The impact of fiscal consolidation on debt to GDP ratios: Self-defeating austerity?

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ABSTRACT

Following the global financial crisis many countries introduced austerity policies aimed at reducing soaring government debts. The purpose was to increase taxes and decrease spending in order to accumulate primary surpluses and reduce debt to GDP ratios. This strategy can work if the value of fiscal multipliers is below one. On the contrary, when fiscal consolidation has strong contractionary effects on output due to high fiscal multipliers, debt to GDP ratios increase rather than decrease, resulting in self-defeating austerity. This paper investigates the impact of austerity episodes on debt ratios over a sample of 15 countries between 1978 and 2014 using both fixed effect and system GMM methods to estimate a dynamic panel regression equation. The main result shows a contemporaneous increase of GDP ratios following fiscal retrenchment, with the effect of spending consolidation being stronger than that of revenue consolidation. In addition, spending consolidation is found to increase contemporaneously the debt ratios more in countries that belong to the Euro Area, in countries of the periphery of the Euro Area and in times of crisis. Investigation of the effect of lags of austerity episodes on debt ratios show that the effect of revenue consolidation takes more time to peter out adverse effects on the debt ratio than spending consolidation does. Overall, fiscal retrenchment is always found to increase debt ratios. The results point out to self-defeating austerity policies and thus hint to values of fiscal multipliers that are greater than one.

Table of contents

List of Tables

Data Appendix

Results Appendix

List of Figures

Data Appendix

1. Introduction

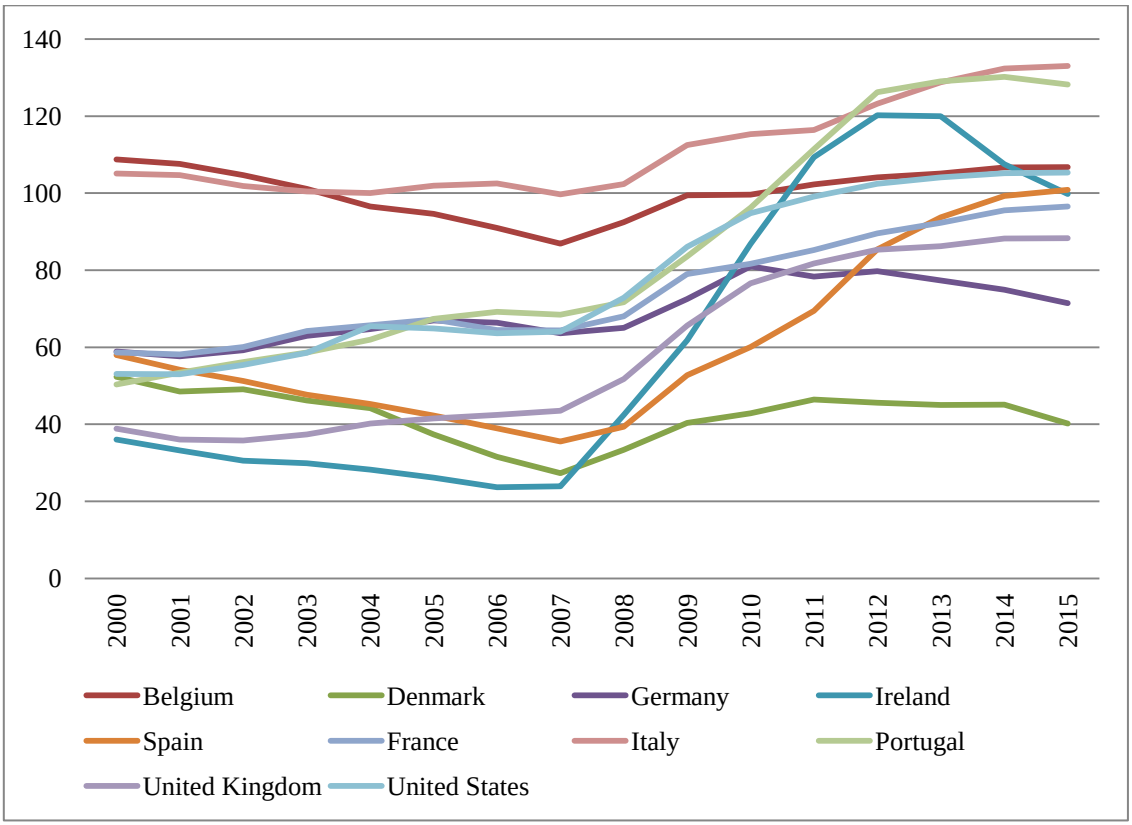
By 2010, the combined effect of the global financial crisis, fiscal stimulus programmes adopted to counter the Great Recession and banks bailouts caused unprecedented increases in public debt of many advanced economies (The Economist, 2013). A report of the IMF (2012) stressed that, while the level of debt was about 75 percent of GDP before 2008, after the crisis it peaked above 100 percent of GDP in many countries. This sparked a debate on the risks related to swallowing public debt and on the policy measures that had to be taken to tackle the potential problem.

On one hand, the publication of a highly debated paper by Reinhart and Rogoff (2010) alluded to a causal link between public debt overhang and slow growth. This supported the claims of those that wanted to return to "normal" fiscal policy and to a balanced budget, declaring that fiscal stimulus programmes had put debt on an unsustainable path. For instance, Jean Claude Trichet (2010), former president of the European Central Bank (ECB), declared: " [..] Now is the time to restore fiscal sustainability. The fiscal deterioration we are experiencing is unprecedented [..]". Concerns about sustainability of public finances, coupled with another paper by Alesina and Ardagna (2010) about the possible expansionary effects of fiscal consolidation, led many countries to implement austerity policies with the intention to reduce soaring government debts. Lower spending and higher taxes should have produced balanced budgets and reduce debt to GDP ratios (henceforth referred to as debt ratios), which are commonly used to measure debt sustainability.

On the other hand, many economists warned politicians and policymakers that the conditions in place at the time could have led to counterproductive results of fiscal consolidation. Among others, Nobel laureate Paul Krugman (2010) wrote on the expected effect of fiscal retrenchment: "There's a very good case to be made that austerity now isn't just a bad idea because of its impact on the economy and the unemployed; it may well fail even at the task of helping the budget balance". In fact, textbook Keynesian theories predict that slashing government spending while a recession is just on the way of recovery, would have negative effects on output, and therefore debt ratios, through denominator effects. In addition, the budget balance as well could have been negatively affected, due to falling government revenue.

Figure 1 shows the evolution of debt ratios in some advanced economies between 2000 and 2015. Severe rounds of fiscal consolidation were introduced in many countries between 2010 and 2013. However, the graph shows that, five years after the introduction of austerity policies, debt ratios do not seem to have been reduced. On the contrary, by 2015 public debt in percentage of GDP is quite high and on a raising path in many countries.

Figure 1 – Evolution of gross government debt as a percent of GDP



Source: European Commission, Ameco.

The obvious question that stems from this observation and that is the focus of this paper is:

Was austerity successful in reducing debt ratios?

In order to answer the question, this paper investigates the impact of austerity episodes on debt ratios over a sample that covers 15 countries between 1978 and 2014. To this purpose, both fixed effect and system GMM methods are used to estimate a dynamic annual panel regression equation. Debt ratios are regressed on a set of controls constituted by the main determinants of government debt, and on narrative measures of fiscal episodes. Narrative episodes refer to discretionary policy actions aimed at reducing the budget deficit. Following a review of the literature, the use of narrative austerity measures is believed to be a superior choice compared to other options. In fact, it seems that the narrative approach is able to better capture consolidation episodes exogenous to output, the denominator of the debt ratio, and therefore to better ensure the validity of the estimation.

The main result of the paper is that fiscal consolidation causes contemporaneous increases in the debt ratio, with the effect of spending consolidation being stronger than that of revenue consolidation. These results are robust to the use of alternative sources of the fiscal variables and to

an alternative estimation strategy. In particular, the use of the Blundell-Bond system GMM estimator, brings further strength to the results as it remedies for potential shortcomings of the fixed effect estimator i.e. the panel data bias and the endogeneity problem. Furthermore, estimates show that the contemporaneous impact of fiscal consolidation on debt ratios varies across different subsamples. In particular, spending consolidation is found to increase debt ratios more in countries that belong to the Euro Area (EA), in countries of the periphery and in times of crisis as opposed to other countries and normal times. Moreover, fiscal retrenchment is found to raise debt ratios not just contemporaneously, but also in the years following its implementation, meaning that austerity policies indeed take some time to peter out their effects. In particular, revenue consolidation raises more the debt ratio than spending consolidation does when lags are considered. Overall, neither contemporaneous consolidation nor its lags seem to be able to reduce debt ratios, but they rather increase them. These results point out to values of fiscal multipliers that lie above one and to self-defeating fiscal austerity.

The paper is structured as follows. Section 2 refers to the theoretical background and literature behind the research question. That is, it investigates why high public debt is dangerous, how debt is determined and what is the impact of fiscal consolidation measures on debt ratios according to the existing literature. Section 3 concerns the empirical methodology of the paper and describes how austerity episodes are identified, the baseline regression to be estimated, the data used, summary statistics and the econometric theory behind the estimation. Section 4 reports the results obtained using fixed effect estimator while section 5 investigates their robustness to different specification of fiscal consolidation episodes and to the use of system GMM as an alternative estimation method. Section 6 extends the analysis to different subsamples i.e. to Euro Area (EA) countries as opposed to non-EA countries, to economies of the EA periphery compared to the remaining countries and to crisis periods compared to normal times. It also investigates the impact of lags of fiscal consolidation episodes on debt ratios. Finally, section 7 concludes the paper and discusses the limitations of the analysis and the policy implications that can be drawn from the results presented.

2. Theoretical background and literature review

2.1. The dangers of high public debt

As mentioned before, the introduction of fiscal consolidation policies followed a debate that was centred on the dangers related to increasing debt ratios. With this respect, Pisani-Ferry (2013) notes that there has been a shift in focus regarding the discussion of negative effects related to high debt ratios. Before the global financial crisis, the debate was focused on debt sustainability and countries' willingness to pay – given financial and economic conditions and long term trends (e.g. population aging). After the crisis, however, debt started to be seen as evil due to the belief of a causal relationship between high public debt and slow growth.

The discussion regarding debt sustainability strictly relates to the fear of debt crises. Public debt is usually considered unsustainable when its level is rising relative to GDP, while it is deemed sustainable when it is maintained constant relative to GDP (Reinhart and Rogoff, 2012). The comparison of debt to GDP – i.e. the use of debt to GDP ratios to measure debt sustainability – reflects the fact that governments tax output to raise resources to pay off debt. Thus, sustainable debt means that the country can repay what it owes with the resources it owns.

When debt is unsustainable, creditors can perceive a country as unable or unwilling (e.g. because of politicians' cost and benefit analysis of default) to roll over its obligations, that is, insolvent. This in turn can trigger an external debt crisis, which is defined as an event in which a country defaults "on payment of debt obligations incurred under foreign legal jurisdiction" (Reinhart and Rogoff, 2011). Default can imply exclusion from future borrowing, cause important disruptions to trade, damage international relations and stop the flow of foreign direct investments to the country (Reinhart and Rogoff, 2012).

In addition, as explained by Romer (2011), there can be a self-fulfilling element to default and debt crises, in which expectations can play an important role. In fact, as the probability of default rises, the risk premium that the government has to offer to its creditors in order to incentivize them to hold its bonds increases. But raising interest rates add up to the debt burden and thus increase the probability of default. This can cause, for instance, a simple liquidity problem, i.e. a country's temporary inability to roll over its debt, to turn into a solvency problem. That is, liquidity problems can make the country to be perceived as riskier by creditors, which in turn would ask a higher risk premium in order to continue holding its debt. Soaring interest rates raise debt, thus increasing creditors worries about debt sustainability and further boosting interest rates. This process can lead to a vicious circle and raise interest rates to the point at which the government is no longer able to meet its obligations (Romer, 2011; De Grauwe and Yi, 2013). At that point default and money

finance are the only options left. As a result, it may be that a solvent country may decide or, even worse, be pushed into default on its debt due to these spiral mechanisms. De Grauwe and Yi (2013) stressed that this dynamic is extremely likely and dangerous for countries that do not have a central bank that acts as lender of last resort (LOLR) i.e. a central bank that can inject liquidity in the system during liquidity crises to avoid them to turn into debt crises.

A second reason for which growing public debt can be seen as dangerous is the belief that elevated debt levels would constitute a drag on economic growth. This was the main argument that policymakers put forward in 2010 in order to introduce austerity policies, and which corresponded to the conclusion of a disputed study written by Reinhart and Rogoff, "Growth in a time of debt". The paper presents empirically stylized facts about growth and claims that debt above 90 percent of GDP has negative effects on economic growth[1]. This would work via different channels, which imply lower investments and consumption and therefore lower growth (Reinhart and Rogoff, 2012). First, soaring debt ratios are likely to diminish the existing investment funds and thus crowd out private investments. Second, raising debt ratios increase solvency risk and therefore imply higher risk premium and interest rates, which in turn lower investments and consumption. Finally, elevated debt could imply higher future taxes – and thus a distortionary mechanism on labour supply – or lower future government spending, that in both cases cause lower output and economic growth (Reinhart and Rogoff, 2012).

Besides the mistakes that were found ex post in the dataset used by the authors, which undermined the value of the paper, many claimed that the causal link that runs from high debt to low growth was never proved. Indeed, the contrary can hold, i.e. that slow growth causes debt increases. That is, slow growth would be accompanied by raising unemployment and therefore a lower government revenue, which in turn would entail debt upsurges (Reinhart and Rogoff, 2012). The literature on this issue remains still far from providing a clear answer about the causal effect between debt and growth, such that the main and most valid concern regarding high level of public debt remains related to sustainability issues.

2.2. The determinants of government debt

In order to be able to understand the effect of fiscal consolidation or any other variable on debt, it is important to define it and understand its dynamics. Standard macroeconomics textbooks show that the government debt accumulation equation stemming from the government budget constraint can be written as:

[1] See also section 2.3 for more details on underlying economic mechanisms.

(1) $$D_t = PB_t + (1 + i_t) D_{t-1}$$

Where D_t stands for government debt in year *t*, which can be seen as the sum of the government primary balance PB_t, the deficits accumulated in precedent years D_{t-1}, i.e. the stock of debt, and interest payments on outstanding debt, represented by $i_t D_{t-1}$. The primary balance is determined by government expenditure net of interest payments minus revenues, which can translate into the government being a net lender (i.e. accumulating primary surpluses) or a net borrower (i.e. it builds ups primary deficits). Equation (1) indicates that government debt grows when the government accumulates primary deficits, i.e. it is a net borrower, and because of interest payments on outstanding debt.

However, as mentioned previously, when discussing sustainability of public finances the measure that is usually taken into account is the debt to GDP ratio. The latter better expresses the government ability to pay off its debt, as output is taxed for that purpose. Specifically, the debt to GDP ratio compares what a country owes to what it owns. Therefore, Equation (1) can be rewritten as a fraction of GDP:

(2) $$\frac{D_t}{Y_t} = \frac{PB_t}{Y_t} + (1 + i_t) \frac{D_{t-1}}{Y_t}$$

Given that $Y_t = (1 + n_t) Y_{t-1}$, where *n* is the growth rate of the economy, Equation (2) can be expressed as:

(3) $$\frac{D_t}{Y_t} = \frac{PB_t}{Y_t} + \frac{(1 + i_t)}{(1 + n_t)} \frac{D_{t-1}}{Y_{t-1}}$$

Setting $\frac{D_t}{Y_t} = d_t$ and $\frac{PB_t}{Y_t} = pb_t$, Equation (3) becomes:

(4) $$d_t = pb_t + \frac{(1 + i_t)}{(1 + n_t)} d_{t-1}$$

It is important to notice that the growth rate of the economy *n* refers to nominal GDP growth. In turn, nominal GDP increases either because of real GDP growth *g*, or due to inflation π, such that Equation (4) can be rewritten to show all the components of the debt ratio as:

(5)
$$d_t = pb_t + \frac{(1+i_t)}{(1+g_t)(1+\pi_t)} d_{t-1}$$

Which represent the standard formula for the debt dynamics equation.

2.3. The impact of fiscal consolidation on debt ratios

From the discussion above it follows that the effect of fiscal consolidation on the debt ratio – which is what this paper is ultimately interested in – depends on its impact on the various components of the debt dynamics equation. In principle, fiscal adjustments should allow the government to run primary surpluses and pay off its debt, thus reducing the debt ratio – even though the decrease may not be one to one (see below). However, debt ratios are influenced also by the denominator: if GDP grows then the debt ratio decreases, while it increases if GDP contracts. The effect of fiscal consolidation – and more generally fiscal policy – on output is debated among academics, with two main theories competing: the neoclassical and the Keynesian paradigm. The dispute on which of the two theories better reflects reality comes down to the size of fiscal multipliers, that is, the size of the change in output following a change in fiscal policy.

On one hand, neoclassical theories assume that prices and wages are perfectly flexible[2], consumers behave in a Ricardian[3] way and claim that demand, and therefore output, is determined by supply side factors. In this context, there is little or no room for fiscal policy, as government intervention would crowd out private spending and investments due to the presence of wealth effects, intertemporal substitution and tax distortions, with different outcomes depending on whether spending cuts or tax increases are implemented (Ramey, 2011; Baxter and King, 1993; Alesina et al., 2014).

Tax hikes are usually expected to have a contractionary impact on output, as they reduce households lifetime resources on the demand side and they introduce distortions on the supply side. The mechanisms behind changes in government spending are somehow more complex. First, higher government spending implies a negative wealth effect for households, as they would expect higher taxes in the future. This in turn causes a fall in consumption and an increase in labour supply[4]. As a consequence, hours worked increase and the real wage diminishes, resulting in an output contraction[5]. However, neoclassical theories claim that when taxes are distortionary and the

[2] Such that monetary policy cannot affect real activity.
[3] That is, consumers' decisions depend on their lifetime resources (permanent income).
[4] Under the neoclassical assumption that consumption and leisure are normal goods.
[5] Given that labor demand remains constant following a change in government spending.

intertemporal elasticity of substitution[6] is high, output decreases (Alesina et al., 2014). In fact, when these conditions hold, greater government spending implies higher distortionary taxes in the future, either on labour or on capital. This in turn lowers the opportunity cost of leisure and increases that of labour in the case of labour taxes, while it reduces incentives to invest in the case of taxes on capital (Baxter and King, 1993). When the intertemporal elasticity of substitution is high, consumers are more willing to postpone consumption to take advantage of good investment and/or job opportunities and vice versa (Fontana and Tabellini, 2015). Therefore, high intertemporal elasticity of substitution implies that the substitution effect dominates the wealth effect, such that labour supply and/or investments decrease and output falls. Therefore, spending multipliers in neoclassical theories are believed to be quite low and usually smaller than one – despite their value is dependent on the relative increase in labour supply compared to the drop in consumption – while tax multipliers are believed to be greater than spending multipliers (Woodford, 2010).

Given the neoclassical premises, Blanchard (1990) among others argues that fiscal retrenchment can even have beneficial effects on output. The introduction of expectations can imply that even austerity implemented through tax increases can exert a positive effect on output. In fact, the implementation of fiscal consolidation today can avoid larger and more painful future correction and can signal tax reductions in the future. This in turn would increase households' future disposable income and raise consumption and investments. The latter is the so called "expansionary fiscal contraction" which has been much cited and debated since the introduction of fiscal consolidation policies in 2010. Empirical literature supporting this hypothesis includes Giavazzi and Pagano (1996), Alesina and Perotti (1995) and Alesina and Ardagna (2010) among others.

On the other hand, Keynesian models see aggregate output as determined by demand side factors, in a context in which there are frictions in price and wage adjustments[7] and consumers behave in a non-Ricardian way[8]. When output is determined by demand side factors, an increase in public demand always results in a raise in output, all else equal. Higher output means greater income for households, and therefore raises consumption, which in turn can increase output even more. The size of multipliers is crucially dependent on the size of the increase in private consumption, which

[6] The intertemporal elasticity of substitution can be defined as the responsiveness of consumption growth to changes in the real interest rate (Hall, 1981). It represents households' willingness to postpone consumption to future periods if attractive investment opportunities arise in the current period, and vice versa. It also affects the infra-temporal consumption-leisure decision and inflences the marginal utility of consumption (Fontana and Tabellini, 2015).

[7] Such that monetary policy now is able to affect real activity, and the effectiveness of fiscal policy depends on the response of central banks.

[8] That is, they are more focused on their current income rather than on their lifetime resources.

in turn is determined by the marginal propensity to consume[9] (Ramey, 2011). In such context, fiscal consolidation can result in great output contractions.

The mechanism described above holds if interest rates and other factors are held constant. Allowing for interest rates to vary, increased government spending boosts aggregate demand and consumption. This in turn translates into a greater demand for money, which raises interest rates and reduces investments. Lower investments in turn mean reductions in consumption and therefore lower output, such that the increase in government spending is at least partially crowed out by the raise in the interest rate and multipliers are reduced in size. On the contrary, the presence of accelerator effects in investments, for instance, can increase multipliers (Ramey, 2011).

Supporters of Keynesian theories see room for fiscal policy and predict that spending cuts would have negative effects on output (e.g. De Long and Summers, 2012). The impact of multipliers on output would work through lower consumption and investments which in turn depress demand and diminish output. Thus, "Keynesian dynamics" refer to fiscal multipliers that are generally about one or greater than one and expenditure multipliers that are larger than tax multipliers, as the effect of spending measures on output is immediate (Woodford, 2010). New Keynesian models build upon neoclassical theories but allow for less than flexible prices. Overall, they hint at multipliers lower than Keynesians' but that can still be above one if consumers behave in non-Ricardian way and employment is demand-determined, or when interest rates are at the zero lower bound (see below; Ramey, 2011)

Recent literature has focused on the specific conditions under which the impact of fiscal policy on output may be enhanced. For instance, when the economy is in a recession, expansionary fiscal policy can have a greater role and counteract the fall in private consumption while stimulating aggregate demand and output. Overall, the monetary policy reaction function and how much the central bank "leans against the wind" is known to affect the size of fiscal multipliers. For instance, in situations in which monetary policy results constrained, e.g. when the central bank's policy rate is at the zero lower bound, the role for fiscal policy can result enhanced. That is, when such condition holds, the central bank cannot lower the interest further to stimulate the economy in response to an adverse shock[10]. Thus, if the monetary channel is impaired, increases in government spending are the only policy option available, while crowding out due to higher interest rate is less likely. The increase in government spending translates into higher expectations of inflation, which, when the nominal interest rate is constant, implies a lower real interest rate and boost the economy.

[9] That is, the change in consumption following a change in income i.e. the proportion which is consumed rather than saved following a raise in income.
[10] As otherwise money holding and bonds would become perfect substitutes for agents in the economy.

Under these conditions, multipliers are expected to be above one, as demonstrated theoretically for instance by Woodford (2010) and Eggerston and Krugman (2012), and empirically by Auerbach and Gorodnichenko (2012).

In addition, as shown by Denes et al. (2013), fiscal retrenchment can have undesirable effects on deficits as well when the economy is in a recession and monetary policy is constrained. This would again work through the contractionary effect of austerity policies on output, which in turn would reduce the tax base and therefore tax revenues and increase government spending via social security contributions. Lower taxes and higher spending would thus worsen the overall fiscal balance.

Moreover, Buiter and Rahbari (2012) stress that there is an additional risk when the financial sector is disrupted and the public sector decides to deleverage – which is a likely scenario in the aftermath of a financial crisis or during a recession. In fact, when governments consolidate when these conditions are in place and when monetary policy is constrained at the zero lower bound, a coordination problem called "paradox of thrift" arises. The latter refers to a situation in which a planned increase in saving weakens output and employment to the point that saving does not increase but might even fall (Buiter and Rahbari, 2012). In fact, higher saving means lower consumption demand, which reduces production and therefore households' disposable income. The paradox consists in the fact that when many agents in the economy want to save, they may end up with less saving due to the general fall in aggregate demand and output. This argument has been proved theoretically by Eggerston and Krugman (2012). Overall, financial frictions and disrupted banking system can cause multipliers to be higher as they do not allow consumption smoothing over time (Warmedinger et al., 2015).

Warmedinger et al. (2015), in a literature review of fiscal multipliers, summarize some additional conditions that can influence their size. Among these, the effect of fiscal policy on output can be dependent on the soundness of countries' public finances. In fact, fragile fiscal positions can imply a higher opportunity cost if compared to a scenario where no consolidation takes place, resulting in a smaller contractionary effect of austerity on output. Moreover, the impact of negative spillovers from one country to another can be exacerbated when economies have a great degree of openness and can thus translate into greater multiplier effects. In addition, the composition of fiscal consolidation can play an important role in the size of multipliers, as for instance the short run impact of some government consumption goods is greater than that of taxes. Finally, Warmedinger et al. (2015) and Boussard et al. (2013) note that throughout the literature, estimates of multipliers are also highly dependent on the methodology that is used to estimate them.

Besides output, the interest rate that governments pays on outstanding debt is another important component of the debt ratio that can be affected by the introduction of fiscal consolidation policies. The literature regarding determinants of interest rates stresses that in the long run what matters are economic fundamentals – i.e. potential output growth and government debt (Poghosyan, 2014). Therefore, if austerity is successful in reducing debt ratios and agents are rational, such that they would expect lower debt and taxes in the future, that would mean lower risk borne by investors holding government securities and a reduced risk premium on the yields. Lower interest rates would then translate into diminished cost of servicing debt and thus smaller debt ratios. On the contrary, if austerity entails lower output growth and therefore higher debt, long term interest rates would raise and the debt ratio would increase further.

Another branch of literature, however, claims that interest rates can also be driven by factors that are unrelated to economic fundamentals, at least in the short term (e.g. De Grauwe and Ji, 2013; Poghosyan, 2014). For instance, markets can misprice sovereign risk and there can be episodes of herding contagion[11] (Beirne and Fratzscher, 2013). Moreover, in times of crisis there can be "safe-heaven" capital flows towards countries that are considered more stable by investors (Hauner and Kumar, 2006). With this respect, Poghosyan (2014) finds that, after the financial crisis, bond yields of core EA countries have been lower than what should have been expected according to economic fundamentals. On the contrary, interest rates in some EA periphery countries were higher than what projected by the underlying fundamentals. In addition, De Grauwe and Ji (2013) stress that, in the absence of a lender of last resort, i.e. a central bank that can assure liquidity will be available at the time of interest payment, markets can ask increasingly high yields on government bonds, if they fear that a country will not be able to pay off its debt. Higher interest rates increase debt to GDP ratios. This in turn would push governments to introduce fiscal austerity to improve macroeconomic fundamentals, which can reduce growth and worsen further debt to GDP ratios. Increases in debt ratios would in turn call for higher risk premium on government bonds. As a result, countries may be pushed into a bad equilibrium and into self-fulfilling crisis (see also section 2.1; De Grauwe and Ji, 2013).

In order to finally understand what is the effect of fiscal consolidation on the main components of the debt ratio, this paper follows Attinasi and Metelli (2016), who show that is useful to rewrite equation (5) as:

[11] That is, episodes of steep and simultaneous upsurges in interest rates across countries (Beirne and Fratzscher, 2013)

(6)
$$d_t = \frac{(1+i_t)}{(1+g_t)(1+\pi_t)} d_{t-1} + \frac{G_t - T_t}{Y_t}$$

Where $(G_t - T_t)/Y_t$ stands for the primary balance as a percentage of GDP[12]. The interest lies in the response of the debt ratio to an increase in taxes or a decrease in expenditures by one percent of GDP. As discussed above, the ratio is not likely to decrease by the same amount due to two channels that can offset the effect of spending cuts and tax increases. The first channel is called "snowball effect" and is represented by the first part of the right-hand side of Equation (6). As discussed above, fiscal consolidation may cause a decrease in output and therefore in GDP growth, which, for a given interest rate and stock of debt, causes the first term of the right-hand side of Equation (6) to increase. This results in an increase of the debt ratio. The snowball effect is also influenced by the interest rate that a government pays on public debt. Fiscal consolidation policies may improve the fiscal position of the sovereign and therefore lower the interest rate and the debt ratio. However, it may as well be that, if austerity negatively affects growth, interest rates raise, causing debt ratios upsurges. Finally, it is important to notice that, for a given primary balance, debt ratios would be constant if the interest rate and economic growth would balance each other.

The second channel is represented by the second part of the right hand side of Equation (6) and is called "primary balance effect". The primary balance can be seen as the sum of the cyclically adjusted primary balance (CAPB) and a cyclical component i.e. a part that varies with the business cycle. A one percent tax increase or spending cut translates into an equal improvement in the CAPB i.e. a lower primary deficit. On the other hand, there can be negative effects on output caused by fiscal adjustment, as mentioned above. These could in turn affect the cyclical component of the primary balance via automatic stabilizers, i.e. the automatic response of fiscal policy to a lower GDP growth. For instance, lower output would translate in lower tax revenues for the government or in a higher unemployment rate, which in turn would increase government spending due to unemployment benefits. Lower tax revenues or higher spending would then offset the positive effect of the initial fiscal adjustment, which would thus not correspond to a full one percent increase in the primary surplus.

Concerning the literature on the impact of fiscal consolidation on debt ratios, so far the focus has been mostly on the effect of austerity policies on output and growth, and therefore on determining

[12] As mentioned above, the primary balance is determined by government expenditure net of interest payments G_t minus revenues T_t, which can translate into the government being a net lender (primary surplus) or a net borrower (primary deficit).

the size of fiscal multipliers. As a result, the impact of fiscal retrenchment on debt ratio has been studied just indirectly, with few studies investigating this matter explicitly.

Among these, Attinasi and Metelli (2016) examine the effect of fiscal retrenchment on debt ratios for 11 Euro Area countries using quarterly data from 2000 to 2012. Using a panel VAR, they trace out the dynamics of debt ratios following a fiscal shock and identify the main channels through which austerity policies affect debt. They find that fiscal consolidation is likely to increase the debt ratio in the short run, with a stronger raise when austerity is implemented via tax increases. In the long run, they show that fiscal consolidation is self-defeating, i.e. increases rather than decreases debt ratios, when it is implemented through tax hikes. On the contrary, austerity policies implemented via spending cuts eventually reduce the debt ratio.

Similarly, Castro et al. (2015) use DSGE models to explore whether and under which conditions fiscal consolidations increase debt ratios. They find that austerity policies can result in debt surges in the short term, even in normal times and when indebtedness levels are low. Also, they show that the negative short term effects of fiscal retrenchment on output and on the debt ratio are exacerbated during financial crises, when indebtedness levels are high and bond yields experience sharp increases. However, they also find that fiscal consolidations achieve debt ratios reduction in the medium term, even though output costs can be sizable if policies are implemented under unfavorable circumstances.

Fatàs and Summers (2015) analyze actual and potential GDP forecast and investigate how they changed following fiscal consolidation plans implemented in 2009-2010. Their horizon covers seven years after the beginning of the global financial crisis. They find that fiscal austerity shocks are able to explain current and potential GDP revisions and that the size of corrections hint to fiscal multipliers that lie well above one. Their results also suggest that attempts to reduce debt ratios are likely to self-defeating due to their persistent and permanent contractionary effect on output and to hysteresis effects.

Cherif and Hasanov (2012) focus on the US economy and estimate the effect of primary surplus shocks on public debt using a VAR framework that includes debt feedback effects. They find that fiscal consolidation reduces debt ratios in the short term. However, debt ratios seem to eventually revert to their pre-shock level after few years, although the effect is not statistically significant. Controlling for economic conditions, fiscal retrenchment is more likely to increase debt ratios, such that low growth increases the risk of self-defeating austerity.

Eyraud and Weber (2013) investigate the possibility that fiscal consolidation can lead to short run increases in the debt ratio via multiplier effects that would affect both output and the primary

balance. Their simulations predict short run increases in the debt ratios, followed by debt reductions. However, they note that short run upsurges may be an issue if governments engage in repeated rounds of austerity and if financial markets focus on the short term behavior of the debt ratio. Similarly, Boussard et al. (2013) simulate debt paths under different economic perspectives while taking into account the debt dynamics equation. They find that fiscal gains during times of crisis may be wiped out by adverse output effects, which can lead to increases in the debt ratios that can last several years.

Finally, Berti et al. (2013) analyze the effects of fiscal retrenchment policies contained in the Stability and Convergence Programmes presented by European Union countries in 2013, considering different assumptions on fiscal multipliers. The effects of fiscal consolidation are compared to a counterfactual scenario in which no consolidation takes place. The authors conclude that large fiscal multipliers entail temporary increases in the debt ratio following fiscal consolidation measures, which last long if financial markets behave myopically.

The present paper aims to enrich the existing literature on the effect of austerity policies on debt ratios, which is still limited especially on the empirical side. As this paper uses data until 2014, the analysis can be of additional relevance concerning policy implications for those countries that are still dealing with consolidation. In addition, the results presented can be used by those countries implementing austerity to calculate and evaluate potential short term losses that the latter entails. Furthermore, the aim is to investigate the effect of fiscal retrenchment on debt ratios over a long time span and including countries that do not belong to the Euro Area to the analysis, which, to my knowledge, has not been done yet.

3. Empirical methodology

3.1. The identification of fiscal consolidation episodes

In order to analyse the effect of austerity on debt ratios it is important to identify changes in taxes and spending that are due to exogenous policy decisions. In fact, a central assumption when making inference is that the independent variable – in this case, fiscal consolidation – is not correlated with the error term of the regression. That is, the decision of implementing austerity policies needs not to be correlated to other factors affecting the dependent variable, such as, for instance, economic conditions that affect output, the denominator of debt ratios. Endogeneity, i.e. correlation between fiscal episodes and the error term, would result in biased estimates of the effect of fiscal episodes on debt ratios. The literature on fiscal consolidation has used different methods to identify fiscal episodes and deal with the issue.

Early work on the effect of austerity on output identifies fiscal consolidation episodes from changes in the cyclically adjusted primary balance (CAPB), which accounts for the variation of tax and spending following business cycle fluctuations. The CAPB is calculated by subtracting from the actual primary balance (i.e. non-interest revenue net of non-interest spending) the estimated effect of business cycle variations on the fiscal account (Guajardo et al., 2014). This measure should reflect the fact that government revenues and spending vary with fluctuations of the business cycle i.e. the cyclical component of GDP.

The first problem of such a method lies in the difficulty of correctly estimating the cyclical component of GDP i.e. the output gap, which in turn is due to the problems in calculating the natural level of employment (Blanchard and Johnson, 2012). Moreover, Guajardo et al. (2014) stress two additional limitations related to the CAPB and to the estimation of the causal effect of austerity on economic activity, the denominator of the debt ratio. First, the CAPB can lead to measurement errors that can be correlated with economic developments. For instance, the CAPB includes revenue increases related to booms in asset prices, which in turn result in changes that are unconnected to policy decisions but correlated with economic activity. Second, the CAPB ignores the motivation behind fiscal actions. In fact, policymakers may decide to cut government expenditures to prevent the economy to overheat, which in turn would cause fiscal episodes identified through the CAPB method to be correlated with prospective economic conditions and result in reverse causality problems.

A second method uses structural vector autoregressive (SVAR) models to identify discretionary changes in fiscal policy (e.g. Blanchard and Perotti, 2002). Romer and Romer (2010), however, note that the identification of fiscal shocks through this methodology is likely to produce biased

estimates of the effect of austerity on output as well. In fact, the approach assumes that, controlling for lags of output growth, changes in government spending and/or taxes are uncorrelated with other developments affecting short term economic developments. This does not account for the chance of responses driven by forward-looking reasons and the measurement error of non-policy episodes in adjusted fiscal data (Guajardo et al., 2014).

In order to obviate to the problems mentioned above, the so called "historical approach" or "narrative method" pioneered by Romer and Romer (2010) has been used by Guajardo et al. (2011) and Devries et al. (2011) to identify exogenous fiscal consolidation episodes. That is, fiscal consolidation episodes that are not correlated with prospective economic conditions and that are defined as discrete policy changes induced by the wish for lower public deficits. This can be done by analyzing the motivation behind policy changes registered in the narrative records of historical documents. Reading through budget reports and official documents, the authors build a new dataset including only austerity episodes that are motivated by the desire of reducing public deficits. This criteria ensures that systematic correlation between austerity episodes and other developments affecting economic activity is unlikely i.e. it excludes endogeneity of fiscal consolidation episodes with respect to output.

For the purpose of this research however, the interest lies on the effect of fiscal consolidation on debt ratios. If exogeneity of fiscal consolidation with respect to output – the denominator of the ratio – is ensured, that may not hold fully for debt. In fact, fiscal consolidation is dictated by the desire to reduce deficits and therefore naturally correlated with the level of debt. If debt in a given year is correlated with fiscal consolidation implemented in the same year, estimates of the effect of fiscal consolidation on debt will be biased. However, it can be argued that debt ratios at time *t* do not influence austerity episodes at time *t*. This is due to the fact that usually there are implementation lags between the observation of unsustainable debt paths and the decision to introduce austerity policies to obviate to it. Therefore, it is likely that fiscal consolidation is usually introduced as a response to the observation of past values of the debt ratio rather than current values of it. Thus, if fiscal consolidation is not *fully* determined by lags of the debt ratios – as argued by Alesina et al. (2015), who claim that fiscal consolidation is weakly determined by past values of government debt – then the estimation should lead to unbiased estimates of the effect of austerity on debt ratios.

While the narrative approach remedies for some of the problems related to the CAPB method, some important limitations remain. Three shortcomings stressed by Guajardo et al. (2011) are common to both the narrative approach and the CAPB method. First, if austerity is postponed until the economy

recovers, fiscal retrenchment will be linked to positive economic conditions in both the CAPB and the narrative approach. Second, fiscal consolidation may cause the economy to fall into a recession, which in turn would lead to a stronger fiscal adjustment that would be associated to negative economic conditions in both methods. Third, both approaches do not take into account anticipation effects, as they record changes in fiscal policy when they are decided. Ramey (2011) claims that anticipation effects may play an important role. However, Beetsma et al. (2008) point out that it can become less relevant at the annual frequency, which corresponds to that used in this paper, and that therefore weakens this last concern.

Finally, there is an important critique that applies to the narrative approach only. The narrative record describes policy changes that are planned in a given year. However, many argue that the actual implementation of austerity measures may vary, due to changes in the subsequent years and/or to political pressures. Therefore, it may be that the narrative method suffers of an important measurement error. To remedy for this, while constructing narrative datasets, recorded fiscal episodes are subsequently checked over their actual implementation by investigating official documents for the following years. If a measure seems not to have been effectively implemented after its announcement, the latter is not recorded in the dataset (Devries et al., 2011). In addition, Guajardo et al. (2014) investigate the differences between the CAPB, which is based on actual changes of the fiscal balance, and of the narrative approach, based on planned changes. They find that while the two measures agree on the size fiscal consolidation episodes in many instances, the larger discrepancies between the two methods are related to inaccurate measurements in the CAPB. Thus, the problem related to the difference between ruled fiscal consolidation and actual implementation of the latter can be mitigated, as the authors find no cases in which the narrative approach is less precise than the CAPB.

Given the discussion above, in this paper narrative fiscal episodes are used as a measure of fiscal consolidation and preferred over the alternative of changes in the CAPB. While exogeneity of episodes with respect to the denominator of the debt ratio seems to be ensured, that with respect to debt can hold when implementation lags are considered, but it may sound less convincing from a theoretical point of view. With this respect, in the next sections, identification will be pursued through econometric techniques in order to try to remedy for potential theoretical shortcomings.

3.2. Baseline regression

In order to write down the regression equation, it is important to recall how debt is determined. To this purpose, the fraction in Equation (6) can be linearly approximated using log-linearization[13] as:

$$d_t = pb_t + d_{t-1}\left(i_t - \pi_t - g_t\right) \tag{7}$$

Which allows to simplify the equation by taking off non-linearities that would complicate the estimation.

Therefore, the baseline equation that will be estimated regresses fiscal consolidation episodes on the debt ratio, while taking into account its components and including time and country fixed effects. Thus, the baseline regression takes the following form:

$$d_{i,t} = \mu_i + \lambda_t + \beta_1 pb_{i,t} + \beta_2 d_{i,t-1} + \beta_3 fc_{i,t} + \beta_4 i_{i,t} + \beta_5 g_{i,t} + \beta_6 \pi_{i,t} + \varepsilon_{i,t} \tag{8}$$

Where $d_{i,t}$ is the debt ratio for country *i* in year *t*, with $i = 1,...,N$ and $t = 1,..,T$. μ_i and λ_t represent country and time fixed effects respectively, which allow to get rid of unobserved heterogeneity. Country fixed effect measure the idiosyncrasies of a country that affect debt ratios but are not time dependent i.e. unobserved time invariant heterogeneity among countries. λ_t measures time effects that are unrelated to other fundamental forces affecting the debt ratio. $\varepsilon_{i,t}$ is a mean zero error term. $d_{i,t-1}$ is the stock of debt observed the previous period, $\varepsilon_{i,t}$ stands for the primary balance, $g_{i,t}$ for output growth and $\pi_{i,t}$ for inflation. $i_{i,t}$ is the average interest rate, calculated as interest payments at time *t* over the total stock of debt at time *t* – 1. With this respect, this paper follows the literature, which indicates the average interest rate as a better option compared to the market interest rate, as the former can be seen as a moving average of the latter, whose length depends on the average duration of public debt (Attinasi and Metelli, 2016). $fc_{i,t}$ stands for fiscal consolidation as a percentage of GDP, which can either be constituted by consolidation measures taken on the revenue or on the expenditure side, or total consolidation i.e. the sum of tax and spending consolidation measures in a given year. The main parameter of interest is β_3, which represents the direct effect of fiscal consolidation on the debt ratio. The latter will be dependent on the size of fiscal multipliers. In fact, as discussed in section 2, if multipliers are below unity, then a one percent increase in fiscal consolidation effort should result in a decrease in the

[13] Note that the smaller the absolute value of the parameters in the log-linearized equation, the better the approximation would be.

debt ratio. On the contrary, when multipliers are above unity, the consolidation effort would be offset by the adverse impact of output, such that debt ratios can increase following the introduction of fiscal consolidation policies. In the latter case, austerity policies are defined as self-defeating.

3.3. Data

Data on fiscal consolidation episodes are derived by merging the dataset of Devries et al. (2011), which covers 17 countries over the period 1978-2009, and that of Kataryniuk and Vallés (2015), which includes 27 economies between 2009 and 2014. The merge of the datasets is possible as Kataryniuk and Vallés (2015) use the same methodology as Devries et al. (2011) and draw on the same sources (see below). This results in time series for fiscal consolidation episodes over the period 1978-2014 composed of 15 countries, namely: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, The Netherlands, Portugal, Spain, United Kingdom and United States. These define the time and country dimension of the entire dataset used throughout the paper.

Regarding the methodology used in collecting fiscal consolidation data, both Devries et al. (2011) and Kataryniuk and Vallés (2015) use the narrative approach. As discussed in section 3.1, this means looking at historical sources and records, which provide the estimated budgetary impact of the measures. The documents reviewed by both papers to collect their data include the Stability and Convergence Programmes presented annually to the European Commission, OECD Economic Surveys and IMF Staff Reports, as well as national sources such as the Congressional Budget Office and several Memorandums of Understanding, national budgets, budget speeches and reports of central banks (Devries et al., 2011; Kataryniuk and Vallés, 2015).

Kataryniuk and Vallés (2015) state that the methodology used to record fiscal consolidation episodes is the same as Devries et al. (2011). The budgetary effect of consolidation is recorded in the year in which it comes into effect, using contemporaneous estimates scaled to GDP. In order to reduce discrepancies among planned and effectively implemented austerity measures, when consolidation episodes are identified, successive editions of documents that report the implementation of the measures are examined. Episodes of fiscal consolidation that are not confirmed by successive historical record are not reported in the database. Austerity data describe the size of fiscal consolidation based on spending cuts and of that consisting of tax increases, together with the total size of austerity measures implemented in a given year.

In order to estimate Equation (8), data on gross government debt, the primary balance and its components, i.e. government revenue, expenditure and net interest payments, inflation and GDP

growth, are needed. As a unique source with complete time series for all the countries in the dataset is not available, data are gathered from different sources. The data collection prioritized the source for which the most complete series were available i.e. the OECD Economic Outlook n. 98 (November 2015). These series were in turn completed by using additional sources, namely: data collected by Mauro et al. (2013), the World Bank (WB) database, the International Monetary Fund (IMF) World Economic Outlook (WEO) of April 2015 and the Australian Treasury. The Data Appendix provides a detailed description of the variables, their sources and collection and merge criteria.

Data on output growth and inflation is derived from the World Bank database. Regarding data on revenue, expenditure, primary balance and interest payments, they are all expressed as a percentage of GDP and retrieved mainly from the OECD Economic Outlook n. 98 (EO, November 2015). However, as there are missing values for each of these variables for three countries i.e. Australia (1978-1988), Germany (1978-1990), Ireland (1978-1989), the series are complemented with data collected by Mauro et al. (2013) and by the Australian Treasury. Mauro et al. (2013) build a historical database on public finance for 55 countries over the period 1800-2011 drawing from cross-country sources[14]. Their data consist of government revenue and expenditure, the interest bill, the primary balance and gross public debt, all expressed as a share of GDP[15].

Series on gross government debt rely almost entirely on Mauro et al. (2013)'s dataset. In fact, their data is available until 2011, while this paper needs observations till 2014. When explaining how they built debt series, they specify that for all countries data are retrieved from the IMF WEO starting from year 2011 (for some countries even before that date). In order to ensure continuity and consistency with previous years data, values from the latest IMF WEO (April 2015) are incorporated to the series for the period 2011-2014 for all countries in the dataset. Table A1 and Table A3 in the Data Appendix describe all variables used, their source(s) and coverage.

Finally, as an investigation of outliers reported in the Data Appendix revealed the presence of extreme values for both the primary balance and the average interest rate, the former is winsorized at the 1^{st} and 99^{th} percentile while the latter at the 5^{th} and 99^{th} percentile. Winsorization consists in a transformation of the data in order to remove extreme values that may influence the results without loss of information. Observations below and above some specified percentiles are replaced with the

[14] IMF's WEO and International Financial Statistics (IFS) and the OECD Analytical Database for the past 20–50 years (subject to availability); the Statistical Yearbooks of the League of Nations and the United Nations for the period between World War I and the 1970s.

[15] Table A1, Appendix reports for the countries and years that are of interest in this paper, the different sources that they used.

values of the latter. A detailed description of the reasons behind this choice is reported in the Data Appendix.

3.4. Summary statistics

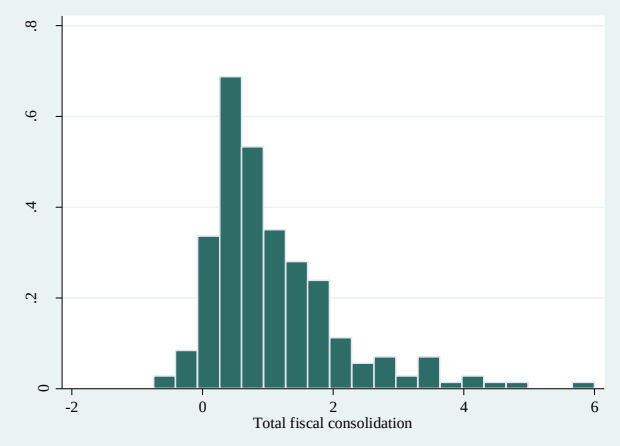
The final dataset on fiscal consolidation contains 211 episodes that document the implementation of austerity measures. Among the episodes considered[16], the average total consolidation is equal to 1.07 percent of GDP and the range runs from -0.75 percent of GDP to 6 percent of GDP (see Figure 2). Of the 211 episodes of fiscal consolidation, 187 included measures taken on the revenue side and 186 measures on the expenditure side. The average spending consolidation is equal to 0.72 percent of GDP while the average revenue consolidation amounts to 0.49 percent of GDP (see Table 1).

Table 1 – Summary statistics of fiscal consolidation episodes

Fiscal Consolidation	Obs.	Mean	Std. Dev.
Total	211	1.07	1.02
Revenue	187	0.49	0.64
Expenditure	186	0.72	0.70

Note: The table reports the number of observations and the summary statistics (mean, standard deviation and variance) for fiscal consolidation episodes over the period 1978-2014.

Figure 2 – Fiscal consolidation episodes: size distribution



Note: The figure shows the size distribution of total fiscal consolidation episodes as a percentage of GDP.

Table 2 reports the summary statistics of the remaining variables that are used in the estimation. It can be observed that the debt variable averages around 60 percent of GDP over the time span considered and displays a large standard deviation. This is not surprising considering the low debt

[16] That is, describing the main statistics dropping observations that are equal to zero as no consolidation took place.

levels observed during the 70s and 80s and observing the steep increase that debt ratios have experienced in recent years. Similarly, for other fiscal variables – i.e. revenues, expenditures, primary balance, interest payments – the standard deviation is quite large, suggesting great variation across countries and over time. The average primary balance displays a negative sign, meaning that primary deficits have been prevalent over time and across countries. This is also confirmed by higher average government spending in comparison to the mean government revenue. The average interest rate, which is calculated as net interest payments divided by the stock of debt, displays a mean that is quite similar to average net interest payments over average debt (percent), as expected. GDP growth averages around 2 percent of GDP and shows quite some variation as well. Finally, inflation averages quite high, but this may be explained by the hyperinflation that characterized the 70s and 80s.

Table 2 – Summary Statistics of the main variables of interest

Variable	Mean	Std. Dev.
Debt ratio	61.06	28.13
Government revenue	42.69	7.08
Government expenditure	46.21	7.18
Net interest payments	2.97	2.36
Primary balance	-0.51	3.16
Average interest rate	4.76	2.65
Inflation	4.08	4.18
GDP growth	2.31	2.31

Note: The table reports summary statistics for the main variables used in the estimation.

In order to get a first impression of the relationships among the variables in the dataset and the main dependent variable, Table 3 reports correlations of the former with debt ratios. Most of the variables display the expected sign (see section 2). First of all, the correlation between fiscal consolidation and debt ratios is positive and slightly more pronounced in the case of expenditure consolidations. Moreover, inflation is negatively correlated with debt ratios, as it would be expected from the theory. Similarly, the correlation between GDP growth and debt ratios displays a negative sign. On the contrary, revenues and the primary balance correlate positively with debt ratios, which somehow seems counter intuitive when the debt dynamics equation is taken into account. The average interest rate displays positive but not extremely strong correlation with debt ratios. The variable that correlates the most with debt is debt in the previous period, while the correlation of debt with net interest payments results quite high as well. This makes perfect sense as interest

payments are determined by the interest rate and the stock of debt in the previous year, which correlates strongly with debt in the successive period.

Table 3 – Correlation between debt ratios and the main variables of interest

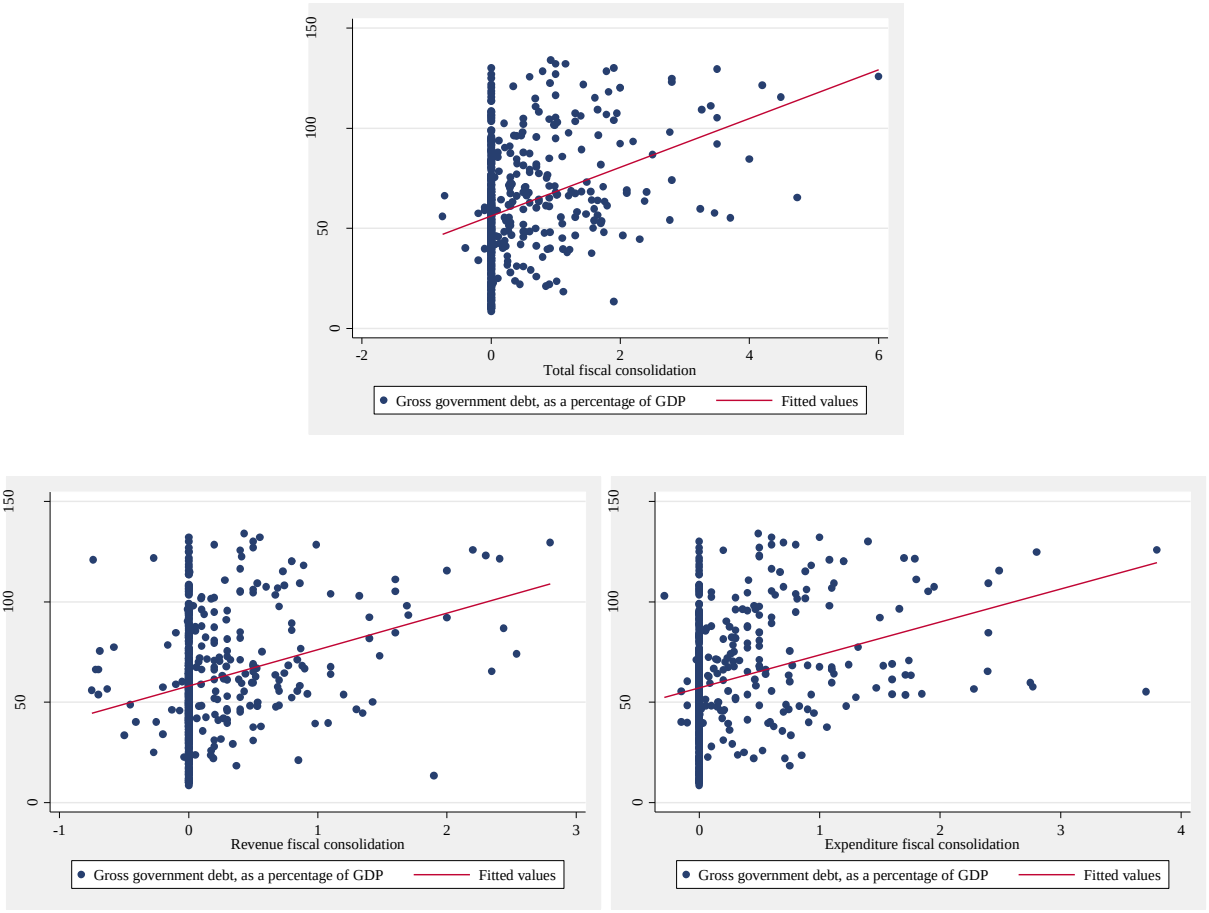
Correlation

	Debt ratio
Total consolidation	0.35
Revenue consolidation	0.28
Expenditure consolidation	0.31
Primary balance	0.07
Government revenue	0.20
Government expenditure	0.41
Net interest payments	0.73
Inflation	-0.34
Average interest rate	0.26
GDP growth	-0.17
Debt ratio (t – 1)	0.98

Note: The table shows how the various variables that are used in the estimation correlate with gross government debt.

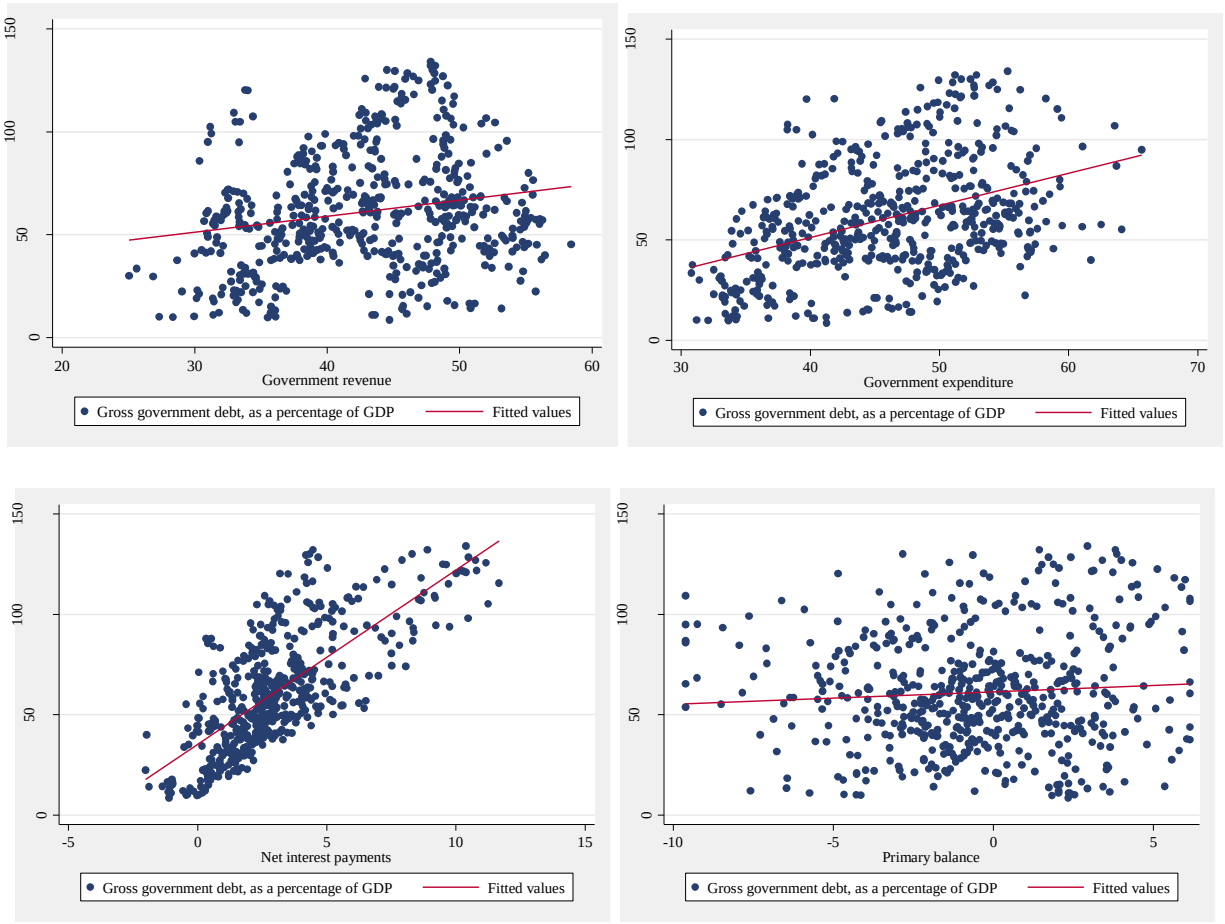
The correlations in Table 3 are also reflected by Figure 3, Figure 4 and Figure 5. All figures display scatters of the variable of interest on the horizontal axis, plotted against debt ratios on the vertical axis. A linear fit is added to the scatter plots in order to better see the relationship among the variables. Figure 3 shows the relationship between debt ratios and fiscal consolidation, which results positive and pronounced for total, revenue and expenditure consolidation. The association between consolidation effort and increasing debt ratios is slightly stronger in the case of spending measures, as shown by the correlation values as well (Table 3). Note that the concentration of observations around a vertical line in Figure 3 represents all the years for which countries did not consolidate, for which fiscal consolidation variables therefore take a value of zero.

Figure 3 – The relationship between fiscal consolidation and debt ratios



Note: The graphs plot total fiscal consolidation, revenue consolidation and expenditure consolidation against debt ratios. The dots around zero represents all the years for which consolidation did not take place. A linear fit is added to the scatter plots in order to give a better idea of the direction of the relationship among the variables.

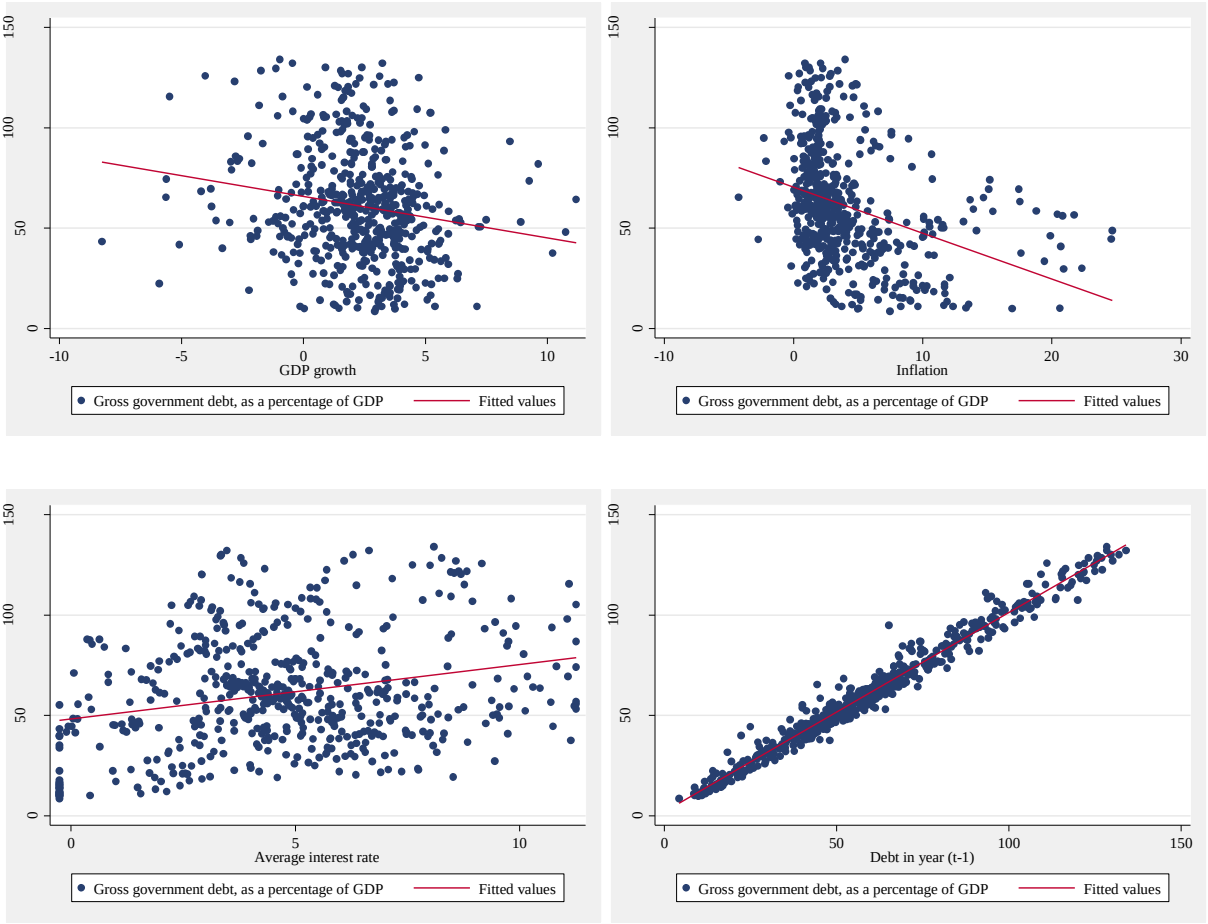
Figure 4 – The relationship between debt ratios and the primary balance and its components



Note: The graphs plot government revenue, expenditure, interest payments on debt and primary balance against debt ratios. A linear fit is added to the scatter plots in order to give a better idea of the direction of the relationship among the variables.

Figure 4 shows the relationship between debt ratio, the primary balance and its components. It can be observed that a positive relationship exists between revenue and debt ratios and between expenditure and debt ratios, even if the association results stronger for government spending (see also Table 3). The relationship between interest payments and debt ratios appears positive and more pronounced than that of revenues and expenditures with debt ratios. In contrast, the association between the primary balance and debt ratios is positive but it seems quite weak in comparison to the variables that determine it. As mentioned in the data section, the primary balance is transformed through winsorization. However, a scatter plot of the untransformed primary balance can be found in the Data Appendix.

Figure 5 – The relationship between debt ratios and growth, inflation the average interest rate, and its own lag



Note: The graphs plot GDP growth, inflation, the average interest rate and one lag of the debt ratio against debt. A linear fit is added to the scatter plots in order to give a better idea of the direction of the relationship among the variables.

Figure 5 concerns the relationship between debt and its lag, GDP growth, inflation and the average interest rate. It can be seen that there is a negative relationship between debt ratios and GDP growth as between debt ratios and inflation. Also, there is a strict association between the debt ratio and its past values. Regarding the relationship between average interest rate and debt ratios, the association appears less pronounced but still positive, suggesting that higher ratios imply higher rates. As mentioned in the data section, the average interest rate is transformed through winsorization. However, a scatter plot of the untransformed average interest rate can be found in the Data Appendix.

3.5. Estimation

Fiscal consolidation episodes are observed for a number of countries *i*, with $i = 1,..,N$ and $N = 15$, over many years *t*, with $t = 1,...,T$ and $T = 37$. This structure defines the nature of the data as panel. The debt dynamics Equation (6) shows that the debt ratio at time *t* is determined by the debt ratio at time $t - 1$ among other variables. This is reflected by the introduction of one lag of the debt ratio in Equation (8). The panel nature of the data and the presence of lags of the dependent variable on the right hand side of the equation, define the estimated model as a dynamic panel regression (Baltagi, 2008). Finally, the presence of country and time fixed effects defines the model specified in (8) as a dynamic fixed effect model. The inclusion of fixed effects is usually preferred in macroeconomic estimations over the alternative random effect model. As noted by Judson and Owen (1999), if time or country specific characteristics are omitted variables, it is likely that these are correlated with other regressors. Moreover, in the context of this research, it appears of great importance to control for unobserved time invariant differences across time and countries.

The presence of a lagged variable in the regression complicates the estimation of Equation (8). As the dependent variable, i.e. the debt ratio in the model of Equation (8), is a function of the error term, lagged values of the dependent variable will be a function of the disturbance as well, resulting in the endogeneity problem discussed above. Correlation between one of the regressors and the error term, i.e. between lagged debt ratio and the residuals, would render the approach that is usually used to estimate fixed effect models – the least squares dummy variable (LSDV) – biased and inconsistent (Baltagi, 2008). It would mean that estimates of the coefficient would capture not only the true effect of lagged debt ratios on the dependent variable, but also the impact of other factors that are contained in the error term. When this is the case, the linear model no longer corresponds to a conditional expectation of the dependent variable given the independent variables (Veerbek, 2008)[17]. This is the so called "panel data bias" (Nickell, 1981). The bias decreases in the time dimension of the dataset i.e. the larger the number of years *T*, the smaller the bias. Therefore, the fixed effect estimator is consistent for $T \to \infty$ (Baltagi, 2008). Judson and Owen (1999) find that with a time dimension as large as 30 years, the bias may be around 20 percent of the coefficient of interest.

[17] Given a statistical model of the form $y_i = x_i'\beta + \varepsilon_i$, the exogeneity requirement implies that the expected value of the error term ε_i given all the explanatory variables x_i is zero i.e. $E(\varepsilon_i \mid x_i) = 0$. Then, it holds that $E(y_i \mid x_i) = x_i'\beta$, where $x_i'\beta$ represents the regression line that describes the conditional expectation of y_i given x_i. The coefficient β_k measures how the expected value of y_i is affected by changes in x_{ik} while keeping all other x_i's constant. Correlations among regressors means that $Cov(x_i, \varepsilon_i) \neq 0$, such that $E(\varepsilon_i \mid x_i) = 0$ does not hold anymore.

Among the solutions proposed to deal with the panel data bias, Kiviet (1995) suggests to use a LSDV approach corrected for the size of the bias (LSDVC), where the estimate of the bias is computed from each county's data. According to the review of estimators of dynamic panel models in macroeconomic dataset made by Judson and Owen (1999), LSDVC outperforms other alternative estimators but it may prove difficult to implement, as an important caveat and limitation is that the correction assumes that all regressors besides the lagged dependent variable are strictly exogenous. Given the nature of the variables considered in the model, strict exogeneity of the regressors is ruled out. In fact, besides the endogeneity of the lagged dependent variable, also other variables in the model can suffer of this problem due to a loop of causality between debt and its determinants.

Alternatively, other approaches are based on differencing the equation to transform the error term and wipe out individual effects and then use additional lags of the endogenous variables as instrumental variables (IV) for the estimation (Anderson and Hsiao, 1981). Arellano and Bond (1991) apply this methodology to a generalized method of moments (GMM) procedure, called "difference GMM", which allows for the use of all available lags as instruments and for gains in efficiency of the estimator (Baltagi, 2008). That is, the approach starts from a linear model with one dynamic dependent variable, additional controls and fixed effects of the form:

(9)
$$y_{i,t} = \alpha y_{i,t-1} + x'_{i,t}\beta + \varepsilon_{i,t}$$

$$\varepsilon_{i,t} = \mu_i + \nu_{i,t}$$

$$E[\mu_i] = E[\nu_{i,t}] = E[\mu_i \nu_{i,t}] = 0$$

Where *i* indexes countries and *t* time. $x'_{i,t}$ is a vector of controls and the disturbance term $\varepsilon_{i,t}$ has two orthogonal components: the fixed effects μ_i and the idiosyncratic shock $\nu_{i,t}$. Equation (9) can be first differenced, to obtain:

(10)
$$y_{i,t} - y_{i,t-1} = \alpha(y_{i,t-1} - y_{i,t-2}) + (x'_{i,t} - x'_{i,t-1})\beta + (\nu_{i,t} - \nu_{i,t-1})$$

$$\Delta y_{i,t} = \Delta\alpha y_{i,t-1} + \Delta x'_{i,t}\beta + \Delta\nu_{i,t}$$

Where the fixed effect component of the disturbance is removed. The differenced lagged dependent variable remains correlated with the differenced residual. However, the bias decreases with the length of the panel, as higher *T* implies that the correlation between the lagged dependent variable and the error term diminishes. Once the equation is first differenced, additional lags of $y_{i,t}$ will be

correlated with the first term on the right hand side of Equation (10) but not with the term containing the difference of idiosyncratic shocks, unless these are serially correlated (Baltagi, 2008). Thus, all additional lags can be used to obtain instruments (moment conditions) for each period forward, which will be used to estimate (10) using a GMM estimator. When lagged variables in levels instrument the differenced form, the estimator is called "difference GMM".

Another option is to perform the so called "system GMM" – or Arellano and Bover (1995), Blundell and Bond (1998) estimator – that makes additional assumptions on the first differences of the instrumental variables not being correlated with the fixed effects. With system GMM, the Arellano and Bond estimator is augmented by including lagged levels as well as lagged differences as instruments and by using lagged changes of the regressors to instrument current levels (see Roodman, 2006; Bun and Sarafidis, 2013). An important characteristic of both GMM estimators is that they allow for regressors not to be strictly exogenous but also endogenous and predetermined. When variables are predetermined feedbacks from the idiosyncratic shock at time t to a regressor at time $s > t$ are not ruled out.

In applications analyzing macro-variables, the literature points out that system GMM can result more suitable than difference GMM, as macro variables usually depend on their past lags with high persistency. When this is the case, difference GMM estimator has little variation to exploit and its performance may be poor. System GMM can make up for this, as it allows to exploit greater variation by using past changes of the endogenous variables as additional instruments to explain current levels (Blundell and Bond, 1998). Moreover, difference GMM can perform poorly when variables that are close to a random walk, i.e. whose lagged value coefficient approaches one, figure in the regression (Roodman, 2009).

Both system and difference GMM estimators are proved to perform better in contexts in which the time dimension is small and the number of individual observations is large (Roodman, 2009). When the time dimension increases, the problem of too many instruments (or over identification problem) may create computational issues, rendering GMM estimators difficult to implement. In fact, the number of moment conditions identified increases quadratically in T, and is given by a number of moment conditions equal to $(T - 2)(T - 1)/2$ (Roodman, 2009). Therefore, as T rises, the number of instrument can grow large relative to the sample size. This can cause asymptotic results and testing to be misleading (Roodman, 2009). In particular, too many instruments can over-fit endogenous variables, failing to remove the endogenous component from the instrumented variable and resulting in biased estimates. This problem can generate invalid outcomes that seem valid because

of misleading identification tests. For instance, the Hansen test for instrument validity can generate implausibly perfect values of $p = 1.000$ (Roodman, 2009).

Roodman (2009) summarizes the techniques to limit the number of instrument used in GMM estimators. A first method proposes the use of restricted GMM that makes use of a limited number of lags instead of all available lags as instruments. A second method suggests to combine instruments through addition into smaller sets, which retains more information compared to the first approach, as no lags are dropped. A collapsed instrument is created for each lag distance, such that they become linear in *T*. The two approaches can also be combined. Overall, difference GMM outperforms system GMM when the time dimension increases, as it makes use of a smaller number of moment conditions.

Another problem that can be encountered when using GMM estimators is second order serial correlation in the idiosyncratic disturbance term. The latter would render some lags invalid instruments as they would become again endogenous. Arellano and Bond (1991) created a test to investigate the existence of serial correlation in the residuals, whose presence forces to the use of further lags to solve the inconsistency problem. Flannery and Hankins (2012) review different estimators for dynamic panel regressions and claim that when residuals are serially correlated, fixed effect or LSDVC estimators may be more accurate than GMM estimators.

In light of the discussion above, Equation (8) will first be estimated using fixed effects (section 4). As a robustness check, system GMM will be used in section 5.2 to estimate Equation (8). As noted above, even though the panel bias in fixed effects estimates may still be sizable, the large time dimension of the dataset ($T = 37$) can provide some reassurance. In fact, as noted by Judson and Owen (1999): "when $T = 30$, LSDV performs just as good or better than the viable alternatives[18]". In addition, Flannery and Hankins (2012) argue that endogeneity among the regressors, a problem that is likely to affect Equation (8), usually has little effect on the fixed effect estimates. In presence of endogeneity, system GMM appears to be one of the preferred solutions, but serially correlated errors and the problem of too many instruments – especially as *T* increases – tend to reduce its performance (Flannery and Hankins, 2012; Roodman, 2009). On the other hand, fixed effects estimators provide quite accurate estimates also in presence of second order correlation among the residuals (Flannery and Hankins, 2012). Therefore, the use of fixed effect estimator in the first place and system GMM to provide additional supporting evidence, tries to remedy for the potential limitations posed by the panel data bias and endogeneity of the variables in the model. Even though

[18] These being: the LSDVC, the Anderson and Hsiao estimator and GMM estimators.

both methods may present important shortcomings, if similar results are obtained using different methodologies, the reliability of the estimates can be enhanced.

4. Results

This section presents the main results obtained by estimating Equation (8) using the fixed effect estimator. As a first exploratory exercise, the simplest equation possible is estimated in order to get an idea of the effect of fiscal consolidation on debt ratios when no controls are added. That is, the following equation is estimated:

$$d_{i,t} = \mu_i + \lambda_t + \beta_1 fc_{i,t} + \varepsilon_{i,t} \quad (11)$$

Where $d_{i,t}$ represents the debt ratio for country *i* at time *t*, $fc_{i,t}$ stands for fiscal consolidation episodes expressed as a percentage of GDP and $\varepsilon_{i,t}$ the error term. The equation is estimated using time λ_t and country μ_i fixed effects. Robust standard errors are used in order to account for the presence of heteroskedasticity. The equation is estimated separately using spending consolidation measures, revenue consolidation measures and total fiscal consolidation i.e. the sum of tax and spending consolidation in a given year. The results are displayed in Table 4.

Table 4 – The effect of fiscal consolidation on debt ratios, no controls added

	Total	**Revenue**	**Expenditure**
Fiscal consolidation	6.23***	7.46***	8.74***
	(1.17)	(2.39)	(1.61)
R-squared	0.805	0.791	0.802
Observations	555	555	555

Note: Robust standard errors in brackets. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The results display the coefficients obtained estimating equation (11) with total fiscal consolidation, revenue side measure and spending consolidation measures regressed on debt ratios. The estimation includes country and time specific fixed effects.

Overall, fiscal consolidation appears to have a positive and significant impact on debt ratios. In fact, a one percentage point increase in fiscal retrenchment is associated with an increase in the debt ratio equal to about 6.2 percentage points (p.p.). The effect of spending consolidation seems to be greater than that of revenue consolidations, and the two effects taken separately have a larger impact on debt ratios than total fiscal consolidation has.

However, Equation (11) is just an over-simplified exercise, as none of the determinants of the debt ratio is inserted in the regression that explains debt. Therefore, as a successive step, the various determinants of the debt dynamics equation are added one by one to Equation (11). This allows to investigate whether the impact of fiscal austerity varies additional regressors are included. The regression to be estimated takes the following form:

(12) $$d_{i,t} = \mu_i + \lambda_t + \beta_1 FC_{i,t} + \beta_2 X_{i,t} + \varepsilon_{i,t}$$

Where $X_{i,t}$ stands for the determinants of the debt equation i.e. past values of government debt, $d_{i,t-1}$, the primary balance $pb_{i,t}$ and its components (revenues, T_t, expenditure, G_t, and net interest payments $nip_{i,t}$), the average interest rate, $i_{i,t}$, inflation, $\pi_{i,t}$, and the growth rate of the economy, $g_{i,t}$, which are included in the regression one by one. Again, the equation is estimated using country and time fixed effects and robust standard errors. In this case, only total fiscal consolidation is regressed on the debt ratio. The results of such exercise are reported in Table 5.

Table 5 – Effect of fiscal consolidation and controls implemented one by one on debt ratios

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Total consolidation	1.88***	6.35***	4.54***	3.12*	2.61	5.66***	5.49***	5.78***
	(0.36)	(1.21)	(1.29)	(1.49)	(1.67)	(1.54)	(1.24)	(1.30)
Debt ratio in year (t –1)	0.96***							
	(0.01)							
Primary balance		0.38						
		(0.33)						
Government revenue			1.79**					
			(0.61)					
Government expenditure				1.70***				
				(0.36)				
Net interest payments					7.80***			
					(1.13)			
Average interest rate						2.56**		
						(1.05)		
Inflation							-0.91**	
							(0.37)	
GDP growth								-0.77
								(0.79)
R^2	0.970	0.546	0.604	0.643	0.778	0.572	0.557	0.548
Observations	555	555	555	555	555	555	555	555

Note: Robust standard errors in brackets. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The results display the coefficients obtained by using fixed effects between regression estimator to estimate equation (12) with total fiscal consolidation and the components of the debt equation inserted one by one and regressed on debt ratios. The estimation includes country and time specific fixed effects.

Table 5 shows that fiscal retrenchment has a positive and highly significant effect on debt ratios in most cases. The two exceptions are when government expenditure and interest payments are added as controls (column 4 ad 5). In the first case, fiscal consolidation remains significant at the 10

percent confidence level, while in the second case the effect of fiscal consolidation is still positive but turns insignificant. Regarding the controls that are introduced, all of them result significant at different confidence levels, except for GDP growth and the primary balance. The impact of additional controls on the debt ratio displays the expected sign, with the exception of the impact of revenues on government debt ratios and that of the primary balance. In fact, it appears that increasing taxes imply higher debt ratios, suggesting implausible tax multipliers. Also, the primary balance coefficient displays a positive sign, implying that primary surpluses increase the debt ratio (even though the coefficient is insignificant). These results, however, will be overturned later on when the controls will be jointly inserted in the regression (see below).

Concerning the size of the impact of fiscal consolidation on debt ratios, it varies substantially depending on the controls that are added to the equation. In comparison to Table 4, the presence of the debt stock in the regression, for instance, reduces the impact of fiscal consolidation on debt ratios to about 1.88 percentage points. This result is not surprising, given that the debt stock in the previous period is probably the most important component of the debt equation, as it multiplies interests, growth and inflation (see section 2). The positive and significant coefficient of debt at time ($t - 1$) means that much of the variation in debt is explained by its previous period value. On the other hand, other controls do not reduce the impact of fiscal consolidation on debt ratios as much, which for instance remain as high as about 6.35 p.p. when the primary balance is added to the equation. The size of the control variables' coefficients also varies a lot, with the highest number being the coefficient of net interest payments.

Overall, the results reported in Table 5 need to be interpreted with care, as there may be important omitted variables bias due to the fact that not all determinants of the debt ratio are included. This can cause the variation that belongs to omitted variables to be attributed to those inserted in the regression mistakenly (Verbeek, 2008).

Therefore, as a successive step, all controls are included jointly and Equation (8) is estimated using time and country fixed effects and robust standard errors. The results are reported in Table 6, which shows that the impact of fiscal retrenchment on debt ratios is positive and significant both for total, revenue and expenditure consolidation. This means that a one percentage point increase in the total fiscal consolidation effort raises the debt ratio by about 0.9 percentage points, ceteris paribus. The increase in the debt ratio is greater when revenue and expenditure measures are taken separately, with tax increases raising the debt ratio by about 1.1 p.p. and spending cuts by about 1.2 p.p. on average. Overall, the increase in the debt ratio that follows austerity policies and the greater impact of spending consolidation compared to revenue consolidation seem to point out to short term

Keynesian dynamics. In fact, it seems that, at least in the short term, the fall in economic activity that follows the introduction of fiscal retrenchment outweighs the gains obtained through tax increases and spending cuts. As explained in section 2, this would work via lower consumption and investment, which in turn depress output. The fall in output causes the debt ratio to increase in response to the introduction of fiscal consolidation policies, pointing out to fiscal multipliers that lie above one and to short term self-defeating austerity. The greater impact of spending cuts compared to tax increases would work via the direct impact of the former on aggregate demand.

Table 6 – The impact of fiscal consolidation on debt ratios

	Total	**Revenue**	**Expenditure**
	(1)	(2)	(3)
Fiscal consolidation	0.94***	1.09***	1.23***
	(0.23)	(0.35)	(0.38)
Debt ratio in year (t –1)	0.96***	0.97***	0.97***
	(0.01)	(0.01)	(0.01)
Primary balance	-0.70***	-0.72***	-0.69***
	(0.09)	(0.09)	(0.10)
Inflation	-0.26***	-0.29***	-0.27***
	(0.08)	(0.07)	(0.08)
Average interest rate	0.56***	0.57***	0.57***
	(0.11)	(0.13)	(0.11)
GDP growth	-0.60***	-0.64***	-0.64***
	(0.19)	(0.19)	(0.19)
R^2	0.984	0.983	0.983
Observations	555	555	555

Note: Robust standard errors in brackets. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The results display the coefficients obtained estimating equation (8) with total, revenue and spending fiscal consolidation and the components of the debt equation inserted jointly and regressed on debt ratios. The estimation includes country and time specific fixed effects.

In comparison to Table 5, all the controls' coefficients have the expected sign now. In fact, an increase in inflation and GDP growth is followed by a reduction in the debt ratio, all else equal, and output growth reduces the debt ratio more than inflation does. This effect corresponds to the one predicted by the theory (see section 2): as debt sustainability is measured in relation to the country's ability to pay, i.e. its output, an increase in GDP growth reduces the debt ratio. Also, higher inflation diminishes the real value of debt, as GDP can increase both due to inflation and to real growth (see section 2). The coefficient of the average interest rate implies that higher interest means greater ratios, with a one percent increase in interest rates leading to a raise in the debt ratio of about 0.5 percentage points. Finally, the accumulation of primary surpluses now implies a reduction of about 0.7 p.p. in the debt ratio, ceteris paribus. While the sign corresponds to what expected, it is important to notice that the fact that a one percentage point increase in the primary surplus does not

correspond to a *full* one percentage point decrease in the debt ratio, according to the estimates. If primary surpluses are obtained through fiscal consolidation policies, this can be interpreted as evidence of the existence of the primary balance effect discussed in section 2: when austerity policies cause reductions in output, automatic stabilizers come into place such that the cyclical component of the primary balance is affected in a way that the reduction in the debt ratio is not one to one. However, this interpretation needs to be taken with care, as the cyclical component of the primary balance is related to output movements and therefore to the denominator of the debt ratio. This results in endogeneity bias, which may affect the estimated coefficient.

In Table 5, primary balance and government revenue displayed a counterintuitive sign. Table 7 shows that when regressors are inserted together this result is overturned for the primary balance. Similarly, when the primary balance is substituted with its components and all the other controls, government revenue display a negative coefficient, as it would be expected from the theory (outcomes reported in the Resuts Appendix). These changes can be due to omitted variable bias displayed by the regressions in Table 5, as explained above. However, switching signs can also signal multicollinearity of the regressors, i.e. a situation in which variables are highly or moderately correlated between each other and that can results in switching signs following changes in the multiple regression specification (Verbeek, 2008). The multicollinearity problem cannot be ruled out, especially if one looks at the correlation matrix among the variables (Table B 2 in the Appendix), which shows that all the regressors included in the dataset are at least moderately correlated.

5. Robustness checks

5.1. Robustness to different specifications of fiscal consolidation variables

As mentioned above, the dataset that has been used so far for the estimation is derived from the merge of data collected by Devries et al. (2011) and Kataryniuk and Vallés (2015). However, Alesina et al. (2015) also created a dataset of narrative fiscal consolidation episodes built upon the work of Devries et al. (2011). The latter covers the period 2009-2013 for 11 countries and is successively merged with that of Devries et al. (2011) while making some changes to the episodes calculated by the IMF. Given that data by Kataryniuk and Vallés (2015) allowed for the construction of a lager dataset both in terms of country and time dimensions, the latter has been used in this paper.

Kataryniuk and Vallés (2015) did not compare the sources of Alesina et al. (2015) with theirs, but they found that the calculated total consolidations were similar for six of the eleven countries. For the remaining five countries, they point out that Spain is the one that displays the starkest difference. However, after a close investigation of the sources, they claim to be fairly sure about the amount of fiscal consolidation that they report. Given that going through all the different sources for both datasets would prove an extremely time consuming task, data reliability can be checked by running the same regressions using both Alesina et al. (2015) and Kataryniuk and Vallés (2015) data. Stark differences in the results obtained using Alesina et al. (2015)'s fiscal data in comparison to the data retrieved from Kataryniuk and Vallés (2015), could cast a shadow on the reliability of the results.

Table 7 – Summary statistics of Alesina et al. (2015) fiscal consolidation episodes

	Baseline data			**Alesina et al. (2015) data**		
Fiscal Consolidation	Obs.	Mean	Std. Dev.	Obs.	Mean	Std. Dev.
Total	148	1.14	1.09	148	1.25	1.22
Revenue	134	0.59	0.69	136	0.62	0.74
Expenditure	129	0.70	0.67	131	0.78	0.73

Note: The table reports the number of observations and the summary statistics (mean, standard deviation and variance) for fiscal consolidation episodes taken from Alesina et al. (2015) and for the baseline episodes for the reduced sample of 11 countries over 1978-2013.

In order to be able to compare the results obtained using different measures of fiscal consolidation the sample considered needs to be the same. The analysis is therefore adapted to that of Alesina et al. (2015) and restricted to the period between 1978 and 2013 over 11 countries i.e. Austria, Belgium, Denmark, France, Germany, Ireland, Italy, Portugal, Spain, United Kingdom and United

States. The summary statistics relative to the episodes recorded by Alesina et al. (2015) and those of the baseline data when the dataset is restricted are reported in Table 7. It can be seen that there is an equal number of episodes of total consolidation, but Alesina et al. (2015) data record more episodes of revenue and spending consolidation. Average consolidations result higher in Alesina's data than in Kataryniuk and Vallés (2015) episodes.

Table 8 – Comparison of results: baseline fiscal consolidation data vs. Alesina et al. (2015) data

	Baseline data			**Alesina et al. (2015) data**		
	Total	Revenue	Expenditure	Total	Revenue	Expenditure
	(1)	(2)	(3)	(4)	(5)	(6)
Fiscal consolidation	1.02***	1.17***	1.60***	0.86**	1.01**	1.35**
	(0.29)	(0.36)	(0.50)	(0.29)	(0.37)	(0.50)
Debt ratio in year (t –1)	0.98***	0.99***	0.99***	0.99***	0.99***	0.99***
	(0.01)	(0.02)	(0.01)	(0.01)	(0.02)	(0.02)
Primary balance	-0.80***	-0.80***	-0.80***	-0.78***	-0.78***	-0.80***
	(0.05)	(0.05)	(0.05)	(0.06)	(0.06)	(0.05)
Inflation	-0.18**	-0.21***	-0.18**	-0.18***	-0.21***	-0.18**
	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)
Average interest rate	0.49***	0.52***	0.48***	0.48***	0.51***	0.48***
	(0.05)	(0.05)	(0.06)	(0.05)	(0.06)	(0.06)
GDP growth	-0.58**	-0.63***	-0.61***	-0.59**	-0.64***	-0.62***
	(0.19)	(0.18)	(0.19)	(0.19)	(0.19)	(0.19)
R^2	0.988	0.987	0.988	0.987	0.987	0.987
Observations	396	396	396	396	396	396

Note: Robust standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The estimation includes country and time fixed effects**.**

As a successive step, the same regressions as those reported in Table 6 are run using first the fiscal episodes of Kataryniuk and Vallés – which are reported in the first three columns of Table 8 – and then using those identified by Alesina et al. (2015) – which are reported in the fourth, fifth and sixth column of Table 8. Table 8 shows that the results obtained using different fiscal consolidation measures are quite similar. In fact, the percentage change in the coefficients between the baseline data and Alesina et al. (2015) is smaller than 16 percent. Regarding all the remaining variables' coefficients, there seem to be no stark difference among the estimates reported in Table 8 and those of Table 6. Overall, the impact of fiscal consolidation on debt ratios remains positive and significant even when another dataset of austerity episodes is used. It is relevant to notice that Table 8 again shows that the impact of spending measures seems to have a greater impact on debt ratios that that of revenue measures. This holds regardless of the source of fiscal consolidation episodes. Therefore, results are robust to a different specification of the dependent variable.

5.2. Robustness to change of estimator: system GMM results

As explained in section 3, the fixed effect estimator suffers from the panel data bias (Nickel, 1982). The bias decreases in T such that with the time dimension that the dataset used has i.e. $T = 37$, this bias should be relatively small. In fact, in their review that compares the performance of different estimators for dynamic panel data, Judson and Owen (1999) state that the performance of the fixed effect estimator is as good as that of GMM estimators when $T = 30$. In order to further check the strength of the results, however, this section implements the Blundell and Bond's (1998) system GMM estimator discussed in section 3.5. The latter is preferred to the difference GMM as the behaviour of lags of the debt ratio seems to approach a random walk and the research concerns macro variables (see section 3.5 for further details).

As already discussed, the estimator requires assumptions on the nature of the regressors i.e. whether they are to be considered strictly exogenous, predetermined or endogenous. Strict exogeneity rules out any correlation between a variable and past, present and future values of the error term. Except for the time dummies, none of the regressors inserted in Equation (8) can be defined as strictly exogenous given the correlation among one another (see Table B 2, Results Appendix) and the endogeneity problem underlying the variables of the model. Assuming that variables are predetermined, i.e. correlation between the regressors and future values of the error term is not ruled out, is quite a strong assumption. On the contrary, endogeneity appears standard in the literature that uses this estimator and suitable for the model.

Finally, in section 3.5 it has been noticed that the number of instruments is quadratic in T and it is given by $(T - 2)(T - 1)/2$, that in this case where $T = 37$ results in too many instruments. In order to try and limit this problem, Roodman (2009) proposes to reduce the number of lags in order to shrink the instrument count, such that in the estimation just one lag of the variables is used as instruments. Even though difference GMM is usually preferred when the over identification problem is an issue, system GMM is implemented instead as the use of one over the other does not appear to solve the problem of too many instruments, while system GMM seems to better fit the nature of the majority of the regressors (see below).

Therefore, Equation (8) is estimated using system GMM and considering all variables endogenous except for time dummies that are considered exogenous. The number of instruments is limited to one lag for each variable and standard errors are robust. Table 9 displays the results obtained with such specification. Again, the impact of fiscal retrenchment on debt ratios is positive and highly significant for total, revenue and spending consolidations. Overall, the impact of austerity on debt ratios appears to be slightly stronger when using system GMM estimator as compared to the

baseline results of Table 6. Regarding total and revenue consolidation GMM estimates, they increase of about 11 percent as compared to the baseline results, while the increase in the impact of spending consolidation on debt ratios is of about 20 percent (see Table 6).

Table 9 – The effect of fiscal consolidation on debt ratios: system GMM results

	Total	**Revenue**	**Expenditure**
	(1)	(2)	(3)
Total fiscal consolidation	1.05***	1.21***	1.48***
	(0.17)	(0.28)	(0.32)
Debt in year (t –1)	0.99***	0.99***	0.99***
	(0.01)	(0.01)	(0.00)
Average interest rate	0.33*	0.35	0.36**
	(0.18)	(0.21)	(0.17)
Primary balance	-0.68***	-0.71***	-0.66***
	(0.08)	(0.08)	(0.09)
GDP growth	-0.57***	-0.60***	-0.61***
	(0.10)	(0.10)	(0.11)
Inflation	-0.19***	-0.23***	-0.18***
	(0.06)	(0.06)	(0.05)
Hansen test	1,000	1,000	1,000
AR(2) test	0,500	0,685	0,496
Number of instruments	453	453	449
Observations	540	540	540

Note: Robust standard errors in brackets. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. . The results display the coefficients obtained estimating Equation (8) using system GMM estimator. Total, revenue and spending fiscal consolidation and the components of the debt equation are inserted jointly in the equation and regressed on debt ratios. Time dummies are considered exogenous while all other variables are considered endogenous. The number of lag used in the equation is limited to one to try and limit – at least partially – the over identification problem.

The estimates of the other control variables are quite similar to those obtained using fixed effect estimator, with the exception of the average interest rate, which results decreased in its size and significance compared to Table 6. This may be due to the use of system GMM estimator, where lagged differences instrument levels and that may not be the most appropriate choice for the nature of this variable. In fact, when estimation is done using the difference GMM estimator instead, the value of the average interest rate coefficients resembles those reported in Table 6 (see Table B 3 in the Results Appendix). However, system GMM remains preferred over difference GMM as lagged differences to instrument levels fit better all the remaining macro-variables (see also section 3.5). System GMM results appear to be quite robust to different specifications of the nature of the variables, such as for instance when the variables are considered predetermined rather than endogenous (see Results Appendix, Table B 4 and Table B 5).

It is important to notice, however, that while the test for serial correlation can be considered comforting, the Hansen test displays a p-value that is too reassuring and that is likely to be the result of an over identification problem (see section 3.5 for further details). This is also reflected in the high number of instruments reported in Table 9. Splitting the sample does not solve the problem, as the cross section dimension of the dataset is quite small and the nature of fiscal consolidation variables is such that too little variation would be left for the correct identification of their effect on the debt ratio. Nor does using difference GMM instead of system GMM (see Results Appendix, Table B 3) as the number of instruments still remains too high.

In light of the limitations of GMM methods discussed above, system GMM results presented in this section are to be considered as a robustness check for the fixed effect estimator estimates, which remain the favourite specification in this analysis. Given that the results seem quite similar regardless of the specification used, and that the different methods can be seen as compensating one for the shortcomings of the other, the reliability of the estimates is considered overall enhanced and strengthened.

6. Extensions

6.1. Country and time dependent effects of fiscal consolidation on debt ratios

In section 2 it has been noticed how the impact of fiscal consolidation might be dependent upon specific characteristics of the economies or times in which it is implemented. That is, the effect of fiscal consolidation can vary among different subsamples of countries and/or years due to these reasons. Therefore, this section investigates how the impact of fiscal consolidation on debt ratios changes according to different conditions in place.

First, attention is given to potential differences between countries that belong to the Euro Area (EA) and countries that do not. In fact, it can be that structural differences exist among countries that belong to such a peculiar monetary union and countries that do not. In addition, within the EA, some countries have experienced greater fiscal stress and have been considered structurally weaker than others. Therefore, the impact of austerity measures on this subset of countries is also investigated. Finally, as discussed in the theoretical section, multipliers may be higher in times of fiscal and financial crisis or during recessions. Starting from 2008, the global financial crisis sparked financial stress and generalized recession in many advanced economies. Therefore, potential differences between the crisis/recession period (2008-2014) and normal times (1978-2007) are investigated. Hence, regressions are run separately, grouping observations for countries that belong to the EA (starting from 1999, the year in which the Euro was implemented) and countries that do not[19] and for countries belonging to the EA periphery in comparison to the remaining. Finally, the investigation of potential differences in the impact of fiscal retrenchment on debt ratios before and after 2008 is presented.

Table 10 reports the results obtained by running separate regressions for countries belonging to the Euro Area and countries that do not. It can be observed that fiscal retrenchment appears to have a greater impact on countries that belong to the EA, even though the effect results significant only for spending measures and just slightly significant for total consolidation. This may be due to the smaller number of observations for EA countries in comparison to non-EA countries. In addition, it can be noticed that the stronger impact of spending consolidation appears to apply only to countries that belong to the EA, as for non-EA countries revenue consolidation increases the debt ratio slightly more than spending consolidation does. The Results Appendix (section 10.2, Table B 6) reports the results obtained investigating the presence of significant differences among fiscal consolidation in EA and non-EA countries by including the interaction of fiscal consolidation and a

[19] This results in 9 countries that belong to the EA starting from 1999: Austria, Belgium, France, Germany, Ireland, Italy, The Netherlands, Portugal and Spain.

dummy indicating whether a country is in the EA or not[20]. Results show that there is a significantly greater impact of spending consolidation in EA countries than in non-EA countries.

Table 10 – Differences between Euro Area and non-Euro Area countries

	Euro Area countries			**Non Euro Area countries**		
	Total	Revenue	Expenditure	Total	Revenue	Expenditure
	(1)	(2)	(3)	(4)	(5)	(6)
Fiscal consolidation	0.80*	0.76	1.33**	0.71***	0.87***	0.83**
	(0.40)	(0.78)	(0.46)	(0.16)	(0.28)	(0.31)
Debt in year (t –1)	0.91***	0.91***	0.91***	0.97***	0.98***	0.97***
	(0.02)	(0.03)	(0.03)	(0.02)	(0.02)	(0.02)
Primary balance	-0.60*	-0.61*	-0.58**	-0.67***	-0.68***	-0.66***
	(0.26)	(0.28)	(0.25)	(0.10)	(0.09)	(0.10)
Inflation	-0.33	-0.41	-0.34	-0.18*	-0.19*	-0.18*
	(0.44)	(0.48)	(0.48)	(0.09)	(0.10)	(0.10)
Average interest rate	2.83***	2.90***	2.85***	0.60***	0.61***	0.62***
	(0.76)	(0.78)	(0.81)	(0.14)	(0.16)	(0.14)
GDP growth	-1.02**	-1.08**	-1.03**	-0.46**	-0.48***	-0.48**
	(0.43)	(0.43)	(0.40)	(0.16)	(0.15)	(0.16)
R^2	0.980	0.980	0.980	0.981	0.981	0.981
Observations	144	144	144	411	411	411

Note: Robust standard errors in brackets. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The results display the coefficients obtained estimating equation (8) with total, revenue and spending fiscal consolidation and the components of the debt equation inserted jointly and regressed on debt ratios. The regressions are run separately for countries that belong to the Euro Area and countries that do not[21].

The differences that are observed among the two groups can be due to the peculiarity of the EA, which has a common currency and monetary policy but separate fiscal policy, and that therefore may find more difficult to coordinate the fiscal and monetary response to adverse shocks that may hit the economy. In fact, while the fiscal response to an adverse shock will be different from country to country, the monetary response will be common. Therefore, the unique monetary policy may be less able to offset country specific adjustments, as it is based on union-wide aggregates (Cugnasca and Rother, 2015; Erceg and Lindè, 2013). As discussed in section 2, impairment of the monetary channel can imply larger multipliers. Moreover, as Eggerston (2006) showed, when monetary and fiscal policy are coordinated, which is not the case in the EA, their quantitative effect can be stronger. In addition, the fiscal rules that constrain countries' fiscal policies may imply an

[20] And similarly for the other categories i.e. periphery vs. other countries and crisis vs. normal times. For more details about the econometric procedure see section 11.2 in the Results Appendix.

[21] This results in 9 countries that belong to the EA starting from 1999: Austria, Belgium, France, Germany, Ireland, Italy, The Netherlands, Portugal and Spain

impairment of the fiscal response as well, such that the impact of austerity policies can result in more adverse effect for countries belonging to the EA.

Moreover, Table 10 shows that in EA countries the impact of GDP growth, inflation and average interest rate seems to be stronger than in countries outside the EA. Regarding the coefficient for the average interest rate, the surge in its size may reflect the bond market panics that affected countries belonging to the EA during the Eurozone debt crisis. As explained in section 2, higher interest rates imply increases in debt ratios, which in turn call for higher yields and that can result in a spiralling loop which forces countries to default or resort to money finance. As discussed by De Grauwe and Yi (2013), the absence of a lender of last resort in countries that belong to a monetary union without a fiscal union can lead to self-fulfilling crises, as money finance is ruled out (see section 2).

Furthermore, the impact of inflation seems to be lower in EA countries rather than in EA countries. The insignificance of the coefficients for EA countries can be due to the small number of observations. However, the different size of the impact can be related to the fact that a single interest rate is set for a number of countries that display different characteristics and that may need different interest rates to be matched with their rates of inflation. In fact, as explained by Enderlein et al. (2012), the single monetary policy set by the ECB is based on the monetary union as a whole and can thus be either too loose or too strict for individual countries. That is, the common nominal interest rate will translate into low real interest rates in states with inflation rates higher than the EA average. On the contrary, in countries where inflation is below the average, real interest rates will result too high and investment and consumption too low. As a result, the single monetary policy can foster divergences (Enderlein et al., 2012). The impact of monetary policy, and therefore of inflation, on the debt ratio can thus be greater in EA countries due to this characteristic. Moreover, this can be an additional reason for which fiscal consolidation increases more the debt ratio in EA countries compared to non-EA countries. In fact, in EA countries monetary policy can be seen as somehow constrained due to the reasons mentioned above. As discussed in section 2, when monetary policy is impaired, fiscal policy assumes a greater role, such that cutting on government spending can result more counterproductive in the Eurozone than in other countries outside the EA.

Finally, Table 10 shows that the accumulation of primary surpluses reduces less debt in EA countries than in non-EA countries. Although there is a potential endogeneity bias (as discussed in section 4) this can also be interpreted as additional evidence of a greater impact of fiscal consolidation in EA countries than in other countries, which would work also through the primary balance effect explained in section 2. In fact, when austerity policies cause reductions in output, automatic stabilizers come into place such that the cyclical component of the primary balance is

affected in a way that the reduction in debt is not one to one. Therefore, a one percent increase in taxes or cut in spending may result in an improvement in the primary balance below one percent. If the impact of fiscal consolidation on output is greater in EA countries than in other countries, the primary balance effect will be greater as well, translating into the fact that a one percent increase in the primary surplus manages to reduce the debt ratio less in EA countries than in other countries.

Table 11 – Differences between periphery countries and other countries

	EA periphery			**Other countries**		
	(1) Total	(2) Revenue	(3) Expenditure	(4) Total	(5) Revenue	(6) Expenditure
Fiscal consolidation	0.83	0.56	1.86	0.66**	0.90**	0.66*
	(0.54)	(0.72)	(0.82)	(0.21)	(0.38)	(0.30)
Debt in year (t –1)	0.93***	0.94***	0.93***	0.97***	0.98***	0.97***
	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)
Primary balance	-0.53*	-0.56*	-0.51*	-0.69***	-0.72***	-0.69***
	(0.20)	(0.20)	(0.18)	(0.10)	(0.09)	(0.10)
Inflation	-0.26**	-0.26**	-0.28**	-0.34***	-0.35***	-0.35***
	(0.08)	(0.07)	(0.08)	(0.10)	(0.10)	(0.11)
Average interest rate	0.77***	0.80***	0.77***	0.38	0.39	0.39
	(0.11)	(0.11)	(0.09)	(0.24)	(0.26)	(0.25)
GDP growth	-1.18**	-1.25**	-1.15**	-0.27**	-0.28**	-0.28**
	(0.25)	(0.24)	(0.23)	(0.11)	(0.11)	(0.10)
R^2	0.990	0.989	0.990	0.984	0.983	0.983
Observations	148	148	148	407	407	407

Note: Robust standard errors in brackets. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The results display the coefficients obtained estimating equation (8) with total, revenue and spending fiscal consolidation and the components of the debt equation inserted jointly and regressed on debt ratios. The regressions are run separately for countries of the periphery i.e. Portugal, Italy, Ireland and Spain compared to the remaining countries.

Among the economies belonging to the EA, those suffering the most from the debt crisis and from market panics were the so called PI(I)GS i.e. Portugal, Italy, Ireland, Greece and Spain. It may be that, due to their structural weaknesses or to weaker fiscal positions, they drive the different results obtained for EA countries. Except for Greece, all PI(I)GS countries are present in the dataset, such that the impact of fiscal consolidation on these specific economies can be investigated. Table 11 reports the results obtained running regressions separately for periphery countries and all the remaining countries in the sample. The coefficients of total and spending fiscal consolidation on periphery countries are greater than those of other countries, although the effect is insignificant. However, when using interaction terms instead of separate regressions, results show that there are

significant differences among periphery and other countries for total, revenue and spending consolidation (see Table B 7, Results Appendix).

In comparison to Table 10, the size of the impact of revenue consolidation decreases while that of spending consolidation increases, meaning that Keynesian dynamics are exacerbated even further in countries of the EA periphery. This is also supported by the fact that primary surpluses are shown to reduce the debt ratio even less than in Table 10. As mentioned before, periphery countries were among those that suffered the most during the Eurozone debt crises and from which more severe rounds of fiscal consolidation policies have been required, claiming that their fiscal position had deteriorated. The implementation of stronger rounds of fiscal retrenchment may have been suggested in light of the theory mentioned in section 2, for which the effect of fiscal consolidation on output may be less harmful compared to the opportunity cost of a non-consolidation output scenario in countries with weak initial fiscal positions. The results obtained, however, suggest that the implementation of austerity policies in these countries can translate into highly counterproductive results, at least in the short term. Thus, the request of more intense fiscal consolidation can lead to self-defeating outcomes. Finally, in contrast to Table 10, the impact of inflation on debt seems to be higher for core EA countries and other countries rather than for periphery countries.

Table 12 – Differences between crisis periods and normal times

	Crisis periods			**Normal times**		
	Total	Revenue	Expenditure	Total	Revenue	Expenditure
	(1)	(2)	(3)	(4)	(5)	(6)
Fiscal consolidation	1.03	1.16	1.62**	0.76***	0.90***	0.90**
	(0.74)	(1.13)	(0.63)	(0.18)	(0.25)	(0.39)
Debt in year (t –1)	0.88***	0.90***	0.87***	0.97***	0.97***	0.97***
	(0.06)	(0.06)	(0.06)	(0.01)	(0.01)	(0.01)
Primary balance	-0.66	-0.72	-0.58	-0.67***	-0.69***	-0.66***
	(0.58)	(0.57)	(0.58)	(0.09)	(0.08)	(0.10)
Inflation	-0.34	-0.46	-0.32	-0.20**	-0.22**	-0.20**
	(0.37)	(0.37)	(0.38)	(0.07)	(0.07)	(0.07)
Average interest rate	1.22	1.11	1.28	0.60***	0.62***	0.61***
	(1.03)	(1.06)	(1.06)	(0.08)	(0.10)	(0.09)
GDP growth	-0.94	-1.08*	-0.96*	-0.53***	-0.55***	-0.55***
	(0.55)	(0.54)	(0.49)	(0.15)	(0.14)	(0.16)
R^2	0.938	0.936	0.937	0.984	0.983	0.984
Observations	105	105	105	450	450	450

Note: Robust standard errors in brackets. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The results display the coefficients obtained estimating equation (8) with total, revenue and spending fiscal consolidation and the components of the debt

equation inserted jointly and regressed on debt ratios. The regressions are run separately for years of crisis starting from 2008) and normal times.

Successively, differences among crisis times and normal periods are investigated. Table 12 shows that the impact of fiscal consolidation on debt ratios seems to be stronger during crisis periods compared to normal times, even though the effect is significant only in the case of spending measures. Significant differences between crisis and normal times for the impact of spending fiscal consolidation are confirmed when the interaction term is used (see Table B 8, Results Appendix). Table 12 shows that during normal times revenue and spending consolidations seem to be equally contractionary. Again, it can be noticed that the impact of GDP growth and the average interest rate increases, although it is insignificant and with a smaller impact than in Table 10. Regarding growth, during recessions output usually shrinks, such that the impact of output increases can have a greater effect on the debt ratio than in normal times. Concerning the interest rates, it can be that this effect is picked up from the surge in spreads and the bond market panics that EA countries experienced and that can be noticed when the sample is split between EA and non-EA countries (Table 10).

As explained in the theoretical section, the impact of austerity may be greater during recessions for various reasons. For instance, if households, banks and firms are deleveraging, which is a likely scenario during a recession, the role of fiscal policy to support aggregate demand can be enhanced, as automatic stabilizers would come in place to support falling private demand. On the contrary, fiscal consolidation implemented under such circumstances can lead to more adverse outcomes as no sector of the economy would consume, thus reducing aggregate output further. This situation can also lead to the "paradox of thrift" discussed in section 2, resulting in a perverse situation where every sector of the economy tries to "tighten the belt" but these contemporaneous actions cause an overall decrease in savings due to falling output.

6.2. The effect of fiscal consolidation on debt ratios over time

Equation (8) measures the contemporaneous impact of fiscal consolidation on debt ratios. The estimates obtained point out to short term self-defeating austerity in which debt increases following consolidation effort due to contractionary effect of fiscal retrenchment on output. However, this is not informative on the long term effect of austerity policies on debt ratios.

The study of the long term effect of fiscal retrenchment on debt ratios is relevant for several reasons. First, standard new Keynesian theories suggest that fiscal consolidation takes some time to peter out its effects on output, and consequently on debt. If that is true, previous rounds of fiscal consolidation should have a significant impact on the debt ratio. Second, some argue that short time pain is followed by long run gains, such that output losses and consequently debt increases are

necessary to achieve debt reduction. On the contrary, Fatàs and Summers (2015) among others claim that the effect of fiscal retrenchment on debt can be self-defeating also in the long run as it leads to permanent reductions in current and potential output. If fiscal consolidation leads to long run gains, lags of austerity episodes should be able to achieve debt reductions.

In order to examine the impact of fiscal consolidation on debt ratios beyond its contemporaneous effect, fiscal consolidation is replaced with its lags in Equation (8). That is, the following equation is estimated:

$$d_{i,t} = \mu_i + \lambda_t + \beta_1 pb_{i,t} + \beta_2 d_{i,t-1} + \beta_3 fc_{i,t-k} + \beta_4 i_{i,t} + \beta_5 g_{i,t} + \beta_6 \pi_{i,t} + \varepsilon_{i,t} \quad (13)$$

Where $k = 1,\ldots,4$ while the other variables correspond to those described previously. Lags of fiscal consolidation are included one by one in the regression in order to avoid the proliferation of biases. Equation (13) shows the impact of previous rounds of fiscal retrenchment on debt ratios, i.e. what is the impact on the debt ratio in year t following a one p.p. shock in fiscal consolidation in year $t - k$. It is important to notice that in Equation (13) the endogeneity problem is exacerbated in comparison to Equation (8). However, this simply wants to be a first basic exercise to investigate the long term impact of austerity policies. Further and more econometrically sound research on this matter will be needed in the future.

Table 13 – The impact of lagged fiscal consolidation on debt ratios

	Total	**Revenue**	**Expenditure**
	(1)	(2)	(3)
Fiscal consolidation ($t - 1$)	0.93***	1.48***	0.94*
	(0.28)	(0.40)	(0.47)
Fiscal consolidation ($t - 2$)	0.29	0.81**	0.07
	(0.21)	(0.28)	(0.33)
Fiscal consolidation ($t - 3$)	0.15	0.43*	0.02
	(0.18)	(0.21)	(0.28)
Fiscal consolidation ($t - 4$)	-0.09	-0.02	-0.18
	(0.20)	(0.32)	(0.33)

Note: Robust standard errors in brackets. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The results display the coefficients obtained estimating equation (13) with lags of total, revenue and spending fiscal consolidation inserted in the equation one by one.

Table 13 summarizes the results obtained estimating Equation (13) including one lag of fiscal consolidation at the time, while tables reporting the full results can be found in the Results Appendix. Table 13 shows that lagged values of austerity episodes have a significant impact on the debt ratio in particular in the case of revenue measures, which increase the debt ratio up to three lags. While revenue consolidations increased debt ratios contemporaneously of about 1.1 p.p. (see

Table 6), the raise in the debt ratio due to tax hikes implemented in the previous year is of about 1.5 percentage points. Revenue consolidation implemented in year $t - 2$ raises the debt ratio of about 0.8 p.p. and that which took place in $t - 3$ increases debt ratios by approximately 0.4 p.p. (although the effect is just significant). In the case of total consolidation, only its first lag raises the debt ratio significantly by about 0.9 p.p., while regarding spending consolidation, the first lag of fiscal retrenchment is just significant and raises the debt ratio by approximately 0.9 p.p., which is lower than the contemporaneous effect of about 1.2 p.p. (see Table 6).

Overall, results point out to a persistent effect of fiscal consolidation on the debt ratio, with the strength of the persistence being driven mostly by the effect of revenue consolidations. These results are in line with theories predicting that the effect of austerity policies takes some time to peter out. Moreover, the impact of revenue consolidation is higher one year after the implementation of the policy, and continues to adversely affect the debt ratio up to three years following tax hikes. Therefore, especially in the case of tax consolidations, undesirable effects indeed take some time to peter out, as the theory suggests. Over a time horizon of four years, however, no significant improvement in the debt ratio is detected, such that these results confirm what found previously. The impact of fiscal consolidation on debt ratios seems to bring large output losses without delivering any significant debt reduction, such that austerity policies are self-defeating.

7. Conclusion

This paper has investigated the effect of fiscal consolidation strategies on the debt to GDP ratio for a sample of 15 countries between 1978 and 2014. To this purpose, fixed effect estimator has been used, supported by additional robustness checks implementing system GMM estimator. The results obtained point to self-defeating austerity. In fact, following a one percent increase in fiscal consolidation effort, the debt ratio raises contemporaneously by about 0.9 percentage points. When revenue and expenditure measures are considered alone, the contemporaneous increase in the debt ratio is of about 1.1 and 1.2 p.p., respectively. This points out to Keynesian dynamics that lead to a fall in economic activity following fiscal retrenchment that outweighs the benefits obtained via the primary balance, and in which contemporaneous spending multipliers are greater than tax multipliers. Some basic evidence is also provided on the long run effect of fiscal retrenchment. It is found that while spending consolidation increases the debt ratio significantly only in the short term, adverse effects related to tax increases take some time to peter out. Tax based fiscal consolidations are found to increase debt ratios up to a three years after implementation, with the highest raise being a year after implementation, while spending based consolidation increases debt ratios only contemporaneously and one year after implementation.

When splitting the sample between EA countries and non-EA countries, the impact of fiscal consolidation on debt ratios appears to be stronger in the former. The debt ratio of countries that belong to the EA is also found to be more affected by surges in the average interest rate and changes in output growth, while their debt ratio is diminished to a lesser extent than in non-EA countries when primary surplus are accumulated. Similar and even stronger results are found when comparing periphery countries to other countries. Finally, the impact of fiscal consolidation appears to be sensible to economic conditions: during crisis and recession periods, fiscal consolidation is found to increase the debt ratio more than in normal times.

Overall, the analysis points out to values of fiscal multipliers that lie above one, as the fall in output more than offsets the improvement in the primary balance, causing debt ratios to increase rather than decrease. This results in self-defeating austerity that does not seem to achieve debt reductions under any condition.

The analysis presented displays however some important limitations that open up for further research. First of all, the analysis regarding the long term impact of fiscal consolidation on debt ratios is quite basic. More extensive research is needed in order to understand if debt ratios increase permanently or if the raise is just temporary. Furthermore, as discussed in the paper, data are collected from different sources due to lack of a unique and consistence source. Even though the

paper has tried to limit this problem, repeating the analysis with data uniquely identified will be necessary as data become available. Finally, the endogeneity problem of fiscal consolidation episodes with respect to debt and of the variables that determine the debt ratio remains an issue. Further research will be asked to focus on strategies to better deal with the problem.

Despite the shortcomings discussed, the results suggest some indications on the directions of debt paths after the implementation of fiscal consolidation policies. Therefore, some policy implications can be drawn from them. Overall, the results presented can be used to better estimate the short term losses of fiscal consolidation when carrying out cost and benefits analyses on its implementation. Specifically, when fiscal consolidation is introduced to reduce debt ratios, a careful consideration of the short run costs needs to be carried out by policymakers. In particular, conditions in place should be considered in order to understand how to introduce austerity policies (spending vs. revenue side), how much to consolidate and when to do it. In addition, different degrees of fiscal consolidations can be asked to different countries depending on the adverse effect it entails. Finally, these results can be exploited by those countries that are still following fiscal consolidation paths in order to assess and eventually revise their policies, depending on the reason for which fiscal retrenchment was introduced in the first place and keeping in mind that short term self-defeating austerity is indeed a likely outcome.

8. Literature

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9. Data Appendix

9.1. Variables description

In order to better understand the meaning of the variables that have been used throughout the paper, Table A1 lists and describes each of them and the related main sources. Data on fiscal consolidation episodes draw on Devries et al. (2011) for the period that goes from 1978 to 2008 and on Kataryniuk and Vallés (2015) starting from 2009 up until 2014 (see data section for further details). The World Bank database provides complete time series on output and inflation growth while data on the primary balance and its components is retrieved from the OECD Economic Outlook and time series on debt ratios from Mauro et al. (2013).

Table A 1 – Variables description and main source

Variable	Description	Source
Total fiscal consolidation	Sum of spending cuts and tax increases, as a percentage of GDP	Devries et al (2011) + Kataryniuk and Vallés (2015)
Revenue consolidation	Tax increases, as a percentage of GDP	
Expenditure consolidation	Spending cuts, as a percentage of GDP	
Output growth	GDP growth, annual percentage change	World Bank database
Inflation	Annual percentage growth rate of the GDP deflator	
Government revenue	Total receipts general government, as a percentage of GDP	OECD EO n. 98 + supplementation from Mauro et al. (2013) and Australian Treasury
Government expenditure	Total disbursements, general government, as a percentage of GDP	
Interest payments	Net government interest payments, as a percentage of GDP i.e. interest paid for general government debt net of interest received for general government assets	
Primary balance	Government primary balance, as a percentage of GDP i.e. government net borrowing or net lending excluding interest payments on consolidated government liabilities	
Debt	General government gross public debt, as a percentage of GDP	Mauro et al. (2013) + IMF WEO
Average interest rate	Calculated dividing net interest payments in year t by the stock of debt in year t-1	Own calculations

Note: the table reports the description, main source and coverage of all the variables that are used for the estimations. Exceptions to the main sources are discussed below and reported in Table A3.

In section 3.3, it has been noticed that the other non-fiscal variables are collected from different sources, as complete time series from a unique provider are not available. First of all, data on gross government debt are taken from Mauro et al. (2013). However, their data get until 2011 and in the

present paper observations until 2014 are needed. By looking into the sources that they used – which are summarized in Table A 2 – it can be seen that, starting from 2011 and for some countries even before that date, data on government debt are taken from the IMF World Economic Outlook. In order to have continuity and consistency in the dataset, data taken from the same (updated) source is used to obtain observations up until 2014. This extension of the series of Mauro et al. (2013) is seen as a continuation of their work rather than a real imputation, given the same source.

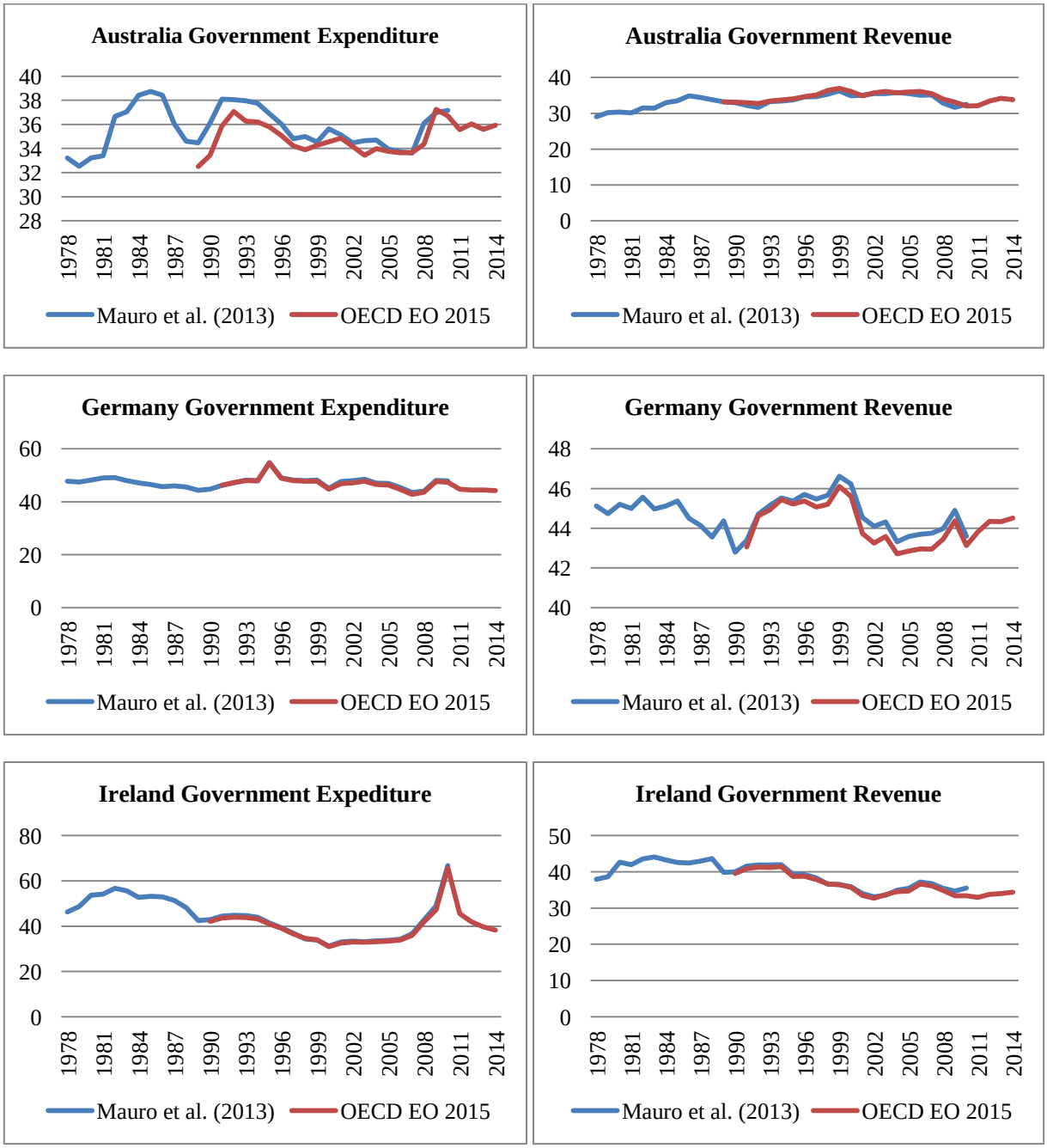
Table A 2 – Sources used by Mauro et al. (2013)

Country	Debt variable	All other variables
AUS	1977-1987 (Miss / OECD); 1988-1992 (OECD); 1993-2005 (WEO / OECD); 2006-2016 (WEO)	1960-2010 (OECD); 2011-2016 (WEO)
AUT	1970-89 OECD, 1990-2010 AMECO, 2011-2016 WEO	1976-2010 AMECO, 2011-2016 WEO
BEL	1970-89 OECD, 1990-2010 AMECO, 2011-2016 WEO	1978-2010 AMECO, 2011-2016 WEO
CAN	1961-2000 OECD, 2001-2016 WEO	1961-2000 OECD, 2001-2016 WEO
DEU	1977-2016 WEO	1970-1990 Bundesbank, 1991-2010 AMECO, 2011-2016 WEO
DNK	1977-89 Miss/Mitchell, 1990-2010 AMECO, 2011-2016 WEO	1971-2010 AMECO, 2011-2016 WEO
ESP	1940-1994 (CT); 1995-2010 (AMECO); 2011-2016 (WEO)	1940-1994 (CT); 1995-2010 (AMECO); 2011-2016 (WEO)
FIN	1948-1978 (UNSY / Mitchell; 1953 IFS / Mitchell), 1979-1989 WEO, 1990-2010 AMECO, 2011-2016 WEO	1975-2010 AMECO, 2011-2016 WEO
FRA	1978-2010 AMECO, 2011-2016 WEO	1978-2010 AMECO, 2011-2016 WEO
IRL	1960-1978 (Miss / OECD), 1979-1989 (WEO), 1990-2010 (AMECO), 2011-2016 (WEO)	1960-1984 OECD, 1985-2010 AMECO, 2011-2016 WEO
ITA	1861-1983 Italian govt, 1984-2010 AMECO, 2011-2016 WEO	1968-1979 OECD, 1980-2010 AMECO, 2011-2016 WEO
NDL	1946-1989 Ndl govt, 1990-2010 AMECO, 2011-2016 WEO	1969-2010 AMECO, 2011-2016 WEO
PRT	1850-1989 (PRT); 1990-2010 (AMECO); 2011-2016 (WEO)	1978-2010 AMECO, 2011-2016 WEO
UK	1880-1991 (UK Govt); 1992-2006 (AMECO); 2007-2016 (WEO)	1970-2010 (AMECO); 2011-2016 (WEO)
USA	1960-2000 (OECD); 2001-2016 (WEO)	1960-2000 (OECD); 2001-2016 (WEO)

Source: Mauro et al. (2013), Electronic chart book. *Note:* The variables displayed in the database are: government revenue and expenditure, government primary expenditure, government primary balance, interest paid on public debt, gross public debt – all expressed as a percentage of GDP – real GDP growth rate.

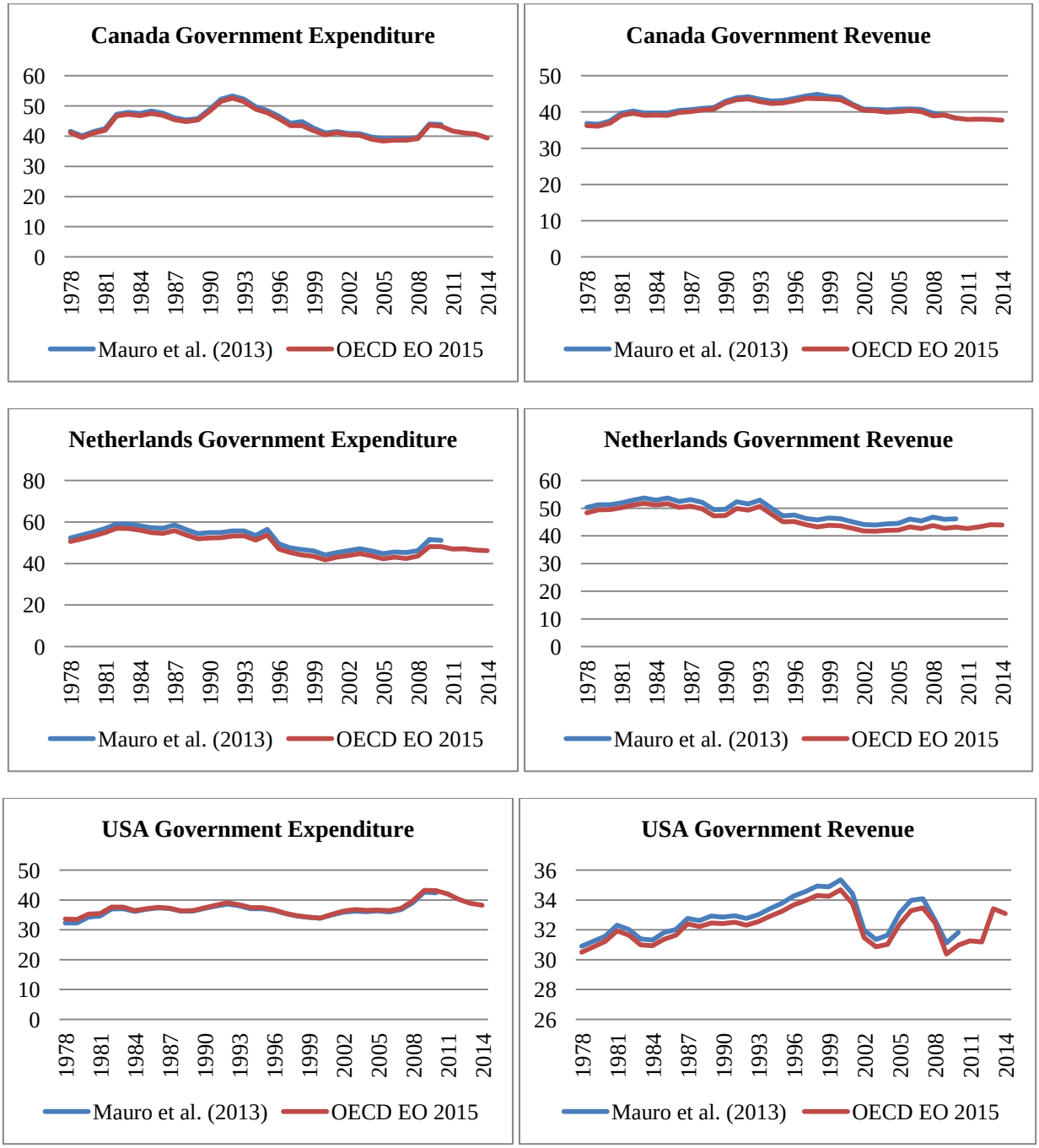
Regarding time series on the primary balance and its components i.e. government revenue, expenditure and interest payments on government bonds, the main source from which data is taken is the OECD World Economic Outlook n. 98. However, in these time series there are three important gaps over all the variables: Australia 1978-1988, Germany 1978-1991, Ireland 1978-1990. As data is available from other sources, I have decided to supplement the uncompleted series with data taken from the latter.

Figure A 1 – Comparison of uncompleted time series from different sources



Note: The figure shows the comparison of time series on government revenue and expenditure taken from the OECD Economic Outlook and those of Mauro et al. (2013) for countries for which the former have been complemented with the latter.

Figure A 2 – Comparison of complete time series with different sources

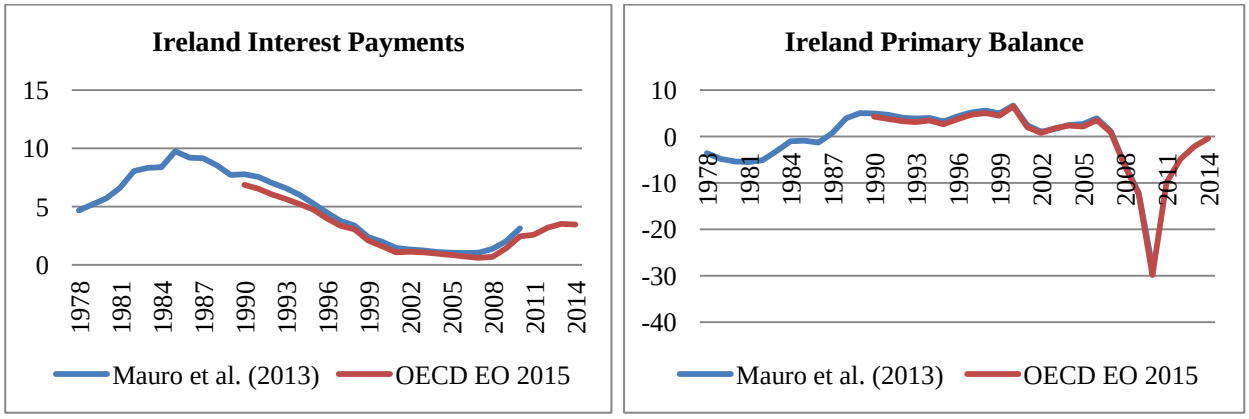


Note: The figure shows the comparison of time series on government revenue and expenditure taken from the OECD Economic Outlook and those of Mauro et al. (2013) for a sample of countries for which complete series are available.

Missing data on government revenue and expenditure are taken from Mauro et. al (2013). In order to check for reliability of the supplementation, I have plotted the series to see how they compare to each other both in the countries in which the substitution has been done and in countries for which the series were complete. As it can be seen from Figure A1 and Figure A 2, both revenue and expenditure data appear to coincide in most of the cases, displaying just few and relatively small differences in size. Figure A1 shows a comparison between government revenue and expenditure

series taken from the OECD Economic Outlook and those taken from Mauro et al. (2013) for the countries in which data have been supplemented. It can be seen that the two series have the same trend and in most cases coincide. Figure A 2 shows the same series for a sample of countries for which data is available from both sources. It can be seen that again, while the trend is the same in all cases, the reported sized are just slightly different in few cases while in many instances they correspond.

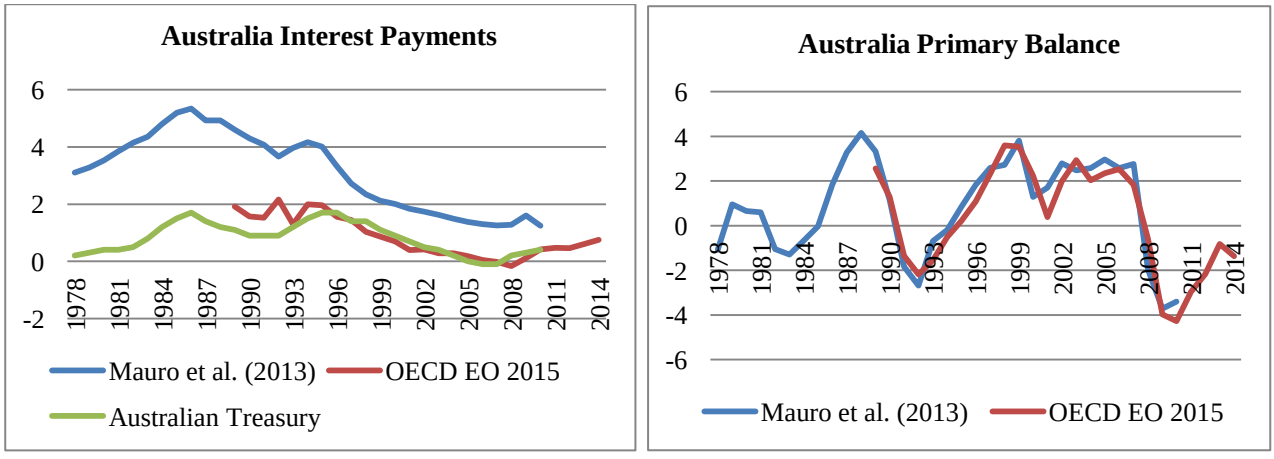
Figure A 3 – Comparison of different time series, Ireland



Note: The figure shows the comparison of time series on net interest payments and primary balance taken from the OECD Economic Outlook and those of Mauro et al. (2013) for Ireland.

Regarding data on interest payments and the primary balance, there are differences from country to country. For instance, it can be seen that in the case of Ireland, the data available from Mauro et al. (2013) closely resemble those of the OECD World Economic Outlook (Figure A 3), such that the latter are complemented with the former.

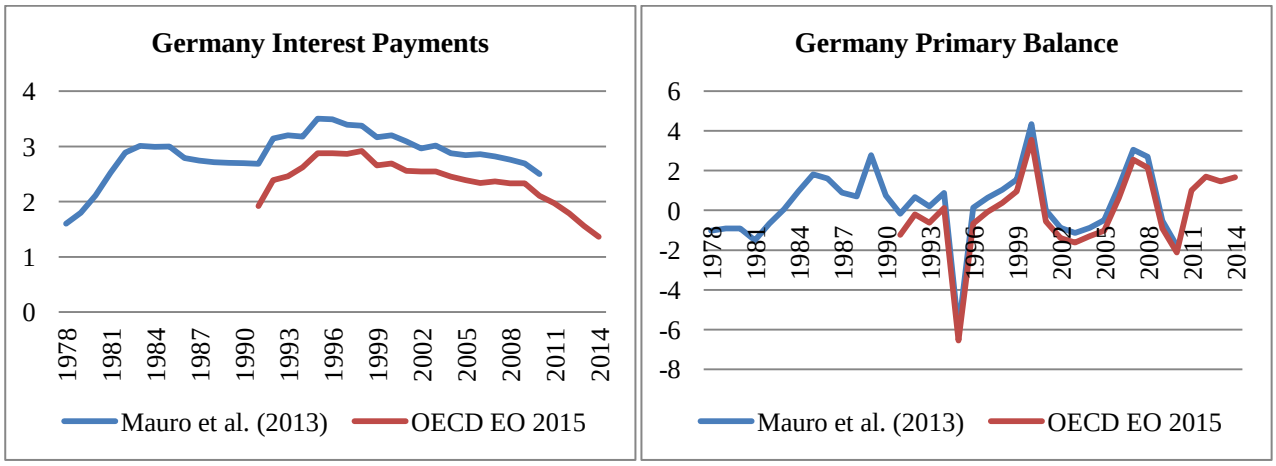
Figure A 4 – Comparison of different time series, Australia



Note: The figure shows the comparison of time series on net interest payments and primary balance taken from the OECD Economic Outlook, those of Mauro et al. (2013) and of the Australian Treasury.

Concerning Australia, Figure A4 shows that Mauro et al. (2013) time series on net interest payments in this case are quite different from those of the OECD, even if they do not result in great differences in the primary balance series. As data on net interest payments are available at the Australian Treasury as well, I plotted them together with the previous series. It can be seen that, in this case, data from the Australian Treasury seem to better resemble those of the OECD. Therefore, the latter data are preferred over that of Mauro et al. (2013) to complement the main series. Successively, for the period 1978-1988, the primary balance is calculated manually.

Figure A 5 – Comparison of different time series, Germany



Note: The figure shows the comparison of time series on net interest payments and primary balance taken from the OECD Economic Outlook and those of Mauro et al. (2013).

Finally, Figure A 5 shows the comparison among different series in the case of Germany. It can be seen that the differences in the time series are not as large as in the case of Australia but not as similar as in the case of Ireland. However, as the trend in the series is the same, differences are small and no additional source is available to my knowledge, the OECD series are complemented with Mauro et al. (2013) data.

To conclude, Table A3 summarizes how the OECD time series of government revenue, expenditure, interest payments and primary balance have been supplemented. Overall, 35 observations over 555 have been implemented using additional data. Despite we are aware of the limitations in terms of consistency that this approach can pose, the discussion above aimed to stress that supplementation of data with others sources has sought consistency in time series and thought carefully about the options available. The hope and aim is that the dataset on which the analysis is built is constituted by reliable and complete time series.

Table A 3 – Summary of supplementation of main OECD WEO time series

Country and Years	Variable	Source
Australia 1978-1988	Revenue Expenditure Interest payments Primary balance	Mauro et al. (2013) Australian Treasury Own calculations
Germany 1978-1991	Revenue Expenditure Interest payments Primary balance	Mauro et al. (2013)
Ireland 1978-1990	Revenue Expenditure Interest payments Primary balance	Mauro et al. (2013)

Note: The table displays how the main series of government revenue, expenditure, interest payments and primary balance have bees supplemented with additional sources for those years and countries in which observations are missing

9.2. Treatment of outliers

In section 3.3 it has been mentioned that the average interest rate and the primary balance have been treated following an investigation of outliers, as the latter can lead to poor estimates of the regression coefficients. Table A 4 reports the summary statistics for the untransformed primary balance and average interest rate. Means and standard deviations of the variables do not change much compared to those used in the main regressions (see **Errore. L'origine riferimento non è stata trovata.**). For the primary balance both standard deviation and mean slightly decrease when the variables are untransformed while for the average interest rate the mean value decreases and the standard deviation increases a little.

Table A 4 – Summary statistics of the untransformed primary balance and interest rate

Variable	Mean	Std. Dev.
Primary balance (u)	-0.48	3.40
Average interest rate (u)	4.44	3.70

Note: The table displays the summary statistics of the primary balance and the average interest rate series before Winsorization. These values compare to those reported in **Errore. L'origine riferimento non è stata trovata.**.

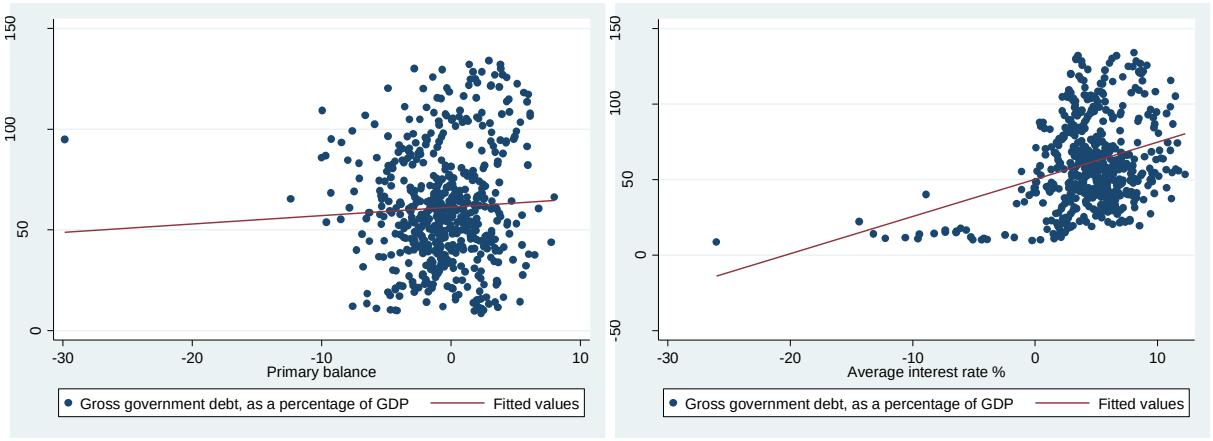
Table A 5 shows the correlation between the untransformed variables and the debt ratio. The latter is also reflected in Figure A 6, which presents the scatters of the untransformed primary balance and average interest rate plotted against debt. The correlation between debt and primary balance and average interest rate is lower when the untransformed variable is used compared to the winsorized one (see Table 3). Also, as shown by Figure A 6, important outliers are displayed in both graphs.

Table A 5 – Correlation between debt and the untransformed primary balance and interest rate

Correlation	
	Debt
Primary balance (u)	0.05
Average interest rate (u)	0.32

Note: The table displays the correlation between debt and the primary balance and the average interest rate series before Winsorization.

Figure A 6 – The correlation between the untransformed primary balance and interest rate and the debt ratio



Note: The figure shows the scatters of the primary balance and the average interest rate plotted against debt before the Winsorization of the two series. These graphs compare to Figure 4 and 5.

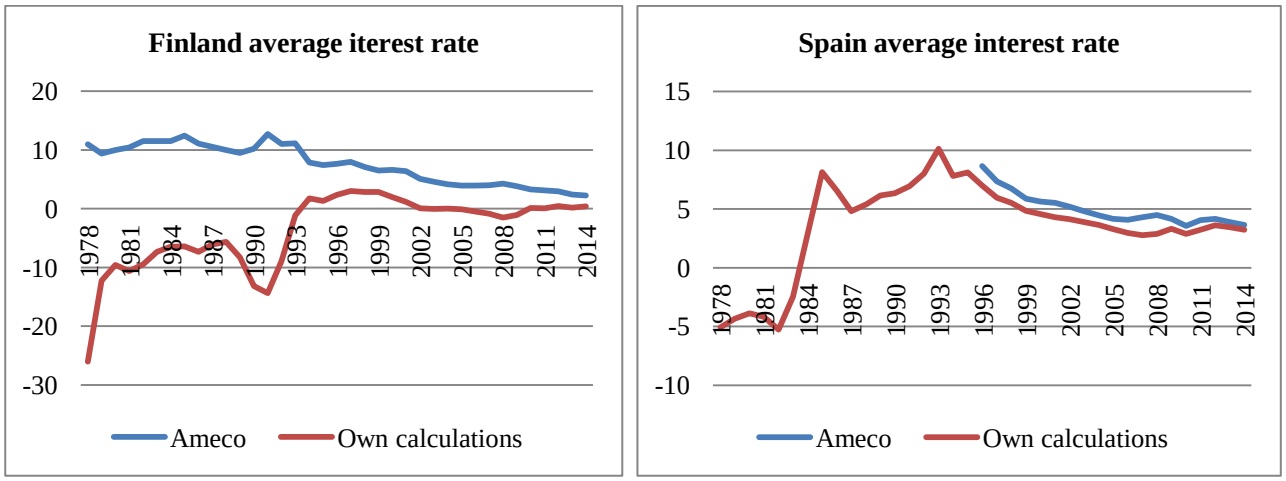
For both variables, extreme values are investigated in order to better understand their impact. Regarding the primary balance, there is just one important outlier, that corresponds to Ireland in 2010. That year, the budget deficit grew to 29 percent of GDP while in 2009 it was 12 percent. These two observations most probably correspond to the important banks bailouts related to Anglo Irish Bank and Irish Nationwide Building Society that the country faced. While other countries that recapitalized their banks did not write the bill costs on the deficit but on debt, Ireland made use of promissory notes to finance the bailout. According to Eurostat's rules, these instruments need to be counted against the general government deficit, which led to a world record result (Whelan, 2013).

Concerning the average interest rate, an investigation of the dataset shows that outliers are constituted by very negative values that are recorded for Finland between 1978 and 1992 and, to a less extent, for Spain between 1978 and 1982. Additional data on average interest rates are supplied by the Ameco database[22]. Figure A 7 plots the Ameco series and the series that I calculated from the data on interest rates and debt. Regarding Finland, complete time series are available on the Ameco

[22] The data provided by Ameco on average interest rate is calculated as in my case by dividing interest payments by the stock of debt of the previous period.

database, such that a comparison can be made. Figure A 7 shows that, while starting from 1994 the two series do not show large differences, before that year the series diverge greatly. Further investigation reveals that the differences appear to lie in the numerator i.e. in the calculation of the interest payments rather than that of debt. Concerning Spain, the Ameco database allows us to compare data only starting from 1996. By looking at Figure A 7 it can be seen that, starting from 1996 the two series are quite similar. However, before 1996 great changes in the data derived from my calculations is observed.

Figure A 7 – Comparison between average interest rate time series: Finland and Spain



Note: The two tables plot time series derived by own calculations on average interest rate (defined as interest payments over the stock of debt in the precedent year) and those retrieved from Ameco database.

The results obtained when running regressions with the untransformed variables for the whole sample are reported in Table A 6. It can be seen that, in contrast to Table 7, the coefficient for the average interest rate becomes insignificant while the impact of the primary balance does not seem to change much. The estimates of the impact of fiscal consolidation and of the remaining controls are only slightly affected. This suggest that extreme values of the interest rates may be driving these results and reduces concerns regarding outliers in the primary balance.

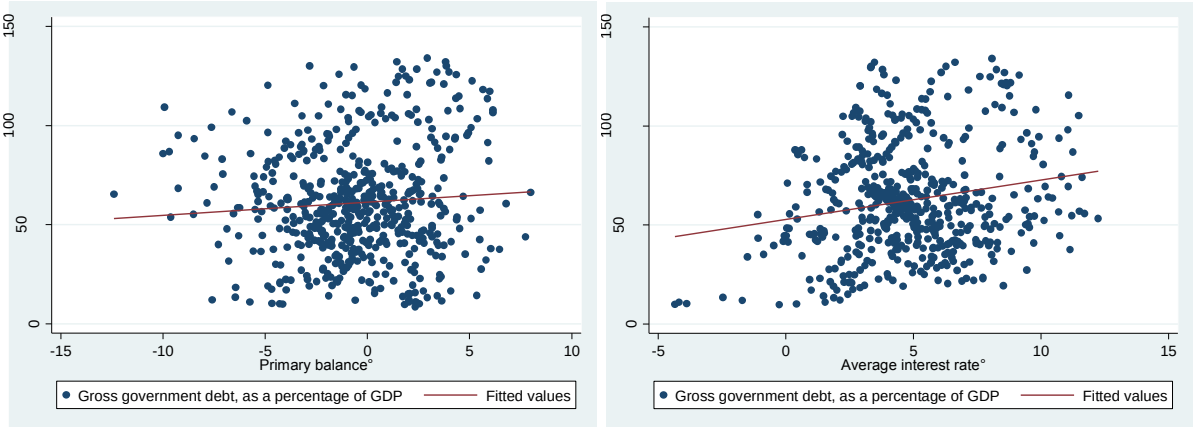
Regarding outliers, there are usually three options that are usually used in research: keep outliers and treat them as other observations (which has been done in Table A 6), drop them from the sample or winsorize them (Ghosh and Vogt, 2012). As a first step to investigate the sensitivity of results to manipulation of outliers, I dropped the extreme observation for the Irish primary balance in 2010 and values that exceeded -5 percent for the average interest rate. These changes result in 18 observations over 555 dropped. Table A 7 displays the summary statistics of the variables that have been modified and their correlation with the debt ratio, while Figure A 8 shows scatters for the primary balance and average interest rate plotted against debt.

Table A 6 – The effect of fiscal consolidation on debt ratios, with untransformed primary balance and average interest rate

	Total	**Revenue**	**Expenditure**
	(1)	(2)	(3)
Fiscal consolidation	0.93***	1.18***	1.16**
	(0.22)	(0.30)	(0.43)
Debt in year (t –1)	0.98***	0.98***	0.98***
	(0.01)	(0.01)	(0.01)
Primary balance (u)	-0.70***	-0.72***	-0.69***
	(0.08)	(0.08)	(0.09)
Inflation	-0.22***	-0.25***	-0.23***
	(0.07)	(0.07)	(0.07)
Average interest rate (u)	0.15	0.16	0.15
	(0.17)	(0.18)	(0.17)
GDP growth	-0.59***	-0.62***	-0.63***
	(0.17)	(0.16)	(0.17)
R^2	0.984	0.983	0.983
Observations	555	555	555

Note: Robust standard errors in brackets. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The results display the coefficients obtained estimating equation (8) with total, revenue and spending fiscal consolidation and the components of the debt equation inserted jointly and regressed on debt ratios. The estimation includes country and time specific fixed effects.

Figure A 8 – The relationship between debt and primary balance and average interest rate, dropping outliers



Note: The graphs plot the primary balance and the average interest rate against debt while adding a linear fit to better display the relationship among the variables. Both of the variables have been treated and that is showed by the symbol °. In the case of the primary balance the outlier of Ireland 2010 is dropped while for the average interest rate all values that are smaller than – 5 percent are dropped.

Table A 7 – Summary statistics of the variables when outliers are dropped

Variable	Obs.	Mean	Std. Dev.	Corr.
Primary balance°	554	-0.50	3.17	0.19
Average interest rate°	538	4.88	2.63	0.10

Note: The table reports summary number of observations, mean, standard deviation and correlation with the debt ratio for the primary balance and the average interest rate once outliers are dropped.

Table A 8 – The effect of fiscal consolidation and additional controls implemented jointly on debt ratios, dropping outliers

	Total	**Revenue**	**Expenditure**
	(1)	(2)	(3)
Fiscal consolidation	0.92***	1.10***	1.19***
	(0.24)	(0.35)	(0.37)
Debt in year (t –1)	0.97***	0.98***	0.97***
	(0.01)	(0.01)	(0.01)
Primary balance°	-0.69***	-0.71***	-0.69***
	(0.07)	(0.07)	(0.08)
Inflation	-0.23***	-0.26***	-0.23***
	(0.06)	(0.06)	(0.06)
Average interest rate°	0.58***	0.58***	0.59***
	(0.07)	(0.07)	(0.08)
GDP growth	-0.55***	-0.59***	-0.59***
	(0.17)	(0.17)	(0.17)
R^2	0.985	0.984	0.985
Observations	537	537	537

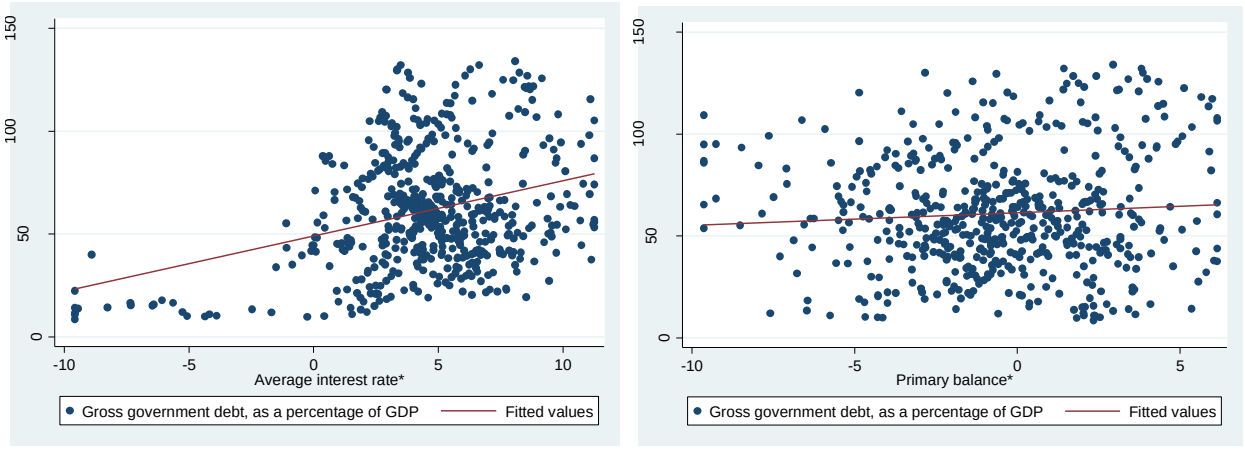
Note: Robust standard errors in brackets. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The results display the coefficients obtained estimating equation (8) with total, revenue and spending fiscal consolidation and the components of the debt equation inserted jointly and regressed on debt ratios. Starting from untransformed data, observation for Ireland in 2010 primary balance and interest rates greater than -5 percent are dropped. The variables that changed are indicated by the symbol °. The estimation includes country and time specific fixed effects.

Then, I reproduced Table A 6 to investigate the sensitivity of the outcomes to this transformation. Table A 9 displays the results of such exercise and the symbol ° marks the variables that have been changed. Compared to Table A 6, the coefficients for fiscal consolidation remain all positive and significant. However, the size of the impact of revenue and total consolidation drop, even though the change is stronger in the case of revenue consolidation. On the other hand, the impact of spending consolidation on debt ratios increases. These two effect combined overturn the result in Table A 6, where revenue consolidations seemed to be slightly more harmful for the debt ratio than spending consolidations. Now austerity on the spending side increases the debt ratio more than that on the revenue side. As in Table 7, the coefficient of the average interest rate increases greatly in

size and becomes highly significant if compared to Table A 6, while the coefficients of the primary balance result quite similar to what obtained previously.

As a second step, I winsorized both the primary balance and the average interest rate at the 1st and 99th percentile. This transformation modifies extreme values in data to minimize the potential impact of outliers without dropping the variables and thus allows to keep a balanced dataset. Outliers that lie below the 1st and 99th percentile are replaced by values of those percentiles. Table A 10 displays the summary statistics of the transformed variables and their correlation with the debt ratio. Figure A 9 shows the two variables plotted against debt. The graphs show that, while for the primary balance no significant outliers appear, for the average interest rate some un-behaved observations are still present in comparison to Figure A 6.

Figure A 9 – The relationship between debt ratios and primary balance and average interest rate, winsorizing outliers



Note: The graphs plot the primary balance and the average interest rate against debt while adding a linear fit to better display the relationship among the variables. Both of the variables have been winsorized at the 1st and 99th percentile and that is showed by the symbol *.

Table A 10 – Summary statistics of the variables when outliers are winsorized

Variable	Obs.	Mean	Std. Dev.	Corr.
Primary balance*	555	-0.51	3.15	0.11
Average interest rate*	555	4.49	3.41	0.19

Note: The table reports summary number of observations, mean, standard deviation and correlation with the debt ratio for the primary balance and the average interest rate once outliers are dropped.

Next, Equation (8) is estimated using the average interest rate and the primary balance wisorized at the 1st and 99th percentile. Table A11 displays the results and the symbol * marks variables that have been winsorized. It can be seen that the coefficients for fiscal consolidations remain all positive and significant and again the impact of expenditure consolidation seems to be more

harmful than that of revenue consolidation, which overturns the results of Table A 6. Concerning the impact of the variables that have changed, the size of the coefficient for the primary balance is almost unchanged while the impact of the average interest rate increases in size compared to Table A 6 but remains insignificant. This again may be attributed to the remaining outliers that are visible in Figure A 6.

Table A 11 – The effect of fiscal consolidation and additional controls implemented jointly on debt ratios, with Winsorization of outliers

	Total	**Revenue**	**Expenditure**
	(1)	(2)	(3)
Fiscal consolidation	0.96***	1.16***	1.24***
	(0.22)	(0.31)	(0.41)
Debt in year (t –1)	0.97***	0.98***	0.97***
	(0.01)	(0.01)	(0.01)
Primary balance*	-0.70***	-0.72***	-0.69***
	(0.10)	(0.10)	(0.11)
Inflation	-0.24***	-0.27***	-0.25***
	(0.08)	(0.08)	(0.08)
Average interest rate*	0.22	0.23	0.22
	(0.18)	(0.19)	(0.18)
GDP growth	-0.63***	-0.67***	-0.67***
	(0.20)	(0.20)	(0.20)
R^2	0.983	0.982	0.982
Observations	555	555	555

Note: Robust standard errors in brackets. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The results display the coefficients obtained estimating equation (8) with total, revenue and spending fiscal consolidation and the components of the debt equation inserted jointly and regressed on debt ratios. Observations for the primary balance and the average interet rate are winsorized at the 1st and 99th percentile, and this transformation is indicated by the symbol *. The estimation includes country and time specific fixed effects.

Therefore, as a last step, I winsorize the average interest rate at the 5th and 99th percentile while keeping the Winsorization of the primary balance between the 1st and the 99th percentile. The estimation of Equation (8) using these variables such transformed is reported in the results section in the main body of this paper (see section 4). Overall, it appears more plausible after this investigation to claim that the impact of expenditure consolidation on the debt ratio is greater than that of revenue consolidation. This is supported by the additional time series from Ameco, that differ extremely from those calculated using the data used. As the results obtained with the second Winsorization and those obtained by dropping observations are quite similar, I decided to use for the main regressions the primary balance winsorized at the 1st and 99th percentile and the average interest rate winsorized at the 5th and 99th percentile. This allows not to lose observations, which is

of help considering that the fixed effect estimator performs worse when datasets are unbalanced (Flannery and Hankins, 2013).

10.Results Appendix

Table B 1 – The effect of fiscal consolidation on debt ratios, with components of the primary balance

	Total	**Revenue**	**Expenditure**
	(1)	(2)	(3)
Fiscal consolidation	0.83**	0.95**	1.07**
	(0.28)	(0.43)	(0.37)
Debt ratio in year (t –1)	0.94***	0.94***	0.94***
	(0.03)	(0.03)	(0.03)
Government revenue	-0.76***	-0.78***	-0.75***
	(0.10)	(0.11)	(0.10)
Government expenditure	0.68***	0.71***	0.68***
	(0.08)	(0.07)	(0.09)
Net interest payments	-0.08	-0.05	0.00
	(0.26)	(0.24)	(0.25)
Inflation	-0.29***	-0.31***	-0.29***
	(0.08)	(0.07)	(0.08)
Average interest rate	0.30	0.28	0.27
	(0.19)	(0.20)	(0.19)
GDP growth	-0.58***	-0.61***	-0.61***
	(0.14)	(0.14)	(0.14)
R^2	0.985	0.985	0.985
Observations	555	555	555

Note: Robust standard errors in brackets. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The results display the coefficients obtained estimating equation (8) with total, revenue and spending fiscal consolidation and the components of the debt equation inserted jointly and regressed on debt ratios. The difference compared to Table 7 relies in the fact that the primary balance is substituted by its components i.e. revenues, expenditures and interest payments. The estimation includes country and time specific fixed effects.

Table B 2 – Correlation matrix of the variables of interest

	Debt	Tot FC	Tax FC	Exp FC	Debt (t-1)	Pb	Rev	Exp	IntP	AvInt	Gdp G.	Inf.
Debt	1											
Tot. FC	0.35	1										
Tax FC	0.28	0.81	1									
Exp. FC	0.31	0.87	0.41	1								
$Debt_{(t-1)}$	0.99	0.30	0.24	0.26	1							
Pb	0.05	-0.19	-0.16	-0.16	0.17	1						
Rev	0.20	0.10	0.01	0.14	0.20	0.30	1					
Exp	0.41	0.27	0.16	0.29	0.35	-0.14	0.85	1				
IntP	0.73	0.25	0.22	0.21	0.72	0.13	0.02	0.29	1			
AvInt	0.32	0.11	0.10	0.08	0.32	-0.04	-0.17	0.09	0.71	1		
GDP g.	-0.17	-0.26	-0.25	-0.19	-0.08	0.35	-0.20	-0.36	0.04	0.08	1	
Inf	-0.34	-0.13	-0.05	-0.16	-0.34	-0.15	-0.38	-0.29	0.04	0.15	0.09	1

Note: The table shows the correlation matrix for the variables of interest. Tot. FC = Total fiscal consolidation, Tax FC = revenue consolidation, Exp. FC = expenditure consolidation, Pb = primary balance, Rev = revenue, Exp=expenditure, IntP = interest payments, GdpG.= GDP growth, AvInt = average interest payments, Inf.= inflation.

10.1. Additional GMM results

Table B 3 – The impact of fiscal consolidation on debt ratios: difference GMM results

	Total	**Revenue**	**Expenditure**
	(1)	(2)	(3)
Total fiscal consolidation	0.43	0.16	0.77
	(0.34)	(0.37)	(0.53)
Debt in year (t –1)	0.97***	0.98***	0.96***
	(0.02)	(0.02)	(0.02)
Average interest rate	0.55**	0.61***	0.54**
	(0.21)	(0.20)	(0.20)
Primary balance	-0.81***	-0.81***	-0.79***
	(0.13)	(0.12)	(0.14)
GDP growth	-0.74***	-0.80***	-0.73***
	(0.18)	(0.16)	(0.16)
Inflation	-0.34***	-0.35***	-0.34***
	(0.11)	(0.10)	(0.11)
Hansen test	1,000	1,000	1,000
AR(2) test	0,617	0,806	0,587
Number of instruments	243	243	241
Observations	525	525	525

Note: Robust standard errors in brackets. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. . The results display the coefficients obtained estimating Equation (8) using difference GMM estimator. Total, revenue and spending fiscal consolidation and the components of the debt equation are inserted jointly in the equation and regressed on debt ratios. Time dummies are considered exogenous while all other variables are considered endogenous. The number of lag used in the equation is limited to one.

Table B 4 – The impact of fiscal consolidation on debt ratios: system GMM results when all variables are considered as predetermined

	Total	**Revenue**	**Expenditure**
	(1)	(2)	(3)
Fiscal consolidation	1.05***	1.25***	1.42***
	(0.17)	(0.27)	(0.33)
Debt in year (t –1)	0.98***	0.99***	0.99***
	(0.01)	(0.00)	(0.01)
Average interest rate	0.36*	0.35	0.38*
	(0.19)	(0.22)	(0.19)
Primary balance	-0.69***	-0.71***	-0.68***
	(0.09)	(0.09)	(0.10)
GDP growth	-0.54***	-0.59***	-0.55***
	(0.11)	(0.11)	(0.11)
Inflation	-0.20***	-0.22***	-0.19***
	(0.07)	(0.07)	(0.06)
Hansen test	1,000	1,000	1,000
AR(2) test	0,495	0,680	0,503
Number of instruments	460	460	457
Observations	540	540	540

Note: Robust standard errors in brackets. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. . The results display the coefficients obtained estimating Equation (8) using system GMM estimator. Total, revenue and spending fiscal consolidation and the components of the debt equation are inserted jointly in the equation and regressed on debt ratios. Time dummies are considered exogenous while all other variables are considered predetermined. The number of lag used in the equation is limited to one.

Table B 5 – The impact of fiscal consolidation on debt ratios: difference GMM results when all variables are considered as predetermined

	Total	**Revenue**	**Expenditure**
	(1)	(2)	(3)
Fiscal consolidation	0.78***	0.64*	1.10***
	(0.23)	(0.32)	(0.30)
Debt in year (t –1)	0.99***	1.00***	1.00***
	(0.02)	(0.02)	(0.02)
Average interest rate	0.63***	0.72***	0.68***
	(0.20)	(0.19)	(0.18)
Primary balance	-0.73***	-0.76***	-0.74***
	(0.12)	(0.10)	(0.14)
GDP growth	-0.67***	-0.69***	-0.70***
	(0.18)	(0.17)	(0.18)
Inflation	-0.33***	-0.36***	-0.29**
	(0.11)	(0.10)	(0.11)
Hansen test	1,000	1,000	1,000
AR(2) test	0,504	0,709	0,525
Number of instruments	244	244	243
Observations	525	525	525

Note: Robust standard errors in brackets. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. . The results display the coefficients obtained estimating Equation (8) using difference GMM estimator. Total, revenue and spending fiscal consolidation and the components of the debt equation are inserted jointly in the equation and regressed on debt ratios. Time dummies are considered exogenous while all other variables are considered predetermined. The number of lag used in the equation is limited to one.

10.2. Investigation of significant differences among subsamples

The existence of significant differences between EA and non-EA countries, normal and crisis/recession time and periphery and other countries is further investigated by interacting dummies the fiscal consolidation variable. That is, the following equation is estimated:

(1) $$d_{i,t} = \mu_i + \lambda_t + \beta_1 X'_{i,t} + \beta_2 D_{i,t} + \beta_3 fc_{i,t} + \beta_4 fc * D_{i,t} + \varepsilon_{i,t}$$

Where $D_{i,t}$ denotes the dummy variable while all the other variables are the same as in equation (2). The estimation of this specification allows testing for the presence of significant differences between the two subsamples of interest. In fact, the coefficient β_3 represents the effect of fiscal consolidation for those that are not in group one (i.e. for which $D_{i,t} = 0$)[23], while the coefficient β_4 indicates how the effect of fiscal consolidation differs across groups. That is, if for instance β_4 is positive, this would mean that fiscal consolidation has a larger effect in group one, i.e. when $D_{i,t} = 1$ than it has in the other group, i.e. $D_{i,t} = 0$. In other words, β_4 tests the null hypothesis that the two groups are equal: if the coefficient is significant then the effect of fiscal consolidation for EA countries or during crisis/recession is significantly different from that of countries that do not belong to the EA or to normal times periods. The results obtained estimating Equation (1) are reported in Table B 6, Table B 7 and Table B 8.

[23] In fact, if the impact of additional controls ($\beta_1 X'_{i,t}$) is not considered, the expected value of debt when e.g countries do not belong to the EA i.e. $D_{i,t} = 0$ is: $E(d_{i,t} \mid D_{i,t} = 0) = \mu_i + \lambda_t + \beta_3 fc_{i,t}$, given that the expected value of the error term is zero. Therefore, when e.g. countries do belong to the EA i.e. $D_{i,t} = 1$, and given that the expected vaue of the error term is zero, $E(d_{i,t} \mid D_{i,t} = 1) = \mu_i + \lambda_t + \beta_3 fc_{i,t} + \beta_4 fc$.

Table B 6 – Differences between Euro Area and non-Euro Area countries, with interaction term

	Total	**Revenue**	**Expenditure**
	(1)	(2)	(3)
Fiscal consolidation	0.69***	0.71**	0.86**
	(0.17)	(0.26)	(0.32)
EA dummy	-0.24	-0.08	-0.27
	(0.71)	(0.78)	(0.68)
Interaction FC*EA	0.68	1.07	1.37**
	(0.39)	(0.79)	(0.53)
Debt in year (t –1)	0.96***	0.97***	0.96***
	(0.01)	(0.01)	(0.01)
Primary balance	-0.70***	-0.72***	-0.69***
	(0.09)	(0.09)	(0.10)
Inflation	-0.24***	-0.27***	-0.25***
	(0.08)	(0.08)	(0.08)
Average interest rate	0.58***	0.59***	0.59***
	(0.11)	(0.12)	(0.11)
GDP growth	-0.58***	-0.63***	-0.61***
	(0.20)	(0.19)	(0.19)
R^2	0.984	0.983	0.984
Observations	555	555	555

Note: Robust standard errors in brackets. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The results display the coefficients obtained estimating Equation (8) with total, revenue and spending fiscal consolidation and the components of the debt equation inserted jointly and regressed on debt ratios.

Table B 7 – Differences between periphery and other countries, with interaction term

	Total	**Revenue**	**Expenditure**
	(1)	(2)	(3)
Fiscal consolidation	0.48**	0.40	0.53*
	(0.19)	(0.37)	(0.25)
Periphery dummy	0.00	0.00	0.00
	(.)	(.)	(.)
Interaction FC*Periphery	0.77**	1.05*	1.70***
	(0.32)	(0.57)	(0.54)
Debt in year (t –1)	0.96***	0.97***	0.96***
	(0.01)	(0.01)	(0.01)
Primary balance	-0.71***	-0.72***	-0.72***
	(0.08)	(0.08)	(0.08)
Inflation	-0.25***	-0.29***	-0.24***
	(0.08)	(0.08)	(0.07)
Average interest rate	0.56***	0.57***	0.56***
	(0.12)	(0.13)	(0.12)
GDP growth	-0.58***	-0.63***	-0.59***
	(0.19)	(0.19)	(0.19)
R^2	0.984	0.983	0.984
Observations	555	555	555

Note: Robust standard errors in brackets. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The results display the coefficients obtained estimating Equation (8) with total, revenue and spending fiscal consolidation and the components of the debt equation inserted jointly and regressed on debt ratios.

Table B 8 – Differences between crisis periods and normal times, with interaction term

	Total	**Revenue**	**Expenditure**
	(1)	(2)	(3)
Fiscal consolidation	0.76***	0.78***	0.94**
	(0.17)	(0.23)	(0.36)
Crisis dummy	0.80	0.19	0.66
	(1.82)	(1.74)	(1.67)
Interaction FC*crisis	0.58	1.07	1.20*
	(0.40)	(0.80)	(0.58)
Debt in year (t –1)	0.96***	0.97***	0.97***
	(0.01)	(0.01)	(0.01)
Primary balance	-0.70***	-0.72***	-0.69***
	(0.09)	(0.09)	(0.10)
Inflation	-0.25***	-0.28***	-0.25***
	(0.08)	(0.08)	(0.08)
Average interest rate	0.57***	0.58***	0.58***
	(0.11)	(0.13)	(0.11)
GDP growth	-0.59***	-0.63***	-0.61***
	(0.19)	(0.19)	(0.19)
R^2	0.984	0.983	0.984
Observations	555	555	555

Note: Robust standard errors in brackets. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The results display the coefficients obtained estimating Equation (8) with total, revenue and spending fiscal consolidation and the components of the debt equation inserted jointly and regressed on debt ratios.

10.3. The impact of fiscal consolidation on debt ratios over time

Table B 9 – The impact of fiscal consolidation on the debt ratio over time: first lag

	Total	**Revenue**	**Expenditure**
	(1)	(2)	(3)
Fiscal consolidation ($t-1$)	0.93***	1.48***	0.94*
	(0.28)	(0.40)	(0.47)
Debt in year ($t-1$)	0.96***	0.97***	0.96***
	(0.02)	(0.02)	(0.02)
Primary balance	-0.72***	-0.74***	-0.72***
	(0.09)	(0.09)	(0.10)
Inflation	-0.29***	-0.30***	-0.31***
	(0.07)	(0.08)	(0.07)
Average interest rate	0.62***	0.62***	0.62***
	(0.13)	(0.14)	(0.14)
GDP growth	-0.62***	-0.62***	-0.66***
	(0.16)	(0.15)	(0.17)
Constant	5.19***	4.70***	4.77***
	(1.10)	(1.05)	(1.17)
R^2	0.983	0.983	0.983
Observations	540	540	540

Note: Robust standard errors in brackets. * p < 0.1, ** p < 0.05, *** p < 0.01. The results display the coefficients obtained estimating equation (13) with fiscal consolidation measures and their first lag regressed on debt ratios. The estimation includes country and time specific fixed effects**.**

Table B 10 – The impact of fiscal consolidation on the debt ratio over time: second lag

	Total	**Revenue**	**Expenditure**
	(1)	(2)	(3)
Fiscal consolidation ($t-2$)	0.29	0.81**	0.07
	(0.21)	(0.28)	(0.33)
Debt in year ($t-1$)	0.97***	0.97***	0.97***
	(0.02)	(0.02)	(0.02)
Primary balance	-0.73***	-0.74***	-0.73***
	(0.09)	(0.08)	(0.09)
Inflation	-0.34***	-0.34***	-0.35***
	(0.08)	(0.08)	(0.08)
Average interest rate	0.62***	0.62***	0.62***
	(0.15)	(0.15)	(0.15)
GDP growth	-0.70***	-0.68***	-0.71***
	(0.18)	(0.18)	(0.18)
Constant	4.38***	4.32***	4.14***
	(1.22)	(1.16)	(1.23)
R^2	0.982	0.982	0.982
Observations	525	525	525

Note: Robust standard errors in brackets. * p < 0.1, ** p < 0.05, *** p < 0.01. The results display the coefficients obtained estimating equation (13) with fiscal consolidation measures and their second lag regressed on debt ratios. The estimation includes country and time specific fixed effects**.**

Table B 11 – The impact of spending fiscal consolidation on the debt ratio over time: third lag

	Total	**Revenue**	**Expenditure**
	(1)	(2)	(3)
Fiscal consolidation ($t-3$)	0.15	0.43*	0.02
	(0.18)	(0.21)	(0.28)
Debt in year ($t-1$)	0.97***	0.97***	0.97***
	(0.02)	(0.02)	(0.02)
Primary balance	-0.74***	-0.74***	-0.74***
	(0.09)	(0.09)	(0.09)
Inflation	-0.32***	-0.32***	-0.32***
	(0.08)	(0.08)	(0.08)
Average interest rate	0.64***	0.64***	0.63***
	(0.17)	(0.16)	(0.16)
GDP growth	-0.72***	-0.72***	-0.73***
	(0.18)	(0.18)	(0.18)
Constant	3.90***	3.93***	3.78***
	(1.24)	(1.25)	(1.21)
R^2	0.980	0.980	0.980
Observations	510	510	510

Note: Robust standard errors in brackets. * p < 0.1, ** p < 0.05, *** p < 0.01. The results display the coefficients obtained estimating equation (13) with fiscal consolidation measures and their third lag regressed on debt ratios. The estimation includes country and time specific fixed effects**.**

Table B 12 – The impact of spending fiscal consolidation on the debt ratio over time: fourth lag

	Total	**Revenue**	**Expenditure**
	(1)	(2)	(3)
Fiscal consolidation ($t-4$)	-0.09	-0.02	-0.18
	(0.20)	(0.32)	(0.33)
Debt in year ($t-1$)	0.98***	0.98***	0.98***
	(0.02)	(0.02)	(0.02)
Primary balance	-0.75***	-0.75***	-0.75***
	(0.10)	(0.10)	(0.10)
Inflation	-0.32***	-0.32***	-0.33***
	(0.09)	(0.09)	(0.09)
Average interest rate	0.63***	0.63***	0.64***
	(0.18)	(0.18)	(0.18)
GDP growth	-0.73***	-0.73***	-0.73***
	(0.18)	(0.18)	(0.18)
Constant	1.38	1.39	1.38
	(2.09)	(2.10)	(2.08)
R^2	0.979	0.979	0.979
Observations	495	495	495

Note: Robust standard errors in brackets. * p < 0.1, ** p < 0.05, *** p < 0.01. The results display the coefficients obtained estimating equation (13) with fiscal consolidation measures and their fourth lag regressed on debt ratios. The estimation includes country and time specific fixed effects**.**