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Report on the impact of low inflation on the Kingdom of Spain's public finances

Executive summary

- The euro area is experiencing a period of persistently low inflation. HICP inflation has averaged 0.6% for the last three years, the lowest level since the introduction of the euro. Inflation has systematically and substantially undershoot the *"below, but close to, 2%"* level, which is used by the European Central Bank as a benchmark to define price stability. Latest indicators and forecasts suggest this situation will continue in the medium term.

- The risks associated with persistently low inflation have been fully acknowledged by the European Central Bank. Accordingly, the Governing Council of the ECB has adapted the tools of monetary policy, introducing a variety of non-standard measures specifically designed to be effective in an environment of very low inflation. While the effect of these non-standard measures has been positive, the Governing Council has recently stated that risks to the inflation outlook remain tilted to the downside and a further reconsideration of ECB non-standard measures may occur in coming months. The ECB has clearly warned that risks of low inflation or deflation are just as damaging to the prosperity and stability of European economies as high inflation.

- In view of the above, it is beyond doubt that euro area inflation dynamics have not been consistent with price stability for the last three years.

- The economic consequences of undershooting the objective of price stability are particularly acute in a monetary union like the euro area, where Member States can face asymmetric shocks and factor mobility is yet incomplete. Because currency devaluations cannot be used to absorb these shocks, realignments in real exchange rates to correct Member States' external imbalances require them to maintain lower inflation than the euro area average.

- During the last three years Spain has achieved remarkable progress in restoring its competitiveness and in correcting its external imbalances. Exports have reached record levels and the external position has been in surplus for the last four years and is expected to remain positive in 2016-2018. Economic growth has resumed strongly and is expected to remain buoyant in coming years, gradually correcting Spain's high unemployment rate.

- The European Commission has acknowledged in several instances that low inflation in the euro area is hindering Spain's real exchange realignment and its efforts to restore external sustainability.

- In fact, the restoration of external sustainability and improvement in competitiveness has required, on average, negative inflation rates in Spain. In effect, although for the last three years average HICP inflation in Spain has been 0.2%, when corrected for the effect of VAT hikes and other tax measures, the average HICP inflation at constant taxes has been negative (-0.2%).

- Cumulative negative surprises in the GDP deflator, the deflator of private consumption or HICP inflation have all amounted to approximately to a cumulative -3% in the three years from 2013 to2015. All in all, the negative surprises in price deflators have been larger than the positive deviations in real demand. Because of this, nominal GDP in 2015 will still be 1% lower than the level initially forecasted in 2013.

- Negative inflation rates have also had a detrimental impact on Spain's public finances:

    - First, negative inflation has diluted a significant fraction of the positive effects on tax revenues that would have usually been associated with the recovery in economic activity. This has been particularly clearly shown in the case of nominal wage growth that has remained subdued as a consequence of very low inflation. In the past wages in Spain tended to experience quick turnarounds in the early stages of economic recoveries, which in turn impacted positively on social security contributions and income tax revenues. Standard estimates of the elasticity of tax revenues to real demand do not account for this, which may introduce a bias in the evaluation of Spain's fiscal effort.

    - Second, the consolidation measures approved by the Spanish government have been very effective in containing expenditure pressures in nominal terms. In fact, total expenditure, excluding interest payments and the costs of banking sector restructuring operations, will be approximately 3% lower in nominal terms in 2015 than in 2011. The fact that this restraint in nominal fiscal expenditure has not resulted in sharper falls in the expenditure to GDP ratio, is a consequence of the persistent downward pressures on Spain's inflation, which in turn have been caused by low average inflation in the euro area.

- It is worth highlighting that some reforms have had very profound implications for expenditure trends over the longer term, even if their initial short term impact may have been detrimental for the achievement of additional savings that might have accrued in a context of zero or negative inflation. A particularly relevant example is the reform of pension revaluation rules, which has eliminated automatic indexation to CPI and substituted it with a richer formula that takes into account

the overall situation of Social Security revenues and expenditures. In the same vein, diverse deindexation measures were introduced starting in 2013 and later reinforced with the deindexation law approved in 2015. As a consequence of these measures, for example, public procurement contracts can no longer use CPI indexation clauses which were pervasive in the past. These reforms may have resulted in moderate short-term increases in expenditure above the levels that would have otherwise occurred given negative HICP inflation in Spain. However,their long term impact is clearly positive for medium and long term fiscal sustainability.

- Based on a detailed analysis of revenue and expenditure items and their elasticity to inflation developments, it is estimated that Spain's General Government net borrowing as a percentage of GDP would have been approximately 0.7 percentage points (pp). lower in 2015 if inflation developments had been aligned with the European Commissions' economic forecasts of 2013. As an additional reference, it is estimated that, had price developments at the euro area resulted in 2% average inflation, the fiscal deficit would have been approximately 1 pp lower. The underlying elasticities supporting these results are broadly in line with the conclusions expressed by the European Commission in its latest Report on Public Finances in EMU. This estimate confirms that inflation dynamics almost fully explain the deviation from Spain's agreed headline deficit target which the European Commission currently forecasts for 2015.

- Despite the detrimental impact of exceptionally low inflation for Spain's fiscal consolidation strategy, the European Commission still expects the headline budget deficit to get below the 3% threshold of the EDP procedure in 2017. Moreover, the European Commission latest forecasts confirm that Spain has achieved the largest improvement in its structural balance between 2011 and 2015 of all euro area Member States not under a macroeconomic adjustment programme.

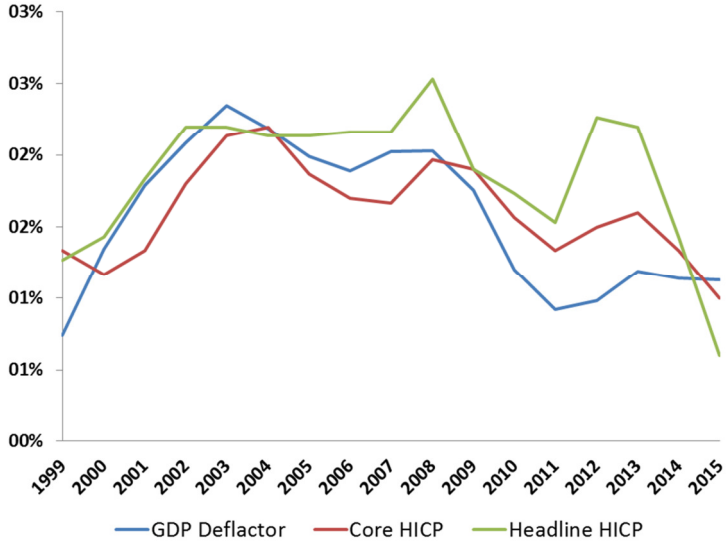
- Overall, the exceptional circumstances created by price developments in the euro area have hampered Spain's fiscal and external adjustments. According to article 119(3) of the Treaty on the Functioning of the European Union, stable prices, sound public finances and monetary conditions and a sustainable balance of payments must all simultaneously be the guiding principles of Member States activities. However, as inflation dynamics at the euro level have deviated clearly from a situation of price stability, Spain has experienced negative inflation, which in turn has been detrimental for the consolidation of public finances. On the other hand, a strategy of allowing higher domestic inflation to facilitate the achievement of fiscal targets, if pursued in the context of low inflation at the euro area level, would have delayed the required adjustment in its real exchange rate, thereby jeopardizing the sustainability of its balance of payments.

Report on the impact of low inflation on the Kingdom of Spain's public finances.

1. Introduction

The euro area is experiencing a long period of persistently low inflation. The average annual growth rate in the harmonized index of consumer prices of the Euro area for the last three years has been only 0.6%. This marks the minimum rate of inflation experienced by the euro area on a three year period since the introduction of the Euro and is substantially below the stated objective of the European Central Bank ("inflation rates below, but close to, 2% over the medium term") (see graph 1.1[1]). Underlying inflation shows a similar trend. The HICP index excluding food and energy has grown by an annual average of only 1% in the last three years, the lowest level on record. Given their persistence and their generalization across different categories of goods and services, these price developments cannot be attributed to temporary shocks stemming from external factors such as commodity prices.

Graph 1.1: EMU: deflactor and HICP (3-year moving average).



Latest data and forecasts suggest these difficulties are highly likely to persist in the short and medium term. Euro area HICP inflation was 0.2% in December 2015. In his prepared remarks delivered after the Governing Council meeting of 21st January 2016, ECB President Mr. Draghi acknowledged recent inflation was lower than expected and confirmed than, on the basis of available information at the time of the meeting, the ECB expects inflation rates "*to remain at very low or negative levels in the coming months and to pick up only later in 2016."* Moreover, members of the Governing Council of the ECB consider that the balance of risks to the inflation outlook is "*tilted to the downside, as the prolonged period of low headline inflation*

[1] In the following graphs, results for 2015 are either estimates or provisional data.

could affect underlying inflation and trigger second-round effects, which had to be monitored closely."

In view of the above, there is ample evidence that inflation rates for the euro area have been below the levels consistent with price stability for the last three years.

The ECB has always defended that the definition of price stability is not and should not be 0% growth in aggregate prices. There are three arguments to justify why inflation close to 2% is the appropriate reference in the Eurozone. First, inflation at 0% would not allow a margin to avoid risks of deflation, which is considered necessary as some of the tools of monetary policy may be less effective when inflation rates are negative. Second, available evidence suggests that HICP inflation may overstate true inflation as a consequence of some well-known biases (substitution and quality effects being two prominent examples). Third, average inflation at 0% would force countries requiring negative inflation differentials to have inflation below 0% for protracted periods, therefore creating risks of deflation in those countries.

Moreover, the ECB has defended that its stated goal of inflation "below but close to 2%" is symmetric; that is, inflation should be neither too high nor too low. Indeed, according to Mr. Draghi: "*history shows that deflation can be just as damaging to the prosperity and stability of our economies as high inflation*".

Persistently low inflation has already forced the ECB to adapt its toolset of monetary policy instruments, in full recognition that the current situation is exceptional and warrants changes in the way economic policy is performed in the euro area. As Mr. Draghi has stated: "*From the start of 2014, it became increasingly clear that without our comprehensive response, medium-term price stability was at risk*." The list of non-standard measures adopted by the ECB includes, among others, setting negative interest rates on the deposit facility, adoption of long-term liquidity auctions linked to the evolution of private credit, implementation of several asset purchase programs of public and private assets and the provision of forward-guidance as regards the future path of monetary policy.

All these measures have had a positive impact in containing the risks of persistently low inflation in the euro area, but based on current evidence there is still a high likelihood that additional steps will be needed, probably as soon as the next Governing Council meeting of March 2016.

To summarize, the euro area is experiencing a long period of too low inflation, dating back to, at least, 2013. Average HICP inflation has been persistently and substantially below the levels required to achieve the target of price stability and the latest data confirm this situation is likely to continue at least into 2017. The ECB has acknowledged the risks stemming from this situation and has adapted the instruments of monetary policy accordingly.

2. The effect of euro area's low inflation on Spain's external rebalancing

The risks associated with persistently low inflation rates are particularly acute in the context of monetary unions, such as the European Monetary Union, because they can suffer asymmetric shocks. As the members of a monetary union cannot make use of currency devaluations to absorb economic shocks, the burden of the adjustment falls on internal flexibility and on factor mobility. However, as shown by the difficulties experienced in the last years, the level of economic integration of EMU Member States is still far from a situation where asymmetric shocks could be corrected exclusively or mostly through factor mobility across Member States.

In these conditions, real exchange rates adjustments are needed to restore the competitive position of Member States' suffering shocks affecting their balance of payments. In particular, for countries that need to correct large negative external positions, real exchange rate depreciations are imperative and they can only be achieved through a negative inflation differential vis-à-vis the euro area average.

In normal times, achieving these lower rates of inflation in countries would be costly but generally feasible. However, when average inflation rates in the Eurozone are as low as is currently the case, countries undergoing internal adjustments will actually need to maintain their inflation very close to 0% or negative. However, the existence of nominal rigidities in the economy exacerbates the adjustment costs associated with negative inflation. In fact, this was one of the reasons for adopting the "below, but close to, 2% inflation" definition of price stability[2]. The non-linearity of adjustment costs when inflation rates are negative arise from a number of well-established economic and institutional constraints, of which two prominent cases are nominal wage rigidities and the 0% floor on nominal interest rates.

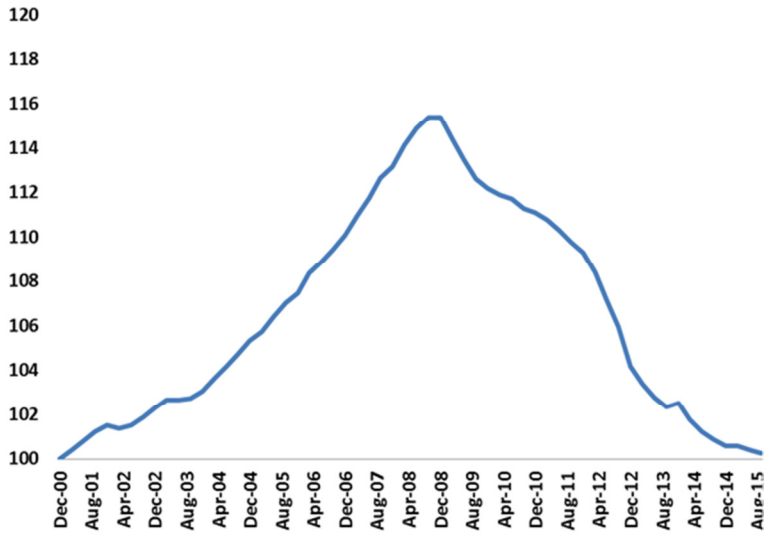
Spain's trajectory in the euro area is a clear example of the risks of real exchange misalignment. It is also an example of the difficulties associated with its correction in a context of low average inflation. In the first years after the introduction of the euro, excessively loose financial conditions distorted rational behavior of economic agents and promoted excessive indebtedness and the accumulation of imbalances. In particular, these developments also fostered significant competitiveness losses driven by persistent positive inflation and wage growth differentials. As a consequence, an unprecedented external imbalance developed, with the current account reaching a deficit of almost 10% of GDP in 2007 (more than 100.000 euros, the World's second highest current account deficit in absolute terms after the US). Against this backdrop, a realignment of the real exchange rate was the only

[2] To cite just one relevant reference, as far back as 2003, Otmar Issing, then Chief Economist at the European Central Bank, acknowledged that: "*This clarification emphasizes the need for a sufficient safety margin against the risk of deflation and at the same time is also sufficient to cover the potential presence of a measurement bias in the HICP and the implications of inflation differentials of a structural nature within the euro area*."

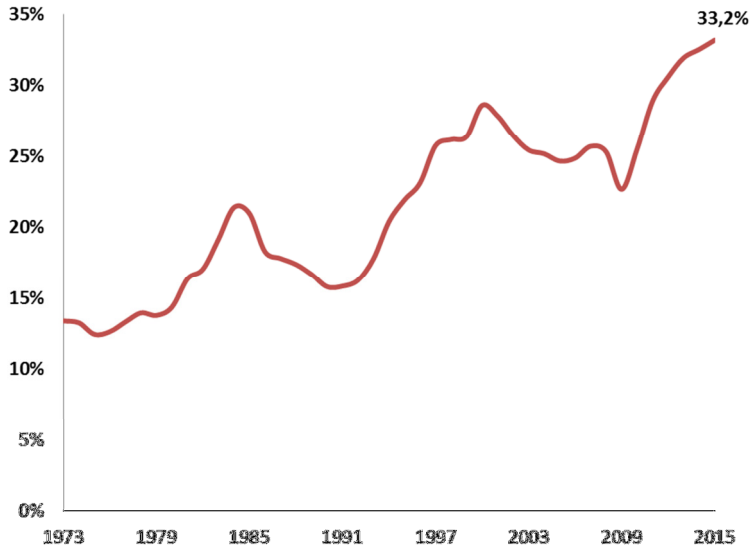
instrument to restore the competitive position of the Spanish economy and its long term growth potential.

Spain has in fact achieved remarkable advances in the process of recovering lost competitiveness in recent years. According to the latest data available, the effective real exchange rate using unit labor costs as the deflator is now back at the levels prevailing at the time of the introduction of the euro (see graph 2.1). The economic effects of this realignment are already clear. Spain's ratio of exports to GDP has experienced a dramatic improvement, reaching 33.2% of GDP in late 2015, an unprecedented level (see graph 2.2).

Graph 2.1: Unit Labor Costs relative to the euro are average. Source: Eurostat.



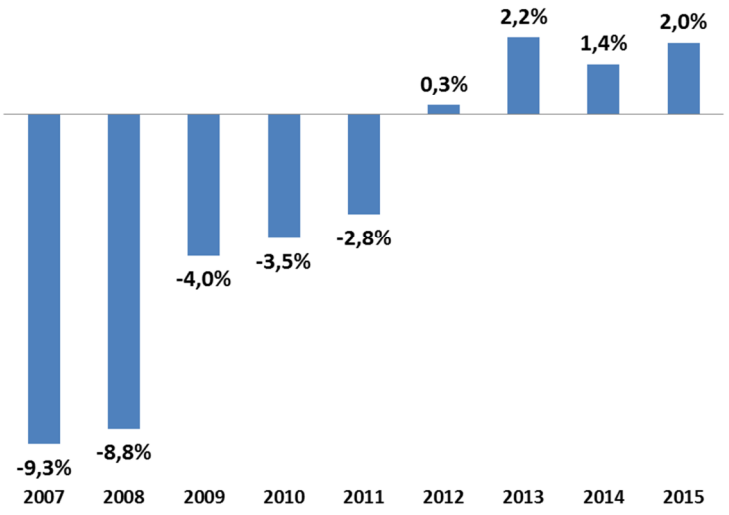
Graph 2.2: Exports of goods and services as a percentage of GDP. Source: INE.



At the same time, Spain's balance of payments has moved into a substantial surplus and is expected to remain on the positive in the next years, resulting in the longest

period of external surpluses on record for the Spanish economy (see graph 2.3). As a result, Spain is clearly correcting its historical tendency to depend on external financing, which has been the usual cause of boom-bust patterns in its growth.

Graph 2.3: Balance of Payments external position: current and capital accounts. Source: Banco de España.



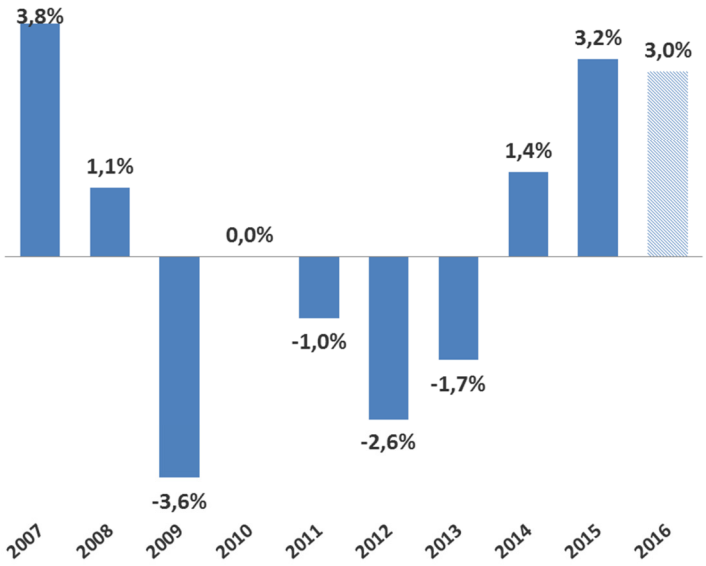
Finally, the improvement in competitiveness has allowed Spain to recover from the 2011-2013 recession with remarkable strength. Growth is expected to have reached 3,2% in 2015 and official forecasts expect this strong performance to continue in 2016-2018 (see graph 2.4). Despite the outperformance of the Spanish economy in recent times in comparison with the euro area average, there are no indications at this stage that the external position is worsening, clearly indicating that the structural component of the improvement in Spain's competitiveness is very significant.

However, as expected, the realignment of the real exchange rate has forced Spain to maintain exceptionally low or even negative inflation rates. Spain's HICP inflation has been lower than the euro area average for the last three years and, as each successive data release in the euro area has trended lower, Spain's inflation has gone closer to the 0% threshold. Spain's HICP inflation in 2015 has been -0.5% and, even discounting the effect of lower oil prices, underlying inflation has been only 0.4%. On a three year average basis, Spain's inflation performance is similar: HICP inflation has averaged 0.2% and underlying inflation has been 0.6%.

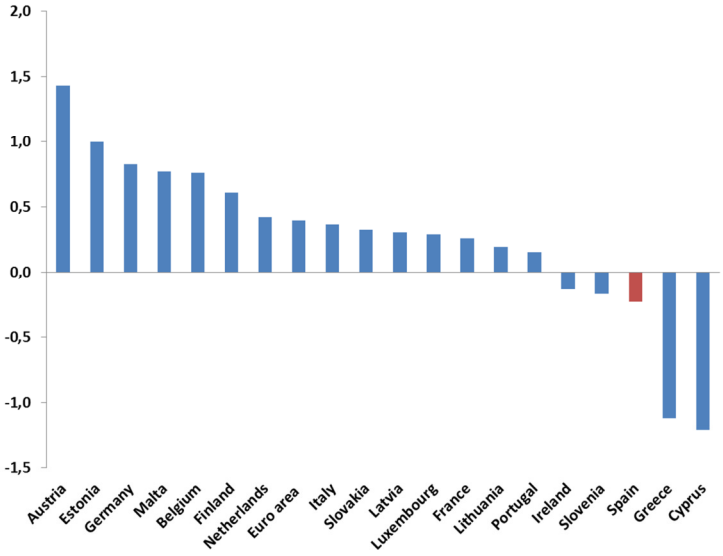
In fact, these figures overstate the relevant inflation dynamics, as they are heavily influenced by VAT hikes and other tax changes that took place mainly in 2012 and which had a very significant impact on 2013 headline inflation rates. Correcting for these tax changes, the 3-year average HICP inflation rate in Spain has been -0.2%. Therefore, it can be argued that Spain has in fact experienced negative inflation for the last three years. Only five countries in the euro area have experienced negative

HICP at constant taxes in this period (Spain, Ireland, Slovenia, Greece and Cyprus) (graph 2.5).

Graph 2.4: GDP growth (yoy growth rate). Source: INE.



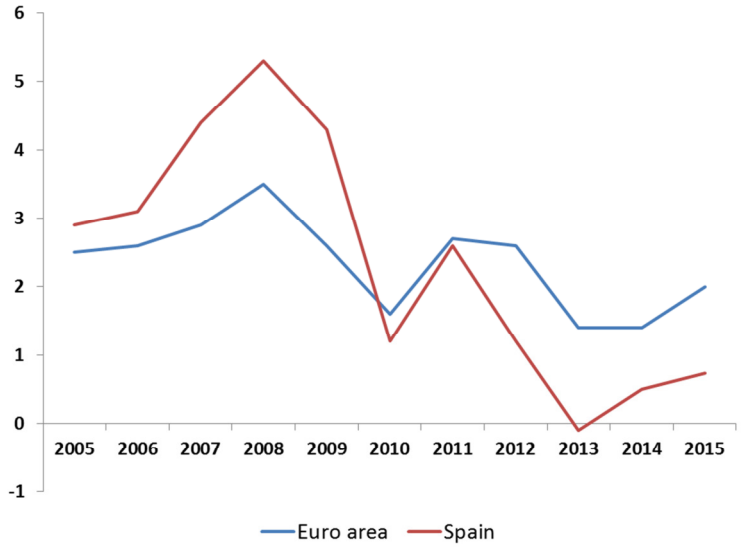
Graph 2.5: HICP at constant taxes (3-year average). Source: Eurostat.



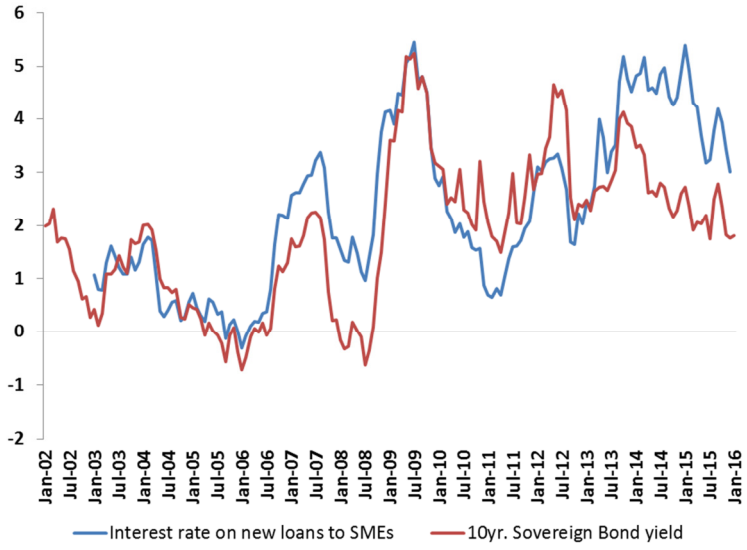
Negative inflation, as previously discussed, creates non-linear effects in other variables. In particular, nominal growth of wages in the Spanish economy has been also very low, in response to extremely low inflation (see graph 2.6). On the other hand, while nominal interest rates have improved for public and private borrowers, the beneficial effects of this trend have been partially neutralized by lower inflation.

Because of this, when measured in real terms[3], interest rates are not at historically low levels in Spain despite the fact that the ongoing recovery would clearly benefit from loose financial conditions (see graph 2.7).

Graph 2.6: Wages and salaries: Euro area and Spain. Yoy growth rate (%). Source: Eurostat.



Graph 2.7: Rates and yields minus HICP inflation. Source: Bloomberg, Banco de España and own calculations.



The European Commission has acknowledged in several instances that low inflation in the euro area is hindering Spain's real exchange realignment and its efforts to restore external sustainability. Spanish inflation has been systematically below European Commission forecasts and clearly below the levels that would have prevailed if price developments in the euro area had been consistent with price stability. More precisely:

[3] As a simple approximation, real rates have been estimated simply by subtracting current inflation to nominal interest rates.

1) Spain's cumulative inflation in the period 2013-2015 has been 2.9% lower than expected by the European Commission in 2013. A slightly higher deviation is observed using the GDP deflator instead, for which the cumulative difference is 3.1%. The cumulative difference in HICP inflation is -2,2%.

2) Spain's cumulative inflation as measured by the consumer price deflator has been 3.9% lower than expected in an scenario where EMU average inflation had averaged 2% and Spain had maintained a -0.5% negative differential per year. The result for the GDP deflator is a deviation of 3.7%. The cumulative difference in HICP inflation is -3,8%.

The magnitude of these deviations is very substantial and sufficiently large to completely cancel the positive impact of positive surprises in real activity indicators. Given the drag observed in the GDP deflator, nominal GDP in 2015 is expected to be 1% lower than forecasted in 2013, despite the fact that real GDP has grown by approximately 1.9% more than initially envisioned.

To summarize, very low inflation in the euro area has very significant consequences for the countries that are in the process of devaluating their real effective exchange rates as they must achieve that realignment through negative inflation. Nevertheless, Spain has made substantial progress in restoring the sustainability of its balance of payments, as demonstrated by the turnaround in indicators of competitiveness, by the surpluses observed in the current account and by the associated return to economic growth. However, this progress has come at the cost of maintaining extremely low or negative inflation rates. On a cumulative basis, in the period 2013-2015, HICP inflation in Spain has been -0.2% when corrected for tax effects. Overall, measures of inflation have undershot European Commission forecasts by approximately -3% and they turned out almost -4% below the levels that would have prevailed in a "normalized" scenario of 2% inflation for the euro area average. As a consequence of this, nominal GDP in 2015 is 1% lower than initially envisioned, despite the positive evolution of activity indicators in the Spanish economy.

3. The effect of negative inflation on Spain's public finances

The need to maintain negative inflation has had a detrimental impact on Spain's public finances. In this regard, it is well-known that inflation developments may affect fiscal outcomes through various channels. Lower growth of consumer or asset prices and/or of wages and corporate profits will result in lower tax revenues growth, potentially with some lag depending on the specific regulations of each tax figure. On the other hand, since most expenditure items are not indexed, lower inflation will not necessarily result in lower nominal expenditure automatically but, through its effects on the denominator, it will as a general rule increase the ratio of expenditure to GDP. As a consequence, the budget balance will worsen when inflation is lower, both in nominal terms and when expressed as a ratio to GDP. Moreover, this detrimental effect will be further exacerbated in negative inflation scenarios, as opposed to low but positive inflation scenarios.

The European Commission has confirmed the negative implications of negative inflation surprises for several European countries, most recently in its 2015 Report on Public Finances in EMU[4] (hereafter, EC (2015)). According to this work, the effect of a negative surprise in inflation of -1pp "*is comprised between -0.1% of GDP and -0.3% of GDP, implying it could have a material impact in terms of the annual change in the headline balance".* The European Commission's work evaluates the negative surprise in inflation of 2014 on the basis based on qualitative estimates of the elasticities of fiscal items to inflation.

The purpose of this section is to present quantitative estimates of the effects on fiscal policy of Spain's inflation developments in the period 2013-2015. Towards that end, the methodology employed by the European Commission is extended in several important dimensions:

- First, the time horizon is extended to include the negative inflation surprises experienced between 2013 and 2015. Instead of analysing the effect of a generic -1pp inflation shock, the exercise presented in this section uses a scenario approach: two alternative scenarios are constructed that simulate the higher inflation dynamics in Spain that would have occurred if euro area inflation had been consistent with price stability in 2013-2015, and the fiscal outcomes associated with these alternative scenarios are then calibrated.

- Second, a more nuanced estimation of elasticity parameters is performed, which accounts more precisely for the specific characteristics of Spain's tax system.

- Third, the definition of the shock is more detailed. The inflation shock is considered to affect wages and corporate profits. This allows using more precise elasticities for each fiscal item. For example, the shock applied to social contributions is not based on consumer prices but on the simulated evolution of wages, which are clearly more relevant for this particular tax.

- Fourth, several alternative approaches to the estimation of elasticities are presented. This allows gaining additional insight into the robustness of the results.

The main conclusion of the exercise is that the influence on the headline balance of the negative inflation shock experienced by the Spanish economy has been very significant. It is estimated that Spain's headline balance in 2015 would have been 0.7% of GDP higher if inflation in the euro area and Spain had evolved as expected in the Spring 2013 Economic Forecasts. In an alternative scenario with 2% inflation in the euro area and 1.5% inflation in Spain, the headline deficit in 2015 would have been 0.9% of GDP higher.

Overall, the results are broadly in line with those obtained by the European Commission but they tend to show a slightly larger impact of inflation, mainly as a consequence of the extension of the time horizon considered. As the full shock

[4] Report on EMU Public Finances 2015. Part III.

observed between 2013 and 2015 is larger, it is logical to find that the negative impact in the fiscal balance is more intense than in European Commission estimates.

An explanation of the estimation strategy followed in this exercise.

As discussed in sections 1 and 2, low inflation in the euro area has forced Spain to maintain negative inflation (after adjusting for tax changes) in 2013-2015. To calibrate the influence of Spain's negative inflation, this exercise estimates what fiscal outcomes in terms of revenues, expenditure and headline balance would have occurred if inflation had been higher. Two alternative higher-inflation scenarios are considered, based on the previously mentioned references: 1) the predictions for the GDP deflator and consumer prices in the 2013 Spring Economic Forecast; 2) a situation characterized by 2% inflation in the euro area and 1,5% inflation in Spain. The difference between the observed fiscal outcomes and the simulated results under each of these scenarios, gives an indication of the detrimental impact of Spain's inflation shock.

Taking as a starting point the inflation rates under these alternative scenarios, an extrapolation into wages and corporate profit developments is made. As regards wages, it is assumed that the differences in inflation between the simulated scenario and the observed data would be fully translated into wages per employee (on a full time equivalent basis, as is standard for Spanish data on employee remuneration in the national accounts). Because of this, real variables in the labor market are assumed to evolve exactly as in the observed data, whereas nominal wages adjust upwards by an amount equivalent to the inflation surprise. Alternative approaches could be considered but all of them would imply that the simulated scenarios and the observed data differ in the evolution of real variables, which would be contradictory with the objective of focusing exclusively on the impact of lower inflation. A more complete approximation would be to endogeneize the response of real variables and inflation in a joint model, but this approach is not without drawbacks[5] and has not been attempted in this exercise. As regards corporate profits, they have been extrapolated on the basis of the evolution of the GDP deflator and wages. Table 3.1 summarizes the simulated paths for the relevant price indexes in each of the scenarios considered.

[5] In particular, there is no widely accepted model in the literature and identification issues may be difficult to solve. Spain's Independent Authority for Fiscal Responsibility (AIREF) has informed that it is working in a model along these lines.

Table 3.1. Description of simulated scenarios.

Scenario 1: 2013 Spring Economic Forecast

	2013	2014	2015	Cumulative 2015-2013	Cumulative difference from observed
GDP Deflator	1,6	1,1	1,2	3,9	-3,1
Private Consumption Deflator	1,7	1,0	0,8	3,5	-2,9
HICP	1,5	0,8	0,6	2,9	-2,2
Compensation per employee	0,9	0,5	1,9	3,3	-2,9
Corporate profits	0,3	3,1	2,5	5,9	-4,2
Euro area HICP inflation	1,6	1,5	1,4	4,5	-2,8

Scenario 2: normative 2% inflation in euro area

	2013	2014	2015	Cumulative 2015-2013	Cumulative difference from observed
GDP Deflator	1,5	1,5	1,5	4,5	-3,7
Private Consumption Deflator	1,5	1,5	1,5	4,5	-3,9
HICP inflation	1,5	1,5	1,5	4,5	-3,8
Compensation per employee	0,7	1,0	2,6	4,3	-3,9
Corporate profits	0,3	3,4	2,2	5,9	-4,3
Euro area HICP inflation	2,0	2,0	2,0	6,0	-4,3

Observed data

	2013	2014	2015	Cumulative 2015-2013
GDP Deflator	0,6	-0,4	0,6	0,8
Private Consumption Deflator	1,0	0,2	-0,6	0,6
HICP inflation	1,5	-0,2	-0,6	0,7
Compensation per employee	0,2	-0,3	0,5	0,4
Corporate profits	-1,2	0,4	2,4	1,6
Euro area HICP inflation	1,3	0,4	0,0	1,7

<u>The quantitative approximation used to calibrate the effects of inflation on Spain's public finances: brief description.</u>

Using a standard approach to the decomposition of changes in the headline balance, the impact of a deviation of inflation from a base scenario can be calculated as:

$$db = \frac{\partial r}{\partial \ln P} d\ln P - \frac{\partial pe}{\partial \ln P} d\ln P - - \frac{\partial i}{\partial \ln P} d\ln P$$

The expected change in the headline budget balance expressed as a ratio to nominal GDP (b) in response to a deviation in a price or wage index (P) is the sum of the response of fiscal revenue items (r) minus the response of primary expenditure items (pe) and debt interest payments (i), all of them expressed also relative to GDP. In the above formula, $d\ln P$ represents the percent difference between the simulated scenario and the observed data.

For each fiscal item considered, the expected response is the product of three factors: 1) the item-specific elasticity to inflation (ε_i), adjusted to account for the increase in nominal GDP associated with the increase in the relevant price or wage variable (which is based on the assumption of unitary elasticities in this exercise); 2) the weight of each fiscal item over GDP (W_i); 3) the deviation in the relevant nominal index (consumer prices, wages or corporate profits, depending on the particular item being considered) versus the baseline scenario. This is shown in formula 2 for revenues, as an example:

$$\frac{\partial r}{\partial \ln P} = [(\varepsilon_r - 1)r]\, d \ln P$$

Revenue and expenditure can be further decomposed into their sub-components following an analogous procedure. For tax revenue items, it is usual practice to decompose the elasticity in two components: the elasticity to the tax base and the elasticity of the tax base to the relevant price or wage index. For primary expenditure items, the elasticity to price of wage indexes is usually estimated directly, either using econometric models based on aggregated figures or calibrating the impact of automatic indexation mechanisms.

In view of the above decomposition, the deterioration in the headline budget balance that would be associated with a negative inflation surprise is larger when:

1) the elasticity of tax revenues to price or wage indexes is higher.

2) the elasticity of primary expenditure to price or wage indexes is lower.

3) the pass-through of higher inflation to borrowing costs is lower.

Impact of inflation on tax revenues.

Very low or negative inflation observed in 2013-2015 have been a drag on the growth rates of tax revenues, particularly as they have diluted some of the expected benefits that would have been typically associated with the economic recovery in Spain.

Around 90% of all fiscal income in Spain comes from tax sources whose tax bases are linked to the evolution of consumer prices, asset prices, wages or corporate profits.

As previously discussed, it is generally accepted that tax revenues will decrease in response to lower inflation. In fact, depending on the specificities of each country's tax code, the elasticity may be higher than 1, so that tax revenues may decrease more than proportionally on the face of a negative inflation shock and, as a result, their ratio to GDP will decrease. A clear example of this situation is the income tax. Spain's main income tax (Impuesto sobre la Renta de las Personas Físicas, IRPF) has a progressive tax rate schedule for labor income, which in turn constitutes around 70% of total receipts accrued from the tax. Negative shocks to wages,

therefore, not only lower the total tax base but also have a negative impact on the average tax rate, due to bracket-creeping effects. In view of this, the reduction in revenue is expected to be proportionally larger than the initial fall in wages.

The specific estimates will depend on the particular tax being considered. Broadly speaking, it is expected that progressive taxes will have elasticities higher than 1, but other tax figures may also share this characteristic for diverse reasons. Table 3.2 presents alternative estimates for the main tax figures in the Spanish tax code and their weight over GDP[6].

Results are presented for three different estimation methodologies: 1) based on simple regression models[7]; 2) based on OECD estimates of tax to base elasticities and ad-hoc calibrations of base to inflation elasticities[8]; 3) based on the calibration employed by Spain's tax agency (Agencia Tributaria).

Table 3.2. Estimated elasticities for tax revenue items.

	Method 1. Regression.	Method 2. OECD elasticities.	Method 3. Tax parameters.		Average of alternative methods	Weight over GDP
Income tax	1,12	1,04	1,31		1,16	8,1
Corporate tax	1,16	1,32	1,00		1,16	2,1
Indirect taxes	1,17	1,00	0,97		1,05	8,8
Social Security Contributions	1,00	0,59	1,00		0,86	12,4
Non-tax revenue	0	0	0		0,00	6,8
Aggregate elasticity	0,90	0,71	0,88		0,83	
Total weight of revenue over GDP						38,2

These results are broadly in line with previous findings in the literature, though it has to be acknowledged that substantial variation is found on the existing papers. For example, the comparatively lower elasticity of social contributions contradicts the results obtained in Heinemann (2001)[9], but the Heinemann's methodology accounts for endogenous changes in tax rates, which is not the case in these estimates.
Overall, the aggregated elasticity of tax revenues (0.83) is higher than the estimation presented in EC (2015) for Spain, particularly for regression based estimates. The explanation for this probably lies in the differences in the definition of the relevant shock. As previously discussed, in EC (2015) the shock was defined in terms of the

[6] Weights are based on year 2013 figures.
[7] Additional data on the equations employed can be found in the technical appendix.
[8] The results are based on the OECD Economics Department Working Paper "New Tax and Expenditure Elasticity Estimates for EU Budget Surveillance" by Robert W.R. Price, Thai-Thanh Dang and Yvan Guillemette, December 2014. Estimates on the tax base to price or wage indexes are based on own calculations and models published by Spain's Independent Authority for Fiscal Responsibility on the following publications: "Report on the General Government draft budgets and main budgetary lines for 2016" (full text in Spanish only) and "Documento de Trabajo 2/2015 Modelización y proyección de ingresos por el Impuesto sobre la Renta de las Personas Físicas" (full text in Spanish only).
[9] Heinemann, F., 'After the Death of Inflation: Will Fiscal Drag Survive?' Fiscal Studies (2001) vol.22. no4.

inflation surprise in 2014 and the elasticities were calculated relative to consumer prices. The impact of wage developments was not explicitly quantified, although the questionnaire used does consider the possibility of inflation-wage pass-through as the reason for tax sensitivity to inflation. This being the case, some tax items that are not directly linked to inflation (such as income taxes) may have been found to have a lower elasticity to consumer inflation.

However, in the current exercise the scenarios have been constructed assuming full pass-through from inflation to wages and corporate profits, in order to maintain real variables constant. Given this assumption, the elasticities presented in the table are in relation to changes in the appropriate price or wage index for each tax: wages for income tax and social contributions, consumer prices for indirect taxes and profits for corporate tax. Logically, this yields higher estimates of the relevant elasticities.

The estimated aggregate elasticity is nevertheless in line with the results of EC (2015) for other European countries whose tax code shares several features with Spain's, such as France or Italy.

These elasticities allows calculating the hypothetical impact on the revenue to GDP ratio in 2015 of higher inflation scenarios in Spain. To do so, the two alternative scenarios previously discussed are used: one where prices and wages are based on the European Commission Spring Forecast 2013 and another where inflation is assumed at 2% for the euro area and 1.5% for Spain.

Because the aggregate elasticity of tax revenues is lower than unity (0.83), it is estimated that higher inflation would have resulted in a fall in the ratio of revenues to GDP of 0.2% in the scenario based on the 2013 Spring Forecasts and 0.3% in the normative scenario.

Impact of inflation on fiscal expenditure.

The effects of low or negative inflation on expenditure are more diverse and they depend on the particularities of each item. Generally speaking, it is expected that fiscal expenditures that involve direct purchase of goods and services will become cheaper when inflation is lower, so that holding their real value constant, nominal expenditure will also be lower. For other items, the main consideration is whether there are indexation rules in place that require expenditures to adjust automatically to inflation. Rules requiring that the real value of social transfers (pensions, minimum income rents, etc.) is held constant are a typical example in this regard. There may be some instances where the relevant indexation is not to consumer prices, but to wages. Unemployment benefits are a typical example, as they are usually partially linked to the recipient's latest wage. Pensions can also fall into this category, whether because revaluation rules are linked with wage developments or because the initial pension level is calculated on the basis of the wage earned before retirement. When indexation rules are in place, lower or negative inflation will result in lower nominal expenditure. Finally, for expenditure items that do not involve direct government purchases or that are not subject to indexation, nominal expenditure will not adjust downwards in response to negative inflation surprises. When this is the case, it is

expected that the ratio of expenditure to GDP will actually increase when inflation is negative, even if nominal expenditure is constant, as a consequence of the lower value of GDP in the denominator.

In the case of Spain, indexation mechanisms were frequent for several large expenditure items in the past, most notably pensions and public contracts. This was a consequence of the historical tendency of Spanish inflation to be high and volatile. Nominal indexation to consumer prices was introduced in public expenditure rules to protect the real value of Government payments, meaning that inflation risk was usually borne by the public sector. A perverse effect of this mechanism was that private sector agents did not fully internalize the aggregate costs of high inflation which in turn made persistent positive inflation differentials relative to its trade partners the norm in the Spanish economy. This led to recurrent episodes of real exchange rate appreciation that called for periodic devaluations of the peseta and forced Spain to pay significant risk premiums in its external borrowings. Membership of Spain in the euro area, which made devaluations impossible, should have been accompanied by structural reforms to correct this persistent inflationary bias in the Spanish economy, but unfortunately this was not the case. Spain did in fact maintain significant inflation differentials (as explained in section 2) in the initial years of the euro, leading to the need for internal adjustment observed in the last years.

However, as part of the structural reforms the Government has undertaken during the most recent period, very important changes in indexation rules of fiscal expenditure have been introduced. Two prominent examples are the reform of pension revaluation rules approved in 2013 and the deindexation law of 2015, which completed a series of deindexation measures taken since 2013 (see Box below).

Box: Deindexation of the Spanish Economy: Pensions and Deindexation Law

As regards pensions, prior rules in Spain established automatic and complete indexation of pension payments. The budget law for a given year established the revaluation of pensions based on official forecasts for inflation at the time. If inflation turned out higher than expected, which was usually the case, retired persons received a one-off payment at the end of the year to compensate for this deviation. However, Law 23/2013 established a different revaluation formula, designed to ensure a structural balance in the Social Security system. The new formula is based on two factors. First, when the Social Security accounts are balanced, pension revaluation each year will match the expected growth of Social Security revenues adjusted for the expected automatic growth of expenditure that results from the increase in the number of retired persons and the fact that newly retired persons enter the system with a higher pension. In other words, when the system is in balance, revaluation will be calculated exactly to maintain that situation. Second, an adjustment factor is added, so that when the Social Security accounts show a deficit, revaluation will be lower than implied by the previous rule, and viceversa. This second factor ensures that deficits or surpluses will be corrected over the medium term. To smooth the evolution of pensions, all variables in the formula are calculated 10 year averages. As a second smoothing mechanism, limits on the minimum and

maximum revaluation per year are established, set at 0.25% and CPI+0.5% respectively. Overall, the new mechanism sets a sound foundation for ensuring a sustainable trend in pension expenditures over the medium and long term.

Application of the formula since 2013 has resulted in a revaluation of 0.25%, as the lower limit has been binding in this period. Because of this, nominal growth of pension expenditure (other than driven by the increase in the number of retired persons) has not been influenced by consumer price developments. In fact, since CPI inflation was negative in 2014 and 2015, it could be argued that, had indexation remained in place, some scope for nominal savings would have existed. However, benefiting from these savings would have required postponing the application of Law 23/2013, jeopardizing a reform with very positive long-term effects.

As regard deindexation measures, the Government has pursued a systematic strategy to eliminate automatic indexation in regulated prices, public contracts, etc. Starting in 2014, the budget law forbid public contracts' indexation to aggregate price indexes, such as the CPI, industrial production prices, etc. In 2015, Law 2/2015 established a more general framework which covers all the instances where a monetary value is determined by the public sector. The definition of monetary value is very wide, and would encompass regulated prices, the amount of a subsidy or a levy, for example. The law applies to all levels of the Government. As a general rule, Law 2/2015 rules out automatic indexation clauses and requires revisions of monetary values to be justified in an ad-hoc report and be based on an analysis of the economic costs involved. Indexation formulas will only be valid in exceptional circumstances where the need to update the monetary value occurs very frequently. A typical example is the regulated components of energy prices, which usually require frequent updates to account for changes in the prices of oil or natural gas, for example. These exceptions must be explicitly allowed in a Royal Decree and the formulas will have to be based on specific prices that closely match the relevant costs in each case. As regards public contracts, automatic indexation to CPI –which was essentially enshrined in law until 2013– is no longer accepted and, moreover, there is a presumption that all public procurement contracts will be based on a fixed price. Automatic indexation formulas will only be valid for longer term contracts where the recovery period of the contractor's required investments is longer than five years. In this case, the formulas will have to be based on specific prices and they must be designed to reflect the underlying cost structure of the economic activity being performed. Overall, the deindexation law forces private operators to account for the risks of inflation when interacting with the public sector and fosters "inflation-discipline" in the behaviour of public authorities.

The application of indexation clauses might have resulted in some savings in public expenditure as a as a consequence of negative inflation rates in 2014 and 2015. In this regard, deindexation reforms may have impeded some savings in public expenditure that would have been possible. Nevertheless, benefitting from these savings would have meant forfeiting the opportunity to improve indexation mechanisms in Spain's public expenditure.

As consequence of the above reforms and the broader efforts aimed at rationalization of public expenditure, it is estimated that the inflation sensitivity of public expenditure in Spain has fallen substantially in the 2013-2015 period. This trend has been observed in other European countries, as documented in EC (2015). Because of this, negative inflation has not, in practice, facilitated savings in Government expenditure.

Despite this, in view of the aggregate evolution of nominal expenditure in recent years, consolidation measures adopted in this period have been very effective in containing nominal expenditure. Primary expenditure for the General Government is expected to be approximately 3% lower than in 2011. The ratio of expenditure to GDP has fallen substantially, by approximately 2 percentage points. However, a sharper fall would have occurred if price developments in the Spanish economy had not resulted in a negative inflation rate.

To estimate the impact of this higher inflation scenario, expenditure elasticities for different items in the budget have been calculated. The assumptions used in reaching at these elasticities are discussed below.

1) For budget items representing partially or mostly Government purchases of goods and services, an elasticity of 1 has been assumed. Included in this category are intermediate consumption, social transfers in kind, gross fixed capital formation and other capital expenditure.

The previous assumption is clearly conservative. For example, it is unlikely that the components in the “Other capital expenditure” category would adjust upwards in a higher inflation scenario, as most of them do not reflect direct purchases of goods and services nor are they linked to them. Also, in view of new rules for public procurement pricing introduced in Law 2/2015, the elasticity of expenditure in public contracts of a longer duration should be expected to be lower than 1.

2) For the component “Transfers to EU”, an elasticity of 1 has been assumed, as this payment is directly indexed to nominal GDP.

2) For the “Compensation of Employees” component, an elasticity of 0 has been assumed. Spanish laws do not contemplate automatic indexation of public sector wages to inflation and, in fact, nominal freezes have occurred in years of high inflation.

3) Regarding subsidies, an elasticity of 0 has been assumed. Many subsidies in Spain are linked to a “minimum income indicator” (IPREM, Indicador Público de Renta de Efectos Múltiples) which is not indexed to inflation. Moreover, after Law 2/2015, indexation of other subsidies is not allowed.

4) Regarding “Social transfers other than in kind”, an elasticity of 0.15 has been assumed, based on detailed estimates of this item’s components.

More specifically, the following parameters have been used to arrive at the elasticity of this item:

- Pension payments. As previously discussed, revaluation rules after Law 23/2013 mean that the stock of pensions is no longer indexed to inflation. However, the initial retirement pension is calculated on the basis of earnings in the previous 16 to 18 years[10]. Because of this, some elasticity to wages in total pension expenditure is expected. For a newly retired person, the impact of 1% additional growth in wages in the three years immediately before its retirement would be an increase of 0.2% in its initial pension, as those three years would only weight approximately 20% in the 17 years used in the determination of the initial pension (in fact, 3/17=0.18). Moreover, the number of newly retired persons has been slightly above 0.52 million per year, compared to a stock of pension receivers of approximately 9 million. Accordingly, the wage shock would only affect about 0,17% of beneficiaries (1.56 million new beneficiaries divided by 9 million existing beneficiaries). In aggregate, total pension expenditure would experience an additional increase of 0.03% as a consequence of additional growth of wages of 1% maintained for three years. Accordingly, the estimated elasticity to wages of pension expenditure is estimated at 0.03%. This figure is probably biased upwards, as several important features of Spain's pension system have not been considered. For example, for all persons whose initial pension is above the maximum regulatory monthly payment (2.567 euros per month as of 2015), higher wage growth would not result in additional expenditure. Also, the amount of minimum pensions is not indexed to inflation or wages in Spain, and for the group of pension beneficiaries earning the minimum higher wage growth would also not change their initial pensions. For aggregation purposes, the total weight of pension payments is estimated to be 71% of all social transfers not in kind.

- Unemployment benefits. The amount of the unemployment benefit in Spain depends on the recipients' latest wage. In view of this, a positive elasticity of unemployment benefits to wages must be expected. For contributory benefits, this elasticity is assumed to be 1. However, non-contributory subsidies are referenced to the IPREM, which is not linked to wages, and they amount to approximately 29% of total expenditure in this area. The estimated elasticity is then taken as 0.71. Again, this figure is probably biased upwards as it does not take into account that contributory benefits are subject to a ceiling (1087.20 euros per month for recipients who have no children). For aggregation purposes, the total weight of unemployment benefits is estimated to be 18% of all social transfers not in kind.

- The remaining components of social transfers not in kind are not indexed either to inflation or wages, and their elasticity is taken to be 0.5) For interest payments, an elasticity of 0.3 is used, based on the results of EC (2015).

[10] Starting in 2013, an additional year has been added to the computation on successive years. This means that the computation considered 16 years for a person retiring in 2013, 17 years for a person retiring in 2014 and 18 years for a person retiring in 2015.

There are potentially relevant arguments to consider that higher inflation in Spain would not have resulted in higher interest rates, given the situation observed in European sovereign markets in the period 2013-2015. On the one hand, ceteris paribus, market participants are likely to require higher nominal rates when their inflation expectations are higher (Fisher effect), but there is consensus in the literature that the adjustment will not be one-for-one. In fact, EC (2015) estimates explicitly account for this using a 0.5 pass-through parameter. However, even this estimate may be biased upwards for Spain and other European countries in the current situation. If markets recognize that negative inflation is detrimental for fiscal sustainability, which clearly seems to be the case, the risk premium observed in countries undergoing structural adjustments and experiencing negative inflation differentials will be higher. In this situation, a positive inflation shock may improve market participant's perception of sovereign risk and reduce the risk premium. The reduction in the risk premium would counterweight the Fisher effect, thereby resulting in a lower (or even negative) pass-through from inflation shocks to interest rates. This possibility has not been considered in the following analysis, but it suggests the 0.3 estimate used here may be biased upwards too.

The aggregate elasticity of fiscal expenditure to inflation is found to be 0.29. This result is higher than the estimation for Spain in EC (2015), which found an aggregate elasticity of 0.13 for primary expenditure and 0.3 for interest payments, but it is, nevertheless, broadly in line with the figures for other European economies, like France or Italy. The difference would seem to confirm that the calibrated parameters used in this exercise are generally biased upwards. However, since a higher elasticity of primary expenditure tends to mitigate the detrimental impact of low inflation on the headline balance, this bias would in any event work in the direction of understating the improvement in Spain's deficit that would have occurred in higher inflation settings. Table 3.3 summarizes the estimated elasticities and presents weight over GDP for each expenditure item.

On the basis of the above elasticities, it is estimated that the ratio of fiscal expenditures to GDP would have improved by 0.9% of GDP in the scenario based on the European Commission Spring 2013 Forecast. Under the "normative scenario" of 2% average inflation for the euro area, the improvement would have been larger, reaching -1.3% of GDP.

Table 3.3. Estimated elasticities for expenditure items.

	Calibrated elasticity		Weight over GDP
Compensation of employees	0,00		11,1
Intermediate consumption	1,00		5,3
Social transfers in kind	0,00		2,7
Social transfers other than in kind	0,15		16,5
Interest payments	0,30		3,3
Subsidies	0,00		1,1
Transfers to EU	1,00		1,0
Gross fixed capital formation	1,00		2,2
Other capital expenditure	1,00		1,0
Other expenditure	0,00		0,7
Aggregate elasticity	0,29		

Total weight of expenditure over GDP	45,1

Total impact of inflation on the headline balance.

When considered together, the estimated effect of the higher inflation scenarios is found to be very significant. Using the European Commission Spring 2013 forecast, it is estimated that Spain's headline balance would have experienced an improvement of 0.7% of GDP as a consequence of higher inflation, as fiscal revenue would have fallen by 0.2% of GDP but expenditure would have decreased by 0.9% of GDP. If the reference used is the normative scenario with 2% inflation in the euro area, the estimated improvement in the headline balance is estimated at 1% of GDP, due to a fall of 0.3% in the fiscal revenue ratio and of 1.3% in the expenditure ratio. Using a reverse argumentation, it can be argued that Spain's headline balance has been 0.7% lower (or 1% lower) because of the undershooting of inflation expectations relative to a situation or price stability in the period 2013-2015. This confirms that price developments have been clearly detrimental for Spain's fiscal outcomes in recent times.

A useful way of evaluating the quantitative importance of this detrimental effect is to consider its implications relative to current European Commission forecasts for Spain's headline deficit. In its 2016 Winter Economic Forecast, the European Commission predicts a headline deficit for 2015 of 4.8% of GDP. Assuming all other factors constant and adding the estimated impact of negative inflation dynamics previously described, the headline budget prediction would change to 4.1% of GDP if inflation had evolved as expected in 2013 and 3.8% of GDP under the normative inflation scenario. Based on these figures, then, it is reasonable to consider that Spain's deficit would have matched or improved on the agreed target for 2015 (4.2% of GDP) had it not been for the drag resulting from negative inflation.

4. Conclusions

The results in this report give evidence on the extent and channels through which exceptional circumstances created by price developments in the euro area have hampered Spain's fiscal and external adjustments.

Facing the need to adjust the substantial overvaluation of its real exchange rate in order to restore its external sustainability, Spain has maintained a persistently negative inflation differential relative to the euro area average. However, given the low level of euro area inflation, this has resulted in negative HICP inflation (at constant taxes) in 2013-2015, a situation that has only occurred in four other countries in EMU. In the presence of nominal rigidities, it is well-known that negative inflation has a non-linear effect on the real costs of economic adjustment. The European Commission has acknowledged in several instances that low inflation in the euro area is hindering Spain's real exchange realignment and its efforts to restore external sustainability.

Using a standard methodological approach, it is also found that negative inflation has had a particularly detrimental effect on Spain's headline deficit outcomes. In fact, it is estimated that, had it not been for the downward pressures exerted by low inflation at the euro level, Spain's headline deficit in 2015 would have been 0.7% or 1% of GDP lower, depending on the reference scenario considered.

Despite the detrimental impact of exceptionally low inflation for Spain's fiscal consolidation strategy, the European Commission still expects the headline budget deficit to get below the 3% threshold of the EDP procedure in 2017. Moreover, the European Commission latest forecasts confirm that Spain has achieved the largest improvement in its structural balance between 2011 and 2015 of all euro area Member States not under a macroeconomic adjustment programme.

This situation has created a difficult policy dilemma. According to article 119(3) of the Treaty on the Functioning of the European Union, stable prices, sound public finances and monetary conditions and a sustainable balance of payments must all simultaneously be the guiding principles of Member States activities. However, as inflation dynamics at the euro level have deviated clearly from a situation of price stability, Spain has experienced negative inflation, which in turn has been detrimental for the consolidation of public finances. However, pursuing domestic initiatives to allow higher inflation in order to facilitate the achievement of fiscal targets, in the context of extremely low inflation at the euro area level, would have delayed the required adjustment in its real exchange rate, thereby jeopardizing the sustainability of its balance of payments.

Technical annex. Regression equations for revenue elasticities.

This annex contains an explanation of the **budget sensitivity exercise equations** used to estimate General Government revenues and security social contributions.

The sample used covers the period from the first quarter of 1995 to the third of 2015. The sources of the data used are the Quarterly National Accounts (seasonally and calendar adjusted) for the explanatory variables, and the National Audit Office for all public administrations, seasonally adjusted, for estimates. For direct taxes, seasonally adjusted data from non-financial accounts of institutional sectors are used.

In the case of the VAT equation, the evolution of the natural logarithm of VAT revenue is estimated by:

$$Ln\ VAT_t = a+b * \ln(Cons_t) + c*OG_t + d*dummy_t + \varphi *(\ln IVA_{t-1}-(a+b * \ln(Cons_{t-1}) + c*OG_{t-1} + d*dummy_{t-1})) + \varepsilon_t$$

Where $\mathbf{VAT_t}$ is tax collection due to VAT; **Cons** is the nominal household consumption, net of imputed rents; **OG** is the output gap GDP ratio and **dummy** is a variable that equals 1 from the third quarter of 2013 and zero before.

The evolution of income from other indirect taxes on products is estimated by the equation:

$$Ln\ (IIEE_t) = a + b * \ln(Cons_t) + c*OG_t + \varphi *(\ln (IIEE_{t-1})-(a+b * \ln(Cons_{t-1}) + c*OG_{t-1})) + \varepsilon_t + \Theta*\varepsilon_{t-2}$$

IIEE are other taxes on products other than VAT which includes excises and also the transfer tax and stamp duty. As in the above equation **Cons** is the nominal household consumption, net of imputed rents; **OG** is the output gap GDP ratio.

The equation used for personal income tax is as follows:

$$Ln\ (IRPF_t)= a + b * \ln(Rem\_As_t)+c*OG_t + \varphi *(\ln (IRPF_{t-1})-(a + b * \ln(Rem\_As_{t-1})+c*OG_{t-1})) + \varepsilon_t + \Theta*\varepsilon_{t-2}$$

IRPF is the personal income tax revenue, seasonally adjusted; **Rem_As** is the compensation of employees, and **OG** the output gap ratio.

Revenues from social security contributions are estimated using the equation:

$$Ln\ (C\_SS_t) = a+b * \ln(Rem\_As_t) + \varphi_1 *(\ln (C\_SS_{t-1})-a-b * \ln(Rem\_As_{t-1})) + \varphi_2 *(\ln (C\_SS_{t-2})-a-b * \ln(Rem\_As_{t-2})) + \varepsilon_t$$

where **CSS** is income from contributions to Social Security seasonally adjusted and **Rem_As** is the compensation of employees.

Finally, the equation used to estimate the evolution of corporate tax is:

$$Ln\ (IS_t) = a + b * \ln(EBE_t) + c * OG_t + \varphi * (\ln\ (IS_{t-1}) - (a + b * \ln(EBE_{t-1}) + c * OG_{t-1})) + \varepsilon_t$$

Where **IS** are the revenues from corporate tax, **EBE** is the gross operating surplus and **OG** the output gap GDP ratio.