17-6 Does Greece Need More Official Debt Relief? If So, How Much?

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April 2017

Abstract

Creditor countries and international organizations continue to disagree whether Greece should receive additional official debt relief, and if so how much. This paper first shows that these disagreements can be attributed to competing assumptions about Greece's future capacity to repay, particularly about economic growth and the fiscal primary balance. It next evaluates the plausibility of alternative primary balance assumptions using international evidence about fiscal adjustment experiences. It concludes that primary balance paths required to make Greece's debt sustainable are not plausible and that Greece will therefore require additional debt relief. Finally, the paper shows that the debt relief measures suggested by the Eurogroup in May 2016 (albeit with significant caveats on whether they will in fact be granted or not) could be sufficient to address Greece's sustainability problem, provided the Eurogroup is prepared to accept both very long maturity extensions on European Financial Stability Facility (EFSF) debt (to 2080 and beyond) and interest deferrals that could lead to a large *rise* in EFSF exposure to Greece before it begins to decline. If the Eurogroup wishes to avoid the latter, it will become necessary to either (1) extend the scope of the debt restructuring, (2) lower the interest rates charged by the EFSF significantly below current predictions, or (3) extend European Stability Mechanism (ESM) financing beyond 2018 and delay Greece's return to capital markets for a protracted period.

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I. INTRODUCTION

Since mid-2015, the International Monetary Fund (IMF), EU institutions, and European creditor countries have been arguing whether Greece requires additional official debt relief—and if so, how much.[1] One-and-a-half years later, their positions seem as far apart as ever. In a report released on February 7, 2017, the IMF argued that Greece's debt is "highly unsustainable" and called for deep debt relief involving all official creditors but itself. This report is the fourth in a series of increasingly pessimistic IMF reports released since June 2015 (IMF 2015a, 2015b, 2016, and 2017). Two days later, Klaus Regling, managing director of the European Stability Mechanism (ESM), published a response in which he stated that if Greece fully implemented its ESM-supported reform program, debt sustainability could be "within reach," and that in any case, Greece's euro area partners had pledged additional debt relief at the end of the ESM program, should it be needed (Regling 2017).

This paper explains and evaluates the arguments in the debate about Greek debt sustainability. This debate turns out to be more complex than editorials suggest—among other reasons, because the European camp is itself divided, with European institutions advocating some debt relief, while several creditor countries remain unpersuaded. The paper aims to make three contributions. The first is to characterize the underlying assumptions of each view on Greece's capacity to repay and to analyze the sustainability of Greece's public debt for each of these sets of assumptions. The second is to empirically assess the plausibility of competing assumptions about Greece's future primary surplus path, which turns out to be the most important area of disagreement. This will answer the question whether additional debt relief is needed or not. Third, the paper examines whether possible debt relief mechanisms that have already been suggested by the Eurogroup in its May 25, 2016 statement (albeit with significant caveats on whether they will be used or not) would be sufficient to address Greece's sustainability problem.

The main results are as follows:

1. Conflicting views on Greek debt sustainability among IMF, EU institutions, and European creditor countries are internally consistent in that each party's assumptions do in fact support its claims about debt sustainability. Hence, deciding whether Greece's debt is sustainable or not comes down to deciding which set of assumptions is most credible.

2. Historical experience—not just Greece's experience, but that of a typical advanced country—is inconsistent with the primary surplus paths that would make Greece's current debt sustainable.

3. The debt relief measures suggested by the Eurogroup may suffice to restore Greece to sustainability, provided the Eurogroup is prepared to accept not only very long maturity extensions on European

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1. For the history of previous official and private debt relief to Greece and the related policy debate, see Cline (2013, 2015a, 2015b), Zettelmeyer et al. (2013), Xafa (2014), and Schumacher and Weder di Mauro (2015).

Financial Stability Facility (EFSF) debt (to 2080 and beyond) but also interest deferrals that could lead to a large *rise* in EFSF exposure to Greece before this begins to decline.

4. If the Eurogroup wishes to avoid the latter, it will become necessary to either (1) lower the funding costs of future EFSF loans significantly below current official projections, by attempting to take advantage of the still very low interest rate environment, (2) extend the scope of the restructuring to include bilateral official debt issued under the 2010 Greek Loan Facility (GLF), or (3) delay Greece's return to capital markets and extend official financing through the ESM for a prolonged period.

Measures (1) and (2) described above were not explicitly named in the May 25, 2016 Eurogroup statement, but they would likely be within the political and legal confines laid out in that statement, namely, "that nominal haircuts are excluded, and that all measures taken will be in line with existing EU law and the ESM and EFSF legal frameworks" (Eurogroup 2016a, b). Measure (3) would conflict with the current intentions of the Eurogroup. But it may also save creditors significant resources compared to the alternative plan, in which debt relief (or additional fiscal effort) would have to offset the high costs of borrowing from the private sector.

The purpose of this paper is not to propose a specific debt relief plan. That would require addressing additional questions, most importantly, how to credibly reconcile debt relief with incentives for reforms and sound fiscal policies in Greece. That said, the paper could contribute to finding such a plan by pointing to alternative approaches to extending debt relief that could achieve debt sustainability.

II. COMPETING VIEWS ON THE SUSTAINABILITY OF GREEK DEBT

Greece's public debt currently amounts to about €326 billion (roughly 180 percent of GDP), of which €226 billion are owed to European official creditors (the EFSF and its successor, the ESM, the European Central Bank, and euro area governments) and €13 billion to the IMF. This is a result of the 2012 debt restructurings, which both reduced the face value of Greece's privately held sovereign debt by about €100 billion (50 percent of GDP at that time) and substituted a portion of it with official borrowing (see Zettelmeyer et al. 2013). Figure 1 shows the amortization profile of these debts over time.

There are essentially three views about Greece's ability to service these debts. Some government officials in European creditor countries argue that if Greece only carried out its program commitments and subsequently adhered to EU fiscal rules, it would not need any debt relief. The public embodiment of this view is German Finance Minister Wolfgang Schäuble, who has repeatedly stated that Greece's problem is lack of reform, rather than excessive debt.[2] The opposing view (on the debt relief issue, not on Greece's reform

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2. Most recently, at a panel debate during the IMF-World Bank Annual Meetings; see "CNN Debate on the Global Economy," October 6, 2016, minute 43, http://www.imf.org/external/am/2016/mmedia/view. aspx?vid=5160749356001 (accessed on March 21, 2017). See also Shawn Donnan, "Wolfgang Schäuble rules out

record), has come from the IMF, which has argued that Greece's debt is "highly unsustainable" and requires a deep restructuring—one that might require either face value reductions or lower EFSF and ESM interest rates below funding costs. Both options would violate the political boundaries agreed by the Eurogroup. The view of the European institutions lies somewhere in the middle. Like the IMF, European institutions have "serious concerns regarding the sustainability of Greece's public debt" (European Commission 2016). At the same time, they think that it is possible to restore debt sustainability by combining reforms and fiscal adjustment with the "medium and long term" debt relief measures sketched by the Eurogroup in May 2016. These include the "re-profiling of the EFSF amortization as well as capping and deferral of interest payments" and the return of Eurosystem central bank profits earned on Greek bonds to Greece.[3]

As shown below, these three competing views are closely related to alternative scenarios about how Greece's economy and its capacity to repay European creditors will develop in the future. The most important elements of these scenarios are assumptions about future real growth and primary fiscal surpluses, summarized in table 1:

- Scenario A is the baseline scenario of the European institutions as of mid-2016 (European Commission 2016). Economic performance is assumed to follow program targets until 2018, with growth rising to over 3 percent and the primary surplus to 3.5 percent of GDP, where it remains for 10 years, and subsequently gradually declines to 1.5 percent by 2040. Real growth is assumed to decline to 1.5 percent in the medium term, and to 1.25 from 2030 onwards.

- Scenarios B and C are more pessimistic variants taken from the same European Commission paper. Like scenario A, they assume program performance meets targets initially but is followed by faster declines in both growth and the primary surplus. In scenario B, the primary surplus of 3.5 percent is maintained for six years, in scenario C for just one year.

- Scenario I reflects the baseline scenario of the IMF, which is more pessimistic than any of the European Commission scenarios. The primary surplus is assumed to rise to just 1.5 percent of GDP by 2018. Growth in the medium and long term is assumed to be just 1 percent per year, reflecting the IMF's view that Greece will not undertake the structural reforms needed to achieve higher potential growth (IMF 2017).

- Scenario D, in contrast, is more ambitious than the baseline. In the hawkish interpretation, such as held by Mr. Schäuble, this scenario reflects what Greece committed to achieve when the third program

was politically agreed: a 3.5 percent primary surplus as long as necessary (here taken to be until 2033, 15 years beyond the end of the program) and sufficient structural reforms to achieve a medium-term growth rate of 1.75, declining to 1.5 percent in the long run.

In addition to making different assumptions about real growth and fiscal adjustment, these scenarios also differ in terms of the assumptions on inflation—and hence nominal growth—and privatization:

- All scenarios except scenario I use the European Commission's most recent inflation forecasts (February 13, 2017). These envisage inflation slowly rising from 1.3 percent in 2017 to 2 percent by 2022. Scenario I uses the inflation forecast of the IMF (2017). This assumes that inflation converges to 1.7 percent rather than 2 percent, as lack of structural reform puts continued downward pressure on wages and prices relative to the euro area.

- With respect to privatization, scenario A assumes total revenues of €17.4 billion (€4.5 billion from bank assets and €13 billion from nonbank assets), while scenario D assumes about €28.5 billion (€22.9 billion from nonbank assets and privatization of banks of €5.7 billion, reflecting the potential proceeds from the new privatization and investment fund Hellenic Corporation of Assets and Participations [HCAP]). In the more pessimistic scenarios B and C, total privatization revenues are assumed to be only €5 billion, and in the IMF's scenario I just €2.9 billion.

Methodology

The question is what these scenarios imply for the sustainability of Greek public debt. To answer this, some ancillary assumptions are needed—in particular, when Greece will return to private borrowing and how the interest rate demanded by private creditors will evolve (see box 1)—as well as a criterion for deciding what "sustainability" means. Since one of the objectives of this paper is to understand why the IMF and the European institutions arrive at such different conclusions, the approach is to stick as closely as possible to the assumptions and debt sustainability criteria used by the IMF and the European institutions themselves, provided that these are mutually consistent and appear reasonable.

Specifically, the paper focuses on two debt sustainability criteria: the evolution of the debt-to-GDP ratio, which has traditionally been used by the IMF and other official institutions, and the government's borrowing requirements (public sector "gross financing needs," or GFN for short) as a share of GDP.[4] Debt sustainability is interpreted as requiring both that the debt-to-GDP ratio should follow a downward path and that gross financing needs should not exceed 15 to 20 percent of GDP in any given year. The latter

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4. Gross financing needs are defined as the gap between debt service (amortization and interest payments) coming due in a given year and available nondebt creating resources. The latter include the primary surplus, privatization receipts, and other nondebt financing items (see IMF 2013, annex III).

reflects an empirically-based rule of thumb that the IMF has been using in its debt sustainability method-ology for countries with capital market access.[5] This criterion was endorsed by the Eurogroup in May of 2016[6] and is used in the remainder of this paper.

Calculations showing the evolution of gross financing needs and the debt-to-GDP ratio were previ-ously presented by the European Commission (2016) for scenarios A-D and the IMF (2017) for scenario I, among others. The value added of this paper is two-fold: First, it evaluates scenarios A-D using updated assumptions, including a set of "short-term" debt relief measures that were decided by the ESM in January 2017.[7] Second, it attempts to quantify the impact of growth, inflation, and interest rate uncertainty on the projected paths using a "fan chart approach" based on Monte Carlo simulations (see figure 2 and box 2 for details on the underlying assumptions). This differs from the usual approach of dealing with uncertainty in debt sustainability analysis, which is to do sensitivity analysis, that is, to show how GFN and debt-to-GDP paths would be affected by specific alternative assumptions about growth and interest rates.[8] For readers who prefer the traditional approach, the results of a sensitivity analysis are shown in appendix 1.

With respect to predicting uncertainty to debt sustainability, the methodology used in this paper is subject to at least three sources of bias, two of which go in the direction of understating uncertainty and one in the direction of overstating it. First, the paper models feedback from debt to bond yields using a relationship estimated by Laubach (2009) on US data, which arguably reflects neither default nor rollover risk. While this approach predicts end-of-program *levels* of spreads of a plausible order of magnitude, it may understate the speed with which spreads could both decline if Greece's debt stays on a declining path and rise if it does not. While in reality bond prices and yields are forward looking, the Laubach rule links bond spreads only to *current* debt levels, leading to gradual, "sticky" changes in spreads when the debt situ-ation improves or deteriorates. Second, the approach here models the debt dynamics arising from positive feedback loops between interest rates and debt (higher interest rates lead to higher debt accumulation, which tends to increase the borrowing spread) but ignores feedback from interest rates and debt to growth

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5. See IMF 2013, particularly appendix II. The IMF uses 15 percent as the relevant threshold for emerging-market countries and 20 percent for advanced countries (see IMF 2013, tables A1 and A2, respectively. Note that foot-note 2 table A2 is misplaced: It ought to refer to external, rather than public, gross financing requirements). The thresholds are calibrated to best predict the occurrence of debt distress in the sense of minimizing the sum of the missed crises and false alarms.

6. "The Eurogroup agrees to assess debt sustainability with reference to the following benchmark: ... GFN should remain below 15% of GDP during the post programme period for the medium term, and below 20% of GDP there-after." Eurogroup statement on Greece, May 25, 2016.

7. These include: smoothing the EFSF repayment profile under the current weighted average maturity, using the EFSF/ESM funding strategy to reduce interest rate risk, and waiver of the step-up interest rate margin related to the debt buy-back tranche of the EFSF program for 2017. See ESM 2017.

8. Sensitivity analysis requires no estimation and no distributional assumptions. Because it does not make such assumptions, however, it does not give a sense of the likelihood that the debt might or might not be sustainable—that step is implicitly left to the reader. However, not every reader may have an empirically grounded intuition, for example, about uncertainty regarding growth. Furthermore, sensitivity analyses typically vary one parameter at a time and hence give no sense of the uncertainty arising from joint deviations from the assumed baselines.

(the central paths of growth and inflation are determined by the scenario assumptions and are hence treated as exogenous). Third, as a technical shortcut, inflation shocks and shocks to the risk-free interest rate are assumed to be uncorrelated. This will tend to overstate uncertainty, as a positive correlation would imply that the negative (positive) effect of higher (lower) interest rates on debt sustainability would be partly offset by the positive (negative) effect of higher (lower) nominal output.

Uncertainty may also be biased by the way in which the parameters used to quantify growth and inflation uncertainty have been estimated. Because Greek growth, inflation, and government borrowing costs have recently been dominated by experiences that are unlikely in the future, the estimation is based on a panel of euro area members (see box 2). If Greece suffers higher growth and inflation uncertainty in the future than a typical euro area country suffers during the sample period, the fan charts in figure 2 will understate uncertainty. That said, the period used to estimate growth and inflation uncertainty includes the Great Recession of 2008–09, resulting in an estimated annual standard deviation of growth that is high for advanced economies (over 2 percentage points).

Results

Figure 2 shows Monte Carlo–based confidence bands around the GFN and debt-to-GDP paths generated by four of the five scenarios summarized in table 1. These are generated under the assumption that (1) real growth, inflation, and interest rates exhibit uncertainty around the average or steady state values described by scenario assumptions and the assumed interest rate rule (see boxes 1 and 2); while (2) the primary surplus and privatization receipts evolve deterministically, as envisaged in each scenario. The point of figure 2 is hence to allow statements of the type: "If the primary surplus and privatization paths were to evolve as assumed in scenario X, and long-term growth evolves broadly as assumed—albeit with shocks—then Greek debt would be sustainable with p percent probability."

In scenario A, the baseline scenario of the European Commission's June 2016 analysis, Greece's public debt is best described as borderline sustainable. Both the deterministic (solid blue line) and the median (dash line) GFN paths "max out" at levels above the IMF's lower (emerging-market country) threshold of 15 percent but below its upper advanced country threshold of 20 percent (thresholds represented by red lines in figure 2). The deterministic and median debt-to-GDP ratio is on a smoothly declining path, which falls below 100 percent of GDP by 2033 and below 60 percent of GDP by 2060. This looks significantly better than in the European Commission's analysis, which showed gross financing needs rising to 22 percent by 2050 and continuing to rise thereafter, and the debt ratio remaining above 100 percent of GDP even by 2050 (see table 4, p. 15 in European Commission 2016). The difference is partly caused by the "short-term" debt relief measures decided in January 2017 and partly by differences in interest rate assump-

tions for the ESM and EFSF.[9] ESM Managing Director Regling may have been referring to this scenario when he stated that debt sustainability was now "within reach." At the same time, debt in this scenario is only "borderline" sustainable in the sense that a minor perturbation could make it unsustainable. The shadings indicate that with almost 50 percent probability gross financing needs will rise above 20 percent and that with about 40 percent probability the debt-to-GDP ratio will never decline below 100 percent of GDP.

The pictures look very different in the more pessimistic scenarios B and I. Debt is clearly not sustainable in these scenarios, with median GFN far exceeding the upper threshold of 20 percent. In the IMF's baseline scenario I, the probability that the debt path becomes explosive exceeds 80 percent; even in the European Commission's only mildly pessimistic scenario B, it is above 50 percent. The mechanism that eventually forces gross financing needs to 20 percent and reverses the debt path is the gradual but accelerating substitution of official debt by more expensive borrowing from private sources (see figure 3, which decomposes the evolution of gross financing needs for scenario B). Debt is unlikely to be sustainable in this scenario, because beginning in the late 2020s primary surpluses are overwhelmed by rising private creditor amortization needs. However, the fan charts also suggest that it would take some time before the relevant thresholds are exceeded. In scenario B, gross financing needs stay below 20 percent until 2036. Even in the IMF's scenario, it would take almost 10 years after the end of the program for gross financing needs to rise above the 20 percent threshold.

Finally, in scenario D, Greece's debt would be clearly sustainable. In particular, Greece would remain on a declining debt path with at least 70 percent probability and below the 20 percent GFN threshold with about 60 percent probability. Compared to scenario A, this difference is driven in part by more optimistic growth assumptions and in part by the fact that Greece is assumed to maintain a higher primary surplus over a significantly longer time: at least 3.5 percent until 2030 and above 2.5 percent until 2037.

Thus, both sides of the debate—those who argue that Greece's debt is not sustainable and those who argue that, with adequate fiscal and reform effort, it would be—are internally consistent in their arguments. Under the scenarios assumed by either side, their claims with respect to debt sustainability are indeed true. Hence, deciding whether Greece's debt is sustainable or not comes down to a comparison of the reasonableness of the assumptions made, particularly assumptions regarding the evolution of the primary surplus.

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9. This paper uses updated funding rate assumptions for the EFSF that are slightly lower in the short and medium term than those of the European Commission (2016). More importantly, the futures-based marginal funding rate projections for the ESM (see box 1) are lower than those used in the analysis of the Commission, which envisaged quicker convergence to the steady state funding rate.

III. EVALUATING THE PLAUSIBILITY OF PRIMARY SURPLUS ASSUMPTIONS

Divergent views about the fiscal effort that can and should be expected of Greece over the coming years are at the core of the debate about whether Greece requires debt relief. This section evaluates the plausibility of these views based on international experience. This angle is clearly not the only relevant one: A complete analysis would take into account the special circumstances of Greece, including its current fragile economic state and structural problems (Obstfeld and Thomsen 2016). Focusing on the international experience is nonetheless useful for two reasons. First, Greece is not the first country to undergo fiscal adjustment in a cyclically and structurally difficult environment, so looking at the broad historical record is perhaps useful. Second, Greece's creditors are not easily persuaded by the IMF's argument that Greece's current structural impediments preclude a high primary surplus, since these impediments should be under Greece's control at least in the medium term. Instead, the attitudes of European creditors on what primary surpluses can be "reasonably" demanded of Greece are significantly influenced by what other countries have achieved in the past. Hence, even if the behavior of other countries were irrelevant in a predictive sense (because Greece turns out to be structurally highly atypical), it could be important in a normative sense, from the vantage point of creditors.

To ensure that the conclusions in this analysis are robust, the question of a reasonable primary surplus is approached from three different angles: first, a conditional forecast of Greece's primary surplus starting from present debt and primary surplus levels; second, an approach that calculates the probability of observing episodes of primary surpluses of a certain length, conditioned on Greece's current debt levels; and finally, an approach that focuses on the length of time that primary surpluses are typically maintained once a certain level has been reached, using a statistical technique known as survival analysis.

The starting point of the analysis is a study by Eichengreen and Panizza (2016), who examine the plausibility of primary surpluses required under current EU fiscal rules in light of international experience, based on a dataset compiled by Mauro et al. (2013). This paper extends their methodology in two directions—conditional VAR-based forecasts and survival analysis—and focuses specifically on the case of Greece. Related comparisons of debt surplus episodes have been conducted by the IMF (2016, box 1) and the ESM. However, the IMF does not conduct a full analysis, while the ESM's analysis is unpublished and limited to the euro area experience. Furthermore, both institutions disagree in their reading of the international experience, suggesting that this experience does not entirely speak for itself.

Replicating primary surplus paths as conditional forecasts

Suppose that the way in which primary surpluses react to debt, inflation, and growth in Greece is similar to that observed in other countries. How, then, would the primary surplus evolve over time, conditional on current debt levels and debt service obligations, and assuming a return to moderate growth as well as some

feedback from debt levels to the interest rate? In particular, is it possible to replicate any of the primary surplus scenarios of table 1 using conditional forecasts of this type?

To answer this question, a 4-variable vector autoregression (VAR) is estimated, based on a panel of 17 advanced countries,[10] using annual data from 1980 to 2015, for the primary surplus, debt to GDP, inflation, and growth. According to Eichengreen and Panizza (2016), the debt-to-GDP ratio and real growth are the two main robust (and easy to measure) macroeconomic determinants of the primary balance, while inflation affects nominal growth and hence the debt-to-GDP ratio.[11] The sample includes most of the "old" Organization for Economic Cooperation and Development (OECD) countries except Ireland and Japan, which were dropped because they constitute outliers.[12] The VAR was limited to advanced countries to avoid estimates based on structurally very different countries, and also because this group of countries, mostly in the euro area, is arguably close to the economic structure that Greece either already has or aspires to.

The parameter estimates of this VAR are well-behaved in the sense that they generate reasonable impulse response functions as well as stability of the debt-to-GDP ratio (see appendix 2). The basis for this stability is that primary balances respond positively to high debt levels, and the debt-to-GDP ratio declines in response to higher primary balances, as one would expect.

These estimates are then used to forecast Greece's primary surplus, taking Greece's actual current and lagged debt, GDP, growth, and inflation levels as the starting point and making the following assumptions: (1) Real growth and inflation evolve as assumed in the scenarios presented in the last section; (2) Greece undertakes the debt service (amortizations and interest payments) implied by its current debt obligations; and (3) gross financing needs are met from official sources until the end of 2018 and subsequently by issuing medium-term bonds at interest rates determined by the Laubach (2009) rule. Hence, these are very similar assumptions to those used in the Monte Carlo simulations of the previous section, with two main differences. First, the primary surplus path is now being treated as endogenous rather than assumed—it is the variable being (conditionally) forecast. Second, uncertainty is abstracted from growth, inflation, and the interest rate rule—that is, all uncertainty in the forecast comes from the error term of the primary surplus equation of the VAR.

Results are shown in figure 4 for scenarios A, B, D, and I (scenario C is ignored because it falls midway between scenarios B and I). The thick black lines show the VAR-based central forecasts for the Greek primary surplus, conditional on the growth assumptions shown in table 1. Also shown are 60, 70, 80, and

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10. Specifically, the sample includes: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Italy, the Netherlands, Portugal, Spain, Sweden, Switzerland, the United Kingdom, and the United States.

11. The VAR was identified using a Choleski decomposition with the following ordering: real growth, inflation (percentage change in the GDP deflator), the primary balance, and the debt-to-GDP ratio. See appendix 2.

12. Japan was an outlier because of extremely high debt and Ireland because of the high volatility of its primary balance during the crisis period. Appendix 3 shows how the results change if these countries are added to the sample.

90 percent confidence bands, as well as each scenario's *assumed* primary surplus path, represented by orange dashed lines.

The results can be summarized as follows:

1. The VAR-based forecasts predict roughly the same *profile* of fiscal adjustment assumed in the European Commission's scenarios A, B, and C (to a lesser extent D), namely, a front-loaded fiscal adjustment reaching about 3.5 percent of GDP, followed by a gradual fiscal easing. The mechanism behind this result is that higher debt levels induce higher primary surpluses, which in turn reduce debt levels; as this reduction happens, primary surpluses are also reduced.

2. The VAR forecasts a *more gradual* fiscal adjustment than assumed in any of the European Commission scenarios: a rise to 3.5 percent by 2020 or 2021 rather than reaching 3.5 percent as early as 2018 (the program target). This is true even though negative feedback from fiscal adjustment to growth, which may slow fiscal adjustment further, has been assumed away in the forecasts (since these are conditional on the growth assumptions of table 1).

3. The IMF's scenario I gets the initial speed of adjustment "right," but not its extent. Given high initial debt, the VAR forecasts that the primary surplus will rise above 1.5 percent by 2021 with about 80 percent probability. Furthermore, the VAR predicts that under the long-run growth and inflation assumptions of scenario I (just 1 percent real growth and 1.7 percent inflation), the primary surplus will stay above 2 percent. This reflects the fact that in the IMF's scenario, the debt-to-GDP ratio remains high throughout and in fact begins exploding from about 2035 onwards, which in the empirical model further increases the primary balance.

4. The VAR predicts a much faster decline to lower primary surplus levels than predicted in scenarios A and D. Scenario D, which envisages the primary surplus staying at 3.5 percent for 15 years (until 2033) appears particularly unrealistic: The confidence band shading indicates that the VAR-based probability that the primary surplus will fall below 3.5 percent is 70 percent by 2027 and over 80 percent by 2032—even though the VAR-based primary forecasts are conditioned on optimistic growth assumptions. Scenario B, in contrast, seems to get it about right; it is the only one of the four scenarios in which—apart from the overly abrupt initial rise in the primary surplus—the assumed path stays inside the +10/–10 percent confidence band around the conditional forecast.

Two further considerations strengthen the conclusion that scenarios A and D are not plausible:

First, although the VAR regression results are robust with respect to technical assumptions such as the ordering of the variables in the VAR, they are not robust with respect to outlier countries, particularly Japan. Including Japan in the sample significantly weakens the feedback from debt to the primary surplus. As a result, conditional forecasts for Greece estimated on the full sample of advanced countries would predict

fiscal surpluses of just 1.5 to 2 percent of GDP until the late 2030s, after which debt and the primary surplus explode (see appendix 3). That said, including Japan in the sample is probably not appropriate, since its debt levels and debt dynamics are the result of a special financing situation—a deep domestic financial system coupled with high home bias—that euro area creditors are unlikely to want to emulate.

A second and perhaps stronger reason that the fiscal adjustments predicted in figure 4 can be considered too optimistic is the fact that Greek debt levels are very much an outlier once Japan is taken out of the sample.[13] Hence, the relatively high primary surplus predicted by the VAR is based on a linear extrapolation of the impact of debt on the primary surplus at moderate levels of debt. This extrapolation may not be appropriate—for example, because of the increasing marginal social cost of primary surpluses. As a result, it is important to check the conclusions from figure 4 using techniques that do not make the assumption that the relationship between debt levels and fiscal effort is linear. The remainder of this paper focuses on two such techniques.

Probability of observing high primary surplus episodes

Following Eichengreen and Panizza (2016), episodes for which the average primary surplus exceeded a certain threshold for a given number of years are identified and the probability of observing such an episode is then calculated. Since the episodes of greatest interest are those in which high primary surpluses were sustained for a long period of time—which tend to be rare—the sample is expanded to an unbalanced panel of 48 advanced and emerging economies over the period 1955 and 2015.[14] To best compare the scenarios, the analysis focuses on episodes of 6, 10, 16, and 20 years' duration (6, 10, and 16 being the assumed lengths of primary surpluses at 3.5 or above in the scenarios B, A, and D, respectively; and 20 being the maximum length episode for which this methodology can still estimate meaningful probabilities).[15]

The top panel of figure 5 shows the unconditional probability (with a 95 percent confidence interval) of observing 6, 10, 16, and 20 years of average primary surpluses ranging between zero and 7.5 percent of

13. The average debt-to-GDP ratio in this sample is 65 percent (60 percent if Japan and Greece are excluded) with debt ranging between 10 and 250 percent of GDP (10 and 138 percent of GDP if Japan and Greece are excluded).

14. Namely, the G-7 countries (Canada, France, Germany, Italy, Japan, United Kingdom, United States) plus Argentina, Australia, Austria, Belgium, Brazil, Chile, Colombia, Costa Rica, Cyprus, Czech Republic, Denmark, Estonia, Finland, Greece, Iceland, India, Indonesia, Ireland, Israel, Korea, Latvia, Lithuania, Luxembourg, Mexico, Netherlands, New Zealand, Panama, Peru, Philippines, Poland, Portugal, Russia, Singapore, Slovak Republic, Slovenia, South Africa, Spain, Sweden, Switzerland, Thailand, and Turkey. The sample periods for the formerly centrally planned economies begin in the 1990s.

15. Specifically, the frequency of n-year periods for which a country maintains an average primary surplus of at least x percent of GDP ("episodes") is compared with that of n-year periods for which this is not the case ("control group"). When a country has an average primary surplus of more than x percent for a longer period than n, the non-overlapping n-year periods with the largest average primary surplus are chosen. The control group contains all non-overlapping n-year periods that (i) do not overlap with a window starting two years before and ending two years after a selected episode and (ii) do not overlap with any other period for which the average primary surplus is above the threshold but lower than the average primary surplus in the selected episode. See Eichengreen and Panizza (2016) for details.

GDP. For instance, there is a 40 percent probability of observing a primary surplus of at least 1 percent of GDP for at least 6 years, while the probability of observing a 5 percent primary surplus for at least 6 years is lower than 10 percent. The figure also shows that the likelihood of observing a 3.5 percent primary surplus for at least 16 years is very small (4 percent, to be precise, only just significantly greater than zero). The probability of observing a 3.5 percent primary surplus for at least 10 years is hardly bigger, while it rises to just under 8 percent if the episode length is reduced to 6 years—twice as high, but still small.

However, these probabilities may not be very meaningful because they do not take into account any country characteristics that might influence the probability of observing a primary surplus episode of a certain length. Given the relationship between debt and fiscal effort suggested by the VAR, one should at least account for the effect of debt levels. This can be done by defining a set of dummy variables for each episode length and primary surplus threshold, regressing these dummy variables on the debt-to-GDP ratio at the beginning of the episode, and using the estimates to predict the probability of observing the episode conditional on Greece's debt-to-GDP ratio. The results are shown in the bottom half of figure 5, which presents probabilities for the same events as in the top half, conditional on a debt-to-GDP ratio of 180 percent. The probability of observing an extended episode involving a high primary surplus is now much higher. For instance, the point estimate of observing a 6- or 10-year 3 percent episode is now about 30 percent, and that of a 16-year episode about 20 percent (compared to just 4 percent for the unconditional probability).

Unfortunately, the conditional estimates have large error margins (because they are extrapolating probabilities for a level of debt that is rarely observed in the sample). This limits their usefulness, particularly for assessing episode probabilities at higher primary surplus levels. In particular, the probability of observing a 16-year episode with a primary surplus of 3.5 percent or higher is insignificantly different from zero (but could also be as high as 60 percent), while that of a 10- or 6-year episode is only barely statistically significant.

Hence, the results of this analysis are consistent with the view that scenario D is particularly unrealistic (point estimate of the conditional probability, 20 percent; unconditional probability, 4 percent), but too imprecise to draw firm conclusions. In particularly, the results are too imprecise to discriminate between scenarios D, A, and even B. Furthermore, since the longest episode for which a probability can be estimated is 20 years, this methodology reveals nothing about the realism of an extremely long episode with a moderate primary surplus, as assumed in the IMF's baseline scenario.

Probability of sustaining high primary balances once they have been reached

To better compare the plausibility of the various scenarios in *relative* terms—particularly the four of the European Commission—it makes sense to focus on the main aspect in which these scenarios differ, namely, on how long a high primary surplus can be expected to be maintained above a certain level *once this level has*

been reached. There is a statistical approach, "survival analysis," that answers that question. Hence, in this approach, this analysis abstracts from the question of how realistic it is to achieve a given primary surplus to begin with, and instead concentrates on the main difference between scenarios A, B, C, and D—namely, the length of time over which that primary surplus is maintained.

Figure 6 gives the answer using a nonparametric technique (the "Kaplan-Meier estimator"), which summarizes the relative frequency of primary surplus periods (or "spells") using the same sample of countries used in the last section. To account for differences between high and low-debt countries, the sample is divided into countries that had debt below 60 percent of GDP and above 60 percent of GDP at the beginning of the period.[16] Each plot describes the probability that a given primary balance exceeds a period of a certain length.

In addition to distinguishing between four levels of the primary balance (zero percent, 1.5 percent, 2.5 percent, and 3.5 percent of GDP), the plots use two alternative definitions of what defines a "period." In the top four charts, a period ends when the primary balance dips below the pre-specified level for the first time (even if it subsequently immediately recovers). The bottom four charts use a less stringent definition: Here, the high primary balance period ends only once the *average* primary balance, evaluated over the entire period, drops below the threshold level. For example, by the first definition, Italy had a period with primary balances exceeding 2.5 percentage points from 1995 until 2000, after which primary balances dropped below 2.5 percent, followed by a second period of just one year, 2007, when the primary balance returned to about 3 percent. By the second definition, it had just one long primary surplus period in excess of 2.5 percent from 1995 until 2008, with an average primary balance of 2.75 percent.

Figure 6 exhibits three regularities that one would expect based on the discussion so far. First, higher primary balance periods tend to be shorter, on average, than lower primary balance periods. For example, according to the more stringent definition of what constitutes such a period (top two rows), about 20 percent of primary balance (PB) > 1.5 percent periods in high-debt countries survive after 10 years, while virtually no PB > 3.5 percent periods survive for so long. Second, the survival rates are higher when the less stringent definition of a high primary balance period is used. For example, while virtually no PB > 3.5 percent periods survive in high-debt countries after 10 years based on the more stringent definition, at least one third of PB > 3.5 percent episodes survive beyond 10 years if this is measured by the *average* over the period rather than in each and every year. Finally, the charts show that high-debt countries tend to sustain high primary balance periods for longer than lower debt countries. This is the survival analysis counterpart to the result found in the regression analysis that higher debt leads to higher primary balances.

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16. This threshold was chosen because a significantly higher threshold would have resulted in too few observations in the "high debt" category.

Consider now what the plots suggest about how realistic some of the scenarios in table 1 are. Scenario D assumes that a 3.5 percent primary surplus, once reached, is maintained for 16 years. According to the plots, the frequency with which this has happened in the past (conditional on attaining the 3.5 level in the first place) is zero in the stringent definition and 15 to 20 percent in the average-based definition (for high-debt countries). Scenario A, which envisages a 10-year period with a 3.5 percent surplus, fares a bit better in the average definition (for high-debt countries) but not in the stringent definition. Scenario B begins to look more realistic: The probability of seeing a 3.5 percent primary surplus sustained for six years in a high-debt country, based on the average criterion, is about 50 percent, while the probability of seeing it sustained in every year is 25 percent. But scenario B also assumes that the average primary surplus stays at 2.5 percent for 20 years and above 1.5 percent for over 40 years. According to figure 6, this happened only in 25 percent of periods even in the high debt cases. So even scenario B must be regarded as very ambitious—not only for assuming that a 3.5 percent surplus, once reached, can be sustained at that level for five more years, but also because it assumes that the surplus will stay high for a very long time after that. This applies to an even greater extent to scenario A, which assumes that the average surplus stays above 3 percent for 21 years and above 2.5 percent for 33 years (until 2051).

It is also interesting what the survival time plots have to say about historical precedents for the two *less* ambitious scenarios C (surplus reaches 3.5 percent in 2018 and then immediately starts declining until it reaches 1.5 percent after 10 years) and I (surplus never reaches 3.5 percent but instead "flatlines" at 1.5 percent for a very long time). Scenario C is more ambitious than I in that it assumes both a higher peak surplus and a higher average surplus—for example, it implies an average surplus of about 2.5 percent between 2018 and 2028, as opposed to just 1.5 percent in scenario I. That said, the lower panel of the figure shows that the probability of maintaining an average surplus of 2.5 percent for 10 years, conditional on having reached at least 2.5 percent, is only slightly lower than the corresponding conditional probability of maintaining a 1.5 percent average surplus for at least 10 years on average. The intuition behind this is that adjustment episodes in which the primary balance exceeds 1.5 percent in high-debt countries typically involve a significant "overshooting" of that level for a few years; hence, episodes for which the primary balance exceeds 2.5 percent and 1.5 percent tend to overlap.

The principal message of figure 6 is that international evidence does not support an adjustment path that envisages a primary surplus of above 3.5 percent for more than three to four years on a continuous basis and for more than seven years on an average basis. Before embracing this conclusion, however, it is important to address a possible problem.[17] The data underlying figure 6 may include episodes in which primary balances were reduced because debt reduction objectives had essentially been achieved. But for the purposes of the present analysis, those episodes should be excluded, since they may result in an overly pessi-

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17. We are grateful to Olivier Blanchard for pointing this out.

mistic picture of how long governments can hold primary balances when they matter for debt sustainability. To use an analogy, if one is trying to find out how far individuals can reasonably be expected to run, one should exclude observations where an individual stopped running because she had reached her destination.

To address this potential issue, all episodes in which primary balances were maintained above 3.5 percent for at least one year on a continuous basis are examined. Out of the 85 such episodes in the dataset, 31 started with debt above 60 percent of GDP. These episodes were checked to determine whether (1) the debt-to-GDP ratio declined at all during the episode, (2) the debt-to-GDP ratio continued to decline or remained stable after the primary balance dropped below 3.5 percent, (3) the primary balance remained below 3.5 percent of GDP for at least two years after the episode ended, and (4) the level of debt after the end of an episode was less than 100 percent of GDP. If all four criteria were satisfied, it was considered plausible that the episode ended because the debt stabilization aims of the government had been achieved, and it was therefore eliminated from the sample (see appendix 3 for a justification and some examples). This was the case for 12 of the 31 episodes. The survival analysis was then repeated for the remaining 19 episodes—that is, the set of episodes starting with debt at or above 60 percent of GDP that ended "too early" from a debt stabilization perspective.

In figure 7, the line that is closest to the origin (labeled "low-debt countries") is the same as the darker line in the plot in the second row and column of figure 6—that is, it describes the duration of episodes with primary balances in excess of 3.5 percent of GDP for countries with a debt-to-GDP ratio below 60 percent. The outer two lines describe the duration in the high debt sample, except that this time the high primary balance episodes that ended because debt had arguably fallen enough ("high-debt countries") are separated from those that ended "too early" ("high-debt countries; period ended too early"). As expected, the latter is shifted up from the former: High primary balance episodes that started from high debt and do not appear to have achieved their debt stabilization objective tended to last longer than episodes that ended when their stabilization objective was achieved.

However, the differences are fairly modest. The main finding is that the chances that a primary balance of 3.5 percent or higher can be sustained for at least four years now appear a bit higher—namely, 50 percent—than in figure 6. But the conclusions drawn previously from figure 6 are unaffected. In particular, the likelihood of sustaining a primary balance at or above 3.5 percent for 10 years in a row—as assumed in scenario A—is zero, even according to the most outward of the three lines in figure 7.

To conclude, the evidence shown in this section rejects the European Commission's scenarios A and D, which envisage maintaining a high (3.5 percent) primary surplus for an unrealistically long period. But the IMF's baseline scenario I also seems implausible, both because a maximum primary surplus of only 1.5 percent is unusually low for countries with debt as high as Greece and because of the very unusual shape of adjustment, in which the primary surplus never rises above 1.5 percent but is sustained at that level for a very long time.

The European Commission's scenarios B and C look more plausible in that the assumed time path—a few years of significant fiscal effort that subsequently tails off—is quite typical of other high-debt countries in the past. But even these scenarios have elements that are unrealistic based on the international comparison: the speed with which the 3.5 percent target is attained, and particularly the assumption that the primary surplus will remain high (albeit on a declining path) for a long time and not drop below 1.5 percent. That said, it may be possible to argue that these long-run assumptions are somewhat more plausible in the Greek context because of EU fiscal rules—particularly the 3 percent nominal deficit limit, which implies that member states with interest bills in excess of 3 percent must run primary surpluses. While violations of the 3 percent target have been commonplace, the European Union's excessive deficit procedure makes it harder for members to run fiscal deficits in excess of 3 percent on a sustained basis than for the average country in the sample.

IV. EVALUATING DEBT RELIEF MEASURES

The implications of the previous section are clear: The only scenarios in which Greece's debt might be sustainable are rejected. The more plausible scenarios—C and to a lesser extent B—are those that imply that Greece's debt is unsustainable. The remainder of this paper addresses the question of whether this lack of sustainability can be addressed by using measures consistent with the Eurogroup statement of May 25, 2016 (box 3). The analysis proceeds in two steps. First, only measures that are directly mentioned or described in general terms in the statement are considered (other than the "short term measures" that have already been implemented; see ESM 2017). Where these measures are insufficient, the analysis considers additional measures—provided these do not step outside the political boundaries delineated by the Eurogroup, namely, that "nominal haircuts are excluded, and that all measures taken will be in line with existing EU law and the ESM and EFSF legal frameworks."

In addition to answering the question whether these measures can make debt sustainable in scenarios B and C, two new scenarios are considered.

■ **Scenario N1** distills some of the broad lessons from the previous sections: (1) Although getting to a 3.5 percent primary surplus is not implausible for a high-debt country such as Greece, it may take longer than assumed in the present program (basis: VAR-based conditional forecast); (2) the maximum period that one can reasonably assume the primary surplus of 3.5 percent to be sustained is about four years (basis: survival analysis); (3) it is unrealistic to expect a primary surplus of more than 2.5 percent for more than 10 to 15 years on a period average basis (basis: survival analysis). The following scenario roughly respects these lessons: The primary surplus gradually rises from about 1 percent in 2016 to 3.5 percent in 2021, stays at that level for four years, and then falls by 0.25 percentage point per year to

reach 2.5 percent in 2028. It subsequently falls more slowly (at just 0.1 percentage point of GDP per year) until it reaches 1 percent in 2043.[18]

- **Scenario N2** is "in between" scenarios B and C in the medium term and follows scenario N1 in the long term. It assumes that Greece attains a primary surplus of 3.5 percent of GDP by 2018 and stays there for three years. After 2020, it begins falling at a rate of 0.2 percentage point per year, reaching 1.5 percent in 2030, stays at that level until 2038, and subsequently declines until reaching 1 percent in 2043.

Growth, inflation, and privatization assumptions in both of the new scenarios are the same as in scenarios B and C.

Evaluating the debt relief measures listed in the Eurogroup statement

The measures described in the Eurogroup statement (box 3) are operationalized as follows:

1. "Abolish the step-up interest rate margin related to the debt buy-back tranche of the 2nd Greek programme as of 2018." This involves lowering the EFSF interest rates by 200 basis points on a loan tranche amounting to €11.3 billion.

2. "Use of 2014 SMP profits from the ESM segregated account and the restoration of the transfer of ANFA and SMP profits to Greece."[19] The maximum volume of this transfer amounts to about €7.7 billion. This paper assumes that this is disbursed in seven equal tranches of €1.1 billion per year after the successful conclusion of the ongoing program, i.e. from 2019 onwards.

3. "Early partial repayment of existing official loans to Greece by utilizing unused resources within the ESM programme." This paper assumes that the IMF is repaid in full, using cheaper ESM funds, at the end of the ongoing program (namely, about €12 billion).

4. "EFSF reprofiling and capping and deferral of interest payments." This is the most important component of the potential debt relief and is implemented using a combination of three instruments:

   a. An outward shift of the amortization profile by T years (that is, amortizations due in year t become amortizations due in year $t + T$).

   b. Actual amortizations are fixed as share s of GDP in each year (for example, 1 percent). If amortizations due exceed this amount, they are rolled over by one year. If amortizations due fall short of this amount, this triggers early repayment of future amortizations.

18. Specifically, the primary surplus is assumed to fall by 0.25 percentage point per year until reaching 2.5 percent in 2028, and then continue falling by 0.1 percentage point per year until reaching 1 percent.

19. ANFA (Agreement on Net Financial Assets) and SMP ("Securities and Market Programme") were two channels through which the ECB and other members of the Eurosystem acquired Greek government bonds that were not restructured in 2012 and on which the Eurosystem continues to earn interest.

c. Interest payments are capped at p percent of the outstanding debt until 2050. When interest payments due exceed p, the remainder is capitalized (rolled into principal), which is repaid from 2050 onwards. Setting $p = 0$ amounts to a full deferral of interest until 2050.

This is just one example of how "EFSF reprofiling and capping and deferral of interest payments" could be implemented. However, it is a versatile and useful example for two reasons. First, it involves three parameters that can be set separately, implying substantial flexibility for finding a combination of parameters that will keep gross financing needs below 20 percent and the debt-to-GDP ratio on a declining path. If there is no combination of the three parameters that will make the debt sustainable—for a given set of assumptions about the primary surplus path and growth, as in the first section—it is highly unlikely that other ways of implementing "EFSF reprofiling and capping and deferral of interest payments" would fare better. Second, this implementation has some desirable insurance properties, which increase the robustness of a restructuring to a variety of shocks. In particular, point 4.b above is a form of insurance against GDP shocks, while 4.c amounts to insurance against interest rate shocks. The EFSF provides this insurance and is then free to fund itself in the market in whatever way minimizes its funding costs.[20]

The objective is to find a set of parameters T (shifting of maturities), s (annual amortization of EFSF debt in percent of GDP), and p (maximum interest payments as a percent of outstanding debt) which, with the debt relief measures listed in points 1 through 3 above, will achieve sustainable debt with reasonably high probability. T is relevant mainly because it impacts the amortization profile in the first years of EFSF repayments. To smooth the amortization profile, T is set equal to 6 years; this means that EFSF repayments start in 2029, by which time shorter public liabilities (in the "other" category; see figure 1) have amortized. Given this choice of T, the interest deferral parameter p and the annual amortization s is then set so that gross financing needs stay below 20 percent and debt-to-GDP remains on a declining path with at least 60 percent probability.

Figure 8 shows that this objective can be achieved for scenarios B and N1—but not quite for scenarios N2 and C—by making full use of the interest rate deferral parameter ($p = 0$) and choosing annual amortizations s at a sufficiently low percentage of GDP. In scenarios B and N1, this leads to a 60 percent probability of gross financing needs < 20 percent, while the probability that debt remains on a declining path is slightly higher than 60 percent for scenario B and just below 60 percent for scenario N1. In scenarios N2 and C,

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20. A technical caveat may apply. A condition set by the Eurogroup is that any debt relief measures should "be in line with the ESM and EFSF legal frameworks." One aspect of these frameworks is that "each loan tranche has its own specified repayment, or maturity, date." (See "ESM lending toolkit," answer to the question "How are ESM loans repaid?," available at https://www.esm.europa.eu/assistance/lending-toolkit#lending_toolkit [accessed March 23, 2017]. https://www.esm.europa.eu/assistance/lending-toolkit) An open-ended rollover rule such as specified in 4.b would presumably violate this condition. However, this could be addressed by simulating the maximum period for which such rollovers might be necessary—as this paper will do—and then set an upper time limit after which rollovers stop, and the remaining principal is repaid over a fixed maximum maturity.

the probability of maintaining a declining debt-to-GDP ratio is above 50 percent but below 60 percent. In that sense, debt is sustainable in these scenarios but not with high probability.

Perhaps these results could be considered good enough—but there is a hitch. The consequence of granting very low amortization rates and further interest deferrals is not only that Greece will continue to owe money to the EFSF for a very long time but also that Greece's debts to the EFSF will continue to grow as long as interest is deferred. The left chart of figure 9 shows what this would look like in the case of scenario N2, with annual amortization at 0.2 percent of GDP and full interest deferral. Starting from its current level of about €131 billion, Greece's debts to the EFSF would more than double to about €278 billion in 2050, when interest deferral is assumed to end, and then begin a slow decline, but the outstanding amount in 2080 would still be higher than it is today. Although interest deferrals are part of the arsenal of debt relief measures described by the Eurogroup, an increase in exposure of this size—equivalent to new large-scale lending by the EFSF—is politically implausible.

A more palatable repayment profile might look like the right-hand chart in figure 9, with a monotonic, albeit slow, decline in exposure to Greece. However, a repayment profile of this type—giving up on or strongly limiting the use of interest rate deferrals—is inconsistent with restoring debt sustainability in scenarios N1, N2, and C. Of the scenarios considered in this section, debt could be made sustainable without resorting to extensive interest rate deferrals only for scenario B, and only just. But the previous section showed that the probability of sustained fiscal adjustment as assumed in scenario B is only about 25 percent on average in advanced and emerging-market countries (figures 6 and 7). If scenario B is deemed too ambitious for Greece, the Eurogroup would either need to agree to additional measures beyond those that were explicitly listed in the statement or delay Greece's return to capital markets.

Additional measures not mentioned in, but consistent with, the Eurogroup statement

Additional debt relief measures could go in two directions: broadening the scope of debt relief to other official creditors and lowering interest rates within the constraints set by the Eurogroup, which preclude EFSF lending below funding costs.

As the IMF (2017) has pointed out, two additional lenders—other than the IMF itself, whose preferred creditor status is recognized in the ESM treaty—could grant extra debt relief to Greece: the bilateral Greek Loan Facility, which was used to finance Greece's first adjustment program, and the ESM, Greece's current lender. The former is owed about €53 billon by Greece, while the ESM's net disbursements amount to about €30 billion so far. However, the terms of ESM lending to Greece are already highly concessional (10-basis point margin over funding costs, with repayments beginning in 2034 and continuing to 2062).

Furthermore, bailing in the ESM may raise questions about the legality of any further—and possibly past—ESM lending to Greece.[21]

Restructuring the Greek Loan Facility is hence a better possibility for extra debt relief. GLF restructuring could take the form of lengthening maturities, reducing the GLF lending margin of presently 50 basis points over the 3-month Euro Interbank Offered Rate (Euribor), and possibly early repayment of GLF lending funded by the ESM, whose margin over funding costs is just 10 basis points.

The IMF (2017) has also asked for further EFSF and ESM interest rate relief, specifically, fixing "interest rates on all EFSF and ESM loans at low levels for 30 years, not exceeding 1½ percent." Since the cost of the EFSF's existing funding portfolio is about 1.3 to 1.4 percent (with a lending margin of zero), what the IMF appears to have in mind is for the EFSF and ESM to lock in currently low interest rates by issuing very long bonds. Whether this is possible in the required volumes using market-based operations is not clear: A 30-year bond issued by the ESM in late January yielded 1.76 percent, above the range suggested by the IMF. That said, some reduction in the future funding costs currently assumed by the EFSF is probably feasible. This can be inferred from the fact that the presently assumed EFSF funding costs rise significantly above those implied by German government bond futures (see box 1). Hence, the EFSF appears to be taking a conservative view of its future average funding costs.

Figure 10 shows the combined impact of these measures. The top row shows the point of departure, namely gross financing needs and debt-to-GDP ratios after applying all measures analyzed in the previous section but excluding interest deferrals and with EFSF amortization set at a very low annual rate (0.2 percent of GDP). This is the same set of conditions that produced the gently downward sloping path of EFSF outstanding loans to Greece seen earlier in the right-hand chart in figure 9. However, the fan charts in the top row of figure 10 show that notwithstanding the very low EFSF amortization rate, Greece's debts would not be sustainable: Gross financing needs would eventually exceed 20 percent, and while the debt ratio is downward sloping, it becomes stuck at about 90 percent of GDP and explodes with just under 50 percent probability.

Consider next the (additional) impact of lower EFSF funding cost assumptions. These are constructed as a weighted average of the cost of the EFSF current funding portfolio (which slowly declines over time) and the cost of funding the EFSF future financing needs ("marginal funding cost"). The latter is projected using German 6-year bund futures for the first 10 years plus a margin of 20 basis points (see box 1). After 2027, the futures curve as a guide post is abandoned, since this shows a notable flattening that would imply bund yields that remain permanently below the ECB's inflation target. Instead, marginal funding costs are

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21. The ESM can only lend to countries with sustainable debts. The sustainability of Greek debt was doubtful even at the beginning of the third program (European Commission 2015). The case for the ESM to continue lending at the time arguably rested on the presumption that Greece's debt sustainability could be restored, if needed, by restructuring official loans to Greece other than those of the ESM itself.

assumed to continue rising in small increments of 10 basis points per year. This leads to a projected EFSF interest rate between 2 and 3 percent from 2025 onward, quite a bit higher than demanded by the IMF but about 80 basis points lower on average than the rate that was previously assumed. As the second row of figure 10 shows, the impact of this reduction on Greek debt sustainability is considerable: Gross financing needs are now projected to max out at just under 16 percent (median), and the debt ratio falls more steeply. That said, the probabilities that gross financing needs exceed 20 percent and the debt ratio becomes explosive is still relatively high, between 40 and 50 percent.

The bottom row of figure 10 shows the additional impact of restructuring the Greek Loan Facility, as follows: Repayments start eight years later than planned (first amortization in 2028 rather than 2020, to reduce the bunching of amortizations between 2020 and 2027), are subsequently stretched out over 20 more years (last amortization in 2069 rather than 2041 as currently planned), and the margin is reduced to 10 basis points from 50. As the figure shows, this leads to a moderate additional improvement in the debt dynamics, with maximum gross financing needs dropping by a little over 2 percentage points to just under 14 percent and the 2050 debt ratio by 6 percentage points, from 83 percent to 77 percent.

Delaying Greece's return to bond markets

Restoring Greek debt sustainability is complicated by the aim to end ESM support in 2018 at a time when the risk premiums (spreads) demanded by private creditors are still very high. The need for extra debt relief, extra austerity, or both could be reduced if Greece's return to capital markets were delayed until spreads are significantly reduced.[22] Such a delay is not presently under discussion: Both creditors and Greece are intent on ending the current program relationship—a source of friction for almost seven years now—in 2018. However, delaying Greece's return to capital markets would maximize the impact of a given amount of debt relief in net present value terms—or alternatively, minimize the need for debt relief for a given amount of fiscal adjustment in Greece.

To give a sense of the fiscal and/or financing resources that a delayed return to capital markets would save, consider a thought experiment, starting with the benchmark restructuring assumed in the top row of figure 10—that is, full use of the Eurogroup measures without resorting to EFSF interest rate deferrals to avoid the large increase in EFSF exposure shown in the left-hand chart of figure 9. As seen in figure 10, this package of measures is not enough to restore Greece to debt sustainability. The question is how many years and what volume of additional ESM financing it would take to get the Greek debt dynamics to look roughly like either the third row in figure 8, in which a large deferral of EFSF interest achieves extra debt relief, or the last row of figure 10, reflecting all additional measures considered in the last subsection

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22. We thank Daniel Gros for encouraging us to analyze this option.

but no EFSF interest deferral. These sets of measures had an approximately equivalent impact on Greek sustainability.

To answer the question, the debt sustainability analyses are repeated using the same assumptions as in the top row of figure 10, except that for *N* years after 2018, the ESM rather than the private bond market is assumed to cover Greece's gross financing needs. The repayment profile of additional ESM disbursements after 2018 is assumed to be identical to that in the current program, i.e. amortization begins after 19 years and ends after 47 years. *N* is adjusted such that both the deterministic paths of gross financing needs and the debt-to-GDP ratio are roughly the same as in the bottom row of figure 10.[23] The resulting official amortization profile is shown in the left-hand chart of figure 11. The main result is that it would take an extra 14 years (up to and including 2032) and about €100 billion in additional ESM financing to achieve the equivalent of the GLF restructuring and lower EFSF interest rates discussed in the last section.

This seems a tall order. However, the approach would be far less onerous, in terms of required additional official financing, than the approach implicit in the May 2016 Eurogroup statement. To see this, compare the left chart of figure 11 with the left chart of figure 9. The latter shows the path of EFSF exposure to Greece implied by allowing Greece to re-access capital markets in 2018 while using EFSF maturity extensions and interest rate deferrals to make the Greek debt sustainable. While total outstanding ESM and EFSF credit rises to a maximum of €272 billion in figure 11, peak exposure of the official sector is even higher in the left chart of figure 9—almost €278 billion for the EFSF alone. Furthermore, peak exposure in figure 9 is reached much later (in 2050 rather than 2032) and takes much longer to decline. In figure 11, total official exposure is down to about €50 billion by 2080, while in the left chart of figure 11, it would still be over €210 billion at the same point in time.

The right chart of figure 11 gives a sense of why delaying the return of Greece to debt markets may be a good idea. The figure compares projected private interest rates, computed as the sum of ESM marginal funding rates and a spread linked to the debt-to-GDP ratio (see box 1), with projected ESM lending rates, assumed to equal ESM average funding costs plus a fixed 10-basis point markup. The difference between the two interest rates is initially very large (over 450 basis points). Over time, the difference declines, both because the spread over marginal funding costs declines and because average ESM funding costs slowly increase because of the risk-free interest rate rise. When assumed ESM involvement in Greece ends in 2032, the difference between private and official rates is down to about 180 basis points.[24] Until then, Greece

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23. The precise numbers are as follows. The bottom row of figure 10 implies a maximum deterministic GFN of 13.7 percent and a debt-to-GDP ratio declining to 94.1 percent in 2035, 76.9 percent in 2050, and 64.2 percent in 2065. An extra 14 years of reliance on official finance, requiring €101.5 billion in additional ESM financing, would imply maximum gross financing needs of 13.5 percent and a debt-to-GDP ratio falling to 94.7 percent in 2035, 78.9 percent in 2050, and 66.9 percent in 2065.

24. A possible objection to this approach is that the preferred creditor status of the ESM would create an offsetting effect, as new private creditors would in effect be subordinated (see Xafa 2014), leading risk premia to fall by less than what is assumed in figure 11. There are three responses to this objection. First, even if this prediction

would continue to pay low official interest rates on new borrowing, implying a much flatter path of gross financing requirements and hence less need for debt relief in the form of EFSF interest rate deferrals and maturity extensions.

V. CONCLUSION

This paper set out to answer the question of whether Greece needs more official debt relief—and if so, how much more, and how this could be delivered. The analysis yields three main results.

First, Greece does indeed need substantial debt relief beyond what has already been extended in past years (including through an extensive package of interest rate reductions, deferrals, and maturity extensions decided in late 2012, as well as the "short term measures" recently adopted by the ESM). While there are combinations of ambitious fiscal adjustment and reforms that would make additional debt relief unnecessary and examples of countries that have successfully undertaken such adjustments in the past, the analysis here shows that these examples are rare. Based on the typical (average) behavior of advanced and emerging-market countries with high levels of debt, the additional fiscal adjustment that can be expected of Greece will fall far short of what is required to restore debt sustainability without additional debt relief. Furthermore, even the "typical" amount of additional fiscal adjustment may be a lot to expect from a country that has lost approximately one quarter of its output and adjusted its primary balance by approximately 10 percentage points since the 2009 financial crisis, and in which unemployment still stands well above 20 percent.

The second main result of the paper is that the arsenal of "medium- and long-term" debt relief measures put on the table by the Eurogroup in May 2016 could be sufficient to restore debt sustainability, but only if these measures are taken to an extreme. This means accepting an extremely long maturity extension of EFSF debts. In addition, it requires either substantial additional interest rate deferrals, or locking in significantly lower funding costs and hence lower interest rates than the EFSF currently expects, or a combination of both. While these measures are feasible within the red lines described by the Eurogroup, they are likely to be politically and/or technically difficult. Unless the EFSF manages to eke out substantial extra interest relief through creative long-term funding operations, its exposure to Greece will likely have to rise, possibly for

were to turn out to be correct, it is still true that in the period prior to exiting the ESM program, Greece and its creditors can save substantial resources by not resorting to expensive private borrowing. As far as the period after exiting the ESM program is concerned, private borrowing needs would be relatively modest until about 2045, at which point ESM exposure would be rapidly declining. Second, Greece's new bonds outstanding would not be subordinated to the EFSF, which would have over €100 billion in exposure to Greece until about 2060. Third, while the methodology for projecting private spreads does not consider the possible effects of subordination, it also does not consider confidence effects due to an increasingly long track record of good fiscal performance, since spreads are assumed to depend linearly on current debt levels (see first section of this paper). These confidence effects would tend to predict faster declines in private interest rates.

decades, before it starts falling. A private sector creditor would not accept this type of restructuring because it gives the debtor country a strong incentive to default (or at least renegotiate) when the debt is at its peak.[25]

Third, one way out of this dilemma would be to delay Greece's return to capital markets, continuing to finance Greece through ESM programs until its private sector spreads are much lower than they are now. By removing the need to spend fiscal resources on persuading reluctant private creditors to hold additional Greek bonds, this approach would lower the total need for debt relief and/or fiscal effort required to restore Greece to debt sustainability. While it would lead to a significant increase in official creditor exposure to Greece—requiring perhaps €100 billion of extra ESM financing—this is less than the rise in EFSF exposure that would be required in the Eurogroup's approach, which aims to return Greece to private capital markets in 2018 while relying mainly on EFSF maturity extensions and interest rate deferrals for debt relief. Ironically, total official exposure to Greece would decline faster if ESM financing were to continue than if it were to end in 2018.

From an efficiency perspective, and to safeguard the total resources of the public sector, extending ESM financing of Greece to avoid expensive borrowing from private sources would hence clearly be sensible. But it is not currently the intention of the Eurogroup, and it would be deeply unpopular both in Greece and in the creditor countries. However, continued ESM support could perhaps be made politically feasible by making it a condition of debt relief, and persuading the European public that it is the least expensive approach to restoring Greece's debt sustainability.

This paper leaves two important questions unanswered.

The first is on the timing of debt relief. A plausible argument is that a firm commitment to debt relief should happen as soon as possible to reduce the threat of a new creditor-debtor confrontation that could trigger Greece's exit from the euro area, restore investor and depositor confidence in Greece, and allow a recovery that is in the interests of both Greece and its creditors. There is also a counterargument, however, namely that the threat of Grexit could be essential to maintain incentives for reform and adjustment in Greece. This argument cannot easily be dismissed. There is little doubt that it was the experience of July 2015 that brought the present Greek government back to the negotiating table and created the political basis for the current program.

Even if this argument is correct, however, keeping the sword of Grexit dangling as a disciplining device would help reduce debt levels only so long as Greece is being financed with cheap official funds. If, however, Greece returns to capital markets, any beneficial incentives of this approach would likely be offset by the risk premiums that private lenders would charge to a country whose euro membership remains at risk.

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25. A strategic default or renegotiation of this nature is less plausible among countries that are linked through multiple relationships and common interests. In such a setting, the most important determinant of default risk is the pain that a democratically elected government must inflict on its voters to remain current on its debt service. This is related to debt service—interest plus annual amortizations—as a share of GDP, not to the stock of outstanding debt.

It follows that if the objective is to allow Greece to return to capital markets in the second half of 2018, the question of how much debt relief Greece can expect must be credibly answered first. Delaying a clear answer to the debt relief question beyond 2018 is feasible only if the creditors are prepared to extend ESM financing beyond 2018. And feasible does not necessarily mean optimal: In the context of continued ESM financing, the best approach to rekindle growth may well be to combine some upfront debt relief in 2018 with promises of additional debt relief if Greece complies with agreed policies and refrains from expensive borrowing from the private sector.

This leads to the final and most difficult question: How can debt relief be structured to sustain incentives for reforms and a realistic amount of fiscal adjustment after Grexit is no longer a threat? Answering this question is beyond the scope of this paper, but it is not the first time that it has come up in the context of official debt relief. There may be something to be learned, in particular, from the design of the Heavily Indebted Poor Countries Initiative, which tried to blend debt relief with further reform. For example, if there is no further ESM program after 2018, debt relief could be delivered conditional on a set of "post-program" structural or fiscal benchmarks defined and monitored over a 3- to 5-year period. An agreement on which benchmarks this might entail and the debt relief measures that they would trigger might allow both sides to declare political victory and allow a sustainable return to capital markets.

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Figure 1   Greece's current annual amortization profile, 2017–62

billions of euros
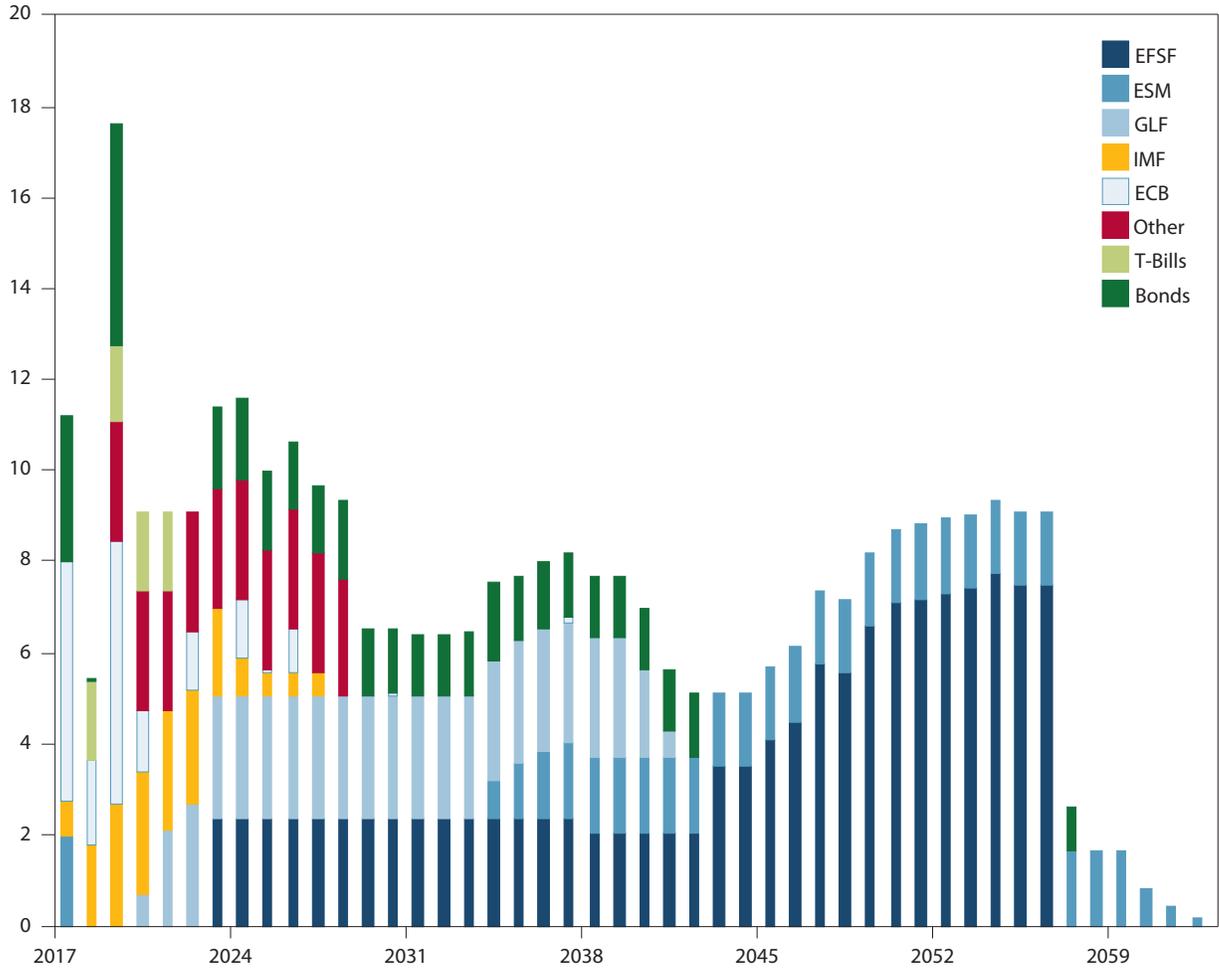
EFSF = European Financial Stability Facility; ESM = European Stability Mechanism; GLF = Greek Loan Facility; IMF = International Monetary Fund; ECB = European Central Bank

Note: "Other" is a residual category encompassing loans by the Bank of Greece, other domestic loans, special purpose and bilateral loans, other external loans, and repurchase agreements.

Sources: ESM/EFSF, IMF, and Hellenic Republic Public Debt Bulletin No. 80, December 2015.

Table 1 Greece: Alternative scenarios for growth and the primary surplus (real growth in percentage year-on-year change in GDP, primary surplus in percent of GDP)

Scenario		2016	2017	2018	2021	2024	2027	2030	2035	2040	2045	2050	2060
A	Real growth	0.40	2.68	3.11	1.97	1.50	1.50	1.25	1.25	1.25	1.25	1.25	1.25
	Primary balance	0.90	1.75	3.50	3.50	3.50	3.50	3.20	2.50	1.50	1.50	1.50	1.50
B	Real growth	0.40	2.68	3.11	1.72	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
	Primary balance	0.90	1.75	3.50	3.50	3.30	2.70	2.10	1.50	1.50	1.50	1.50	1.50
C	Real growth	0.40	2.68	3.11	1.72	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
	Primary balance	0.90	1.75	3.50	2.90	2.30	1.70	1.50	1.50	1.50	1.50	1.50	1.50
I	Real growth	0.40	2.70	2.60	1.50	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Primary balance	0.90	0.30	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
D	Real growth	0.40	2.68	3.11	2.22	1.75	1.75	1.50	1.50	1.50	1.50	1.50	1.50
	Primary balance	0.90	1.75	3.50	3.50	3.50	3.50	3.50	2.75	1.50	1.50	1.50	1.50

Note: The table shows assumed paths for real growth and the primary surplus for five alternative scenarios. 2016 preliminary outcomes and scenario I are taken from IMF 2017. From 2017 onward, scenarios A, B, C, and D are taken from European Commission 2016.

*Sources:* IMF 2017 and European Commission 2016.

Box 1 Additional debt sustainability analysis assumptions

The following additional assumptions are made when projecting the gross financing needs and debt paths:

1. In all scenarios except I, a new €5 billion IMF-supported program for Greece is assumed agreed in 2017 and fully disbursed in 2017 and 2018 (the €5 billion was cited in the German media[1]). For scenario I, a new IMF-supported program is not assumed. Amortizations of the new IMF loan are assumed to begin in 2020 and end in 2028, and the rate of change is 3.5 percent.

2. The most recent (February 2017) official amortization and interest rate profile is assumed, after application of the "short term measures" taken by the ESM in January 2017 to smooth Greece's repayment profile and lower interest rate risk (see ESM 2017). Greece's €2 billion repayment to the ESM following a bank asset sale on February 20, 2017, is also taken into account. This is reflected in the amortization profile of the ESM as well as in privatization proceeds.

3. In line with the terms of official lending arrangements in place, interest rates on official European loans are assumed to equal the 3-month Euribor + 50 basis points for the Greek Loan Facility (GLF), funding costs plus 10 basis points for the ESM and funding costs plus zero for the EFSF. A projection of EFSF funding costs, envisaging a rise from 1.3 percent this year to 3.3 percent by 2034 was kindly made available by the EFSF. Euribor is projected using the futures curve until 2027, with a slow continued rise to 2.76 percent by 2037. ESM funding costs are projected as a weighted average of the average funding cost and maturity structure of the current funding portfolio and a projection of marginal funding costs, assumed to equal the 6-year German bund futures curve until 2027 plus a 20-basis point spread. The latter is based on a linear regression (January 2013 to January 2017) of monthly ESM funding costs on an average of the German yield curve that is calibrated, in each month, to have the same maturity as the ESM funding portfolio (this regression leads to a coefficient of about 1 and a constant of about 0.2). The 6-year German bund is chosen for projection purposes because the average residual maturity of the ESM funding portfolio has been around six years for some time. After 2027, ESM marginal funding costs are assumed to continue rising until reaching 3 percent by 2042.

4. Greece is assumed to regain capital market access in the second half of 2018. No official financing is disbursed after 2018. New sovereign bonds are assumed to be issued to private borrowers at an average maturity of 5.5 years (for smoothness, half of the new issues are assumed to be 5-year bonds and the rest 6-year bonds).

5. Interest rates charged by private creditors are assumed to equal official "risk free" interest rates, which are assumed to equal ESM marginal funding costs, plus a spread based on Laubach (2009). Specifically, a 4-basis point spread is assumed for each percentage point that the Greek debt-to-GDP ratio exceeds the Maastricht treaty debt ratio of 60 percent of GDP. This parametrization predicts a borrowing spread of around 4.5 percentage points when Greece is assumed to re-access bond markets in late 2018 and 2019, which is about in line with Greece's borrowing spread when it last re-accessed capital markets, in July 2014, at a time when fiscal adjustment was perceived to be on track and program exit was in sight. The IMF follows the same approach in its debt sustainability analysis, with one exception: While the IMF constrains the spread not to exceed 4.5 percent, this paper does not impose such a limit but instead constrains bond yields to be no higher than 20 percent, as a tight ex ante restriction on the spread would prevent meaningful Monte Carlo simulations (see box 2). The simulations are not very sensitive to the level of the cap. For example, a cap of 10 percent would not change any of the conclusions of the paper.

6. The Treasury bill stock is reduced to the precrisis level and partly replaced by the new medium-term bonds between 2018 to 2021 (reduction by €1.7 billion each year).

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1. "IWF will sich nur mit geringer Summe an Griechenland-Rettung beteiligen," *Der Spiegel*, February 18, 2017.

Figure 2   Stochastic debt sustainability analysis of selected scenarios shown in table 1
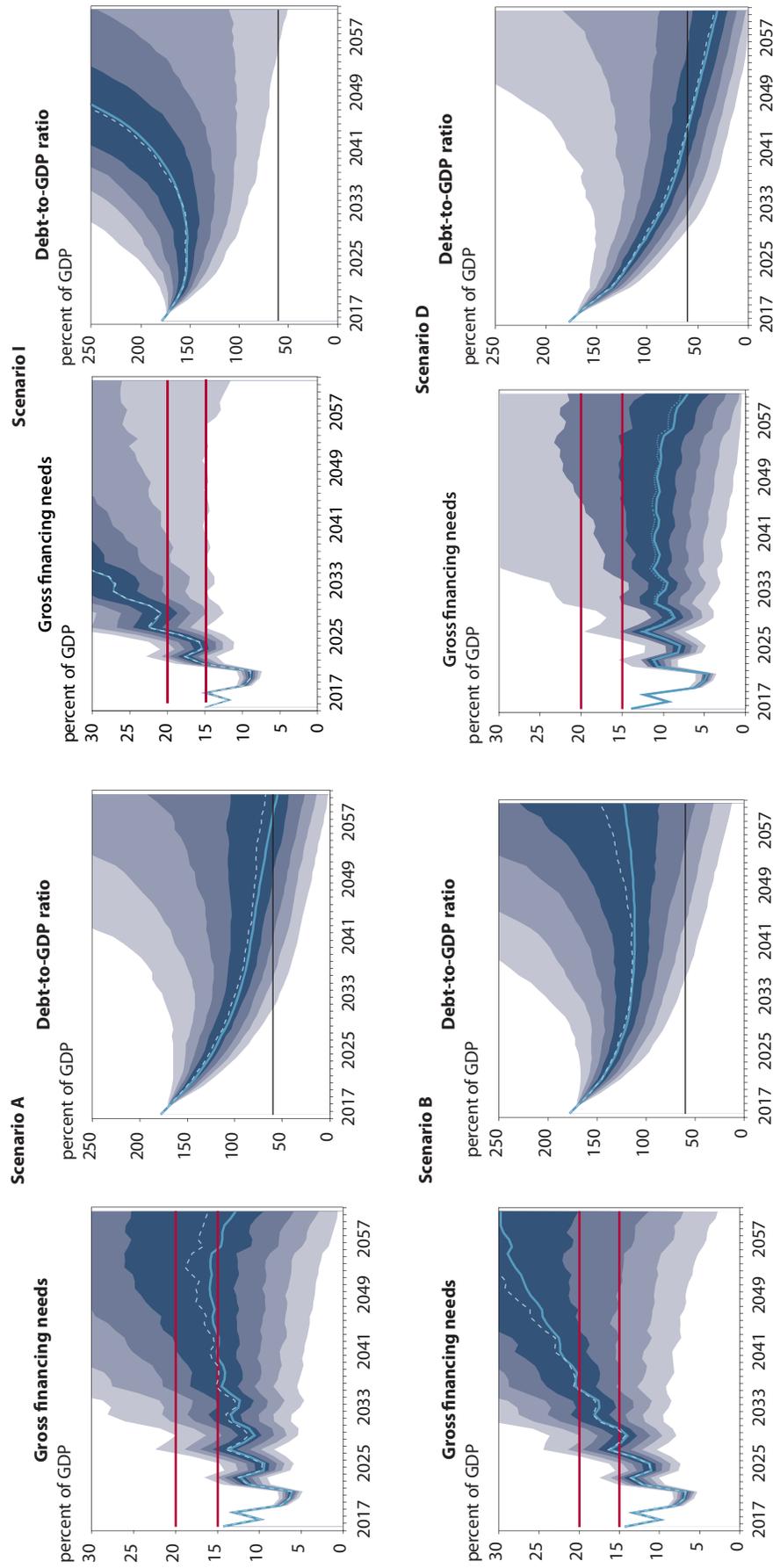
Notes: Left-hand charts show gross financing needs (percent of GDP) and right-hand charts the debt-to-GDP ratio based on the assumptions of table 1 and box 1. Red lines indicate the IMF's upper and lower thresholds for gross financing needs: 15 percent for emerging markets and 20 percent for advanced countries. The solid blue line describes the deterministic projection, the shaded areas the percentiles (60, 70, 80, 90) of the simulation distribution, and the dashed line the median of that distribution. The technique used to create the charts is described in box 2.

Source: Authors' calculations based on scenarios described in table 1 and methodology and data described in boxes 1 and 2.

Box 2   Technical assumptions underlying the Monte Carlo simulations

The Monte Carlo simulations underlying figure 2 attempt to capture uncertainty in the evolution of the four variables that influence the GFN and debt-to-GDP paths and are outside the direct control of Greece: real growth, inflation, the European risk-free rate, and the risk premium. Uncertainty surrounding the risk-free rate, which influences both official and future private borrowing rates, is simulated from 2017 onward. Uncertainty regarding the remaining variables is simulated from 2019 onward, after the end of the program period.

Uncertainty around the expected path of the **risk-free rate** was simulated by drawing 1,500 random shocks, for each period, from a normal distribution with a standard deviation of 1.46. The latter is the standard deviation of the German government bond rate published in the IMF's International Financial Statistics for 1997–2015. Uncertainty for the **risk premium** was simulated using a standard deviation of 1.06, taken from Laubach (2009) to ensure consistency with the approach used to determine the interest rate path (box 1). The risk premium is restricted to be non-negative. Bond rates are restricted not to exceed 20 percent, on the assumption that Greece would lose market access before borrowing at over 20 percent.

For **growth and inflation**, this analysis first estimates a bivariate panel vector autoregression (VAR) of order 2 in the annual percent change in GDP and the annual percent change in the GDP deflator on a 19-year dataset from 1997[1] until 2015, on a sample of all pre-2004 euro members (for robustness, an alternative estimation was undertaken based on data from all pre-2004 EU members, with similar results). The use of a VAR has the advantage that it captures the correlation between growth and inflation shocks. The VAR was identified ordering growth first (i.e. assuming that real growth is independent of contemporaneous inflation, but not vice versa). For each of the scenarios depicted in figure 2, the regression constants of the structural form coefficients were recalibrated to generate the steady state values of growth (between 1.25 and 1.5 percent) and inflation (2 percent for scenarios A, B, C, and D; 1.7 percent for scenario I) that are assumed for Greece.

Subsequently, 1,500 growth and inflation shocks are drawn, assumed to be distributed normally, using the estimated standard deviation of the VAR structural errors (2.31 for the growth equation and 0.96 for the inflation equation). Growth and inflation paths were then computed recursively, using past values of growth and inflation, the structural coefficients of the VAR, and the realized contemporaneous shocks.

The resulting paths can then be combined with known or assumed information about the composition of the initial debt stock, the evolution of amortizations, the primary surplus, privatizations, and the timing of market re-access to generate 1,500 paths each for interest payments to various official creditors, interest payments to private borrowers, nominal output, gross financing needs, and the debt-to-GDP ratio. The percentiles of the empirical distribution of the latter at each point in time are then used to draw figure 2.

Note that although the interest rate shocks that generate these paths are uncorrelated with the inflation and growth shocks, the estimated or assumed structure through which the shocks are propagated (i.e. the coefficients of the VAR and the Laubach rule) generates correlations between these variables that have the expected signs. A negative shock to growth or inflation will raise the debt-to-GDP ratio, which induces a higher expected interest rate via the Laubach rule. That said, the simulation model does not allow for causality in the other direction (from higher interest rates and higher debt to lower growth), since the dynamics of growth and inflation are guided by the scenario assumptions, which are independent of the debt path. For this reason, the fan charts in figure 2 are likely to underestimate both downside and upside risks.

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1. The year in which Exchange Rate Mechanism II was created and the formal transition toward the euro began.

Figure 3   Decomposition of the evolution of gross financing needs in scenario B

percent of GDP
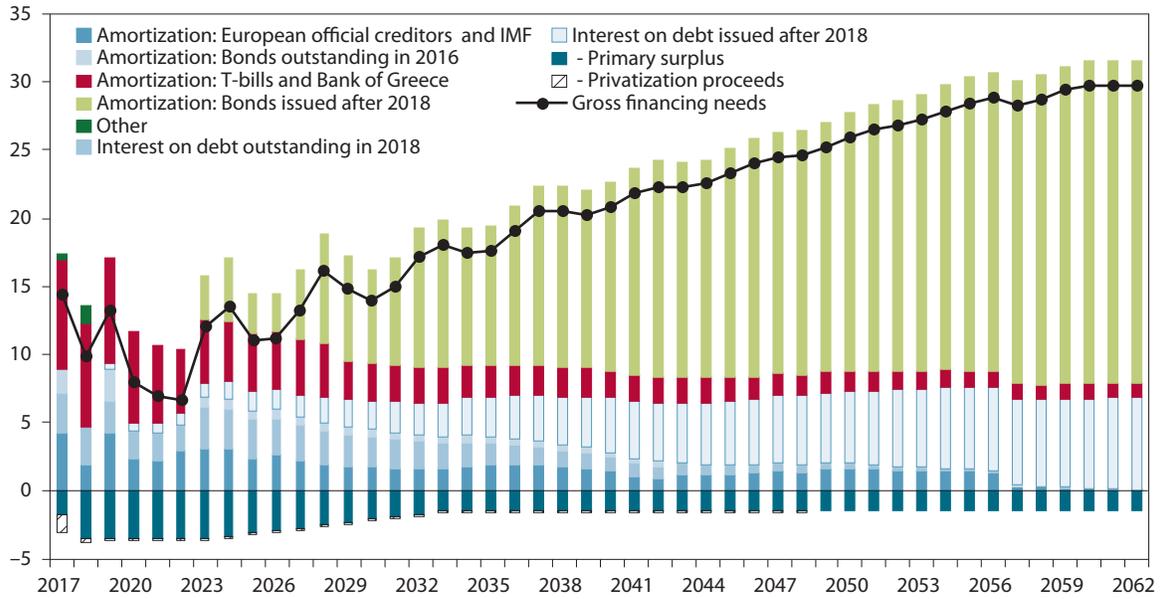
IMF = International Monetary Fund

Note: "Other" is a residual category encompassing loans by the Bank of Greece, other domestic loans, special purpose and bilateral loans, other external loans, and repurchase agreements.

Sources: Figure 1 and authors' calculations.

Figure 4   Primary surplus paths: VAR-based conditional forecasts versus assumptions
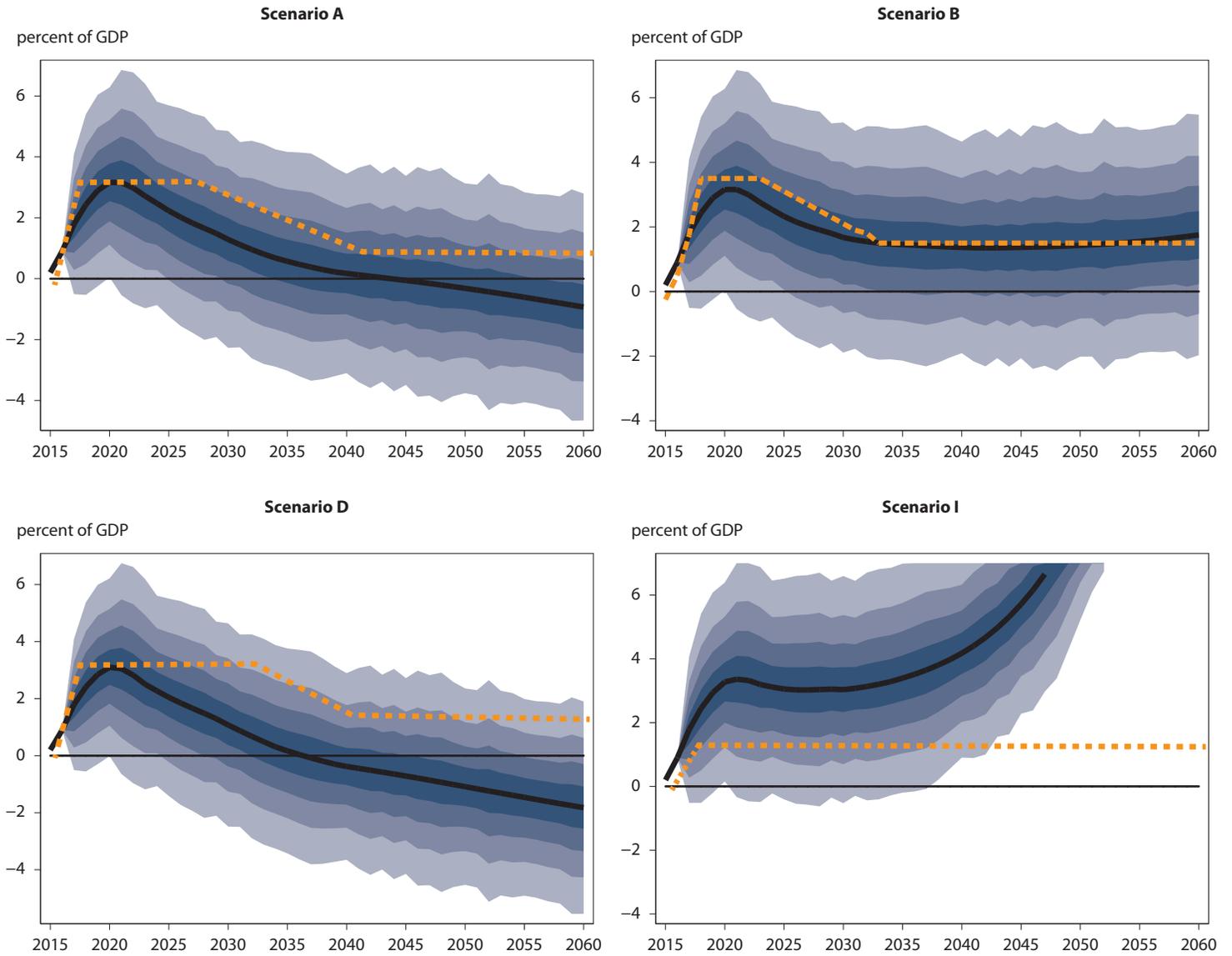
Note: Solid black line in each chart shows the projected evolution of the Greek primary surplus conditional on the real growth projections shown in scenarios A, B, D and I, respectively, of table 1. Inflation assumed to return to 2 percent of GDP after 6 years (i.e., in 2022) in all scenarios, as described in box 1. Dashed orange line shows primary surplus evolution per scenario assumptions. Shaded areas represent 60 percent (darkest), 70 percent, 80 percent, and 90 percent (lightest) confidence intervals around the central forecast. Sample excludes Japan and Ireland.

Source: Authors' analysis and table 1.

Figure 5   Probability of observing long-lived primary surpluses

Unconditional probabilities

6-year surplus

probability (percent)

primary balance threshold

10-year surplus

probability (percent)

primary balance threshold

16-year surplus

probability (percent)

primary balance threshold

20-year surplus

probability (percent)

primary balance threshold

Conditional probabilities

6-year surplus

probability (percent)

primary balance threshold

10-year surplus

probability (percent)

primary balance threshold

16-year surplus

probability (percent)

primary balance threshold

20-year surplus

probability (percent)

primary balance threshold

Note: Charts show the probabilities (with a 95 percent confidence interval) of observing an average primary surplus above the threshold specified in the horizontal axis for 6, 10, 16, and 20 years. The top panel plots unconditional probabilities and the bottom panel plots probabilities conditional on having debt-to-GDP ratio equal to 180 percent of GDP.

Sources: Authors' analysis based on Eichengreen and Panizza (2016).

Figure 6   Distribution of "survival times" conditional on reaching a given primary surplus

Primary balance exceeds threshold in every year of analysis period

> 0 percent of GDP
probability of survival

analysis period, years

> 1.5 percent of GDP
probability of survival

analysis period, years

> 2.5 percent of GDP
probability of survival

analysis period, years

> 3.5 percent of GDP
probability of survival

analysis period, years

Average primary balance exceeds threshold for duration of analysis period

> 0 on a spell average basis
probability of survival

analysis period, years

> 1.5 on a spell average basis
probability of survival

analysis period, years

> 2.5 on a spell average basis
probability of survival

analysis period, years

> 3.5 on a spell average basis
probability of survival

analysis period, years

——— Low debt countries   ——— High debt countries

Note: Figures show Kaplan-Meier plots for "survival times" of various primary surplus levels conditional on reaching those levels in the first place. In the top four charts the end of a period is defined as the first year at which the primary balance is lower than the indicated level. At the bottom, the end is defined as the first year beyond which the average primary balance over the whole period is below the indicated level. Low debt/high debt countries are defined as having debt below/above 60 percent of GDP at the beginning of the period.
Source: Authors' analysis.

Figure 7   Distribution of survival times for high primary balance episodes that ended "too early"

Primary balance > 3.5 percent of GDP in every year
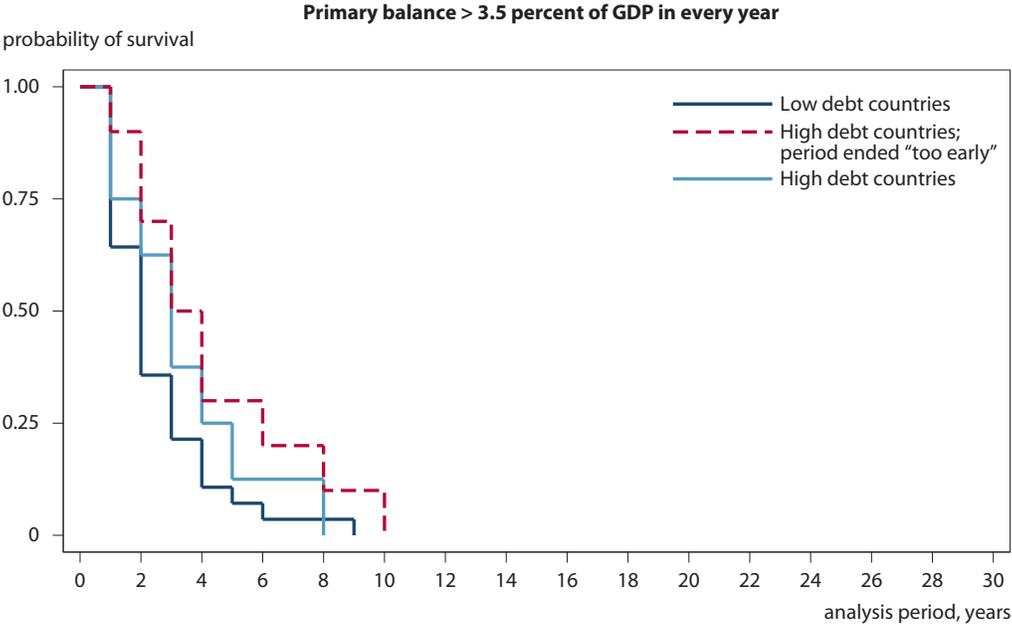
Note: Low debt/high debt countries are defined as having debt below/above 60 percent of GDP at the beginning of the period.

Source: Authors' analysis.

Box 3   Extract from Eurogroup statement on Greece of May 25, 2016

For the medium term, the Eurogroup expects to implement a possible second set of measures following the successful implementation of the ESM programme. These measures will be implemented if an update of the debt sustainability analysis produced by the institutions at the end of the programme shows they are needed to meet the agreed GFN benchmark, subject to a positive assessment from the institutions and the Eurogroup on programme implementation.

- Abolish the step-up interest rate margin related to the debt buy-back tranche of the 2nd Greek programme as of 2018.

- Use of 2014 SMP profits from the ESM segregated account and the restoration of the transfer of ANFA and SMP profits to Greece (as of budget year 2017) to the ESM segregated account as an ESM internal buffer to reduce future gross financing needs.

- Liability management—early partial repayment of existing official loans to Greece by utilizing unused resources within the ESM programme to reduce interest rate costs and to extend maturities. Due account will be taken of exceptionally high burden of some Member States.

- If necessary, some targeted EFSF reprofiling (e.g. extension of the weighted average maturities, re-profiling of the EFSF amortization as well as capping and deferral of interest payments) to the extent needed to keep GFN under the agreed benchmark in order to give comfort to the IMF and without incurring any additional costs for former programme countries or to the EFSF.

For the long-term, the Eurogroup is confident that the implementation of this agreement on the main features for debt measures, together with a successful implementation of the Greek ESM programme and the fulfillment of the primary surplus targets as mentioned above, will bring Greece's public debt back on a sustainable path over the medium to long run and will facilitate a gradual return to market financing. At the same time, the Eurogroup agrees on a contingency mechanism on debt which would be activated after the ESM programme to ensure debt sustainability in the long run in case a more adverse scenario were to materialize. The Eurogroup would consider the activation of the mechanism provided additional debt measures are needed to meet the GFN benchmark defined above and would be subject to a decision by the Eurogroup confirming that Greece complies with the requirements under the SGP. Such mechanism could entail measures such as a further EFSF reprofiling and capping and deferral of interest payments.

Source: Eurogroup 2016a, available at http://www.consilium.europa.eu/en/press/press-releases/2016/05/24-eurogroup-statement-greece/ (accessed on March 23, 2017).

Figure 8 Stochastic debt sustainability analysis after application of Eurogroup debt relief measures
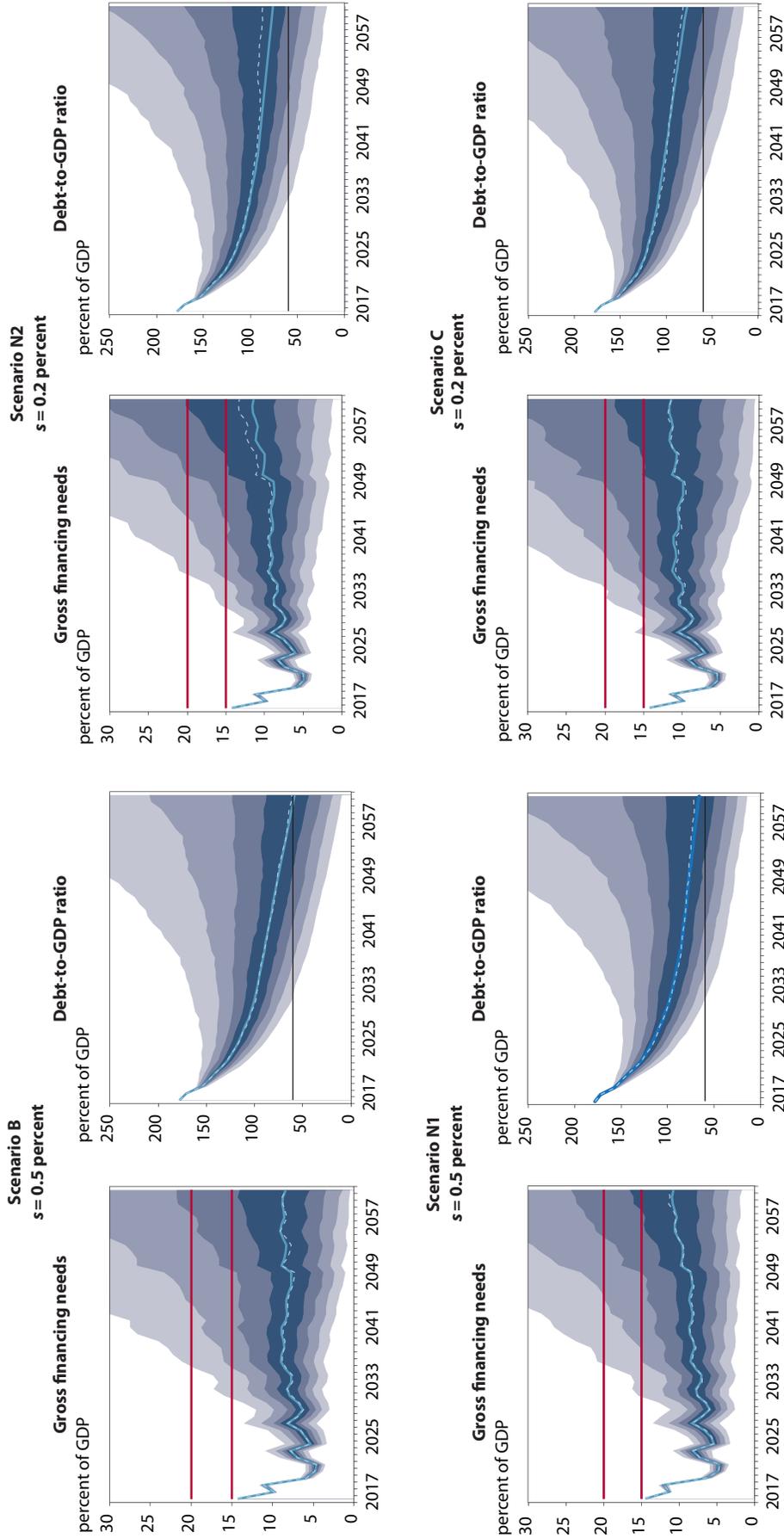
s = annual amortization of European Financial Stability Facility debt in percent of GDP

Notes: Figures show gross financing needs (percent of GDP, left) and the debt-to-GDP ratio (right) for various primary surplus and growth scenarios after the application of the debt relief measures. For all scenarios, the amortization profile is shifted 6 years (*T* = 6) and interest payments are deferred (p = 0 percent). Red lines indicate the IMF's upper and lower thresholds for gross financing needs: 15 percent for emerging markets and 20 percent for advanced countries. The solid blue line describes deterministic projection, the shaded areas the percentiles (60, 70, 80, 90) of the simulation distribution, and the dashed line the median of that distribution. The technique used to create the charts is described in box 2.

Source: Authors' calculations based on scenarios described in table 1 and the text and methodology and data described in boxes 1 and 2.

Figure 9   Amortizations to official creditors, 2017–81, scenario N2, after application of Eurogroup debt relief measures
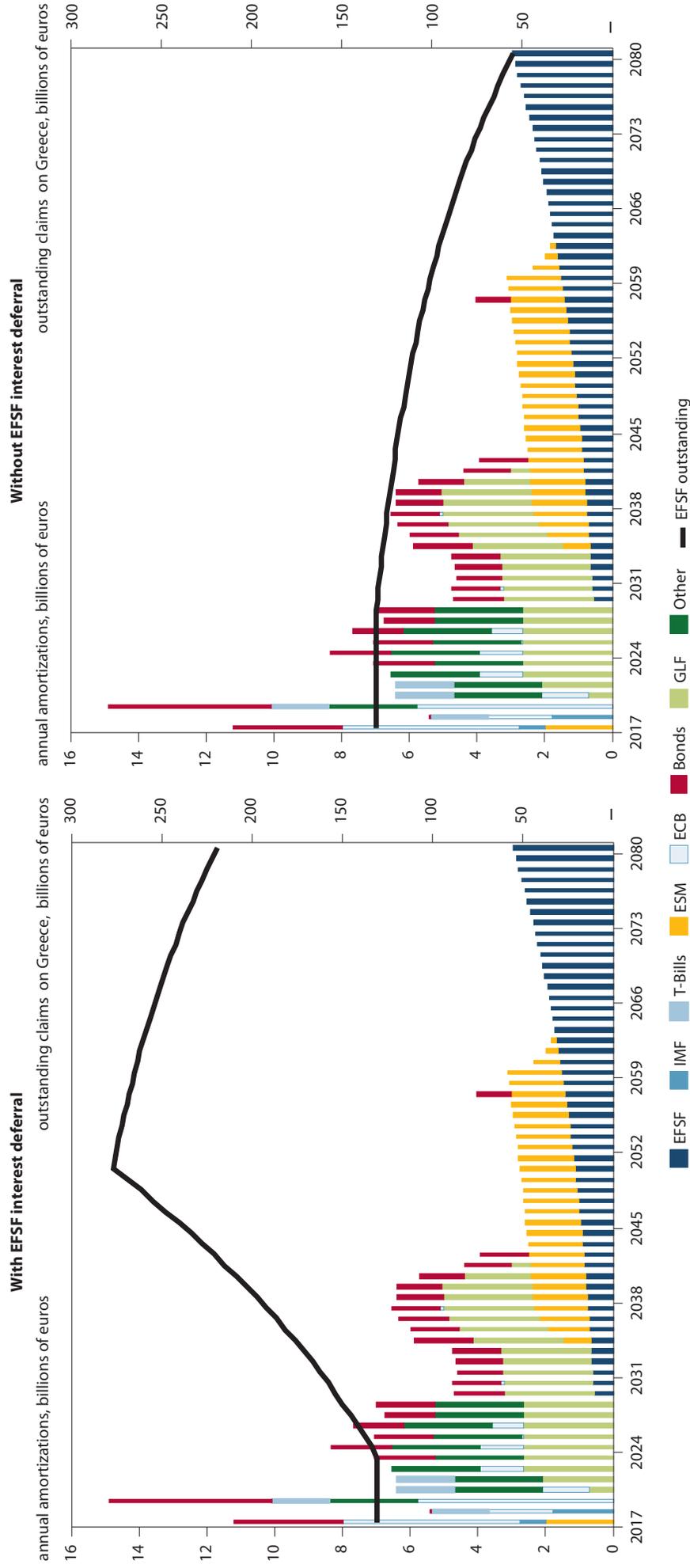
EFSF = European Financial Stability Facility; ESM = European Stability Mechanism; GLF = Greek Loan Facility; IMF = International Monetary Fund; ECB = European Central Bank; SMP/ANFA = Securities Markets Program / Agreement on Net Financial Assets

Notes: Both charts show the time profile of amortizations to official creditors after a debt restructuring including SMP/ANFA profit return, early IMF repayment, a shift of the EFSF maturity profile by 6 years (T = 6), and setting EFSF amortization at 0.2 percent of GDP. The left-hand chart additionally assumes a full interest deferral on EFSF loans until 2050. Left-hand axes show amortization volumes and right-hand axes the level of EFSF outstanding principal, both in billions of euros. "Other" is a residual category encompassing loans by the Bank of Greece, other domestic loans, special purpose and bilateral loans, other external loans, and repurchase agreements.

Sources: Figure 1 and authors' calculations.

Figure 10   Stochastic debt sustainability analysis for scenario N2 after applying Eurogroup measures and additional debt relief measures (without interest deferrals)

**Amortization profile shifted 6 years;
EFSF amortization annual rate = 0.2 percent of GDP**

Gross financing needs

percent of GDP

Debt-to-GDP ratio

percent of GDP

Lower EFSF interest path assumed

Gross financing needs

percent of GDP

Debt-to-GDP ratio

percent of GDP

**Lower EFSF interest path and additional measures
applied to Greek Loan Facility**

Gross financing needs

percent of GDP

Debt-to-GDP ratio

percent of GDP

EFSF = European Financial Stability Facility

Note: Fan charts show gross financing needs (percent of GDP, left) and debt-to-GDP ratios (right) for various primary surplus and growth scenarios after the application of the debt relief measures. Red lines indicate the IMF's upper and lower thresholds for gross financing needs: 15 percent for emerging markets and 20 percent for advanced countries. The solid blue line describes the deterministic projection; the shaded areas the percentiles (60, 70, 80, 90) of the simulation distribution. The technique used to create the charts is described in box 2.

Source: Authors' calculations based on scenario N2 as described in the text and methodology and data described in boxes 1 and 2.

Figure 11   Implications of continued ESM financing of Greece beyond 2018, scenario N2
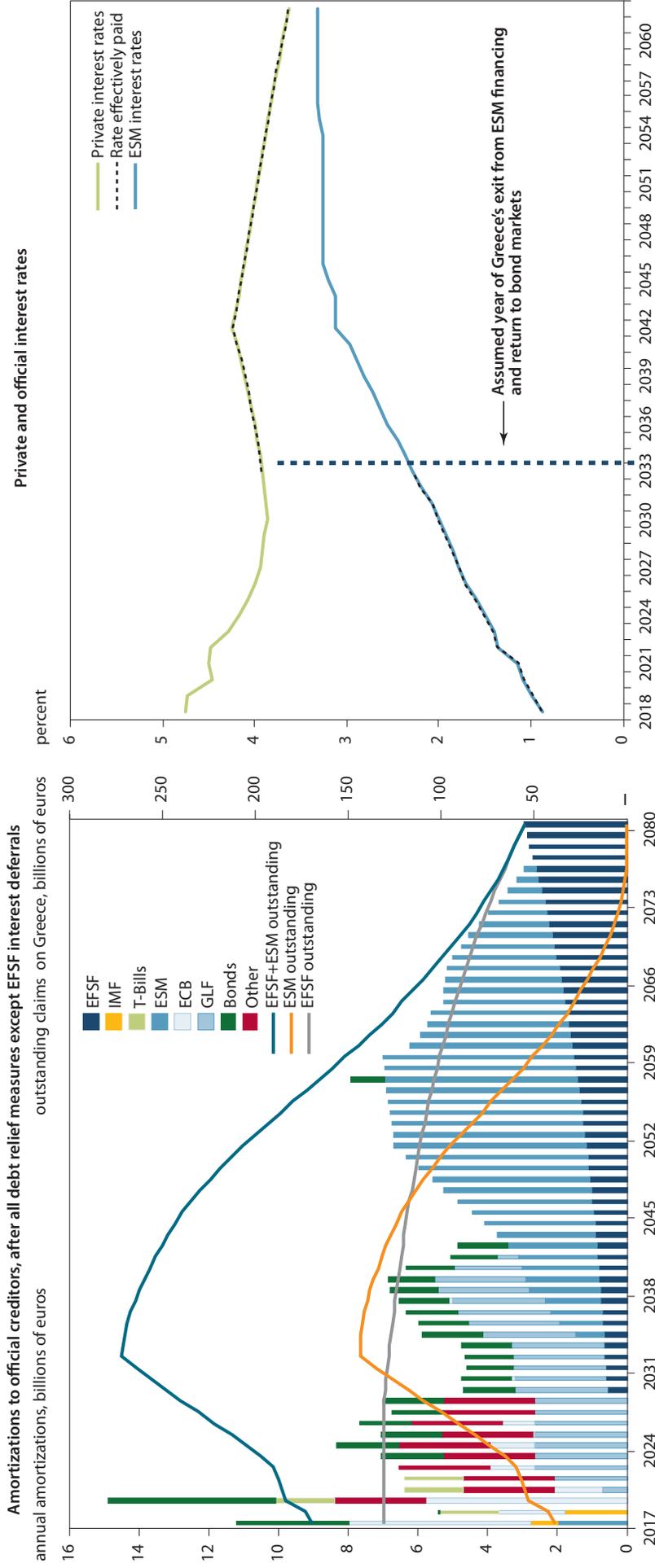
Amortizations to official creditors, after all debt relief measures except EFSF interest deferrals
outstanding claims on Greece, billions of euros

annual amortizations, billions of euros

Private and official interest rates

percent

Legend (left chart):
- EFSF
- IMF
- T-Bills
- ESM
- ECB
- GLF
- Bonds
- Other
- EFSF+ESM outstanding
- ESM outstanding
- EFSF outstanding

Legend (right chart):
- Private interest rates
- Rate effectively paid
- ESM interest rates

Assumed year of Greece's exit from ESM financing and return to bond markets

EFSF = European Financial Stability Facility; ESM = European Stability Mechanism; GLF = Greek Loan Facility; IMF = International Monetary Fund; ECB = European Central Bank

Note: The left chart shows the profile of amortizations (left axis) and credit outstanding (right axis) to official creditors after debt relief, including SMP/ANFA profit return, early IMF repayment, shift of the EFSF maturity profile by 6 years, EFSF amortization fixed at 0.2 percent of GDP, no deferral on EFSF interest, and reliance on ESM financing instead of capital market access until 2032. The right chart shows the path of private and ESM lending rates based on the assumptions of box 1. "Other" is a residual category encompassing loans by the Bank of Greece, other domestic loans, special purpose and bilateral loans, other external loans, and repurchase agreements.

Sources: Authors' calculations; figure 1 (ESM/EFSF, IMF, and Hellenic Republic Public Debt Bulletin No. 80, December 2015).

APPENDIX 1 SENSITIVITY ANALYSIS OF GREEK DEBT SUSTAINABILITY

As an alternative to the Monte Carlo simulations represented in figure 2, this paper presents a sensitivity analysis that plots GFN and debt paths under specific alternative assumptions about real growth, inflation, and interest rates, while maintaining scenario assumptions for the primary surplus and privatization. To keep the discussion manageable, the analysis results for only two scenarios, A and D (see figures A1.1 and A1.2, respectively), are shown. These are chosen because they are "marginal," in the sense that A is the most optimistic scenario among those presented in table 1 that result in unsustainable debt or—as this analysis calls it—borderline sustainable debt (as indicated by the deterministic GFN and debt-to-GDP paths in figure 1), while D is the most pessimistic scenario among those that show debt to be sustainable. The question is how far one needs to change the real growth, inflation, or interest rate assumptions to change these conclusions.

The following real growth, inflation, and interest rate experiments are undertaken:

- With respect to real growth, the analysis explores the consequences of growth converging (after a transition phase, which ends in 2022) to long-term rates that are 1 percentage point below the scenario assumption (for example, 0.5 rather than 1.5), 0.5 below, 0.5 above, and 1 percentage point above the scenario assumption.

- With respect to inflation differentials, the analysis explores two alternative scenarios. The first assumes protracted real exchange rate adjustment, with an inflation differential of 1 percentage point with respect to the euro area (1 percent less inflation) from 2016 to 2021, with subsequent convergence to the euro area exchange rate by 2030 (variation A). The second represents a Balassa-Samuelson-like effect, for example, as a result of successful reform in the tradeable sectors. After catching up with euro area inflation, Greek inflation keeps rising until it reaches a 0.5 positive inflation differential in 2025, which stays until 2040 and then reduces back to zero by 2045 (variation B).

- With respect to interest rates on private debt, interest rates in a 4-percentage-point corridor around the baseline path of each scenario is examined.[26] A 2-percentage-point baseline implies interest rates of about 3 percent in 2018, which is a precrisis level. Two percentage points above result in 7 percent in 2018, a scenario of continuing uncertainty over Greek debt sustainability.

With respect to scenario A, the main conclusion from the sensitivity analysis is that debt would become clearly sustainable, given the assumed primary surplus path, if the parameter assumptions for growth, inflation, or interest rates were to turn out one notch better than in the scenario, that is, if long-term growth were a half percentage point higher, structural reforms were to induce a strong Balassa-Samuelson effect, or

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26. Hence, feedback effects from debt to borrowing rates are ignored in these upper and lower paths for simplicity.

private borrowing rates were one percentage point below the assumed baseline (figure A1.1). At the same time, debt would become clearly unsustainable if any of the parameters shown turns out one notch worse. In this sense, scenario A is clearly the borderline scenario between sustainability and unsustainability.

With respect to scenario D, figure A1.2 shows that the scenario is considerably more robust than scenario A, in the sense that a one notch deterioration of either growth, inflation, or interest parameters would not change the conclusion that debt is sustainable. Regarding private borrowing rates, even an increase by a full 2 percentage points does not bring maximum gross financing needs above the critical 20 percent line. Making debt unsustainable, given the assumed primary surplus path, would require quite a drastic (two notch) deterioration in growth, i.e. long-run growth lower by a full percentage point.

Figure A1.1 Sensitivity analysis based on scenario A

Long-term growth rate

Gross financing needs

percent of GDP

- gross financing needs
- scenario assumption for growth −1 pp
- scenario assumption for growth −0.5 pp
- scenario assumption for growth +0.5 pp
- scenario assumption for growth +1 pp

Debt-to-GDP ratio

percent of GDP

- debt to GDP
- scenario assumption for growth −1 pp
- scenario assumption for growth −0.5 pp
- scenario assumption for growth 0.5 pp
- scenario assumption for growth 1 pp

Inflation differentials

Gross financing needs

percent of GDP

- gross financing needs
- protraced real exchange rates adjustment
- Balassa-Samuelson effect

Debt-to-GDP ratio

percent of GDP

- debt to GDP
- protraced real exchange rates adjustment
- Balassa-Samuelson effect

Interest rates

Gross financing needs

percent of GDP

- gross financing needs
- interest rate on new bonds 2pp below baseline
- interest rate on new bonds 1pp below baseline
- interest rate on new bonds 1pp above baseline
- interest rate on new bonds 2pp above baseline

Debt-to-GDP ratio

percent of GDP

- debt to GDP
- interest rate on new bonds 2pp below baseline
- interest rate on new bonds 1pp below baseline
- interest rate on new bonds 1pp above baseline
- interest rate on new bonds 2pp above baseline

pp = percentage point

Source: Authors' calculations based on scenario A (see table 1) and methodology and data described in box 1 and text.

Figure A1.2   Sensitivity analysis based on scenario D

Long-term growth rate

Gross financing needs

percent of GDP

- gross financing needs
- scenario assumption for growth −1 pp
- scenario assumption for growth −0.5 pp
- scenario assumption for growth +0.5 pp
- scenario assumption for growth +1 pp

Debt-to-GDP ratio

percent of GDP

- debt to GDP
- scenario assumption for growth −1 pp
- scenario assumption for growth − 0.5 pp
- scenario assumption for growth 0.5 pp
- scenario assumption for growth 1 pp

Inflation differentials

Gross financing needs

percent of GDP

- gross financing needs
- protracted real exchange rates adjustment
- Balassa-Samuelson effect

Debt-to-GDP ratio

percent of GDP

- debt to GDP
- protracted real exchange rates adjustment
- Balassa-Samuelson effect

Interest rates

Gross financing needs

percent of GDP

- gross financing needs
- interest rate on new bonds 2pp below baseline
- interest rate on new bonds 1pp below baseline
- interest rate on new bonds 1pp above baseline
- interest rate on new bonds 2pp above baseline

Debt-to-GDP ratio

percent of GDP

- debt to GDP
- interest rate on new bonds 2pp below baseline
- interest rate on new bonds 1pp below baseline
- interest rate on new bonds 1pp above baseline
- interest rate on new bonds 2pp above baseline

pp = percentage point

Source: Authors' calculations based on scenario D (see table 1) and methodology and data described in box 1 and text.

APPENDIX 2 VAR COEFFICIENTS AND IMPULSE RESPONSE FUNCTIONS

As described in the text, this paper estimates a 4-variable panel VAR using annual data covering 17 advanced economies for the period 1980–2015. The VAR model includes two lags. Table A2.1 reports the point estimates of the model, and the 16 panels of figure A2.1 report the impulse response functions, identified using the following Cholesky ordering: real GDP growth, inflation, primary balance as a share of GDP, and debt as a share of GDP measured at the end of the year. This means that the end-of-year debt-to-GDP ratio is assumed to react to the realizations of all other variables during the same year, the primary balance as a share of GDP is assumed to react to real growth and inflation realizations in the same year but not to the debt ratio at the end of the year, inflation is assumed to react contemporaneously to real growth but not to the remaining variables, and real growth is assumed not to react contemporaneously to any of the other variables.

The top four panels of figure A2.1 describe how the four variables in the system react to a GDP growth shock. The results are as expected: Inflation increases, the primary balance increases, and the debt-to-GDP ratio decreases. The four panels in the second row of figure A2.1 describe the response to an inflation shock. The response of the primary balance (positive) and of the debt-to-GDP ratio (negative, albeit not significant) are as expected. The response of growth is negative, indicating that inflation shocks in this sample are mostly supply shocks. The third row looks at the effect of a primary balance shock. Also in this case the responses are as expected: growth, inflation, and debt decrease (albeit the effect on growth is not statistically significant and not long lasting). Finally, the bottom row looks at the effect of a shock to the debt-to-GDP ratio. The analysis finds no effect on growth, a small (and not statistically significant) effect on inflation, and a positive effect on the primary balance.

Experiments with alternative ordering (growth, primary balance, inflation, debt, and inflation; and growth, primary balance, and debt) obtained similar results.

Table A2.1   VAR coefficient estimates

| | (1) | | (2) | | (3) | | (4) | |
| | Growth equation | | Inflation equation | | Primary balance equation | | Debt-to-GDP equation | |
	Coefficient	Standard error	Coefficient	Standard error	Coefficient	Standard error	Coefficient	Standard error
GRt-1	0.53	0.04	0.15	0.03	0.15	0.04	−0.76	0.07
GRt-2	−0.05	0.05	0.04	0.04	0.01	0.04	0.03	0.07
INFLt-1	−0.16	0.05	0.73	0.04	−0.02	0.05	−0.15	0.09
INFLt-2	0.14	0.05	0.14	0.04	0.00	0.04	0.19	0.08
PBALt-1	−0.03	0.05	−0.08	0.04	0.90	0.04	−0.60	0.08
PBALt-2	0.02	0.05	0.06	0.04	−0.14	0.05	−0.08	0.09
DEBTt-1	0.02	0.03	0.03	0.02	0.05	0.02	1.14	0.04
DEBTt-2	−0.02	0.03	−0.03	0.02	−0.04	0.02	−0.14	0.04
Constant	1.33	0.27	−0.33	0.20	−0.98	0.23	2.15	0.43
R^2	0.26		0.87		0.72		0.98	
Number of observations	578		578		578		578	

GR = GDP growth (year-on-year percent change of GDP); INFL = inflation (percent change of the consumer price level, year-on-year); PBAL = primary fiscal balance (share of GDP); DEBT = debt-to-GDP ratio

Note: The table reports the reduced form coefficients and standard errors of a panel VAR that uses annual data covering 17 advanced economies (Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Italy, the Netherlands, Portugal, Spain, Sweden, Switzerland, the United Kingdom, and the United States) for the period 1980–2015.

Source: Authors' analysis.

Figure A2.1   Impulse response functions
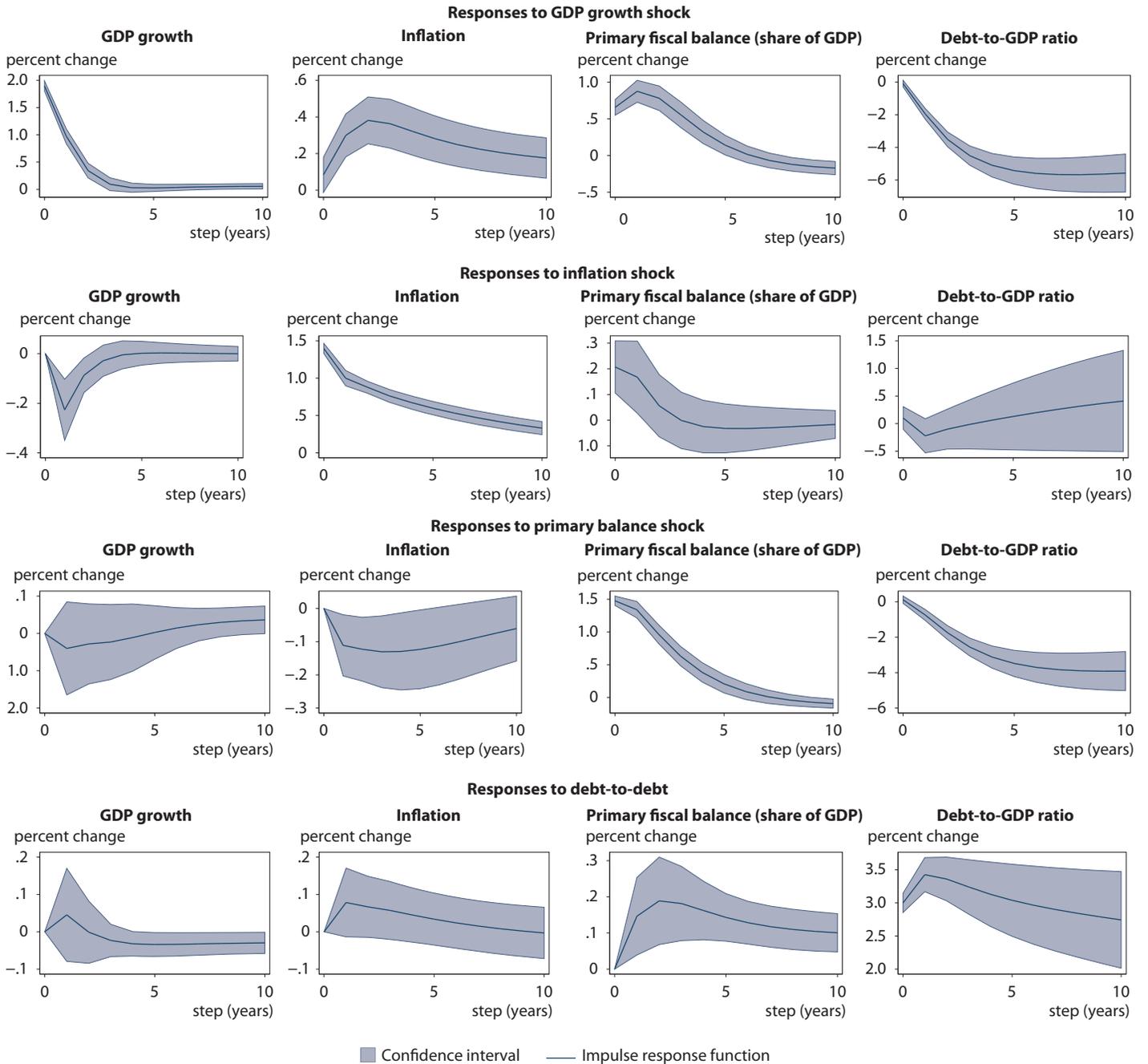
Note: Figures describe the reaction of GDP growth (first column), inflation (second column) the primary fiscal balance (third column), and the debt-to-GDP ratio (fourth column); and the debt-to-GDP ratio to a standard deviation shock in growth (first row), inflation (second row), the primary balance (third row), and the debt-to-GDP ratio (last row), respectively. The impulse response functions are identified using a Cholesky decomposition with the ordering just described, based on the reduced form estimates reported in table A2.1. All confidence intervals at 90 percent. GDP growth is measured as year-on-year percent change of GDP; inflation as percent change of the consumer price level, year-on-year.

Source: Authors' analysis.

APPENDIX 3 VAR-BASED CONDITIONAL FORECASTS INCLUDING JAPAN AND IRELAND

The following figure shows VAR-based conditional forecasts generated using the same assumptions under-lying figure 2, except that the VAR coefficients are estimated using the full sample of advanced economies, including both Ireland and Japan.

While the "hump shape" of the predicted primary surplus path is initially preserved, the data now predict that the primary surplus initially "maxes out" at just 1.5 to 2 percent. The highest primary surplus is predicted at the end of the sample period; this is because of exploding debt levels that eventually force (albeit futile) higher primary surpluses.

Including Japan and excluding Ireland would lead to even more explosive debt paths. A VAR with Ireland but without Japan, instead, would lead to slightly higher primary surpluses than were obtained in figure 2 but would not change the main conclusions.

Figure A3.1   Primary surplus paths: VAR-based conditional forecasts versus assumptions (country sample includes Japan and Ireland)

Scenario A

percent of GDP

Scenario B

percent of GDP

Scenario D

percent of GDP

Scenario I

percent of GDP
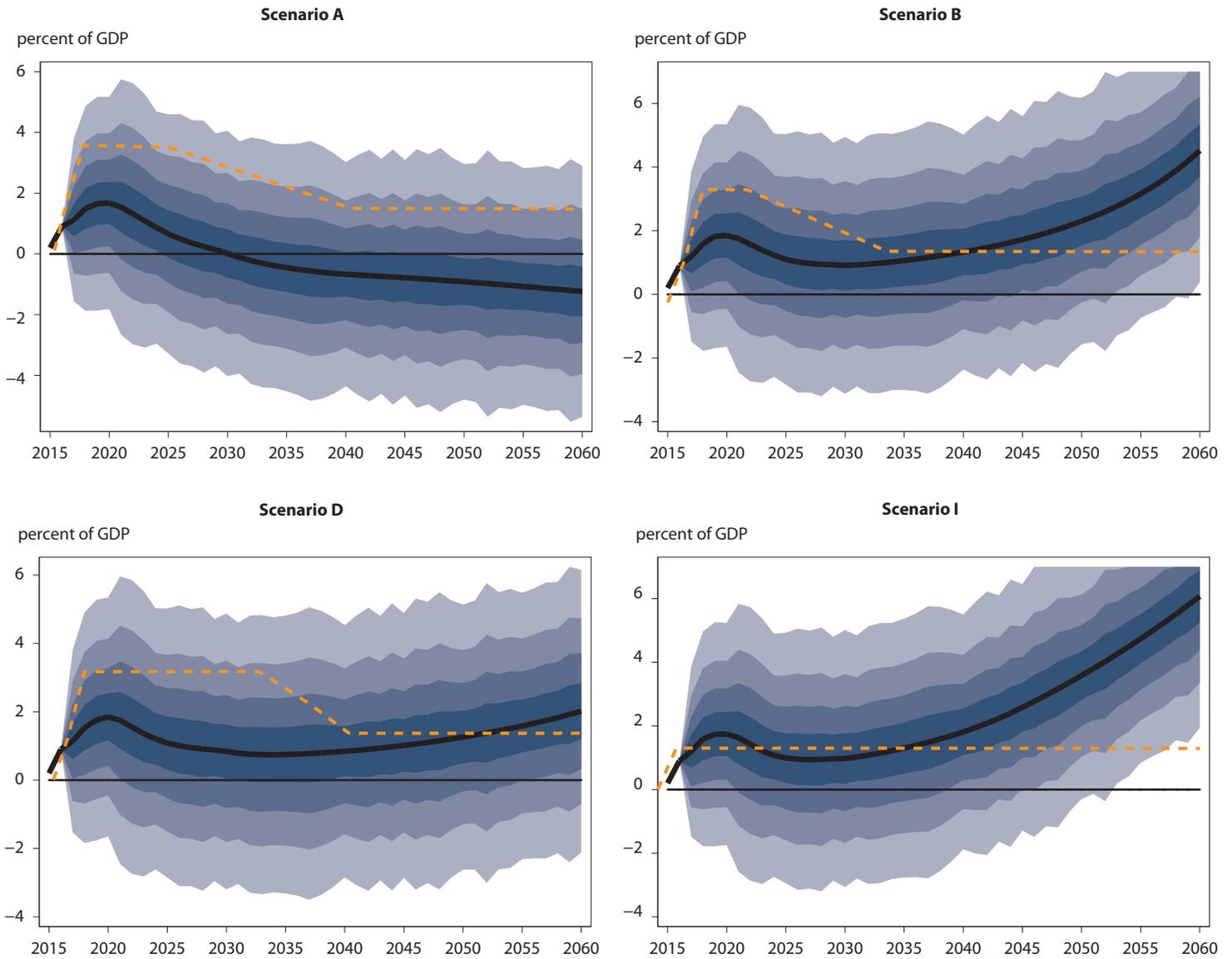
Note: This figure is the same as figure 4 except that Japan and Ireland are included in the sample of countries used to estimate the VAR. Solid black line in each chart shows the projected evolution of the Greek primary surplus conditional on the real growth projections shown in scenarios A, B, D and I, respectively, of table 1. Inflation assumed to return to 2 percent of GDP after 6 years (i.e., in 2022) in all scenarios, as described in box 1. Dashed orange line shows primary surplus evolution per scenario assumptions. Shaded areas represent 60 percent (darkest), 70 percent, 80 percent, and 90 percent (lightest) confidence intervals around the central forecast.

Source: Authors' analysis.

APPENDIX 4 IDENTIFYING HIGH PRIMARY SURPLUS EPISODES THAT ENDED BECAUSE "THE DEBT PROBLEM WAS SOLVED"

As explained in the text, this paper seeks to eliminate primary surplus episodes that ended because the authorities decided that there was no longer a debt problem that justified continued primary balances in excess of 3.5 percent—most obviously, because the debt ratio had fallen sufficiently in the meantime. The problem is that it is not known what "sufficiently" would have meant at the time. For example, if all episodes are eliminated from the sample during which the debt-to-GDP ratio fell at all, too many would be eliminated (if there is a debt problem that justified a high primary balance, a small drop in the debt would not mean that the problem had gone away). Conversely, if only surplus episodes that involved very steep drops in debt are eliminated, enough episodes might not be eliminated.

One way to address this problem would be to check the motivation of the authorities, using historical records, for each episode. Another approach, which is adopted here, is to expand the set of quantitative criteria. Specifically, four questions are asked:

1. Was the debt ratio lower at the end of the episode than at the beginning?
2. Is the debt ratio below 100 percent of GDP at the end of the spell?
3. Did the debt ratio stabilize (or continue to fall) for at least two years after the end of the episode?
4. Did primary surpluses continue below 3.5 percent for at least two years after the end of the spell?

Only if the answer to *all four questions* was "yes," the episode was kept in the dataset. Hence, this establishes a high bar for what remains in the sample to which duration analysis is applied. It is possible that too many episodes were eliminated but unlikely that not enough were eliminated. This means that in terms of valid analysis, this analysis is on the safe side (so long as the sample remains sufficiently large and informative).

The criteria can be justified as follows:

■ Question 1 speaks for itself: If the debt ratio was no lower at the end than at the beginning of the episode, any debt problem present at the beginning was not addressed. Questions 2, 3, and 4 are alternative criteria to determine that the debt ratio, although it may have fallen, did not fall enough.

■ Question 2 sets a level above which it is assumed that policymakers who embark in debt stabilization would never see their task as completed. If a country starts running high primary surpluses to reduce its debt from, say, 130 to 110 percent of GDP and then stops running high primary surpluses, it is hard to argue that it stopped because 110 was low enough. Example: *Israel ran extremely high primary surpluses (above 5 percent of GDP) from 1986 to 1988. During this time, the debt-to-GDP ratio was reduced from 162 percent to 145 percent. In 1989, the primary balance fell back into a deficit.* Analogous episodes include Italy (1996–2000) and the United Kingdom (1955–56 and 1961).

- Questions 3 implies that stabilization is always insufficient if debt levels begin to rise again within a year or two of the end of an episode. ***Example***: *Belgium went through several high primary surplus episodes during the 1990s and 2000 to reduce its debt, which had reached almost 140 percent of GDP in 1993. In the most recent of these episodes, it reduced the debt ratio from 95 in 2005 to 87 percent in 2007. In 2008 and 2009, the primary balance dropped sharply, and within a few years, debt was back at about 100 percent.* The point here is not to argue that the loosening of fiscal policy in Belgium in 2008–09 was wrong—it was a reaction to the Great Recession, and presumably the right thing to do—but merely that the end of the high surplus episode was a consequence of economic pressures, not a deliberate stop to the adjustment process after reaching a low debt ratio. Similar episodes include Belgium (1956), Brazil (2008), Canada (1969), Germany (2000), and Singapore (2014).

- Question 4 focuses on the behavior of policymakers after the end of the episode. If the primary balance goes back up above the threshold within a year or two, this means that policymakers themselves must have concluded that the episode was not sufficient to address the debt problem. ***Example***: *Ireland had an impressive stabilization episode from 1988 to 1994 during which the primary balance was around 4 to 5 percent for seven consecutive years. During this time, the debt ratio was reduced from 109 percent to 89 percent. In 1995, the primary balance dropped to 2.9 percent, but only a year later, it was back over 4 percent, where it remained for another five years. The conclusion is that the reason the primary balance dropped in 1995 was not that the authorities believed that debt was low enough.*

It should be noted that episodes for which only one of the four questions is answered "no" were relatively rare. For example, "no" to questions 1 and 3 usually go together: When a high primary balance fails to reduce the debt level, one frequently also sees an increase in the debt level after the primary balance drops below the 3.5 percent threshold. Similarly, most cases where the primary balance rises again soon after it drops (i.e. "no" in response to question 4) go along with "no" to at least one of the other questions.

In one case, the decision was made to "manually" override the four criteria. From 1986 to 1990 Sweden went through a major high primary balance episode, during which the debt ratio fell from 61 percent to about 40 percent. In 1991, the primary balance fell from about 5 percent to less than 2 percent. The debt ratio initially stayed unchanged, but in the following year, 1992, it shot up to 46 percent, driven a primary deficit of 7 percent. If the criteria were applied mechanically, one would need to say "no" to question 3 and keep the episode in the sample. But the reason for the sharp rise in the debt ratio was known to be the Nordic banking crisis of 1992, and the lowering of the primary surplus in the year *before* the banking crisis may well have reflected the authorities' view that the debt ratio, which stood at just 40 percent, had declined enough. So eliminating this episode from the sample was preferable.

The procedure was applied to (1) all high primary balance episodes (threshold level: 3.5 percent) that started from a debt ratio in excess of 60 percent (31 episodes) and—as a robustness check—(2) all high primary balance episodes with a 3.5 percent threshold level that started from a debt ratio in excess of 60 percent (50 episodes). After applying the "filter" of questions 1 through 4, the first dataset was reduced to 19 episodes, whereas the second dataset was reduced to 24 episodes. The results of the duration analysis are close enough to support the same conclusion. The text focuses on the results from the dataset that requires the higher initial debt level.