Working Paper

WP/2014/2

Spanish Public Debt Sustainability Analysis

Abstract

This note develops an overarching debt sustainability analysis (DSA) framework, encompassing three of its main dimensions: (i) a traditional (deterministic) sustainability exercise, based on a simple accounting application involving the debt accumulation equation; (ii) an assessment of the realism of the assumptions underlying the deterministic debt projections; and (iii) a stochastic exercise aimed at understanding the uncertainty associated with the deterministic path. This framework is applied to the Spanish case, constructing and dissecting the baseline debt path associated with the official macro and fiscal projections. While Spanish public debt appears largely sustainable along this baseline, its realization seems optimistic in the light of historical experience.

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Keywords: Public debt sustainability analysis, general government sector, fiscal reaction function, bootstrapping, vector autoregressive models

JEL: E62, H68

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Special thanks to José Miguel Ramos for his collaboration and inputs. I am grateful to Ana Buisán and Álvaro Sanmartín for their valuable comments and suggestions. Thanks also to José Luis Escrivá, José Marín, Miguel Ángel García, Enrique Quilis, Ángel Cuevas, José Federico Geli and Marta Morano for valuable feed-back and discussions.

Executive summary

As the Spanish economy continues the gradual process of correcting its large cumulated macroeconomic imbalances, the sustainability of its public finances remains a key challenge going ahead. The Spanish General Government debt has soared since the outburst of the crisis, rising more than 60 pp. of GDP. Its level is set to reach 100 per cent of GDP by early 2015 according to the latest official forecast, a threshold that was last surpassed in the early 20th century.

A quick glance at recent developments yields a somewhat positive view on public finances health going forward, although a few shadows remain. Recent consolidation efforts, together with institutional improvements (both on the EU and the domestic fronts) and growing expectations of further monetary easing in the Eurozone have relieved the financial markets' pressure on the Spanish public debt instruments. However, this improvement should not be taken for granted; net exports positive contribution to growth is fading (partially because of subdued growth in the euro area), inflation remains subdued and an overleveraged private sector appears as the main growth engine in the short-term.

In order to reach a deeper understanding about the sustainability of public finances, this note develops an overarching framework, encompassing: (*i*) traditional (deterministic) debt sustainability analysis (DSA) based on a simple accounting application involving the debt accumulation equation; (*ii*) an assessment of the realism of the assumptions underlying the debt projections; and (*iii*) an analysis of the uncertainty associated with the projected macro scenario and the government fiscal outcomes.

According to the deterministic DSA, **the debt path that is consistent with existing commitments, official 2014-2017 projections and standard economic assumptions thereafter, appears largely sustainable.**

This debt path is based on compliance with existing EU and national fiscal rules. Given the current high level of public debt, binding fiscal rules are instrumental to compensate for the snowballing effect of interest rates. While strict compliance with the existing rules would ensure sustainability, there are risks associated with uncertain future economic conditions, which might compromise public finances if the commitment is not strong enough.

The assumptions behind the baseline scenario are shown to be optimistic. First, since the outburst of the crisis medium-term nominal growth forecast has been biased upwards. Second, the projected increase of the primary balance is unprecedented historically (and thus raises concerns about fiscal fatigue symptoms) and largely based on positive cyclical developments, which might not materialize.

All in all, the likelihood of the baseline scenario at the end of the Stability Programme horizon (i.e. 2017) is assessed to be low if fiscal policy follows the historical reaction function. In a stochastic multivariate framework, taking into account a constellation of shocks to GDP, interest rates and the primary balance, if the reaction function of fiscal policy is in line with historical experience the probability that the debt-to-GDP debt surpasses the baseline level in 2017 (i.e. 98.5 per cent of GDP) is above 70 per cent.

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1 Introduction

As the Spanish economy continues the gradual process of correcting its large cumulated macroeconomic imbalances, the sustainability of its public finances remains a key challenge going ahead. Both the general government debt level and its dynamics are reasons for concern. Indeed, the rapid accumulation of general government debt since the outburst of the crisis (more than 60pp. since 2007) will lead to levels above 100 per cent of GDP already in early 2015, according to the latest official forecast.[1] Abating the risks surrounding the sustainability of public finances in the short and medium run will undoubtedly prove to be challenging, especially given its inter-relation with the on-going correction of large cumulated imbalances (very high unemployment rate, private deleveraging pressures and high external indebtedness).[2]

Recent improvements in sovereign bond markets, together with a strengthened institutional framework since 2012 and positive GDP developments in 2014 have eased concerns about Spanish public finances. After peaking at almost 7.5 per cent in July 2012, the Spanish 10 year bond nominal yield has gone down to a record low two years later. This improvement is mirrored by a decline of the sovereign risk premium associated with the Spanish bond (i.e. the 10 year yield spread relative to the German benchmark), which has fallen by more than 500 bps. Several factors lie behind this positive dynamics.[3] On the European front, doubts about the future of the euro area have faded and prospects for the European financial sector have improved. In particular, thanks to a more active role played by the European Central Bank and the establishment and functioning of the single supervisory and the single resolution authorities, which will be operational after the results of the ECB stress tests are published in late October 2014. On the domestic front, exceptionally large and painful consolidation efforts over the last 3 years in order to rein in public deficit figures have been accompanied by important institutional improvements, with the adoption of the budgetary stability law in 2012 and the creation of AIReF (the Spanish independent

1 Update of the Spanish Stability Programme, 2014-2017 (http://www.thespanisheconomy.com/stfls/tse/ficheros/2013/noviembre/Stability_Programme_2014_2017.pdf).

2 See EC (2014) for a deep analysis of the macroeconomic imbalances still affecting the Spanish economy.

3 For a recollection of previous developments in the European sovereign debt crisis, see Benzo and Cuerpo (2012).

fiscal authority in 2014), which will act as a fiscal watchdog.[4] Moreover, real growth is back to positive territory, contributing to fiscal sustainability.

Gauging whether these improvements are likely to stay and will prove to be sufficient to set public debt dynamics on a sustainable path requires a more in-depth scrutiny. The sustainability of public finances generally requires governments to (*i*) maintain access to financial markets (short-term or liquidity factor) and (*ii*) service current and future obligations, fulfilling their intertemporal budget constraint (medium-to-long-term solvency condition). The solvency condition basically implies positive net worth, as signaled in Wyplosz (2007) [5]. This theoretical concept is, however, difficult to translate into practical debt sustainability analysis (DSA). In practice, an encompassing approach towards debt sustainability analysis (DSA) involves:

(i) **The production of a baseline path for debt, given existing commitments and macroeconomic forecasts**: most applied sustainability exercises are ultimately based on a simple accounting application involving the debt accumulation equation, whereby changes in the debt-to-GDP ratio are determined by interest rate-GDP growth gap, the primary balance and one-off deficit-debt adjustments, such as financial sector bail-outs or privatization receipts. Traditional DSA is simple and transparent but presents two important caveats. On the one hand, it needs to be qualified taking into account the likelihood of its underlying assumptions and also potential interdependencies between its different determinants. On the other hand, its deterministic nature does not properly capture the existing uncertainty about future economic conditions and the realization of the government fiscal targets;

(ii) **An assessment of the realism of the baseline assumptions and the production of alternative scenarios:** The robustness of the debt accumulation

[4] A summary of the Organic Law on Budgetary Stability and Financial Sustainability of Public Administrations can be found here: http://www.bde.es/f/webbde/SES/Secciones/Publicaciones/InformesBoletinesRevistas/BoletinEconomico/13/Abr/Files/art2e.pdf.

[5] Or weakly increasing, as in Arrow *et al*. (2004), not ruling out the possibility of net worth being initially negative.

approach will eventually depend on the realization of the assumptions about its components (including the possibility of fiscal fatigue);[6]

(iii) An understanding of the uncertainty associated with the projected macro scenario and government fiscal outcomes, which grows with the lengthening of the forecast horizon. Factoring in the uncertainty associated with future scenarios requires a more sophisticated approach, accounting for the stochastic properties of the series. Within a stochastic framework, a large number of randomly generated shocks allows for a probabilistic assessment of specific occurrences of debt dynamics. The risks associated with the different scenarios can therefore be quantified, expressing the probability that the debt stock will stay below or above a specific benchmark at a given date.

This note develops an overarching framework trying to encompass these three dimensions. Section 2 presents a deterministic analysis of Spanish public debt sustainability, describes the baseline scenario for 2014-2024, assesses the realism behind this scenario, and provides a quantitative sustainability assessment under alternative deterministic scenarios. Section 3 incorporates uncertainty by providing probabilistic statements based on stochastic techniques. Finally, section 4 concludes.

2 Debt dynamics: a deterministic analysis

2.1 Baseline scenario

According to the conventional debt accumulation approach, changes in the debt-to-GDP ratio (Δb_t) are determined by the interest rate-GDP growth gap ($i_t - g_t$), the primary balance (pb_t) and one-off deficit-debt adjustments (dda_t), such as financial sector bail-outs or privatization receipts. Simulations of future deterministic paths for these underlying factors yield insights onto the debt dynamics according to:

$$\Delta b_t = \frac{i_t - g_t}{1+g_t} b_{t-1} - pb_t + dda_t \qquad [1]$$

The projection of the main macroeconomic, financial and fiscal variables underpinning the 2014-2024 baseline scenario for the Spanish general government debt is derived in

[6] Fiscal fatigue defined as the existence of mean reversion properties in the primary balance, particularly at high levels of public debt (see Gosh et al. 2013 for empirical evidence on the existence of fiscal fatigue symptoms in advanced economies).

two batches. First, the latest official forecasts define the scenario until 2017[7] and the following standard economic assumptions are considered thereafter:

i. Real GDP growth is based on potential growth figures as estimated by the European Commission (EC) Output Gap Working Group, assuming a gradual closure of the output gap in 3 years (see figure 1).[8] Implicitly, real and potential growth will be equal as of 2021.

ii. Inflation rate converges to 2 per cent in 3 years, in line with ECB definition of price stability, causing a constant gap between nominal and real growth (figure 2);

iii. Interest rate expenditure is defined as the summation of existing debt instruments at different maturities, weighted by their corresponding interest rate. For this purpose, the shares of short and long-term debt are kept constant at their 2013 value (10.8 and 89.2 per cent, respectively). Moreover, the maturity structure is also kept constant at its 2013 redemptions profile. Long-term interest rates (reference rates for rolled-over and new long-term debt) are defined as the average of 5 and 10 year yields from the zero coupon curve. Short-term rates, given by T-bill rates in 2014, are assumed to go in line with long-term rates. Finally, implicit rates prevalent in *t-1* are used as a reference for outstanding non-maturing debt in time *t* (see figure 3).

iv. The Primary Balance from 2018 onwards is obtained from its individual components: the cyclical balance, the discretional or cyclically-adjusted component, ageing costs and one-off measures. The cyclical bit is achieved by using the standard calibration for the semi-elasticity of the budget balance to the output gap (i.e. 0.48 for Spain) following standard EC methodology (see Mourre *et al*. 2013 for a detailed description). The cyclically adjusted balance (cab), in turn, depends on the assumption about its primary component, which is supposed to remain constant at its 2017 value (i.e. no policy change). The cab is

[7] The official forecasts are consistent with the fiscal effort committed within the framework of the Stability and Growth Pact (SGP). See the update of the Spanish Stability Programme, http://www.thespanisheconomy.com/stfls/tse/ficheros/2013/noviembre/Stability_Programme_2014_2017.pdf).

[8] Assuming potential output growth converging to 2 per cent by 2024. The 2 per cent benchmark is calculated as the historical average rate obtained using the European Commission production function methodology (see d'Auria *et al*. 2010).

equivalent to the structural balance over the projection period, as ageing costs are assumed to be marginal over the next 10 years. The gap between the primary balance and its structural component will therefore disappear as the cyclical component fades out (see Figure 4). One-off measures and deficit debt adjustments are assumed zero over the projection horizon and ageing costs are derived from the estimations obtained at the EC Ageing Working Group and added to the cab to obtain the structural balance.[9]

According to our baseline scenario, public debt is projected to stay on the rise until 2015, when it will reach 101.7 per cent of GDP, as can be seen in figure 5 (and table 1 for detailed numbers). From then on, debt would start on a declining path that ultimately implies a correction of 25 pp. of GDP in 9 years.

Figure 1. Real and potential growth projections

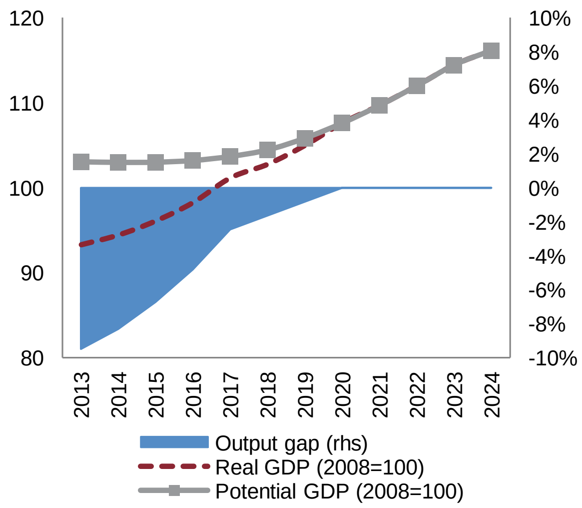
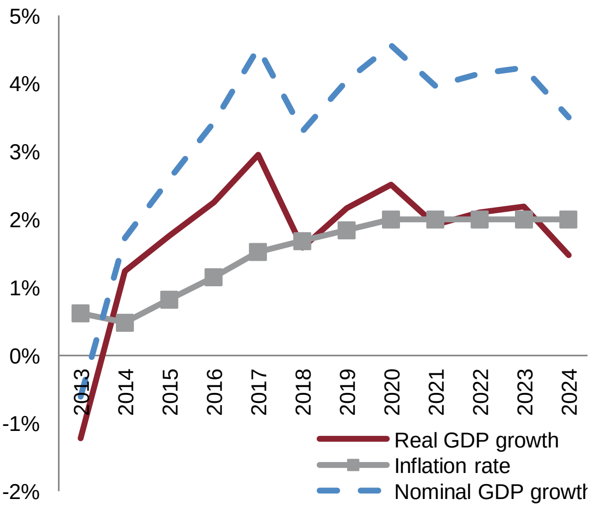


Figure 2. Inflation and GDP projections



Source: INE, Eurostat and own calculations

9 The deficit-debt adjustment has averaged around 0.7% since 1995. Assuming a flat rate from 2018 onwards could be justified in a scenario of a gradual (partial or full) recovery of ESM and credits under the Fund for Financing Payments to Providers.

Figure 3 Interest rates projections

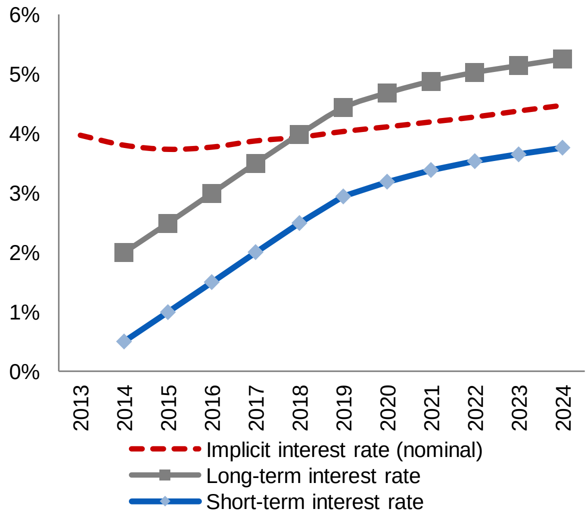
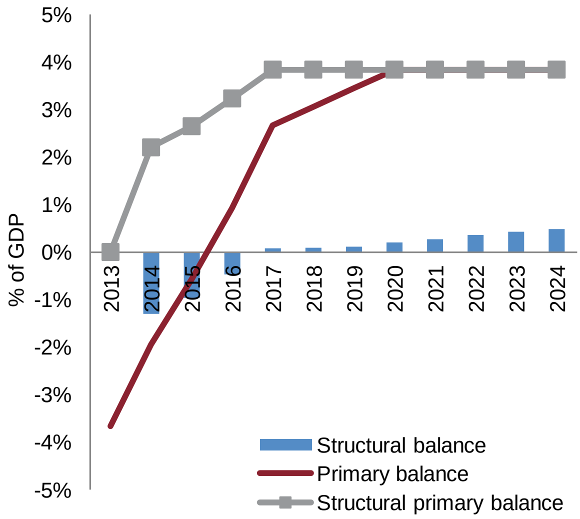
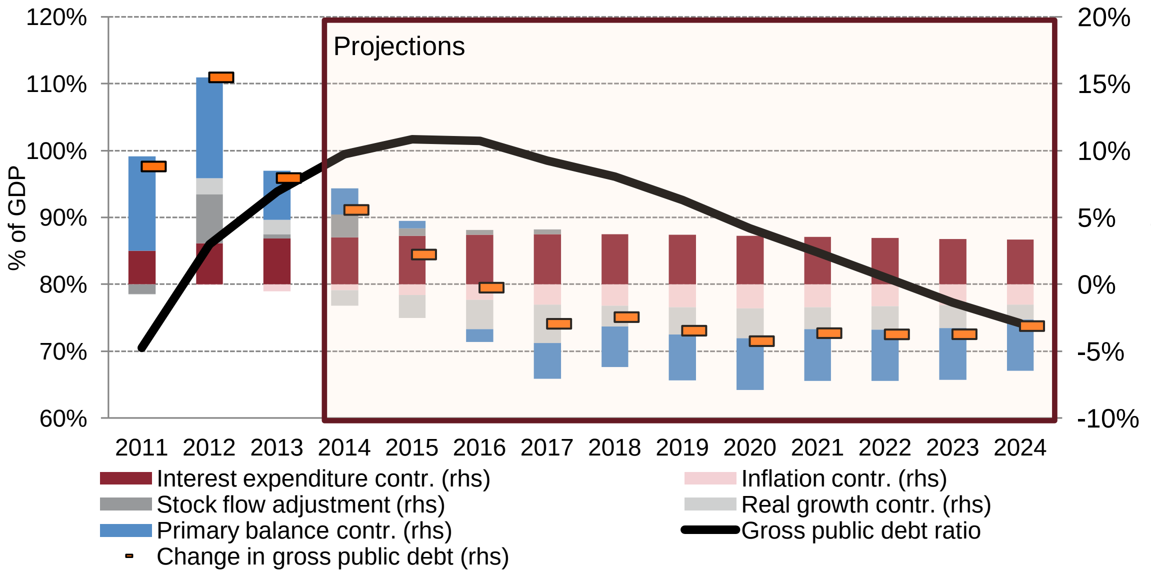


Figure 4. Primary and Structural balance projections



Source: INE, Banco de España and own calculations

Figure 5. Baseline scenario for gross public debt over GDP and the contribution of its underlying factors



Source: own calculations

Table 1. Evolution of gross public debt over GDP and the contribution of its underlying factors, Spain

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Gross public debt ratio	70,5%	86,0%	93,9%	99,5%	101,7%	101,5%	98,5%	96,1%	92,6%	88,4%	84,7%	81,0%	77,3%	74,2%
Changes in the ratio	8,8%	15,5%	8,0%	5,6%	2,2%	-0,2%	-2,9%	-2,4%	-3,5%	-4,2%	-3,6%	-3,7%	-3,7%	-3,1%
of which														
(1) Primary balance	7,0%	7,6%	3,7%	2,0%	0,6%	-0,9%	-2,7%	-3,1%	-3,4%	-3,8%	-3,8%	-3,8%	-3,8%	-3,8%
(2) Snowball effect	2,5%	4,2%	4,0%	1,9%	1,1%	0,3%	-0,6%	0,6%	0,0%	-0,4%	0,2%	0,1%	0,1%	0,7%
Interest expenditure	2,5%	3,1%	3,4%	3,5%	3,6%	3,7%	3,8%	3,8%	3,7%	3,6%	3,6%	3,5%	3,4%	3,3%
Growth effect	-0,03%	1,2%	1,1%	-1,1%	-1,7%	-2,2%	-2,9%	-1,5%	-2,0%	-2,2%	-1,7%	-1,7%	-1,7%	-1,1%
Inflation effect	-0,01%	-0,01%	-0,5%	-0,4%	-0,8%	-1,1%	-1,5%	-1,6%	-1,7%	-1,8%	-1,7%	-1,6%	-1,6%	-1,5%
(3) Stock flow adjustment and one-off measures	-0,7%	3,7%	0,3%	1,7%	0,6%	0,4%	0,4%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%

Note: Cells shaded in grey represent projections

In these circumstances, public debt sustainability appears warranted following a simple rule of thumb that would gauge both the dynamics and the level of the general government debt. Indeed, a relatively rapid stabilization is followed by a sizeable correction, bringing debt levels close to 2011 levels by 2024.

However, this sustainability assessment will only be reliable as long as the assumed baseline path for the underlying variables is found to be realistic. Risks surrounding the materialization of a robust economic upturn and improved primary balances could ultimately jeopardize the sustainability verdict. Indeed, under the baseline scenario, positive developments (meaning negative contributions) coming from nominal growth rates close to 4 per cent and large fiscal primary surpluses more than compensate the drag of interest rate expenditures. If nominal growth figures do not meet expectations (either due to sluggish real developments or flat prices) and/or fiscal fatigue kicks in, worries about the health of public debt dynamics might reappear. Next subsection assesses the realism of the baseline assumptions on growth and fiscal developments.

2.2 Realism of the baseline assumptions: alternative scenarios

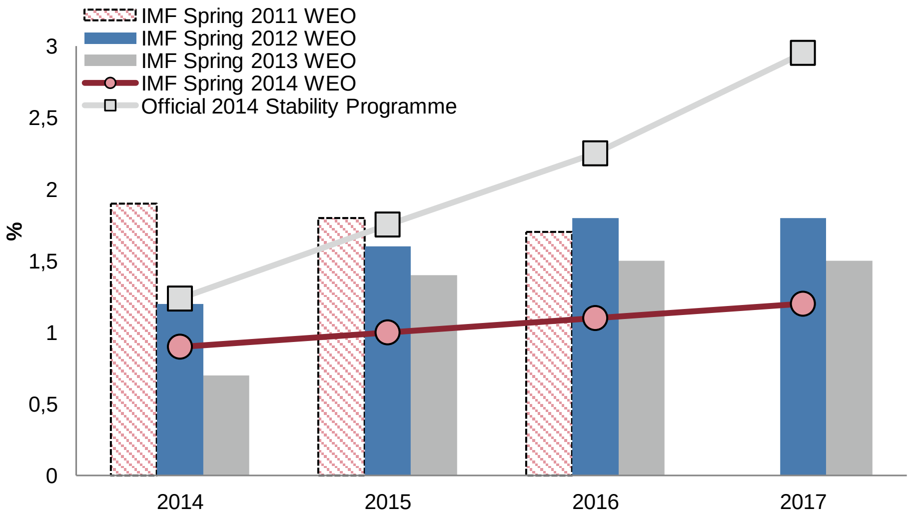
2.2.1 Risks surrounding growth projections

The real GDP growth profile assumed in the baseline scenario is based, for the 2014-2017 period on the Spanish Stability Programme, as stated above. Figure 6 gives a quick overview of how this path ranks with respect to the International Monetary Fund

(IMF) forecast for the same period. [10] Several batches of the IMF forecast are depicted (starting with its 2011 Spring World Economic Outlook) against the last official update (April 2014).

Two conclusions can be drawn from the comparison of short and medium term paths. First, official forecasts are in line with the IMF view for 2014 and (to a lesser extent) 2015. Second, the Spanish government projections for 2016 and 2017 appear on the optimistic side, especially with the latest 2014 IMF Spring forecasts (that have actually been revised downwards), with almost 2 pp. gap and a different profile.

Figure 6. IMF and Spanish Government official GDP forecasts for the 2014-2017 period



Source: IMF and Spanish Government

To what extent is there an upward bias in the medium-term GDP projections of the Spanish Government? In order to investigate this, IMF and Spanish official forecast errors have been compared at different horizons (t to t+3) since the early 2000s. IMF figures are obtained from the WEO database and the official data has been extracted from the existing updates of the Stability Programme (beginning in 1998). Forecast

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10 The IMF projections are taken as a benchmark for comparability reasons, as the IMF is the only international institution providing GDP forecasts beyond t+2.

errors are defined as the difference between the forecast paths and actual growth.[11] For comparison purposes, figures 7-10 also show the interquartile range (difference between third and first quartile) of the IMF forecast errors for a group of advanced economies.[12] This interquartile range is taken as a benchmark out of which the projections are considered biased as they would belong to the tail of the forecast error distribution.

The analysis of the forecast errors appears to confirm the hypothesis of an upward bias in the official medium-term forecast (t+2 and t+3 horizons). Short-term official forecast errors are within the band defined by the IMF advanced economies, showing no systematic bias (with the possible exception of the 2012 rate foreseen one year before). Data for t+2 and t+3 errors points towards the existence of an over-optimism bias starting in 2009 as reflected in errors outside of the interquartile range and also significantly larger than its IMF counterpart as of 2011.

Finally, inflation projections also deserve some attention as they are essential in determining nominal growth rates. The baseline scenario assumes inflation rates of 1.5 per cent already in 2017 and progressive convergence to the 2 per cent target in three years, thereafter.[13] However, a subdued recovery in the euro area in 2014 and a relatively strong euro call for a note of caution against these optimistic developments.

[11] Actual growth rates for the 1998-2013 are taken as of August 2014 to abstract as much as possible from past GDP revisions.
[12] Australia, Austria, Belgium, Canada, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hong Kong, Iceland, Ireland, Israel, Italy, Japan, Korea, Latvia, Luxembourg, Malta, Netherlands, New Zealand, Norway, Portugal, Singapore, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Taiwan, United Kingdom, United States.
[13] GDP deflator is assumed to evolve in line with inflation throughout the rest of the note.

Figure 7. Current year real GDP forecast error

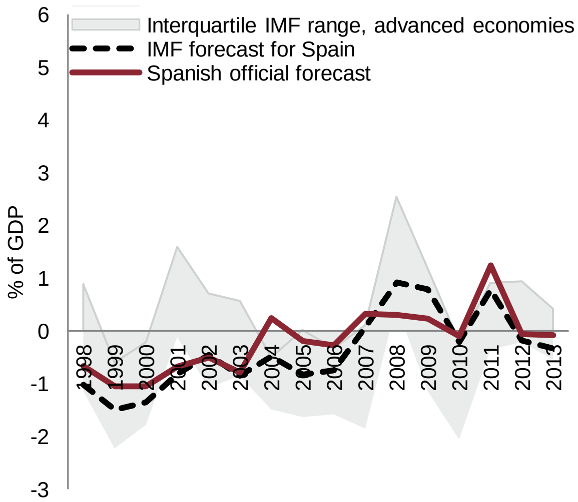
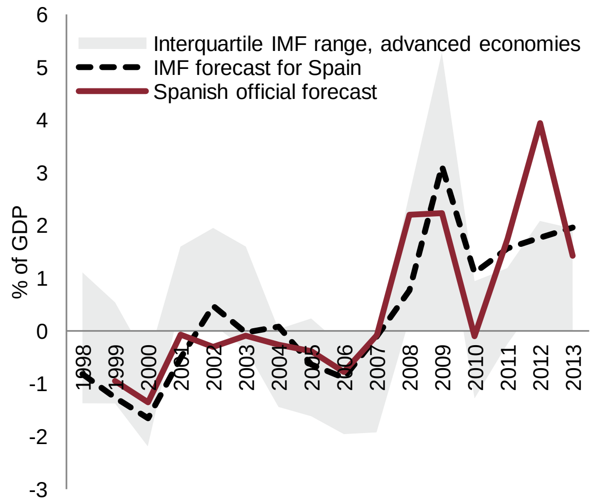


Figure 8. 1 year-ahead real GDP forecast error



Source: IMF, Spanish Ministry of Economy and Competitiveness. Note: forecast error is defined as the difference between the forecast and the actual GDP growth rates. A positive figure implies thus an overestimation.

Figure 9. 2 year-ahead real GDP forecast error

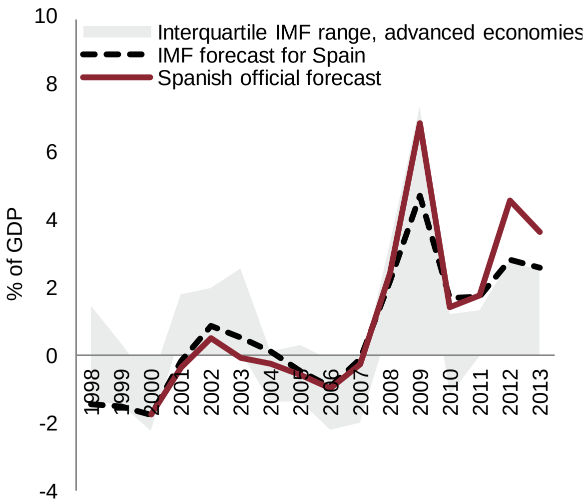
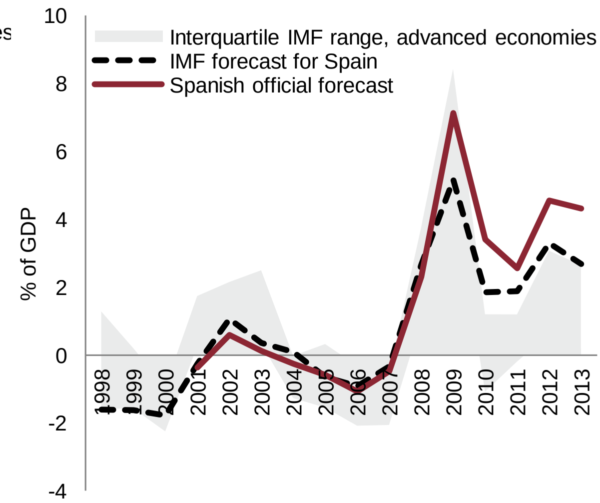


Figure 10. 3 year-ahead real GDP forecast error



Source: IMF, Spanish Ministry of Economy and Competitiveness. Note: forecast error is defined as the difference between the forecast and the actual GDP growth rates. A positive figure implies thus an overestimation.

2.2.2 Risks surrounding fiscal projections

The projected baseline evolution of the primary balance (headline balance net of interest expenses) goes first in line with the fulfillment of existing commitments within the framework of the Stability and Growth Pact (SGP), as outlined in the Updated 2014-2017 Stability Programme.

From 2018 onwards, the primary balance relies on assumptions about its individual components, as outlined in section 2.1. First, the cyclical component is obtained as a proportion of the output gap (according to existing budget balance semi-elasticities) and thus assumed to close in line with the business cycle. Second, one-off measures and deficit debt adjustments are neglected beyond the 2017 horizon. Third, discretional policy (i.e. the cyclically-adjusted or structural primary balance) is considered constant at its 2017 stance, under a “no policy change” clause. Finally, ageing costs introduce a wedge between the cyclically-adjusted balances and the structural ones.

These assumptions yield two main implications, both of which could be contested. First, the quick closure of the output gap accounts for most of the correction in the overall balance, as can be seen in figure 11. However, one might expect declining semi-elasticities. This is particularly the case for revenues as GDP growth will likely be driven by less tax-intensive activities. Ceteris Paribus, the structural tax bases will shrink when compared to the recent past and this could be compensated by normative changes (including hikes in the rates) and efficiency gains (i.e. minimizing tax evasion). A detailed calculation of the impact of recent fiscal reforms on the revenues going forward would shed some light on the realism of the projected cyclical correction, although it is beyond the scope of this paper.

Second, keeping discretional policy at its 2017 stance, with a structural primary balance reaching 3.8 per cent of GDP, helps balance the load of interest rate expenditures (see figure 12). Nevertheless, the 2017 structural primary balance level is a consequence of a continued period of strong fiscal discipline, which should not be taken for granted. Indeed, fiscal fatigue might kick-in, reverting partially (or even in full) the fiscal efforts made so far. This would have immediate consequences on the headline balance and thus public debt projections.

Figure 11. Public balance projections and its components (% of GDP)

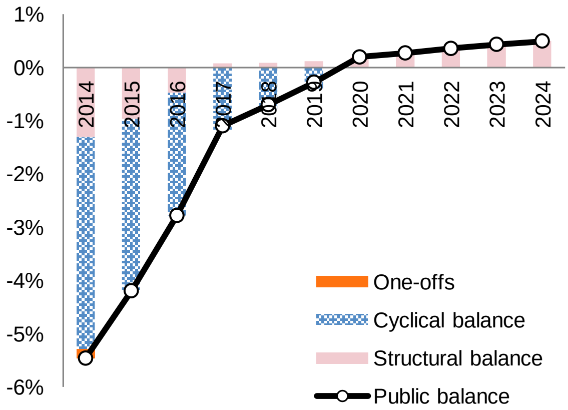
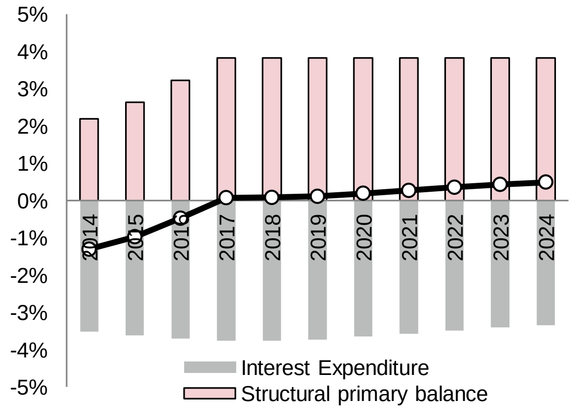


Figure 12. Structural balance (% of GDP)



Source: INE and Banco de España

Figure 13. Primary balance historical and projected distribution, Spain, % of GDP

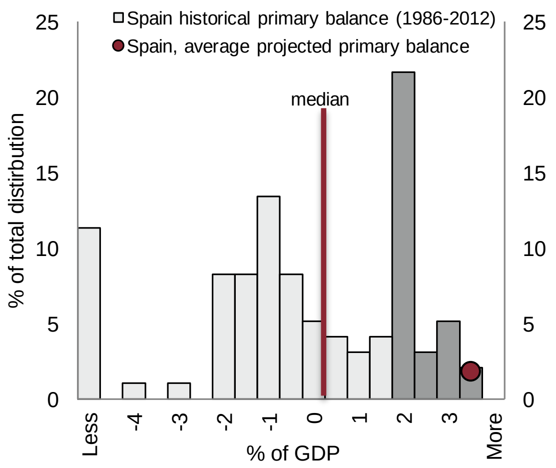
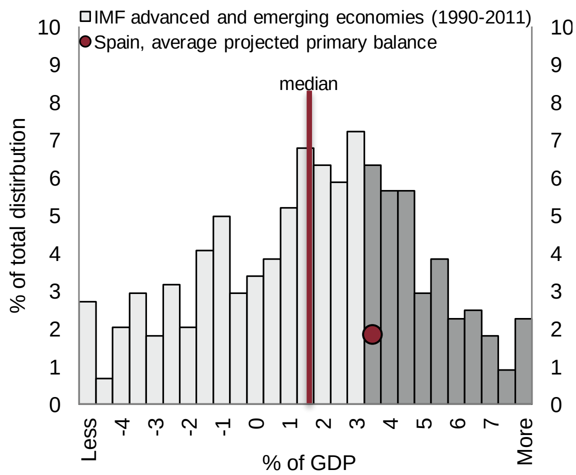


Figure 14. Primary balance selected countries historical distribution vs, Spanish projected values



Source: de Castro *et al*. (2014). Note: Shaded bars represent the upper tercile of the distribution

Source: IMF DSA (2013) and de Castro *et al*. (2014). Note: IMF data covers advanced and emerging economies with debt greater than 60 percent of GDP. Shaded bars represent the upper tercile

In order to investigate whether the primary balance implied by the projected structural primary balance seems realistic, figures 13 and 14 represent the average primary balance projected for the 2017-2024 period within its own historical distribution and with respect to a panel of developed and emerging economies, respectively. In both cases the assumed evolution appears in the upper tercile of the distribution, signaling a potential upward bias in the baseline assumption.

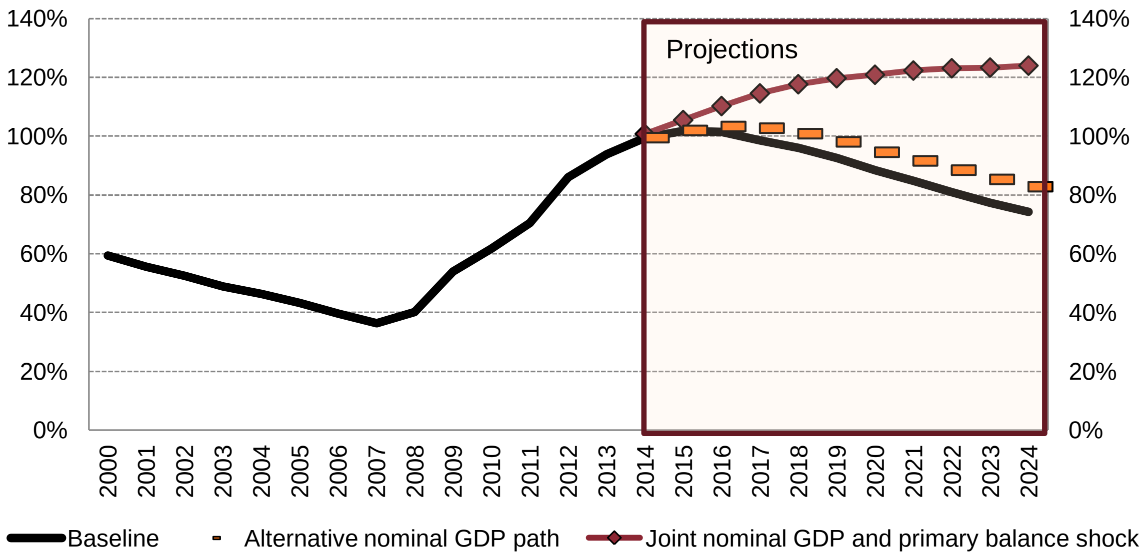
2.2.3 Alternative scenarios

All in all, an alternative, less favorable, scenario could be drawn, trying to correct for the identified biases. It would be based on a corrected path for nominal GDP growth and an evolution of the primary balance more in line with historical developments. More precisely, the alternative projections entail:

- Real GDP growth rates in line with the IMF projections for 2016 and 2017 (1.1 per cent and 1.2 per cent respectively);
- Inflation will take up to 10 years longer to converge to the 2 per cent reference value, starting from its foreseen value for 2014 (0.8 per cent);
- The primary balance will converge to its historical median value since the beginning of the nominal convergence period in 1994, i.e. 1.1 per cent of GDP, including the crisis years, assuming that the new EMU institutional framework represents a structural shift with respect to the pre-convergence period.

The resulting debt dynamics can be seen in figure 15. The new nominal growth path (given by the alternative real growth and inflation scenarios) yields no sizeable change with respect to the baseline. Debt stabilization is delayed one year and the 2024 projections are close to the baseline, around 80 pp. When incorporating the consequences of the “fiscal fatigue” effect (*i.e.* primary balance reverting to its historical median), the impact on public debt is sizeable. Debt sustainability is more in jeopardy as it breaches the 120 per cent of GDP level, and the ratio does not stabilize over the 2014-2024 horizon, although its path is rather flat by the end of the period.

Figure 15. Alternative scenarios for gross public debt over GDP



Source: own calculations

The qualitative sustainability analysis based on the specified rule of thumb (*i.e*. positive trends associated with high stocks represent signs of potential unsustainability) can be inconclusive for intermediate cases, which are not clear-cut (for example debt dynamics stabilizing at a high level). This leaves plenty of room for the expert´s interpretation about the final sustainability decision. A systematic assessment requires, however, more elaborated criteria, allowing for a detailed sustainability diagnosis.

2.3 Sustainability assessment based on a fiscal reaction function

As signaled above, public debt sustainability generally requires governments to meet their intertemporal budget constraint, servicing their obligations. This theoretical concept is, however, difficult to translate into operational debt sustainability analysis (DSA).

In practice, debt is often required not to exceed a specific threshold. In this vein, the seminal contribution in Reinhart and Rogoff (2010) spurred research on the existence of a concave relationship between public debt and economic growth, with controversial findings on possible thresholds for debt-to-GDP ratios from which debt becomes detrimental for long-term growth. [14]

This approach presents, however, several flaws. First, it represents only a gross approximation to sustainability. Furthermore, it is static, and needs to be reassessed against structural changes in the economy, which tend to shift the debt-absorption capacity. Finally, it does not fully take into account country-specificities, such as existing institutional features, which might considerably impact the sustainable level of debt.

In order to address these shortcomings, the literature generally opts for an approach rooted in time series analysis, starting from the public debt accumulation dynamics (equation [1]):

The solution to the difference equation 1 is given by:[15]

$$b_T = \left(\frac{1+i}{1+g}\right)^T b_0 - \sum_{t=1}^{T} \left(\frac{1+i}{1+g}\right)^{T-t} pb_t \qquad [2]$$

Equation [2] can be rearranged so as to summarize the two main conditions for debt sustainability:[16]

$$b_0 = \left(\frac{1+i}{1+g}\right)^{-T} b_T + \sum_{t=1}^{T} \left(\frac{1+i}{1+g}\right)^{-t} pb_t \qquad [3]$$

- Transversality or No-Ponzi games condition: the Net Present Value of future debt must decline to zero over time, meaning that the debt ratio should not grow at a higher rate than the interest rate-growth gap (i.e. the first term on the right-hand side of equation 3 will converge to 0 as $T \to \infty$.
- Intertemporal budget balance condition: the Net Present Value of future primary balances (second right-hand side term) has to be sufficient to repay the initial level of debt.

14 See Herndon *et al*. (2014) for a rebuttal of Reinhart and Rogoff results.

15 Assuming $\frac{i_t - g_t}{1+g_t}$ constant over time and abstracting from the one-off adjustment components.

16 Both conditions are equivalent as shown in Escolano (2010).

The transversality condition is verified via stationarity tests on public debt and deficit figures.[17] Compliance with the intertemporal budget balance condition is generally assessed by testing whether government spending and revenues grow hand in hand (i.e. both series are cointegrated).[18]

This empirical approach was heavily criticized by Bohn (see Bohn 1998, 2005, 2007), claiming that time series tests are not able to fully reject the sustainability hypothesis.[19] Instead, Bohn suggests a model-based approach that pivots around the government fiscal reaction function to the debt-to-GDP ratio. Once estimated, the reaction of the primary balance to the debt level is inserted in the debt dynamics equation in order to assess sustainability. The next subsections develop this approach for the Spanish case, given our baseline and alternative scenarios.

2.3.1 A time-varying fiscal reaction function for the Spanish economy

Following Doi *et al*. (2011), the primary balance (pb_t) is estimated as a function of the previous period´s debt level (d_{t-1}), a stationary control variable such as the output gap (x_t), its own lagged value (pb_{t-1}) in order to smooth the adjustment, and a vector of normally distributed white noise errors (u_t).[20]

$$pb_t = c + \beta d_{t-1} + \gamma pb_{t-1} + \delta x_t + u_t \qquad [4]$$

Intuitively we would expect a sustainable fiscal rule to respond to increasing levels of debt by raising the primary balance ($\beta > 0$). Also the impact of automatic stabilisers should increase the primary balance whenever the economy is in a bullish phase ($\delta > 0$).

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[17] See for example the original work in Hamilton and Flavin (1985), Trehan and Walsh (1991) or Uctum and Wickens (2000) for a more recent analysis of the implications of the SGP.

[18] See Elliot and Kearney (1988), Lui and Tanner (1994) and Afonso (2005) for evidence on Australia, the US and Europe, respectively, and Payne (1997) for an international comparison.

[19] Technically, time series tests are special cases of a more overarching condition that is sufficient for sustainability: public debt being integrated of any finite order. If public debt can be transformed into a stationary series after differencing a finite number of times, the sustainability hypothesis cannot be rejected.

[20] The gap is defined as the deviation of the actual value with respect to its Hodrick-Prescott filtered trend.

The estimation covers the 1986-2012 period. Fiscal data is taken from a novel quarterly database for the main Spanish public finance variables presented in De Castro *et al*. (2014), capturing the most relevant economic facts of the Spanish economy since its accession to the European Economic Community.[21]

A priori, one could expect the reaction of primary balances to public debt to change over time, influenced not only by the business cycle but also by political and institutional shifts. In order to account for parameter instability, the regression model is estimated with Bayesian time-varying coefficients (TVC) techniques. Following Ciapanna and Taboga (2011), the degree of parameter instability is jointly estimated with the path for the parameters.[22]

The estimation results show a high degree of parameter instability, confirming thus our theoretical prior.[23] When looking at the evolution of the beta parameter (see figure 16), the period between 1996 and 2008 stands out as the only period with a well-behaved fiscal reaction (positive beta). The institutional changes implied, first, by the EMU nominal convergence requirements, and then by the entry into force of the SGP, had a clear impact in raising the awareness of fiscal sustainability issues.[24]

However, for the rest of the period, the response of the primary balance to public debt goes fails this sustainability test. These results are in line with De Castro *et al*. (2014a) univariate Markov-Switching approach, which finds evidence of two different fiscal regimes, the first spanning the 1996-2007 period and the second one the 1986-1995 and 2008-2012 intervals. The results for the 2008-2012 period evidence the fragility of the SGP commitments once the system was put under stress. Since then, the SGP has been reinforced through successive reforms aiming at increasing its enforceability,

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21 For a justification of the use of quarterly data for the estimation of the fiscal rule, see Afonso and Toffano (2013).

22 More precisely, the parameter vector $\Theta_t = [\beta, \gamma, \delta]_t$ is assumed to evolve according to an AR(1) process with a unitary autoregressive coefficient and an i.i.d vector of disturbances. Standard conjugate Normal/Inverse gamma priors are automatically imposed on Θ at time $t = 1$ and the variance of the regression disturbances u_t, respectively. We thank the authors for making their matlab estimation routines publicly available.

23 The stability measure π, falls within the range of very strong evidence against parameter instability (i.e. lower than 0.01).

24 It should be acknowledged that construction sector revenue windfalls that came hand in hand with the housing bubble during the 1996-2008 period also had a strong positive influence in the fiscal position.

including the creation of independent fiscal institutions (or watchdogs) in charge of monitoring government compliance with fiscal rules.

To what extent will these improvements translate into a more effective implementation of the EU and Spanish fiscal rules? In order to investigate this, equation 4 is estimated both for the 1986-2024 period according to the baseline (assuming a strict enforcement of the SGP) and the alternative (under a flexible implementation of the SGP, or joint shock case defined above) scenarios. In order to fit the annual frequency of the projected scenarios, the original data for the 1986-2012 period is annualized by taking end of the year values for debt series and the sum of the quarterly primary balance figures.

The results of these two alternative estimations are shown in figure 17. In both cases, the reaction of primary balances progressively goes back into positive territory. The path and the final value differ, however, significantly. Under the strict SGP implementation or baseline scenario, the beta coefficient becomes positive already in 2017 and stays more or less constant for the rest of the period. The alternative or flexible SGP scenario presents a milder correction, reaching positive values only in 2021. Moreover, it barely reaches half of the value attained in the baseline, implying a parsimonious reaction of the government although in the right direction. A positive reaction of the primary balance to changes in debt might, however, not be a sufficient condition for sustainability. The strength of the response of fiscal policy to changes in the debt ratio will have to be assessed against GDP and interest rates developments.

Figure 16. Primary balance reaction to public debt over time, historical evidence, 1988-2012

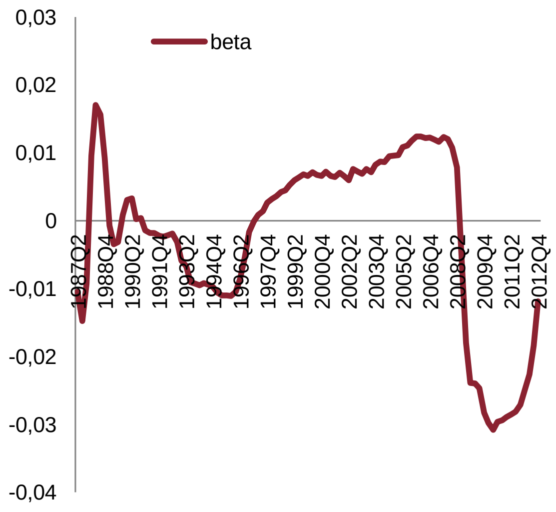
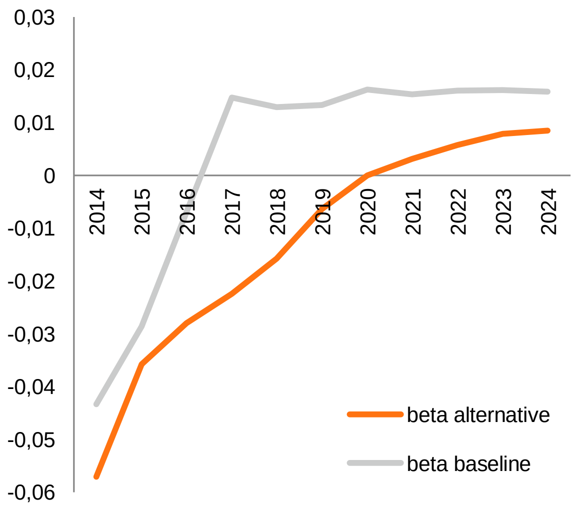


Figure 17. Primary balance reaction to public debt over the projection period, 2014-2024



Source: own calculations

2.3.2 Debt dynamics based on the fiscal reaction function

Following Doi *et al*. (2011), the primary balance is substituted from equation 4 into equation 1' (a simplified version of equation 1), yielding equation 5:

$$b_t = (1 + i - g)b_{t-1} - pb_t \quad [1']$$

$$b_t = (1 + i - g - \beta + \gamma)b_{t-1} - \rho(1 + i - g)b_{t-2} - c - \delta x_t - u_t \quad [5]$$

In order to check whether the reaction implied by the fiscal reaction function is sufficient, equation 5 can be expressed in AR(2) form, mimicking an Augmented Dickey Fueller test regression:

$$\Delta b_t = [(i - g)(1 - \gamma) - \beta]b_{t-1} + \rho(1 + i - g)\Delta b_{t-1} - c - \delta x_t - u_t \quad [6]$$

Public debt stationarity will thus depend on the long-run level of the primary balance being large enough to compensate for the interest rate-GDP growth gap, at which debt grows over time, i.e. $\frac{\beta}{1-\gamma} > (i - g)$. Intuitively, the reaction of the primary balance to changes in debt, β, should provide a sustainability buffer to account for different economic and financial circumstances. The sustainability condition amounts therefore to the following inequality:[25]

$$\frac{\beta}{1-\gamma} - (i - g) > 0 \qquad [7]$$

This simple decomposition of the sustainability factor into its economic growth and fiscal reaction components provides useful insights about our projected scenarios, as shown in table 2.

Under the baseline path, a stronger fiscal reaction is made more effective by higher nominal growth, fulfilling the sustainability condition already in 2017 and thereafter. In contrast, under the alternative scenario, characterized by lower growth, the fiscal reaction appears too timid and debt dynamics are unsustainable for most of the projected period.

Table 2. Sustainability assessment, estimated and projected components

	Beta		1-Rho		i		g		Sustainability condition	
	Baseline	Alternative	Baseline	Alternative	Baseline	Alternative	Baseline	Alternative	Baseline	Alternative
2015	-0,029	-0,036	0,254	0,618	0,037	0,037	0,026	0,023	-0,124	-0,072
2016	-0,007	-0,028	0,137	0,592	0,038	0,038	0,034	0,018	-0,054	-0,067
2017	0,015	-0,022	0,064	0,538	0,039	0,039	0,045	0,020	0,238	-0,060
2018	0,013	-0,016	0,307	0,475	0,039	0,039	0,033	0,025	0,036	-0,048
2019	0,013	-0,006	0,299	0,466	0,040	0,040	0,040	0,032	0,045	-0,022
2020	0,016	0,000	0,275	0,512	0,041	0,041	0,046	0,036	0,064	-0,005
2021	0,015	0,003	0,324	0,465	0,042	0,042	0,040	0,031	0,045	-0,004
2022	0,016	0,006	0,312	0,424	0,043	0,043	0,041	0,034	0,050	0,005
2023	0,016	0,008	0,311	0,390	0,044	0,044	0,042	0,036	0,051	0,013
2024	0,016	0,008	0,335	0,370	0,045	0,045	0,035	0,030	0,038	0,008

Source: own calculations. Note: the sustainability condition is defined as $(i - g)(1 - \gamma) - \beta < 0$

A commitment towards public debt sustainability (positive β) is therefore a necessary although not sufficient condition to ensure a sustainable debt path. Risks associated with future economic conditions, including anemic real GDP growth, low inflation rates or even interest rate increases, or any other factor widening the interest-growth

[25] Marin (2014) presents a similar approach towards sustainability, within a stylized business cycle approach, whereby public finances are sustainable when the steady state equilibrium is stable under a given policy rule, *i.e*. when the application of a rule steers the economy from the starting position towards a steady state equilibrium

differential, might compromise debt sustainability if the fiscal rule is not binding/strong enough.

This analysis presents, however, two important caveats;

i. It ignores potential feed-back loops between the different determinants. For example, too much fiscal tightening could eventually lead to lower growth figures, with self-defeating consequences in terms of public debt sustainability.
ii. Its deterministic nature does not properly capture the existing uncertainty about future economic conditions. Our baseline and alternative scenarios present only 2 possible fiscal and macroeconomic outcomes out of a full constellation of them for the next decade. What is the likelihood associated to any of them, or any other combination of fiscal, nominal growth and interest rate shocks? Beyond the diagnosis on the realism of the different assumptions, a more sophisticated approach should give quantitative indications on the most likely path ahead.

In order to overcome these two limitations, the next section incorporates the uncertainty associated with the projected fiscal and macroeconomic paths in a multivariate Vector Autoregressive (VAR) model. This framework includes interdependencies between the variables at hand. Moreover, it presents a probabilistic approach allowing for a quantification of the likelihood associated with the different scenarios.

3 Debt dynamics: a stochastic analysis

The stochastic approach to public debt sustainability analysis generally relies on simulations of the underlying debt dynamics determinants. Both, non-fiscal variables (i.e. GDP growth, interest rates and inflation) and public finance (mainly the primary balance) variables are projected according to stochastically simulated vectors of residuals or shocks, $\hat{\varepsilon}_t$. The projections for the debt ratio are obtained, in the end, by replacing the projected determinants in the stock-flow equation [1].

The disturbances or shocks, $\hat{\varepsilon}_t$, behind the projections of the main determinants are calculated according to two main variants:

i. Derived from the variance covariance (VCV) matrix $\widehat{\Omega}$ of the historical shocks $\hat{\varepsilon}_t$, generally assuming their joint normal distribution. The shocks are simulated via the Cholesky factorization of the VCV matrix and then added to the original variables, generating the simulated paths:

$\hat{\varepsilon}_t \sim N(0, \widehat{\Omega})$, with $\hat{\varepsilon}_t = W\hat{\vartheta}_t$, $\hat{\vartheta}_t \sim N(0,1)$ and $\widehat{\Omega}$=W'W

International institutions such as the IMF and the European Commission, implement their stochastic DSA analysis based on these historical relations between the variables at hand.[26] This approach is easier to replicate for countries with short data samples and it also suits their objective of evaluating the uncertainty around some externally given central scenario (their experts' judgment or forecasts), as in equation [7]. However, it does not allow an assessment of the central scenario, which is taken as given.

$$x_\tau^{simul} = x_\tau^{central} + \hat{\varepsilon}_\tau \qquad [7]$$

for $\tau \in [t+1, T]$, with T being the forecast horizon.

ii. Simulated from a multivariate non-structural model, such as a vector autoregressive (VAR) model. In this case, the estimated residuals $\hat{\varepsilon}_t$ from the model are used in order to generate the stochastic simulations, either assuming normality of the joint distribution or by bootstrapping procedures, resampling with replacement from the estimated error vectors.[27] Once the shocks are simulated, consistent paths for the macro variables can be projected around the restrictions implied by the VAR model coefficients.

This second approach is followed in this paper as it enables a likelihood assessment for official projections, which are not considered the central or median scenario anymore. Moreover, it allows for a greater variety of exercises, such as structural or

26 See for example IMF (2013), and Berti (2013).

27 Medeiros (2012) implements this approach for the macroeconomic determinants (output, inflation and interest rates), while estimating fiscal reaction functions for the projections of the primary balance.

impulse-response analysis as well as conditional forecasts, enhancing the richness and flexibility of the DSA. It is, however, model dependent.

3.1 VAR analysis: the data

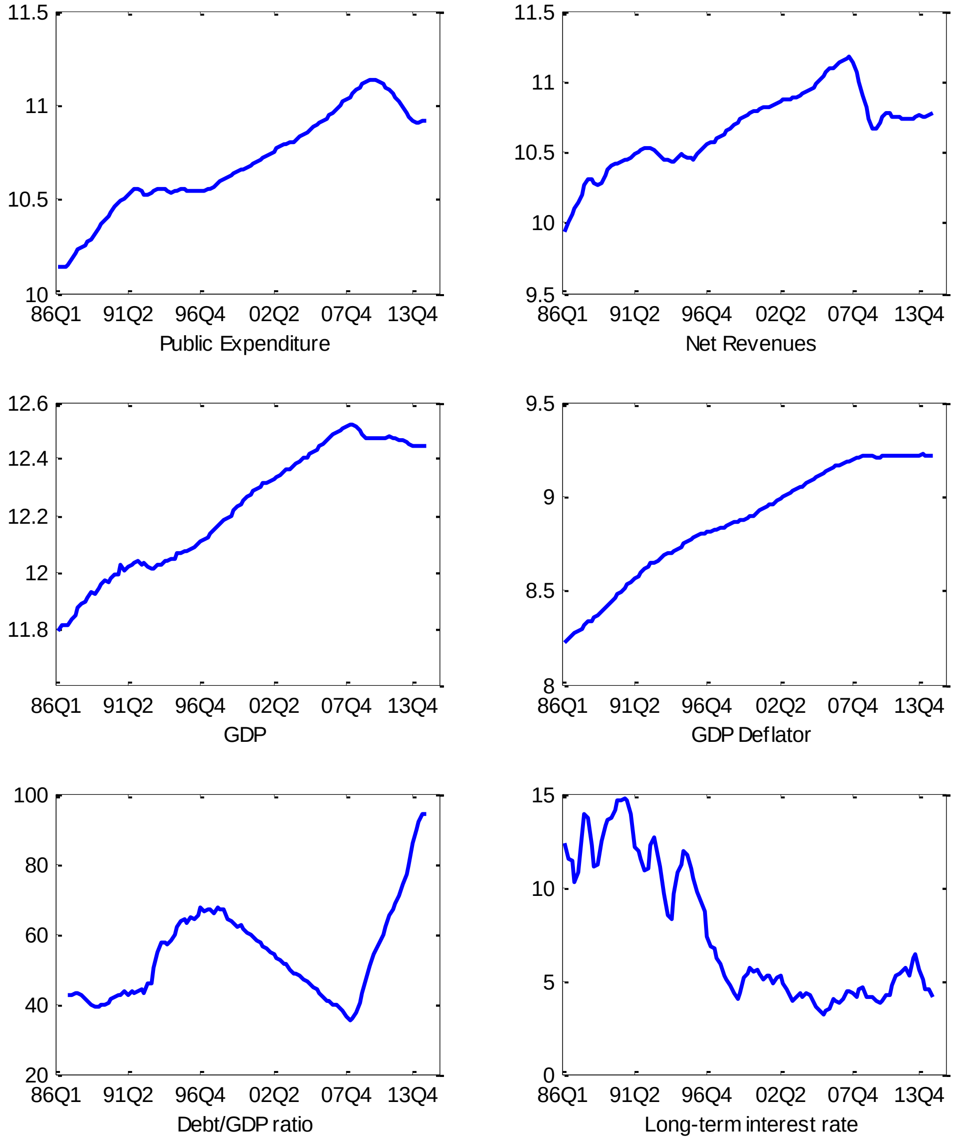
The VAR model is estimated at a quarterly frequency and includes both, macroeconomic and fiscal variables. Following de Castro and Hernández de Cos (2008), the vector of endogenous variables, X_t, includes: (*i*) real public expenditure, ex_t; (*ii*) real net revenues, nr_t; (*iii*) public debt over GDP ratio, by_t; (*iv*) real GDP, y_t; (*v*) GDP deflator, p_t and (*vi*) ten year government bond yields, i_t.[28]

Fiscal data is taken again from the recent quarterly database developed for the main Spanish public finance variables in de Castro *et al*. (2014).[29] GDP and GDP deflator figures are taken from the Spanish Statistical Institute (INE), while the interest rates are from the Bank of Spain databank. The series are represented in figure 18. All of them are adjusted seasonally and taken in logs, except the interest rate and the debt-to-GDP ratio, which are taken in levels. Public expenditure in goods and services (defined as the sum of government consumption and investment) as well as net revenues (total revenues net of social and interest payments) and GDP are expressed in real terms via the GDP deflator.

[28] The only departure from De Castro *et al*. (2014) extended VAR lies in the selection of the long-term yield, instead of the 3 year interest rate. The long-term yield responds more rapid and vividly to changes in debt levels and may therefore be a better benchmark for sustainability analysis.

[29] Despite the recent publication of the ESA2010 annual figures by the National Statistical Institute, the corresponding quarterly profiles will only be available later in the year and thus the database still follows the ESA1995 rules.

Figure 18. VAR selected variables, 1986Q1:201234



Source: De Castro (2014), Banco de España

3.2 VAR analysis: the simulation algorithm

The stochastic approach to debt sustainability analysis follows a three-step algorithm:

Step 1: The unrestricted VAR(p) is estimated

$$X_t = \Theta_0 + \sum_{k=1}^{p} \Theta_k X_{t-k} + a_t \quad [8]$$

With $X_t = [\, ex_t, nr_t, g_t, by_t, p_t, i_t]$ being the vector of endogenous variables, p the maximum lag or order of the VAR, Θ_0, Θ_k the VAR coefficients and a_t the residuals. A VAR(2) model is finally estimated for the 1990Q1-2013Q4 period.[30] The model is stable with all its roots within the unit circle. Moreover, there appears to be no serial correlation in the estimated residuals $\widehat{a_t}$, according to the LM test. Joint normality of the estimated residuals is, however, rejected.

Step 2: Generate disturbances for the projection window, t+1…T

Traditionally, normality of the residuals is assumed (i.e. $a_t \sim N(0, \Omega)$). Their projected values $\hat{a}_{t+1}, \ldots, \hat{a}_T$, are thus drawn from a normal distribution with zero mean and unitary variance, scaled by the Cholesky factor of their original variance, Ω:

$\forall \tau \in [t+1, T], \hat{a}_\tau = W v_t$, with $v_t \sim N(0,1)$ and $\Omega = W'W$

As joint normality was rejected, the stochastic simulations are obtained by bootstrapping procedures, resampling with replacement from the estimated error vector $\widehat{a_t}$. More precisely, 1500 simulated shocks $\hat{a}_\tau^s$, are obtained via resampling replications.

Step 3: Generation of the projected endogenous variables

The resampled residuals $\hat{a}_\tau^s$, and the estimated VAR coefficients, $\widehat{\Theta}_0, \widehat{\Theta}_k$ enable out-of-sample projections for the vector of endogenous variables X_t, which are consistent with the simulated shocks, following equation [9]:

$$X_\tau^b = \widehat{\Theta}_0 + \sum_{k=1}^{p} \widehat{\Theta}_k X_{\tau-k}^b + \hat{a}_\tau^s, \qquad \forall \tau \in [t+1, T] \text{ and } b \leq 1500 \quad [9]$$

[30] There is no agreement between the different selection criteria on the optimal lag. Following Ivanov and Kilian (2005), the final choice is determined via the Schwarz criterion, which gives the most accurate forecasts for samples below 120 observations.

3.3 VAR analysis: simulation results

Making use of the projected paths for the macroeconomic and fiscal variables and the estimated joint distribution of the VAR shocks, probabilistic scenarios can be built for the Spanish public debt. Figure 19 depicts the usual fan chart representation of stochastic DSA, showing the deciles of the distribution of the 1500 simulated debt paths. Moreover, the baseline scenario is also shown for comparison purposes. Following Berti (2013) and as originally stated in Beynet and Paviot (2012), we restrict the stochastic projections to less than 5 years, after which the uncertainty associated with the simulations is too high.

Figure 19: Fan chart for Spanish public debt to GDP ratio (2010-2017)

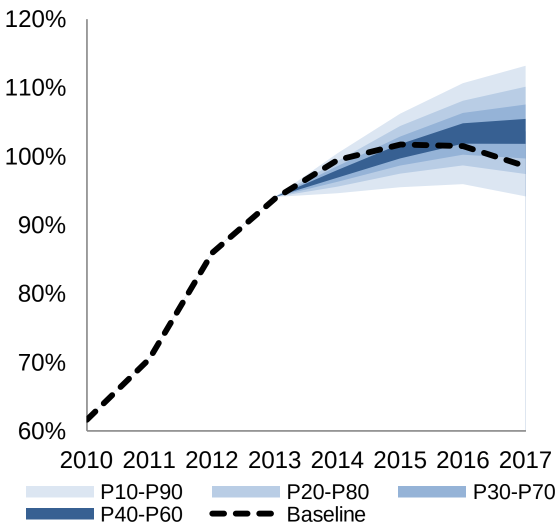
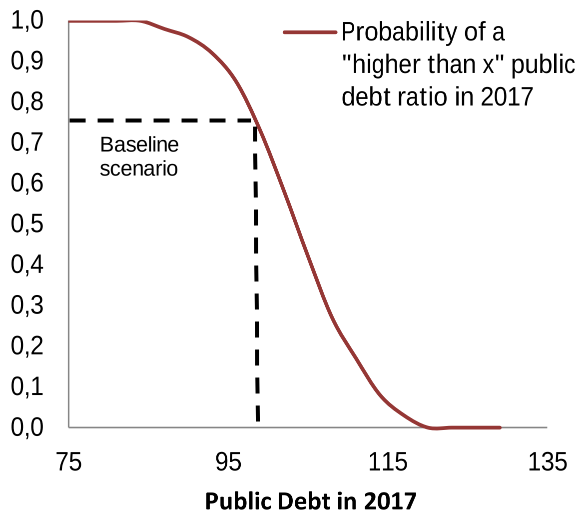


Figure 20. Probable scenarios in 2017



Source: own calculations.

Note: Different color shades represent deciles in the distribution of debt ratios, with the darkest zone representing a 20 per cent interval around the median projection, i.e. between percentiles 40 and 60, and the lighter ones a 40, 60 and 80 per cent confidence interval, respectively.

According to the simulated scenarios, the baseline lies around the 27th percentile. In other words, the VAR estimates a 73 per cent probability for the debt ratio being higher than the baseline scenario in 2017. These results are consistent with a potential optimistic bias in the projection of the baseline determinants from 2016 onwards, which would imply an overshooting of the public debt-to-GDP ratio. [31]

4 Conclusions

Safeguarding fiscal sustainability remains one of the key challenges for the Spanish economy in the decade to come. The Spanish General Government debt has soared since the outburst of the crisis, rising more than 60 pp. of GDP. Its level is set to reach 100 per cent of GDP by early 2015 according to official projections, a threshold that was last surpassed in the early 20th century.

How sustainable are Spanish public finances? A quick glance at recent developments yields a somewhat positive view, although with some shadows. Recent consolidation efforts, together with institutional improvements (both on the EU and the domestic fronts) and growing expectations of further monetary easing in the Eurozone have relieved the financial markets' pressure on the Spanish public debt instruments. However, this environment should not be taken for granted. Net exports positive contribution to growth is fading (partially because growth in the euro area has not lifted off yet) and inflation remains subdued, leaving an overleveraged private sector as the main potential growth engine in the short-term.

In order to reach a deeper understanding of the risks to public finance sustainability, an encompassing debt sustainability (DSA) approach is followed in this paper. First, a debt baseline path for the 2014-2024 period is constructed, consistent with the 2014-2017 official projections (i.e. projections from the Updated Stability Programme) and standard economic assumptions thereafter. Second, the robustness of the baseline is tested by challenging the realism of the underlying assumptions and formulating an alternative scenario. Third, uncertainty is introduced and the likelihood of the baseline path is assessed in a stochastic context. The main messages from this analysis are:

[31] Extreme or tail events are generally not covered by these stochastic techniques, which do not provide a realistic representation of Knightian uncertainty.

i. **The constructed baseline appears sustainable** as debt dynamics stabilize already in 2015 and starts on a declining path from then on, ultimately reaching a cumulated correction of 25 pp. of GDP by 2024.

ii. The realization of the baseline assumes strict compliance with EU and national fiscal rules, which given the current high level of public debt is necessary to compensate for the snowballing effect of interest rates. However, **there are risks associated with uncertain future economic conditions, which might compromise public finances sustainability in Spain, in case of weak commitment to a strict implementation of the fiscal rules**.

iii. **The assumptions behind the baseline scenario are shown to be on the optimistic side.** First, medium-term nominal growth forecast has been biased upwards since the outburst of the crisis. Second, the projected correction of the primary balance is unprecedented historically (and thus raises concerns about fiscal fatigue reactions) and based on a large cyclical improvement, which might not materialize.

iv. The consequences for sustainability of public finances from lifting these two assumptions are dissimilar:

- **Eliminating the bias in medium-term growth figures** and assuming lower inflation rates has a small impact on the debt path and **does not modify the sustainability assessment**.
- On the other hand, **relaxing the response of the primary balance to changes in the debt ratio** (i.e. the conduct of fiscal policy following a reaction function in line with historical experience, instead of a strict implementation of EU and national fiscal rules) triggers a qualitative change in the debt dynamics and **raises concerns about debt sustainability**.

v. **The likelihood of the baseline scenario is assessed to be low if fiscal policy follows the historical reaction function.** In a stochastic multivariate framework, taking into account a constellation of shocks to GDP, interest rates and the primary balance, the probability that the debt-to-GDP debt surpasses the baseline level in 2017 is 68 per cent.

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