approach

William R. Cline

Abstract

This paper introduces a new probabilistic approach to sovereign debt projections and presents new estimates of debt ratios through 2020 for Italy and Spain. The new approach takes account of likely correlations across 243 alternative scenarios with three states (good, baseline, bad) for five key variables (growth, interest rate, primary surplus, bank recapitalization, and privatization). The 25th and 75th percentile scenarios are reported, as are the baseline and probability-weighted outcomes. The results suggest sovereign debt is sustainable in both Italy (where debt ratios are likely to decline because of a high primary surplus) and Spain (where the ratios rise but at a decelerating pace and from relatively low levels).

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Keywords: sovereign debt, Italy, Spain, euro area crisis

William R. Cline, senior fellow, has been associated with the Peterson Institute for International Economics since its inception in 1981. His numerous publications include *Resolving the European Debt Crisis* (co-editor, 2012), *Financial Globalization, Economic Growth, and the Crisis of 2007–09* (2010) and *The United States as a Debtor Nation* (2005).

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Peterson Institute for International Economics

1750 Massachusetts Avenue, NW Washington, DC 20036-1903
Tel: (202) 328-9000 Fax: (202) 659-3225 www.piie.com

INTRODUCTION

A debt simulation model provides a useful basis for analyzing the sustainability of sovereign debt. The basic premise is that if, under reasonable assumptions, the relevant debt ratios show a prospective path of moderation over time, or (for a country with a high debt ratio which is nonetheless still able to access the capital market) at least avoidance of worsening over time, then a country is judged solvent and capable of carrying its sovereign debt load without restructuring or partial forgiveness. This study sets forth such a model, the European Debt Simulation Model (EDSM).[1] The model combines exogenous information, in particular on interest rates and the time profile of maturities coming due for long-term debt already outstanding, with alternative scenarios for key policy and market variables. The scenario variables apply alternative cases for: real GDP growth rates, the primary fiscal surplus, the interest rate on new medium- and long-term debt, the amount of public outlay needed for bank recapitalization or other forms of "discovered debt," and the amount of prospective receipts from privatization. As discussed below, with three alternative states (base case, unfavorable, favorable) and five variables, there are 243 outcomes for the model. This study develops an approach to considering the correlation among the contingent states to provide a sense of the probability distribution of the various outcomes.

The policy context for this study is the centrality of debt sustainability in both Italy and Spain in determining whether the euro area can resolve its debt problem without far more severe economic disruption than has already taken place in the region. If either or especially both countries were forced into some form of sovereign default and/or exit from the euro, the likely damage to the euro area economy and the world economy would be large. In Cline (2012a), I argued that Spain's initially low ratio of debt to GDP gave it considerable room for maneuver. In Cline (2012b), I conducted selected simulations of the EDSM to examine Italy's debt, and concluded that because of a relatively favorable maturity structure of medium-term debt Italy could sustain even relatively high interest rates (over 7 percent) for a number of years so long as it met its primary surplus targets, but that some form of firewall would be highly desirable to ensure that the interest rates did not surge far higher and impose a self-fulfilling prophecy of insolvency.

The new calculations in this study seek to shed more light on the case of Spain, where in recent months market rates have reflected relatively high concern about debt sustainability, and in addition, apply the new probabilistic approach incorporating scenario correlation for the case of Italy.

1. An earlier version of the model was applied in Cline (2011; 2012b).

THE MODEL

The horizon of the model is through 2020, or for year $t = 1$ to 9 for 2012 through 2020. Nominal GDP is calculated as:

$$1) Y_t = Y_{t-1}[1 + g_t][1 + \dot{p}_t]$$

where Y is GDP in billions of current euros, g is the real growth rate, and $\dot{p}$ is the GDP deflator (with the overdot representing proportionate increase).

The fiscal deficit (*DEF*) for the year equals the interest *(INT)* due on public debt minus the primary surplus *(PS)*:

$$2) DEF_t = INT_t - PS_t$$

The interest due is calculated as the sum across three public debt categories of the stock of debt at the end of the previous year multiplied by the interest rate applicable for the current year, with debt divided into short-term (one year or less), "old" medium- and long-term debt outstanding at the end of 2011, and "new" medium- and long-term debt incurred in 2012 and after. Because interest is earned on government financial assets, the net interest relevant for the contribution to the deficit deducts such interest earnings. Thus:

$$3) INT_t = \sum_k D_{k,t-1} r_{kt} - FA_{t-1} r_{at}$$

where D is the stock of debt, $k = 1$ to 3 is the category, r is the interest rate, FA is the stock of public sector financial assets, and subscript a refers to assets.

The primary surplus is the scenario's postulated rate π as applied to nominal GDP, or:

$$4) PS_t = \pi_t Y_t$$

For the year in question, the net borrowing requirement (*NBR)* is then equal to the fiscal deficit, plus the amount of extraordinary increase in debt attributable to recognition of arrears, capital payment in support of banks, or other non-budgetary increase in debt, designated here as *DDIS* for "debt discovery;" minus the amount of receipts obtained from privatization, Z.

$$5)\ NBR_t = DEF_t + DDIS_t - Z_t$$

The gross borrowing requirement will then equal the net borrowing requirement plus amortization (*AMZ)*, plus the amount needed to cover the increase in public financial assets (ΔFA). For its part, amortization in turn will equal the sum of short-term debt to be rolled over (D_{1t}) plus the year's principal maturities on medium- and long-term debt outstanding at the end of 2011 (A_{2t}), plus amortization coming due on the outstanding stock of medium- and long-term debt newly incurred in 2012 and thereafter (A_{3t}):

$$6)\ GBR_t = NBR_t + AMZ_t + \Delta FA_t$$
$$7) AMZ_t = D_{1t} + A_{2t} + A_{3t};$$

The schedule of amortization on old medium- and long-term debt (A_2) is known from Treasury data. It is assumed that the amortization due on newly acquired medium- and long-term debt is a fixed proportion θ of the previous year's outstanding post-2011 medium- and long-term debt, with the calculations applying $\theta = 0.1$ to represent 10-year maturities. The calculations also assume that short-term debt remains constant, at $D_{1t} = D_{1,0}$ where $D_{1,0}$ is the amount outstanding at the end of 2011.

The amount of new borrowing of medium- and long-term debt (B_{3t}) will then be the gross borrowing requirement minus the amount of short-term debt being rolled over, or:

$$8) B_{3t} = GBR_t - D_{1,0}$$

The outstanding stock of short-term debt is constant at $D_{1,0}$. The outstanding stock of old medium- and long-term debt is the previous year-end total less the amount amortized during the year. Outstanding new (post-2011) medium- and long-term debt equals the amount at the end of the previous year, plus the amount of new medium- and long-term borrowing, minus amortization on this debt. Thus:

$$9) D_{1t} = D_{1,0}; D_{2t} = D_{2,t-1} - A_{2t};\ D_{3t} = D_{3,t-1} + B_{3t} - A_{3t}$$

For their part, public financial assets at the end of the year equal the amount at the end of the previous year plus the increment during the course of the year: $FA_t = FA_{t-1} + \Delta FA_t$.

Equations 1 through 9 are accounting relationships that yield paths of debt, net debt, interest payments, and amortization, all of which when compared to GDP provide alternative indicators of the debt burden. The economic influences driving the accounting outcomes are, again, the key variables allowed to vary across the scenarios: growth, primary surplus, interest rate on new long-term debt, bank recapitalization and other debt discovery, and privatization.

CONTINGENT STATE CORRELATION

Appendix A develops a method for taking into account the correlation of "contingent states" (good, bad, central) across the key economic variables for purposes of identifying the relative probabilities of alternative outcomes. The point of departure is the specification of a base case for each variable (a time path of the central expectation for the variable, in this case for 2012 through 2020). An adverse "bad" time path and favorable "good" path are then identified, flanking the base case. With three possible states for five variable-time paths, there will be $3^5 = 243$ possible outcomes.

As developed in the appendix, there can be positive or negative correlation between pairs of states. For example, the "good" growth state is likely to be positively correlated with the "good" market interest rate case because as investors observe stronger growth performance they will be more willing to purchase government bonds at moderate interest rates. Conversely, a "good" state on one variable can be negatively correlated with that on another variable (i.e., correlated with that variable's bad state). For privatization, for example, if there is greater success raising the primary surplus there will be less pressure to raise funds through the substitute means of privatization. The "bad" state of less privatization receipts will be correlated with the "good" state of a high primary surplus.

The specification of scenario probabilities applied in this study is as follows. Other things being equal, the probability that a given variable will be at its "base" case is 40 percent; at its "good" case, 30 percent; and at its "bad" case, 30 percent. However, if another variable with which the variable in question is correlated (with coefficient unity) is at the same non-base state as is the variable (both in their "good" states, for example), then the probability that the variable in question is in its good state is increased by an additive amount, and the probability that the variable in question is in its bad state is correspondingly reduced by this amount. As discussed in appendix A, in the extreme case in which the variable's state is positively correlated with each of the other key variable states, and all of the variables are in the same non-base state, the probability of the variable's non-base state is at its maximum, set at 0.45, and the probability of the opposite non-base state is at is minimum, set at 0.15. The scenario probabilities are then normalized so that they sum to unity.

The effect of calculating the scenario probabilities taking account of scenario correlation across the key variables is to provide a basis for examining the likely range of outcomes based on a particular criterion. For this purpose the estimates here consider the ratio of debt to GDP. The various outcomes are arrayed from best to worst and then the paths representing cumulative 25th percentiles and 75th percentiles are identified, as indicative of the most meaningful range of outcomes. The base case is also identified (in which each key variable has its base case path). Finally, the probability-weighted path is identified. Only by chance will it lie along the base case path.

The calculations in this study apply the correlation coefficients shown in table 1, corresponding to the coefficient ρ in appendix A.

The correlation coefficient between growth and the primary surplus is set to be positive but at a relatively low level of 0.2. The revenue outcome will tend to be strong when growth is strong, making for a positive correlation. However, in the context of fiscal adjustment with still relatively high unemployment, the effort to increase the primary surplus can have a negative impact on growth, eroding what would usually be a positive correlation.

Proceeding across the first row of the table, the correlation between the states (but not the levels, which are the reverse) for growth and interest rates is set at positive unity. As just suggested, investors are likely to take heart when they see stronger growth, and purchase government bonds with a lesser risk premium. Conversely, if they see severe economic contraction, they are more likely to insist on a high risk premium. The good states will be correlated with the good states and the bad ones with the bad ones. The correlation could be the other way around under more normal circumstances. Thus, when the economy is booming and refinancing public debt is not a problem but inflationary pressures are a concern, the central bank would likely increase interest rates.

Still in the first row, a positive correlation is posited between the growth state and the bank recapitalization and debt discovery state (again, state, not amount, which is the reverse). Stronger growth is likely to be associated with lesser need to bail out the banks, and lesser incidence of provincial fiscal gaps that need to be made up at the center. The good growth state will be associated with the good bank recapitalization state, and their respective bad states similarly associated. The correlation is set at less than unity, however, as legacy problems may leave substantial discovered debt (and bank recapitalizations) even in the good growth case.

For the final entry in the first row, countervailing directions seem sufficient to posit a zero correlation between growth and privatization. Although high growth would boost revenue and make privatization less urgent, the revenue effect is dealt with directly in the correlation between the primary surplus and privatization. There might be a weak association the other direction: Poor growth might raise the concern that any privatizations would be at fire-sale prices, so the "bad" state for growth would be associated with the "bad" state of low privatization effort. On balance the two are treated as neutral with respect to each other.

In the second row of the table, the first entry has already been discussed: the correlation of the growth state with the primary surplus state. The first new entry is for the correlation of the primary surplus state with the interest rate state. This coefficient is set at -0.5, meaning loosely that about half of the time the primary surplus will be in its good state (high) when the interest rate is in its bad state (high) but otherwise the two will not be associated. The motivation is that if the country faces higher interest rates, it will need to make a greater fiscal effort to compensate. The negative association between the states is moderated to the extent that investors reward the government with lower interest rates as they observe more ambitious fiscal effort. Once again the correlation could be in the opposite direction in the absence of debt stress, as unusually strong growth might prompt inflationary concerns and induce the central bank to raise interest rates.

The next entry in the second row of table 1 indicates a zero correlation between the primary surplus and bank recapitalization (discovered debt). The final entry in that row indicates a correlation of negative unity between the primary surplus state and the privatization state, because the two are essentially substitutes as sources of cash available to the government.

In the third row of the table, the first entry not yet discussed is for the correlation of the interest rate state with the bank recapitalization state. This coefficient is set at positive unity, on grounds that banks are likely to be under greater stress when the sovereign is under greater stress from higher risk premiums in market interest rates. Finally in this row, the correlation between privatization and the interest rate states is set at zero, for reasons similar to those discussed above for a zero correlation of the growth performance with the privatization effort.

The final correlation not yet discussed is between the extent of bank recapitalization (and debt discovery) on the one hand and privatization on the other. The two are treated as being independent of each other (zero correlation coefficient).

SCENARIOS FOR SPAIN

Table 2 reports the 2012–20 time paths for the unfavorable (1), baseline (2), and favorable (3) scenarios for each of the five key variables: real GDP growth, primary surplus as a percent of GDP, interest rate on new 10-year debt, public outlays for bank recapitalization and discovered debt (billions of euros), and privatization (billions of euros). For comparison, the table also indicates the level of baseline GDP.

For economic growth, the estimates for 2012 and 2013 are based on the International Monetary Fund's (IMF) April 2012 *World Economic Outlook*, or WEO (IMF 2012a) and on Consensus (2012). The unfavorable case applies the average for the three most pessimistic among the 12 private forecasters surveyed by *Consensus Forecasts*; the favorable case, the average for the three most optimistic. The baseline is the average of the WEO and the mean of the Consensus forecasts. For 2014 and after, the baseline applies the WEO projections through 2017 and then extends the 2017 rate for 2018–20 (not included in the WEO horizon). The unfavorable growth scenario for 2014–20 equals the baseline rates minus 0.67 percentage point growth in each year. The favorable growth scenario is set at a flat 3 percent per year, the 1990–2000 average prior to the euro (see IMF 2012a).

For the primary surplus, once again for 2012 and 2013 the unfavorable and favorable estimates are from the pessimistic and optimistic Consensus forecasts; the baseline estimates are the averages of the Consensus mean and the WEO estimate.[2] For 2014 and after, the baseline scenario is premised on a steady overall fiscal deficit of 3 percent of GDP, approximately the target set by the Spanish government.[3]

2. Note that the Consensus projections are for the total fiscal deficit, and are converted into primary balance estimates based on the WEO estimate of interest payments.

3. In early July 2012, Spain and EU officials agreed to relax the 2012 fiscal deficit target from 5.3 percent of GDP to 6.3 percent, and the 2013 target from 3 percent of GDP to 4.5 percent, and set the 2014 target at 2.8 percent of GDP. Miles Johnson and Peter Spiegel, "EU to relax Spain deficit targets," *Financial Times*, July 10, 2012.

The resulting primary surplus of about 1 percent of GDP by 2017 and after is by no means overly ambitious by international standards, and is far below the prospective levels in Italy in particular. In contrast, the IMF is pessimistic about Spain's capacity to achieve a primary surplus. Thus, for 2013 the WEO places the overall fiscal deficit at 5.7 percent of GDP whereas the mean Consensus private forecast places it at 4.0 percent. Similarly the WEO places the primary balance at a deficit of 2.2 percent of GDP in 2014 instead of a zero primary balance in 2014 in the baseline here, and still at a slight deficit of 0.2 percent of GDP by 2017. So in this case the projections here treat the WEO outlook for 2014–17 as the unfavorable scenario for that period. For its part, the favorable scenario for 2014–20 assumes that in each year a primary balance of 0.5 percent of GDP higher than in the baseline path is achieved.

The interest rate scenarios refer to the average interest rate paid in the year in question on new medium- and long-term debt contracted after 2011. The projections are based on a path for the German 10-year bund rate plus alternative spreads.[4] In the unfavorable scenario the spread is 500 basis points for interest payable in 2013, 450 basis points in 2014, 400 in 2015, and 375 thereafter. In the baseline, the spread is set at 350 basis points for 2013 and 300 basis points in 2014, declining by 25 basis points annually until it reaches 175 basis points in 2019 and after. In the favorable case, the spread is 50 basis points lower than in the baseline for each year in 2013–17, and 25 basis points lower than the baseline in 2018–20.

For bank recapitalization outlays and other discovered debt, the estimates begin with the WEO estimate of €36 billion in 2012 for recognition of regional government arrears.[5] This is the figure applied in the favorable scenario. In the baseline scenario, it is also assumed that €5 billion must be allocated by the government to assist in bank recapitalizations, in view of the range of losses already reported by Bankia in particular. The baseline assumes that Spain is successful in obtaining other bank recapitalization amounts from support from the European Stability Mechanism (ESM) directly to the banks without this support winding up in sovereign debt, as agreed in principle in the euro area summit meeting in late June, subject to prior successful establishment of central supervision for euro area banks.[6] In contrast, in the unfavorable scenario, it is assumed that the full amount of bank recapitalization needs accrues to a corresponding increase in sovereign debt.[7] The total amount of debt increase from banking

4. The bund is set at 1.5 percent for 2012 and 2 percent for 2013 (based on the WEO and on Consensus forecasts), 2.5 percent for 2014 (my interpolation), and 3.6 percent in 2015 and 3.7 percent thereafter (based on IMF 2011).

5. The WEO's projections show an increase in public debt in 2012 that is higher than what can be explained by the fiscal deficit by this amount. Communication with IMF experts indicated that region-based debt discovery is the reason.

6. Stephen Fidler, Gabriele Steinhauser, and Marcus Walker, "Investors Cheer Europe Deal," *Wall Street Journal*, June 30–July 1, 2012.

7. This treatment of course raises the question of a corresponding increase in sovereign assets, but for the unfavorable case it is assumed that such asset gains are zero.

recapitalization (as opposed to recognition of regional arrears) is set at €50 billion in this case, the range identified in recent outside reviews of the Spanish banks.[8]

Finally, the privatization outlook is set at zero in both the baseline and unfavorable cases, but at a total of €15 billion over three years in the favorable scenario, based on earlier discussions of privatizing airports and the national lottery prior to the current government's suspension of such efforts because of unfavorable conditions.[9]

SCENARIOS FOR ITALY

Table 3 reports the corresponding scenario assumptions for Italy. In the case of interest rates, the same scenarios are assumed as in table 2 for Spain, and are not repeated. Bank capitalization and discovered debt are assumed to be zero in all scenarios, and are thus not indicated in the table. Privatization receipts are based on a recent statement by Italy's new Minister of Economy, indicating that privatizations (mainly of real estate) could reach €15 billion to €20 billion annually over five years.[10]

For 2012 and 2013 the estimates are again based on Consensus (2012) and the April WEO (IMF 2012a). Again the baseline estimates are the averages of the WEO and Consensus figures. The unfavorable scenarios are the averages from the three most pessimistic private forecasters surveyed by Consensus, and the favorable scenarios are those from the three most optimistic. For 2014–17 the baseline growth projection is that from the WEO, and growth in 2018–20 is extrapolated at the 2017 rate. The unfavorable scenario is lower than the baseline by 0.5 percentage points in each year of 2014–20. The favorable scenario sets growth in 2014–20 at its actual average in 1990–2000, 1.64 percent annually.

The scenarios for the primary balance are derived in the same way for 2012 and 2013 (based on the WEO and Consensus forecasts). For 2014 and after, the baseline adopts the WEO projection, which calls for a high primary surplus of 5.1 percent of GDP by 2017. The favorable scenario adds 0.5 percent of GDP to the primary surplus in each year. The unfavorable scenario sets a ceiling of 2.7 percent of GDP on the primary surplus, the average actually achieved in 1990–2000 (IMF 2012a).

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8. Based on the stress tests conducted by the firms Oliver Wyman and Roland Berger. "Spain may need €62 billion to rescue banks," *Reuters*, June 21, 2012.

9. Pablo Dominguez and David Román, "Spain Halts Plan to Privatize Main Airports," *Wall Street Journal*, January 24, 2012.

10. Ferruccio De Bortoli, "Ecco il piano per ridurre il debito," L'Intervista—Il Ministro dell'Economia, *Corriere della Sera*, July 15, 2012.

RESULTS FOR SPAIN

Figure 1 shows four alternative projections for the ratio of gross public debt to GDP in Spain: the baseline, the paths at the 25th percentile and the 75th percentile across the 243 outcomes, and the probability-weighted average outcome. In the baseline, Spain's sovereign debt rises from 68 percent of GDP in 2011 to 80 percent in 2012 and 84 percent in 2013, and thereafter gradually increases to reach 89 percent of GDP by 2020. Considering that Germany's 2011 ratio of public debt to GDP was 81.5 percent (IMF 2012a), the prospective baseline range for Spain is hardly one representing massive overindebtedness. The baseline broadly confirms the diagnosis in Cline (2012a) that because Spain started from a low debt ratio, it should be able to manage its prospective deficits without becoming insolvent. Thus, in the baseline, Spain's gross public debt would reach 89 percent of GDP by 2020 (table B1), the same level as for France in 2012. (IMF 2012a). The probability-weighted ratio of gross debt to GDP would be only slightly higher, at 92 percent. Even though the ratio is still rising by 2020 in the probability-weighted case, the slope of the increase by then is extremely flat, and at that rate of increase the debt ratio by 2030 would still be under 100 percent—well below the 120 percent that has come to be the benchmark (based on Italy) for a sustainable debt ratio in the euro area.[11]

The 25th percentile path indicates that on the favorable side the debt ratio would stabilize at 85 percent; the 75th percentile path indicates instead that the ratio would reach 99 percent by 2020 and still be rising. The probability-weighted outcome is an expected debt ratio of 92 percent of GDP by 2020, only slightly higher than in the baseline. As discussed in appendix D, the fact that the probability-weighted outcome is less favorable than the baseline is attributable to the "distance" between the baseline on the one hand and the favorable and unfavorable extremes on the other hand. This distance is greater on the adverse side, in the scenarios constructed here, so the effect of giving equal probability to the adverse and favorable alternative scenarios is to make the probability-weighted outcome more adverse than the baseline. As examined in appendix D, the incorporation of correlations across the non-base scenarios pushes the 25th and 75th percentile paths closer to the extremes but has minimal effect on the probability-weighted outcome.

The April WEO (IMF 2012a) gave a somewhat more pessimistic projection of Spain's public debt, indicating that by 2017 it would reach 92 percent of GDP. This level is modestly higher than the 2017 baseline estimate here of 88 percent, and reflects the fact that the IMF has a relatively pessimistic view of the scope for increasing the primary surplus in Spain (as discussed above). Even so, the IMF's debt projection yields almost the same outcome as the probability-weighted estimate here (90 percent for 2017).

11. The probability-weighted debt ratio rises from 90 percent to 92 percent from 2016 to 2020, or by 0.5 percent per year.

As shown in appendix B (figure B1), Spain's net public debt (after subtracting public financial assets) rises from 57 percent of GDP in 2011 to 68 percent in 2012 and 72 percent in 2013, and then gradually rises to reach 78 percent of GDP by 2020. Net interest (figure B2) rises from 2.5 percent of GDP in 2012 to 4 percent by 2020, a relatively high level. Table B1 reports full details of the baseline projections for Spain.

RESULTS FOR ITALY

Figure 2 shows the path of debt relative to GDP for Italy in the baseline, 25th and 75th percentiles, and probability-weighted average outcome. In the baseline, Italy's debt ratio peaks at 123 percent of GDP in 2012–13 and then declines to 104 percent by 2020. In the favorable 25th percentile the decline would be to 100 percent. Even in the unfavorable 75th percentile the debt ratio would decline moderately, to 116 percent by 2020. The probability-weighted debt ratio declines from a peak of 123 percent in 2012 to 109 percent by 2020. The difference between the baseline and probability-weighted cases is modestly larger for Italy than Spain, reflecting (among other influences) the fact that in Italy the unfavorable case allows for a wider shortfall of the primary surplus from the path assumed in the baseline.[12]

The baseline projection for Italy's ratio of gross debt to GDP is qualitatively similar to, but slightly more favorable than, that in Cline (2012b), as the baseline here assumes that the primary surplus remains at the IMF's high projected level of 5.1 percent in 2017 and after, rather than easing to 3.5 percent after 2017 as assumed in my earlier projections. The baseline here is almost the same as that of the WEO through the year 2017 (here the debt ratio is 116 percent in that year; the WEO estimate is 118 percent), and the probability-weighted debt ratio is the same here (118 percent) as the WEO baseline estimate.

As shown in appendix B (figure B3), net debt peaks at 103 percent of GDP in 2013 and declines to 88 percent in the baseline. Net interest payments (figure B4) rise from 4.3 percent of GDP in 2012 to a peak of 5.4 percent in 2016, before easing to 4.9 percent again by 2020 in the baseline, reflecting the relatively high interest burden emphasized in Cline (2012b) and underscoring the importance of achieving the high primary surplus. Table B2 reports full projection details for the baseline for Italy.

VULNERABILITY TO MARKET SHOCKS AND POLICY SLIPPAGE

Over the course of the past year the central question in the European debt crisis has been whether market interest rates facing the two large at-risk countries, Italy and Spain, would spiral out of control in the same fashion as had happened to Ireland, Portugal, and especially Greece. Thus, market rates on 10-year bonds

12. The ratio between the probability-weighted and baseline debt ratios in 2020 is 1.048:1 for Italy and 1.034 for Spain. The annual average gap between the baseline and unfavorable primary surplus paths for 2014–20 is 1.35 percent of GDP for Spain but 2.13 percent for Italy. For further discussion see appendix D.

reached peaks of about 13.5 percent for both Ireland (in August 2011) and Portugal (in March 2012), and the peak reached in Greece was almost 50 percent (March 2012).[13] Rates fell substantially from their peaks for Ireland (to about 6.5 percent by July 2012) and Portugal (to about 10.5 percent).

In contrast, peak interest rates for Italy and Spain have been much more manageable, reaching 7.3 percent in Italy (in late November 2011) and 7.6 percent in Spain (in late July 2012; figure 3). The debt drama in Europe has broadly involved a tug of war between the markets, on the one hand, and the euro area authorities taking successive actions to help stem the attack on the two big economies, on the other. A temporary turning point in this standoff occurred in early 2012 when the two large Long Term Refinancing Operations (LTROs) from the European Central Bank, with a combined amount of about €1 trillion, provided temporary relief from market pressures. By March of 2012, however, the further unraveling of economic management in Greece and a risk of its exit from the euro spurred a resurgence of risk spreads, so that by mid-year interest rates in Spain, and to a lesser extent Italy, were back close to peak levels. (Increasing evidence of Spain's difficulties in meeting fiscal targets also contributed to the rebound in interest rates for Spain.) The escalation of the euro authorities' policy response at the end of June in endorsing a banking union and willingness for the ESM to lend directly to Spanish banks rather than to the sovereign represented the latest round in this war of nerves between the official sector and the markets.

It has become a press cliché that 7 percent has been the threshold at which interest rates have forced euro area economies into bailout programs, which have their own contamination dynamics as they raise the specter of seniority of official funds and hence higher risk of private creditor losses. I showed in Cline (2012b) that actually Italy could withstand even interest rates of 7 percent for several years, because the gradual rather than sudden rollover of its long-term debt combined with the debt servicing power of its prospectively high primary surpluses meant that its debt would not spiral out of control even with sustained interest rates on this order, although it would not make the progress in reducing its debt ratios otherwise possible with more reasonable interest rates.

It is useful to revisit this question using the framework developed in the present study, and to include an examination of it for Spain as well as Italy. Figures 4 and 5 show the baseline paths of debt relative to GDP along with three successively more adverse scenarios. First, the high-interest case (HI); second, the high-interest case plus the low-primary-surplus case (HI+LPS); and third, the high-interest case plus the low-primary-surplus case plus the low-growth case (HI+LPS+LG). For Spain these successively more unfavorable outcomes correspond to the 44th percentile for the baseline, then the 64th, 91st, and 99th percentiles respectively for the successively worse cases. The corresponding percentiles for Italy are 39, 56, 96, and 99.

13. Datastream.

Figures 4 and 5 provide further support for the view in Cline (2012b) that even high interest rates on the order of 7 to 7.5 percent could be sustained for a long time so long as Italy (and in the present analysis, Spain) manage to achieve their baseline fiscal targets. The damage done to debt sustainability is considerably greater for a slip from the baseline primary surplus path to the low primary surplus path than is the damage done by higher interest rates, as shown by the substantially wider gap between the second and third lines from the bottom in both figures (adding the low primary surplus) than between the bottom and second lines (adding high interest rates). The width of the gaps between the paths similarly indicates that even the slip to the lower growth path, which has about the same debt/GDP boosting impact as higher interest rates, is considerably less damaging to debt sustainability than a slip to lower primary surpluses.

POLICY IMPLICATIONS

A central implication of the analysis here is that both Spain and Italy remain solvent. Even in the 75th percentile adverse case, Spain's ratio of debt to GDP reaches only about 100 percent of GDP by 2020 and is not on an explosively rising path; and even in the 75th percentile adverse case, Italy's debt to GDP ratio is lower in 2020 than in 2013, down to 116 percent from a peak of 124 percent. The probability-weighted scenarios yield a debt ratio of 92 percent in 2020 for Spain and 109 percent for Italy, representing a plausible limit on further debt buildup in Spain and progress in reducing relative indebtedness in Italy. So the basic strategy so far in the European debt crisis has been appropriate: The two large at-risk debtors have been and should continue to be treated as solvent and capable of carrying their debt rather than requiring some form and extent of debt forgiveness.

A parallel implication, however, is that successful achievement of fiscal targets is central to the speed of improvement in the debt outlook, for Italy, and degree of avoidance of further debt build-up, for Spain. To be sure, the IMF (2012b) has recently emphasized that the fiscal targets should be pursued in terms of specific policy measures rather than nominal balance outcomes, because the latter can be distorted by cyclical downturns and rigid adherence to the nominal target under such conditions could deepen a recession. The key role played by the fiscal path suggests the importance of including fiscal conditionality in such policy solutions as some form of euro bond.

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Table 1 Correlation coefficient between states for five economic variables

	Growth (g)	Primary surplus (π)	Interest rate (r)	Bank recapitalization and debt discovery (DDIS)	Privatization (Z)
G		0.2	1	0.5	0
π	0.2		–0.5	0	–1
R	1	–0.5		1	0
DDIS	0.5	0	1		0
Z	0	–1	0	0	

Source: Author's calibration.

Table 2 Scenario assumptions for Spain

	2012	2013	2014	2015	2016	2017	2018	2019	2020
					Real GDP growth (percent)				
1	–2.1	–2.1	0.5	1.0	1.1	1.2	1.2	1.2	1.2
2	–1.8	–0.4	1.2	1.6	1.8	1.8	1.8	1.8	1.8
3	–1.2	0.2	3.0	3.0	3.0	3.0	3.0	3.0	3.0
					Primary surplus (percent GDP)				
1	–4.3	–2.6	–2.2	–1.4	–0.8	–0.2	0	0	0
2	–3.6	–2.2	0	0.3	0.6	0.9	1.0	1.0	1.0
3	–3.1	–0.4	0.5	0.8	1.1	1.4	1.5	1.5	1.5
					Interest rate (percent)				
1		7.0	7.0	7.60	7.45	7.45	7.45	7.45	7.45
2		5.5	5.5	6.40	6.20	6.00	5.70	5.45	5.45
3		5.0	5.0	5.85	5.70	5.45	5.45	5.20	5.20
					Bank recapitalization (billions of euros)				
1	86	0	0	0	0	0	0	0	0
2	41	0	0	0	0	0	0	0	0
3	36	0	0	0	0	0	0	0	0
					Privatization (billions of euros)				
1	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0
3	0	5	5	5	0	0	0	0	0
Memorandum: Baseline GDP (billions of euros)									
2	1,063	1,080	1,112	1,150	1,190	1,231	1,274	1,319	1,365

Scenarios: 1 = unfavorable; 2 = baseline; 3 = favorable

Source: Author's estimates. See text discussion.

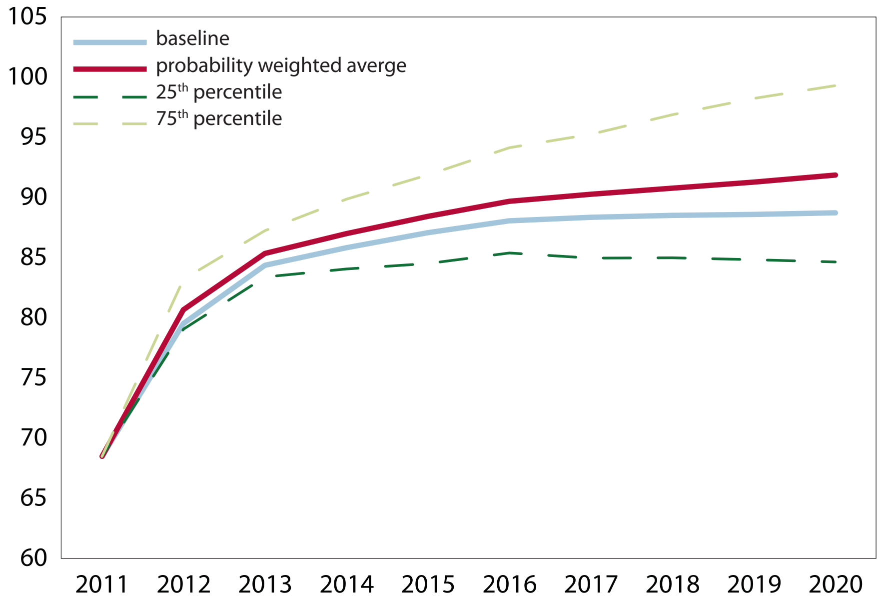
Table 3 Scenario assumptions for Italy

	2012	2013	2014	2015	2016	2017	2018	2019	2020
				Real GDP growth (percent)					
1	–2.4	–1.0	0	0.5	0.7	0.7	0.7	0.7	0.7
2	–2.0	–0.3	0.5	1.0	1.2	1.2	1.2	1.2	1.2
3	–1.7	0.2	1.6	1.6	1.6	1.6	1.6	1.6	1.6
				Primary surplus (percent GDP)					
1	2.2	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7
2	2.3	3.1	4.1	4.4	4.8	5.1	5.1	5.1	5.1
3	2.5	3.7	4.6	4.9	5.3	5.6	5.6	5.6	5.6
				Privatization (billions of euros)					
1	0	0	0	0	0	0	0	0	0
2	0	10	10	10	10	10	0	0	0
3	0	20	20	20	20	20	0	0	0
Memorandum: Baseline GDP (billions of euros)									
2	1,571	1,587	1,614	1,652	1,695	1,730	1,785	1,832	1,879

Scenarios: 1 = unfavorable; 2 = baseline; 3 = favorable

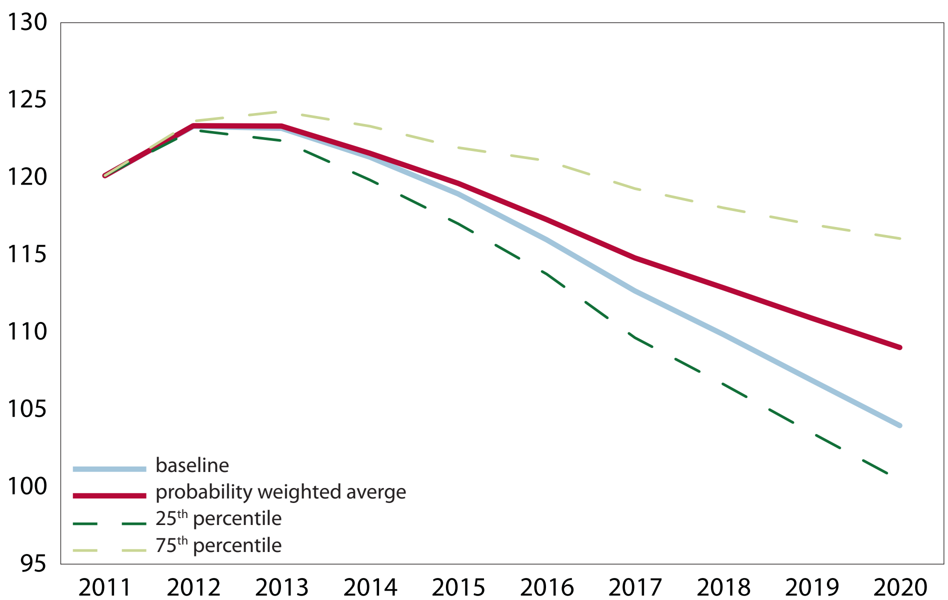
Source: Author's estimates. See text discussion.

Figure 1 Spain: Gross public debt as a percent of GDP



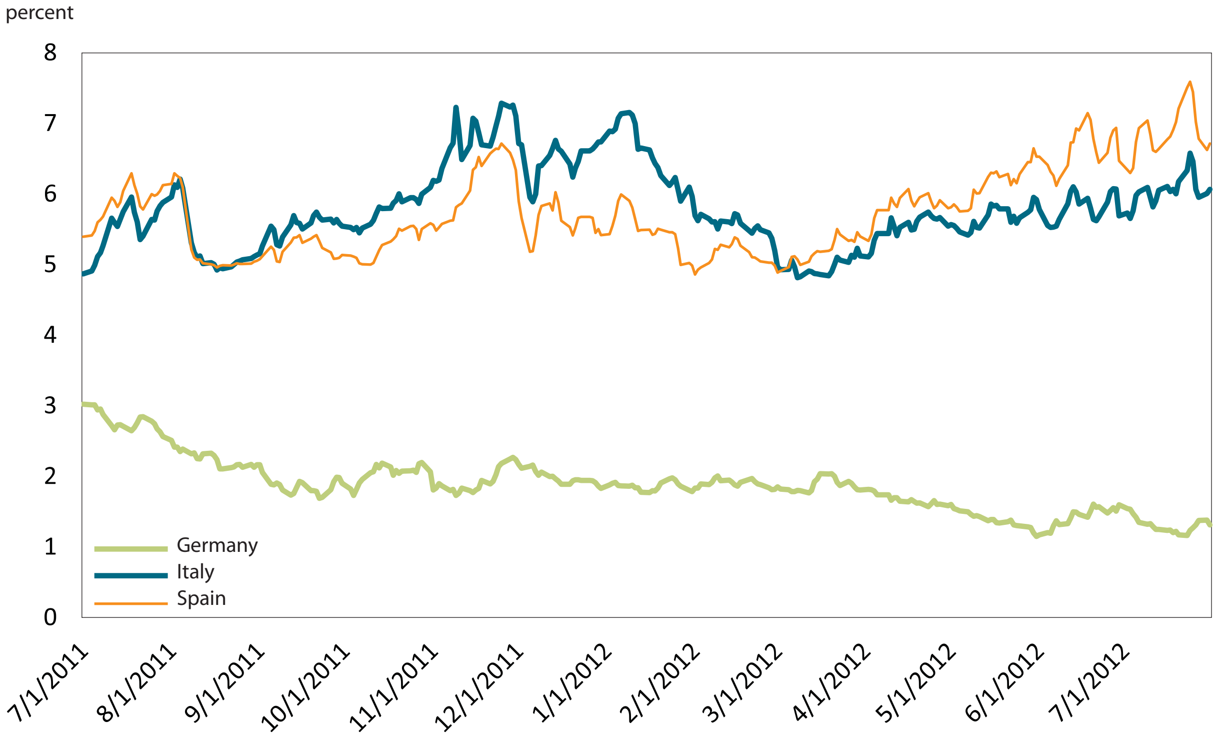
Source: Author's calculations.

Figure 2 Italy: Gross public debt as a percent of GDP



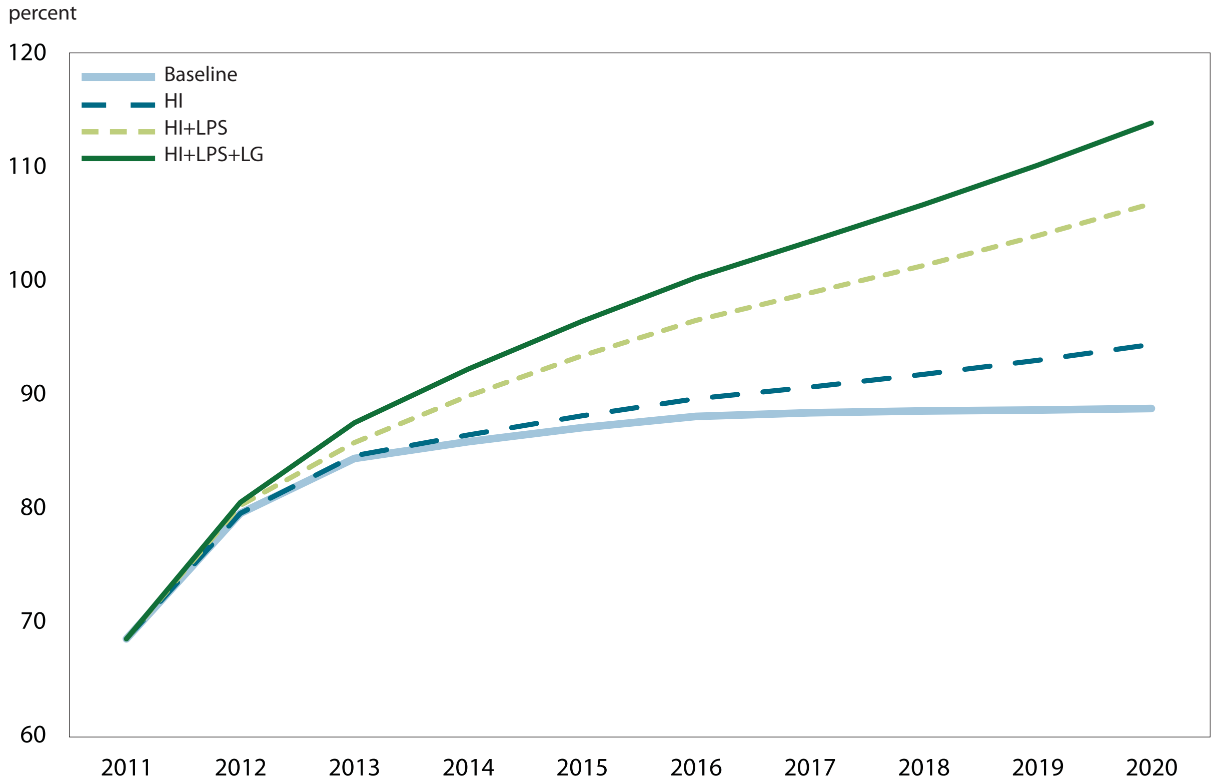
Source: Author's calculations.

Figure 3 10-year government bond yields in Germany, Italy, and Spain



Source: Datastream.

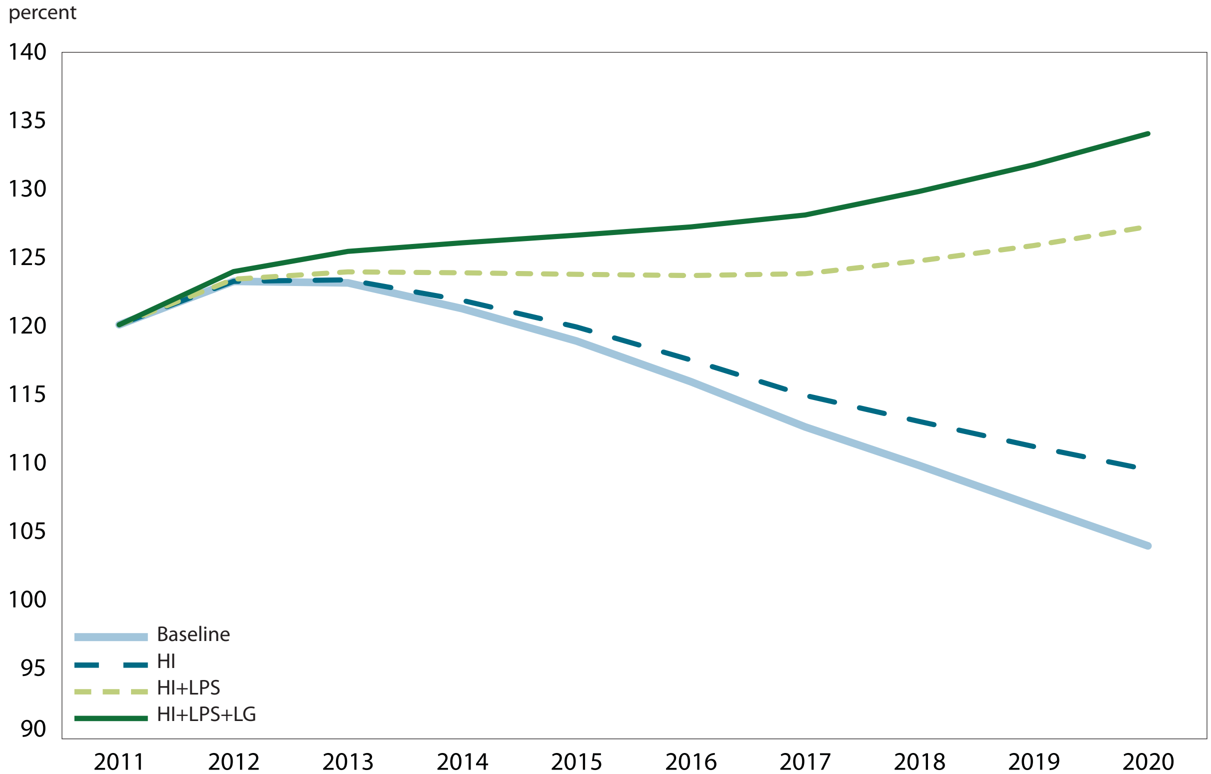
Figure 4 Debt/ GDP under selected scenarios: Spain



HI = high-interest case; HI+LPS = high-interest case plus the low-primary-surplus case; HI+LPS+LG = the high-interest case, plus the low-primary-surplus case, plus the low-growth case

Source: Author's calculations.

Figure 5 Debt/GDP under selected scenarios: Italy



HI = high-interest case; HI+LPS = high-interest case plus the low-primary-surplus case; HI+LPS+LG = the high-interest case, plus the low-primary-surplus case, plus the low-growth case

Source: Author's calculations.

APPENDIX A
SCENARIO ANALYSIS WITH CORRELATED CONTINGENT STATES

Many areas of policy analysis draw upon projections to evaluate the merits and feasibility of alternative policy choices. For example, decisions about fiscal reform depend in part on projections of future ratios of public debt to GDP. Typically projection analyses will include a "baseline" central case, and one or more "alternative" projection paths under different assumptions for the key variables. When there are a number of crucial variables, and it is desirable to give reasonable consideration to alternative future "states" for each of them, the resulting number of possible outcomes multiplies quickly. Suppose, for example, that there are four key variables, and for each it is desired to take account of a central, bad, and good outcome. Then there will be $3^4 = 81$ possible scenarios.

A fan diagram can then be used to indicate the range and likelihood of the likely time paths across the various scenarios. The extreme perimeter on the unfavorable side will be that scenario that combines all of the "bad" outcomes on all of the key variables. Conversely, the single scenario combining all of the "good" outcomes for the key variables will be the favorable perimeter. The base or central case will lie somewhere in between. For example, in a fan diagram with the debt/GDP ratio on the y-axis and time on the x-axis, the unfavorable perimeter might show a substantial increase in the debt burden over time; the baseline might show the debt ratio unchanged; and the favorable perimeter might show the debt burden falling over time.

The likelihood of a given range of scenarios can then be examined by the distribution of the scenarios around the central baseline scenario. Suppose for simplicity that the good, central, and bad cases on each of the variables are treated as having equal probability. The baseline scenario will be that combination for the "central" variant on each variable. Out of the 81 paths (for the example with 4 variables and three outcome states), there will be 40 paths less favorable than the baseline and 40 more favorable. Suppose the paths are arrayed from least to most favorable. Then the 20th path would represent the 25th percentile ($0.25 \times 81 \cong 20$), and the 61st path would be the 75th percentile. If each of the four variables were equally important in determining the outcome, the 20th path would be representative of the 16th through 31st paths, all of which would be identical in that they represent one central case, one good case, and two bad cases. Similarly, the 75th percentile would be representative of cases 51 through 66, all of which would have one central case, one bad case, and two good cases.[14]

In a real economic problem, the influences of each of the key variables will not all be equal. Importantly, their distribution of states will tend to show some correlation, rather than being independent of each other. For example, in arriving at a "good" outcome for the prospective debt ratio (stable or falling

14. This can be seen by assigning the scores 1, 2, or 3 to bad, central, and good, respectively, for each of four variables, then enumerating the possible combinations, and then ordering by the average across the variables. The average score for the base (central) case is 2; for the 25th percentile it is 1.75; and for the 75th percentile it is 2.25.

over time), the occurrence of the "good" state for economic growth as an influence will tend to coincide with the occurrence of the "good" state for the market risk premium spread (low spread) in so far as investors have more confidence when the economy is growing faster. There can also be negative correlation. Suppose for example that a larger trade deficit is perceived as "bad" for country creditworthiness. In this case there can be a negative correlation between the state for growth (good for high growth) and the state for current account (large deficit and hence "bad" when growth is strong). If in practice the states tend to be positively correlated (for most variables the good outcomes occur when the outcomes are also good on the other variables), then the distribution of outcomes will no longer be accurately represented by the random distribution discussed above. Indeed, in the extreme in which there is 100 percent positive correlation between all of the states, the distribution would collapse to three cases, one each for bad, base case, and good. If the states tend to be positively correlated, the gap will tend to be wider between the central baseline case and either the 25th percentile or 75th percentile cases than if there is no scenario correlation, because the correlations of bad with bad cases and good with good cases will tend to generate clustering of outcomes close to the bad and good perimeters. Contingent case correlation will thus essentially widen the range of uncertainty around the central baseline. Conversely, if the state correlations are predominantly negative, the effect will be to push the 25th and 75th percentile outcomes toward the baseline.

The likelihood of a particular overall outcome will depend on the probabilities of the states for each variable and the correlations of these probabilities. In the simple case with three equally likely states for each variable and zero correlation across variables, we have the example given above for the 81 outcomes. Figure 1 shows a histogram for these outcomes, where the measure of the outcome is simply the average score across the four variables with each variable at 1 for bad, 2 for base case, and 3 for favorable.

The introduction of correlations across scenarios will alter the profile of the outcomes shown in the figure. What follows is an operational example of the identification of scenario probabilities for the case of five underlying economic variables and three states (bad, base, favorable).

First, define an array of possible scenarios. With five variables and three states, there are $3^5 = 243$ possible scenarios. Using 1, 2, and 3 as the states for each variable, and using the first subscript to refer to the first variable, the second to the second, and so forth, then the first scenario will be S11111, the second scenario S11112, and so forth up to the final scenario S33333. For example, scenario S13211 will be the scenario in which the first variable takes the bad state (1), the second variable the favorable state (3), the third variable the base state (2), the fourth variable the bad state (1), and the fifth variable the bad state (1).

A tractable if ad hoc way of proceeding is to posit that if a variable is at its base state, the probability of the case from the standpoint of that variable is a standard "central" probability, set for example at 0.4. However, if the variable is at either its bad or favorable state, then if all other variables are at their base states, its probability (from the standpoint of the single variable) will be the "alternate" probability, in this case 0.3 (that is: 0.3 bad + 0.4 base + 0.3 favorable = 1).

Correlation among variables can then be incorporated as follows. Define α as the probability if the variable is in its base-case state; define β as the probability if it is in either its favorable or unfavorable state and all other variables are in their base-case state (with α = 0.4 and β = 0.3 in the example here). Let ρ_{ij} be defined as the correlation coefficient between the states of variable i and variable j. Define "δ" as the increment in the probability that a variable is in its bad (favorable) state when another variable with which it is positively correlated is in its bad (favorable) state.

The probability that a particular variable "i" will take a particular state "s" in a particular scenario "k" will then be calculated as:

$$A1) p_{ik} = \alpha \;\; if\ s_{ik} = 2;$$

$$= \beta + \delta \textstyle\sum_{j \in A} \rho_{ij} - \delta \sum_{j \in B} \rho_{ij} \;\; if\ s_{ik} \neq 2$$

where "A" is the set of other variables that are in the same state as variable i (for example, at bad state "1" when for variable "i" the state is s=1), and "B" is the set of other variables that are at the opposite state from that of variable "i" (in this example, at s=3 instead of 1).

Calibrating the size of the probability increment δ will depend on the number of variables and on the desired ratio of the probability in the case that the variable in question is at the highest likely state when the other variables are in their non-base states to the corresponding lowest probability. In the five-variable case, potentially there would be an additive amount of 4δ for the case in which the four other variables are all in their state that is associated with the good state of the variable in question. Suppose one seeks the maximum probability for a non-base case, for the variable in question, to be three times the opposite-state non-base probability. For the base probability α =0.4, this condition is met at δ =0.0375. That is: the high non-base probability will be 0.3+4(0.0375) = 0.45; the low non-base probability will be 0.3–4(0.0375) = 0.15.

Across the 243 scenarios (five variable case), the unadjusted probability of the particular scenario *k* will then be:

$$A2) p_k = \prod_i p_{ik}$$

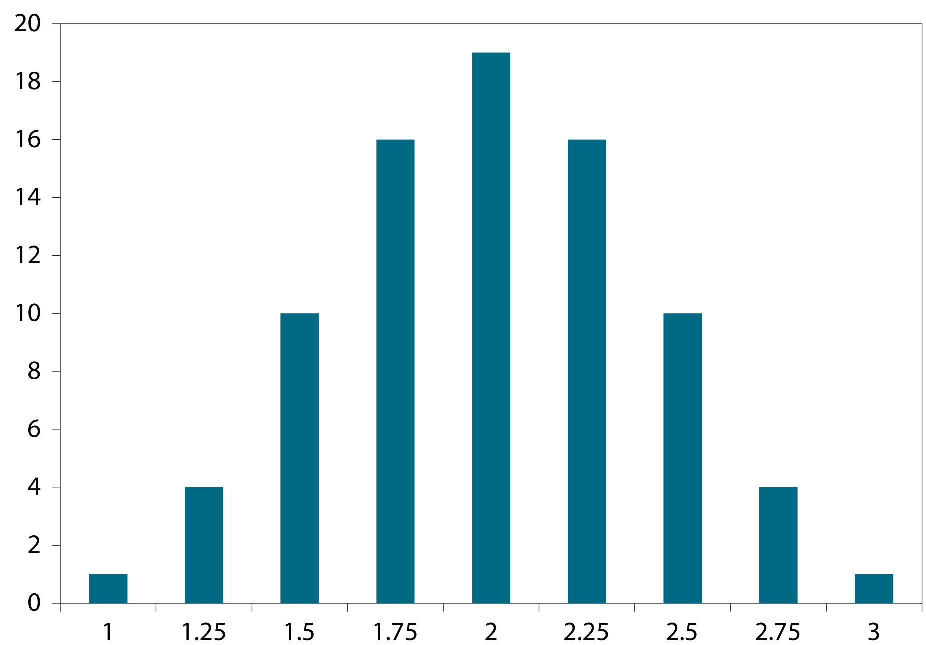
A final adjustment is then necessary to take account of the fact that it will only be by chance that the construction of the weighted probabilities taking account of correlations will yield a sum of unity probability across all scenarios. The final adjusted probability of the particular scenario *k* is then:

$$A3) p_k^* = \lambda p_k \;\; where\ \lambda = \frac{1}{\sum_k p_k}$$

If there is some outcome variable that serves as a summary measure, such as the debt to GDP ratio in the terminal year, then the scenarios can be arrayed in order based on the value of this measure. The cumulative sum of the probabilities of the scenarios thus arrayed can then be observed to derive overall inferences from the projections. For example, it might be that in the full set of projections, with their weighted probabilities and taking into account likely correlations among the variables, the central estimate for the debt ratio will be 90 percent of GDP in 2020; the most favorable outcome, 70 percent; the least favorable outcome, 125 percent; and the 33th and 67th percentiles in the distribution of outcomes, debt ratios of (say) 80 percent and 112 percent respectively.

The overall effect of this approach is to provide a somewhat greater sense of the realism of alternative outcomes than would otherwise be obtained solely by treating all of the possible variants as equally likely.

Figure A1 Frequency of average state scores for four variables, three states, and no correlation[a]

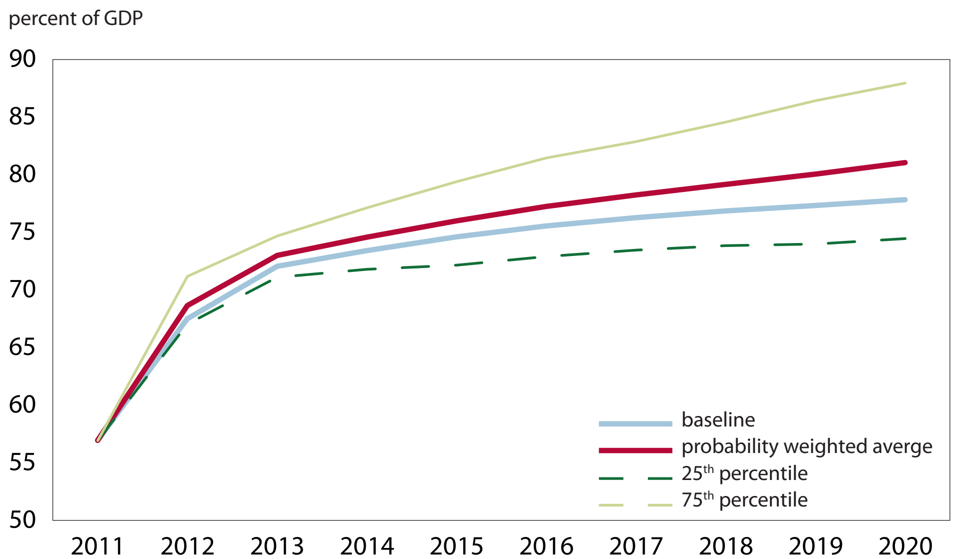


a. With scores of 1 = bad; 2 = central; 3 = good

Source: Author's calculations.

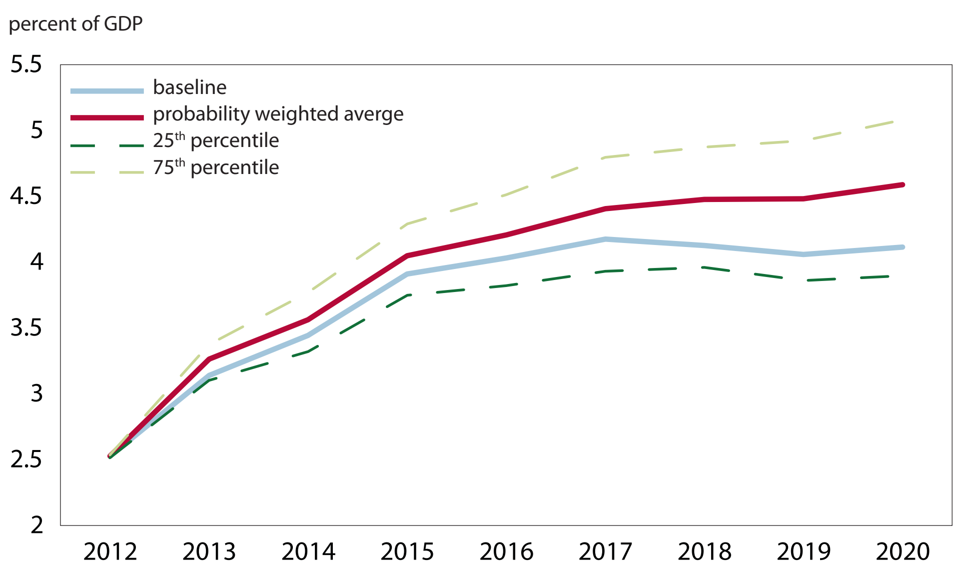
APPENDIX B

Figure B1 Net debt: Spain



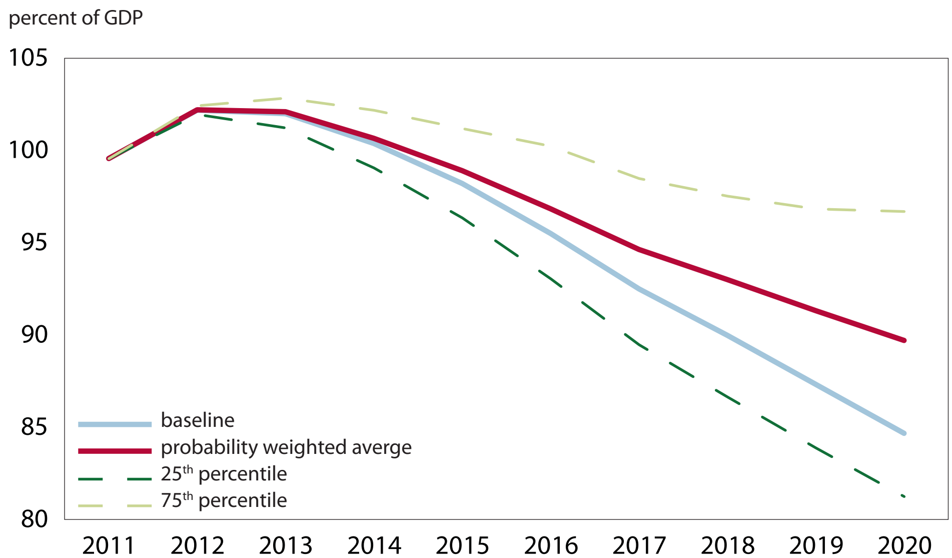
Source: Author's calculations. See text and appendix C.

Figure B2 Net interest: Spain



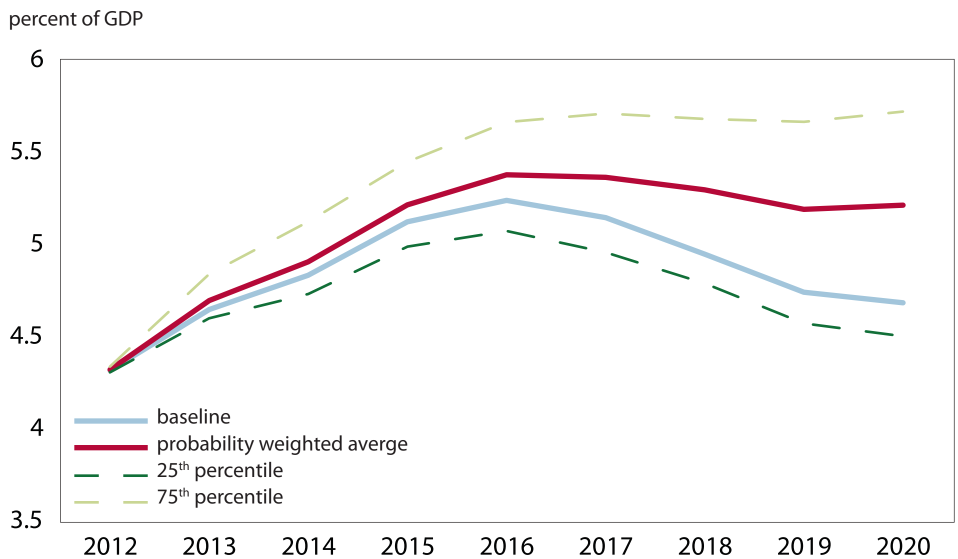
Source: Author's calculations. See text and appendix C.

Figure B3 Net debt: Italy



Source: Author's calculations. See text and appendix C.

Figure B4 Net interest: Italy



Source: Author's calculations. See text and appendix C.

Table B1 Baseline projections for Spain

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Percent GDP:										
Debt	68.5	79.5	84.4	85.8	87.1	88.0	88.4	88.5	88.6	88.7
Net debt	56.9	67.5	72.0	73.4	74.6	75.6	76.3	76.8	77.3	77.8
Net interest		2.5	3.1	3.4	3.9	4.0	4.2	4.1	4.1	4.1
Amortization		13.3	15.5	16.0	14.5	15.0	14.4	13.3	14.4	14.9
Billion euros:										
Primary deficit		38.6	23.2	0.0	–3.4	–7.1	–11.0	–12.7	–13.1	–13.6
Total deficit		65.5	57.0	38.1	41.3	40.6	40.1	39.7	40.1	42.3
(+) bank recapitalization[a]		41.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(–) privatization receipts		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Net borrowing requirement		106.5	57.0	38.1	41.3	40.6	40.1	39.7	40.1	42.3
(+) financial asset purchase		4.0	4.6	5.0	5.3	5.3	0.0	0.0	0.0	0.0
Amortization		141.1	166.6	177.6	166.1	178.2	177.0	168.7	188.6	202.2
ST		95.0	90.6	90.6	90.6	90.6	90.6	90.6	90.6	90.6
MLT (pre-2012)		46.1	60.4	59.2	37.4	41.1	31.2	15.8	30.2	36.7
MLT (new)		0.0	15.7	27.9	38.1	46.5	55.2	62.3	67.9	74.9
Gross borrowing requirement		251.6	228.2	220.7	212.7	224.1	217.1	208.4	228.8	244.5
Debt	735.0	845.5	907.1	950.2	996.8	1042.7	1082.9	1122.5	1162.7	1205.0
ST	90.6	90.6	90.6	90.6	90.6	90.6	90.6	90.6	90.6	90.6
MLT (pre-2012)	644.3	598.3	537.9	478.7	441.4	400.3	369.1	353.3	323.1	286.4
MLT (new)		156.6	278.6	380.8	464.8	551.8	623.1	678.6	748.9	828.0
Net interest payments		26.9	33.8	38.1	44.8	47.7	51.2	52.3	53.3	55.9
ST		1.8	1.8	1.7	1.5	1.4	1.7	1.9	1.9	1.9
MLT (pre-2012)		27.5	25.9	23.8	21.6	20.4	19.3	17.9	17.4	16.2
MLT (new)		0.0	8.6	15.3	24.4	28.8	33.1	35.5	37.0	40.8
(–) financial assets		2.5	2.6	2.6	2.7	2.9	3.0	3.0	3.0	3.0
Financial assets	123.7	127.7	132.3	137.3	142.6	147.9	147.9	147.9	147.9	147.9
Net debt	611.3	717.8	774.7	812.9	854.2	894.8	935.0	974.6	1014.8	1057.1

ST = short term; MLT = medium and long term

a. Includes other debt discovery.

Source: Author's calculations. See text and appendix C.

Table B2 Baseline projections for Italy

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Percent GDP:										
Debt	120.1	123.3	123.2	121.3	118.9	116.0	112.7	109.8	106.9	104.0
Net debt	99.6	102.2	102.0	100.4	98.2	95.5	92.5	90.0	87.3	84.7
Net interest		4.3	4.6	4.8	5.1	5.2	5.1	4.9	4.7	4.7
Amortization		20.7	19.4	18.2	19.1	16.2	16.8	15.2	16.7	15.8
Billion euros:										
Primary deficit		–36.3	–49.7	–66.4	–73.0	–82.0	–89.4	–91.0	–93.4	–95.9
Total deficit		31.5	24.0	11.6	11.6	6.7	0.0	–2.8	–6.6	–7.9
(+) bank recapitalization		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(–) privatization receipts		0.0	10.0	10.0	10.0	10.0	10.0	0.0	0.0	0.0
Net borrowing requirement		31.5	14.0	1.6	1.6	–3.3	–10.0	–2.8	–6.6	–7.9
(+) financial asset purchase		6.9	4.7	1.4	4.6	4.4	3.9	3.9	3.9	3.9
Amortization		324.6	307.3	294.0	315.9	275.1	291.5	272.0	305.8	297.6
ST		131.2	131.2	131.2	131.2	131.2	131.2	131.2	131.2	131.2
MLT (pre-2012)		193.3	152.9	122.5	131.7	77.2	85.7	58.3	86.1	69.6
MLT (new)		0.0	23.2	40.3	52.9	66.7	74.5	82.5	88.4	96.8
Gross borrowing requirement		363.0	326.1	297.0	322.1	276.2	285.4	273.1	303.1	293.6
Debt	1897.9	1936.4	1955.1	1958.2	1964.4	1965.4	1959.4	1960.5	1957.8	1953.9
ST	131.2	131.2	131.2	131.2	131.2	131.2	131.2	131.2	131.2	131.2
MLT (pre-2012)	1766.7	1573.4	1420.5	1298.0	1166.3	1089.1	1003.3	945.1	858.9	789.3
MLT (new)		231.8	403.4	528.9	666.8	745.1	824.8	884.3	967.7	1033.3
Net interest payments		67.8	73.7	78.0	84.6	88.7	89.4	88.2	86.8	88.0
ST		2.6	2.6	2.4	2.2	2.0	2.5	2.7	2.7	2.7
MLT (pre-2012)		71.6	65.0	60.1	55.5	52.2	49.5	45.5	43.0	39.7
MLT (new)		0.0	12.7	22.2	33.6	41.3	44.3	47.0	48.2	52.7
(–) financial assets		6.5	6.6	6.7	6.8	6.8	6.9	7.0	7.1	7.2
Financial assets	324.6	331.6	336.3	337.7	342.4	346.7	350.7	354.6	358.5	362.4
Net debt	1573.3	1604.8	1618.8	1620.4	1622.0	1618.7	1608.7	1605.9	1599.3	1591.4

ST = short term; MLT = medium and long term

Source: Author's calculations. See text and appendix C.

APPENDIX C:
Notes on Debt and Interest Rate Data[15]

ITALY
Maturity Profile of Old Debt

Short-term (ST) disbursement and amortization figures for 2012–20 are based on the assumption that ST debt rollover rate would be 1. The 2011 ST ending stock figure is drawn from table 4 (page 10) of *Supplements to the Statistical Bulletin: The Public Finances, borrowing requirement and debt* (Number 24, May 14, 2012) available at http://www.bancaditalia.it/statistiche/finpub/pimefp/2012/sb24_12/en_suppl_24_12.pdf.

The source for the medium- and long-term (MLT) (pre-2012) amortization schedule through 2020 is *Outstanding of Public Securities (breakdown by maturity), December 2011* (available at http://www.dt.tesoro.it/export/sites/sitodt/modules/documenti_en/debito_pubblico/scadenze_titoli_suddivise_per_anno/Outstanding_public_securities_31-12-2011_GPO.pdf). The 2011 MLT ending stock figure is forced to comply with the IMF April 2012 WEO estimated debt path.

Interest Rates

MLT (pre-2012) interest rates are calculated as the weighted average interest rate of all outstanding Treasury bonds (fixed-rate bonds only) as of end-December 2011. The interest rates of all outstanding Treasury bonds (fixed-rate bonds only) as of end-December 2011 are drawn from *Outstanding of Public Securities (breakdown by maturity), December 2011* (available at http://www.dt.tesoro.it/export/sites/sitodt/modules/documenti_en/debito_pubblico/scadenze_titoli_suddivise_per_anno/Outstanding_public_securities_31-12-2011_GPO.pdf).

SPAIN
Maturity Profile of Old Debt

The 2011 ending stock figure and the 2012 amortization figure for ST debt are drawn from *Public Debt Statistics Bulletin May 2012* published by the General Secretariat of the Treasury and Financial Policy of Spain (available at http://www.tesoro.es/doc/EN/home/estadistica/geneng1.pdf, assessed on May 30, 2012); the ST debt amortization figures for 2013–20 are based on the assumption that ST debt amortization rate would be 1 throughout the period.

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15. Prepared by Yimei Zou.

The MLT (pre-2012) amortization schedule for 2012–20 is compiled from the website of Tesoro Publico (http://www.tesoro.es/en/valores/circulacion/valores_circulacion.asp), as well as *Public Debt Statistical Bulletin May 2012* (available at http://www.tesoro.es/doc/EN/home/estadistica/geneng1.pdf, accessed on May 30, 2012). The schedule considers only government bonds (assumed debt and foreign currency debt are excluded). In addition, the 2011 MLT ending stock figure is forced to comply with the IMF April 2012 WEO estimated debt path.

Interest Rates

MLT (pre-2012) interest rates are calculated as the weighted average interest rate of all outstanding Treasury bonds as of end-December 2011. The interest rates of all outstanding Treasury bonds as of end-December 2011 are drawn from the website of Tesoro Publico (http://www.tesoro.es/en/valores/circulacion/valores_circulacion.asp), as well as *Public Debt Statistical Bulletin May 2012* (available at http://www.tesoro.es/doc/EN/home/estadistica/geneng1.pdf , accessed on May 30, 2012). Assumed debt and foreign currency debt are excluded in the calculation of weighted average interest rates for MLT (pre-2012) debt.

SHORT-TERM INTEREST RATES

For both Italy and Spain, short-term interest rates are projected as follows. The rates for 2012–15 are forced along a linear descending trend from 2 percent in 2012 to the projected 2016 level. The rates for 2016–18 are set at three-month Euro Interbank Offered Rate (Euribor) rates calculated from three-month EURIBOR future prices (settlement prices as of May 30, 2012); the figures for 2019–20 are extrapolated at the 2018 level.

APPENDIX D:
PROBABILITY-WEIGHTED VERSUS BASELINE PROJECTIONS

The approach in this study incorporates correlation between the non-base scenarios to obtain a sense of the probability of alternative outcomes. As indicated in appendix A, the principal influence of taking correlations into account will be to spread the 25th and 75th percentiles toward the extremes, if the important correlations between the cases are positive (good with good), or toward the baseline if the dominant correlations are negative (good with bad).

The results here for both Spain and, to a greater degree, Italy, show that the probability-weighted outcomes are worse than the baseline outcomes. The divergences raise the question of whether the differences arise from the particular configurations of correlations between the non-base scenarios, or from something else. It turns out that the main cause of this outcome is indeed something else: a wider "distance" in the scenario specifications between the baseline and the adverse scenario than between the baseline and the favorable scenario. With equal probability being attached to the adverse and favorable scenarios, abstracting from non-base correlations, the effect is to make the probability-weighted outcome less favorable than the baseline.

For Italy, the unfavorable primary surplus scenario has an average primary surplus in 2013–20 that is lower than the corresponding average in the baseline by 1.9 percent of GDP; the favorable scenario's average outcome is higher by only 0.5 percent. Similarly, the interest rate scenarios show a wider distance on the unfavorable side (1.58 percentage point average higher interest rate than in the baseline) than on the favorable side (0.42 percentage point lower than in the baseline).

In contrast, the correlation of scenarios has little influence on the difference between the baseline and the probability-weighted outcome. Although positive correlation between the non-base scenarios would move the frequency distribution of the outcomes towards the extremes, and negative correlation would move it toward the baseline (appendix A), it is unlikely to change the probility-weighted averages. Tests for Italy indicate that when the correlation coefficients are all set to zero, the debt ratios for 2020 are 100 percent for the 25th percentile and 117 percent for the 75th percentile. In the main results these two outcomes are 102 percent and 116 percent. So incorporation of the correlations pushes frequencies away from the extremes toward the baseline (104 percent in 2020). The implication is that for Italy the dominant state correlations are negative, particularly that between the privatization and primary surplus states. In contrast, there is no difference between the time path of the probability-weighted debt ratio for the test in which correlations are set to zero and the probability-weighted debt ratio in the main results. Both show the debt ratio easing to 109 percent of GDP by 2020.