Are automatic stabilisers immune from asymmetries and extreme events?

Mårten Blix*

2009-02-06.

---

* Ministry of Finance, Sweden. This paper was written at the Fiscal affairs divisions of the European Central Bank. The opinions expressed in this paper need not reflect those of the European Central Bank or the Swedish Ministry of Finance. Email: mp.blix@gmail.com. This is a revised version of a paper previously called “How useful are the automatic stabilisers” presented at the ECB workshop “Challenges for government revenues in the EU” on 12 December 2008. I am grateful for detailed comments from António Afonso, Christophe André as well as the discussion from Sandro Momigliano. I have benefited from comments from Marianna Blix Grimaldi, Sebastian Hauptmeier, Christophe Kamps and Ad van Riet. I am grateful to Silvia Albrizio and Petit Vivien for providing research assistance.

Contents

Abstract

In this paper we estimate automatic stabilisers in a single equation regression framework for the following countries: Denmark, France, Germany, Italy, Japan, the UK, the US, Spain and Sweden. We take some steps to investigate departures from a simple OLS/IV model. Specifically, we test if there are asymmetric effects on automatic stabilisers depending on the sign of the output gap; we test if the automatic stabilisers are sensitive to extreme gaps, here assumed to be an output gap larger than 3%; we test if there are non-linear effects from government size and finally we investigate the effects of allowing the shocks to vary in size over time. Both the literature review and our results indicate that the estimates of automatic stabilisers are not generally robust and should be interpreted with care. Overall, we find considerable evidence for possible non-linear effects, with significant results in about half of the 72 tests performed. When controlling for extreme output gaps, we find that the automatic stabilisers are less smoothing on the revenue side and more smoothing on the spending side for Italy, Japan, the US, Spain and Sweden. We also find some evidence of parameters changing over time and some indication of asymmetries over the cycle. Therefore we argue that for policy purposes the automatic stabilisers should be viewed in a broader context of which shocks are occurring and also how strong the other forces in the economy may be.

JEL: H20, H30, E62.

Keywords: Automatic stabilisers, discretionary fiscal policy, asymmetry, structural breaks.

Non-technical summary

The automatic stabilisers are defined by the feature that they move contemporaneously with the movement of the cycle and that they do not require active decisions by the government. Their composition reflects the aggregation of rules and legislation provided by the government, for example on payment of taxes and the spending on unemployment benefits. Therefore, the automatic stabilisers reflect the institutional features of the country in question.

The automatic stabilisers are a useful part of the policymakers' toolbox especially because they can immediately act to smooth shocks to the cycle even before they might be discovered – much less acted on – by the government. This is in contrast to discretionary measures, such as attempts to boost demand, that often cannot be implemented until a delay of a few months or quarters.

Though the automatic stabilisers have many advantages, there are several caveats that should be attached to the estimated numbers that are not always as prominently displayed as they should be or that tend to get lost when academic papers are drawn on in a policy context.

To separate the discretionary fiscal policy changes from the automatic ones requires a view of how fiscal policy affects the economy, i.e. how the shocks can be identified. In this paper, we focus on another type of challenge for the automatic stabilisers, namely that they may be sensitive to the assumptions that automatic stabilisers are always and everywhere linear.

We perform four tests per country, both the spending and the revenue side of the budget, to test for various departures from a benchmark linear model. More specifically, we test if there are asymmetric effects on automatic stabilisers depending on the sign of the output gap; we test if the automatic stabilisers are sensitive to extreme gaps, here assumed to be an output gap larger than 3%; we test if there are non-linear effects from government size and finally we investigate the effects of allowing the shocks to vary in size over time.

Overall, we find that in about half of the 72 tests performed the test cannot reject that there may be significant departure from the benchmark model. All in all, there is considerable evidence that some departures from linearity can be important.

On the test for asymmetric effects over the business cycle, we find no evidence for any of the countries on the revenue side (except weakly for Spain), but

some evidence in just over half the countries on the spending side. Thus, it appears that while tax codes are complicated they do not bring about different effects if the output gap is positive or negative. On the test for extreme events as measured by an output gap larger than 3%, we find that about one-third of the countries show cannot reject the hypothesis that this variable should be included. On the test for effects of government size, we find that this test cannot be rejected for about half the countries. It is noteworthy that both the biggest and the smallest governments are significant but some of the medium size ones are not, perhaps suggesting that non-linear effects may relevant for governments that are either rather small or rather big.

There are some noteworthy patterns that stand out. Sweden and Japan both have systematically negative deviations from OLS in almost all the tests for departures from linearity. This may be a coincidence but both countries experienced significant fiscal crises in the 1990's that may be important for the results. Denmark and France present the most stable results (i.e. the fewest significant tests for departures from linearity). The Anglo-Saxon countries exhibit similar patterns and show significance in tests for asymmetry on the spending side. The countries picking up the most significant departures from OLS are Japan, Sweden and Spain.

What happens to automatic stabilisation when the output gap is extreme? We then find that the automatic stabilisers are less smoothing on the revenue side and more smoothing on the spending side for Italy, Japan, the US, Spain and Sweden. Moreover, for Sweden we find that the effects from the extreme gap are similar to those from the asymmetry. For the UK, the results are the opposite from Sweden and all estimates of effects point to more smoothing on revenue side and less on the spending side.

We found considerable evidence for parameter instability. Only for one country (Denmark) on the spending side and two countries on the revenue side (UK and Sweden) is there no evidence of change in the automatic stabiliser over time. While there are several possible explanations, the results indicate that estimates of automatic stabilisers while not having exactly "expire by dates" still probably need to be updated periodically.

1. Introduction

The disagreements in fiscal policy sometimes makes the discussions in monetary policy seem like a cosy consensus by comparison. Empirical work on fiscal policy finds a wide range of effects on the economy, ranging from none to the substantial. Discussions are hampered by data limitations and methodological difficulties in identifying shocks.

The work in this paper is motivated in part by the wide range of results found in the literature on the effects of fiscal policy on the economy; it is goal in itself to provide an overview of some methods and results. In part, it is also motivated by testing some (pre-)sumptions that are not always prominently displayed as they should be.

The focus in the paper is on some recent work on the size and role of automatic fiscal stabilisers. We discuss some of the issues and shortcomings that are important to consider both for empirical work and for policy. Following Darby and Melitz (2008), we estimate a simple model and extend it in some critical dimensions to investigate a) the size of automatic stabilisers across major countries; b) test four different departures from the simple linear OLS/IV-specification. In particular, we test:

- Do the automatic stabilisers operate symmetrically over the business cycle?
- Are they affected non-linearly by government size?
- Are the affected by extreme deviations from the output gap, so that for example automatic stabilisers at a time of crisis may be different?
- Are they affected by incorporating the possibility of lower volatility in the recent decades by letting the errors follow a GARCH process?

Finally, we also test in some detail how stability of the parameters. This is important as automatic stabilisers depend on the institutional framework and so can presume to change (slowly) over time.

The rest of this paper is organised as follows. The next section contains a critical assessment of some assumptions and issues in the literature on automatic stabilisers. The third section contains the results from the empirical work and the final section concludes.

2. Literature

In this section we discuss the evidence of effects from automatic stabilisers and, to a lesser extent, discretionary fiscal policies.[1] Automatic stabilisers are more of a concept than a precise definition, which in part contributes to empirical work using different approaches to estimate them.[2]

For our purposes, we follow related work and let the automatic stabiliser be the contemporaneous association between the business cycle (the output gap) and government spending and revenues. For government spending, there should be a negative association with movements of the business cycle as in good times governments typically need to spend less on social programmes, such as unemployment benefits; for government revenues, by contrast, there should be a positive association as governments typically earn higher revenues in good times when firms' profits are good. The automatic stabiliser is further characterised by the property that it does not require any active decisions by the government.

The automatic stabilisers are one part of fiscal policy, the other being government's discretionary changes in spending. The effects from the automatic and discretionary parts together on output are sometimes referred to as total fiscal multipliers. The simple notions of the different components of fiscal policies, however, are not enough to econometrically identify the different parts. One challenge is the difficult in separating the effects on output from the automatic and the discretionary part. Another challenge is to separate these forces from other underlying effects, such as productivity shocks, terms-of-trade and monetary policy to name a few.[3]

The size of the automatic stabilisers is of interest for several reasons, see for example ECB (2002, 2004, 2008). For forecasting and policy considerations, it is useful to know how much smoothing of the cycle can be expected without any active choices by the government. Another reason is particular for EU-countries, for whom the commitments to the Stability and Growth Pact imply that only when there is

---

[1] For discussion on discretionary fiscal policy see for example Andersen (2004), Beetsma (2008), Blinder (2003), Fatás and Mihov (2003a,b), Hemming et al (2002), IMF (2008a,b), Marcellino (2002), OECD (2003).

[2] Melitz (2005) uses the terminology "non-discretionary fiscal policy" as a more general term than automatic stabilization, arguing that there may well be "automatic" components that the government have time to exercise discretion on.

[3] For a discussion on identification issues, see for example Blanchard and Perotti (2002), Caldara and Kamps (2008), Ramey and Shapiro (1998), and Mountford and Uhlig (2005).

sufficient safety margin to the 3% of GDP reference value for the deficit can the automatic stabilisers operate freely. Therefore, normally the larger the stabilisers the larger should be the safety distance to the reference value in order not to risk being obliged by the treaty obligations to reduce discretionary policy in a downturn. Being in such a position is doubly awkward as it risks increasing the volatility of the cycle and working against the smoothing effect of the automatic stabilisers. Therefore, as discussed further below, the different estimates of the size of the automatic stabilisers in the literature matter for policy and for policy analysis.[4]

2.3. Asymmetries and extreme output gaps

Automatic stabilisers as estimated in econometric models are usually symmetric by assumption as the coefficient is assumed constant over the sample while discretionary fiscal policies are presumed to vary over time. In particular, the stylised facts about discretionary fiscal policy are that it tends to be counter-cyclical in downturns and pro-cyclical in upturns based on ex-post data, see for example Alesina and Tebellini (2008), European Commission (2004), Dabán et al (2003) and OECD (2003).

Notably, relatively little is known whether the stabilisers are symmetric over the cycle or not: it is usually just assumed. While it is plausible that discretionary fiscal policy changes over time (not least since governments change), at least more than the automatic stabilisers, it is not evident that the automatic stabilisers could not also exhibit some asymmetry, particularly on the spending side, for example if there are cut-off points and non-linearities from eligibility rules in which the structure of automatic payments are enacted. If indeed automatic stabilisers have some asymmetry, then most estimates that assume time-invariance may imply that the measure of discretionary policy inherits some asymmetry that may belong to the stabilisers.[5]

To the best of our knowledge, the potential effects of extreme output gaps on automatic stabilisers have not been investigated in the literature. The question is of interest for a number of reasons. If the output gap is large, it is of interest to know if

---

[4] For example, the European Commission (Interim Forecast January, 2009) estimates that in the coming two years there will be a fiscal stimulus of about 4% of GDP during 2009-10, half of which are the automatic stabilisers.

[5] This points to the desirability of identifying automatic stabilisers and discretionary fiscal policy jointly.

the degree of automatic stabilisation will be the same, larger or smaller than in "normal" times. If the automatic stabiliser is larger than in normal times, the economy has a stronger bounce back effect without active decisions and so the arguments for discretionary fiscal stimulus measures would be correspondingly weaker; if the automatic stabiliser were lower, by contrast, the opposite would be true.

The reasons large output gaps may have different effects than in normal times are similar to those put forth for possible asymmetries. When the output gap is large, benefit systems and other rules are more likely to be stretched to their limits, perhaps introducing threshold effects in which payments are reduced on the spending side. On the revenue side, one could conceive of an extreme downturn causing an extra number of bankruptcies compared to a "normal" recession and thereby potentially a correspondingly larger drop in the tax from firm's profits. Overall, these could of importance and it is ultimately an empirical question to what extent they matter.

2.4. The size of government and the extent of automatic stabilisation

Automatic stabilisation provides smoothing of shocks from a variety of sources on government revenues and spending. But it is useful to have a broader perspective on this question than simple parameter estimates in regression models, a point also stressed in van den Noord (2000). In particular, it is of interest to know the sources of smoothing from various components and if the contributions change systematically over time in some way. One paper in this direction is Asdrubali et al (1996). They use US data to decompose the overall smoothing of shocks into the following components: 39% smoothing through capital markets, 13% smoothed by federal government and 23% smoothed by credit markets; the remainder 25% is not smoothed. For work on this also in a European context, see for example Melitz and Zumer (1999) and Afonso and Furceri (2008).

This result is interesting in the context of the literature of government size and automatic stabilisation. In Fatás and Mihov (2001), panel estimation with 20 OECD countries indicates that there seems to be a systematically positive relation between the size of governments and the size of the automatic stabilisers. This result is fairly intuitive in that larger governments as measured by revenues or expenditure tend to be those that devote more government resources to factors often associated with automatic stabilisation, such as unemployment benefits, work programmes and health care. The DSGE-model in Andrés et al (2008) also yields a positive correlation between automatic stabilisers and government size.

Lee and Sung (2007) find results in line with Fatás and Mihov (2001), but their larger panel of 94 countries displays some other interesting features. In particular, they find that for developing countries oil and military spending matters significantly for the results. The also find that government spending tends to move more countercyclically in OECD countries than in developing countries. Further, they argue that their IV estimation is more appropriate than previous work based on OLS-estimation, resulting in larger estimates of automatic stabilisation. Notably, their full sample estimate of the size of the automatic stabiliser is 0.616, higher than estimates in other papers (see below), but this hides a very uneven effect between OECD and developing countries: for OECD countries, the coefficient is only 0.049, much less than in the literature and for developing countries it is 0.64. The large discrepancies between the estimates further strengthen the argument above that automatic stabilisation should be viewed in the context of the structure of the whole economy. The difference between OECD and non-OECD countries in this regard is suggestive that size of the government is not enough to gauge the size of automatic stabilisation.

The result that bigger governments imply more automatic stabilisation is reviewed and questioned in Debrun et al (2008). Their results indicate that government size beyond 40% of GDP does not yield additional smoothing though the mechanism behind this result is unclear. Moreover, they measure output volatility directly rather than isolate only the automatic stabilisation. The point made by Asdrubali et al (1996) and van den Noord (2000) is relevant in this context: Shocks from various sources are smoothed by different features of institutions in the economy. It is not impossible, for example, that if automatic stabilisers smooth less, there is some other source of smoothing that picks up some or all of the slack. The difference between EU-countries and the US in this regard is particularly apparent, whereby smoothing by automatic stabilisers in European countries typically is of a higher order of magnitude. Arguably, it may be useful to assess the overall degree of smoothing in the whole economy by considering the joint effects of automatic stabilisers, discretionary fiscal and monetary policy, trade, labour and capital markets.

As regards the link between the size of government and automatic stabilisers, Buti et al (2003) discuss a model where there are tradeoffs between size of stabilisers and efficiency. Their model implies that as governments become very big they may contribute to a less efficient economy, as more resources are unscrutinised by the discipline of market forces and the price-mechanism. Put another way, it is of scant comfort to have Olympic automatic stabilisation if the economy grows slowly.

The link to efficiency in this context serves to highlight that automatic stabilisers are part of a set of institutional rules and incentives decided by the government, either implicitly or explicitly. The literature on automatic stabilisers often estimates it as the coefficient on output (or deviations from potential output) in a regression, which implicitly takes a view on them as time invariant (see also the discussion in Barell and Pina (2003). This is a rather strong assumption. For example, some government have policies to improve incentives to work, which may involve cutting benefits on the expenditure side (less generous and lengthy unemployment or sick care benefits) or in lowering taxes. Such reforms would probably tend to reduce the amount of automatic stabilisation but in the longer term increase productivity and potential growth in line with the suggested trade-off in Buti et al (2003).

Admittedly, changes in the degree of automatic stabilisation may take time and may depend on which shocks occur (domestic/foreign, supply/demand), but in the longer run the automatic stabilisers are endogenous, the end result of policies accumulated over long periods. Some of the empirical work, such as Debrun et al (2008) finds different effects of government size on the standard deviation of output over different time periods.

2.5 The size of automatic stabilisers and total fiscal multipliers

For an overview of different results found in the literature on automatic stabilisers and the effects of total fiscal multipliers see tables 1, 2, and 3. As can be seen, the results vary rather a lot, though to some extent the table may overstate the differences as the measurements used are different. The diversity of results echoes previous papers, such as the comments in Blanchard (2006), and the empirical work by Bouthevillain et al (2001), Golinelli et al (2007) and Henry et al (2004).

Table 1. Size of automatic stabilisers.

Paper/source of shock	E(stimated) or C(alibrated)	Euro area /1	EU /1	OECD	USA	Austria	Belgium	Finland	Germany	France	Italy	Ireland	Netherlands	Portugal	Spain	Denmark	Sweden	UK
Asdrubali et al (2002) /a	E				13													
Auerbach and Feenberg (2000) /b	E				8													
Barrell and Pina (2003) /c	C	12.1				10	15	10	25	4	6	4	8	9	4			
Brunila et al (2002) /d	C																	
Gov consumption		28	27			22	19	32	28	37	29	30	20	30	34	22	26	
Gov investment		8	7			6	6	7	8	10	10	9	6	6	7	6	5	
Exports		11	10			8	8	11	11	14	12	12	8	10	11	8	8	
Productivity		5	5			3	2	2	6	6	10	10	2	5	4	2	9	
Caldara & Kamps (2008) /b	E				3.5													
Darby & Melitz (2008) /b	E																	
Coeff sum of taxes			2	-9														
Coeff sum current spending			-33	-38														
Girouard and André (2005) /d	E	49	48	44	34	47	52	48	51	53	53	38	53	46	44	59	55	45
Lee and Sung (2007) /b	E																	
Coeff expenditures				5														
Coeff revenues				95														
Marcellino (2002) /b	E																	
coefficient on taxes									15	32	38				-9			
coefficient on spending									7	41	18				24			
van den Noord (2000) /e	E	25	31		20		30	40	60	20	30	10	30		20		30	40

Notes. The units in the papers are different which limits comparison. In particular, some measures of automatic stabilisers are in terms of contribution to the variance and therefore positive, whereas some estimates (including in this paper) are of the coefficients directly. For spenind, the automatic stabilisers are expected to have negative signs in Darby & Melitz (cited above) as well as in this paper. Specific comments: /a Decomposition of cross-sectional variance in gross state product, percent; /b Estimated regression coefficient in percent; /c Relative contribution to RMSD in output in percent; /d Smoothing of shock of size 1 percentage point of GDP to specified component; e/ Contribution to RMSE reduction in output gap; 1/ Estimate based only on arithmetic average of available country estimates in columns.

Table 2. Total spending multipliers.

Paper/source of shock	E(stimated) or C(alibrated)	Euro area /1	EU /1	USA	Austria	Belgium	Finland	Germany	France	Italy	Ireland	Netherlands	Portugal	Spain	Denmark	Sweden	UK
Blanchard & Perotti (2002) /a	E																
4 quarters				0.45													
20 quarters				0.97													
Brunila et al (2002) /b	C																
Gov employment		1.0	0.9		1.0	1.0	1.0	0.9	0.9	0.9	1.0	1.0	1.0	1.0	0.9	0.8	1.0
Gov investment		0.7	0.6		0.6	0.5	0.7	0.7	0.7	0.7	0.5	0.6	0.5	0.7	0.6	0.6	0.7
Gov purchases		0.7	0.6		0.6	0.5	0.7	0.7	0.6	0.7	0.4	0.5	0.4	0.7	0.6	0.5	0.6
Gov transfers		0.2	0.2		0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.2	0.1	0.1	0.2
Caldara & Kamps (2008) /a																	
Recursive, 3 yrs				1.85													
Blanchard, 3 yrs				1.76													
Sign restrictions, 3 yrs				1.72													
Event study, 3yrs				1.61													
Church et al (2000) /b	C/E																0.5
Henry et al (2004) /b	C	1.6				0.5		1.1		1.4			1.5	1.5			
Perotti (2002) /a	E																
1 yr				0.3				0.4									-0.2
3 yrs				0.1				-1.4									-1.2

Notes. The units in the papers are different which limits comparison, see also note in table 1. Specific comments: /a Estimated regression coefficient in percent. /b Smoothing of shock of size 1 percentage point of GDP to specified components; 1/ Estimate based only on arithmetic average of available country estimates in columns.

Table 3. Total revenue multipliers.

Paper/effect	E(stimated) or C(alibrated)	Euro area /1	EU /1	USA	Austria	Belgium	Finland	Germany	France	Italy	Ireland	Netherlands	Portugal	Spain	Denmark	Sweden	UK
Blanchard & Perotti (2002) /a	E																
4 quarters				-0.7													
20 quarters				-0.2													
Brunila et al (2002) /b	C																
Labour income		0.2	0.2		0.2	0.1	0.2	0.2	0.2	0.2	0.8	0.2	0.2	0.2	0.2	0.2	0.2
Corporate tax		0.2	0.2		0.2	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
VAT		0.5	0.5		0.4	0.3	0.5	0.5	0.6	0.5	0.3	0.4	0.4	0.5	0.5	0.4	0.5
Caldara & Kamps (2008) /a																	
Recursive, 3 yrs				-0.2													
Blanchard, 3 yrs				-0.2													
Sign restrictions, 3 yrs				-0.5													
Church et al (2000) /b	C/E																-0.3
Henry et al (2004) /b	C																
income taxes		-0.6				-0.2		-0.9		-0.5			-0.7	-1.0			
indirect taxes		-0.8				0.0		-0.5		-0.5			-0.4	-0.7			
social security		-0.6				-0.2		-0.9		-0.5			-0.4	-1.0			
Perotti (2002) /a	E																
lower taxes, year 1				-0.4				0.0									-0.2
lower taxes, year 3				-2.1				-0.3									-0.9

Notes. The units in the papers are different which limits comparison. Specific comments: /a Estimated regression coefficient in percent; /b Smoothing of shock of size 1 percentage point of GDP to specified components; /1 Estimate based only on arithmetic average of available country estimates in columns.

3. Empirical specification

In this section we consider a simple specification in order to estimate the automatic stabilisers for several countries. While not able to address all the issues discussed above, it has several advantages in terms of tractability and ease of understanding. The ease of understanding and tractability are non-trivial issues over the long time period of 1970-2007 with yearly data that we are considering. We want to compare the estimates across time, between countries and investigate the robustness in various dimensions. Nonetheless, the simplicity of the model sets some limitations. In particular, government spending and revenues are endogenous with the movement of output. In order to address this issue, we will be using instrumental variables, discussed further below.

3.1. The model

The basic specifications is

(1) $$\Delta X_t = \beta_0 + \beta_1 \tilde{Y}_t + \beta_2 \pi_t + \beta_3 R_t + \beta_4 Z_t + \varepsilon_t ,$$

where $\Delta X_t = G_t$ or T_t is the change in either nominal government spending G_t or revenues T_t (in natural logarithms), $\tilde{Y}_t$ is the output gap in percent of potential GDP, π_t is inflation, R_t is the long term interest rate, Z_t contains exogenous variables (explained further below in 3.2.) and $\varepsilon_t \rightarrow iid(0,\sigma^2)$ is the disturbance term. Thus, the RHS of (1) is presumed to be the same whether we consider spending or revenue regressions.

This specification follows closely the model in Darby & Melitz (2008). It is a very simple form that nevertheless captures most of the salient mechanisms. The period 1970-2007 contains episodes of high inflation and higher nominal long term interest rates. We focus on the automatic stabiliser on the spending and revenue side as captured by β_1 depending on which regression is run (i.e. if $\Delta X_t = \Delta G_t$ or ΔT_t). The interpretation is that a one unit increase in the output gap brings about a corresponding β_1 change in government spending or revenues. Whenever β_1 is negative in spending regressions, it contributes to smoothing fluctuations in the sense that government spending decreases when output is rising above the potential and is thus countercyclical; the converse applies to regressions with revenues as dependent variable if the estimates of the revenue stabiliser is positive.

3.2 Variations on the basic specification

The model in (1) is the starting point for estimating several other variations, summarised in table 4 below. Each model starts with the previous specification and adds another variable in the Z_t vector (except for model 5).

Table 4. Models estimated.

Model 1	Equations (1)	$Z_t = 0$
Model 2	Lagged dep. variable	$Z_t = \Delta X_{t-1}$
Model 3	Dummy for asymmetry	$Z_t = \Delta X_{t-1} + D_t$
Model 4	Government size	$Z_t = \Delta X_{t-1} + D_t + 100(G/Y)_t + 100(G/Y)_t^2$
Model 5	GARCH(1,1)	$Z_t = \Delta X_{t-1}$, $\sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \alpha_2 \sigma_{t-1}^2$

Note: Each successive model incorporates the previous, except for model 5, which is based on model 2 but with GARCH(1,1) disturbances where it is assumed that ε_t has a time varying conditional variance σ_t^2.

Model 2 also includes a lagged dependent variable to capture the dynamics; model 3 is a way to investigate asymmetry with respect to the output gap. More specifically, we define a dummy variable as

(2) $$D_t = \begin{cases} 0 & \text{if } \tilde{Y}_t < 0 \\ \tilde{Y}_t & \text{if } \tilde{Y}_t \geq 0 \end{cases}.$$

Thus, the dummy variable is takes the value of the output gap when the output gap is positive and is zero otherwise. This is a simple method of capturing possible asymmetries over the cycle. In effect, we will obtain two measures of the automatic stabilisers for these regressions (discussed in section 4.3 below), when the output gap is negative it will be β_1 and when positive, $\beta_1 + \beta_{4D}$ where β_{4D} is the coefficient for the dummy variable in (2).

Government size in level and square are included in model 4. It is measured by government spending as share of GDP in percent. Its inclusion is motivated by the result that larger governments (measured as spending as a share of GDP) often are associated with larger automatic stabilisers. Here we cannot straightforwardly compare the size of government on the automatic stabilisers in the way that studies with panel data can do, but it provides a convenient way to investigate possible non-linearities.

Model 5 is a simple variation on model 2 to detect possible changing structures in the variance term. The great moderation in the US may imply that it could be useful to explicitly model the variance term. More specifically, there is a presumption that the variance of output has become less (at least prior to the financial crisis that started in 2007), which is relevant for the estimation of the automatic stabilisers over the long time period we consider.

We test some further variations on equation (1) where the results in the next section are presented more in overview form. In particular, we define another dummy variable that captures extreme deviations in the output gap,

$$(3) \qquad EX_t = \begin{cases} 0 & \text{if } \left|\tilde{Y}_t\right| < 3 \\ \tilde{Y}_t & \text{if } \left|\tilde{Y}_t\right| \geq 3. \end{cases}$$

In other words, the dummy variable EX_t takes the value zero unless the absolute deviation of the output gap is 3 percentage points. Admittedly, this number is somewhat arbitrary but would normally be considered a large deviation from potential output.

4. Estimation of the automatic stabilisers

4.1. The data

The data is in annual frequency from the Ameco database and the ouput-gap is calculated with a simple HP-filter with smoothing parameter set to 100 for annual data. To some extent, the degrees of freedom problems dictate some of the choices. With yearly data going back to the 1960’s for many of the countries, several business cycles are included in the estimates. It is clearly an advantage to assess the automatic stabiliser over several cycles. On the other hand, the period from the 1960’s is also a period of rather significant changes in fiscal policy, with downward trends in nominal growth for many countries since the oil shocks in the 1970’s.

In order to compare countries for the same time periods and due to the availability of instruments, we will use data primarily for 1970-2007 as it is available for most countries. While the spending regressions generally start in 1970, in some cases due to data limitations revenue regression start later, see table 5 below.

The instruments used in the regressions are similar to those by Darby and Melitz (2008) and include lags of spending and revenues as well as world (or OECD) output and oil prices from the IFS database.

Table 5. Estimation period, from year specified in table to 2007.

	Denmark	France	Germany	Italy	Japan	UK	US	Spain
Spending	1970	1970	1970	1975	1970	1970	1970	1970
Revenues	1970	1980	1980	1980	1970	1970	1970	1975

Note: Data for Germany prior to 1990 is for West Germany.

In table 6 we display the results for the automatic stabiliser for the different model specifications. The full estimation results for each country are in the appendix. By and large the estimates have the right sign but the estimates tend to vary. This is not surprising given the wide range of estimates found in the literature review.

For ease of comparison both OLS and IV estimates are shown. Overall we find that the instruments matter for the estimates and that the spending regressions are more stable than the revenue side. This reflects the larger volatility on the revenue side both compared to changes in spending and in the output gap. The revenue regressions perform less well than on the spending side in terms of having more wrong signs and more “switches” between negative and positive.

It is likely that the output gap as identified by the HP-filter is not entirely successful in separating the trend from the cycle, as is well recognised in the literature. This may explain some of the “wrong signs”, notably when the instruments are not good enough to help to pin down the structural innovations. Overall, our approach share many of the problems noted in the output gap literature, but it still remains a useful frame of reference if the results are interpreted with caution.

Table 6. Estimates of automatic stabilisers on the spending and revenue side, up to 2007 and from year specified in table 5.

	Government spending stabilisers								Government revenues automatic stabilisers							
Model	1		2		3		4	5	1		2		3		4	5
	Equation (1)		Model 1 + lagged dep. variable		Model 2+ dummy for pos. output gap		Model 3+ gov. size	Model 2+ GARCH	Equation (1)		Model 1 + lagged dep. variable		Model 2 +dummy for pos. output gap		Model 3+ gov. size	Model 2+ GARCH
Method	**OLS**	**IV**	**OLS**	**IV**	**OLS**	**IV**	**OLS**	**GARCH**	**OLS**	**IV**	**OLS**	**IV**	**OLS**	**IV**	**OLS**	**GARCH**
Denmark	-0.41	-0.73	-0.35	-0.52	-0.18	-0.25	-0.17	-0.26	0.29	0.49	0.45	0.49	0.88	0.20	0.89	0.24
	**	*	**	ns	ns	ns	ns	***	ns	*	ns	ns	*	ns	ns	ns
France	-0.19	-0.75	-0.18	-0.72	-0.61	-0.80	-0.50	0.08	0.02	0.24	-0.01	0.15	0.08	0.22	0.16	0.02
	ns	**	ns	**	*	**	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Germany	-0.25	-0.37	-0.24	-0.39	-0.10	-0.11	-0.08	-0.17	-0.19	-0.21	-0.19	-0.22	-0.17	0.58	0.26	-0.05
	ns	ns	ns	ns	ns	ns	ns	*	ns	ns	ns	ns	ns	ns	ns	ns
Italy	-0.24	-0.47	-0.17	-0.36	-0.29	-0.38	-1.00	-0.09	-0.16	-0.27	-0.25	-0.58	-0.37	-0.62	0.18	-0.22
	ns	ns	ns	ns	ns	ns	***	ns	ns	ns	ns	ns	ns	ns	ns	ns
Japan	-0.29	-0.33	-0.27	-0.29	-0.70	-0.48	0.12	-0.24	-0.36	-0.06	-0.36	-0.03	-0.48	0.13	-0.11	-0.38
	ns	ns	ns	ns	**	ns	ns	ns	**	ns	**	ns	ns	ns	ns	**
UK	-0.19	-0.02	-0.20	-0.01	-0.60	-0.32	-0.69	-0.18	-0.04	0.24	-0.04	0.29	-0.12	0.05	-0.10	-0.16
	ns	ns	ns	ns	***	ns	***	ns	ns	ns	ns	ns	ns	ns	ns	ns
USA	-0.28	-0.39	-0.11	-0.08	-0.72	-0.28	-0.77	-0.07	0.52	0.29	0.47	0.11	0.21	0.32	0.25	0.51
	ns	ns	ns	ns	**	ns	**	ns	ns	ns	ns	ns	ns	ns	ns	**
Spain	0.06	-0.35	0.07	-0.09	-0.21	-0.15	-0.13	-0.09	0.06	0.41	-0.04	0.36	-0.33	0.43	-0.24	-0.13
	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Sweden	0.00	-0.63	0.06	-0.35	0.31	0.04	0.34	0.15	-0.01	-0.35	-0.02	-0.51	0.33	0.94	0.67	-0.16
	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns

Note: ns implies not significant, * implies significance at the 10% level, ** implies significance at the 5% level, and *** implies significance at 1% level. Standard errors for the automatic stabilisers can be found in the appendix for respective country.

On the spending side, the results are reasonably stable for Denmark, France, Germany and the US. While the estimates differ a bit, the ranges obtained do not seem unreasonable given that some of the models included contain complicated dynamics. For the UK and Spain, the results on the spending side are less stable. For Sweden, one of the countries with the largest public sector in the OECD, none of the estimates are significant and sometimes of the wrong sign.

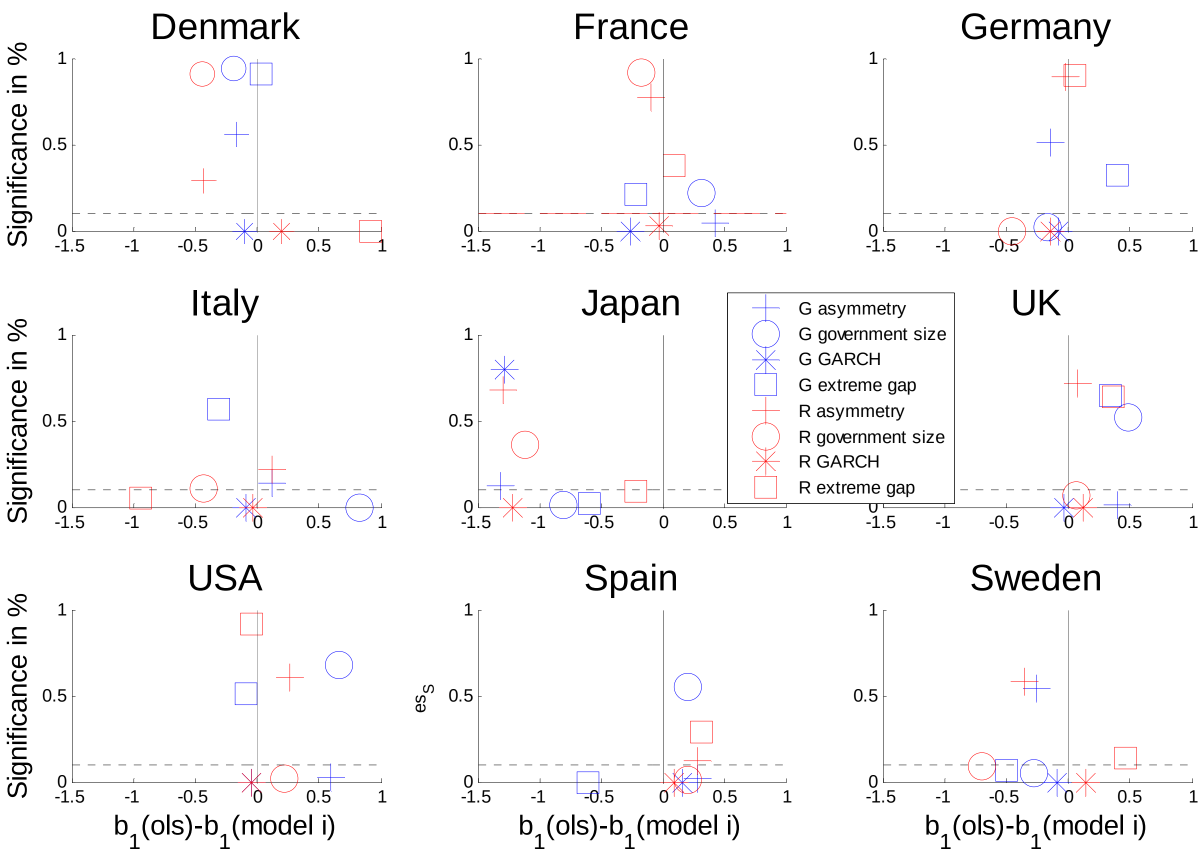
On the revenue side, there are more "wrong" signs, likely reflecting both the volatility of revenues and the difficulty of separating the trend from the cycle. Results are fairly stable for Denmark and the US, but less so for France, Germany, Italy, Japan, the UK and Spain.

4.2 Testing for departures from simple OLS

In Diagram 1 below we summarise all departures from the simple OLS model as measured by the difference of the automatic stabiliser from model 2 (OLS) to each of the four different specifications (asymmetry, non-linearities from government size, GARCH-effects, and sensitivity to extreme events). More specifically, we plot $\beta_1(Model\ 2, OLS) - \beta_1(non-linear)$. On the Y-axis we show the significance level of a Wald test for the respective departure (not the significance level of automatic stabiliser itself). For example, for government size we show the significance level of a Wald test that both coefficients on the terms $100(G/Y)_t + 100(G/Y)_t^2$ are jointly zero. For the GARCH specification, the significance level is from a Wald test that there is no autoregressive component in the error, i.e. the standard OLS assumption. Finally, for extreme events and asymmetry, there is only one coefficient being tested against the null hypothesis and so the test is similar to a standard t-test.

Overall, we find that in about half of the total 72 tests for various departures from simple OLS, the null hypothesis that the effect is zero be rejected; if we ignore the GARCH specifications where the tests are almost always significant, we reject the null of no "non-linearity" in just over one-third of the cases. While it is true that the rejection of the null can stem from a variety of sources not necessarily reflecting the merits of each test in question, the results are still indicative that neglecting possible non-linearities can be a serious mistake when estimating the automatic stabilisers, especially for some countries.

Diagram 1. Deviations of automatic stabilisers from model 2 (OLS).



Note: On the X-axis, the departure from model 2 (OLS) is subtracted by the respective estimate from the alternative non-linear model; on the Y-axis, the dotted line shows which departures are significant at the 10% level. The numbers are displayed in table B1 in the appendix.

In table 6 below, we summarise the significant departures from diagram 1. As can be seen from the table, the deviations are on both the spending side and on the revenue side of the budget. Below, we discuss these results in some detail.

Japan and Sweden are the countries with largest fiscal crises in the 1990's and both have a majority of deviations on the negative side, especially so for Japan. The most stable results are those for Denmark and France with almost no significant departures from OLS. The US and the UK have fairly similar patterns, with only significant positive departures for asymmetry. The countries with the most significant departures from OLS are Japan, Sweden and Spain.

Table 6. Automatic stabilisers, significant departures from OLS model 2

	Government Spending	**Government Revenues**
Asymmetry	FR, (IT), (JP), UK, US, ES	(ES)
Government Size	DE, IT, JP, SE	DE, (IT), UK, US, ES, SE
GARCH	DK, FR, DE, IT, UK, US, ES, SE	DK, FR, DE, IT, JP, UK, US, ES, SE
Extreme output gap	JP, SP, SE	DK, IT, JP, (SE)

Note. Departures from simple OS that significant at 10% level are shown, except for those in parenthesis which are significant at 15% level.

Non-linearities – innovations following GARCH process

As can be seen from table 6, GARCH errors are almost always significant in the specifications, but diagram 1 reveals that the estimates of the automatic stabilisers are only marginally affected – for the most part by less than 0.1 percentage points. Given the uncertainty of the estimates, the GARCH errors do not bring about a quantitatively interesting departure even if the regressions clearly pick up some time-varying variance.[6]

Non-linearities – Asymmetric effect from the output gap

Asymmetry can be strongly rejected on the revenue side for all countries except Spain. This can be interpreted as evidence that despite complicated tax-codes, by and large, government revenues have the same stabilising function in both upturns as in

[6] This is perhaps not surprising. In order to affect the automatic stabilisers, we would need to estimate a model where there is some feedback from the variance to the mean, such as a GARCH-M. We reserve this to future research.

downturns. On the spending side, however, the hypothesis cannot be rejected at the 10% level for 5/9 countries, with notably large deviations from OLS by UK and the US. As can be seen from diagram 1, all the significant departures affect the automatic stabiliser positively (the observations are to the right of the vertical line at the origin).

Non-linearities – government size

The effect on that automatic stabilisers from government size as a potential non-linearity cannot be rejected for 4/9 countries on the spending side and 5/9 on the revenue side. Some of the biggest governments are among those that have significant results, such as Sweden and Japan. But the US and the UK are also included on the revenue side. A possible explanation for this is that non-linear effects from government size can come both from rather small governments and from big governments. A notable exception is Denmark, having one of largest governments in the OECD but not significant in the results (more on this below). The estimates of government size affect the automatic stabilisers both with positive and negative direction with no clear pattern among the significant departures.

Non-linearities – extreme output gaps

In table 7 we show how many observations are classified as having an output gap larger than 3% in absolute value. This cut-off is somewhat arbitrary, but represents a trade-off between the number of observations and extreme the gap is. We find that overall about one-third of the countries show significant departures. Notably, Sweden is present both on the spending side and the revenue side, perhaps not surprising from the crisis in the 1990's. Japan is also significant on the revenue side. As can be seen from careful examination of diagram 1, all deviations that are significant at 10% level for the extreme output gaps bring about a more negative estimate of the automatic stabiliser (i.e. the observations are to the left of the vertical line at the origin), except for Denmark.

Table 7. Number of observations where output gap exceeds 3%.

	Denmark	France	Germany	Italy	Japan	UK	USA	Spain	Sweden
Nr of extreme observations	9	11	12	7	9	11	4	7	6

4.3. Patterns of deviations with extreme gaps and asymmetries

In this section we examine the automatic stabiliser from the specifications that include a dummy variable for the output gap, i.e. a dummy for possible asymmetric effect and a dummy for if the output gap is larger then 3%. Whereas in the section 4.2. above, we compared the automatic stabiliser between different models, here we investigate the effect on the automatic stabiliser *within* the same model. More specifically, we are interested in $\beta_1(Model\,3, OLS)$ and in $\beta_1(Model\,3, OLS) + \beta_{4d}$, where β_{4d} is the coefficient in front of the dummy variable for either the "asymmetric gap" (model 3) or the "extreme output gap".

Since both dummy variables are defined as zero or the level of the output gap, we can simply add the coefficients together when the conditions for the dummy variable to be non-zero are met. This is shown in diagram 2, where the "automatic stabiliser1" is plotted on the X-axis and "automatic stabiliser2" is plotted on the Y-axis reflecting $\beta_1(Model\,3, OLS)$ and $\beta_1(Model\,3, OLS) + \beta_{4d}$ respectively. Also plotted is a 45-degree line that shows whether the estimates from the "asymmetric" and "extreme gap" automatic stabilisers are smaller or larger than $\beta_1(Model\,3, OLS)$. Estimates below the 45-degree line are less smoothing for revenues and more smoothing for spending; the converse holds for estimate above the 45-degree line.

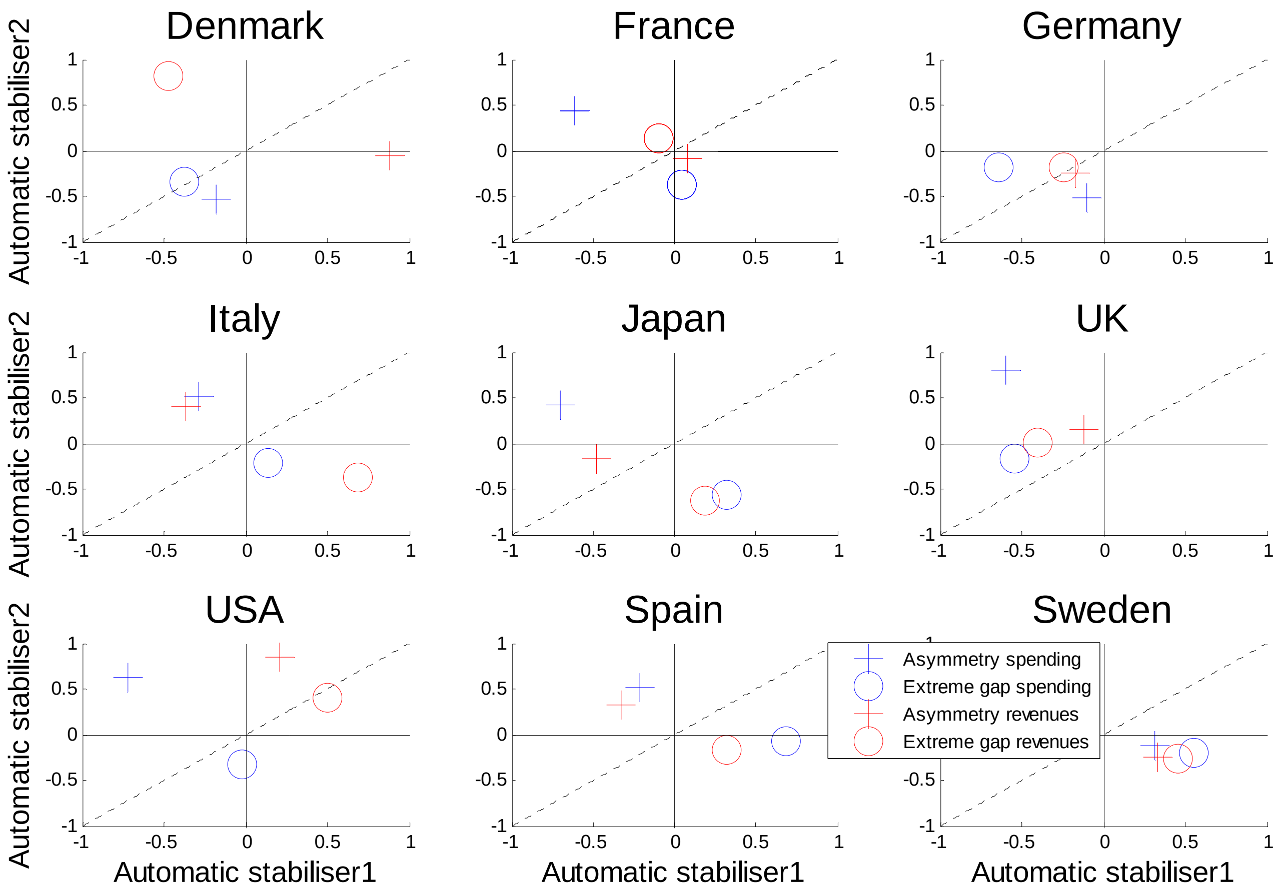
From diagram 2, there are a few features that stand out. The automatic stabilisers incorporating the extreme gap are less smoothing on the revenue side and more smoothing on the spending side for Italy, Japan, the US, Spain and Sweden. For France and Germany, the results are somewhat mixed. For Sweden in particular, all estimates are below the 45-degree line, implying that the effects on asymmetry are rather similar to those from the extreme output gap.[7] For the UK by contrast, all estimates are above the 45-degree line, implying more smoothing on the revenue side and less on the spending side.

For those countries where the departures from simple OLS are not significant (see table 6 above), this is by and large mirrored in observations coming close to the 45-degree line, with Denmark as an exception. The quantitative differences should be viewed together with the considerable parameter uncertainty reflected in the standard errors. Nonetheless, it is interesting to note that more than half of the countries (5/9) share the pattern the pattern that the automatic stabilisers incorporating the extreme gap are less smoothing on the revenue side and more smoothing on the spending side.

---

[7] This could, of course, be due to the same dominant observations during the fiscal crisis in the 1990's when the output gap was rather negative and even below -4%.

Diagram 2. Automatic stabilisers from models with effects from asymmetric and extreme output gaps.



Note: Departures from the 45-degreee line denotes estimates where the automatic stabiliser differ when there is asymmetric or extreme output gap.

4.4. Testing for stability of parameter estimates and estimating split samples

In table 7 below, we display the Quandt-Andrew's unknown break-point test on model 2 to find the year when a break is most likely. The results from the Quandt-Andrew's test are then used in a simple Chow test to investigate if parameter stability can be rejected. We use model 2 because it is the simplest model that yet contains important dynamics of spending or revenues.

As can be seen from table 7, for all countries except the UK on the revenue side and Denmark on the spending side, a test of no-structural break can be rejected. Over such a long sample period it may well reflect many other changes unrelated to the automatic stabilisers, but overall it provides some evidence that structural breaks may be important and, at the very least, it points to the need for caution when using older estimates for automatic stabilisers.

Table 7. Testing for absence of a structural break.

		Denmark	France	Germany	Italy	Japan	UK	USA	Spain	Sweden
Spending	Break year	1980	1979	1981	1981	1981	1977	1976	1994	1980
	P- value Chow test	0.11	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.02
Revenues	Break year	1987	1986	1991	1990	1978	1994	1981	1985	1983
	P-value of Chow test	0.00	0.02	0.00	0.03	0.00	0.22	0.01	0.03	0.19

Note. The break year shows the Quandt Andrew's test and the Chow test is obtained by splitting the sample at the year indicated.

While table 7 uses a breakpoint identified by the Quandt-Andrew's test, table 8 assumes the existence of a breakpoint in 1990. A break in 1990 is interesting because it is one way to capture some important institutional changes in that decade, such as several central banks gaining mandates for independence to pursue price stability. Moreover, the 1990’s had more integrated financial markets than previously and lower inflation, making estimates from 1990 more reflective of the institutional framework than the pre-ceding decades.

Table 8. Automatic stabilisers from split sample: 1970-1990 and 1990-2007.[8]

		Denmark	France	Germany	Italy	Japan	UK	USA	Spain
Spending	Full sample	-0.35	-0.18	-0.24	-0.17	-0.27	-0.20	-0.11	0.07
	First sample	-0.13	-0.31	-0.23	-0.62	-0.25	-0.24	-0.44	0.05
		(0.38)	(0.36)	(0.27)	(0.35)	(0.33)	(0.15)	(0.24)	(0.10)
	Second sample	-0.18	0.25	-0.23	0.91	0.49	-0.57	0.01	0.75
		(0.15)	(0.21)	(0.84)	(0.42)	(0.51)	(0.71)	(0.20)	(0.40)
Revenues	Full sample	0.45	-0.01	-0.19	-0.25	-0.36	-0.04	0.47	-0.04
	First sample	0.83	0.33	-0.20	-0.93	-0.11	0.02	0.58	-0.01
		(0.79)	(0.25)	(0.21)	(0.38)	(0.26)	(0.22)	(0.52)	(0.17)
	Second sample	-0.21	-0.32	0.65	0.82	0.99	0.63	-0.34	0.77
		(0.46)	(0.26)	(0.80)	(0.67)	(1.09)	(1.02)	(0.65)	(0.61)

Note. Standard errors are displayed in parenthesis.

Since there are few observations, the standard errors of the split sample in table 8 are larger. Overall it shows that full sample estimates sometimes differ substantially for different time periods. On the spending side, only Germany appears stable and, to a lesser extent, Denmark and the UK. For France and Italy on the spending side, the estimates switch signs and for Spain they are of the wrong sign. Clearly, caution should be used when interpreting the estimates from the sub-samples but they are nevertheless a good indication that the automatic stabilises may be changing over time. One notable feature of the results is how the automatic stabilisers on the spending side for the US diminish in size in the second sample, in line with the arguments put forth in Debrun et al (2008). On the revenue side, all results appear to be unstable comparing sub-samples to the full sample.

5. Concluding remarks

The automatic stabilisers are a useful part of the policymakers' toolbox but there are many caveats that should be attached to the numbers that are not always as prominently displayed as they should be or that tend to get lost when academic papers are drawn on in a policy context.

The reasons that make estimation of automatic stabilisers difficult could roughly be found in the chapter headings of many econometrics textbooks: challenges in identification of shocks, questions about parameter stability, potential non-linearities and not least the quality of the data. Some of these have been discussed in section 2 and further in the empirical part in section 4. We have found that the sign of

---

[8] The start of the first sample is 1970 unless otherwise specified in table 4. Full sample standard errors are displayed in the appendix for each respective country. With so few observations, some large residuals become more dominant and for this reason there are a few minor deviations in the split sample estimates compared to the full sample ones.

the estimates are mostly right, but the standard errors tend to be large, and that the estimates are sensitive to the choice of instruments. This is not surprising in light of previous findings.

We perform four tests per country on both the spending and the revenue side of the budget to test for various departures from OLS (i.e. potential non-linearities) that can affect the automatic stabilisers. More specifically, we test if there are asymmetric effects on automatic stabilisers depending on the sign of the output gap; we test if the automatic stabilisers are sensitive to extreme gaps, here assumed to be an output gap larger than 3%; we test if there are non-linear effects from government size and finally we test if assuming GARCH(1,1)-errors changes the results.

Overall, we find that in about half of the 72 tests performed the test cannot reject the null hypothesis of a departure from OLS. Notably, virtually all the GARCH tests are significant at high levels but their quantitative impact is small. If we only consider the other three tests, we find that in about one-third of 54 tests can the null hypothesis be rejected. All in all, there is considerable evidence that some departures from linearity can be important.

On the test for asymmetric effects over the business cycle, we find no evidence for any of the countries on the revenue side (except weakly for Spain), but some evidence in just over half the countries on the spending side. Thus, it appears that while tax codes are complicated they do not bring about different effects if the output gap is positive or negative. On the test for extreme events as measured by an output gap larger than 3%, we find that about one-third of the countries show cannot reject the hypothesis that this variable should be included. On the test for effects of government size, we find that this test cannot be rejected for about half the countries. It is noteworthy that both the biggest and the smallest governments are significant but some of the medium size ones are not, perhaps suggesting that non-linear effects may relevant for governments that are either rather small or rather big. This hypothesis would be interesting to explore further in a panel data context where a more formal test might be constructed.

There are some noteworthy patterns that stand out. Sweden and Japan both have systematically negative deviations from OLS in almost all the tests for non-linearities. This may be a coincidence but both countries experienced significant fiscal crises in the 1990's that may be important for the results. Denmark and France present the most stable results (i.e. the fewest significant tests for non-linearities). The Anglo-

Saxon countries exhibit similar patterns and show significance in tests for asymmetry on the spending side. The countries picking up the most significant departures from OLS are Japan, Sweden and Spain.

What happens to automatic stabilisation when the output gap is extreme? We then find that the automatic stabilisers are less smoothing on the revenue side and more smoothing on the spending side for Italy, Japan, the US, Spain and Sweden. For Sweden, we find that the effects from the extreme gap are similar to those from the asymmetry. For the UK, the results are the opposite from Sweden and all estimates of effects point to more smoothing on revenue side and less on the spending side.

We found considerable evidence for parameter instability. Only for one country (Denmark) on the spending side and two countries on the revenue side (UK and Sweden) can the null of no parameter change in the automatic stabiliser be rejected. While there are several possible explanations, the results indicate that estimates of automatic stabilisers while not having exactly “expire by dates” still probably need to be updated periodically.[9]

While we have not specifically explored this issue in the empirical part, it may be reasonable to think of the automatic stabilisers as a slowly changing variable, just like the institutional frameworks also mostly tend to change slowly. In Debrun et al (2008), some evidence is found in this regard and in particular, they argue that the automatic stabilisers may have become less important in recent years. One challenge for such an agenda is that while it is reasonable to think that institutions and rules normally change slowly, this is clearly not always the case. For example, when there is a switch of government form “left” to “right” (or the other way around), the new government could immediately implement an agenda that makes unemployment benefits more strict (and consequently lower the automatic spending) as well as implement significant changes in taxation. To specify more formally how the automatic stabilisers can change over time would be a useful topic for further research.

[9] The OECD studies by Girouard and Andre (2005) and van den Noord (2000) probably reflect an appropriate updating frequency.

Appendix

Table A1. Denmark

	Denmark, spending regressions 1970-2007								Denmark revenue regressions, 1970-2007							
	Model 1	**Model 1**	**Model 2**	**Model 2**	**Model 3**	**Model 3**	**Model 4**	**Model 5**	**Model 1**	**Model 1**	**Model 2**	**Model 2**	**Model 3**	**Model 3**	**Model 4**	**Model 5**
	OLS	**IV**	**OLS**	**IV**	**OLS**	**IV**	**OLS**	**GARCH**	**OLS**	**IV**	**OLS**	**IV**	**OLS**	**IV**	**OLS**	**GARCH**
C	0.06	-0.34	-0.07	-0.34	0.09	0.01	-15.86	-0.17	1.59	1.50	1.48	1.49	1.79	1.18	24.61	0.27
	0.61	0.68	0.60	0.59	0.68	3.05	52.41	0.27	1.18	1.32	1.21	1.56	1.24	2.66	51.35	0.51
GAP	-0.41	-0.73	-0.35	-0.52	-0.18	-0.25	-0.17	-0.26	0.29	0.49	0.45	0.49	0.88	0.20	0.89	0.24
	0.18	0.44	0.17	0.46	0.33	3.89	0.37	0.09	0.26	0.26	0.28	0.44	0.53	3.14	0.56	0.21
PI	0.83	0.45	0.86	0.43	0.87	0.86	0.95	0.73	0.76	0.66	0.81	0.65	0.81	0.37	0.83	0.46
	0.24	0.33	0.25	0.32	0.26	0.87	0.39	0.19	0.29	0.52	0.31	0.74	0.34	1.03	0.59	0.21
LR	0.29	0.49	0.32	0.41	0.33	0.33	0.28	0.36	0.20	0.25	0.20	0.25	0.21	0.36	0.19	0.47
	0.15	0.18	0.17	0.22	0.18	0.31	0.24	0.10	0.22	0.33	0.24	0.34	0.24	0.40	0.42	0.17
DG/DT			-0.05	0.13	-0.06	-0.06	-0.04	-0.02			-0.05	0.00	0.01	0.08	0.01	0.08
			0.16	0.18	0.17	0.19	0.17	0.12			0.22	0.31	0.22	0.32	0.25	0.09
Dummy					-0.35	-0.27	-0.39						-0.92	-0.05	-0.85	
					0.60	5.50	0.64						0.87	4.61	0.92	
size							0.59								-0.90	
							2.00								2.04	
size^2							-0.54								0.88	
							1.91								2.04	
C_arch								-0.01								9.13
								0.10								5.00
RESID(-1)^2								-0.20								1.36
								0.07								1.14
GARCH(-1)								1.13								-0.83
								0.07								0.28
Dummy																
Adj rsquared	0.87	0.86	0.88	0.88	0.88	0.87	0.87	0.87	0.56	0.51	0.57	0.50	0.57	0.47	0.54	0.50

Note: C denotes constant term, gap is the output gap, pi is inflation, lr is the long interest rate, the first dummy in the column is the output gap if positive and zero otherwise, size and size squared are measured as government spending as share of GDP; the next section of estimates refers to the constant and Arch terms in a GARCH(1,1) model. The final dummy variable (if specified) denotes a country specific dummy variable for a particular year. Standard errors estimated with White's heteroskedasticity consistent estimates are given below each parameter.

Table A2. France

	France, spending regressions 1970-2007								France, revenue regressions from 1980-2007							
	Model 1 OLS	**Model 1 IV**	**Model 2 OLS**	**Model 2 IV**	**Model 3 OLS**	**Model 3 IV**	**Model 4 OLS**	**Model 5 GARCH**	**Model 1 OLS**	**Model 1 IV**	**Model 2 OLS**	**Model 2 IV**	**Model 3 OLS**	**Model 3 IV**	**Model 4 OLS**	**Model 5 GARCH**
C	2.49	0.49	2.19	0.29	1.75	0.23	3.97	1.91	2.19	2.81	1.77	2.30	1.81	2.04	36.59	1.77
	0.72	1.25	0.72	1.32	0.73	1.44	32.55	0.44	0.82	0.82	0.84	0.94	0.88	0.97	179.59	0.50
HP	-0.19	-0.75	-0.18	-0.72	-0.61	-0.80	-0.50	0.08	0.02	0.24	-0.01	0.15	0.08	0.22	0.16	0.02
	0.17	0.36	0.18	0.36	0.33	0.36	0.34	0.09	0.13	0.23	0.14	0.25	0.37	0.61	0.62	0.09
PI	1.33	0.87	1.15	0.72	1.09	0.72	1.02	1.29	0.98	1.11	0.74	0.87	0.74	0.78	0.71	0.74
	0.22	0.34	0.27	0.38	0.26	0.44	0.28	0.24	0.14	0.18	0.26	0.32	0.26	0.27	0.31	0.14
LR	-0.11	0.34	-0.12	0.32	-0.12	0.31	-0.06	-0.06	0.03	-0.12	0.00	-0.10	0.01	-0.02	0.02	0.00
	0.19	0.31	0.18	0.32	0.17	0.39	0.19	0.10	0.15	0.17	0.13	0.17	0.13	0.14	0.13	0.09
DG/DT			0.15	0.14	0.12	0.13	0.10	0.02			0.22	0.21	0.23	0.23	0.23	0.21
			0.12	0.12	0.12	0.14	0.12	0.13			0.17	0.17	0.17	0.17	0.18	0.08
Dummy					1.04	0.22	0.84						-0.15	-0.32	-0.28	
					0.51	1.17	0.53						0.52	0.89	0.74	
size							0.02								-1.31	
							1.51								7.05	
size^2							-0.13								1.24	
							1.70								6.92	
C_arch								-0.09								0.40
								0.14								0.19
RESID(-1)^2								-0.05								-0.19
								0.16								0.09
GARCH(-1)								1.04								0.76
								0.30								0.28
Adj rsquared	0.88	0.86	0.88	0.86	0.89	0.86	0.89	0.85	0.90	0.89	0.91	0.90	0.90	0.90	0.89	0.90

Note: C denotes constant term, gap is the output gap, pi is inflation, lr is the long interest rate, the first dummy in the column is the output gap if positive and zero otherwise, size and size squared are measured as government spending as share of GDP; the next section of estimates refers to the constant and Arch terms in a GARCH(1,1) model. The final dummy variable (if specified) denotes a country specific dummy variable for a particular year. Standard errors estimated with White's heteroskedasticity consistent estimates are given below each parameter.

Table A3. Germany

	Germany, spending regressions 1970-2007								Germany, revenue regressions from 1980-2007							
	Model 1	**Model 1**	**Model 2**	**Model 2**	**Model 3**	**Model 3**	**Model 4**	**Model 5**	**Model 1**	**Model 1**	**Model 2**	**Model 2**	**Model 3**	**Model 3**	**Model 4**	**Model 5**
	OLS	**IV**	**OLS**	**IV**	**OLS**	**IV**	**OLS**	**GARCH**	**OLS**	**IV**	**OLS**	**IV**	**OLS**	**IV**	**OLS**	**GARCH**
C	-4.37	-3.56	-4.33	-3.59	-4.51	-2.95	137.54	-3.78	-1.27	-1.33	-1.28	-1.45	-1.30	-2.59	24.18	-1.60
	1.88	2.14	2.00	2.18	2.09	3.69	157.74	0.89	1.82	1.95	1.99	2.13	2.03	2.26	74.67	0.94
GAP	-0.25	-0.37	-0.24	-0.39	-0.10	-0.11	-0.08	-0.17	-0.19	-0.21	-0.19	-0.22	-0.17	0.58	0.26	-0.05
	0.17	0.39	0.16	0.40	0.28	3.16	0.26	0.10	0.14	0.26	0.14	0.26	0.21	1.37	0.22	0.11
PI	1.14	1.42	1.11	1.51	1.06	-0.38	0.88	1.06	1.14	1.18	1.15	1.30	1.14	0.67	0.50	0.48
	0.45	0.68	0.51	0.77	0.51	2.66	0.69	0.28	0.50	0.61	0.56	0.67	0.57	1.22	0.33	0.25
LR	0.93	0.66	0.92	0.66	1.03	0.63	0.97	0.92	0.46	0.43	0.46	0.47	0.48	1.13	0.79	0.72
	0.40	0.53	0.43	0.55	0.53	2.35	0.45	0.20	0.38	0.43	0.43	0.47	0.46	1.06	0.34	0.20
DG/DT			0.02	-0.04	0.01	0.92	-0.09	-0.07			-0.00	-0.09	-0.00	-0.04	-0.34	-0.05
			0.24	0.24	0.24	0.28	0.26	0.07			0.20	0.21	0.20	0.20	0.17	0.08
Dummy					-0.41	-0.16	0.12						-0.07	-1.64	0.25	
					0.63	4.71	0.24						0.52	2.85	0.39	
size							-5.99								0.05	
							7.20								3.40	
size^2							6.32								-1.25	
							8.16								3.84	
C_arch								1.10								0.48
								0.55								0.31
RESID(-1)^2								-0.28								-0.24
								0.12								0.24
GARCH(-1)								1.14								1.17
								0.19								0.35
Dummy 1991	8.07	8.82	7.92	9.17	8.89	2.14	8.60	9.84	8.13	8.38	8.14	8.72	8.29	11.22	7.90	10.77
	4.63	5.01	5.00	5.20	5.13	9.65	5.06	2.22	3.75	3.87	3.80	3.50	4.02	5.79	1.66	1.64
Adj rsquared	0.60	0.59	0.59	0.57	0.58	0.19	0.63	0.57	0.54	0.55	0.53	0.54	0.52	0.40	0.74	0.44

Note: C denotes constant term, gap is the output gap, pi is inflation, lr is the long interest rate, the first dummy in the column is the output gap if positive and zero otherwise, size and size squared are measured as government spending as share of GDP; the next section of estimates refers to the constant and Arch terms in a GARCH(1,1) model. The final dummy variable captures the large movements around re-unification. Standard errors estimated with White's heteroskedasticity consistent estimates are given below each parameter.

Table A4. Italy

	Italy, spending regressions from 1975-2007								Italy, revenue regressions from 1980-2007							
	Model 1 OLS	**Model 1 IV**	**Model 2 OLS**	**Model 2 IV**	**Model 3 OLS**	**Model 3 IV**	**Model 4 OLS**	**Model 5 GARCH**	**Model 1 OLS**	**Model 1 IV**	**Model 2 OLS**	**Model 2 IV**	**Model 3 OLS**	**Model 3 IV**	**Model 4 OLS**	**Model 5 GARCH**
C	-0.30	-0.83	-0.03	-0.42	-0.15	-0.35	-200.03	-0.38	0.15	-0.44	-0.08	-1.26	-0.18	-1.18	126.55	-1.08
	1.22	1.35	1.29	1.42	1.25	1.43	48.03	0.64	1.32	1.43	1.32	1.41	1.35	1.48	69.93	0.78
GAP	-0.24	-0.47	-0.17	-0.36	-0.29	-0.38	-1.00	-0.09	-0.16	-0.27	-0.25	-0.58	-0.37	-0.62	0.18	-0.22
	0.34	0.33	0.32	0.34	0.33	0.37	0.36	0.07	0.26	0.36	0.33	0.44	0.35	0.50	0.47	0.16
PI	1.19	1.00	1.02	0.90	1.05	1.01	1.41	0.93	1.02	0.93	1.12	0.94	1.13	1.05	0.19	1.11
	0.36	0.33	0.34	0.33	0.34	0.35	0.44	0.13	0.33	0.37	0.32	0.35	0.33	0.37	0.60	0.20
LR	0.20	0.35	0.09	0.22	0.07	0.12	-0.10	0.16	0.33	0.43	0.48	0.76	0.46	0.66	1.22	0.52
	0.30	0.29	0.30	0.31	0.29	0.32	0.36	0.10	0.28	0.31	0.34	0.42	0.35	0.43	0.48	0.17
DG/DT			0.19	0.17	0.16	0.14	0.09	0.16			-0.18	-0.28	-0.21	-0.30	-0.21	-0.14
			0.15	0.15	0.15	0.15	0.13	0.05			0.19	0.21	0.19	0.21	0.17	0.09
Dummy					0.80	0.91	2.17						0.78	1.09	0.39	
					0.54	0.54	0.65						0.64	0.75	0.67	
size							8.07								-4.44	
							1.84								2.60	
size^2							-8.13								3.69	
							1.78								2.42	
C_arch								1.60								0.57
								0.46								0.68
RESID(-1)^2								-0.25								-0.25
								0.17								0.24
GARCH(-1)								1.03								1.16
								0.36								0.32
Dummy																
Adj rsquared	0.88	0.87	0.88	0.87	0.88	0.88	0.90	0.86	0.82	0.83	0.82	0.82	0.82	0.83	0.84	0.82

Note: C denotes constant term, gap is the output gap, pi is inflation, lr is the long interest rate, the first dummy in the column is the output gap if positive and zero otherwise, size and size squared are measured as government spending as share of GDP; the next section of estimates refers to the constant and Arch terms in a GARCH(1,1) model. The final dummy variable (if specified) denotes a country specific dummy variable for a particular year. Standard errors estimated with White's heteroskedasticity consistent estimates are given below each parameter.

Table A5. Japan

	Japan, spending regressions 1997-2007								Japan, revenue regressions 1970-2007							
	Model 1 OLS	**Model 1 IV**	**Model 2 OLS**	**Model 2 IV**	**Model 3 OLS**	**Model 3 IV**	**Model 4 OLS**	**Model 5 GARCH**	**Model 1 OLS**	**Model 1 IV**	**Model 2 OLS**	**Model 2 IV**	**Model 3 OLS**	**Model 3 IV**	**Model 4 OLS**	**Model 5 GARCH**
C	-0.60	-0.86	-0.21	-0.51	-1.07	-0.95	70.48	-0.24	-0.31	-0.24	-0.28	-0.14	-0.48	0.22	7.91	-0.52
	1.32	1.44	1.56	1.63	1.75	2.08	25.34	1.41	1.43	1.47	1.45	1.59	1.62	1.95	30.59	0.69
HP	-0.29	-0.33	-0.27	-0.29	-0.70	-0.48	0.12	-0.24	-0.36	-0.06	-0.36	-0.03	-0.48	0.13	-0.11	-0.38
	0.27	0.32	0.24	0.29	0.35	0.52	0.39	0.17	0.18	0.51	0.18	0.54	0.34	0.79	0.59	0.16
PI	1.17	1.17	1.02	0.99	1.06	1.00	0.54	1.01	0.98	0.94	0.93	0.89	0.94	0.89	0.76	0.87
	0.16	0.17	0.18	0.19	0.19	0.20	0.20	0.16	0.19	0.23	0.21	0.30	0.21	0.30	0.26	0.17
LR	0.80	0.83	0.58	0.60	0.52	0.55	0.99	0.58	0.80	0.81	0.74	0.74	0.72	0.82	0.36	0.61
	0.29	0.30	0.38	0.38	0.36	0.36	0.46	0.33	0.29	0.29	0.40	0.45	0.38	0.46	0.52	0.16
DG/DT			0.16	0.19	0.13	0.17	0.00	0.16			0.05	0.06	0.04	0.06	0.03	0.21
			0.16	0.17	0.16	0.17	0.12	0.14			0.22	0.27	0.23	0.30	0.25	0.08
Dummy					1.12	0.68	0.24						0.32	-0.74	-0.33	
					0.72	0.98	0.76						0.78	1.38	1.09	
size							-3.99								0.12	
							1.55								1.68	
size^2							5.51								-0.78	
							2.38								2.39	
C_arch								3.57								0.77
								10.62								0.89
RESID(-1)^2								0.04								-0.16
								0.17								0.21
GARCH(-1)								0.48								1.08
								1.47								0.36
Dum98	13.72	13.95	13.78	14.09	14.44	14.40	11.51	13.84								
	1.07	1.19	1.18	1.30	1.36	1.69	2.62	1.07								
Dum99	-11.27	-11.13	-13.73	-13.92	-12.86	-13.36	-11.03	-13.63								
	0.88	0.90	2.79	2.79	2.71	2.91	2.32	2.42								
Adj rsquared	0.85	0.85	0.85	0.85	0.86	0.86	0.88	0.85	0.70	0.68	0.69	0.66	0.68	0.65	0.68	0.68

Note: C denotes constant term, gap is the output gap, pi is inflation, lr is the long interest rate, the first dummy in the column is the output gap if positive and zero otherwise, size and size squared are measured as government spending as share of GDP; the next section of estimates refers to the constant and Arch terms in a GARCH(1,1) model. The final dummies capture the extreme spending changes in 1998-99. Standard errors estimated with White's heteroskedasticity consistent estimates are given below each parameter.

Table A6. UK

	UK, spending regressions 1970-2007								UK, revenue regressions 1970-2007							
	Model 1 OLS	**Model 1 IV**	**Model 2 OLS**	**Model 2 IV**	**Model 3 OLS**	**Model 3 IV**	**Model 4 OLS**	**Model 5 GARCH**	**Model 1 OLS**	**Model 1 IV**	**Model 2 OLS**	**Model 2 IV**	**Model 3 OLS**	**Model 3 IV**	**Model 4 OLS**	**Model 5 GARCH**
C	5.61	5.54	6.23	5.57	6.48	5.99	3.74	5.66	4.86	5.09	4.83	5.58	4.85	5.11	132.51	5.28
	2.11	2.22	2.55	2.63	2.51	2.61	93.31	1.36	1.60	1.67	1.49	1.51	1.49	1.61	72.56	0.49
HP	-0.19	-0.02	-0.20	-0.01	-0.60	-0.32	-0.69	-0.18	-0.04	0.24	-0.04	0.29	-0.12	0.05	-0.10	-0.16
	0.16	0.26	0.16	0.26	0.18	0.43	0.21	0.13	0.21	0.17	0.22	0.18	0.35	0.39	0.35	0.15
PI	1.17	1.22	1.32	1.22	1.20	1.13	1.24	1.13	1.01	1.09	1.01	1.19	0.98	1.09	1.13	0.71
	0.23	0.20	0.31	0.28	0.32	0.29	0.32	0.13	0.17	0.14	0.21	0.21	0.22	0.28	0.24	0.12
LR	-0.38	-0.42	-0.41	-0.42	-0.53	-0.54	-0.75	-0.46	-0.21	-0.29	-0.21	-0.32	-0.23	-0.27	-0.24	-0.41
	0.33	0.32	0.35	0.34	0.34	0.36	0.42	0.18	0.24	0.24	0.23	0.22	0.24	0.25	0.36	0.12
DG/DT			-0.14	-0.00	-0.11	0.01	-0.17	0.15			0.00	-0.09	0.02	-0.05	-0.10	0.35
			0.19	0.15	0.20	0.15	0.19	0.05			0.18	0.17	0.19	0.19	0.22	0.06
Dummy					1.40	1.09	1.66						0.27	0.13	0.15	
					0.55	0.92	0.72						0.76	0.94	0.82	
size							-0.02								-5.67	
							4.17								3.35	
size^2							0.30								6.26	
							4.70								3.93	
C_arch								1.95								0.54
								0.70								0.13
RESID(-1)^2								-0.18								-0.17
								0.09								0.11
GARCH(-1)								0.97								1.02
								0.18								0.15
Adj rsquared	0.63	0.69	0.62	0.68	0.65	0.72	0.63	0.58	0.60	0.69	0.58	0.67	0.57	0.69	0.57	0.51

Note: C denotes constant term, gap is the output gap, pi is inflation, lr is the long interest rate, the first dummy in the column is the output gap if positive and zero otherwise, size and size squared are measured as government spending as share of GDP; the next section of estimates refers to the constant and Arch terms in a GARCH(1,1) model. The final dummy variable (if specified) denotes a country specific dummy variable for a particular year. Standard errors estimated with White's heteroskedasticity consistent estimates are given below each parameter.

Table A7. US

	US, spending regressions 1970-2007								US, revenue regressions 1970-2007							
	Model 1	**Model 1**	**Model 2**	**Model 2**	**Model 3**	**Model 3**	**Model 4**	**Model 5**	**Model 1**	**Model 1**	**Model 2**	**Model 2**	**Model 3**	**Model 3**	**Model 4**	**Model 5**
	OLS	**IV**	**OLS**	**IV**	**OLS**	**IV**	**OLS**	**GARCH**	**OLS**	**IV**	**OLS**	**IV**	**OLS**	**IV**	**OLS**	**GARCH**
C	1.90	1.27	1.73	1.54	1.22	1.43	65.66	2.28	4.75	4.62	4.40	3.79	4.06	3.93	228.79	4.75
	0.87	1.04	0.75	0.66	0.85	0.80	123.37	0.26	1.90	2.53	2.27	2.62	2.38	2.38	195.92	1.03
HP	-0.28	-0.39	-0.11	-0.08	-0.72	-0.28	-0.77	-0.07	0.52	0.29	0.47	0.11	0.21	0.32	0.25	0.51
	0.21	0.32	0.17	0.17	0.36	0.41	0.37	0.07	0.40	0.60	0.43	0.60	0.82	1.10	0.68	0.21
PI	0.86	0.85	0.76	0.76	0.73	0.75	0.80	0.63	0.65	0.65	0.56	0.44	0.50	0.52	0.24	0.53
	0.11	0.11	0.12	0.12	0.12	0.12	0.16	0.05	0.19	0.21	0.24	0.26	0.24	0.24	0.24	0.14
LR	0.18	0.26	0.02	0.03	0.11	0.05	0.03	-0.21	-0.06	-0.03	-0.06	-0.02	-0.06	-0.10	0.31	-0.03
	0.14	0.15	0.16	0.16	0.16	0.18	0.19	0.06	0.25	0.33	0.28	0.32	0.28	0.29	0.28	0.11
DG/DT			0.27	0.28	0.13	0.23	0.11	0.50			0.11	0.24	0.12	0.16	-0.01	0.08
			0.19	0.19	0.20	0.20	0.20	0.05			0.21	0.20	0.21	0.22	0.20	0.10
Dummy					1.34	0.49	1.48						0.64	0.74	0.84	
					0.62	0.67	0.64						1.25	1.68	1.03	
size							-3.95								-12.23	
							7.28								11.49	
size^2							6.06								16.47	
							10.75								16.76	
C_arch								0.41								0.68
								0.12								0.44
RESID(-1)^2								1.29								-0.22
								0.34								0.10
GARCH(-1)								-0.02								1.14
								0.01								0.16
Adj rsquared	0.70	0.72	0.73	0.74	0.76	0.75	0.75	0.69	0.17	0.18	0.25	0.17	0.14	0.23	0.22	0.15

Note: C denotes constant term, gap is the output gap, pi is inflation, lr is the long interest rate, the first dummy in the column is the output gap if positive and zero otherwise, size and size squared are measured as government spending as share of GDP; the next section of estimates refers to the constant and Arch terms in a GARCH(1,1) model. The final dummy variable (if specified) denotes a country specific dummy variable for a particular year. Standard errors estimated with White's heteroskedasticity consistent estimates are given below each parameter.

Table A8. Spain

	Spain, spending regressions 1970-2007								Spain, revenue regressions 1975-2007							
	Model 1 OLS	**Model 1 IV**	**Model 2 OLS**	**Model 2 IV**	**Model 3 OLS**	**Model 3 IV**	**Model 4 OLS**	**Model 5 GARCH**	**Model 1 OLS**	**Model 1 IV**	**Model 2 OLS**	**Model 2 IV**	**Model 3 OLS**	**Model 3 IV**	**Model 4 OLS**	**Model 5 GARCH**
C	2.73	2.69	2.21	2.04	1.76	1.87	-2.33	2.28	4.45	4.34	3.16	3.63	2.75	3.75	-8.20	3.75
	0.63	0.78	0.73	0.71	0.76	0.71	12.26	0.34	0.72	0.89	1.15	1.53	1.15	1.73	23.86	0.95
GAP	0.06	-0.35	0.07	-0.09	-0.21	-0.15	-0.13	-0.09	0.06	0.41	-0.04	0.36	-0.33	0.43	-0.24	-0.13
	0.09	0.33	0.09	0.20	0.13	0.25	0.29	0.05	0.10	0.85	0.14	0.58	0.22	0.92	0.34	0.13
PI	1.30	1.25	1.17	1.11	1.21	1.18	1.16	1.16	1.06	1.10	0.77	0.94	0.77	0.89	0.75	0.97
	0.05	0.08	0.12	0.13	0.11	0.10	0.12	0.06	0.06	0.13	0.23	0.30	0.25	0.27	0.28	0.17
LR																
DG/DT			0.10	0.14	0.05	0.08	0.01	0.11			0.27	0.15	0.24	0.20	0.08	0.08
			0.09	0.08	0.09	0.08	0.11	0.04			0.20	0.26	0.21	0.22	0.22	0.16
Dummy					0.73	0.49	0.75						0.64	-0.47	0.81	
					0.31	0.48	0.48						0.42	1.42	0.52	
size							0.46								1.11	
							0.75								1.17	
size^2							-0.85								-1.96	
							1.15								1.51	
C_arch								0.11								1.05
								0.16								1.13
RESID(-1)^2								-0.21								0.40
								0.18								0.16
GARCH(-1)								1.23								0.49
								0.19								0.23
Dummy																
Adj rsquared	0.90	0.87	0.92	0.91	0.92	0.92	0.92	0.91	0.81	0.78	0.82	0.79	0.82	0.78	0.85	0.81

Note: C denotes constant term, gap is the output gap, pi is inflation, lr is the long interest rate, the first dummy in the column is the output gap if positive and zero otherwise, size and size squared are measured as government spending as share of GDP; the next section of estimates refers to the constant and Arch terms in a GARCH(1,1) model. The final dummy variable (if specified) denotes a country specific dummy variable for a particular year. Standard errors estimated with White's heteroskedasticity consistent estimates are given below each parameter.

Table A9. Sweden

	Swedish spending regressions								Swedish revenue regressions from 1970							
	Model 1	**Model 1**	**Model 2**	**Model 2**	**Model 3**	**Model 3**	**Model 4**	**Model 5**	**Model 1**	**Model 1**	**Model 2**	**Model 2**	**Model 3**	**Model 3**	**Model 4**	**Model 5**
	OLS	**IV**	**OLS**	**IV**	**OLS**	**IV**	**OLS**	**GARCH**	**OLS**	**IV**	**OLS**	**IV**	**OLS**	**IV**	**OLS**	**GARCH**
C	1.14	0.61	0.65	0.34	0.91	0.59	31.04	0.44	3.678654	3.713642	2.430491	2.615026	2.82986	3.407259	69.15381	1.832639
	0.68	0.90	0.65	0.76	0.81	1.00	31.41	0.43	0.83726	0.861021	0.919571	1.075622	1.218767	2.013587	40.31306	0.789939
GAP	0.00	-0.63	0.06	-0.35	0.31	0.04	0.34	0.15	-0.01	-0.35	-0.02	-0.51	0.33	0.94	0.67	-0.16
	0.18	0.60	0.19	0.57	0.53	0.86	0.56	0.10	0.25	0.35	0.23	0.38	0.70	1.70	0.62	0.17
PI	1.30	1.30	0.97	0.97	1.00	0.92	1.06	0.75	0.88	0.83	0.51	0.36	0.57	0.72	0.60	0.49
	0.12	0.13	0.25	0.27	0.26	0.27	0.24	0.09	0.15	0.14	0.14	0.15	0.21	0.43	0.22	0.11
LR																
DG/DT			0.28	0.26	0.28	0.30	0.21	0.39			0.40	0.46	0.38	0.35	0.33	0.42
			0.15	0.17	0.16	0.16	0.16	0.07			0.13	0.15	0.13	0.19	0.16	0.10
Dummy					-0.43	-0.04	-0.42						-0.59	-2.21	-0.96	
					0.70	1.16	0.75						1.05	2.73	0.90	
size							-0.91								-2.27	
							1.11								1.45	
size^2							0.65								1.93	
							0.98								1.31	
C								0.37								0.89
								0.33								1.05
RESID(-1)^2								-0.23								0.03
								0.22								0.18
GARCH(-1)								1.14								0.79
								0.34								0.27
Dummy 1992									-11.46	-18.43	-12.24	-27.25	-12.36	-11.76	-12.98	-11.57
									0.79	12.78	0.79	19.47	0.88	1.08	2.00	0.63
Adj rsquared	0.77	0.73	0.78	0.79	0.78	0.81	0.82	0.77	0.54	0.50	0.63	0.36	0.62	0.58	0.67	0.62

Note: C denotes constant term, gap is the output gap, pi is inflation, lr is the long interest rate, the first dummy in the column is the output gap if positive and zero otherwise, size and size squared are measured as government spending as share of GDP; the next section of estimates refers to the constant and Arch terms in a GARCH(1,1) model. The final dummy variable (if specified) denotes a country specific dummy variable for a particular year. Standard errors estimated with White's heteroskedasticity consistent estimates are given below each parameter.

Appendix B. Table B1. Tests against null hypothesis of no non-linearity.

	Denmark		France		Germany		Italy		Japan		UK		USA		Spain		Sweden	
	Spending	Revenue	Spending	Revenue	Spending	Revenue	Spending	Revenue	Spending	Revenue	Spending	Revenue	Spending	Revenue	Spending	Revenue	Spending	Revenue
Asymmetry	-0.17	-0.43	0.43	-0.09	-0.15	-0.02	0.12	0.12	-1.32	-1.30	0.40	0.08	0.60	0.26	0.28	0.28	-0.26	-0.35
Gov size	-0.19	-0.44	0.32	-0.17	-0.17	-0.46	0.83	-0.43	-0.81	-1.12	0.49	0.06	0.66	0.22	0.21	0.20	-0.28	-0.70
GARCH	-0.10	0.20	-0.26	-0.03	-0.08	-0.15	-0.09	-0.03	-1.28	-1.22	-0.03	0.12	-0.05	-0.05	0.16	0.09	-0.09	0.14
Extreme	0.03	0.92	-0.22	0.09	0.40	0.05	-0.31	-0.94	-0.59	-0.22	0.34	0.36	-0.09	-0.04	-0.61	0.32	-0.50	0.46
Sig asy	0.56	0.29	0.04	0.77	0.51	0.89	0.14	0.22	0.12	0.68	0.01	0.72	0.03	0.61	0.02	0.13	0.54	0.58
Sig size	0.94	0.91	0.22	0.92	0.02	0.00	0.00	0.11	0.01	0.36	0.52	0.07	0.68	0.02	0.55	0.01	0.05	0.09
Sig Garch	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sig extrem	0.91	0.00	0.21	0.38	0.32	0.90	0.57	0.05	0.02	0.09	0.65	0.64	0.51	0.92	0.00	0.29	0.07	0.14

Note: This is the data that is used to plot figure 1 in the paper. The upper panel shows $\beta_1(Model\ 2, OLS) - \beta_1(non-linear)$ and the lower panel shows the significance level of a test for each respective non-linearity (not a test of the significance of the automatics stabilser). For example, for “Sig size”, what is shown is the p-value of a Wald test that that both coefficients on $100(G/Y)_t + 100(G/Y)_t^2$ are jointly zero.

References

Afonso, A. and D. Furceri (2008), “Business cycle synchronization and insurance mechanisms in the EU,” Journal of International Money and Finance, 2008, 27 (2), pages 169-187.

Alesina, A. and G. Tabellini (2008), “Why is fiscal policy often procyclical?” Journal of the European Economic Association, special edition on political economy,vol. 6, issue 5, forthcoming.

Andersen, T. M. (2004), “Is there a role for an active stabilization policy?” CESIFO working paper 1447.

Andrés, J., R. Domenech and A. Fatás (2008), "The Stabilizing Role of Government Size," Journal of Economic Dynamics and Control (Forthcoming).

Asdrubali, P., B.E. Sørensen and O. Yosha (1996), “Channels of interstate risk sharing: United States 1963-1990,” Quarterly Journal of Economics, Vol. 111, No.4, pages 1081-1110.

Auerbach, A. and D. Feenberg (2000), “The significance of federal taxes as automatic stabilizers,” NBER working paper 7662.

Barrell, R. and A.M. Pina (2002), “How important are automatic stabilisers in Europe? A stochastic simulation assessment,” Economic Modelling, 21, pages 1-35.

Beetsma, R. (2008), “A survey of the effects of discretionary fiscal policy”, paper presented at the Ministry of Finance in Stockholm, February 2008.

Blanchard, O. and R. Perotti (2002), “An empirical characterization of the dynamic effects of changes in government spending and taxes on output”, Quarterly Journal of Economics, 117(4), pp 1329-1368.

Blanchard, O. (2006), Comments on ``The case against the case against discretionary fiscal policy’’, by Alan Blinder, in ``The macroeconomics of fiscal policy’’, edited by Richard Kopcke, Geoffrey Tootell and Robert Triest, MIT Press, pages 62-67.

Blinder, A. (2003), “The case against the case against discretionary fiscal policy,” CEPS Working Paper No. 100.

Bouthevillain, C., P. Cour-Thimann, G. van den Dool, P. Hernandez de Cos, G. Langenus, M. Mohr, S. Momigliano and M. Tujula (2001), “Cyclically Adjusted Budget Balances: An Alternative Approach”, European Central Bank Working Paper, No. 77.

Buti, M., C. Martinez-Mongay, K. Sekkat and P. van den Noord (2003), “Automatic fiscal stabilisers in EMU: a conflict between efficiency and stabilisation?” CESifo Economic Studies, Vol. 49,1/2003.

Brunila, A., M. Buti and J. Veld (2002), “Fiscal policy in Europe: how effective are the automatic stabilisers?” European Commission Working Paper No. 177.

Caldara, D. and C. Kamps (2008), “What are the effects of fiscal policy shocks? A VAR-based comparative analysis?” ECB working paper Nr 877.

Church, K.B., J.E. Sault, S. Sgherri and K.F. Wallis (2000), “Comparative properties of models of the UK economy,” National Institute Economic Review, No. 171, January.

Dabán, T., E. Detragiache, G. di Bella, G.M. Milesi-Ferretti and S. Symansky (2003), "Rules based fiscal policy in France, Germany, Italy and Spain," IMF Occasional paper no 225.

Darby, J. and J. Melitz (2008), "Social spending and automatic stabilizers in the OECD", mimeo.

Debrun, X., Pisani-Ferry, J. and A. Sapir (2008), "Government size and output volatility: should we forsake automatic stabilisation?" IMF working paper 08/122.

ECB (2002), "The operation of automatic fiscal stabilisers in the euro area", Monthly Bulletin, pages 33-45, April, 2002.

ECB (2004), "Fiscal policy influences on macroeconomic stability and prices", Monthly Bulletin, April 2004, pages 45-57.

ECB (2008), "Discretionary fiscal policies, automatic stabilisation and economic uncertainty", Monthly Bulletin, pages 78-80, June, 2008.

European Commission (2004), "The pro-cyclicality of fiscal policy in EMU", Quarterly Report on the Euro Area, Vol. 3, No. 3.

Fatás, A. and I. Mihov (2001), "Government Size and Automatic Stabilizers: International and Intranational Evidence," Journal of International Economics.

Fatás, A. and I. Mihov (2003a), "The Case for Restricting Fiscal Policy Discretion," Quarterly Journal of Economics.

Fatás, A. and I. Mihov (2003b), "On Restricting Fiscal Policy in EMU," Oxford Review of Economic Policy, 19(1).

Girouard, N. and André, C. (2005), "Measuring cyclically-adjusted budget balances for OECD countries," OECD Working papers, No. 434.

Golinelli, R. and S. Momigliano (2007), "The cyclical response of fiscal policies in the euro area – why do results of empirical research differ so strongly?", paper presented at the Banca d'Italia workshop in Perugia, 29-21 March, 2007.

Hemming, R., M. Kell and S. Mahfouz (2002), "The effectiveness of fiscal policy in stimulating economic activity – a review of the literature", IMF wp/02/208.

Henry, J., P. Hernández de Cos and S. Momigliano (2004), "The short-term impact of government budgets on prices – evidence from macroeconometric models," ECB working paper 396.

IMF (2008a), "When does fiscal stimulus work?" Box 2.1, World Economic Outlook, pages 70-75, spring.

IMF (2008b), "Fiscal policy as a countercyclical tool", chapter 5 in World Economic Outlook, autumn.

Lee, Y. and T. Sung (2007), "Fiscal policy, business cycles and economic stabilization: evidence from industrialised and developing countries," Fiscal Studies, vol. 28, no.4, pages 437-462.

Marcellino, M. (2002), "Some stylized facts on non-systematic fiscal policy in the euro area," CEPR Discussion paper series, No 3635.

Melitz, J. (2005), "Non-Discretionary and Automatic Fiscal Policy in the EU and the OECD," CEPR working paper 4988.

Melitz, J. and F. Zumer (1999), "Smoothing of Regional Shocks within Countries and Lessons for EMU" Carnegie-Rochester Conference series on Public Policy, Volume 51, pp 149-188

Mountford, A. and H. Uhlig (2005), “What are the effects of fiscal policy shocks?” SFB 649 Discussion paper 168, CEPR, London.

Van den Noord, P. (2000), “The size and role of automatic stabilizers in the 1990s and beyond,” OECD Economics Department working paper no 230.

OECD (2003), “Economic Outlook – Special Focus on Fiscal Policy and Institutions”, Vol 2003/2, No 74, pages 125-175.

Orphanides, A. and S. van Norden (2005), “The reliability of inflation forecasts based on output gap estimates in real time,” Journal of Money, Credit and Banking, 37(3), pp. 583-601.

Perotti, R. (2002), “Estimating the effects of fiscal policy in OECD countries”, ECB working paper 168.