



EUROPEAN CENTRAL BANK

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WORKING PAPER SERIES

NO 1241 / SEPTEMBER 2010

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**MAJOR PUBLIC
DEBT REDUCTIONS
LESSONS FROM THE
PAST, LESSONS FOR
THE FUTURE**

by Christiane Nickel,
Philipp Rother
and Lilli Zimmermann



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by Christiane Nickel², Philipp Rother³
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¹ The views expressed in this paper reflect those of the authors and not necessarily those of the institutions for which they work. We would like to thank Michael Frenkel, Eliza Lis, Jan-C. Rülke, Ad van Riet and participants of an internal ECB seminar for very helpful comments. Kryzstof Bankowski provided excellent research assistance.

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ISSN 1725-2806 (online)

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Abstract

The financial crisis of 2008/2009 has left European economies with a sizeable public debt stock bringing back the question what factors help to reduce these fiscal imbalances. Using data for the period 1985-2009 this paper identifies factors determining major public debt reductions. On average, the total debt reduction per country amounted to almost 37 percentage points of GDP. We estimate several specifications of a logistic probability model. Our findings suggest that, first, major debt reductions are mainly driven by decisive and lasting (rather than timid and short-lived) fiscal consolidation efforts focused on reducing government expenditure, in particular, cuts in social benefits and public wages. Second, robust real GDP growth also increases the likelihood of a major debt reduction because it helps countries to “grow their way out” of indebtedness. Third, high debt servicing costs play a disciplinary role strengthened by market forces and require governments to set up credible plans to stop and reverse the increasing debt ratios.

JEL classification: C35, E62, H6

Keywords: Fiscal policy, public debt, binary choice models

Non-technical summary

In the course of the financial and economic crisis of 2008/2009 rising budget deficits, low economic growth and the unprecedented government interventions to support financial institutions resulted in the accumulation of sizeable public debt in the European Union (EU). As rising debt levels can trigger a decline of investor confidence in governments' creditworthiness and raise doubts about the sustainability of government finances, it is of utmost importance to analyze the factors determining major public debt reductions.

In a first step, a stylized analysis of major public debt reduction in the EU since 1985 shows that most of the episodes of major debt reductions spanned over a relatively long time horizon. The time span of episodes ranges from five years in Portugal to fourteen years in Belgium and Denmark. The relatively long time span of major episodes indicates that the debt reductions were remarkably large and persistent. On average over the countries, the impact from major debt reductions amounted to 36.9 percentage points of GDP and reached up to 69.2 percentage points in the case of Ireland.

In a second step, this paper estimates several specifications of a logistic probability model to assess which factors determine the probability of a major debt reduction in the EU-15 during the period 1985-2009. Our results are three-fold. First, major debt reductions are mainly driven by decisive and lasting (rather than timid and short-lived) fiscal consolidation efforts focused on reducing government expenditure, in particular, cuts in social benefits and public wages. Revenue-based consolidations seem to have a tendency to be less successful. Second, robust real GDP growth also increases the likelihood of a major debt reduction because it helps countries to "grow their way out" of indebtedness. Here, the literature also

points to a positive feedback effect with decisive expenditure-based fiscal consolidation because this type of consolidation appears to foster growth, in particular in times of severe fiscal imbalances. Third, high debt servicing costs play a disciplinary role strengthened by market forces and require governments to set up credible plans to stop and reverse the increasing debt ratios.

The present paper offers several extensions to the previous research work on debt reductions. So far the existing literature predominantly focused on debt reduction periods which were strongly linked to fiscal consolidation efforts. More precisely, only those public debt reductions were considered which were the result of a sizeable improvement in either the primary balance or the cyclically adjusted primary balance. Other potential determinants of public debt reductions such as business cycle developments and the magnitude of debt servicing costs were largely left unattended. It is the aim of the present paper to assess the relevant driving forces of large public debt reductions in a wider scope. By defining a major debt reduction as a lasting and decisive improvement in the public debt-to-GDP ratio we can observe the debt reduction episodes directly and assess what factors determine the probability of a major debt reduction. In our empirical analysis we, therefore, do not only concentrate on fiscal actions as potential determinants but also control for the trend growth and the output gap as well as the interest burden.

1 Introduction

In the course of the financial and economic crisis of 2008/2009 rising budget deficits, low economic growth and the unprecedented government interventions to support financial institutions resulted in the accumulation of sizeable public debt in the European Union. The general government gross debt-to-GDP ratio of the EU is estimated to rise from 79 to around 89 percent during the period 2009-2011 (European Commission, 2010). As rising debt levels can trigger a decline of investor confidence in governments' creditworthiness and raise doubts about the sustainability of government finances, it is of utmost importance to analyze the factors determining major public debt reductions. Against this background this paper analyzes past episodes of reductions in the general government gross debt-to-GDP ratio in the EU-15 to provide insights on policy options for major debt reductions in the future.

Based on the estimations of several specifications of a logistic probability model, we assess which factors determine the probability of a major debt reduction in the EU-15 during the period 1985-2009. Our results are three-fold. First, major debt reductions are mainly driven by decisive and lasting (rather than timid and short-lived) fiscal consolidation efforts focused on reducing government expenditure, in particular, cuts in social benefits and public wages. Revenue-based consolidations seem to have a tendency to be less successful. Second, robust real GDP growth also increases the likelihood of a major debt reduction because it helps countries to "grow their way out" of indebtedness. Here, the literature also points to a positive feedback effect with decisive expenditure-based fiscal consolidation because this type of consolidation appears to foster growth, in particular in times of severe fiscal imbalances. Third, high debt servicing costs play a disciplinary role strengthened by market forces and require governments to set up credible plans to stop and reverse the increasing debt ratios.

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The remainder of this paper is organized as follows. Section 2 gives some stylized facts on debt developments in EU-15 countries since 1985 and provides a short overview of the related literature. Section 3 defines the episodes of a major debt reduction and describes the data set. Section 4 sets up the empirical analysis framework and discusses the main results. Section 5 summarizes the main findings of the study and concludes.

2 Stylised facts and literature overview

In response to the financial and economic crisis of 2008/2009, governments and central banks provided substantial support to the financial sector and massively intervened to restore economic activity, by allowing automatic sta-

bilisers to operate and by providing additional discretionary fiscal stimulus. This resulted in a significant deterioration of fiscal balances and an accumulation of large public debt. The rising public debt ratios in the EU-15 raise the question of what factors will help to stabilise these ratios and then put them on a steadily declining path. An analysis of successful past experience in the EU-15 countries provides valuable insights when considering potential policy options for debt reduction in the future. Table 1 provides information on the evolution of general government gross debt-to-GDP ratios in the EU-15.

Table 1: Evolution of general government gross debt-to-GDP ratios

	1985	1995	2000	2005	2010 ^f
EU 15	51.0	69.6	63.1	64.2	81.8
Austria	48.0	68.3	66.4	63.7	73.9
Belgium	115.1	129.8	107.8	92.2	101.2
Denmark	74.7	72.5	51.7	37.1	35.3
Finland	16.0	56.7	43.8	41.4	47.4
France	30.6	55.5	57.3	66.4	82.5
Germany*	39.5	55.6	59.7	67.8	76.7
Greece	49.0	99.2	101.8	98.8	124.9
Ireland	100.6	81.1	37.7	27.5	82.9
Italy	80.5	121.5	109.2	105.8	116.7
Luxembourg	10.3	7.4	6.4	6.1	16.4
Netherlands	69.7	76.1	53.8	51.8	65.6
Portugal	58.4	61.0	50.4	63.6	84.6
Spain	41.4	62.7	59.2	43.0	66.3
Sweden	60.9	72.1	53.6	51.0	43.6
UK	51.8	50.8	41.0	42.3	80.3

Note: Debt figures in the Maastricht delineation, expressed in percent of GDP. The figures are based on ESA (European System of Accounts) 79 until 1993 and on ESA 95 from 1994 onwards.

* Debt figures for Germany before 1991 refer to West-Germany.

^f Forecast values Source: European Commission, 2009, AMECO (Annual Macroeconomic Data) database.

As can be seen from Table 1, debt-to-GDP ratios followed an upward trend over the period 1985-1995 before they leveled off during the period 2000-2005. The debt ratios build up in the period from 1985-1995 cannot be traced back to severe economic downturns or military conflicts but rather to changes in the level and structure of government spending (Hauptmeier et al., 2007). The modern welfare state was expanded in this period implying an acceleration of public spending (Schuknecht and Tanzi, 2003).

The evolution of the debt ratio for the EU-15 as a whole masks marked differences in the development of debt ratios across the individual EU-15 countries. While a number of countries, i.e. Belgium, Finland, and Ireland, which accumulated sizeable public debt during the period 1985-1995, experienced large debt reductions during the period 1995-2005. Other countries with high debt ratios such as France and Germany have hardly seen any improvement in their public debt positions so far.

2.1 Macroeconomic effects of high public debt

One major concern about rising debt ratios relates to their sustainability. As debt ratios increase, investor confidence in governments' creditworthiness may decline. This pushes interest rates up as debt holders demand a higher risk premium, which in turn burdens the sustainability of public debt further. In particular expectations about future potential growth, real interest rates and governments' ability to generate primary surpluses play a crucial role in assessing whether public debt is on a sustainable path. Therefore, a one-time increase in public debt does not necessarily constitute a threat to the sustainability. If, however, market participants consider the debt accumulation to be of structural nature, doubts about the sustainability might arise (Buiters, 2005). Apart from sustainability concerns, high public debt levels may directly or indirectly harm economic growth (Checherita and Rother, 2010; Kumar and Woo, 2010; Reinhart and Rogoff, 2010). The channel most frequently discussed in this context refers to the crowding-out of private investment. Public debt competes with private debt for the allocation of savings. To the extent that public debt is used to finance productive government expenditure and the availability of debt instruments that combine high liquidity with low risk could result in higher savings but not necessarily in lower capital accumulation. However, if the debt-to-GDP ratio increases persistently over time, the newly issued

bonds can only be absorbed by the market participants if they yield higher real returns, with a consequent crowding-out of private investment.

Empirical evidence also points to a nonlinear relationship between public finances and private savings. Namely, households tend to increase precautionary savings when the debt-to-GDP ratio reaches the 100% mark (Nickel and Vansteenkiste, 2008). Furthermore, high debt levels reduce the flexibility of fiscal policy to respond to economic shocks. Indeed, countries with high debt levels were more restrictive in their responses to the 2008/2009 financial crisis than countries with relatively lower debt levels.

2.2 Previous work on successful public debt reduction

So far substantial research efforts have examined the developments of public debt in advanced economies almost exclusively within the fiscal consolidation analyses. Two strands of literature are predominant in this respect. The first strand of literature concentrates on debt sustainability and explores which fiscal action stabilizes public debt. In this context several studies introduce an econometric approach to estimate whether public debt is a mean reverting process and whether governments of advanced economies are able to stabilize public debt in times of high debt levels by running fiscal surpluses. To analyze whether governments satisfy the intertemporal budget constraint many researchers focus their analysis on the test of the no-Ponzi game condition (e.g. Bohn, 1995 and 1998; Greiner et al., 2007). In this context Rompuy and Vanhorebeek (1995) apply the test for stationarity on the primary budget balances and the debt-to-GDP ratios to a sample of eight European countries over the period 1970-1994. While their results indicate sustainable public debt ratios in the UK, they reject the sustainability hypothesis for France, Denmark and Germany. Several other studies such as by Bravo and Silvestre (2002) and



Afonso (2005) apply the test for cointegration between government revenues and government expenditures in order to examine the sustainability hypothesis for a sample of selected EU countries. Given that the conventional cointegration tests lack power in relatively short time series, more recent studies introduce the panel cointegration framework to test for debt sustainability. Based on the test for panel cointegration between the primary budget balance and the debt-to-GDP ratio, Prohl and Schneider (2006) find that the fiscal policy is consistent with the intertemporal budget constraint for a panel of fifteen EU member countries over the period 1970-2004.

The second strand of literature touches upon public debt reductions within the analysis of large fiscal adjustment programmes (e.g. Giavazzi and Pagano, 1990 and 1996; Alesina and Perotti, 1995 and 1997; Afonso et al., 2006). Though the empirical evidence is relatively scarce and largely based on OECD countries and prominent case studies, this second strand supports the view of expansionary effects on growth of large fiscal consolidations.¹ These expansionary effects are likely to occur in countries with high levels of government debt and a strong deterioration of the budgetary outlook, where consumer and business confidence might be heavily depressed because of fears over fiscal sustainability. These effects can occur if fiscal consolidations are large, persistent and credible, and if the fiscal adjustment programmes are implemented mostly on the expenditure side (and not the revenue side) as cuts in public employment, transfers and government wages.²

¹These positive effects of fiscal consolidations on growth are also referred to as “non-Keynesian effects”. While according to the traditional Keynesian theory, reductions in budget deficits can harm economic growth especially in the short run, non-Keynesian effects are associated with positive expectational effects which offset the standard negative Keynesian effect on growth.

²For a comprehensive literature overview see, for instance, Afonso (2001) and van Aarle and Garretsen (2003).

To evaluate the success of fiscal actions, some researchers estimate logit or probit specifications where the dependent variable assumes the value of one if fiscal tightening is successful and the value of zero if it is not successful. For instance, McDermott and Wescott (1996) estimate logit models for the OECD countries. They define an episode of fiscal consolidation as one in which the primary structural balance improves by at least 1.5 percentage points over two years and does not decrease in either of the two years. Within these episodes a successful fiscal adjustment is defined as one in which the two-year fiscal tightening leads to a sizeable public debt reduction. Their findings are two-fold. Their results suggest that the greater the magnitude of the fiscal tightening the more likely it is to succeed in reducing the debt ratios. Further, they find that in contrast to revenue-based consolidation expenditure-based consolidation tends to increase the probability of a successful adjustment. Numerous studies have applied a similar empirical methodology to analyse the success of fiscal actions and derive comparable results (Giavazzi et al., 2000; EC, 2003).

3 Determining episodes of public debt accumulation and reduction

As we are interested in the economic factors which contribute to a sizeable reduction of the debt-to-GDP ratio, we first split our sample into two groups. The first represents episodes of debt accumulation or stagnation, in which the year-on-year change in the gross public debt-to-GDP ratio is zero or positive. The second group represents episodes of debt reduction, in which the year-on-year change in the gross public debt-to-GDP ratio is negative. Further, we split the second group into two subgroups representing major and modest episodes of debt reductions, respectively. We define a major debt reduction as follows: Among all negative year-on-year changes of the gross general government debt-to-GDP ratio, we define an episode

as major if the debt ratio declines by more than 10 percentage points in 5 consecutive years.³ Setting this rather demanding threshold with respect to the size of the debt reduction and the period, we identify on the one hand major debt reductions and on the other hand persistent and long lasting improvements in the debt ratios. Using data from the AMECO database of the European Commission for the period 1985-2009, we identify 184 episodes of debt accumulation and 191 episodes of debt reduction in the EU-15. Among the debt reduction periods 59 episodes are considered as major and the remaining 132 episodes as modest according to our definition.

3.1 Assessing episodes of major debt reduction

According to our definition 10 out of 15 countries experienced at least one major and persistent debt reduction during the period 1985-2009. Table 2 reports all the major debt reduction episodes identified for each country under consideration.

Most of the episodes of major debt reductions span over a relatively long time horizon. The time span of episodes ranges from five years in Portugal to fourteen years in Belgium and Denmark. The relatively long time span of these episodes indicates that the debt reductions were remarkably large and persistent. On average over the countries, the impact from major debt reductions amounted to 36.9 percentage points of GDP and reached up to 69.2 percentage points in the case of Ireland.

³To test the robustness of our results we also examine an alternative definition of a major debt reduction episode in Section 4.3.

Table 2: Periods of major public debt reduction (1985-2009)

Country	Period of major debt reduction ($t_0 - t_n$)	Debt ratio (in % of GDP)		Change in debt ratio ($t_n - t_{-1}$)
		Peak	Trough	
		(t_{-1})	(t_n)	
Austria				
Belgium	1994-2007	134.2	84.0	-50.2
Denmark	1994-2007	80.1	26.8	-53.2
Finland	1997-2002	56.9	41.3	-15.6
	2004-2008	44.2	33.4	-10.8
France				
Germany				
Greece				
Ireland	1994-2006	94.1	24.9	-69.2
Italy	1996-2003	121.5	104.4	-17.1
Luxembourg				
Netherlands	1996-2002	76.1	50.5	-25.6
Portugal	1996-2000	61.0	50.4	-10.6
Spain	1997-2007	66.8	36.2	-30.6
Sweden	1985-1990	61.2	41.2	-20.0
	1996-2000	72.1	53.6	-18.5
	2003-2008	52.6	38.0	-14.6
UK	1985-1990	52.4	33.3	-19.1
	1997-2002	51.0	37.5	-13.5

Note: Debt figures in the Maastricht definition, expressed in percent of GDP. The figures are based on ESA (European System of Accounts) 79 until 1993 and on ESA 95 from 1994 onwards.
Source: European Commission, 2009, AMECO (Annual Macroeconomic Data) database.

Further, it is interesting to note that major debt reductions in the EU-15 are concentrated in the years 1995 through 2000 with more than 50 percent of all observations occurring in this period. This finding may also be explained by the incentive that the goal of becoming a euro area member and fulfilling the Maastricht convergence criteria gave to deficit and debt reduction.

While some countries, such as Finland, Sweden and UK experienced two to three periods of large debt reductions during the time span under consideration, other countries, such as Austria, France, Germany, Greece and Luxembourg did not experience any episodes of major debt reductions. In the case of Luxembourg this outcome likely reflects its low public debt ratios during the period under consideration.⁴ The other four countries,

⁴Luxembourg experienced a debt-to-GDP ratio of 7.4 percent on average during the period 1985-2009.

however, experienced high debt ratios clearly exceeding the 60 percent benchmark set by the Treaty of Maastricht but were not able to curb back the debt ratios successfully.

3.2 Identifying factors that support major debt reduction

Governments of advanced economies have in general a limited number of options to reduce their public debt. On the one hand they can adjust fiscal policies by running sufficient primary budget surpluses to lower their debt. On the other hand they can create an environment conducive to growth through the implementation of sound macroeconomic and structural policies in order to “grow their way out” of indebtedness.

Two further options, inflation and stock-flow adjustments are of limited effect and not advisable for various reasons: Inflation can only have a short-term effect as its impact on debt works via surprise increases in the price level. Once agents expect further inflation increases, this will be priced in yield expectations and thus burden public finances. Moreover, such policies risk to unanchor inflation expectations and thus contribute to macroeconomic instability. From an institutional point of view, central bank independence would risk to be undermined, possibly undermining the credibility of domestic governance structures. Finally, given current maturity profiles and the share of debt financed at variable rates, the quantitative impact of surprise inflation would likely be limited.

The effects on debt developments arising from stock-flow adjustments, which comprise changes in the government stock of financial assets and changes in the value of foreign debt due to exchange rate fluctuations, also seem to provide little room for political manoeuvre. The accumulation of financial assets (e.g. via privatisations) has obvious limits. Since advanced

economies mostly issue debt in their home currency, the relatively small amount of public debt issued in foreign currencies with flexible exchange rates relative to the home currency offers little scope for debt reductions via exchange rate movements.

In order to analyze the contributing factors we first observe the underlying macroeconomic differences between episodes of debt accumulation and debt reductions.

Table 3: Contributing factors to debt accumulation and reduction

	Total sample	Debt accumulation	Debt reduction	Major debt reduction	Modest debt reduction
Δ public debt-to-GDP ratio	0.5	3.7	-2.6	-3.4	-2.3
Primary balance	1.5	0.2	2.8	4.0	2.3
Δ primary expenditure ratio	0.2	0.7	-0.3	-0.5	-0.2
Δ revenue ratio	0.2	0.4	0.0	-0.1	0.0
Real GDP growth	2.6	1.5	3.6	3.8	3.5
Real GDP trend growth	2.6	2.2	3.0	3.4	2.8
Real output gap	0.0	-0.6	0.6	0.4	0.7
Real implied interest rate	3.9	4.2	3.6	4.2	3.3
No. of observations	375	184	191	59	132

Note: Figures display average annual values of all episodes under consideration using annual data for the EU-15 countries from 1985-2009. The real trend growth is derived by applying the Hodrick-Prescott-Filter to the real GDP growth series for each EU-15 country over the period 1985-2009. The real output gap is then calculated as the difference between the real GDP growth and the trend growth.

Source: European Commission, 2009, AMECO (Annual Macroeconomic Data) database.

As can be seen in Table 3 the increase in the public debt-to-GDP ratio was mainly driven by low fiscal balances with increasing expenditure ratios in an environment of sluggish trend growth. Whereas public debt reductions mainly occurred during times of strong economic growth and were driven by high primary balances induced by expenditure cuts.

Looking at major and modest debt reduction episodes, the average year-on-year change in the debt ratio is much higher in the case of major debt reductions than in the case of modest debt reductions. During the major episodes debt was annually reduced by 3.4 percentage points on average, while in the case of modest debt reductions the average year-on-year change was about 2.3 percentage points. Looking at the potential drivers of a major debt reduction, the primary balance seems to be a striking factor.

The primary surpluses were on average almost twice as high during the episodes of major debt reductions if compared to the episodes of modest debt reductions. This already indicates that pronounced tightening of fiscal policies contributed importantly to major debt reductions.⁵ Further, it is interesting to note that revenue increases do not seem to have induced debt reductions, whereas cuts in primary expenditure seem to have contributed significantly in the case of major debt reductions.

Table 4: Change in interest burden during major public debt reductions

Country	Period of major debt reduction ($t_0 - t_n$)	Interest burden (in % of GDP)		Change in interest burden ($t_n - t_{-1}$)
		Peak (t_{-1})	Trough (t_n)	
		Austria		
Belgium	1994-2007	10.8	3.9	-6.9
Denmark	1994-2007	6.7	1.6	-5.1
Finland	1997-2002	4.2	2.1	-2.1
	2004-2008	1.9	1.5	-0.4
France				
Germany				
Greece				
Ireland	1994-2006	6.6	0.9	-5.7
Italy	1996-2003	11.6	5.2	-6.4
Luxembourg				
Netherlands	1996-2002	5.6	2.8	-2.8
Portugal	1996-2000	5.8	3.1	-2.7
Spain	1997-2007	5.2	1.6	-3.6
Sweden	1985-1990	8.1	4.8	-3.3
	1996-2000	5.3	3.5	-1.8
	2003-2008	3.1	1.7	-1.4
UK	1985-1990	5.1	3.7	-1.4
	1997-2002	3.6	2.0	-1.6

Source: European Commission, 2009, AMECO (Annual Macroeconomic Data) database.

It is also worth noting that major debt reductions mainly occurred in times of higher interest burden or debt servicing cost. In particular, the

⁵Even though the cyclically adjusted primary balance would allow to adjust for the influences of the business cycle and therefore, entail more information about the effectiveness of fiscal policies on debt reductions than the primary balance itself, we refrain from using this measure for several reasons. First, cyclically adjusted primary balances are not yet available in a comparable manner across the countries under consideration. Second, this concept is subject to several drawbacks which are linked to methodological problems in estimating budgetary sensitivities and trend growth as well as the disputable treatment of revenue windfalls and shortfalls (Jonung and Larch, 2006; Salto, 2005; Forni and Momigliano, 2005).

requirement of the market participants to take on a government's debt only in return for higher bond yields might have put pressure on governments to substantially and persistently reduce public debt. Major debt reductions may have become necessary to contain the self-reinforcement effect of public debt accumulation arising from a positive differential between the implied interest rate and the GDP growth rate. As can be seen in Table 4 the high interest burden faced by the governments to refinance the debt might therefore have played a disciplinary role forcing the governments to persistently curb back public debt.

4 Empirical analysis and results

In this section we assess empirically whether and to what extent the factors discussed in the previous section affect the success of major debt reductions. Our empirical investigation is based on a logistic model with the aim to estimate the probability that the debt-to-GDP ratio will decline by at least 10 percentage points in 5 consecutive years, conditional upon information about the implementation of fiscal consolidation and upon the macroeconomic environment.

Using a truncated panel data set of debt reduction years we estimate a logistic probability model, defining

$$P_i = E[S = 1 | Z_i] = \frac{e^{Z_i}}{1+e^{Z_i}} \quad (1)$$

where $E[S = 1 | Z_i]$ is the conditional expectation of the success of a debt reduction, given Z_i , with

$$S = \begin{cases} 1, & \text{in case of a major debt reduction} \\ 0, & \text{in case of a modest debt reduction} \end{cases} \quad (2)$$

One can interpret equation 2 as the conditional probability that a major debt reduction occurs given Z_i , and

$$Z_i = \beta_0 + \beta_1 f_i + \beta_2 PEXP_i + \beta_3 trendg_i + \beta_4 outputg_i + \beta_5 burden_i \quad (3)$$

where f_i is the sum of the primary balance in the two years prior to the debt reduction period. This controls for the effect that with sticky primary deficits debt reductions starting from high primary balance ratios will tend to be more successful.⁶ $PEXP_i$ is a dummy variable, which controls for the composition of the fiscal adjustment, i.e. whether or not the change in primary expenditure is significant vis-à-vis the change in the primary balance. We construct the expenditure dummy as follows:

$$PEXP_t = \begin{cases} 1, & \text{if } (\Delta PEXP_t / \Delta pb_t) > \lambda \\ 0, & \text{otherwise} \end{cases} \quad (4)$$

A fiscal adjustment is defined as expenditure based if at least λ percent of the change in the primary budget balance in percent of GDP comes from current expenditure cuts.

The explanatory variable $trendg_i$ represents the real trend growth computed by applying the Hodrick-Prescott-Filter on the real GDP growth series for each country under consideration over the period 1985-2009. The variable $outputg_i$ represents the change in the output gap and is computed as the difference between real GDP growth and real trend growth. These explanatory variables are supposed to absorb the effects of the business cycle on public debt developments. The last variable that we consider is $burden_i$, which represents the debt financing costs as a percentage of GDP. It is included in order to observe whether the interest burden has a stabilizing effect.

⁶Leaving out this control variable does not change the results materially.

In order to achieve more conclusive results on the structure of fiscal consolidation which is more likely to lead to a major debt reduction we also assess a slightly modified version of Z_i by exchanging the expenditure dummy by a revenue dummy.

$$Z_i = \beta_0 + \beta_1 f_i + \beta_2 REV_i + \beta_3 trendg_i + \beta_4 outputg_i + \beta_5 burden_i \quad (5)$$

The revenue dummy is defined in an analogous way to the expenditure dummy.⁷

4.1 Estimation results

The estimation results of the equations (3) and (5) are reported in Table 5. To address the fact that most of the episodes occurred consecutively over a longer period of time which may result in autocorrelation in the error term, the estimation results are based on non-zero between cluster error terms which correct for the potential heterogeneity between the independent debt reduction periods. This allows us to specify that observations are independent across clusters of episodes but not necessarily independent within clusters of episodes.

⁷ $REV_t = \begin{cases} 1, & \text{if } (\Delta REV_t / \Delta pb_t) > \lambda; \\ 0, & \text{otherwise} \end{cases}$

Table 5: Estimation results

	Threshold for the dummy variable $\lambda = 70$		Threshold for the dummy variable $\lambda = 60$	
	(1)	(2)	(1')	(2')
	Fiscal impulse	0.10** (0.05)	0.09* (0.05)	0.09* (0.05)
PEXP	0.74** (0.36)		0.52 (0.38)	
REV		0.04 (0.61)		-0.07 (0.58)
Trend growth	0.43*** (0.15)	0.42*** (0.15)	0.42*** (0.15)	0.42*** (0.15)
Output gap	-0.03 (0.07)	-0.02 (0.07)	-0.03 (0.07)	-0.02 (0.07)
Interest burden	0.23** (0.10)	0.22** (0.10)	0.22** (0.10)	0.22** (0.10)
Constant	-3.76*** (0.85)	-3.49*** (0.83)	-3.65*** (0.83)	-3.46*** (0.83)
No. of observations	191	191	191	191
No. of major debt reductions	59	59	59	59
Pseudo R^2	0.15	0.13	0.14	0.13
Wald χ^2 (5) statistics	14.09	11.72	13.00	11.04
Marginal effects				
Fiscal impulse	0.02	0.02	0.02	0.02
PEXP	0.16		0.11	
REV		0.01		-0.01
Trend growth	0.09	0.09	0.09	0.09
Output gap	-0.01	0.00	-0.01	0.00
Interest burden	0.05	0.05	0.05	0.05

Note: Cluster robust standard errors are given in parenthesis. ***, **, * indicate statistical significance at 1%, 5% and 10% levels, respectively. Marginal effects (dP/dZ) indicate the marginal change in the probability of success for the average values of the independent variables. In case of dummy variables the marginal effects refer to the discrete change from 0 to 1.

Our results suggest that the composition of the fiscal adjustment plays an important role in explaining the success of a debt reduction. The expenditure dummy which reflects the size of the change in the primary expenditure relative to the change in the primary balance has the expected positive sign and is statistically significant. The results indicate that the discrete change of the expenditure dummy from 0 to 1 increases the probability of a major debt reduction by more than 10 percent. The revenue dummy, on the other hand, turns out to be statistically insignificant. Therefore, it seems that expenditure-based consolidations have a higher probability to succeed, while tax increases are less likely to contribute to a large and persistent debt reduction.

Further, our results suggest that real trend growth is an important factor determining the success of a debt reduction. A one percent increase in real trend growth increases the probability of a major debt reduction by nine percent. The change in the output gap, however, turns out to be statistically insignificant. Against this background, our results suggest that the implementation of sound macroeconomic and structural policies promoting growth is crucial for a major debt reduction because it helps countries to “grow their way out” of indebtedness. Here, the literature also points to a positive feedback effect with decisive expenditure-based fiscal consolidation because this type of consolidation appears to foster growth, in particular in times of severe fiscal imbalances (see Section 2.2. and the literature quoted there, in particular, Giavazzi and Pagano, 1990 and 1996; Alesina and Perotti, 1995 and 1997; Afonso et al., 2006). The control variable on the level of the primary balance prior to the debt reduction has the expected positive sign. As expected, inflation does not contribute to major debt reductions. Further, the negative and significant constant term might reflect the political-economy induced debt-deficit bias.

Another factor which determines the success of a debt reduction is the interest burden. It turns out to be statistically significant and has a positive sign. A one percent increase in the interest burden increases the probability of a major debt reduction by five percent. This finding supports the view that the increase in debt servicing cost faced by governments to refinance their debt plays a disciplinary role strengthened by market forces. Because financial markets are only willing to take on more of government debt in return for higher bond yields, this sets a strong incentive for governments to consolidate forcefully.

4.2 Identifying the composition of government expenditure cuts

In the next step we analyze which types of government expenditure cuts are more likely to lead to a major debt reduction. The following five components are considered: (a) subsidies paid by the general government, (b) social benefits including social security benefits, retirement pensions paid by autonomous pension funds and social assistance benefits such as child allowances and welfare benefits, (c) government consumption of goods and services, (d) compensation of employees including salaries, wages and employers' social contributions and (e) the gross fixed capital formation of the government.

Table 6: Characteristics of expenditure-based consolidations

	Debt reduction	Major debt reduction	Modest debt reduction
No. of episodes	191	59	132
No. of debt reduction episodes with: $\Delta PEXP_t/\Delta pb_t > 60$	58	22	36
<i>Of which average annual change in:</i>			
Total expenditure	-1.97	-2.07	-1.87
Subsidies	-0.13	-0.16	-0.10
Social benefits	-0.62	-0.69	-0.55
Government consumption	-0.48	-0.54	-0.42
Compensation of employees	-0.33	-0.37	-0.28
Gross fixed capital formation	-0.10	-0.07	-0.12

Source: European Commission, AMECO (Annual Macroeconomic Data) database

Of all the 191 debt reduction episodes 58 episodes included an expenditure-based consolidation according to our definition. Table 6 displays the year-on-year changes of the government expenditure components during the time of expenditure-based consolidations for the major and modest debt reduction episodes. As can be seen in Table 6 expenditure cuts were more pronounced in the case of major debt reductions than in the case of modest debt reductions. The only exception seems to be the gross fixed capital formation component. Further, it is worth noting that especially the cuts in social benefits seem to be relatively high, followed by government consumption and the compensation of employees.

In order to assess whether and to what extent the expenditure components affect the success of large debt reductions, we estimate the previously defined logistic model with slightly modified versions of Z_i of the following general form:

$$Z_i = \beta_0 + \beta_1 f_i + \beta_2 trendg_i + \beta_3 outputg_i + \beta_4 burden_i + \beta_5 dummy_i \quad (6)$$

The variable $dummy_i$ now controls for the composition of the government expenditure cuts, i.e. whether or not the change in the expenditure component is significant vis-à-vis the change in the primary expenditure cuts. We construct the expenditure component dummies in the following general form:

$$Dummy_i = \begin{cases} 1, & \text{if } (\Delta Com_t / \Delta PEXP_t) > \mu \\ 0, & \text{otherwise} \end{cases} \quad (7)$$

The dummy variable takes the value of one, if the change of the expenditure component vis-à-vis the change of the primary expenditure is higher than its average value among all expenditure-based consolidations and it takes the value of zero otherwise. The results are presented in Table 7.

Table 7: Estimation results

	(1)	(2)	(3)	(4)	(5)
Fiscal impulse	0.09* (0.05)	0.10** (0.04)	0.09* (0.05)	0.10** (0.02)	0.09* (0.05)
Trend growth	0.45*** (0.15)	0.44*** (0.15)	0.41*** (0.15)	0.43*** (0.15)	0.42*** (0.15)
Output gap	-0.01 (0.07)	-0.02 (0.06)	-0.02 (0.07)	-0.02 (0.06)	-0.02 (0.07)
Interest burden	0.24** (0.11)	0.23** (0.10)	0.22** (0.10)	0.23** (0.10)	0.23** (0.10)
Subsidies	-1.26 (0.90)				
Social benefits		1.38*** (0.33)			
Government consumption			0.56 (0.45)		
Compensation of employees				1.12** (0.49)	
Gross fixed capital formation					-0.05 (0.42)
Constant	-3.57*** (0.87)	-3.86*** (0.81)	-3.58*** (0.83)	-3.80*** (0.86)	-3.47*** (0.82)
No. of observations	191	191	191	191	191
No. of major debt reductions	59	59	59	59	59
Pseudo R^2	0.14	0.17	0.14	0.16	0.13
LR (5) statistics	12.14	31.62	12.50	14.73	10.85
Marginal effects					
Fiscal impulse	0.02	0.02	0.02	0.02	0.02
Trend growth	0.09	0.09	0.09	0.09	0.09
Output gap	0.00	0.00	0.00	0.00	0.00
Interest burden	0.05	0.05	0.04	0.05	0.05
Subsidies	-0.19				
Social benefits		0.31			
Government consumption			0.12		
Compensation of employees				0.26	
Gross fixed capital formation					-0.01

Note: Cluster robust standard errors are given in parenthesis. ***, **, * indicate statistical significance at 1%, 5% and 10% levels, respectively. Marginal effects (dP/dZ) indicate the marginal change in the probability of success for the average values of the independent variables. In case of dummy variables the marginal effects refer to the discrete change from 0 to 1.

The estimation results indicate that expenditure-based consolidation which mainly concentrates on cuts in social benefits and government wages is more likely to lead to a major debt reduction. A significant decline in social benefits or public wages vis-à-vis the overall decline in the primary expenditure will increase the probability of a major debt reduction by 31 and 26 percent, respectively. Sizeable cuts in government subsidies, government consumption and gross fixed capital formation, on the other hand, turned out to be insignificant in explaining the success of a debt reduction.

4.3 Robustness tests

The robustness of our results is tested by the following measures: (1) accounting for panel heterogeneity across countries and (2) using an alternative definition of a major debt reduction episode. All in all, the results of the alternative specifications indicate that the reported results seem to be robust to variations of the logistic probability model.

Since panel heterogeneity may result in autocorrelation in the error terms due to country-specific effects, we reestimate the logit specifications controlling for the differences of the countries under consideration. This allows us to specify that observations are independent across countries but not necessarily independent within a country. Table 8 in the Appendix shows that in general the results are robust if compared with the baseline results.

Further, we test the model using an alternative definition of a major debt reduction. The alternative that we take into consideration refers to a more demanding threshold for the cumulative debt reduction. In this case we define an episode as successful, if the debt-to-GDP ratio declines by 15 percentage points in 5 consecutive years. One drawback of this definition is, however, that it reduces the number of major episodes. Table 9 in the Appendix reports the results using a threshold of 15 percentage points. Again, the results are broadly consistent with our baseline model.

5 Conclusions

Many of the EU-15 countries will have to undertake policy measures in the near future to reverse the trend of rising debt ratios. Therefore, the question of how to successfully reduce public debt is of eminent interest.

Based on the estimation of different specifications of a logistic probability model over the period 1985-2009, our results indicate that especially the composition of the fiscal adjustment, the real trend GDP growth and the interest burden are crucial factors in explaining the success of a debt reduction. The results are robust to alternative thresholds for the identification of major debt reductions and the composition dummies.

First, our results suggest that major debt reductions are mainly driven by decisive and lasting (rather than timid and short-lived) fiscal consolidation efforts focused on reducing government expenditure, in particular, cuts in social benefits and public wages. Revenue-based consolidations do not seem to contribute to a major debt reduction.

Second, robust real GDP growth also increases the likelihood of a major debt reduction because it helps countries to “grow their way out” of indebtedness. Short-term fluctuations in the business cycle, however, do not seem to affect the success of a debt reduction. The literature also points to a positive feedback effect of decisive expenditure-based fiscal consolidation to growth because this type of consolidation seems to foster growth, in particular in times of severe fiscal imbalances (for a literature review see Section 2.2). In this regard, our results present a starting point for further research: given that periods of strong growth by themselves facilitate a reduction in expenditure ratios, there is a risk that the underlying policy effort in such periods is overestimated. In

other words, the reduction in expenditure ratios reflects less an active fiscal policy tightening but rather a windfall from an overall favourable (if unsustainable) economic environment. Further research could try to disentangle the precise fiscal impacts of such particularly favourable periods.

Third, high debt servicing costs play a disciplinary role and require governments to set up credible plans to stop and reverse the increasing debt ratios. Because financial markets are only willing to take on more of government debt in return for higher bond yields, this sets a strong incentive for governments to consolidate forcefully.

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Appendix

Table 8: Estimation results: Panel heterogeneity clusters

	Threshold for the dummy variable $\lambda = 70$		Threshold for the dummy variable $\lambda = 60$	
	(1)	(2)	(1')	(2')
PEXP	0.74** (0.34)		0.52 (0.35)	
REV		0.04 (0.63)		-0.07 (0.62)
Trend growth	0.43*** (0.09)	0.42*** (0.08)	0.42*** (0.09)	0.42*** (0.09)
Output gap	-0.03 (0.06)	-0.02 (0.06)	-0.03 (0.06)	-0.02 (0.06)
Interest burden	0.23** (0.10)	0.22** (0.10)	0.22** (0.10)	0.22** (0.10)
Constant	-3.76*** (0.77)	-3.49*** (0.77)	-3.65*** (0.78)	-3.46*** (0.79)
No. of observations	191	191	191	191
No. of major debt reductions	59	59	59	59
Pseudo R^2	0.15	0.13	0.14	0.13
Wald χ^2 (5) statistics	29.93	30.93	28.86	29.29
Marginal effects				
Fiscal impulse	0.02	0.02	0.02	0.02
PEXP	0.16		0.11	
REV		0.01		-0.01
Trend growth	0.09	0.09	0.09	0.09
Output gap	-0.01	0.00	-0.01	0.00
Interest burden	0.05	0.05	0.05	0.05

Note: Cluster robust standard errors are given in parenthesis. ***, **, * indicate statistical significance at 1%, 5% and 10% levels, respectively. Marginal effects (dP/dZ) indicate the marginal change in the probability of success for the average values of the independent variables. In case of dummy variables the marginal effects refer to the discrete change from 0 to 1.

Table 9: Estimation results: Threshold 15 percentage points

	Threshold for the dummy variable $\lambda = 70$		Threshold for the dummy variable $\lambda = 60$	
	(1)	(2)	(1')	(2')
PEXP	0.88** (0.45)		0.53 (0.46)	
REV		-0.26 (0.59)		-0.33 (0.57)
Trend growth	0.42*** (0.13)	0.44*** (0.13)	0.43*** (0.13)	0.43*** (0.13)
Output gap	-0.02 (0.09)	-0.02 (0.08)	-0.02 (0.08)	-0.01 (0.08)
Interest burden	0.26** (0.13)	0.26** (0.13)	0.25* (0.13)	0.25** (0.13)
Constant	-4.77*** (1.00)	-4.41*** (0.90)	-4.60*** (0.96)	-4.38*** (0.90)
No. of observations	191	191	191	191
No. of major debt reductions	38	38	38	38
Pseudo R^2	0.18	0.16	0.17	0.16
Wald χ^2 (5) statistics	19.93	25.65	20.94	23.72
Marginal effects				
Fiscal impulse	0.01	0.01	0.01	0.01
PEXP	0.13		0.08	
REV		-0.03		-0.04
Trend growth	0.05	0.06	0.06	0.06
Output gap	0.00	0.00	0.00	0.00
Interest burden	0.03	0.03	0.03	0.03

Note: Cluster robust standard errors are given in parenthesis. ***, **, * indicate statistical significance at 1%, 5% and 10% levels, respectively. Marginal effects (dP/dZ) indicate the marginal change in the probability of success for the average values of the independent variables. In case of dummy variables the marginal effects refer to the discrete change from 0 to 1.

