ENDOGENOUS FISCAL CONSOLIDATIONS

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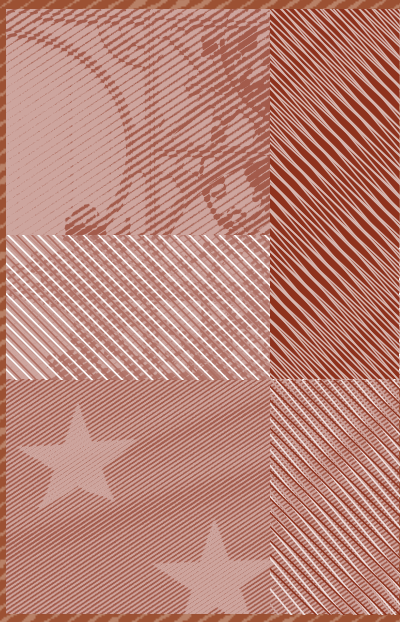
Documentos de Trabajo
N.º 1102



BANCO DE **ESPAÑA**
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ENDOGENOUS FISCAL CONSOLIDATIONS [*]

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BANCO DE ESPAÑA

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ISSN: 0213-2710 (print)
ISSN: 1579-8666 (on line)
Depósito legal: M. 13453-2011
Unidad de Publicaciones, Banco de España

Abstract

There is evidence in the literature of fiscal consolidation episodes producing (non-Keynesian) expansionary effects (e.g. Alesina and Ardagna, 1998). We replicate this result for a panel of OECD countries under exogeneity of the fiscal tightening decision, and provide evidence that this decision is endogenous to GDP so that the exogeneity assumption might be inappropriate. Once this endogeneity is taken into consideration, we find that fiscal consolidations have a negative impact on GDP as expected in a Keynesian framework. We also investigate the determinants of successful consolidations. In particular, we use model averaging to overcome the problem of model uncertainty, and conclude that economic recovery and cuts in public wages are the most important ingredients of a consolidation program for successfully reducing budget deficits.

Keywords: Fiscal consolidation, panel data, endogeneity, model averaging.

JEL classification: H30, H62, C23.

Resumen

Hay evidencia en la literatura sobre episodios de consolidación fiscal que producen efectos expansivos (no keynesianos) (por ejemplo, Alesina y Ardagna, 1998). En este documento replicamos este resultado para un grupo de países de la OCDE asumiendo exogeneidad de la decisión de ajuste fiscal, y aportamos evidencia de que esta decisión es endógena respecto al PIB, por lo que el supuesto de exogeneidad podría ser inadecuado. Una vez que esta endogeneidad se tiene en cuenta, encontramos que las consolidaciones fiscales tienen un impacto negativo sobre el PIB como se esperaba en un marco keynesiano. También investigamos los determinantes de las consolidaciones exitosas. En particular, se utiliza un promedio Bayesiano de modelos para atajar el problema de la incertidumbre del modelo, y concluimos que la recuperación económica y los recortes en los salarios públicos son los ingredientes más importantes de un programa de consolidación para lograr reducir el déficit presupuestario.

Palabras clave: Consolidación fiscal, datos de panel, endogeneidad, promediado de modelos.

Códigos JEL: H30, H62, C23.

1 Introduction

In response to the global crisis that erupted in 2008, comprehensive support packages have been implemented by fiscal authorities in many G20 countries. These expansionary fiscal measures, together with cyclical revenue losses and expenditure hikes, have resulted in sharp increases in budget deficits. Therefore, many governments are already preparing (or have already implemented) budgetary consolidation measures to ensure fiscal sustainability. In this context it is interesting to investigate the potential impact of fiscal consolidations on economic growth, an issue that it is far from having a definitive answer in the literature.

Giavazzi and Pagano (1990) describe the possibility that fiscal consolidation episodes could be expansionary for an economy, challenging the broadly accepted Keynesian notion concerning the existence of a positive fiscal policy multiplier.[1] In particular, they observed a consumption increase during the fiscal stabilisation in Ireland from 1987 to 1989 and in Denmark from 1983 to 1986. Since this consumption increase was not fully explained by the usual sources such as disposable income, the authors concluded that it was due to the fiscal adjustment and thus these episodes constituted expansionary fiscal adjustments.

Giavazzi and Pagano's (1990) paper has generated a growing literature concerning the so-called non-Keynesian effects of fiscal policy, e.g. Cour et al. (1996), Alesina and Ardagna (1998, 2010), Miller and Russek (2003). These studies are based on empirical analyses in which they first identify periods of drastic and sizeable budget cuts within a panel of OECD countries, and then perform a descriptive analysis of the sample characteristics of macroeconomic aggregates, mainly GDP, before, during, and after the year in which the consolidation episode took place. The main conclusion from this literature is that fiscal adjustments are often followed by an improved growth performance, which is interpreted as evidence of non-Keynesian effects during fiscal consolidation episodes.

A positive correlation between fiscal consolidation episodes and GDP growth does not necessarily mean that fiscal consolidations generate economic growth. In fact, this literature usually assumes that the consolidation episode is exogenous to GDP, and thus causality issues are well beyond the scope of these papers.[2] The positive correlation between fiscal adjustments and economic growth may be the result of a positive effect from GDP growth to fiscal consolidation instead of the other way around as suggested

[1] Feldstein's (1982) paper is probably the first to find evidence in favor of the non-Keynesian hypothesis of fiscal policy. In particular, the paper presents a negative and statistically significant estimate for the public expenditure coefficient in a private consumption function. Feldstein argued that reductions in public expenses may be expansionist if they are seen as an indication of future tax cuts. Kormendi and Meguire (1990) also find evidence of this non-Keynesian result.

[2] Some attempts have been made in the literature to address this potential endogeneity issue. For example, Ardagna (2004) instruments fiscal consolidation episodes with political variables such as the orientation of the government party, but ignores the endogeneity of other fiscal variables such as the size of the consolidation. Giavazzi and Pagano (1996) and Giavazzi et al. (2000) respectively estimate consumption and savings equations accounting for potential endogeneity problems of fiscal variables such as taxes (i.e. the instrument government taxes with the government surplus), but ignore the potential endogeneity of the fiscal adjustment episode per se.

in this literature: the expectation of a recovery (stronger during the trough of the cycle) may increase the likelihood of public finance consolidation (i.e. consolidation episodes are endogenous to GDP). Accepting as valid the main empirical analysis and framework of these previous papers, the main aim of this paper is first to tackle these endogeneity issues in order to investigate whether there is a causal effect from fiscal consolidation to GDP growth in the short run (i.e. non-Keynesian effects of fiscal adjustment episodes). Our main conclusion is that endogeneity biases are chiefly responsible for the non-Keynesian results previously found in the literature; hence, fiscal adjustments are found to have a negative effect on GDP growth.

Another critical point in previous approaches is the definition of the fiscal consolidation episodes. Selecting large-scale fiscal adjustments implies, on the one hand, choosing a measure of fiscal policy, and, on the other, defining what "large-scale" means precisely. As for the measure of fiscal policy, the empirical literature essentially relies on large reductions observed in the cyclically adjusted primary budget balance (e.g. Blanchard, 1993). With respect to the meaning of "large scale", we might consider the size criterion (i.e. a sufficiently large reduction in the primary balance in a given period), the persistence criterion (i.e. a sufficiently long time period during which the primary budget balance constantly improves), or a combination of both. However, all these fiscal consolidation definitions suffer from a potential problem of sample selection. This is so because, according to the different criteria employed in the literature, the different studies only analyse successful consolidations while many failed attempts to reduce fiscal deficits are ignored. In search of exogenous sources of variation in fiscal policy, Ramey and Shapiro (1998), and Romer and Romer (2010) follow a narrative approach for defining large discretionary changes in fiscal policy that do not depend on the success of the policy.[3] Although both papers are based on a VAR framework,[4] this narrative approach seems to be a promising alternative when defining fiscal consolidation episodes. In fact, the IMF's WEO (October 2010) follows this narrative approach and defines fiscal consolidation episodes for a sample of OECD countries over the period 1980-2009. According to the IMF definition, fiscal consolidations are, on average, followed by negative GDP growth in the short run. In this paper we find that, controlling for endogeneity biases, the two alternative definitions of fiscal consolidations proposed in the literature provide the same result: fiscal adjustments are found to have a negative effect on GDP growth.

Regardless of their impact on GDP, another crucial issue from a policy perspective is how to succeed in terms of deficit reductions and subsequent economic performance when a fiscal consolidation is carried out. According to the different criteria considered in the

[3] Romer and Romer (2010) identify large tax policy actions in the US according to the narrative record, such as presidential speeches and Congressional reports. Ramey and Shapiro (1998) construct a war dummy that identifies large increases in government expenditure due to military reasons in the US.

[4] There is an enormous VAR literature analysing the macroeconomic effects of fiscal policy. Methods for separately identifying government expenditure and government revenue shocks in VARs have been developed in the work of Blanchard and Perotti (2002) and Mountford and Uhlig (2009). Within the VAR framework, Perotti (1999) finds that there is a higher probability of fiscal policy being non-Keynesian when there is a significantly high public debt-to-GDP ratio.

literature, a fiscal consolidation is successful if the reduction in the debt-to-GDP ratio is sufficiently large and persistent (e.g. Alesina and Ardagna, 2010; Alesina and Perotti, 1995). The empirical analysis of the main factors driving this success is controversial because there is no theoretical model of reference. The usual approach in the empirical literature investigating the determinants of success in reducing budget deficits is based on a regression of a dummy variable of successful consolidations on a set of candidate determinants (e.g. Alesina and Ardagna, 1998; Giudice et al., 2007). Due to the lack of clear theoretical guidance, the results depend very much on the particular variables included in the regression. In order to empirically overcome this model uncertainty problem, we avoid the model choice problem and consider model averaging techniques. By doing so we estimate all possible models resulting from different combinations of regressors, and identify the most relevant factors in explaining the success of fiscal consolidation programs. Empirical results indicate that favorable economic conditions in terms of small output gaps are found to be the only relevant factor that unambiguously generates successful (in terms of reducing debt-to-GDP ratios) fiscal consolidations. If the focus is on the persistence of the primary deficit reductions, cutting public wages seems to be the only crucial factor explaining successful fiscal adjustments.[5]

The remainder of the paper is organised as follows. The data used in the paper are described in Section 2. Section 3 illustrates the endogeneity of fiscal consolidation episodes, and Section 4 describes the empirical approach considered to estimate causal effects from fiscal consolidations to economic performance. In Section 5 we present the empirical results. Section 6 investigates the main determinants of successful consolidations. Finally, some concluding remarks are discussed in Section 7.

2 Data

The data used in this paper are from the OECD Economic Outlook No. 84.[6] The sample includes annual information for 21 OECD countries (Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany,[7] Greece, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom and the United States) from 1980 to 2007.

The fiscal variables included in the dataset can be classified in three different groups: (i) those variables related to the fiscal situation of the country (e.g. government debt and primary budget balance as a share of GDP); (ii) variables capturing the composition of the fiscal consolidation (or stimulus) program (e.g. current primary expenditure, government wage and non-wage expenditures, subsidies, income taxes, social security contributions...);

[5] The rationale for this result comes from the investment channel described in Alesina et al. (2002) who emphasize that deficit reductions achieved through spending cuts from the wage bill (rather than tax increases) are more likely to be successful. This is so because cutting public wages might generate downward wage pressures in the private sector that result in higher levels of investment.

[6] We thank Silvia Ardagna for kindly sharing the data.

[7] The data for Germany starts in 1992.

and finally, (iii) the change in cyclically adjusted primary deficit as a proxy for the size of the fiscal manoeuvre. The dataset also incorporates a set of macro variables such as the GDP growth rate, the exchange rate, and the short-term interest rate.

Finally, we also consider in the dataset two different dummy variables identifying the consolidation episodes. On the one hand, we have the dummy from Alesina and Ardagna (2010) — henceforth AA2010 — that identifies a fiscal consolidation episode in a given year if the cyclically adjusted primary balance (CAPB) improves by at least 1.5 per cent of GDP (analogously, a stimulus dummy takes the value 1 if the CAPB deteriorates by at least 1.5 per cent of GDP). Alternatively, we also consider the IMF consolidation dummy defined following the narrative approach and focusing on policy actions (i.e. years in which the government implemented tax hikes or spending cuts to reduce the budget deficit regardless of the change in the CAPB).

Additional information on the variables considered can be found in the Appendix.

3 Are Fiscal Consolidation Episodes Endogenous?

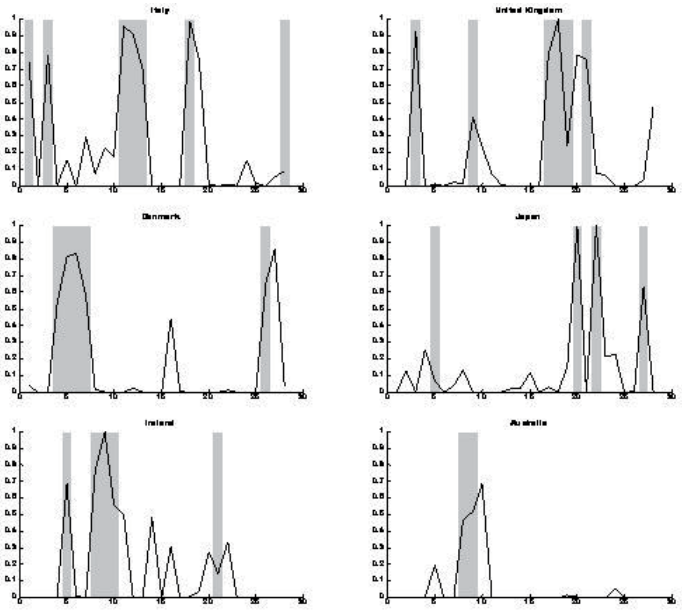
In this section we provide some motivating and heuristic evidence of our main concern throughout the paper, the endogeneity of fiscal consolidation episodes.

It is reasonable to argue that the decision to make a fiscal adjustment by the fiscal authorities is not exogenous to developments in the economy. For example, agents might now anticipate fiscal retrenchments in view of recent increases in budget deficits as a consequence of support packages. The deficit consolidation decision is not an exogenous and unanticipated shock to economic agents, an essential prerequisite to give a causal interpretation to previous non-Keynesian findings in the literature.

In order to informally test this intuition we run a probit of the consolidation dummy on two lags of GDP growth and primary budget deficits. We then estimate the probabilities of a fiscal consolidation being carried out in a given year based on past economic outcomes. These predicted probabilities might be interpreted as the agents' expectations of fiscal adjustments given the course of the economy. In Figure 1 we plot the real consolidation episodes according to the AA2010 definition (top panel) and the IMF definition (bottom panel) represented as grey areas, and a solid line corresponding to the predicted probabilities (or agents' expectations) for a group of six OECD countries (Italy, United Kingdom, Denmark, Japan, Ireland and Australia).

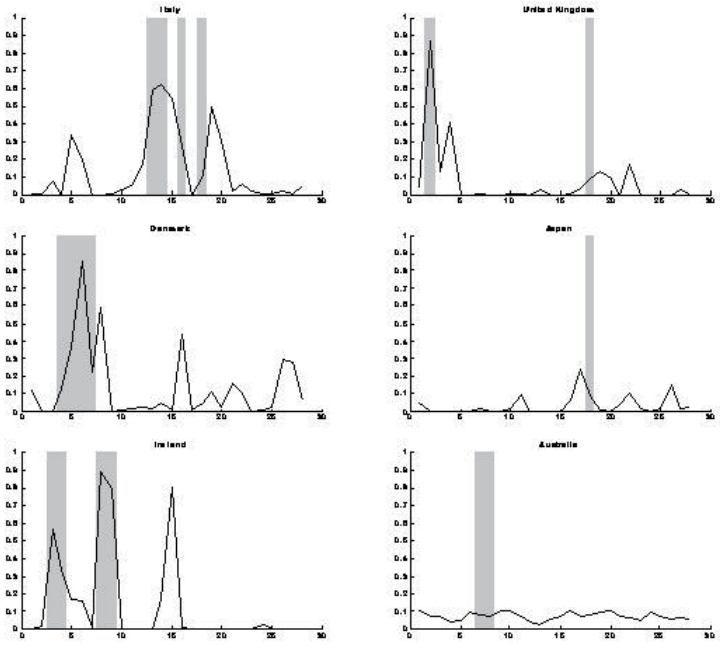
Figure 1: Fiscal Consolidations and Predicted Probabilities

AA2010 Dummy



This graph presents the consolidation episodes over the period 1980-2007 defined as in AA2010 (grey areas) and the precited probabilities from past economic information (solid line).

IMF Dummy



This graph presents the consolidation episodes over the period 1980-2007 defined according to the IMF narrative approach (grey areas) and the precited probabilities from past economic information (solid line).

Looking at the top panel of Figure 1, the AA2010 dummy seems to be fairly endogenous in the sense that it is very well predicted from past economic outcomes so that agents can easily anticipate the consolidation episode according to this definition. We argue that this result invalidates the exogeneity assumption of fiscal consolidation episodes implicitly considered in the literature.

On the other hand, although some consolidation episodes defined according to the IMF narrative criterion in the bottom panel are well predicted from past economic information, some others are not predicted at all. One interpretation is that, as expected from the narrative approach, the IMF dummy is "less endogenous" than the AA2010 dummy. Still, there seems to be an endogeneity problem also with this definition.

In our view, Figure 1 is illustrative of the fiscal consolidation endogeneity we address in this paper.

4 Empirical Approach: Endogeneity vs. Exogeneity

One common approach for estimating the effect of fiscal consolidations on GDP growth is based on a regression of GDP growth between t and $t-1$ (g_t) on a consolidation dummy (D_t) which takes the value one at period t if there was a fiscal consolidation in this year and zero otherwise.[8] In general, studies along these lines implicitly assume that fiscal authorities ignore developments in GDP when taking the decision to make a fiscal consolidation and thus the consolidation is an unanticipated shock to agents in the economy (i.e. the consolidation dummy is exogenous to GDP). The evidence presented in the previous section contradicts this assumption. As a consequence, in this paper we relax this assumption. In particular, our working assumption is that fiscal authorities, when deciding on fiscal policy[9] in year t, take into account developments in the economy up to this year but do not anticipate the future. Given this assumption, fiscal consolidations are no longer unanticipated shocks to economic agents (i.e. the consolidation dummy is partially endogenous to GDP). Note that alternatively we might also assume that fiscal authorities can also predict future GDP (i.e. the consolidation decision is correlated with the full path of GDP growth, past and future). However, identification under this full endogeneity assumption requires extra sources of variation correlated with fiscal policy but fully uncorrelated with GDP, which are not available to the best of our knowledge.

Within an Instrumental Variables (IV) framework the two working hypothesis described in the previous paragraph give rise to two set of instruments for the consolidation dummy. The exogeneity assumption implies that all the observations are valid instruments. In the case of partially endogenous consolidations, only past consolidations are independent of current GDP growth and hence valid instruments.

[8] Note that this is equivalent to the comparison of GDP growth means before and after the consolidation episode.

[9] Note that fiscal policy in our framework is restricted to the binary decision of making a fiscal adjustment or not.

Formally, the panel data model to be estimated is as follows:

$$g_{it} = \alpha g_{it-1} + \beta D_{it} + \eta_i + \delta_t + v_{it} \tag{1}$$

where g_{it} represents the GDP growth rate for country i ($i = 1, ..., N$) in year t ($t = 1, ..., T$), and D_{it} is the consolidation indicator for the same country in the same year. The model also includes country-specific unobserved heterogeneity (η_i) as well as a set of time-varying common factors (δ_t) which allow the existence of cross-sectional correlations across different countries in a given period.

In this framework, the two alternative assumptions are given by:

$$E(v_{it}|g_i^{t-1}, D_i, \eta_i, \delta_t) = 0 \qquad \text{(EXOGENOUS CONSOLIDATION)} \tag{2}$$

$$E(v_{it}|g_i^{t-1}, D_i^t, \eta_i, \delta_t) = 0 \qquad \text{(ENDOGENOUS CONSOLIDATION)} \tag{3}$$

where $g_i^{t-1} = (g_{i1}, g_{i2}, ..., g_{it-1})'$, $D_i = (D_{i1}, ..., D_{it}, ..., D_{iT})'$, and $D_i^t = (D_{i1}, ..., D_{it})'$.

Note that the key difference between the two alternatives is given by the element D_i versus D_i^t in the conditioning set. While in the exogenous consolidation case D_i indicates that the full path of consolidations for a given country i is independent of the shock to GDP in period t, D_i^t in the endogenous consolidation assumption implies that only past consolidation episodes are independent of the current shock to GDP growth while future consolidations will be affected by current GDP growth. Additionally, note that correlation between the country-specific effects and the regressors (g_{it-1} and D_{it}) is allowed, and that endogeneity of the lagged dependent variable due to the dynamics of the model is also taken into consideration.

Given the endogenous consolidation assumption in (3) and the dimensions of our panel dataset[10] we can make use of the panel IV estimator proposed by Anderson and Hsiao (1982) that exploits the following moment conditions:

$$E(\sum_{t=2}^{T} g_{it-2}\Delta v_{it}) = 0 \tag{4}$$

$$E(\sum_{t=1}^{T} D_{it-1}\Delta v_{it}) = 0 \tag{5}$$

Note that the variables are in first-differences to eliminate the fixed effects. Moreover, the number of reduced form coefficients does not grow with T, which is a desirable property given we have a panel in which neither T is small nor N is large. This is why the Anderson and Hsiao (1982) approach is preferred to commonly-used first-differenced GMM (e.g. Arellano and Bond, 1991) estimators in which the proliferation of reduced form coefficients is a concern when we have small samples in the cross-sectional dimension (N) and many time periods (T).

With respect to the exogenous consolidation case, we make use of the same estimator but substituting D_{it-1} by ΔD_{it} in the second moment condition because D_{it} is exogenous and is a valid instrument for itself.

[10] The dataset includes 21 countries ($N = 21$) and 27 years ($T = 27$)

This paper presents the different estimates obtained under the two alternative assumptions. Anticipating the results, while the estimates based on exogenous consolidations produce the so-called non-Keynesian effects (i.e. $\beta > 0$), the estimates based on endogenous consolidations do not (i.e. $\beta < 0$). The results obtained from the version under exogeneity are in line with previous literature. However, by relaxing the exogeneity assumption and allowing a very simple version of endogeneity, we obtain the expected effects in a Keynesian framework (i.e. fiscal consolidations negatively affect GDP growth in the short run). This is true for the consolidation dummy defined as in AA2010. For the IMF definition we obtain that in both cases the effect is negative, confirming the evidence in the previous section that the IMF dummy is "less endogenous".

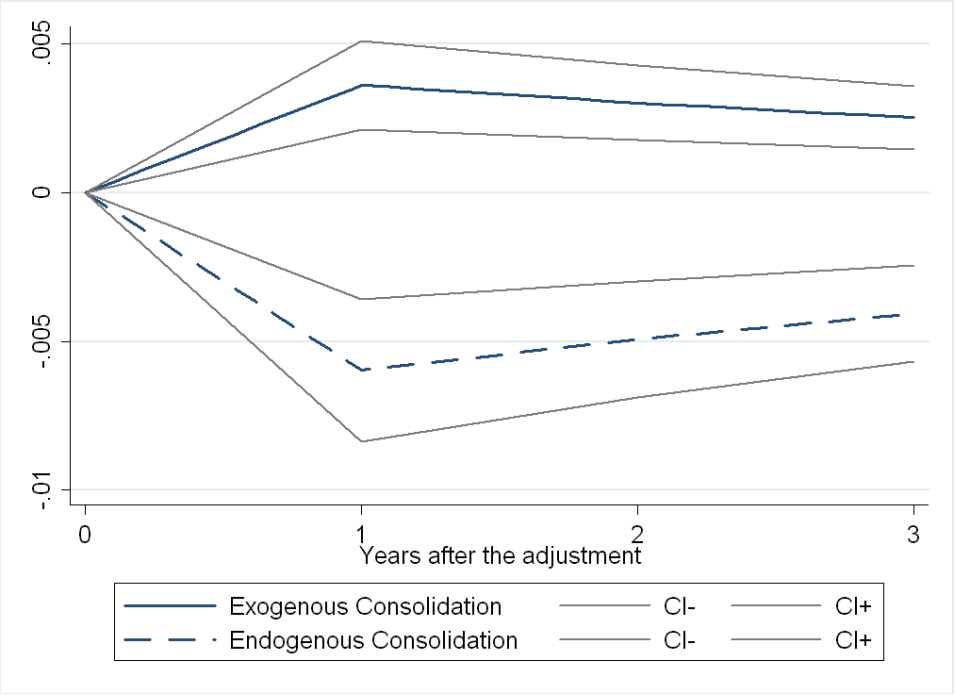
The same exercise is conducted considering a fiscal stimulus dummy (as in AA2010) and the same results with the opposite sign are obtained. While exogenous stimuli produce a reduction in GDP growth, the endogenous ones have the expected positive effects on GDP. Let us present the results with more detail in the next section.

5 Results

We estimate the model in (1) under the two alternative assumptions (2) and (3) and compute the impulse-response functions (IRFs) up to three years ahead together with Monte Carlo simulated standard errors. The top panel in Figure 2 plots the IRFs computed for the AA2010 dummy under exogeneity (solid line) and endogeneity (dashed line) while the bottom panel presents the IRFs corresponding to the IMF dummy.

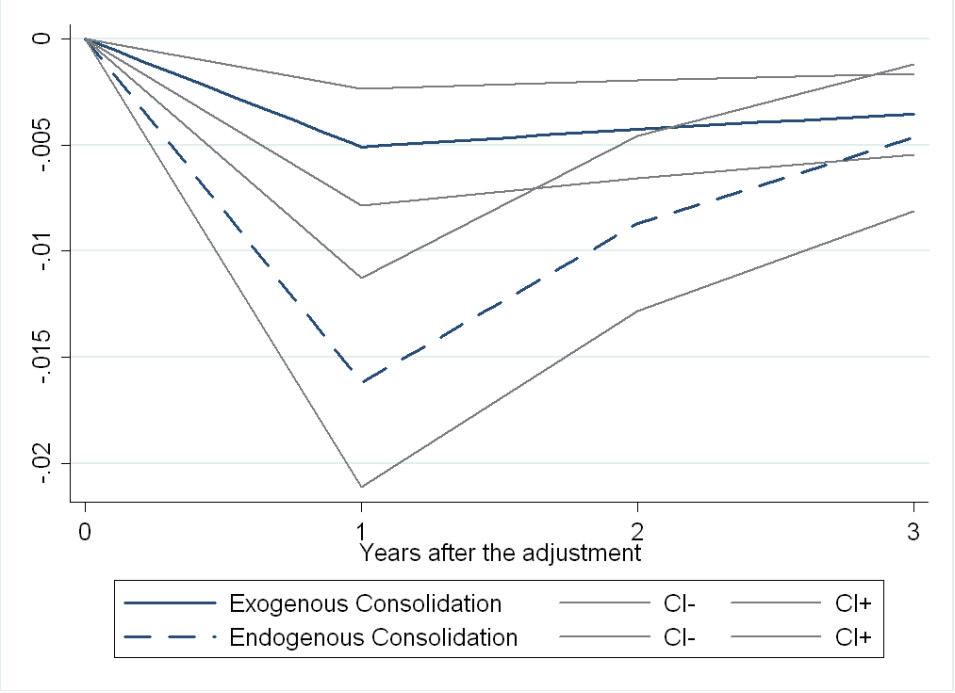
Figure 2: IRFs of a Fiscal Consolidation Shock

AA2010 Dummy



This graph presents the IRFs computed for the effect of a consolidation episode (defined according to the AA2010 criterion) on GDP growth in subsequent periods. The solid line corresponds to a consolidation assumed to be exogenous and the dashed line to an endogenous consolidation.

IMF Dummy

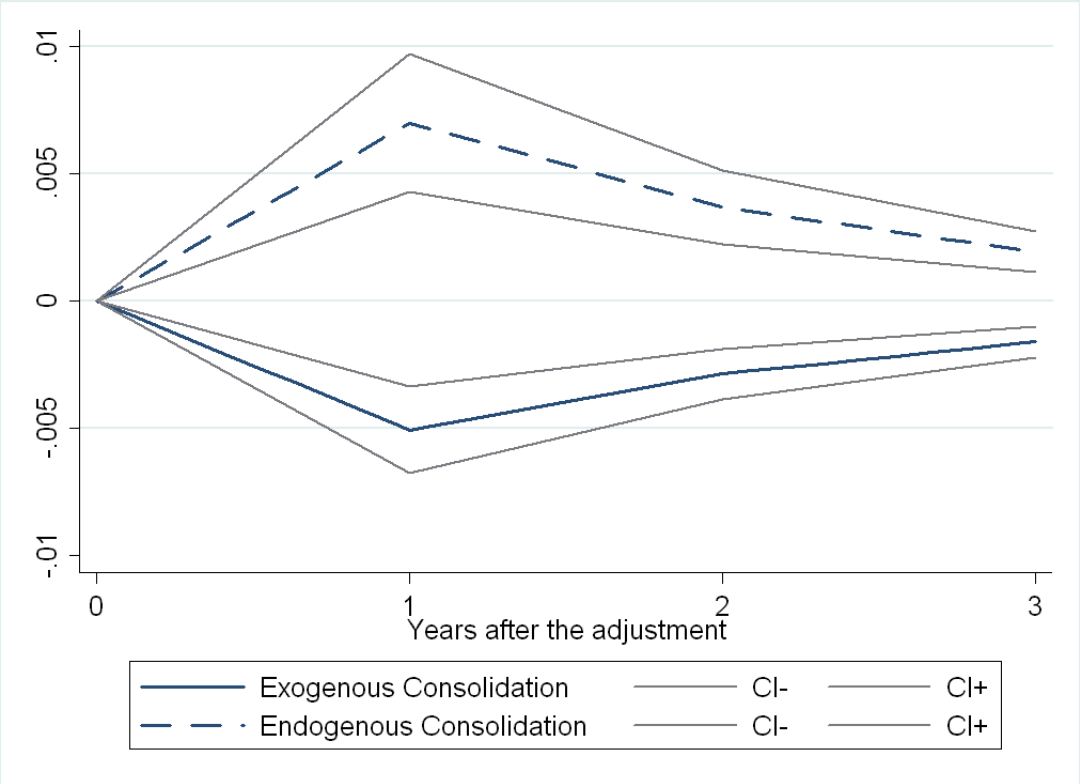


This plot presents the IRFs computed for the effect of a consolidation episode (defined according to the IMF criterion) on GDP growth in subsequent periods. The solid line corresponds to a consolidation assumed to be exogenous and the dashed line to an endogenous consolidation.

In the case of the AA2010 definition the result is enlightening. Assuming exogeneity of the consolidation, we replicate the non-Keynesian result previously found in the literature that the fiscal multiplier might be negative (e.g. Giavazzi and Pagano, 1990; Alesina and Ardagna, 1998). However, once we account for the possible endogeneity of the consolidation decision, we recover the typical Keynesian result and the fiscal adjustment produces a decrease in GDP in the short term. For the IMF definition of consolidation, we find that the impact of the fiscal retrenchment episode is negative in both cases (i.e. under exogeneity and under endogeneity). This is so because, as illustrated in the previous section, the IMF definition is to some extent exogenous to GDP and therefore the "endogeneity bias" is smaller.[11]

As for the stimulus episodes, we can see in Figure 3 that the same results apply: while stimuli assumed to be exogenous produce a negative effect on output, endogenous stimuli have the expected Keynesian effect and generate an increase in GDP in the short run. The magnitude of the effects is similar to that in the case of fiscal consolidations, so that our tentative conclusion is that there is no evidence of non-symmetric effects in this respect.

Figure 3: IRFs of a AA2010 Fiscal Stimulus Shock



This Figure presents the IRFs computed for the effect of a fiscal stimulus program (defined according to the AA2010 criterion) on GDP growth in subsequent periods. The solid line corresponds to a stimulus assumed to be exogenous and the dashed line to an endogenous stimulus.

[11] The associated fiscal multipliers under endogeneity of the fiscal consolidation range from 0.2 using the AA2010 definition to 0.5 considering the IMF definition.

5.1 Heterogeneous Effects

According to Blanchard (1990) and Perotti (1999), if consolidation is undertaken starting from a low level of current debt, a traditional positive fiscal multiplier will ensue. If, instead, fiscal consolidation is made starting from a high debt level, non-Keynesian effects via consumption might appear as a result of an expected increase in permanent income. The reason for this is that by consolidating now, the government will not raise taxes too much in the future to pay back the debt. This reduces the dead-weight loss imposed by taxes, thus raising agents' permanent income.

Alternatively, non-Keynesian effects of consolidations may take place via the behavior of investment. The link between fiscal policy and investment behavior is formalized in Alesina et al. (2002). The main effect is represented by the impact of the government wage bill on the labor market. Investment decisions by firms are driven by the expected present value of the net marginal product of capital, which in turn is a negative function of real wages. Fiscal consolidations obtained through expenditure cuts can then reduce wage pressures and so increase short-run investments. This hypothesis crucially depends upon the composition of adjustment (expenditure cuts, particularly the wage bill, versus tax increases) and on institutional factors such as the functioning of the labor market.

According to the standard Keynesian view, a fiscal consolidation might be expansionary (i.e. it might be followed by revived economic growth) if it is accompanied by a sufficiently lax monetary policy. Therefore a reduction in the interest rate, or a devaluation in the case of a small economy, might generate economic growth during the process of a fiscal consolidation.

In order to maintain the price stability within the Eurozone, the Maastricht criteria impose some requisites on the inflation rate, the annual government deficit, the level of government debt, and the long-term interest rate of the country members. The effects of a fiscal adjustment in countries subject to the Maastricht Treaty might differ from those in countries without these requisites.

During the year 2010, financial crisis have exerted an important effect on fiscal policy and in particular on the timing of fiscal consolidation programs. If fiscal retrenchments are clearly necessary (for instance because the country is paying unsustainable prices for its debt), once the government finally undertakes the consolidation, economic agents might react optimistically increasing consumption and/or investment because they have already discounted the adjustment.

In order to further investigate the existence of expansionary effects through the channels discussed above, we consider the following specification:

$$g_{it} = \alpha g_{it-1} + \beta D_{it} + \gamma Z_{it} D_{it} + \eta_i + \delta_t + v_{it} \tag{6}$$

where Z_{it} is one of the following variables: the government level of debt, the proportion of the adjustment due to cuts in current expenditures and more particularly in the public

wage bill, a structural reform dummy[12] capturing changes in institutional factors during the fiscal consolidation episode, changes in the interest rate and the exchange rate to capture monetary policy movements, a dummy for those country-year under the Maastricht Treaty, and finally, the spread of the ten-year government bond with respect to Japan. These eight variables aim to explain the possibility of fiscal consolidation followed by economic growth.

Note that now the effect of the consolidation on GDP is given by:

$$\phi = \beta + \gamma Z_{it} \tag{7}$$

so that even if β is negative, ϕ might become positive for certain values of the Z variables; for instance, for a sufficiently high level of debt or interest rate spread, for a sufficiently high cut in public wages, for those consolidations accompanied by pro-market structural reforms or expansive monetary policy.

Table 1 presents the results for estimating equation (6) for the four different Z variables considered using the two alternative consolidation dummies available (CAPB-based from AA2010, and action-based from the IMF). As described in the previous section, we estimate the equation under both exogeneity and endogeneity of the Z variables.[13]

[12] We employ the reform dummy in Duval (2008). For the construction of this dummy, we first consider an overall index of rigidity measuring the anti-competitive/distortionary effects of policies for the 21 OECD countries included in our sample over the period 1985-2003 in five policy areas: labor taxes, unemployment benefit system, employment protection legislation (EPL), retirement schemes and product market regulations. Secondly, given this index, a reform in a given policy field is identified by a dummy taking value 1 whenever the corresponding index of rigidity falls sufficiently. As a benchmark, the requirement is a change in the index to be below the 20th percentile of its distribution across the whole sample. A labor market reform dummy from Boeri and Garibaldi (2009) was also considered with the same results.

[13] The consolidation dummy is always assumed to be endogenous.

Table 1: Heterogeneous Effects of Fiscal Consolidations

PANEL A: Estimation Under Exogeneity

	AA2010 Dummy				IMF Dummy			
Z Variable	Government Debt Level	Public Wages	Current Expenditure	Structural Reform	Government Debt Level	Public Wages	Current Expenditure	Structural Reform
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Growth_{t-1}	0.84	0.85	0.85	0.84	0.84	0.85	0.84	0.84
(t-ratio)	(30.7)	(34.2)	(35.4)	(30.0)	(31.4)	(35.8)	(35.7)	(30.8)
Consolidation	−0.04	−0.01	−0.01	−0.007	−0.09	−0.02	−0.02	−0.02
(t-ratio)	(−3.27)	(−3.15)	(−2.74)	(−2.19)	(−2.28)	(−3.17)	(−3.15)	(−2.58)
Z * Consolidation	0.06	0.04	0.009	0.006	0.09	0.009	−0.00	0.007
(t-ratio)	(3.45)	(4.62)	(3.37)	(1.00)	(2.14)	(1.79)	(−1.19)	(1.03)
$\phi > 0$ if:	$Z > 0.66$	$Z > 0.25$	$Z > 1.44$	Never	$Z > 1.00$	Never	Never	Never
Z Variable	Interest rate Change	Exchange rate Change	Maastricht Dummy	Spread	Interest rate Change	Exchange rate Change	Maastricht Dummy	Spread
	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Growth_{t-1}	0.86	0.86	0.84	0.84	0.86	0.85	0.83	0.84
(t-ratio)	(35.9)	(35.3)	(34.1)	(32.8)	(36.6)	(35.5)	(34.5)	(33.5)
Consolidation	−0.008	−0.006	−0.007	−0.02	−0.017	−0.02	−0.02	−0.05
(t-ratio)	(−2.87)	(−2.64)	(−2.64)	(−4.08)	(−3.24)	(−2.91)	(−3.26)	(−2.91)
Z * Consolidation	−0.03	0.03	0.01	0.004	−0.06	0.02	0.02	0.005
(t-ratio)	(−3.54)	(2.23)	(2.51)	(4.62)	(−4.61)	(1.02)	(1.39)	(2.59)
$\phi > 0$ if:	$Z < -0.28$	$Z > 0.23$	$Z = 1$	$Z > 625$	$Z < -0.26$	Never	Never	$Z > 940$

PANEL B: Estimation Under Endogeneity

	AA2010 Dummy				IMF Dummy			
Z Variable	Government Debt Level	Public Wages	Current Expenditure	Structural Reform	Government Debt Level	Public Wages	Current Expenditure	Structural Reform
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Growth_{t-1}	0.85	0.84	0.84	0.84	0.84	0.84	0.84	0.84
(t-ratio)	(34.7)	(33.1)	(33.1)	(30.0)	(34.9)	(34.6)	(34.6)	(30.5)
Consolidation	−0.002	−0.005	−0.016	−0.005	−0.03	−0.01	−0.016	−0.01
(t-ratio)	(−0.29)	(−1.90)	(−3.14)	(−1.76)	(−2.11)	(−3.04)	(−3.31)	(−1.76)
Z * Consolidation	−0.004	−0.008	−0.006	−0.009	0.02	−0.003	−0.00	−0.02
(t-ratio)	(−0.57)	(−0.66)	(−1.57)	(−1.28)	(1.24)	(−0.44)	(−1.25)	(−1.98)
$\phi > 0$ if:	Never	Never	Never	Never	Never	Never	Never	Never
Z Variable	Interest rate Change	Exchange rate Change	Maastricht Dummy	Spread	Interest rate Change	Exchange rate Change	Maastricht Dummy	Spread
	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Growth_{t-1}	0.86	0.86	0.84	0.85	0.86	0.85	0.83	0.84
(t-ratio)	(36.6)	(35.3)	(34.2)	(34.9)	(36.6)	(35.4)	(34.5)	(35.0)
Consolidation	−0.02	−0.006	−0.006	−0.01	−0.02	−0.02	−0.02	−0.02
(t-ratio)	(−3.29)	(−2.58)	(−2.61)	(−2.94)	(−3.29)	(−3.18)	(−3.40)	(−2.99)
Z * Consolidation	−0.006	0.02	0.01	0.001	−0.06	0.04	0.03	0.001
(t-ratio)	(−3.53)	(0.95)	(1.53)	(1.78)	(−3.53)	(1.42)	(1.66)	(1.05)
$\phi > 0$ if:	$Z < -0.28$	Never	Never	Never	$Z < -0.28$	Never	Never	Never

Notes: This table presents the results of estimating equation (6) ($g_{it} = \alpha g_{it-1} + \beta D_{it} + \gamma Z_{it} D_{it} + \eta_i + \delta_t + v_{it}$) under diferent exogeneity/endogeneity assumptions and for two alternative consolidation dummies (AA2010 and IMF). In this specification we regress the GDP growth rate on the consolidation dummy adding an interaction term between the dummy and eight alternative Z variables (Z * Consolidation). This interaction term allows the possibility of a positive effect of the fiscal consolidation episode for certain values of Z even if β is negative. In particular, the overall effect of the fiscal adjustment is given by $\phi = \beta + \gamma Z_{it}$. The significance of the interaction term allows us to test if non-keynesian effects might appear under certain circumstances surrounding the consolidation episode as proposed in the literature (e.g. consumption channel if the debt of Government debt is high enough, investment channel if the adjustment is based on reducing public wages, lax monetary policy accompanying the consolidation...) The Anderson and Hsiao (1982) panel IV estimator is employed in all columns but with different moment conditions depending on the exogeneity/endogeneity assumption of the Z variables. Dependent variable is always the GDP growth rate.

The main conclusion from the estimates in Table 1 is that under endogeneity (Panel B) of the Z variables, in general there is no positive effect from fiscal consolidations to GDP growth through the channels tested (i.e. ϕ is negative). Neither the investment channel

nor the consumption channel of non-Keynesian effects seem to be at work according to these results (see columns from (1) to (8) of Panel B). On the other hand, neither the Masstricht dummy nor the spread of the ten-year government bonds seem to explain consolidations followed by economic growth (see columns (11), (12), (15), and (16) of Panel B in Table 1).

However, the estimates in columns (9) and (13) indicate that a positive coefficient arises when the fiscal consolidation is accompanied by lax monetary policy.[14] In particular, if the fiscal adjustment is carried out together with a reduction in the short-term interest rate larger than 28%, we might expect revived economic growth in the subsequent periods. Our interpretation is that the Keynesian effects of such a monetary policy compensate the negative (and also Keynesian) effects of the fiscal retrechment.

In order to further illustrate the importance of the exogeneity/endogeneity configuration considered, Panel A of Table 1 presents the results under exogeneity. The positive and significant estimates of the monetary policy channel in columns (9) and (13) of Panel A might receive a causal interpretation given the results in the same columns of Panel B. However, the evidence in favor of the consumption channel presented in columns (1) and (5) of Panel A is not confirmed when we take into account endogeneity in columns (1) and (5) of Panel B.

5.2 Effect on Consumption, Investment, and Unemployment

In order to further investigate the channels through which fiscal consolidations affect GDP, we now turn to the estimation of the effects of fiscal consolidations on private consumption, private investment and the unemployment rate for a panel of OECD countries. van Aarle and Garretsen (2003) and Hogan (2004), among others, estimate consumption functions and test whether the impact of government revenues and expenditures on consumption is different when fiscal consolidations take place. Alesina et al. (2002) conduct the same kind of analysis but estimating investment equations instead of consumption equations. We may also interpret the estimate of the consolidation effects on consumption and/or investment as an additional test of the two non-Keynesian hypotheses in the previous section.

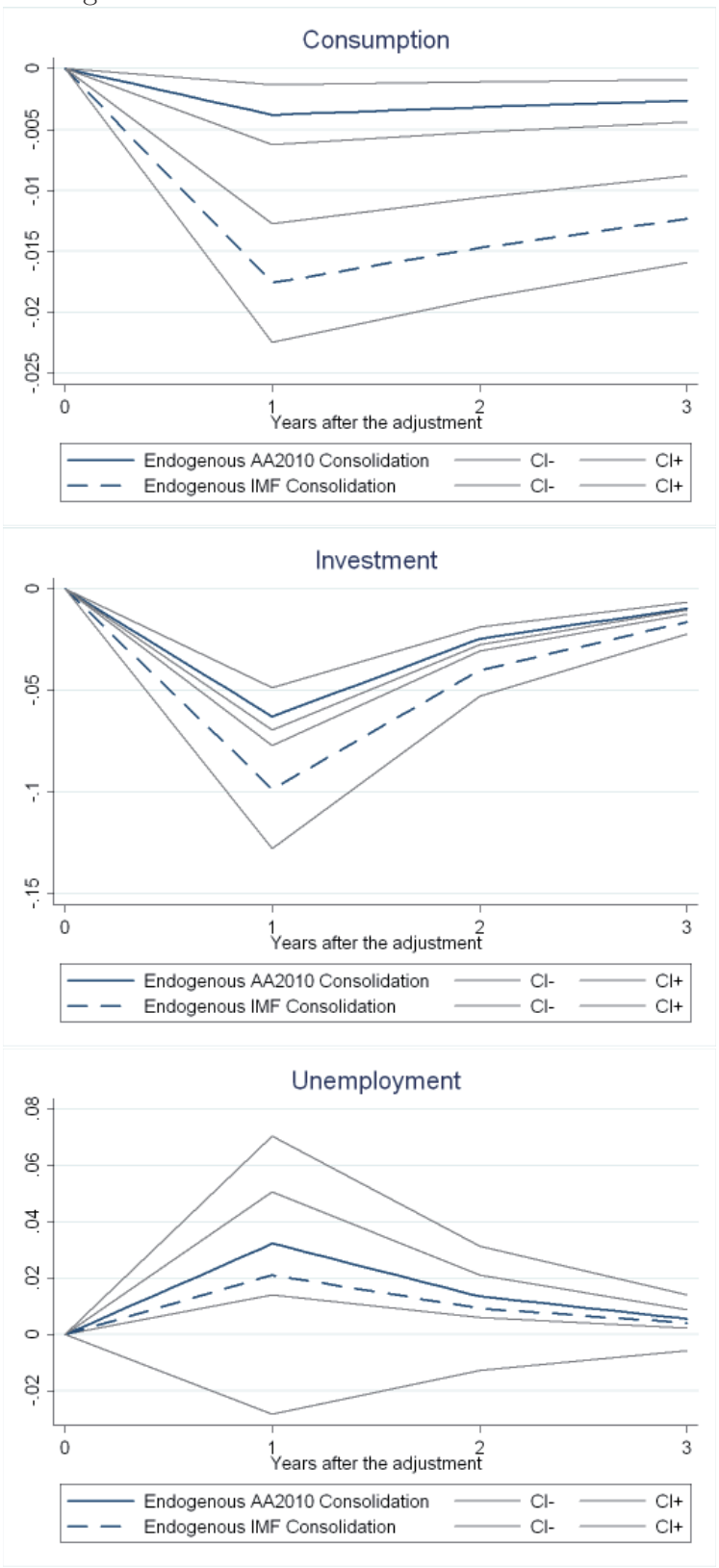
We again estimate equation (1) but replacing GDP growth with consumption, investment, and unemployment growth:

$$g^I_{it} = \alpha g^I_{it-1} + \beta D_{it} + \eta_i + \delta_t + v_{it} \tag{8}$$

where g_{it} represents the growth rate between $t-1$ and t in country i, I=(consumption, investment, unemployment), and the remaining terms are as in equation (1). We estimate this model under endogeneity of the fiscal adjustment for the two alternative definitions of consolidation (AA2010 and IMF).

[14] In the form of interest rate reductions. Changes in the exchange rate do not seem to account for expansionary fiscal consolidations according to the results in columns (10) and (14).

Figure 4: IRFs of a Fiscal Consolidation Shock



This figure plots the IRFs computed for the effect of a consolidation episode on consumption growth (upper panel), investment growth (middle panel), and unemployment growth (bottom panel). The solid line corresponds to a consolidation defined as in Alesina and Ardagna 2010 (AA2010) and the dashed line to the consolidation definition by the IMF. In all cases consolidations are assumed to be endogenous.

Figure 4 plots the IRFs of a consolidation episode on the growth rates of consumption, investment, and unemployment. In all three cases, Keynesian effects arise for the two definitions of fiscal consolidation, the CAPB-based definition by AA2010, and the action-based definition by the IMF (2010). In particular, the effect on consumption and unemployment growth is of a similar magnitude (i.e. a consolidation program lowers the growth rate of consumption by between 4 and 17 basis points in the first year, and increases unemployment growth by $20 - 32$ basis points). The effect on investment is larger; the consolidation causes a decrease in the rate of growth of investment of $60 - 99$ basis points.

6 Determinants of Successful Consolidations

According to AA2010, successful fiscal adjustments are those in which the cumulative reduction of the debt-to-GDP ratio three years after the beginning of the adjustment is greater than 4.5 percentage points.

What are the main characteristics of these successful fiscal consolidations? Understanding under which circumstances a fiscal consolidation might succeed in reducing the level of debt and the primary deficit is crucial from a policy perspective. In order to answer this question, the typical approach in the literature is to construct a successful consolidation dummy that takes the value one for those country-years in which the consolidation succeeded in terms of the previous definition, and zero otherwise. Then, they run a regression of this dummy on a set of macro and fiscal variables capturing the environment in which the successful consolidation took place. Depending on the t-statistics of this regression, they conclude which are the most relevant characteristics surrounding a successful fiscal consolidation.

In broad terms, researchers aim to disentangle the importance of four competing explanations: (i) the country's fiscal situation prior to the consolidation, proxied by, for example, the government debt as a share of GDP in the previous year; (ii) the size of the adjustment proxied by the change in primary deficit during the episode; (iii) the composition of the adjustment in terms of the change in the different items of the public bill as a share of the whole change in the primary deficit; (iv) the macroeconomic situation captured through the output gap or the growth rate of GDP.

The papers by Ardagna (2004), Alesina and Ardagna (1998), and Giudice et al. (2007) are good examples of this approach. All the three papers regress the successful consolidation dummy on a set of regressors aiming to capture some of the four hypothesis described above. However, there is no agreement on which regressors / hypothesis must be included in the empirical model (model uncertainty), so that each of the three papers considers a different model. Table 2 presents the results we obtain replicating the regressions in these papers but using our dataset.[15]

[15]Note here that some of the results are not exactly replicated because either the sample period or the variables' definition is not equal to the original papers. Nevertheless, these results are only an illustration of the model uncertainty problem for the sake of motivation.

Table 2: Characteristics of Sucessful Fiscal Consolidations

	AA98	A04	G07
Dependent variable is the successful consolidation dummy			
GDP growth		12.47	
(t-ratio)		(4.67)	
Government debt in $t-1$		-0.02	-0.23
(t-ratio)		(-0.17)	(-1.58)
Deficit level in $t-1$		0.34	
(t-ratio)		(0.31)	
Consolidation Size	1.91	2.52	2.44
(t-ratio)	(0.61)	(0.90)	(0.76)
Δ wage expenditures	-0.03	-0.41	0.01
(t-ratio)	(-0.18)	(-2.07)	(0.05)
Δ interest rate			-0.01
(t-ratio)			(-0.22)
Δ exchange rate			0.01
(t-ratio)			(0.32)
Output gap			0.02
(t-ratio)			(0.82)
R^2	0.01	0.29	0.06
Obs.	73	73	73

Notes: This Table presents the results from estimating three OLS regressions of the successful (in terms of debt reduction) consolidation dummy on the determinants suggested in Alesina and Ardagna (1998) [AA98], Ardagna (2004) [A04], and Giudice et al. (2007) [G07]. The change in wage expenditures is relative to the change in primary budget deficit (i.e. Δwage expenditures is one of the items in $\Delta item_{it}/\Delta Def_{it}$; an increase in this variable means that a larger share of the reduction of the primary deficit is obtained by cutting the public wage bill.).

In view of the results presented in the AA98 column in Table 2, one might conclude that the composition in terms of wage expenditures does not affect the success of the consolidation program. However, according to the A04 column, a consolidation based on cutting public wages is expected to reduce the probability of success in terms of debt reduction.[16] On the other hand, the macroeconomic environment proxied by the output gap is not significantly correlated with the successful consolidation dummy according to the G07 specification. Nevertheless, if we proxy the macro conditions using the GDP growth rate, as in the A04 column, they are found to positively affect the probability of success in reducing the debt-to-GDP ratio. Moreover, these results might again change if we consider different proxies and the number of them we include in the regression (for instance, we can also include other items of the public bill such as non-wage expenditures, transfers, business taxes, income taxes...). Since the number of potential proxies for the four candidate theories (i.e. fiscal situation, consolidation size, consolidation composition, and macroeconomic situation) is enormous, the universe of potential regressions

[16] Ardagna (2004) concludes that stabilizations implemented by cutting public spending lead to higher GDP growth rates, and also that the success of fiscal adjustments in reducing debt-to-GDP ratio depends on the size of the contraction and less on its composition.

to estimate given all the possible combinations of proxies is very difficult to work with. Therefore, extracting conclusions robust to the particular regression estimated might be extremely difficult in this setting in view of the simple examples presented in Table 2.

To overcome these issues we consider model averaging methods. Model averaging represents an agnostic alternative to the previous approach based on selecting a single regression and deciding which variable is important depending on its associated t-ratio. The key idea of model averaging is to consider and estimate all the possible regressions, and then report a weighted average as the estimate of interest. Therefore, model averaging is an agnostic approach in the sense that a researcher relying on this approach holds the view that the true single model is unknown and probably unknowable. The best she can do, then, is to consider all the possible alternatives instead of basing her conclusions on one probably incorrect regression.

The model averaging methodology allows a ranking to be constructed of the variables ordered by their relative importance in the contribution to the model fit, i.e. the Posterior Inclusion Probability (PIP). Those variables with higher PIP are the ones that contribute most to explaining the dependent variable's variation, in our case the successful consolidation episodes. A brief introduction and formal details of model averaging techniques can be found in the Appendix.

Table 3: Characteristics of Successful Consolidations *via* Model Averaging

	PIP	P. Mean	P. Std.
Output gap	0.60	0.05	0.02
ΔS.s. contributions	0.42	−0.58	0.30
ΔOther taxes	0.28	−0.57	0.37
ΔTransfers	0.25	0.28	0.21
GDP growth	0.21	4.50	3.64
ΔBusiness taxes	0.20	0.31	0.27
ΔGovernment investment	0.16	0.15	0.16
Deficit level	0.15	−1.36	1.61
ΔNon-wage expenditures	0.14	−0.32	0.43
Government debt level	0.13	−0.15	0.18
ΔWage expenditures	0.13	−0.19	0.31
ΔIndirect taxes	0.12	−0.13	0.26
ΔInterest rate	0.11	−0.02	0.03
ΔIncome taxes	0.11	−0.03	0.22
Consolidation size	0.11	−1.87	3.84
ΔSubsidies	0.11	−0.24	0.56
ΔExchange rate	0.10	−0.01	0.02
Prior Inclusion Probability		0.5	
Number of models estimated		131,072	

Notes: PIP refers to the posterior inclusion probability of a particular regressors. Given the prior inclusion probability is equal for all the variables (i.e. 0.5), those variables with PIP higher than 0.5 are labeled as robust determinants of successful consolidations. All the regressors belonging to the public bill (e.g. ΔSubsidies, ΔIndirect taxes,...) are divided by the total change in the primary deficit to focus on the proportion of the adjustment which was due to a particular item as proxies of the composition. P. Mean refers to the posterior mean conditional on inclusion of a given regressor in the empirical model, which is a weighted average of model-specific coefficient estimates with weights given by the model-specific R-squares. P. Std. is the square root of the posterior variance which is a weighted average of model-specific variances also including the variance of the estimates across different models. The sample is formed by 73 country-year pairs in which a consolidation took place. The 131,072 estimated models come from all the possible combinations of the 17 regressors ($2^{17} = 131,072$).

Table 3 presents the results when applying model averaging to estimate all the candidate regressions in order to investigate which regressors are robust determinants of successful consolidations. Output gap is the only variable for which the posterior inclusion probability (PIP) is higher than the prior inclusion probability, whereby the main conclusion emerging from Table 3 is that the output gap is the only robust determinant of successful fiscal consolidations. Moreover, its posterior standard error is smaller than its posterior mean. Therefore we can also conclude that the output gap positively affects the probability of success of a fiscal consolidation package. This result implies that whatever the composition or the size of the adjustment, the most relevant economic policies in times of fiscal consolidation must be oriented toward the objective of sustained and higher

rates of GDP growth. Those consolidations not accompanied by economic reforms aimed at increasing employment and productivity will have more difficulties in the reduction of debt-to-GDP ratios. One interpretation of this result is that it is easier to succeed by increasing the denominator (GDP) than by reducing the numerator (debt). Which are the best policies for increasing GDP is of course a controversial question that is beyond the scope of this paper.

6.1 Alternative Definitions of Successful Consolidations

How to define a successful consolidation is not straightforward, and the literature has considered different criteria. Once we have identified the fiscal consolidation episodes in the OECD according to the CAPB-based definition in AA2010,[17] in this sub-section we isolate successful consolidations considering two alternative criteria, in addition to the debt-to-GDP ratio criterion considered in the previous section (which is usually the most common approach in the literature).

First, we use an expansionary criterion in terms of GDP growth to identify successful consolidations. According to this expansionary criterion, a fiscal consolidation succeeds if average trend growth between t and $t+2$ is greater than between $t-1$ and $t-2$ (e.g. Giudice et al., 2007). These fiscal consolidations are usually labeled in the literature as expansionary consolidations.

Second, we also consider a persistence criterion. This criterion identifies as successful those consolidations in which the primary cyclically adjusted budget balance improves by at least three percentage points of GDP over three consecutive years (i.e. between $t-2$ and t, between $t-1$ and $t+1$ or between t and $t+2$), and in each year the change in the primary cyclically adjusted budget balance cannot be below -0.5 percentage points of GDP.

Using these two dummy variables we repeat the analysis carried out in the previous section using model averaging. Results are presented in Table 4; columns (1), (2), and (3) report the robust determinants of successful consolidations defined according to the persistence criterion. With respect to expansionary consolidations, results are reported in columns (4), (5), and (6) of Table 4.

[17] The consolidation dummy from AA2010 identifies a fiscal consolidation episode in a given year if the cyclically adjusted primary balance (CAPB) improves by at least 1.5% of GDP.

Table 4: Characteristics of Successful Consolidations: Alternative Definitions

	Persistence Criterion			Expansionary Criterion		
	PIP	P. Mean	P. Std.	PIP	P. Mean	P. Std.
	(1)	(2)	(3)	(4)	(5)	(6)
ΔWage expenditures	0.72	0.38	0.15	0.10	0.05	0.22
ΔIncome taxes	0.34	0.19	0.11	0.11	−0.07	0.16
GDP growth	0.17	2.13	2.00	0.10	−0.51	2.81
ΔIndirect taxes	0.14	−0.12	0.15	0.10	−0.06	0.20
ΔGovernment investment	0.13	−0.07	0.10	0.13	−0.09	0.13
ΔS.s. contributions	0.13	0.13	0.19	0.16	0.28	0.27
Output gap	0.12	0.01	0.01	0.17	−0.02	0.02
ΔOther taxes	0.12	−0.12	0.25	0.10	−0.10	0.31
ΔTransfers	0.12	−0.06	0.12	0.14	0.14	0.16
ΔBusiness taxes	0.12	−0.08	0.16	0.11	−0.08	0.22
ΔNon-wage expenditures	0.11	0.12	0.24	0.12	0.25	0.34
Government debt level	0.10	0.04	0.11	0.10	0.04	0.15
Deficit level	0.10	−0.29	0.82	0.19	1.46	1.20
ΔInterest rate	0.10	0.00	0.02	0.10	0.00	0.03
ΔSubsidies	0.10	0.06	0.31	0.10	0.11	0.46
ΔExchange rate	0.10	0.00	0.01	0.10	0.00	0.01
Consolidation size	0.10	0.11	2.19	0.26	4.84	3.20
Prior Inclusion Probability		0.5			0.5	
Number of models estimated		131,072			131,072	

Notes: PIP refers to the posterior inclusion probability of a particular regressors. Given the prior inclusion probability is equal for all the variables (i.e. 0.5), those variables with PIP higher than 0.5 are labeled as robust determinants of successful consolidations. All the regressors belonging to the public bill (e.g. ΔSubsidies, ΔIndirect taxes,...) are divided by the total change in the primary deficit to focus on the proportion of the adjustment which was due to a particular item as proxies of the composition. P. Mean refers to the posterior mean conditional on inclusion of a given regressor in the empirical model, which is a weighted average of model-specific coefficient estimates with weights given by the model-specific R-squares. P. Std. is the square root of the posterior variance which is a weighted average of model-specific variances also including the variance of the estimates across different models. The sample is formed by 73 country-year pairs in which a consolidation took place. The 131,072 estimated models come from all the possible combinations of the 17 regressors ($2^{17} = 131,072$).

Regarding the persistence criterion, only the change in wage expenditures as a share of the total change in the primary deficit is a robust determinant of successful consolidations. This implies that the higher the proportion of the consolidation conducted via reducing public wages, the higher the probability of the adjustment being successful in terms of persistence in the deficit reduction. Cutting public wages is a very costly political decision and, therefore, governments will only reduce the public wage bill when they take seriously the fiscal consolidation program, and they are thus more likely to achieve the deficit reduction objective.

With respect to the expansionary criterion, given that the prior inclusion probability for each variable is 0.5 and all the PIPs are below this threshold, we conclude that there is no variable robustly affecting the probability of a fiscal consolidation being expansionary. This is the most-commonly used criterion for labeling variables as robust / non-robust in the model averaging literature. We assume a priori that all variables are equally robust (i.e. prior inclusion probability of 0.5) and we label as robust those variables for which the

PIP is higher than 0.5. This would imply that the data support these variables more than the rest of the regressors, but if no variable satisfies this criterion, the conclusion is that no variable is robust. In addition, all the variables considered as candidate determinants have posterior standard errors larger than the corresponding posterior means, which reinforces the previous conclusion of no variable robustly correlated with expansionary fiscal consolidations.

7 Concluding Remarks

The decision to carry out a fiscal adjustment in order to restore the budget balance is not independent of developments in the economy. This paper estimates the effect of fiscal retrenchments on GDP growth accounting for the endogeneity of these episodes. Non-Keynesian effects of fiscal consolidation episodes previously found in the literature are due to endogeneity biases. Considering endogenous consolidations as we do in this paper, fiscal adjustments have the expected negative (and Keynesian) effect on GDP growth in the short term.

Successful consolidations are those in which the reduction of the debt-to-GDP ratio three years after the beginning of the adjustment is greater than 4.5%. We analyse which factors are the most relevant in generating successful consolidations via model averaging techniques. Our results indicate that, in order to succeed in reducing budget deficits, economic growth is the only relevant ingredient. Without economic recovery, fiscal consolidations will have huge difficulties in reducing budget deficits. However, we also find that cuts in public wages are the only ingredient of fiscal consolidations in which persistent reductions in primary budget deficits were achieved.

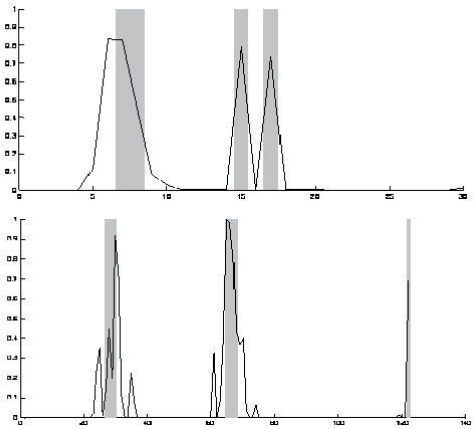
A Appendix

A.1 The Spanish Experience

In this appendix we repeat the exercises conducted in the paper (with a panel of OECD countries) but using Spanish (annual and quarterly) data for the period 1980-2010.

We consider two consolidation dummies. For the annual data we use the consolidation episodes defined by AA2010 in terms of CAPB which correspond to the years 1987, 1987, 1994, and 1996. We run a probit of this dummy on two lags of GDP growth. The predicted probabilities together with the "real" consolidation episodes are plotted in the top panel of Figure 5. Further, we define a quarterly consolidation dummy based on the AA2010 definition that corresponds to the following consolidation episodes: 1986:Q3-1987:Q2, 1996:Q1-1996:Q4, and 2010:Q2. The bottom panel in Figure 5 presents the predicted probabilities of consolidation. In both cases we see that fiscal consolidations are well anticipated based on previous economic outcomes.

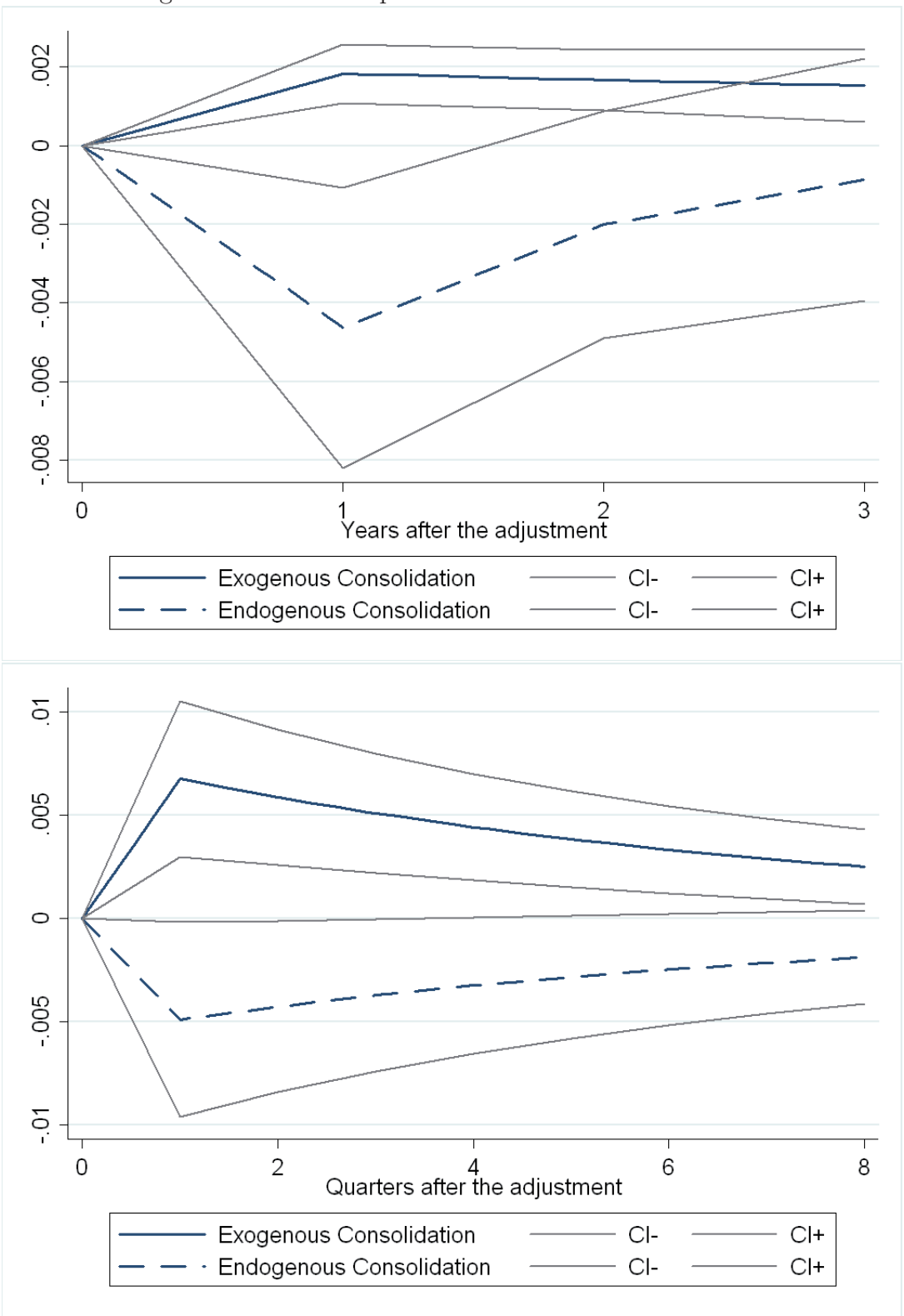
Figure 5: Spanish Fiscal Consolidations and Predicted Probabilities



This Figure presents the Spanish consolidation episodes (grey areas) and the precited probabilities from past economic information (solid line). The upper panel corresponds to annual data over the period 1980-2010 while the bottom panel presents the results using quarterly data from 1980:Q1 to 2010:Q2.

Once we have checked that fiscal consolidation episodes seem to be endogenous in Spain, we repeat the estimation and computation of IRFs from a consolidation episode to GDP growth. Figure 6 presents the results using both annual and quarterly data. The main paper's conclusion holds in the Spanish case: endogeneity biases are responsible for the non-Keynesian effects found in the literature. Once we account for endogeneity, fiscal consolidations have a negative impact on GDP growth. More concretely, if a consolidation is carried out in year t, the GDP growth rate between t and $t+1$ is expected to be 5 basic points lower.

Figure 6: IRFs of a Spanish Fiscal Consolidation Shock



This Figure presents the IRFs computed for the effect of a Spanish consolidation episode on GDP growth in subsequent periods. The solid line corresponds to a consolidation assumed to be exogenous and the dashed line to an endogenous consolidation. The upper panel corresponds to annual data while the bottom panel presents the results using quarterly data.

A.2 Data Appendix

This section describes the data employed in the paper. All data are from the OECD Economic Outlook Database no. 84.

- Government debt level: government gross debt as a share of GDP.
- Deficit level: cyclically adjusted primary deficit as a share of GDP (i.e. primary expenses minus total revenue)
- Consolidation size: Change in the cyclically adjusted primary balance as a share of GDP.
- ΔWage expenditures: Change in government wage bill expenditures.
- ΔNon-wage expenditures: Change in government non wage bill expenditures.
- ΔSubsidies: Change in subsidies to firms.
- ΔTransfers: Change in cyclically adjusted transfers as a share of GDP.
- ΔGovernment investment: Change in the gross government consumption on fixed capital.
- ΔIncome taxes: Change in cyclically adjusted direct taxes on household as a share of GDP.
- ΔBusiness taxes: Change in cyclically adjusted direct taxes on businesses as a share of GDP.
- ΔIndirect taxes: Change in cyclically adjusted indirect taxes as a share of GDP.
- ΔOther taxes: Change in cyclically adjusted other taxes (different from income, business or indirect) as a share of GDP.
- ΔS.s. contributions: Change in cyclically adjusted social security contributions paid by employers and employees as a share of GDP.
- GDP growth: Yearly growth rate of real per capita GDP for each country.
- Output gap: % of potential GDP.
- ΔInterest rate: Change in the real short-run interest rates between $t+1$ and $t-1$.
- ΔExchange rate: Change in the exchange rate between $t+1$ and $t-1$.

Note that all the regressors belonging to the public bill (e.g. ΔWage expenditures, ΔSubsidies, ΔIndirect taxes,...) are divided by the total change in the primary deficit (ΔItem/ΔDeficit) to focus on the proportion of the adjustment which was due to a particular item as proxies of the composition. More concretely, an increase in these

variables means that a larger share of the change in the primary deficit is due to a change in the particular item of the public bill. For the spending items, an increase in these variables means that a larger share of the increase (reduction) of the primary deficit is obtained by increasing (cutting) the particular spending item. For the revenue items, an increase in these variables means that a larger share of the increase (reduction) of the primary deficit is obtained by cutting (increasing) the particular revenue item of the government budget.

A.3 (Bayesian) Model Averaging

Within the paper's framework, model uncertainty arises because the lack of clear theoretical guidance on the choice of regressors affecting the probability of success during fiscal consolidation episodes results in a wide set of possible specifications. Therefore, researchers' uncertainty about the value of the coefficient of interest in a regression exists at two distinct levels. The first is the uncertainty associated with the parameter conditional on a given empirical model. This level of uncertainty is of course assessed in virtually every empirical study. What is not fully assessed is the uncertainty associated with the specification of the empirical model. It is typical for a given paper that the specification of the regression is taken as essentially known; while some variations of a baseline model are often reported, via different choices of control variables, standard empirical practice does not systematically account for the sensitivity of claims about the parameter of interest to model choice.

Many researchers consider that the most promising approach to account for model uncertainty is to employ model averaging techniques to construct parameter estimates that formally address the dependence of model-specific estimates on a given model. The basic idea behind model averaging is to estimate the distribution of unknown parameters of interest across different models. The fundamental principle of model averaging is to treat models and related parameters as unobservable, and to estimate their distributions based on the observable data. In contrast to classical estimation, model averaging copes with model uncertainty by allowing for all possible models to be considered, which consequently reduces the biases of parameters.

Formally, consider a generic representation of an empirical model of the form:

$$\Psi = \theta X + \epsilon \tag{9}$$

where Ψ is the dependent variable of interest (the successful consolidation dummy in our case), and X represents a set of covariates (such as the level of government debt, the size of the consolidation...). Imagine that there are potentially very many empirical models, each given by a different combination of explanatory variables (i.e. different vectors X), and each with some probability of being the 'true' model. This is the starting idea of the Bayesian Model Averaging methodology.[18]

[18] While model averaging can be interpreted from a frequentist viewpoint, its roots are based on the Bayesian paradigm. See Moral-Benito (2010) for an overview of model averaging methods.

Using the Bayesian jargon, a model is formally defined by a likelihood function and a prior density. Suppose we have K possible explanatory variables. We will have 2^K possible combinations of regressors, that is to say, 2^K different models - indexed by M_j for $j = 1, ..., 2^K$- which all seek to explain y -the data-. M_j depends upon parameters θ^j. In cases where many models are being entertained, it is important to be explicit about which model is under consideration. Hence, the posterior for the parameters calculated using M_j is written as:

$$g\left(\theta^j|y, M_j\right) = \frac{f\left(y|\theta^j, M_j\right) g\left(\theta^j|M_j\right)}{f\left(y|M_j\right)} \tag{10}$$

and the notation makes clear that we now have a posterior, a likelihood, and a prior for each model. The logic of Bayesian inference suggests that we use Bayes' rule to derive a probability statement about what we do not know (*i.e.* whether a model is correct or not) conditional on what we do know (*i.e.* the data). This means the posterior model probability can be used to assess the degree of support for M_j. Given the prior model probability $P\left(M_j\right)$ we can calculate the posterior model probability using Bayes Rule as:

$$P\left(M_j|y\right) = \frac{f\left(y|M_j\right) P\left(M_j\right)}{f\left(y\right)} \tag{11}$$

Since $P\left(M_j\right)$ does not involve the data, it measures how likely we believe M_j to be the correct model before seeing the data. $f\left(y|M_j\right)$ is often called the marginal (or integrated) likelihood, and is calculated using (10) and a few simple manipulations. In particular, if we integrate both sides of (10) with respect to θ^j, use the fact that $\int g\left(\theta^j|y, M_j\right) d\theta^j = 1$ (since probability density functions integrate to one), and rearrange, we obtain:

$$f\left(y|M_j\right) = \int f\left(y|\theta^j, M_j\right) g\left(\theta^j|M_j\right) d\theta^j \tag{12}$$

The quantity $f\left(y|M_j\right)$ given by equation (12) is the marginal probability of the data, because it is obtained by integrating the joint density of (y, θ^j) given y over θ^j. The ratio of integrated likelihoods of two different models is the Bayes Factor and it is closely related to the likelihood ratio statistic, in which the parameters θ^j are eliminated by maximization rather than by integration.

Moreover, considering θ a function of θ^j for each $j = 1, ..., 2^K$, we can also calculate the posterior density of the parameters for all the models under consideration:

$$g\left(\theta|y\right) = \sum\nolimits_{j=1}^{2^K} P\left(M_j|y\right) g\left(\theta|y, M_j\right) \tag{13}$$

If one is interested in point estimates of the parameters, one common procedure is to take expectations across (13):

$$E\left(\theta|y\right) = \sum\nolimits_{j=1}^{2^K} P\left(M_j|y\right) E\left(\theta|y, M_j\right) \tag{14}$$

Following Leamer (1978), we calculate the posterior variance as:

$$\begin{aligned} V\left(\theta|y\right) &= \sum\nolimits_{j=1}^{2^K} P\left(M_j|y\right) V\left(\theta|y, M_j\right) \\ &+ \sum\nolimits_{j=1}^{2^K} P\left(M_j|y\right) \left(E\left(\theta|y, M_j\right) - E\left(\theta|y\right)\right)^2 \end{aligned} \tag{15}$$

Inspection of (15) shows that the posterior variance incorporates both the estimated variances of the individual models as well as the variance in estimates of the θ's across different models. Hence, the uncertainty at the two different levels mentioned above is taken into account.

Moreover, the BMA methodology allows constructing a ranking of variables ordered by their robustness. In our particular case, robustness as determinants of successful fiscal consolidations. In order to construct our measure of robustness, we estimate the posterior probability that a particular variable h is included in the regression, and we interpret it as the probability of that the variable belongs in the true empirical model. In other words, variables with high posterior probabilities of being included are considered as *robust* determinants of succeed when a fiscal adjustment is carried out. This is called the *posterior inclusion probability* for variable h, and it is calculated as the sum of the posterior model probabilities for all of the models including that variable:

$$\text{posterior inclusion probability} = P\left(\theta_h \neq 0|y\right) = \sum\nolimits_{\theta_h \neq 0} P\left(M_j|y\right) \tag{16}$$

As an indication of our ignorance, we assume that all the possible models are equally probable a priori so that $P(M_j = 1/2 \ \ \forall \ \ j = 1, ..., 2^K$. This prior on the model space also implies a prior on the regressors, in particular, it implies that all regressors have a prior inclusion probability equal to 0.5. It is usual in the model averaging literature to impose a threshold to determine which variables are robust. More concretely, the most commonly-used threshold is the prior inclusion probability, i.e. those regressors with posterior inclusion probability higher than the prior inclusion probability are labeled as robust because the data supports their inclusion in the model.

On the other hand, we make use of the Schwarz asymptotic approximation to the Bayes Factor, and therefore replace equation (11) by:

$$P(M_j|y) = \frac{P(M_j) N^{\frac{-k_j}{2}} SSE_j^{-\frac{N}{2}}}{\sum_{i=1}^{2^K} P\left(M_i\right) N^{\frac{-k_i}{2}} SSE_j^{-\frac{N}{2}}} \tag{17}$$

where SSE_j is the sum of squares for model j, and N is the number of observations. Therefore, instead of equation (14) we will use:

$$E\left(\theta|y\right) = \sum_{j=1}^{2^K} P\left(M_j|y\right) E\left(\theta|y, M_j\right) = \sum_{j=1}^{2^K} P\left(M_j|y\right) \widehat{\theta}_{OLS}^{j} \tag{18}$$

where $\widehat{\theta}_{OLS}^{j}$ is the OLS estimate for model j. Equation (18) is true if we either assume diffuse priors on the parameter space for any given sample size, or have a large sample for any given prior on the parameter space. Equations (17) and (18) are the basis of the BACE approach described in Sala-i-Martin et al. (2004) in the context of growth regressions.

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