

Reicher, Christopher Phillip

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A set of estimated fiscal rules for a cross section of countries: Stabilization and consolidation through which instruments?

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This paper provides a set of detailed estimated fiscal reaction functions for a panel of twenty industrialized countries, and it discusses commonalities and differences with regard to systematic fiscal policies across countries. In general, the countries in the panel adjust tax revenues strongly in response to the public debt, and they adjust tax revenues and transfer payments, but, interestingly, not tax rates, strongly in response to output fluctuations. Some countries such as Germany appear to adjust government consumption and investment relatively strongly in response to the public debt, while the United States adjusts capital tax rates relatively strongly. In general, an increased emphasis in the theoretical literature on the effects of procyclical tax revenues and countercyclical transfer payments as automatic stabilizers may be warranted.

Keywords: Fiscal policy, fiscal rule, deficits, taxes, government purchases, transfer payments.

JEL classification: E62, E63, H20, H62.

Christopher Phillip Reicher

Kiel Institute for the World Economy
24100 Kiel, Germany
Telephone: +49 (0)431 8814 300
E-mail: christopher.reicher@ifw-kiel.de

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A set of estimated fiscal rules for a cross-section of countries: Stabilization and consolidation through which instruments?

Christopher Phillip Reicher*
Institut für Weltwirtschaft
Hindenburgufer 66
24105 Kiel, Germany

This version: August 20, 2013

Abstract

This paper provides a set of detailed estimated fiscal reaction functions for a panel of twenty industrialized countries, and it discusses commonalities and differences with regard to systematic fiscal policies across countries. In general, the countries in the panel adjust tax revenues strongly in response to the public debt, and they adjust tax revenues and transfer payments, but, interestingly, not tax rates, strongly in response to output fluctuations. Some countries such as Germany appear to adjust government consumption and investment relatively strongly in response to the public debt, while the United States adjusts capital tax rates relatively strongly. In general, an increased emphasis in the theoretical literature on the effects of procyclical tax revenues and countercyclical transfer payments as automatic stabilizers may be warranted.

*Email: christopher.reicher@ifw-kiel.de; Telephone: +49 431 8814 300.

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1 Introduction

In response to the failure of the Stability and Growth Pact, the Great Recession, the European Debt crisis, and the ongoing debate about fiscal rules, researchers and policymakers have shown a renewed interest in understanding the systematic conduct of fiscal policy. Efforts have been made at the policymaking level to simulate the effects of fiscal policy rules such as Germany's *Schuldenbremse* ("Debt brake"), and to design fiscal rules which allow for a reasonable degree of anti-cyclical fiscal policy. In order to design a fiscal rule which has a better chance of success, it is important to understand the past behavior of fiscal policy—particularly anti-cyclical fiscal policy (or "automatic stabilizers") and consolidation in response to the debt. It is also interesting in its own right to understand the behavior of systematic fiscal policy—for instance, when comparing institutions, making forecasts, or calibrating DSGE models. With the policy debate as well as the academic literature in mind, this paper presents a set of estimated multi-instrument fiscal rules for a panel of twenty OECD countries. In these rules, individual fiscal instruments, i.e., different categories of government purchases, taxes, or transfers, may respond to the public debt or to the output gap. This paper finds that transfer payments play a particularly important but underexplored role in anti-cyclical fiscal policy across a panel of countries, while most consolidation in response to the debt occurs on the tax margin. Most of the previous academic literature, by contrast, has focused instead on countercyclical government purchases or procyclical tax rates as tools of stabilization policy, to the neglect of transfer payments.

Systematic fiscal policy across countries has shown several commonalities and several differences throughout recent decades. Most countries in the sample have substantially adjusted tax revenues in response to growth in the public debt, while they have appeared reluctant to adjust transfer payments in response to the public debt. Some countries (such as Germany) have also adjusted government purchases, particularly government investment, while others have not. Meanwhile, the United States has relied more than other countries upon adjustments to capital taxes in response to the public debt. In response to the business cycle, every country in the sample except for one (Italy) has shown a procyclical response of primary surpluses to the output gap. In most countries, this response has taken the form of responses of tax revenues (but not tax rates) and to transfer payments. Government purchases have tended not to respond to the output gap. Most countries have exhibited these basic patterns, although the results for individual countries sometimes differ in interesting ways.

The previous literature on systematic fiscal policy is large but has come to somewhat con-

tradictory conclusions. While the consensus in macroeconomic modeling has turned toward modeling monetary policy as following an interest rate rule following Taylor (1993), there has been somewhat less consensus with respect to how to model systematic fiscal policy. The latter is complicated by a multiplicity of possible fiscal aggregates or fiscal instruments, each of which might operate through different economic channels. The empirical literature has already described the behavior of deficits, total revenues, or total spending in response to the business cycle and/or the public debt. Bohn (1991), using a VECM approach, find a significant role for adjustments to taxes and to total spending in the United States in response to the public debt since 1791. Taylor (2000) proposes a fiscal policy rule (a "fiscal Taylor rule") which allows for a procyclical response of fiscal surpluses to the output gap. Auerbach (2002) estimates a two-instrument fiscal rule featuring revenues and spending and replicates the results of Bohn (1991) for the postwar period.

While the early literature focuses mostly on the United States, the later literature has focused more on patterns across countries. Lane (2003) provides econometric evidence that political power dispersion may positively affect the procyclicality of various categories of government spending based on an estimated government spending rule, while GDP per capita may negatively affect the procyclicality of government spending. Galí and Perotti (2003) estimate a set of fiscal rules which allow for deficits to respond to the output gap, past deficits, and the level of the public debt, for a panel of countries. They find a clear pattern of countercyclical deficits and error correction in deficits, but not in the debt level, with a further look at the pre-EMU and post-EMU periods for the EMU countries. They also find ambiguous results with respect to the behavior of revenues and spending when taken separately. García, Arroyo, Mínguez, and Uxó (2009) find broadly similar results to Galí and Perotti with some exceptions. In contrast with most other studies, García et al. look at the behavior of fiscal in individual countries. They caution that fiscal policy across European countries appears to be strongly heterogeneous. Égert (2010) notes a general tendency for fiscal deficits in OECD countries to shrink in response to either output or the public debt, particularly when a fiscal rule is estimated in first differences, with some possible asymmetries over the business cycle. Végh and Vuletin (2012) discuss the cyclical behavior of statutory tax rates, finding acyclical tax rates on average across countries. Bénétrix and Lane (2012) discuss the possible weakening of the link between the public debt and fiscal adjustments since the adoption of the Euro, and they also point out a possible additional link between the financial cycle and systematic fiscal policy.¹ In general, results from the empirical fiscal policy

¹Other studies on estimating the cyclicity of fiscal policy include those of van den Noord (2000), Bouthevillain et al. (2001), Girouard and André (2005), Fedelino et al. (2009), and Fatás and Mihov (2012).

literature have varied widely, with results sensitive to model specification, time period, time-series assumptions, and the aggregates and countries under study. Plödt and Reicher (2013) systematically explore the role that the choice of cyclical indicators, sample length, and time-series assumptions on the order of integration play in estimating a particular primary surplus rule for the euro area, finding only small differences for the most part across specifications of that rule.

The literature has so far not generally focused on transfer payments but rather on taxes and government spending more broadly. There is some evidence which indicates that the time-series behavior of transfer payments is worth exploring. Reicher (2012) estimates a three-instrument fiscal rule (i.e. a rule featuring taxes less subsidies, purchases, and transfer payments) for the postwar United States taking the endogeneity of output into account. In that study, countercyclical transfer payments count for an important share of procyclicality in the primary surplus. Methodologically, this paper extends the results of Reicher (2012) to a set of twenty OECD countries, for a wider variety of fiscal instruments. This paper goes on to link the behavior of fiscal policy at the country level with the cross-sectional evidence on output stabilization, as discussed by Fatás and Mihov (2001) and Debrun and Kapoor (2010). Both sets of authors find a negative relationship between government size and output volatility. This paper extends their findings, by showing that a high rate of taxation or particularly transfer spending seems to be related to reduced volatility in output growth.

The results from this paper have implications for the specification of theoretical models of the macroeconomy. DSGE models have increasingly featured simple fiscal rules, since expected future fiscal policy may feed back to current economic conditions. This paper offers guidance as to which components of systematic fiscal policy may play an important role in those models. Previous theoretical work includes the work of Muscatelli, Tirelli, and Trecroci (2004), who estimate a two-instrument fiscal rule (i.e. a rule featuring revenue and total spending) for the United States within a New Keynesian DSGE model. They then derive its theoretical implications with respect to monetary policy interactions. Leeper, Plante, and Traum (2010) estimate a rich multi-instrument fiscal rule for the United States in a Bayesian DSGE framework, where the underlying model has an RBC structure. They, in addition to Leeper, Walker, and Yang (2010), find a possibly important role for the systematic conduct of fiscal policy in determining the size and time path of fiscal multipliers. Corsetti, Meier, and Müller (2012) find that systematic fiscal policy can also affect fiscal multipliers, using a simple calibrated rule for government purchases. Most of these studies,

however, have not focused on transfer payments. With the exception of recent work by Kumhof and Laxton (2010), Bi and Kumhof (2011), and McKay and Reis (2013), most of that literature has focused on the possible theoretical macroeconomic effects of systematically procyclical tax rates and countercyclical government purchases, rather than countercyclical transfer payments. The findings from this paper suggest that researchers may benefit from paying closer attention instead to the role of countercyclical transfer payments.²

The format of the rest of this paper is as follows: Section 2 discusses the specification of the fiscal rule and it discusses the data sources which this study draws upon. Section 3 presents results for an estimated fiscal rule covering taxes, government purchases, transfers, and other net revenue, and it also presents detailed results by category of government purchases and taxes. Section 4 discusses the statistical relationships between the prevalence of individual fiscal policy instruments and output volatility, and Section 5 concludes. There is also a separate data appendix which describes the compilation of the dataset used in this paper.

2 Specification and data sources

2.1 The specification of the fiscal rule

The fiscal rule is a simplified version of the multi-instrument rule of Reicher (2012).³ Each fiscal instrument i as a share of potential GDP, represented by $x_{i,t}$, has three components—a component which varies according to the output gap y_t , a response to the ratio of debt to potential GDP at the end of the previous year which is given by b_t , plus a long-run component $z_{i,t}$, such that:

$$x_{i,t} = \alpha_i^y y_t + \alpha_i^b b_t + z_{i,t}. \tag{1}$$

The long-run component $z_{i,t}$ is assumed to follow an exogenous random walk with a drift parameter μ_i . It embodies a slow-moving shifter to fiscal policy which may include components such as military build-ups or draw-downs, demographic shifts, or ideological shifts. In

²This statement is also true in relation to policy actions taken after the Great Recession. Oh and Reis (2012), for example, point out the important role played by adjustments to transfer payments following the Great Recession.

³Reicher (2012) adds an additional autocorrelation term which is not typically statistically distinguishable from zero and has hence been omitted from the current study.

this case it is possible to write the system (1) in first differences, such that:

$$\Delta x_{i,t} = \mu_i + \alpha_i^y \Delta y_t + \alpha_i^b \Delta b_t + \varepsilon_{i,t}, \quad (2)$$

where $\varepsilon_{i,t}$ is an iid shock. In the case of Germany, equation (2) is augmented by using a dummy variable for the structural break in 1991, which is equivalent to assuming that Germany experienced a once-and-for-all level shift in that year.

If fiscal policy has a systematic effect on output, then an OLS estimation of (2) produces inconsistent results. Valid instruments for output growth would include debt growth Δb_t , the lagged output gap y_{t-1} , two lags of filtered output growth Δy_{t-1} and Δy_{t-2} , and the reunification dummy where appropriate. Log real GDP growth Δy_t is detrended using a Hodrick-Prescott (HP) filter with a smoothing parameter of 100; a lower smoothing parameter removes much of what appear to be cyclical movements in output growth. The output gap in levels y_t (which is used to instrument for future output growth but not in the estimation equation) is equal to HP-filtered output with a smoothing parameter of 10. Equation (2) is then estimated using two-stage least squares. For every country, the first-stage regression explains output growth with a high R-squared, typically in the 0.5 to 0.7 range, and with overwhelming F statistics.

2.2 A cross-country fiscal dataset

2.2.1 Main aggregates

The data series for aggregates at the country level form a panel of 20 countries, which is in turn compiled using data from a combination of OECD sources, national sources, and other sources. The construction of the panel is described in the data appendix. The series are annual, start in various years, and end in 2007 in order to avoid issues associated with the Great Recession. The series are broken out into taxes (current taxes plus contributions for government social insurance less subsidies), purchases (consumption and gross investment less consumption of fixed capital), transfers (government social benefits to persons), and other net revenue (a balancing item). Debt equals the previous year's end-of-year liabilities of the consolidated government sector.

Since the analysis proceeds in first differences, it is not necessary to know the level of potential

GDP in order to know the changes in fiscal instruments $\Delta x_{i,t}$ as a share of potential GDP. Instead, changes in shares of potential GDP may be calculated using the following first-order approximation:

$$\Delta x_{i,t} = \Delta \frac{X_{i,t}}{Y_t} + .5 \left(\frac{X_{i,t}}{Y_t} + \frac{X_{i,t-1}}{Y_{t-1}} \right) \Delta y_t, \quad (3)$$

where $X_{i,t}/Y_{i,t}$ is the nominal share of instrument i relative to GDP. This expression removes from $\Delta x_{i,t}$ the components of the growth in the share of the fiscal instrument relative to GDP which are attributable to GDP growth rather than to shifts in the fiscal instrument itself.

Table 1 displays some summary statistics for the main aggregates as a share of GDP using the same timing convention used to arrive at (3). There is substantial cross-sectional variation in output volatility, taxes less subsidies as a share of GDP, transfer payments as a share of GDP, and debt levels, in particular. The patterns in the data are as expected, with European welfare states exhibiting higher rates of taxation and transfer payments than Korea, Japan, and the United States.

2.2.2 Tax rates

A set of extensions to this analysis involves estimating (2) with changes in tax rates (instead of tax levels) as dependent variables. That analysis is constrained by the availability of income-side GDP data broken out to a sufficient degree of detail, and it therefore features data from different time periods and for a smaller panel of countries than for the main aggregates. These tax rates are calculated in the spirit of the tax studies of Mendoza, Razin, and Tesar (1994), Jones (2002), and Leeper, Plante, and Traum (2010). Following Jones, I treat half of proprietor's income as labor income, and half as capital income. To the extent that the OECD expands its income-side GDP estimates, future work may help to revise these estimates. Data on tax instruments are obtained through the OECD's Revenue Statistics program.

The equations deriving tax rates from the OECD's aggregates are as follows, where labor and capital income are taxed on a gross basis and consumption payments are taxed on a net

basis:

$$\text{Personal tax rate (PTR)} = (1100) / [(SD1R)^h - (2200) + (SB2G_B3G)^h + (SD4R)^h]; \quad (4)$$

$$\text{Labor tax rate (LTR)} = [(PTR)\{(SD1R)^h - (2200) + .5(SB2G_B3G)^h\} + (2000) + (3000)] / [(SD1R)^h + .5(SB2G_B3G)^h]; \quad (5)$$

$$\text{Capital tax rate (KTR)} = [(PTR)\{.5(SB2G_B3G)^h + (SD4R)^h\} + (1120) + (1200) + (4100)] / [(SB2G_B3G)^e - .5(SB2G_B3G)^h]; \quad (6)$$

and

$$\text{Consumption tax rate (CTR)} = [(5110) + (5121) - (SD2P)g] / [(SP3P)h - (5110) - (5121) + (SD2P)g], \quad (7)$$

where (1100) denotes personal taxes on income and profits; (1120) denotes personal taxes on capital gains; (1200) denotes taxes on corporate income; (2000) denotes total social security contributions; (2200) denotes the employer's portion of social security contributions; (3000) denotes taxes on payroll and workforce; (4100) denotes recurrent taxes on immovable property; (4400) denotes taxes on financial and capital transactions; (5110) denotes general taxes; (5121) equals excise taxes; (SD1R) denotes compensation of employees, received; (SB2G_B3G) equals gross operating surplus and mixed income, of which (SB3G) is mixed income; (SD2P) equals taxes on production and imports, payable; (SP3P) equals final consumption expenditure; and (SD4R) denotes property income received by households and nonprofits. Superscripts marked ^e pertain to the total economy; superscripts marked ^h pertain to the household and nonprofits sector; and subscripts marked ^g pertain to the government sector.

3 Results

3.1 Results for main aggregates

3.1.1 Coefficients on debt: Consolidation through which instruments?

Table 2 contains the estimated multi-instrument fiscal rule coefficients for the main aggregates, along with standard errors. In most countries, fiscal authorities have appeared to increase taxes, possibly decrease government purchases, and hold transfer payments and other net revenue relatively steady in response to changes in the public debt, as reflected by the α_i^b coefficients. On average, there has appeared to be a positive response of the primary surplus to increases in the public debt. While the effects of the public debt for any particular country are not especially precisely estimated, the general pattern throughout the sample indicates that fiscal authorities have appeared to consolidate slowly in response to fiscal imbalances.

There does appear to be possible heterogeneity across countries. While there is no evidence that Finland or Japan has undertaken systematic consolidation in response to fiscal imbalances during recent decades, countries such as Australia, France, Germany, and New Zealand have appeared to respond quite aggressively to fiscal imbalances through consolidation. The United States appears to have responded somewhat more weakly to the public debt than Germany but more aggressively than Japan. In eighteen of the twenty countries, the government sector has appeared to increase the primary surplus in response to the public debt. There does seem to be a general tendency, noted by previous authors, in the panel for countries to engage in fiscal consolidation in response to changes in the public debt.

Revised estimates for the United States indicate a smaller role for government purchases in fiscal consolidation than the original estimates of Bohn (1991), Auerbach (2002), and Reicher (2012). This difference primarily reflects the choice of time periods—from 1955 onward in the current study, versus from 1791 onward in the study of Bohn (1991) and from 1946 onward in the study of Reicher (2012). The previous studies contain spending reversals which result from war, most notably the winding-down of military spending immediately after World War II and the Korean War. The current study omits those periods. To the extent that government purchases naturally wind down after wars, one should expect reductions in

government purchases following large wartime increases in the public debt.⁴ The peacetime dynamics of fiscal financing in the United States tend to place more consolidation activities into the tax domain and fewer consolidation activities into the spending domain, relative to wartime.

For the other countries, there appears to have been significant heterogeneity in the responses of individual fiscal instruments to the debt. Germany, for instance, has shown a pattern of spending reversals during peacetime. Interestingly, Germany is the one country in the sample where the change in the borders of that country resulted in a transitory wave of infrastructure investment during the 1990s. Germany has aggressively reversed purchases in addition to raising taxes during periods of rising debt, as to a weaker extent have the Republic of Korea, the Netherlands, Sweden, and the United Kingdom. Canada and France, like the United States, have relied more on taxes as a consolidation device. Individual estimates have come with fairly wide standard errors, but there appears to have been some possible heterogeneity in the ways in which individual countries have engaged in fiscal consolidation.

There do seem to have been a few commonalities in the consolidation behavior of countries as well. Few countries have adjusted transfer payments substantially in response to debt growth. To the extent that future expected imbalances are governed by an increased demand for transfer payments in countries such as Germany and the United States, one should expect these transfer payments to be financed through higher taxes in both countries, with possible additional cuts to government purchases playing a role, especially in Germany. In general, the basic pattern appears to be that most countries have increased taxes and possibly decreased purchases to some degree in response to the debt. The concerns about spending reversals expressed by Corsetti et al. (2012) appear to be supported by the data to a certain extent, though the results on spending reversals vary from country to country.

3.1.2 The countercyclicality of fiscal policy

The α_i^y coefficients in Table 2 capture the responses of individual fiscal instruments to the business cycle. Several commonalities emerge. In all countries, the estimated response of the primary surplus to output has been positive, with the possible exception of Italy. Tax revenues have been procyclical in most countries; government purchases have been more or less acyclical in most countries; and transfer payments have been countercyclical in most

⁴I thank an anonymous referee for making this point in response to Reicher (2012).

countries. These patterns indicate that fiscal responses to the business cycle are of their "expected" signs or are neutral, and the average response of primary deficits to the cycle among countries (0.47) is of the same order of magnitude (about 0.5) as that proposed by Taylor (2000) and identified by Girouard and André (2005) and Fatás and Mihov (2012) among OECD countries and by Plödt and Reicher (2013) among euro area countries.⁵

In the average country of the panel, the response of tax levels to the business cycle has been somewhat more aggressive than in the United States. To the extent that a high-tax country experiences business cycle fluctuations, the amount of tax revenue will respond more sensitively to output fluctuations than in a low-tax country. With regard to transfer payments a similar pattern holds. A number of countries with larger welfare states such as France and Germany apparently have featured more countercyclicality in transfer payments than the United States, although in the United States, transfer payments have featured about as much countercyclicality as in Sweden. The net result of all of this is that while the United States has featured strong and robust anti-cyclical fiscal policy, of which countercyclical transfer payments are an important part, most countries in the panel appear to have featured somewhat stronger anti-cyclical fiscal policy than the United States. Furthermore, procyclical tax revenues and countercyclical transfer payments, in that order, both comprise a large proportion of procyclical primary surpluses. Government purchases on average are not highly countercyclical.

3.2 Spending instruments in detail

Table 3 contains a similar set of calculations to Table 2, except with a focus on individual components of government purchases. Government purchases equal gross consumption plus gross investment, less consumption of fixed capital. In the United States, most consolidation activity related to government purchases in response to the public debt has occurred through changes to government consumption (and to the consumption of fixed capital) rather than to changes to government gross investment. The government sector in the United States has not apparently cut investment in response to the debt, and the evidence on government consumption is itself not particularly strong.

In some countries this has not apparently been the case. In particular, countries such as

⁵Debrun and Kapoor (2010), among many others, caution that this result may not hold beyond a sample of OECD countries. A large literature, which is not cited here, hints at the possibility of the procyclicality of fiscal policy in developing economies.

Germany and Italy have tended to cut both government consumption and government gross investment in response to the public debt, with a number of other countries showing negative (but imprecisely estimated) coefficient estimates as well. There appears to be some heterogeneity in the ways in which individual countries have carried out consolidation when that consolidation has come through adjustments to government purchases.

3.3 Tax instruments in detail

Table 4 contains the estimated responses of different tax rate instruments to the public debt and to the business cycle. The availability of estimates is severely constrained by the availability of income-based GDP data with which to carry out the calculations described in Section 2.2.2. For the purpose of comparison, Table 4 presents estimated effects of tax rates on a GDP base as well. Notably, the panel loses such major countries as Germany (where the income-based data begin in 1995, producing too short of a time series) and Japan (which is in the process of revising its national accounts), when looking at tax rates on specific income bases.

In the United States, capital income tax rates have responded strongly to the public debt and weakly to the business cycle, while labor tax rates and consumption tax rates have appeared not to respond to either the public debt or to the business cycle. Total tax rates on a GDP basis appear to respond weakly to the public debt and appear to be acyclical. The United States appears to utilize capital income taxes as its main adjustment mechanism, and it features the strongest estimated response of capital income taxes to the public debt out of the reduced panel. The role of capital taxation in the United States appears to be relatively large, although it is important to take into account the reduced sample of countries when making comparisons.

In the panel of countries, most estimated coefficients have their "expected sign", with a few surprises. On average, the countries in the panel appear to have possibly adjusted all three tax instruments in response to the public debt, although the adjustment coefficients have not in general been precisely estimated. Interestingly, tax rates on labor income and on consumption, but not necessarily on capital, have appeared to be acyclical. The procyclicality of capital taxes, however, is not a robust fact across countries. Altogether, the progressivity of most tax systems at an individual level has not translated into the procyclicality of average

tax rates at an aggregate level.⁶ Progressive tax rates at an individual level do not seem to necessarily imply strongly procyclical tax rates in a time-series sense.

4 Evidence on output stabilization

Table 5 contains the results from a series of regressions with the standard deviation of output growth at a national level on the left side, and a constant, plus either the coefficient α_i^y or the sample average level of instrument i as a share of GDP \bar{x}_i on the right hand side. These regressions capture a reduced-form set of aggregate statistical relationships between the cyclicality and size of individual aggregates, on one hand, and output volatility on the other. As in similar studies conducted by Fatás and Mihov (2001) and Debrun and Kapoor (2010) for aggregate deficits, coefficients different from zero indicate the degree to which the properties of individual fiscal instruments seem to be related to more or less stable business cycles. As in those earlier studies, these statistical relationships where they exist should not be interpreted as structural relationships, but rather as broad statistical tendencies. Unfortunately, due to the small sample size in the cross-section and due to the near-multicollinearity of certain combinations of right-hand-side variables, it is not possible to engage in a richer multivariate analysis.

The contents of Table 5 indicate that among the twenty countries from the sample, the levels of taxes and transfer payments (and, interestingly, the level of the public debt) as a share of GDP are negatively correlated with volatility in output growth in a manner which is statistically distinguishable from zero. In line with Galí (1994), Fatás and Mihov (2001), and the subsequent literature, there also appears to be a possible negative correlation between the level of government purchases and volatility in output growth, but that statistical relationship is not precisely estimated, and the results for different components of government purchases do not paint a clear picture. Despite the clear evidence linking a large welfare state with economic stabilization, there does not appear to be a strong relationship between any of the estimated cyclical response coefficients α_i^y and automatic stabilization. As Debrun and Kapoor (2010) point out, these coefficients are not estimated with a great degree of precision, and so the regressions presented here are subject to a great degree of attenuation bias. It is

⁶This finding is in line with recent findings by Végh and Vuletin (2012) on the cyclicality of statutory tax rates. The presence of systematic movements in the income distribution with respect to the business cycle—for instance, due to indivisible labor—may be one reason that the micro and macro elasticities of taxes with respect to income would differ from each other.

therefore hazardous to make sweeping statements about α_i^y . In general, the results in Table 5 are in line with the results of previous studies where these studies overlap. To summarize, countries with large governments, particularly large welfare states, tend to exhibit reduced volatility in output growth.

5 Conclusion

When looking at an estimated fiscal rule in a panel of countries, there emerge a number of commonalities and a number of differences. Most countries in the panel have tended to engage in fiscal consolidation in response to the public debt through tax adjustments, with some countries engaging in adjustments to government purchases as well. Most countries have exhibited a tendency to avoid adjusting transfer payments in response to the public debt. In some countries, most notably Germany, consolidation within government purchases has taken the form of adjustments to government investment as well, while the United States has tended to adjust tax rates on capital income to an extraordinary degree.

Most countries in the panel have also engaged in some degree of anti-cyclical fiscal policy, mostly through adjustments to the levels of taxes and transfer payments, but largely not to government purchases. On average, cyclical fluctuations in taxes have come through changes in the tax base rather than through changes in tax rates over the business cycle. Interestingly, a progressive tax system at the individual level in many countries has not resulted in countercyclical average tax rates. The micro and macro elasticity of tax rates with respect to income seem to differ. Particular caution is therefore warranted when making statements about aggregates based on individual-level features of the tax system. Countercyclical transfer payments seem to be the main instrument which varies systematically over the business cycle.

Several directions for future work become apparent. On the empirical side, the careful extension of the OECD's income-based GDP estimates would allow for extensions to Table 4 to be calculated, particularly for important countries such as Germany and Japan, and to generate better estimates for Italy, the Netherlands, and the United Kingdom. In addition, the estimates from this paper suggest that the choice of priors, when estimating fiscal rules in a DSGE context, should allow for some coefficients to take on values at or near zero, particularly those coefficients which relate tax rates and purchases to the business cycle and those coefficients which relate transfer payments to the public debt. On the theoretical

side, an increased understanding of the role of transfer payments (and tax payments, but not tax rates) as automatic stabilizers would be warranted. Even in countries with smaller welfare states such as the United States, transfer payments comprise an important share of automatic stabilizers and hence deserve further study.

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Table 1: Sample summary statistics for main aggregates by country

Variable i	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Australia 1959-2007	0.016	0.248	0.177	0.163	0.037	0.024	0.064	0.004	0.012	0.231
Austria 1976-2007	0.013	0.399	0.198	0.189	0.029	0.019	0.181	-0.016	0.003	0.540
Belgium 1985-2007	0.012	0.436	0.217	0.216	0.019	0.018	0.161	-0.015	0.042	1.161
Canada 1970-2007	0.018	0.310	0.219	0.210	0.029	0.020	0.098	0.042	0.035	0.886
Denmark 1971-2007	0.018	0.442	0.255	0.253	0.023	0.021	0.161	0.013	0.040	0.488
Finland 1975-2007	0.024	0.409	0.222	0.211	0.032	0.021	0.157	0.013	0.043	0.294
France 1978-2007	0.010	0.420	0.238	0.229	0.032	0.023	0.172	-0.013	-0.002	0.434
Germany 1970-2007	0.015	0.377	0.199	0.190	0.027	0.017	0.164	-0.012	0.002	0.421
Ireland 1990-2007	0.021	0.319	0.181	0.164	0.030	0.013	0.097	-0.002	0.038	0.580
Italy 1980-2007	0.011	0.371	0.201	0.190	0.027	0.016	0.157	-0.007	0.006	0.970
Japan 1980-2007	0.013	0.265	0.180	0.151	0.050	0.022	0.086	0.010	0.009	1.013
Korea 1970-2007	0.033	0.189	0.151	0.117	0.047	0.013	0.013	-0.001	0.024	0.185
Luxembourg 1990-2007	0.023	0.360	0.182	0.157	0.042	0.018	0.140	-0.015	0.024	0.062
Netherlands 1969-2007	0.014	0.395	0.244	0.232	0.037	0.025	0.154	0.017	0.014	0.710
New Zealand 1986-2007	0.016	0.350	0.190	0.180	0.026	0.016	0.121	0.010	0.049	0.435
Spain 1985-2007	0.014	0.331	0.197	0.174	0.038	0.015	0.125	-0.003	0.005	0.511
Sweden 1980-2007	0.015	0.469	0.281	0.271	0.033	0.023	0.167	0.004	0.025	0.575
Switzerland 1990-2007	0.012	0.235	0.123	0.116	0.026	0.019	0.104	-0.005	0.003	0.475
UK 1960-2007	0.017	0.341	0.211	0.195	0.028	0.012	0.115	0.002	0.017	0.615
USA 1955-2007	0.020	0.259	0.181	0.165	0.040	0.024	0.086	0.015	0.008	0.632

Source: Author's calculations, fiscal database. Variables: (1) Standard deviation of output growth; and the sample averages of (2) taxes less subsidies, (3) government purchases, (4) gross consumption, (5) gross investment, (6) consumption of fixed (7) capital, transfer payments, (8) other net revenue, (9) the primary surplus, and (10) the public debt as a share of GDP, respectively. Averages are taken between t and $t - 1$ values for level shares, in keeping with the timing conventions used to calculate growth rates.

Table 2: Estimated fiscal responses by major category / potential GDP

Variable i Coefficient	(1) α_i^b	α_i^y	- (2) α_i^b	α_i^y	- (3) α_i^b	α_i^y	+ (4) α_i^b	α_i^y	= (5) α_i^b	α_i^y
Australia	0.052	0.310	-0.089	0.011	0.003	-0.105	0.032	0.021	0.171	0.425
1959 - 2007	0.063	0.082	0.058	0.075	0.028	0.037	0.027	0.035	0.094	0.122
Austria	0.106	0.059	-0.008	0.027	0.050	-0.103	0.065	0.015	0.129	0.149
1976 - 2007	0.071	0.158	0.035	0.077	0.032	0.070	0.029	0.064	0.090	0.200
Belgium	-0.013	0.184	-0.035	-0.232	-0.010	-0.112	0.009	-0.079	0.041	0.449
1985 - 2007	0.044	0.169	0.031	0.118	0.013	0.052	0.030	0.113	0.063	0.241
Canada	0.054	0.199	-0.035	-0.116	0.011	-0.146	-0.009	0.049	0.069	0.511
1970 - 2007	0.030	0.099	0.018	0.059	0.013	0.044	0.011	0.037	0.040	0.129
Denmark	0.056	0.605	-0.014	-0.063	0.056	-0.180	0.001	-0.019	0.015	0.829
1971 - 2007	0.031	0.128	0.020	0.082	0.018	0.074	0.012	0.050	0.043	0.176
Finland	0.013	0.385	-0.087	0.008	0.054	-0.332	-0.070	-0.055	-0.023	0.654
1975 - 2007	0.067	0.134	0.028	0.057	0.027	0.054	0.023	0.045	0.081	0.162
France	0.165	0.367	-0.032	-0.080	-0.017	-0.133	0.024	-0.011	0.238	0.569
1978 - 2007	0.061	0.124	0.033	0.068	0.024	0.050	0.039	0.080	0.083	0.169
Germany	0.082	0.348	-0.126	0.000	-0.008	-0.216	0.008	-0.140	0.223	0.424
1970 - 2007	0.072	0.103	0.044	0.064	0.048	0.069	0.048	0.069	0.108	0.156
Ireland	0.196	0.318	-0.031	0.032	0.065	-0.072	0.003	-0.008	0.164	0.350
1990 - 2007	0.089	0.140	0.064	0.100	0.047	0.074	0.040	0.062	0.126	0.198
Italy	0.062	-0.146	-0.097	0.158	0.005	-0.129	0.001	-0.067	0.154	-0.242
1980 - 2007	0.072	0.256	0.033	0.118	0.021	0.075	0.025	0.088	0.086	0.304
Japan	-0.004	0.469	-0.016	-0.091	0.020	-0.028	0.006	0.049	-0.002	0.637
1980 - 2007	0.034	0.133	0.019	0.073	0.009	0.036	0.025	0.096	0.047	0.183
Korea	0.007	0.197	-0.049	-0.004	0.012	-0.028	0.025	-0.020	0.069	0.209
1970 - 2007	0.053	0.052	0.042	0.041	0.013	0.012	0.027	0.027	0.074	0.073
Luxembourg	0.476	0.259	-0.069	0.011	-0.312	-0.042	0.048	0.015	0.904	0.304
1990 - 2007	0.535	0.181	0.412	0.139	0.207	0.070	0.238	0.080	0.746	0.252
Netherlands	0.003	0.292	-0.064	-0.032	0.000	-0.169	0.009	-0.034	0.076	0.459
1969 - 2007	0.048	0.177	0.023	0.086	0.028	0.104	0.029	0.107	0.068	0.247
New Zealand	0.030	0.439	-0.063	0.006	-0.030	-0.219	0.119	-0.151	0.243	0.501
1986 - 2007	0.055	0.169	0.033	0.100	0.034	0.104	0.057	0.175	0.093	0.283
Spain	-0.050	0.556	-0.080	0.214	-0.016	-0.009	0.022	0.045	0.068	0.396
1985 - 2007	0.053	0.148	0.028	0.077	0.023	0.063	0.027	0.075	0.069	0.193
Sweden	0.008	1.031	-0.050	-0.174	-0.014	-0.104	-0.005	0.397	0.067	1.705
1980 - 2007	0.055	0.205	0.024	0.088	0.020	0.075	0.036	0.134	0.073	0.270
Switzerland	0.023	0.406	-0.021	-0.166	0.033	-0.251	0.063	-0.144	0.075	0.679
1990 - 2007	0.061	0.164	0.028	0.074	0.031	0.084	0.057	0.153	0.094	0.250
UK	0.038	-0.007	-0.069	-0.027	-0.011	-0.098	0.002	-0.013	0.120	0.105
1960 - 2007	0.045	0.101	0.032	0.072	0.022	0.048	0.017	0.038	0.062	0.138
USA	0.068	0.269	-0.021	0.039	-0.010	-0.102	-0.003	0.007	0.096	0.339
1955 - 2007	0.049	0.074	0.031	0.047	0.017	0.025	0.011	0.017	0.062	0.093
(Average)	0.069	0.327	-0.053	-0.024	-0.006	-0.129	0.018	-0.007	0.145	0.473

Coefficient estimates are followed by standard errors. Variables: (1) Tax revenues, (2) Purchases, (3) Transfer payments, (4) Other Net Revenue, (5) Primary surplus. Source: Author's calculations.

Table 3: Estimated fiscal responses by category of purchases / potential GDP

Variable i Coefficient	(1)		+ (2)		- (3)		= (4)	
	α_i^b	α_i^y	α_i^b	α_i^y	α_i^b	α_i^y	α_i^b	α_i^y
Australia	-0.074	0.006	-0.016	-0.001	-0.001	-0.007	-0.089	0.011
1959 - 2007	0.044	0.057	0.026	0.034	0.005	0.007	0.058	0.075
Austria	0.013	0.040	-0.013	-0.018	0.008	-0.005	-0.008	0.027
1976 - 2007	0.028	0.061	0.019	0.041	0.009	0.019	0.035	0.077
Belgium	-0.028	-0.197	-0.014	-0.044	-0.007	-0.009	-0.035	-0.232
1985 - 2007	0.026	0.099	0.013	0.049	0.003	0.013	0.031	0.118
Canada	-0.028	-0.113	-0.007	0.000	0.000	0.003	-0.035	-0.116
1970 - 2007	0.016	0.053	0.006	0.020	0.002	0.005	0.018	0.059
Denmark	0.005	-0.124	-0.013	0.043	0.005	-0.017	-0.014	-0.063
1971 - 2007	0.019	0.077	0.006	0.026	0.002	0.008	0.020	0.082
Finland	-0.072	-0.024	-0.016	0.037	-0.001	0.006	-0.087	0.008
1975 - 2007	0.023	0.046	0.011	0.023	0.003	0.006	0.028	0.057
France	-0.023	-0.174	-0.014	0.081	-0.005	-0.013	-0.032	-0.080
1978 - 2007	0.029	0.058	0.017	0.035	0.005	0.009	0.033	0.068
Germany	-0.094	-0.037	-0.036	0.042	-0.004	0.005	-0.126	0.000
1970 - 2007	0.040	0.058	0.018	0.026	0.003	0.005	0.044	0.064
Ireland	0.004	-0.002	-0.041	0.053	-0.007	0.019	-0.031	0.032
1990 - 2007	0.049	0.077	0.031	0.049	0.018	0.028	0.064	0.100
Italy	-0.063	0.108	-0.037	0.045	-0.003	-0.004	-0.097	0.158
1980 - 2007	0.027	0.096	0.013	0.048	0.001	0.005	0.033	0.118
Japan	0.025	-0.015	-0.037	-0.072	0.004	0.004	-0.016	-0.091
1980 - 2007	0.009	0.034	0.014	0.054	0.001	0.005	0.019	0.073
Korea	-0.035	-0.016	-0.009	0.002	0.005	-0.010	-0.049	-0.004
1970 - 2007	0.030	0.030	0.028	0.027	0.004	0.004	0.042	0.041
Luxembourg	-0.296	-0.037	0.195	0.043	-0.033	-0.005	-0.069	0.011
1990 - 2007	0.220	0.074	0.338	0.114	0.020	0.007	0.412	0.139
Netherlands	-0.058	-0.049	-0.008	0.018	-0.002	0.001	-0.064	-0.032
1969 - 2007	0.022	0.081	0.010	0.036	0.002	0.007	0.023	0.086
New Zealand	-0.037	-0.062	-0.029	0.060	-0.003	-0.008	-0.063	0.006
1986 - 2007	0.028	0.085	0.011	0.034	0.003	0.008	0.033	0.100
Spain	-0.047	0.066	-0.033	0.145	0.000	-0.003	-0.080	0.214
1985 - 2007	0.022	0.062	0.021	0.057	0.002	0.004	0.028	0.077
Sweden	-0.042	-0.124	-0.009	-0.028	-0.002	0.021	-0.050	-0.174
1980 - 2007	0.021	0.078	0.009	0.032	0.003	0.010	0.024	0.088
Switzerland	-0.020	-0.130	-0.001	-0.021	0.001	0.015	-0.021	-0.166
1990 - 2007	0.025	0.066	0.009	0.025	0.004	0.010	0.028	0.074
UK	-0.049	-0.080	-0.024	0.058	-0.003	0.004	-0.069	-0.027
1960 - 2007	0.022	0.049	0.019	0.042	0.002	0.004	0.032	0.072
USA	-0.014	0.019	0.001	0.010	0.007	-0.010	-0.021	0.039
1955 - 2007	0.023	0.035	0.014	0.022	0.002	0.004	0.031	0.047
(Average)	-0.047	-0.047	-0.008	0.023	-0.002	-0.001	-0.053	-0.024

Coefficient estimates are followed by standard errors. Variables: (1) Government consumption, (2) Government gross investment, (3) Consumption of fixed capital, (4) Purchases. Source: Author's calculations.

Table 4: Estimated fiscal responses by category of tax rates

Variable i Coefficient	(1)		(2)		(3)		(4)	
	α_i^b	α_i^y	α_i^b	α_i^y	α_i^b	α_i^y	α_i^b	α_i^y
Australia	-0.016	0.092	-0.135	-0.161	0.077	-0.009	0.051	0.072
1959 (1965) - 2007	0.077	0.109	0.171	0.242	0.074	0.104	0.062	0.081
Austria							0.106	-0.336
1976 - 2007							0.072	0.158
Belgium							-0.013	-0.247
1985 - 2007							0.044	0.167
Canada	0.052	-0.083	0.047	-0.202	0.002	-0.028	0.056	-0.113
1970 - 2007	0.025	0.082	0.045	0.148	0.033	0.108	0.030	0.099
Denmark							0.056	0.174
1971 - 2007							0.031	0.127
Finland	0.206	-0.131	-0.243	0.227	0.055	0.303	0.015	-0.030
1975 - 2007	0.070	0.140	0.094	0.188	0.055	0.111	0.066	0.132
France	0.064	-0.188	0.156	0.175	0.236	0.115	0.167	-0.050
1978 (1965) - 2007	0.080	0.162	0.110	0.223	0.057	0.116	0.061	0.124
Germany							0.083	-0.028
1970 - 2007							0.072	0.104
Ireland							0.196	-0.004
1990 - 2007							0.090	0.142
Italy	0.070	-0.254	0.003	-0.525	0.043	0.101	0.064	-0.496
1980 (1990) - 2007	0.101	0.427	0.158	0.668	0.047	0.197	0.071	0.253
Japan							-0.004	0.198
1980 - 2007							0.034	0.132
Korea	0.013	-0.008	0.024	0.076	-0.078	0.042	0.007	0.011
1970 (1975) - 2007	0.062	0.047	0.132	0.101	0.052	0.039	0.053	0.052
Luxembourg							0.477	-0.100
1990 - 2007							0.524	0.177
Netherlands	0.094	-0.145	0.109	0.499	0.010	0.172	0.004	-0.102
1969 (1990) - 2007	0.123	0.435	0.102	0.362	0.041	0.145	0.049	0.178
New Zealand							0.031	0.082
1986 - 2007							0.055	0.169
Spain							-0.049	0.233
1985 - 2007							0.053	0.148
Sweden							0.007	0.566
1980 - 2007							0.055	0.203
Switzerland							0.026	0.177
1990 - 2007							0.060	0.161
UK	0.017	0.120	0.028	0.879	0.051	-0.138	0.038	-0.346
1960 (1990) - 2007	0.043	0.097	0.225	0.503	0.043	0.096	0.045	0.099
USA	-0.036	-0.032	0.297	0.060	0.009	-0.032	0.069	0.012
1955 (1970) - 2007	0.045	0.072	0.142	0.226	0.016	0.026	0.049	0.074
(Average)	0.052	-0.070	0.032	0.114	0.045	0.058	0.069	-0.016

Coefficient estimates are followed by standard errors. Dates in parentheses refer to the availability of data on tax rates. Variables: (1) Labor tax rate, (2) Capital tax rate, (3) Consumption tax rate, (4) Tax rate on a GDP basis. Source: Author's calculations.

Table 5: Estimated statistical relationships with $\text{std}(\Delta y_t)$ as a dependent variable

Aggregate i	Coefficient α_i^y	Level of aggregate \bar{x}_i
Taxes less subsidies (levels)	0.0008	-0.0263
	0.0051	0.0150
Taxes less subsidies (rates)	0.0018	-0.0263
	0.0053	0.0150
Purchases	0.0070	-0.0370
	0.0118	0.0335
Consumption	0.0108	-0.0439
	0.0155	0.0291
Investment	0.0031	0.2771
	0.0256	0.1436
CFC	-0.0170	-0.4067
	0.1192	0.3023
Transfers	0.0075	-0.0685
	0.0152	0.0238
Other Net Revenue	0.0016	0.0711
	0.0110	0.0852
Primary Surplus	-0.0011	0.1377
	0.0033	0.0689
Aggregate	Coefficient α_i^b	Level of debt \bar{b}
Primary Surplus	0.0041	-0.0101
	0.0063	0.0037

Source: Author's calculations, using a series of regressions with a constant and two independent variables each. Dependent variables: Standard deviation of output growth from Table 1. Independent variables: Coefficients α_i^y and α_i^b correspond with coefficients reported in Tables 2 through 4. Levels correspond with average levels reported in Table 1. Coefficient estimates are followed by standard errors.