How is tax policy conducted over the business cycle?*

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Abstract

It is well known by now that government spending has typically been procyclical in emerging economies but acyclical or countercyclical in industrial countries. Little, if any, is known, however, about the cyclical behavior of tax *rates* (as opposed to tax revenues, which are endogenous to the business cycle and hence cannot shed light on the cyclicality of tax rates). We build a novel dataset on tax rates for 62 countries for the period 1960-2009 that comprises corporate income, personal income, and value added tax rates. We find that, by and large, tax policy is acyclical in industrial countries but procyclical in developing countries. Further, tax policy is more procyclical the higher is output volatility. We show that the evidence is consistent with a model of optimal fiscal policy under uncertainty.

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1 Introduction

There is by now a strong consensus in the literature that fiscal policy, or more precisely government spending, has been typically procyclical in developing countries and countercyclical or acyclical in industrial economies.[1] Figure 1, which updates evidence presented in Kaminsky, Reinhart, and Végh (2005), illustrates this phenomenon by plotting the correlation between the cyclical components of output and government spending for 94 countries during the period 1960-2009. Yellow bars depict developing countries and black bars denote industrial countries. The visual impression is striking: while a majority of black bars lie to the left of the figure (indicating countercyclical government spending in industrial countries), the majority of yellow bars lies to the right (indicating procyclical government spending in developing countries). In fact, the average correlation is -0.17 for industrial countries and 0.35 for developing countries.

Several hypothesis have been put forth in the literature to explain the procyclical behavior of government spending in developing countries, ranging from limited access to international credit markets to political distortions that tend to encourage public spending during boom periods. While, as argued by Frankel, Végh, and Vuletin (2011), some emerging economies seem to have been able to graduate from procyclical fiscal policy over the last decade or so, fiscal procyclicality remains a pervasive phenomenon in the developing world and reinforces – instead of mitigating – the underlying business cycle volatility.

The other pillar of fiscal policy is, of course, taxation. Hence, one would like to analyze the cyclical behavior of tax *rates,* which are the policy instrument (as opposed to tax revenues, which are a policy outcome). Unfortunately – and leaving aside a few studies focusing on individual countries such as Barro (1990), Lin (1993), and Strazicich (1997) for the United States and Maihos and Sosa (2000) for Uruguay – there is no systematic international evidence regarding the cyclicality of tax rate policy. The main reason is, of course, the absence of readily-available cross-country data on tax rates. To get around this limitation the literature has relied on the use of (i) the inflation tax (Talvi and Végh, 2005; Kaminsky, Reinhart, and Végh, 2005) or (ii) tax revenues, either in absolute terms or as a proportion of GDP (Gavin and Perotti, 1997; Braun, 2001; Sturzenegger and Wernek, 2006). Both approaches, however, have severe limitations.

The problem with the first approach is that there is simply no consensus on whether the inflation tax should be thought of as "just another tax." While there is, of course, a theoretical basis for doing so that dates back to Phelps (1973) and has been greatly refined ever since (see, for example, Chari

[1] See, for example, Ilzetzki and Végh (2008) and the references therein.

and Kehoe (1999)), there is little, if any, empirical support (Roubini and Sachs, 1989; Poterba and Rotemberg, 1990; Edwards and Tabellini, 1991; Roubini, 1991). Indeed, Delhy Nolivos and Vuletin (2011) show that the inflation tax can be thought of as "just another tax" only when central bank independence is low in which case the fiscal authority effectively controls monetary policy and uses inflation according to revenue needs. When central bank independence is high, however, inflation is set by the central bank and is essentially divorced from fiscal considerations. Notwithstanding these limitations, Figure 2 suggest and Table 1, columns 1 and 2 confirm that the inflation tax is countercyclical in most industrial countries while it is, on average, acyclical in developing countries.

On the other hand – and as argued by Kaminsky, Reinhart, and Végh (2005) – the second approach is fundamentally flawed because tax revenues constitute a policy outcome (as opposed to a policy instrument) that endogenously responds to the business cycle. Indeed, tax revenues almost always increase during booms and fall in recessions as the tax base (be it income or consumption) moves positively with the business cycle. Therefore, if tax revenues are positively related to the business cycle, there is little that we can infer regarding tax rate policy since positively related tax revenues are consistent with higher, unchanged, and even lower tax rates during good times. It is only when tax revenues are negatively related to the business cycle that we can conclude that tax rate policy is procyclical.[2] Since, as shown in Figure 3 and Table 1, columns 3 and 4, tax revenues tend to be positively related to the business cycle, there is little that we can infer regarding the procyclicality of tax rates.

In an attempt to correct for the endogenous fluctuations in the tax base, some authors have used revenues as a ratio of GDP, referring to it as an "average tax burden." As discussed in Kaminsky, Reinhart, and Végh (2005), however, nothing can be inferred from such an indicator regarding the cyclical properties of the policy instrument (i.e., the tax rate). For these reasons, this fiscal indicator is completely uninformative regarding the tax policy cyclicality. To show the practical relevance of this point, Figure 4 and Table 1, columns 5 and 6 show the correlation between the cyclical components of government revenue to GDP ratio and real GDP. Based on this, one would (erroneously!) conclude that tax policy is acyclical in developed economies and countercyclical in developing countries. As we will show in this paper, tax policy is actually procyclical in most developing countries.

In sum, there is really no good substitute for having data on tax rates when it comes to evaluating the cyclical properties of tax policy. This is precisely the purpose of this paper. To our knowledge,

[2] A note on terminology is important at this point. We will define procyclical (countercyclical) tax rate policy when tax rates are negatively (positively) correlated with the business cycle; that is tax rates tend to fall (increase) in booms and increase (fall) in recessions. An acyclical tax rate policy captures the case of zero correlation (i.e., no systematic relation between tax rate and the business cycle).

this is the first paper to systematically study the cyclical properties of tax policy based on the use of the policy instrument (tax rate) as opposed to outcome (tax revenues). To this end, we build a novel annual dataset that comprises value-added, corporate, and personal income tax rates for 62 countries, 20 industrial and 42 developing, for the period 1960-2009. Using these tax rates, we compute the degree of cyclicality of each tax and of a tax index. From an identification point of view, we also control for endogeneity concerns using instrumental variables.[3]

We can summarize our main empirical findings as follows:

1. Tax policy is more volatile in developing countries than in industrial countries in the sense that developing countries change their tax rates by larger amounts than industrial economies. This is particularly the case for personal income and value-added taxes.

2. Tax policy is mostly acyclical in industrial countries, with the corporate income tax policy being weakly countercyclical. On the other hand, developing economies pursue procyclical tax policies.

Why would the cyclical properties of fiscal policy differ across industrial and developing countries? One compelling explanation is the presence of imperfections in international credit markets (Gavin and Perotti, 1997; Riascos and Végh, 2003). To illustrate this idea, we present the simplest possible model of optimal fiscal policy under incomplete markets. We show that government consumption is procyclical regardless of preferences and output volatility. Intuitively, government consumption acts much like private consumption and is higher (lower) in the good (bad) state of nature. Interestingly enough, however, the cyclical properties of tax policy depend on preferences. Under the most realistic parameterization in which the intertemporal elasticity of substitution between a consumption composite and leisure is lower than the elasticity of substitution between private and public consumption, tax rate policy is procyclical. Further, the degree of procyclicality varies directly with output volatility. This provides a plausible explanation for the stylized facts mentioned above.

The paper proceeds as follows. As a background, Section 2 briefly characterizes the tax revenue structure – both in terms of size and composition – of countries around the world. Section 3 presents the tax rate data used in the study. It also shows some basic statistics relevant for our study of cyclicality of taxation; namely the frequency and magnitude of changes in tax rates. Section 4 presents a preliminary analysis of cyclicality of tax policy using contingency tables, cross-country correlation plots, and basic regression analysis. Section 5 addresses endogeneity issues. Section **??** develops our theoretical model of optimal fiscal policy under incomplete markets. Final thoughts are presented in Section 7.

[3]See Rigobon (2004) and Jaimovich and Panizza (2007) who challenge the idea that fiscal policy is proclical in developing countries based on endogeneity problems. Ilzetzki and Végh (2008), however, argue that even after addressing endogeneity concerns, there is causality running from the business cycle to government spending.

2 Tax revenue structure

The tax burden, defined as government revenue expressed as percentage of GDP, varies significatively across countries, ranging from 42.1 percent for Norway to 7.3 percent for the Democratic Republic of Congo.[4] The average tax burden in industrial countries is 25.5 percent of GDP, compared to 18.8 percent for developing countries (Table 2, panel A).

The relative importance of income – both corporate and personal – and value-added taxes varies significatively across countries and groups of countries. Generally speaking, industrial countries rely heavily on direct taxation, particularly on personal income taxation. In contrast, developing economies rely more on indirect taxation, particularly the value-added tax (Table 2, panel B).[5]

Compared to corporate and personal income taxation, value-added taxation is fairly modern. The first value-added tax dates back to France in 1948. Beginning in the late 1960s, the value-added tax spread rapidly (Figure 5). Denmark was the first European country to introduce a value-added tax in 1967. Brazil also introduced it in 1967, and it quickly spread in South America. The widespread adoption observed since the early 1990s is mainly explained by developing countries, particularly in Africa, Asia, and transition economies.[6]

3 Tax rate data

Part of this paper's contribution is the creation of a novel tax rate data. Our annual data consist of corporate and personal income tax rates as well as value-added tax rates for 62 countries – 20 industrial and 42 developing – for the period 1960-2009.[7] For corporate and personal income data we use top marginal tax rates. Most of the corporate and personal income tax data was obtained from the World Development Indicators (WDI-World Bank) and World Tax Database (University of Michigan, Ross School of Business). Our data comprises, on average, about 30 and 40 years of personal and corporate income tax rate data respectively.[8] Value-added data consist of a single standard rate.[9] Value-added data was obtained from various sources, including countries' revenue agencies, countries'

[4] See Appendix 4, Table 1A, column 1 for corresponding country statistics.

[5] See Appendix 4, Table 1A, columns 2-6 for individual country statistics.

[6] Appendix 3 reports the year in which the value-added tax was introduced in each country included in our study.

[7] Industrial countries comprise: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Italy, Japan, Luxembourg, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom, United States. Developing countries comprise: Argentina, Barbados, Bolivia, Botswana, Brazil, Bulgaria, Chile, China, Colombia, Costa Rica, Czech Rep., Dominican Rep., El Salvador, Ethiopia, Fiji, Georgia, Ghana, Honduras, Hungary, India, Jamaica, Kenya, Korea, Latvia, Lithuania, Malta, Mauritius, Mexico, Namibia, Pakistan, Papua New Guinea, Paraguay, Peru, Philippines, Romania, Russia, South Africa, Tanzania, Thailand, Turkey, Uruguay, Zambia.

[8] Appendix 1.2 describes the data sources. Appendix 3 describes each country period coverage for each type of tax.

[9] We should note that some countries have a lower value-added rate that typically applies to selected goods such as some foodstuffs and child and elderly care.

national libraries, books, newspapers, tax law experts, as well as research and policy papers.[10] We should note that for 55 out of the 62 countries included in the sample, we were able to gather the complete time series of the value-added tax rate (i.e., since its introduction).[11] We later use all of these tax rates to calculate an index of cyclicality of the tax policy.

Needless to say, while fairly comprehensive, our dataset does not come free of limitations. First, it does not include all available tax rates such as social security, trade, property, alcohol, and tobacco, among others. Having said that, we should note that value-added and corporate and personal income taxes represent around 65 percent of total tax revenues in developing countries and almost 80 percent in industrial countries. Second, personal and corporate income taxes have several brackets and marginal rates associated with them. They also have an intricate system of deductions and exemptions which complicate the calculation of effective marginal tax rates. While some effective marginal tax rates are available for some industrial countries, they have been calculated for very short periods of time making them unsuitable for our kind of study. What follows is a description of the five most important features of the tax rate data regarding cyclicality issues:

1. About two thirds of personal and corporate income tax rates changes are negative, both in industrial and developing countries. The opposite occurs with value-added rates; about one third of such changes are negative (Table 3). These patterns reflect a slow and moderate downward trend of personal and corporate income tax rates and an upward trend of value-added tax rates. Individual tax rates decreased from about 50 percent in early 1980s to 30 percent in late 2000s. Similarly, corporate tax rates decreased from about 40 percent in early 1980s to 25 percent in late 2000s. On the contrary, value-added tax rates moderately increased from 15 percent in early 1980s to about 17 percent in late 2000s.

2. In spite of the above-mentioned differences in long-run trends across personal, corporate and value-added rates, tax rates changes are moderately synchronized in the short-run. That is to say, they tend to commove in the same direction in the short-run in spite of showing, generally speaking, different long-run patterns. Table 4 shows that we cannot reject that tax rates changes are moderately positively correlated across different taxes.

3. A key difference between government spending and tax rates is that the latter rarely vary every year. While government spending occurs more or less continuously throughout the budget cycle, changes in tax rates do not occur every year arguably because they typically require explicit

[10] Appendix 1.2 describes the data sources.
[11] Appendix 3 describes each country year of introduction of value-added tax rate as well as its period of coverage.

approval from congress/parliament. Indeed, the overall sample frequency of tax rate changes are 0.19, 0.18, and 0.10 for personal, corporate, and value-added taxes, respectively. Put differently, tax rates change, on average, about every 5 years for income taxes and every 10 years for value-added tax.

Table 5, panel A shows that with the exception of the personal income tax, which varies more frequently in industrial countries, the frequency of tax rate changes is quite similar across industrial and developing countries.

4. Industrial as well as developing countries share some common average variation in tax rates (Table 5, panel B). For personal and corporate income taxes, tax rates change about 3 percent annually for each group. This figure is about 2 percent for value-added taxes. Naturally, the annual average change in tax rates varies significantly across countries and taxes. For example, Norway's annual average change in personal income tax rate is about 6 percent. This is the result of frequent changes in this tax rate, which has fluctuated from values close to 70 percent during the 1970s to about 25 percent during the 1980s, and back up again to the 40 percent range in the early 2000s. At the other side of the spectrum, Korea has never changed its VAT tax rate (of 10 percent) since its introduction in January 1977.[12]

5. The similarity across groups of countries described above hides important differences regarding the magnitude of tax rate changes. When focusing only on tax rate changes different from zero, developing countries show larger magnitude of tax rate changes than industrial countries (Table 5, panel C). With the exception of corporate tax rates, the percentage change in tax rates is much higher – about 50 percent – for developing countries than industrial economies. For example, since its introduction in January 1, 1986 Portugal has changed its VAT rate by relatively small amounts: from 16 to 17 (February 1, 1988), from 17 to 16 (March 24, 1992), from 16 to 17 (January 1, 1995), from 17 to 19 (June 5, 2002), from 19 to 21 (July 1, 2005), and from 21 to 20 (July 1, 2008). At the other side of the spectrum, since its introduction on January 1, 1985 Turkey changed its VAT rate on May 15, 2001 from 10 to 18 percent; that is to say, a one time increase of 80 percent.

   These findings regarding taxation policy (i.e., based on tax rates) are consistent with the regularities observed on the government consumption side; developing countries show more volatile fiscal policy than industrial economies. Indeed, annual average variation in real government spending is about 60 percent higher in developing countries than in industrial economies included in our

[12] See Appendix 4, Table 2A, columns 1-3 for corresponding country statistics.

sample.

4 Cyclicality of tax policy. Preliminary analysis

In this section we perform a first analysis of the cyclicality of tax policy. First we use tax rate changes. In particular, we calculate the average percentage tax rate changes in good, normal, and bad times. Later we focus on the cyclical component of tax rates; using both cross-country correlation plots and regression analysis. In each case we analyze the behavior of each tax rate as well as that of a tax index that weights the behavior of each tax rate by its relative importance. Specifically, the tax rate index is given by

$$c_{it}^{tax\ index} = w_i^{PIT} \times c_{it}^{PIT} + w_i^{CIT} \times c_{it}^{CIT} + w_i^{VAT} \times c_{it}^{VAT}, \quad (1)$$

where c_{it}^{PIT}, c_{it}^{CIT}, and c_{it}^{VAT} are the percentage change or cyclical components of the personal income tax rate, corporate income tax rate, and value-added tax rate, respectively. The weights w_i^{PIT}, w_i^{CIT}, and w_i^{VAT} capture the importance of each tax as a proportion of total tax revenues. This weighting structure aims at capturing the relative relevance of each tax in the tax system.

Table 6 shows the average tax rate change evaluated at different stances of the business cycle. While industrial countries reduce personal income tax rates both in good and bad times, developing economies strongly decrease them in good times. This suggest that personal income tax policy is acyclical in industrial countries and procyclical in developing ones. Corporate income tax rates increase in good times in industrial countries, however they typically increase in bad times in developing economies. This suggest that corporate income tax policy is countercyclical in industrial countries and procyclical in developing ones. Value-added tax rates decrease in good times in industrial countries and increase in bad times in developing economies. Therefore, procyclicality seems to be supported both in industrial and developing countries. The tax index, as defined in equation (1), decreases both in good and bad times in industrial countries. On the contrary it decreases in good times and increases in bad times in developing economies. Overall speaking, the tax policy seems to be acyclical in industrial countries and procyclical in developing countries.

We now focus on the behavior of the cyclical components of tax rates. Figure 6 shows country correlations between the cyclical components of personal income tax rate and real GDP. Industrial countries are evenly distributed: nine countries have countercyclical tax policy (i.e., positive correlation) and eleven countries show procyclicality (i.e., negative correlation). In sharp contrast, the number of developing economies pursuing procyclical tax policy is more than twice as much as the ones showing countercyclical tax policy. Panel regression analysis indeed supports acyclicality in industrial countries and weak procyclicality in developing countries (Table 7, columns 1 and 2).[13]

Figure 7 reports analogous results for the case of the corporate income tax. Once again, the distribution of industrial countries is about even: eleven countries have countercyclical tax policy (i.e., positive correlation) and nine countries show procyclical tax policy (i.e., negative correlation). In contrast, the number of developing countries pursuing procyclical policies is more than twice as much the ones showing countercyclical policy. Regression analysis support these findings (Table 7, columns 3 and 4).

Figure 8 shows country correlations between the cyclical components of value-added tax rate and real GDP. Unlike the pattern observed in Figures 6 and 7, about half of both industrial and developing show procyclical policy and less than a third show countercyclicality. Table 7, columns 5 and 6 support these findings; procyclical tax policy seems to be fairly common across the board.

Figure 9 shows country correlations between the cyclical tax index, as defined in equation (1), and real GDP. Industrial countries are evenly distributed: nine countries have countercyclical tax policy (i.e., positive correlation) while eleven countries show procyclical tax policy (i.e., negative correlation). The number of developing pursuing procyclical policies is almost three times as much as those showing countercyclical tax policy. Regression analysis supports these findings (Table 7, columns 7 and 8).

In sum, our preliminary analysis supports the idea that tax rate policy is, broadly speaking, acyclical in developed countries and mostly procyclical in developing countries. Of course, correlations do not imply any particular direction of causation and it could well be that real GDP is responding to changes in tax policy rather than the other way around. The next section addresses such endogeneity issues.

5 Cyclicality of tax policy. Endogeneity concerns

The previous section characterized the degree of pro/counter cyclicality of tax policy – both at the individual tax level and aggregate tax policy – exploiting the comovement between the cyclical components of tax rates and real GDP. This implicitly assumes that there is no reverse causality; that is, causality runs from business cycle fluctuations to tax policy changes and not the other way around. While this has been the traditional approach in the literature, more recent studies (Rigobon, 2004; Jaimovich and Panizza, 2007; Ilzetzki and Végh, 2008) have shown that ignoring the problem of endogeneity can potentially lead to a misleading picture. Indeed, for example, the alleged procyclicality of

[13] Throughout the paper we use the term "weak" to indicate coefficients that are significant only at the 15 percent level.

tax policy identified in Section 4 could just reflect that the tax multiplier is negative; when tax rates increase (decrease) output decreases (increases).

In this section we address endogeneity concerns by using instrumental variables. We use three instruments that have already been used in the literature. First, we use an instrument suggested by Jaimovich and Panizza (2007):

$$ShockJP_{it} = \frac{X_i}{GDP_i} \sum_j \phi_{ij,t-1} RGDPGR_{j,t}, \tag{2}$$

where $RGDPGR_j$ measures real GDP growth rate in country j, ϕ_{ij} is the fraction of exports from country i to country j, and X_i/GDP_i measures country's i's average exports expressed as share of GDP.[14] This index of weighted real GDP growth of trading partners attempts to capture an external shock.[15]

Second, we also use another external shock: changes in price of exports. This terms of trade based variable has been commonly suggested as a driver of business cycles (Mendoza, 1995; Ilzetzki and Végh, 2008). The effective change of prices of exports is measured as follows:

$$ShockPX_{it} = \frac{X_i}{GDP_i} PXGR_{it}, \tag{3}$$

where $PXGR_i$ measures price of exports growth rate in country i. This variable aims to capture the effective change of prices of exports. Lastly, we use an instrument proposed by Ilzetzki and Végh (2008). They suggest the use change of real returns on U.S. Treasury bills to capture global liquidity conditions.[16]

In this section we also account for concerns regarding the structure of errors assumptions in the regression analysis. We allow errors to present arbitrary heteroskedasticity and arbitrary intra-country correlation (i.e., clustered by country). The relaxation of the non-autocorrelation assumption is important for a study using the cyclical components of both dependent variables and regressors.

Table 8 shows the first stage regression for instrumental variables estimates for each group of

[14] As discussed in Jaimovich and Panizza (2007, page 13) "a time-invariant measure of exports over GDP is used because a time-variant measure would be affected by real exchange rate fluctuations, and, therefore, by domestic factors. This is not the case for the fraction of exports going to a specific country...because the variation of the exchange rate that is due to domestic factors has an equal effect on both numerator and denominator."

[15] Ilzetzki and Végh (2008, page 20) argue that while it is unlikely that current government spending of smaller economies has an effect of the growth rates of their trading partners, which include mainly larger economies, this could be the true in the case of larger economies in the sample and hence suggest that results for high-income countries should be taken with a grain of salt. Instead, for industrial countries' regressions, we use the lagged year trade partners real GDP growth rates (i.e., $RGDPGR_{j,t-1}$) rather than the current ones to avoid reverse causality concerns.

[16] Since this instrument might be endogenous in the case of the United States, we exclude this country from the instrumental variables analysis. Results are virtually unchanged when the United States is included.

countries. For both groups of countries we can reject that instruments are weak (i.e., instruments are good predictors of the business cycle) at standard 5 percent confidence. The index of weighted real GDP growth of trading partners ($ShockJP$) is positive and strongly significant, indicating that an increase in real GDP of main trade partners boosts real GDP. Changes in the price of exportable goods ($ShockPX$) is positive. However, it is only statistically significant for industrial countries. This is mostly due to multicolinearity, especially with $ShockJP$.[17] The global interest rate is negative related to the business cycle in developing countries but is statistically insignificant for both groups of countries.

Table 9 shows the instrumental variables regressions for personal income, corporate income, and value-added tax rates as well as for the tax index. Before analyzing the cyclicality of taxation coefficient results, two issues are worth noting. In all cases the over-identification tests cannot reject the null hypothesis that instruments are valid (i.e., uncorrelated with the error term) and correctly excluded from the estimation equation. Moreover, C-statistics validate the exogeneity of each instrument. These two findings, together with the absence of weak instruments described above, strongly support the validity and strength of our instrumental variables estimates.

Table 9, columns 1 and 2 supports the preliminary findings from Table 7, columns 1 and 2. Personal income taxation is acyclical in industrial countries and procyclical in developing economies. Table 9, columns 3 and 4, broadly supports the preliminary findings from Table 7, columns 3 and 4: industrial economies are more countercyclical in their corporate taxation than their developing counterparts. Corporate income taxation is weakly countercyclical in industrial countries and acyclical in developing economies. Findings for value-added tax rates (Table 9, columns 5 and 6) are quite different than those of Table 7, columns 3 and 4. While developing countries pursue procyclical value-added tax policy, industrial countries' procyclicality vanishes once endogeneity concerns are addressed. The later finding supports the presumption regarding the relevance of reverse causality. That is to say, increase (decrease) in value-added tax rates decrease (increase) output in developed countries and not the other way around. This rationale is consistent with Riera-Crichton, Végh and Vuletin (2011) who find sizable tax multipliers for industrial countries. Table 9, columns 5 and 6 supports the preliminary findings from Table 7, columns 5 and 6. The tax index is acyclical in industrial countries and procyclical in developing economies.

To sum up, after addressing endogeneity concerns, we find that tax policy is acyclical in industrial countries. Such acyclicality is present not only at an aggregate level (i.e., tax index) but also for

[17] The spearman correlation coefficient between $ShockJP$ and $ShockPX$ is 0.31 and statistically significant at the 1 percent level.

personal income and value-added taxation. Corporate income taxation is weakly countercyclical. On the other hand, procyclicality dominates the behavior of tax policy in developing countries both at the aggregate and individual tax level, with the exception of corporate taxation.

6 Model (incomplete)

This section develops a simple static model of optimal fiscal policy in the presence of uncertainty that can generate both procyclical government spending and procyclical tax rate policy in response to fluctuations in output. Further, government spending and tax rate policy will be more procyclical, the more volatile output is.

Consider a one-period small open economy perfectly integrated into goods markets. There is a single tradable good in the world. There is uncertainty regarding the exogenous output path

$$\begin{aligned} y_H &= y + \gamma, \\ y_L &= y - \gamma, \end{aligned}$$

where $y > 0$, $\gamma \geq 0$, and H and L denote the high output and low output state of nature, respectively. Output follows the binomial distribution

$$\begin{aligned} &y_H \quad \text{with probability } p, \\ &y_L \quad \text{with probability } 1-p. \end{aligned}$$

Preferences follow the standard expected utility approach:

$$W = \begin{cases} \underset{i=H,L}{E}\left[\alpha \frac{c_i^{1-\frac{1}{\sigma_c}}-1}{1-\frac{1}{\sigma_c}} + (1-\alpha)\frac{g_i^{1-\frac{1}{\sigma_g}}-1}{1-\frac{1}{\sigma_g}}\right], & \sigma_g \neq 1 \textit{ or } \sigma_c \neq 1, \\ \underset{i=H,L}{E}\left[\alpha \ln(c_i) + (1-\alpha)\ln(g_i)\right], & \text{otherwise} \end{cases} \tag{4}$$

where g is govermnet spending, c represents private consumption, and $1 > \alpha > 0$.

The household constraints are given by[18]

$$y_i = (1+\tau_i)c_i, \qquad i = L, H, \tag{5}$$

where a subscript indicates the state of nature. Households choose $\{c_H, c_L\}$ to maximize lifetime

[18] For simplicity, and with no loss of generality, we assume initial assets equal to zero.

utility (4) subject to the constraints (5).

6.1 Government constraints

The government finances its spending with a consumption tax. The government's constraints are given by

$$\tau_i c_i = g_i, \qquad i = L, H, \tag{6}$$

6.2 Aggregate constraints

Combining the household's constraints, given by expression (5), with the government's, given by equation (6), we obtain the economy's aggregate constraints:

$$c_i + g_i = y_i \qquad i = L, H, \tag{7}$$

6.3 Ramsey problem

The Ramsey planner chooses an allocation $\{c_H, c_L, g_H, g_L\}$ to maximize the households' lifetime utility (4) subject to the government's constraints (given by (6)), the economy's aggregate constraints (given by (7)) and the household's implementability conditions.

We solve this problem numerically (see Appendix @ for details).

Table 10 shows our main results. The benchmark case is the logarithmic case ($\sigma_g = \sigma_c = 1$). In this case, both private and public consumption are procyclical but tax rates are acyclical in the sense that they are the same across states of nature. When $\sigma_c = \sigma_g$ the ratio c/g is constant across states of nature (same results are obtain when using CES preferences). Since c and g increase proportionately in good state of nature, higher tax base allows Ramsey planner to leave the tax rate unchanged ($\tau_H = \tau_L$; acyclical tax rates). In the more realistic case in which $\sigma_c > \sigma_g$, we see that tax policy is procyclical (i.e., $\tau^H < \tau^L$). When $\sigma_c > \sigma_g$ the ratio c/g is *higher* in good state of nature. Since c increase *more* than proportionately than g in good state of nature, much higher tax base induce Ramsey planner to reduce the tax rate ($\tau_H < \tau_L$; procyclical tax rates).

In the opposite case ($\sigma_g > \sigma_c$), we see that tax policy is countercyclical (i.e., $\tau^H > \tau^L$). When $\sigma_c < \sigma_g$ the ratio c/g is *lower* in good state of nature. Since c increase *less* than proportionately than g in good state of nature, lower tax base induce Ramsey planner to increase the tax rate ($\tau_H > \tau_L$; countercyclical tax rates).

To illustrate how the procyclicality of government spending and tax policy depend on output volatility, we define cyclicality indices for both government spending and the tax rate. A positive (negative) value indicates a positive (negative) relationship between government spending or the tax rate and output in the second period.

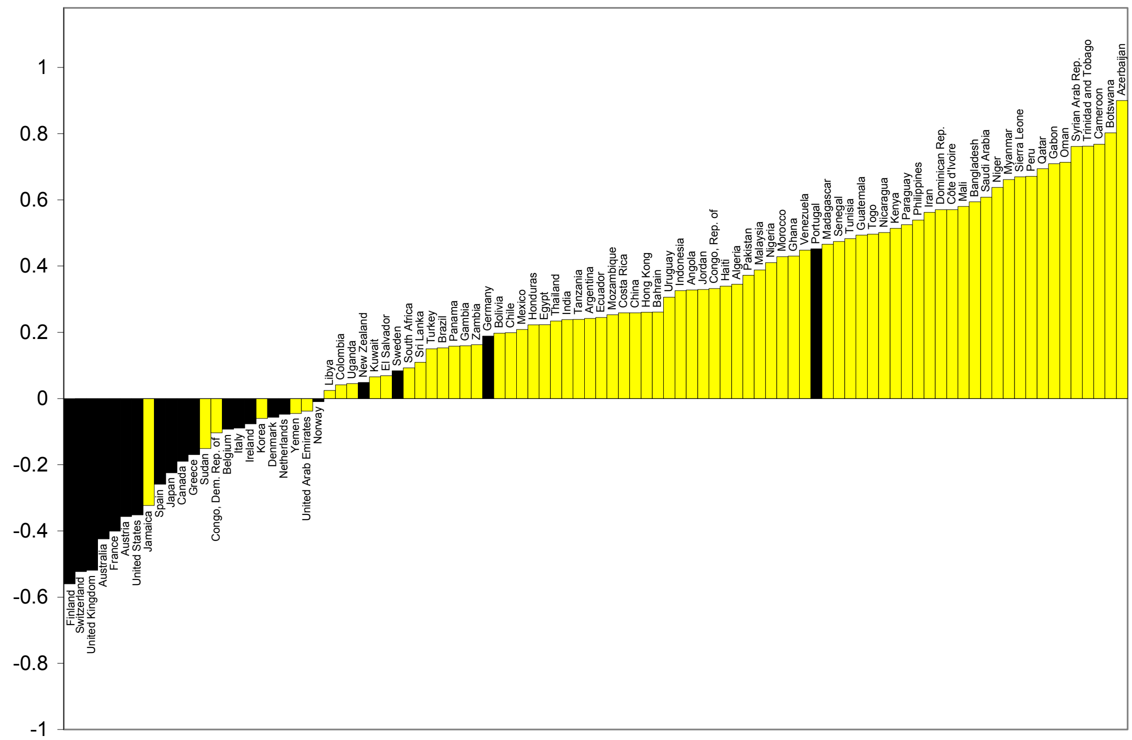
Figures 10 and 11 plot each of these indices as a function of γ. The higher is γ, the more volatile output is. Figure 10 shows that the higher is output volatility, the higher is the cyclicality of government consumption. Figure 11 shows that the higher is output volatility, the higher is the procyclicality of tax policy (i.e., the more negative becomes the index).

7 Conclusions[to be added]

8 References [to be added]

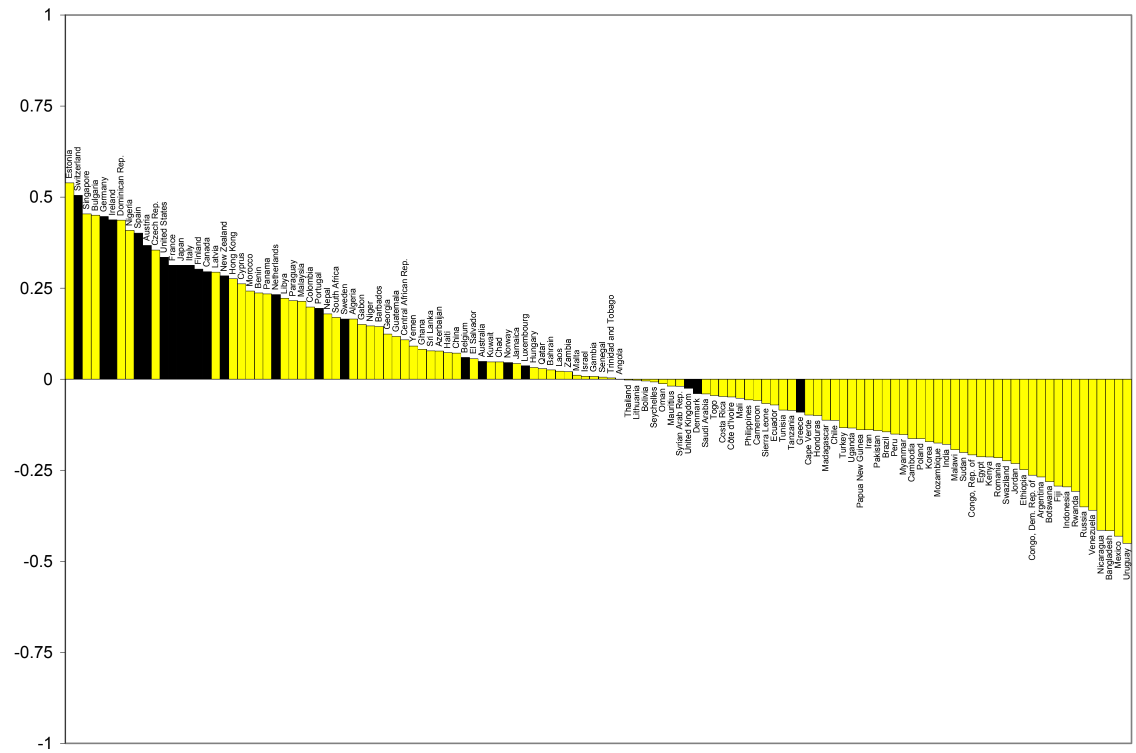
9 Appendices [to be added]

Figure 1. Country correlations between the cyclical components of real government expenditure and real GDP. 1960-2009



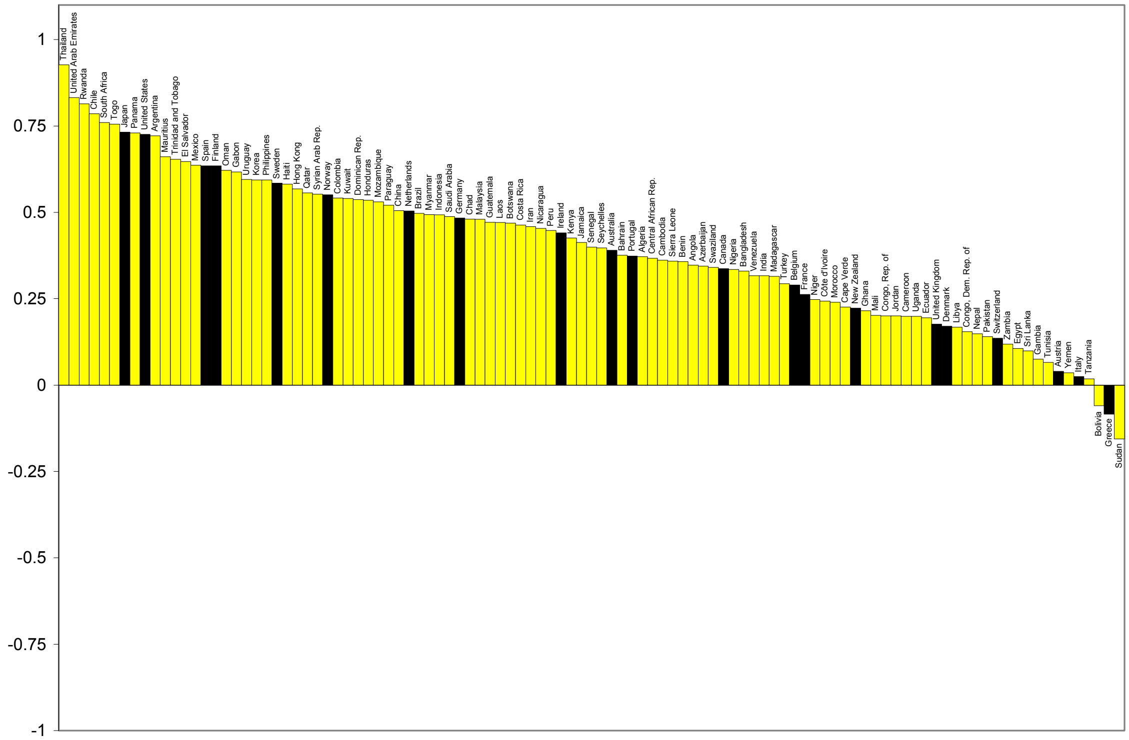
Notes: Dark bars are industrial countries and light ones are developing countries. The cyclical components have been estimated using the Hodrick-Prescott Filter. Real government expenditure is defined as central government expenditure and net lending deflated by the GDP deflator.
Source: Frankel, Végh and Vuletin (2011).

Figure 2. Country correlations between the cyclical components of the inflation tax and real GDP. 1960-2009



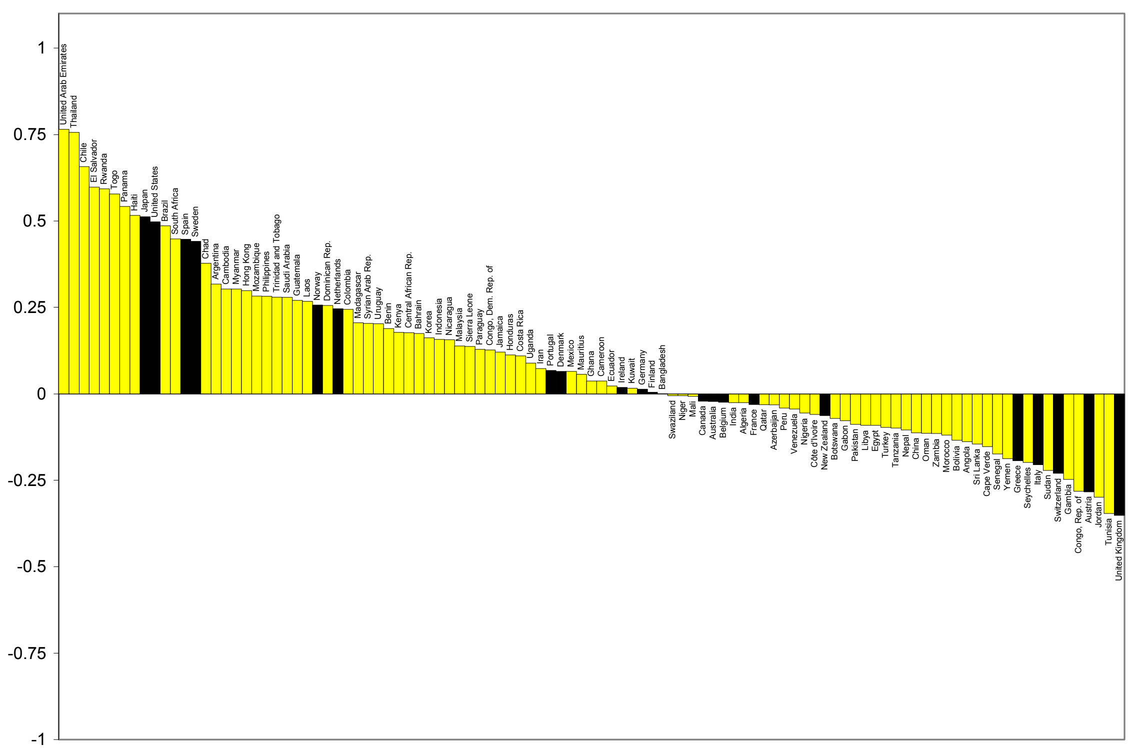
Notes: Dark bars are industrial countries and light ones are developing countries. The cyclical components have been estimated using the Hodrick-Prescott Filter. Inflation tax is defined as (π/(1+ π))*100, where π is inflation. Sample includes 124 countries.

Figure 3. Country correlations between the cyclical components of the real government revenue and real GDP. 1960-2009



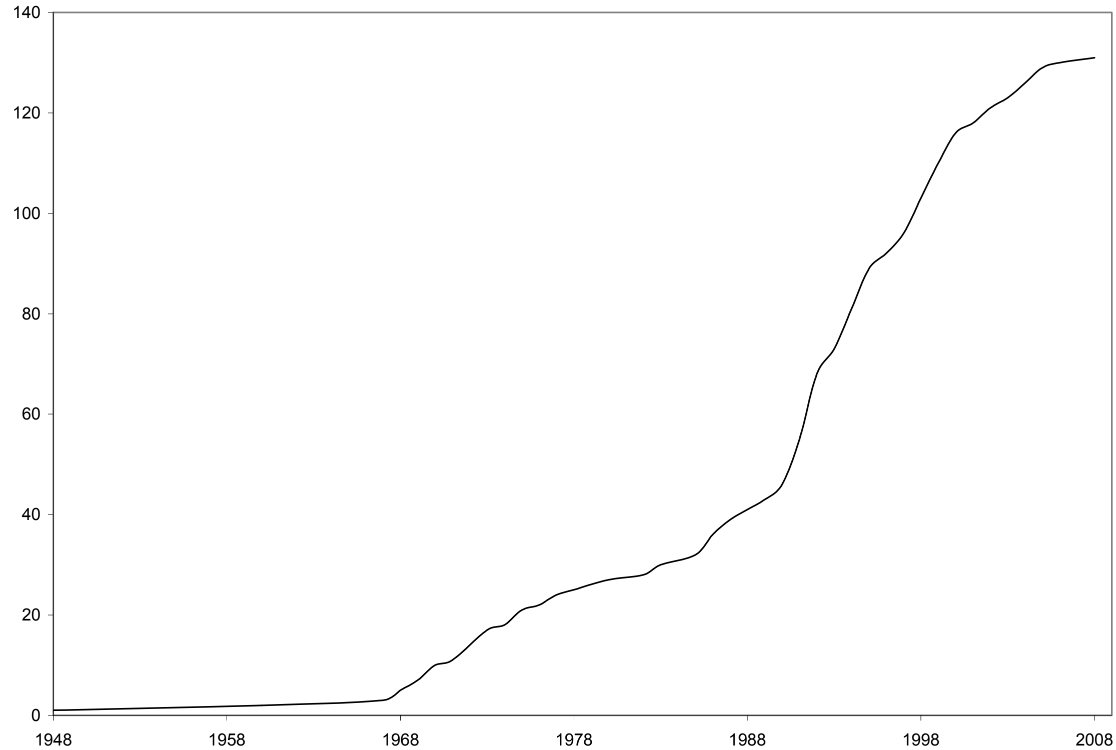
Notes: Dark bars are industrial countries and light ones are developing countries. The cyclical components have been estimated using the Hodrick-Prescott Filter. Real government revenue is defined as central government total revenue and grants deflated by the GDP deflator. Sample includes 105 countries.

Figure 4. Country correlations between the cyclical components of the government revenue/GDP and real GDP. 1960-2009



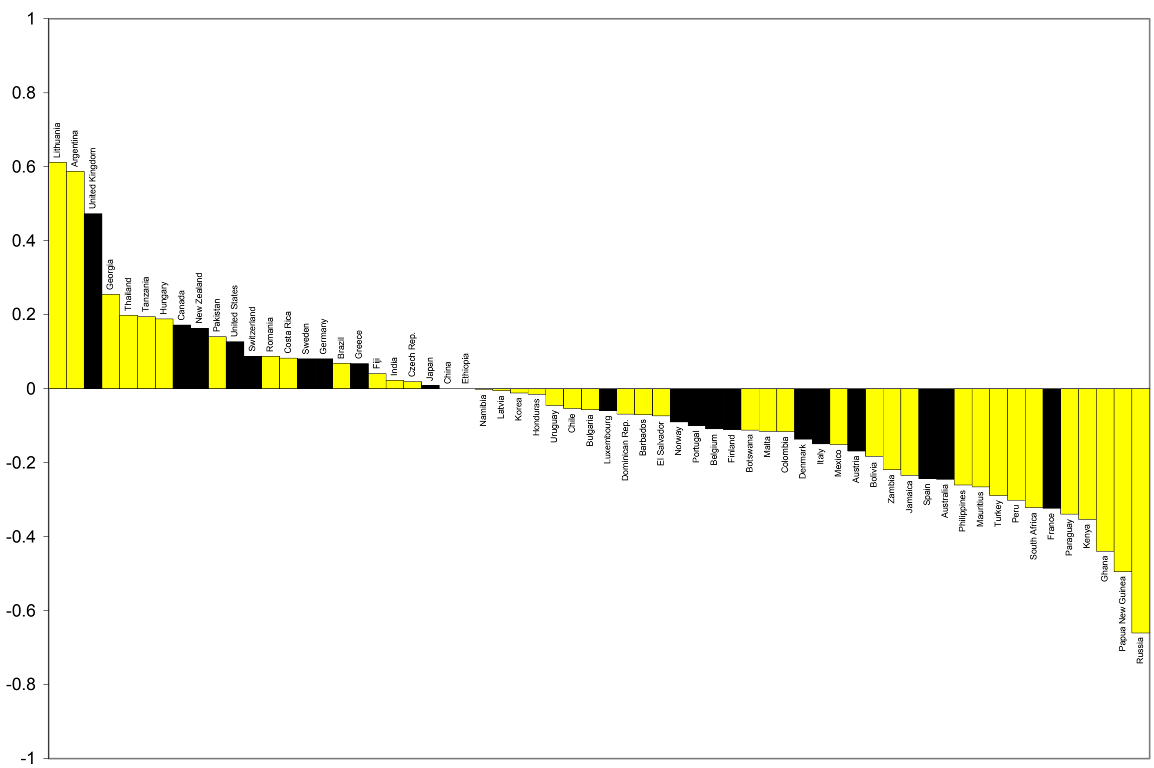
Notes: Dark bars are industrial countries and light ones are developing countries. The cyclical components have been estimated using the Hodrick-Prescott Filter. Real government revenue is defined as central government total revenue and grants deflated by the GDP deflator. Sample includes 105 countries.

Figure 5. Number of countries with value-added tax. 1948-2009



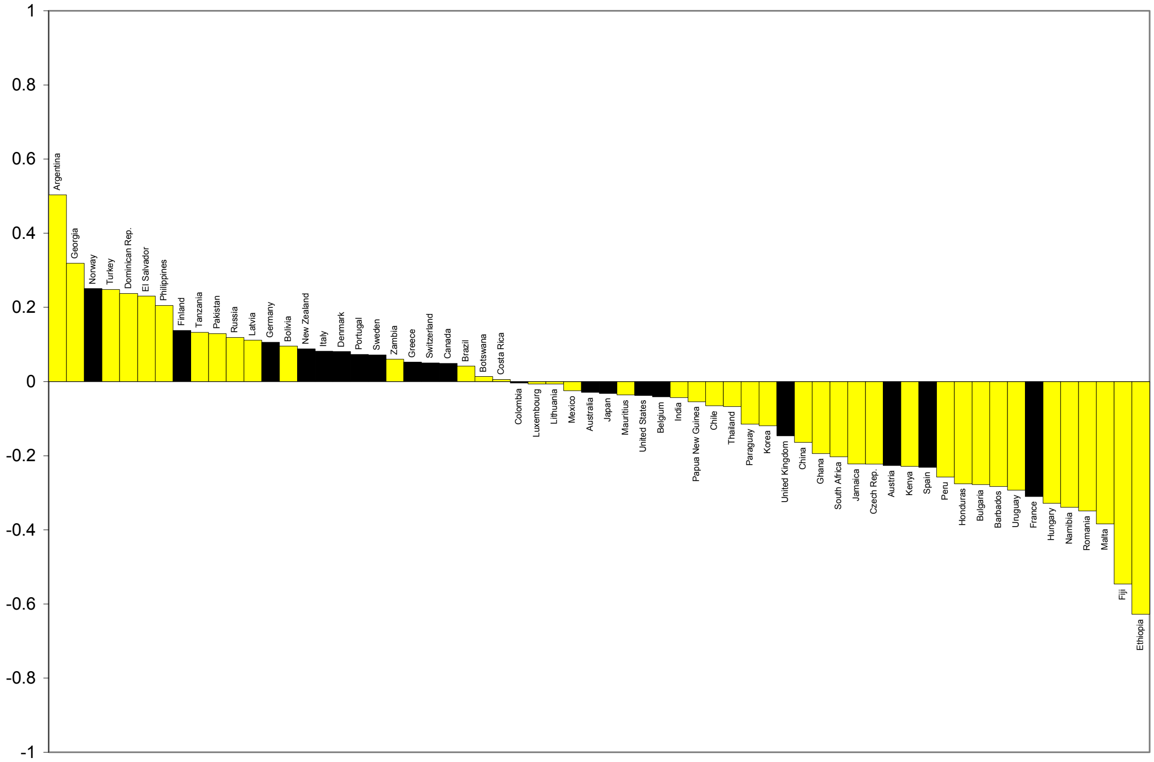
Source: Schenk and Oldman (2007) and authors' sources.

Figure 6. Country correlations between the cyclical components of the personal income tax rate and real GDP. 1960-2009



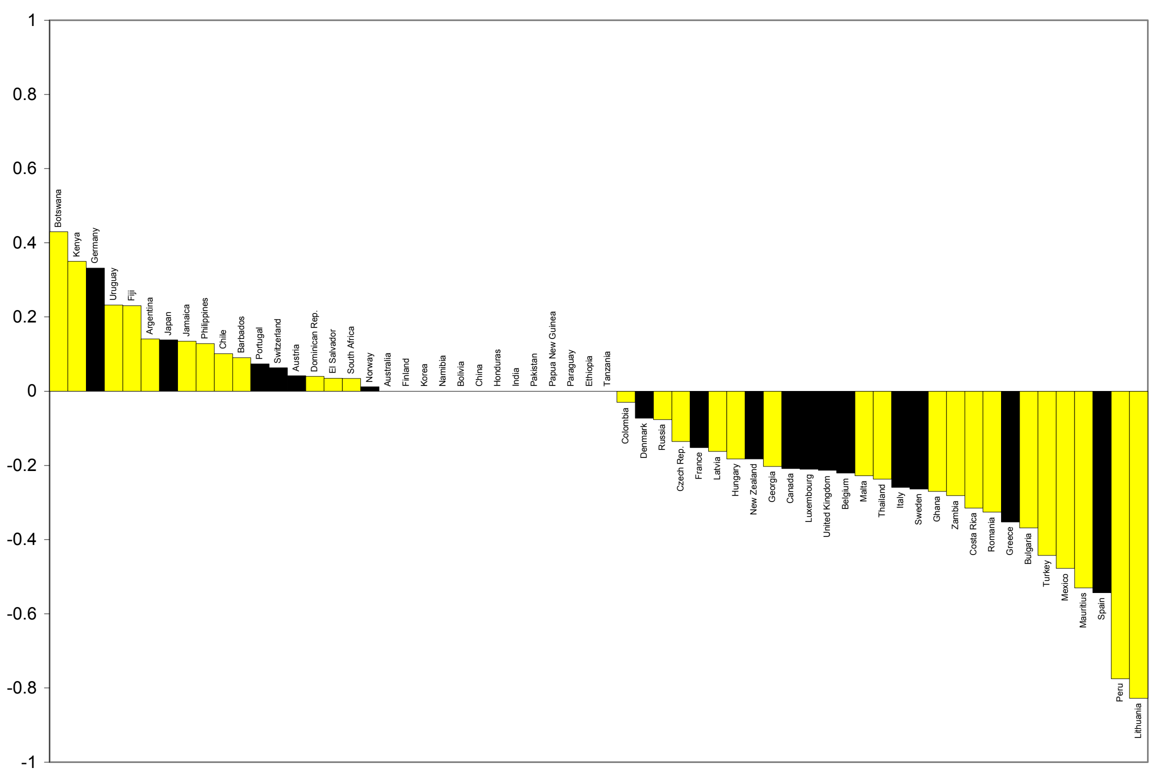
Notes: Dark bars are industrial countries and light ones are developing countries. The cyclical components have been estimated using the Hodrick-Prescott Filter. A negative (positive) correlation indicates procyclical (countercyclical) fiscal policy. Sample includes 62 countries.

Figure 7. Country correlations between the cyclical components of the corporate income tax and real GDP. 1960-2009



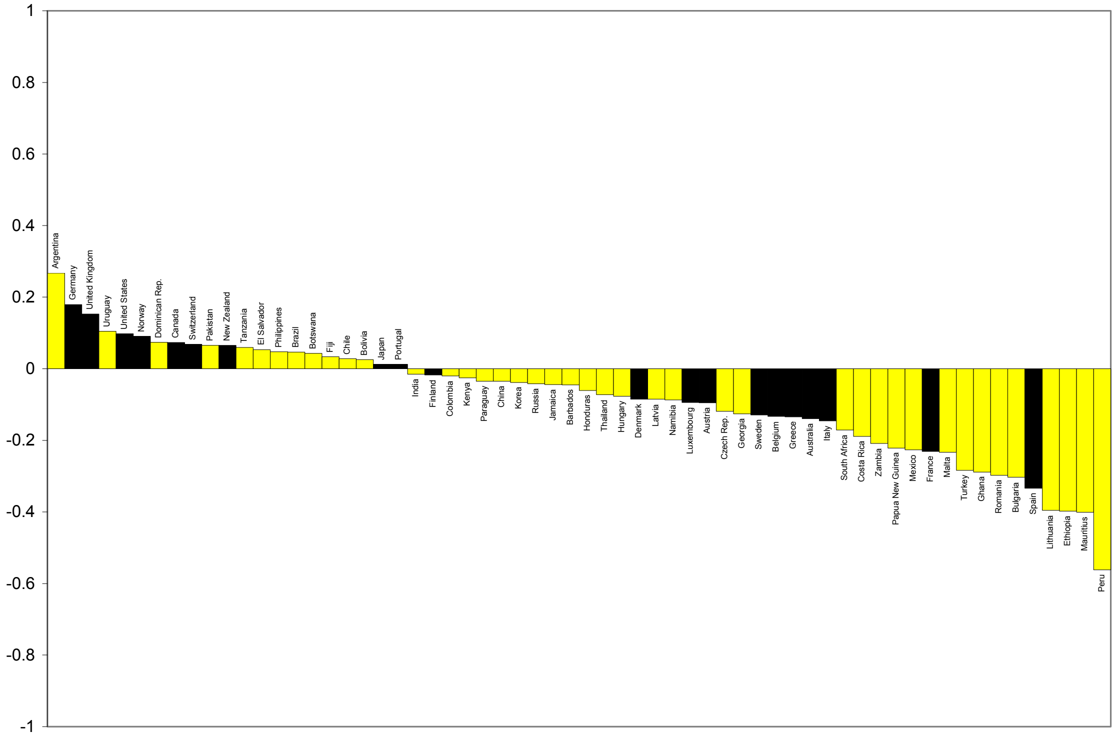
Notes: Dark bars are industrial countries and light ones are developing countries. The cyclical components have been estimated using the Hodrick-Prescott Filter. A negative (positive) correlation indicates procyclical (countercyclical) fiscal policy. Sample includes 62 countries.

Figure 8. Country correlations between the cyclical components of the value-added tax and real GDP. 1960-2009



Notes: Dark bars are industrial countries and light ones are developing countries. The cyclical components have been estimated using the Hodrick-Prescott Filter. A negative (positive) correlation indicates procyclical (countercyclical) fiscal policy. Sample includes 60 countries.

Figure 9. Country correlations between the cyclical components of the tax index and real GDP. 1960-2009



Notes: Dark bars are industrial countries and light ones are developing countries. The cyclical components have been estimated using the Hodrick-Prescott Filter. A negative (positive) correlation indicates procyclical (countercyclical) fiscal policy. Sample includes 62 countries.

Figure 10. Theoretical scatter plot of government spending cyclicality versus output volatility

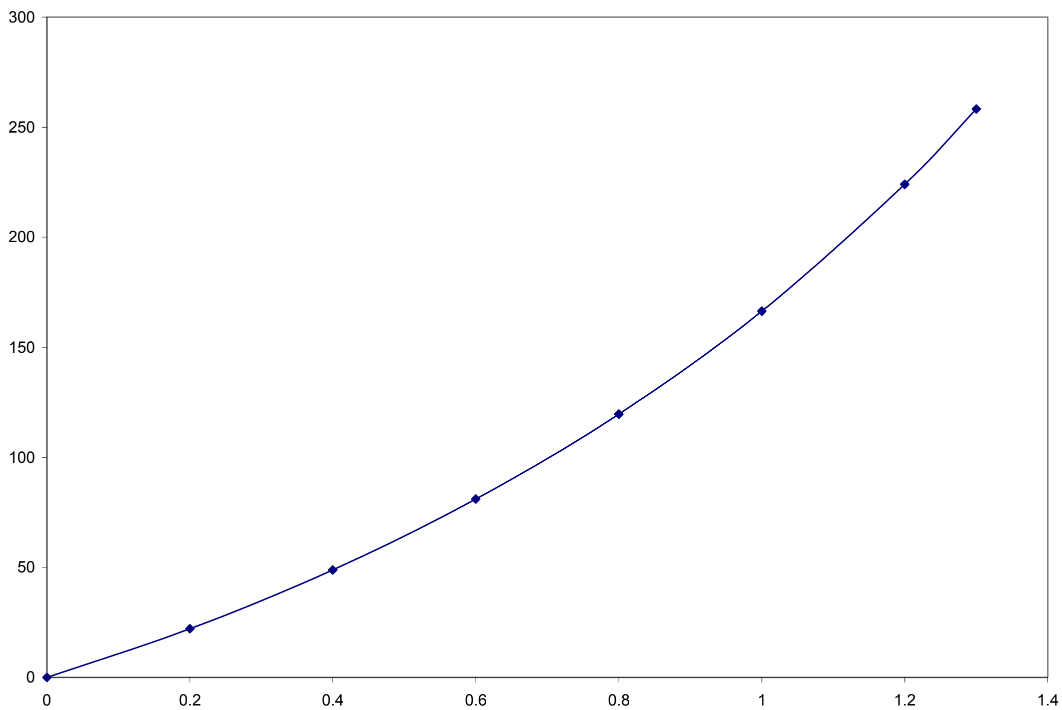


Figure 11. Theoretical scatter plot of tax rate cyclicality versus output volatility

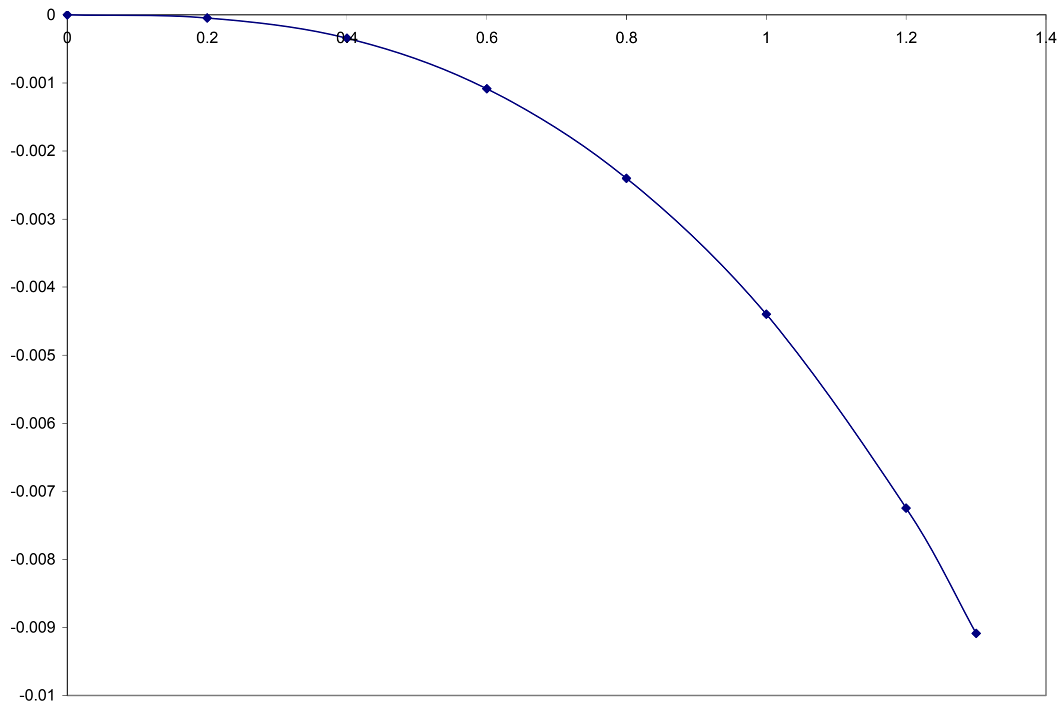


Figure 12. Empirical scatter plot of government spending cyclicality versus output volatility

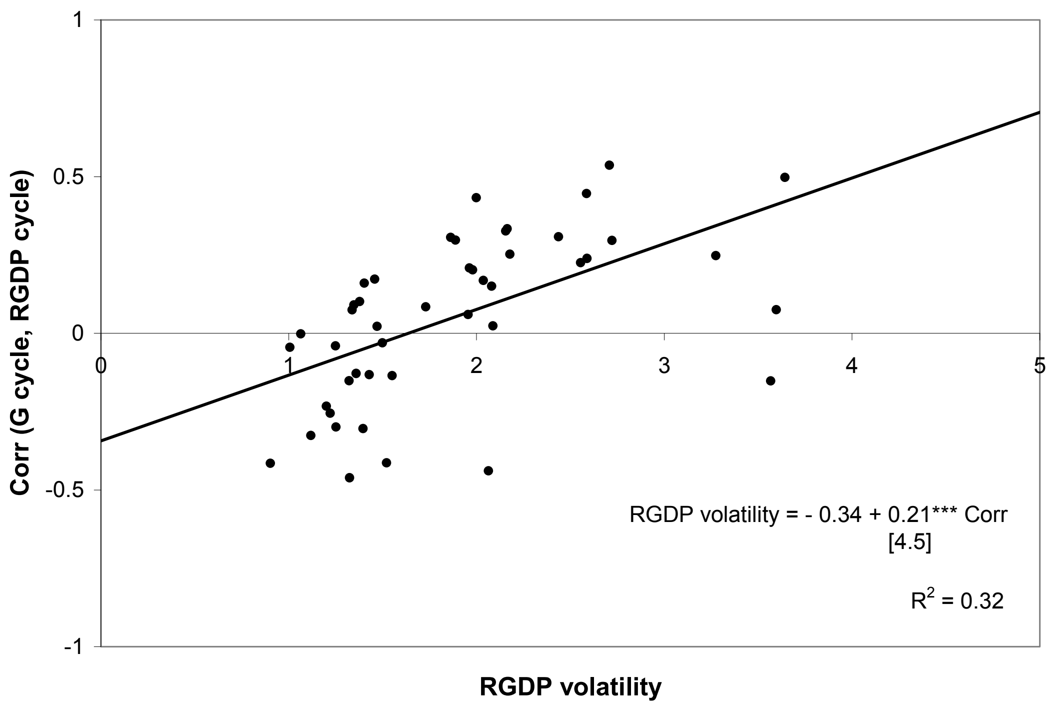


Figure 13. Empirical scatter plot of tax rate cyclicality versus output volatility

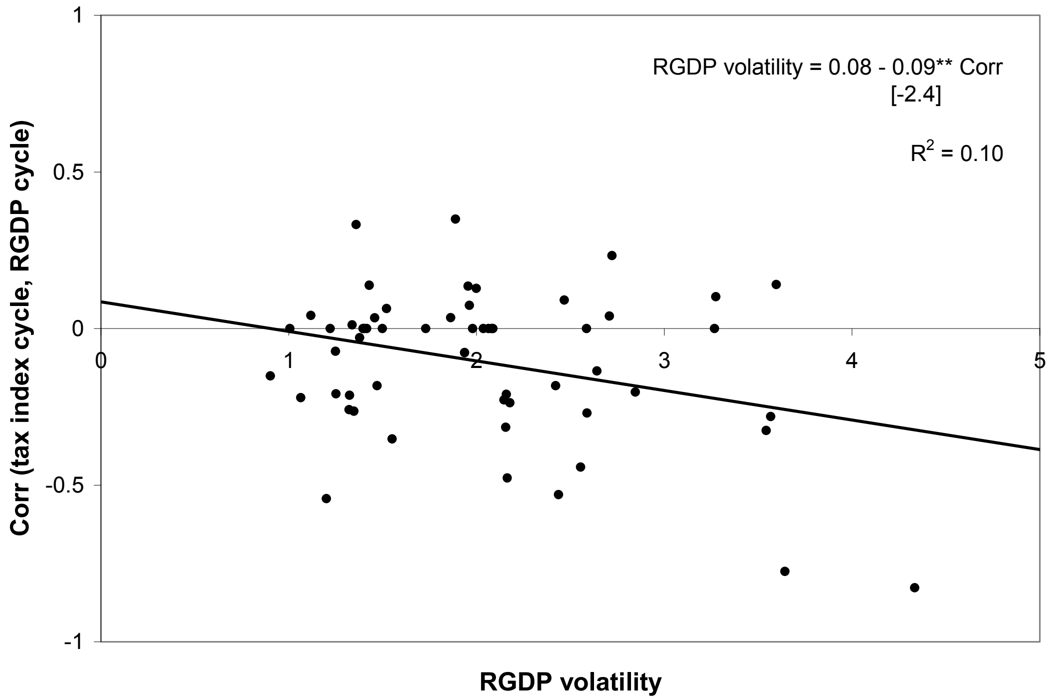


TABLE 1

Cyclicality of tax policy: Alternative tax indicators frequently used in the literature

	Inflation tax		Revenues		Revenues/GDP	
	Industrial	Developing	Industrial	Developing	Industrial	Developing
	(1)	(2)	(3)	(4)	(5)	(6)
RGDP cycle	10.48***	1.87	0.98***	1.50***	0.02	0.59***
	[6.0]	[0.3]	[7.5]	[16.8]	[0.1]	[6.2]
Number of observations	1030	3666	901	3008	901	3008
Number of countries	22	86	21	67	21	67

Notes: The dependent variable is the cyclical component of each tax indicator: inflation tax, revenues, and revenues/GDP. Inflation tax is defined as $(\pi/(1+\pi))*100$, where π is inflation. Real government revenue is defined as central government total revenue and grants deflated by the GDP deflator. The regressor is the cyclical component of real GDP. Estimations are performed using country-fixed-effects. t-statistics are in square brackets. Constant term is not reported.
ˣ, *, ** and *** indicate statistically significant at the 15%, 10%, 5% and 1% levels, respectively.

TABLE 2

Tax revenue structure: Tax burden and tax revenue composition

	Industrial (1)	Developing (2)	Difference ≡ (1) - (2) (3)
PANEL A: Tax burden			
Tax revenues (as % of GDP)	25.5	18.8	6.7***
PANEL B: Tax revenue composition (as % of total tax revenues)			
1. Tax revenue on income, profits, and corporations	50.1	31.0	19.1***
1.1. Personal income tax revenues	35.4	12.6	22.8***
2.2. Corporate income tax revenues	14.4	16.3	-1.9***
2. Good and services tax revenues	44.2	46.5	-2.3**
2.1. Value-added tax revenues	28.8	31.6	-2.8***
3. Others	5.7	22.5	-16.8***

Notes: The mean test is a t-test on the equality of means for two groups; the null hypothesis is that both groups have the same mean. Major oil producer countries are not included.
*, ** and *** indicate statistically significant at the 10%, 5% and 1% levels, respectively.

TABLE 3

Direction of tax rates changes

	Personal income tax		Corporate income tax		Value-added tax	
	Industrial (1)	Developing (2)	Industrial (3)	Developing (4)	Industrial (5)	Developing (6)
Tax rate increases	34	21	52	72	53	42
Tax rate decreases	101	134	114	161	13	25
Total tax rate changes	135	155	166	233	66	67

TABLE 4

Correlation between tax rates changes

	Personal income tax	Corporate income tax	Value-added tax
Personal income tax	1		
Corporate income tax	0.15***	1	
Value-added tax	0.07**	0.05*	1

Notes: Spearman's rank correlation coefficients are reported.
*, ** and *** indicate statistically significant at the 10%, 5% and 1% levels, respectively.

TABLE 5

Frequency and magnitude of tax rate changes

	Industrial (1)	Developing (2)	Difference ≡ (1) - (2) (3)
PANEL A: Frequency of tax rate changes			
Personal income tax	0.23	0.16	0.07***
Corporate income tax	0.11	0.18	-0.07
Value-added tax	0.11	0.09	0.02
PANEL B: Percentual absolute change in tax rates. Including zero changes			
Personal income tax	2.86	3.08	-0.22
Corporate income tax	2.65	3.23	-0.58
Value-added tax	1.57	2.18	-0.61
PANEL C: Percentual absolute change in tax rates. Without including zero changes			
Personal income tax	12.24	18.23	-5.99***
Corporate income tax	14.52	17.98	-3.46
Value-added tax	14.41	22.85	-8.44***

Notes: The mean test is a t-test on the equality of means for two groups; the null hypothesis is that both groups have the same mean. *, ** and *** indicate statistically significant at the 10%, 5% and 1% levels, respectively.

TABLE 6

Tax rate changes across different stances of the business cycle

	Personal income tax		Corporate income tax		Value-added tax		Tax index	
	Industrial (1)	Developing (2)	Industrial (3)	Developing (4)	Industrial (5)	Developing (6)	Industrial (7)	Developing (8)
Good times	-0.29	-1.19	0.74	0.09	-0.64	-0.17	-0.01	-0.25
Normal times	0.16	0.34	-0.08	-0.81	0.23	-0.28	0.12	0.04
Bad times	-0.11	0.42	-0.55	1.54	0.13	0.89	-0.29	0.15

Notes: The differences are reported as difference with respect to the overall (i.e., not distinguishing across stances of the business cycle) mean. Therefore, positive (negative) values indicate tax rate changes above (below) the mean. Good (bad) times are defined as those years for which the real GDP cycles are in the first higher (lower) quartile for each country. Normal times are defined as those years for which the real GDP cycles are in the second and third quartile for each country.

TABLE 7

Cyclicality of tax policy: Alternative tax indicators

	Personal income tax		Corporate income tax		Value-added tax		Tax index	
	Industrial	Developing	Industrial	Developing	Industrial	Developing	Industrial	Developing
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
RGDP cycle	0.03	-0.39ˣ	0.14	-0.11**	-0.26**	-0.35***	-0.09	-0.24***
	[0.2]	[-1.6]	[0.9]	[-2.2]	[-2.6]	[-5.5]	[-0.9]	[-3.6]
Number of observations	639	1089	900	1323	614	764	509	662
Number of countries	20	42	20	42	20	42	20	42

Notes: The dependent variable is the cyclical component of each tax indicator: personal income tax rate, corporate income tax rate, value-added tax rate, and the cycle of tax index. The regressor is the cyclical component of real GDP. Estimations are performed using country-fixed-effects. t-statistics are in square brackets. Constant term is not reported.
ˣ, *, ** and *** indicate statistically significant at the 15%, 10%, 5% and 1% levels, respectively.

TABLE 8

First stage regression for instrumental variables estimates

	Industrial	Developing
	(1)	(2)
ShockPX	0.05*	0.02
	[2.0]	[0.6]
ShockJP	1.14***	1.04**
	[3.9]	[2.7]
Global interest rate	0.05ˣ	-0.04
	[1.5]	[-0.5]
STATISTICS		
Weak-identification test (p-value)	0.005	0.042
Number of observattions	397	451
Number of countries	17	26

Notes: The dependent variable is the cyclical component of real GDP. The regressors in the first stage regressions (i.e., the excluded instruments) are ShockPX, ShockJP, and Global interest rate. Estimations are performed using two-step efficient GMM country-fixed-effects, allowing errors to present arbitrary heteroskedasticity and arbitrary intra-country correlation (i.e., clustered by country). t-statistics are in square brackets. Constant terms are not reported. The weak-identification test is Kleibergen-Paap Wald rk F statistic; the null hypothesis is that the model is weakly identified (i.e., the excluded instruments have a nonzero correlation with the endogenous regressors but small).
ˣ, *, ** and *** indicate statistically significant at the 15%, 10%, 5% and 1% levels, respectively.

TABLE 9

Cyclicality of tax policy: Instrumental variables regressions

	Personal income tax		Corporate income tax		Value-added tax		Tax index	
	Industrial	Developing	Industrial	Developing	Industrial	Developing	Industrial	Developing
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
RGDP cycle	-0.20 [-0.3]	-11.30ˣ [-1.6]	0.69ˣ [1.6]	-0.88 [-0.8]	0.15 [0.9]	-1.15** [-2.5]	-0.02 [-0.1]	-1.39** [-2.0]
STATISTICS								
Over-identification test (p-value)	0.23	0.51	0.51	0.55	0.32	0.62	0.91	0.54
Exogeneity of ShockPX (p-value)	0.39	0.25	0.47	0.38	0.14	0.81	0.75	0.27
Exogeneity of ShockJP (p-value)	0.75	0.27	0.60	0.78	0.13	0.54	0.88	0.37
Exogeneity of Global int. rate (p-value)	0.09	0.60	0.41	0.71	0.68	0.35	0.73	0.67
Number of observattions	397	451	397	451	397	451	397	451
Number of countries	17	26	17	26	17	26	17	26

Notes: The dependent variable is the cyclical component of each tax indicator: personal income tax rate, corporate income tax rate, value-added tax rate, and the cycle of tax index. The regressor is the cyclical component of real GDP. The excluded instruments are ShockPX, ShockJP, and Global interest rate (see Table 8 for first stage regression estimates). Estimations are performed using two-step efficient GMM country-fixed-effects, allowing errors to present arbitrary heteroskedasticity and arbitrary intra-country correlation (i.e., clustered by country). t-statistics are in square brackets. Constant terms are not reported. The over-identification test is Hansen's J statistic; the null hypothesis is that the instruments are exogenous (i.e., uncorrelated with the error term). The exogeneity test of each excluded instrument is C statistic; the null hypothesis is that the excluded instrument tested is exogenous (i.e., uncorrelated with the error term).
ˣ, *, ** and *** indicate statistically significant at the 15%, 10%, 5% and 1% levels, respectively.

Table 10

Theoretical outcomes for different values of σ and ρ

	σ=ρ=1	σ=0.5; ρ=1 ("normal" case)	σ=1; ρ=0.5 (NON-"normal" case)
c_0	0.1636	0.1639	0.2455
c_1h	0.2035	0.2033	0.2909
c_1l	0.1368	0.1366	0.2162
g_0	0.1636	0.1639	0.2455
g_1h	0.2035	0.2033	0.2909
g_1l	0.1368	0.1366	0.2162
%Δ in g	48.73	48.82	34.57
t_0	1	0.999991723	1.002945153
t_1h	1	1.000007024	0.997383801
t_1l	1	1.000010454	0.99647938
%Δ in t	0	-0.000342956	0.0907616
PS_0	0	-1.35636E-06	0.000722969
PS_1h	0	1.42775E-06	-0.00076102
PS_1l	0	1.42775E-06	-0.00076102

Appendix 1. Definition of variables and sources

1.1 Macroeconomic data

Gross Domestic Product

World Economic Outlook (WEO-IMF) and International Financial Statistics (IFS-IMF) were the main data sources. Series NGDP (gross domestic product, current prices) for WEO and 99B for IFS-IMF. For Azerbaijan, Bahrain, Kuwait, Libya, Qatar, and United Arab Emirates data were provided by Middle East Department at the IMF. Data period covers 1960-2009.

Government total revenue

World Economic Outlook (WEO-IMF) was the main data source, series GCRG (central government, total revenue and grants). Due to non availability of central government data, general government data were used for Ecuador, Kuwait, Libya, Qatar, and United Arab Emirates. For Azerbaijan, Bahrain, Kuwait, Libya, Qatar, and United Arab Emirates data were provided by Middle East Department at the IMF. Data period covers 1960-2009.

GDP deflator

World Economic Outlook (WEO-IMF) and International Financial Statistics (IFS-IMF) were the main data sources. Series NGDP_D (gross domestic product deflator) for WEO-IMF and 99BIP for IFS-IMF. For Azerbaijan, Bahrain, Kuwait, Libya, Qatar, and United Arab Emirates data were provided by Middle East Department at the IMF. Data period covers 1960-2009.

Consumer price index

World Economic Outlook (WEO-IMF) and International Financial Statistics (IFS-IMF) were the main data sources. Series PCPI (consumer price index) for WEO-IMF and 64 for IFS-IMF. For Azerbaijan and Kuwait data were taken from Global Financial Data (GFD). Data period covers 1960-2009.

Government tax structure data

Government Finance Statistics (GFS-IMF) was the data source for Government tax structure data. Data for Australia were from Australian Government Budget Office.

The variables are defined as follows: tax revenue (Central government, taxes. Series cB_BA_11 and aB_BA_11), tax revenue on income, profits and corporations (Central government, taxes on income, profits and corporations. Series cB_BA_111 and aB_BA_111), personal income tax revenue (Central government, taxes on individuals. Series cB_BA_1111 and aB_BA_1111), corporate income tax revenue (Central government, taxes on corporations. Series cB_BA_1112 and aB_BA_1112), goods and services tax revenue (Central government, taxes on goods and services. Series cB_BA_114 and aB_BA_114), and value added tax revenue (Central government, value added tax. Series cB_BA_11411 and aB_BA_11411). Data period covers 1990-2009.

Exports of goods and services (as % of GDP)

World Economic Outlook (WEO-IMF) and World Development Indicators (WDI-World Bank) were the main data source, series BX and NGDPD (WEO-IMF) and NE.EXP.GNFS.ZS (WDI-World Bank). Data period covers 1960-2009.

Global interest rate

Global interest rate was calculated by deflating the returns on U.S. Treasuries by the CPI inflation rate of the previous year. As Ilzetzki and Végh (2008), we use an adaptive-expectations measure of real interest rates. These variables were obtained from International Financial Statistics (IFS-IMF). Data period covers 1960-2009.

Real external shock (ShockJP)

Following Jaimovich and Panizza (2007) we created an index of weighted GDP growth of trading partners. In particular,

$$\mathrm{S}chockJP_{\mathrm{it}} = \frac{\mathrm{X_i}}{\mathrm{GDP_i}} \sum_j \phi_{ij,t-1} RGDPGR_{j,t} \ ,$$

where $RGDPGR_j$ measures real GDP growth rate in country j, ϕ_{ij} is the fraction of export from country i going to country j, and $\mathrm{X_i} / \mathrm{GDP_i}$ measures country i's average exports expressed as share of GDP.

Export weights data was from Robert Feenstra and Robert Lipsey, NBER-United Nations Trade Data, 1962-2000 (http://cid.econ.ucdavis.edu/) for period 1962-1985 and from Direction of Trade Statistics database (DOTS-IMF) for the period 1986-2009. Data period covers 1962-2009.

Real external shock (ShockPX)

We created the following index of price of exports,

$$\text{S}hockPX_{\text{it}} = \frac{\text{X}_{\text{i}}}{\text{GDP}_{\text{i}}} PEGR_{it} ,$$

where $PEGR_i$ measures price of exports growth rate in country i and $\text{X}_{\text{i}}/\text{GDP}_{\text{i}}$ measures country i's average exports expressed as share of GDP.

World Economic Outlook (WEO-IMF) and International Financial Statistics (IFS-IMF) were the main data sources for price of exports. Series TXG_D (price deflator for exports of goods) for WEO and 74 for IFS-IMF. Data period covers 1962-2009.

1.2. Tax rate data

Personal income tax

Maximum marginal personal income tax rate. World Development Indicators (WDI-World Bank) and World Tax Database (University of Michigan, Ross School of Business). Data period covers 1960-2009.

Corporate income tax

Maximum corporate income tax rate. World Development Indicators (WDI-World Bank) and World Tax Database (University of Michigan, Ross School of Business). Data period covers 1960-2009.

Value added tax rate

Incomplete

Appendix 2. Countries in the sample

Industrial countries (22)	Developing countries (104)			
Australia	**Algeria**	Dominican Rep.	Latvia	**Qatar**
Austria	**Angola**	**Ecuador**	**Libya**	Romania
Belgium	Argentina	Egypt	Lithuania	Russia
Canada	**Azerbaijan**	El Salvador	Madagascar	Rwanda
Denmark	**Bahrain**	Estonia	Malawi	**Saudi Arabia**
Finland	Bangladesh	Ethiopia	Malaysia	Senegal
France	Barbados	Fiji	Mali	Seychelles
Germany	Benin	**Gabon**	Malta	Sierra Leone
Greece	Bolivia	Gambia	Mauritius	Singapore
Ireland	Botswana	Georgia	Mexico	South Africa
Italy	Brazil	Ghana	Morocco	Sri Lanka
Japan	Bulgaria	Guatemala	Mozambique	**Sudan**
Luxembourg	Cambodia	Haiti	Myanmar	Swaziland
Netherlands	Cameroon	Honduras	Namibia	Syrian Arab Rep.
New Zealand	Cape Verde	Hong Kong	Nepal	Tanzania
Norway	Central African Rep.	Hungary	Nicaragua	Thailand
Portugal	Chad	India	Niger	Togo
Spain	Chile	Indonesia	**Nigeria**	Trinidad and Tobago
Sweden	China	**Iran**	**Oman**	Tunisia
Switzerland	Colombia	Israel	Pakistan	Turkey
United Kingdom	Congo, Dem. Rep. of	Jamaica	Panama	Uganda
United States	Congo, Rep. of	Jordan	Papua New Guinea	**United Arab Emirates**
	Costa Rica	Kenya	Paraguay	Uruguay
	Côte d'Ivoire	Korea	Peru	**Venezuela**
	Cyprus	**Kuwait**	Philippines	**Yemen**
	Czech Rep.	Laos	Poland	Zambia

Notes: Countries in bold represent major oil producer countries. Total number of countries is 126.

Appendix 3. Countries with tax rates information

	Corporate income tax rate	Personal income tax rate	Value-added tax rate		
	Period of coverage	Period of coverage	Year of introduction	Period of coverage	Period of coverage (as % of maximum potential)
Argentina	1979-2009	1976-2009	1974	1974-2009	100
Australia	1960-2009	1974-2009	2000	2000-2009	100
Austria	1960-2009	1975-2009	1973	1973-2009	100
Barbados	1960-2009	1974-2009	1997	1997-2009	100
Belgium	1960-2009	1975-2009	1971	1971-2009	100
Bolivia	1979-2009	1976-2006	1973	1994-2009	41.7
Botswana	1960-2009	1974-2009	2002	2002-2009	100
Brazil	1979-2009	1974-2009			
Bulgaria	1993-2009	1995-2009	1994	1994-2009	100
Canada	1960-2009	1975-2009	1991	1991-2009	100
Chile	1979-2009	1974-2009	1975	1975-2009	100
China	1980-2009	1981-2009	1994	1994-2009	100
Colombia	1979-2009	1976-2009	1989	1989-2009	100
Costa Rica	1979-2009	1974-2009	1975	1999-2009	29.4
Czech Rep.	1991-2009	1991-2009	1993	1993-2009	100
Denmark	1962-2009	1975-2009	1967	1967-2009	100
Dominican Rep.	1979-2009	1979-2007	1983	1992-2009	65.4
El Salvador	1979-2009	1974-1999	1992	1992-2009	100
Ethiopia	1995-2009	2002-2007	2003	2003-2009	100
Fiji	1960-2009	1976-2007	1992	1992-2009	100
Finland	1960-2009	1974-2009	1995	1995-2009	100
France	1960-2009	1975-2009	1948	1968-2009	67.2
Georgia	1992-2007	1992-2009	1992	1992-2009	100
Germany	1960-2009	1975-2009	1968	1968-2009	100
Ghana	1960-2009	1991-2009	1998	1998-2009	100
Greece	1961-2009	1975-2009	1987	1987-2009	100
Honduras	1979-2009	1979-2007	1976	2000-2009	27.3
Hungary	1990-2009	1990-2009	1988	1988-2009	100
India	1960-2009	1974-2009	2005	2005-2009	100
Italy	1960-2009	1975-2009	1973	1973-2009	100
Jamaica	1960-2009	1974-2009	1991	1991-2009	100
Japan	1960-2009	1972-2009	1989	1989-2009	100
Kenya	1960-2009	1974-2004	1990	2000-2009	47.4
Korea	1980-2009	1974-2009	1978	1978-2009	100
Latvia	1995-2009	1995-2009	1992	1992-2009	100
Lithuania	1993-2009	1994-2009	1994	1994-2009	100
Luxembourg	1963-2009	1974-2009	1970	1970-2009	100
Malta	1960-2009	1981-2009	1995	1995-2009	100
Mauritius	1960-2009	1988-2009	1998	1998-2009	100
Mexico	1980-2009	1974-2009	1980	1980-2009	100
Namibia	1991-2009	1991-2009	2000	2000-2009	100
New Zealand	1960-2009	1974-2009	1987	1987-2009	100
Norway	1960-2009	1974-2009	1970	1970-2009	100
Pakistan	1960-2009	1974-2009	1995	1995-2009	100
Papua New Guinea	1960-2009	1974-2009	1999	1999-2009	100
Paraguay	1979-2009	1974-2009	1991	1991-2009	100
Peru	1979-2009	1976-2009	1973	1982-2009	75
Philippines	1980-2009	1974-2009	1988	1988-2009	100
Portugal	1964-2009	1976-2009	1986	1986-2009	100
Romania	1993-2009	1994-2009	1994	1994-2009	100
Russia	1990-2009	1990-2009	1992	1992-2009	100
South Africa	1960-2009	1974-2009	1992	1992-2009	100
Spain	1965-2009	1975-2009	1986	1986-2009	100
Sweden	1960-2009	1974-2009	1969	1969-2009	100

Appendix 3. Countries with tax rates information Cont.

	Corporate income tax rate	Personal income tax rate	Value-added tax rate		
	Period of coverage	Period of coverage	Year of introduction	Period of coverage	Period of coverage (as % of maximum potential)
Switzerland	1960-2009	1975-2009	1995	1995-2009	100
Tanzania	1960-2009	1988-2009	1998	1998-2009	100
Thailand	1975-2009	1974-2009	1992	1992-2009	100
Turkey	1983-2009	1975-2009	1985	1985-2009	100
United Kingdom	1978-2009	1975-2009	1973	1973-2009	100
United States	1960-2009	1960-2009			
Uruguay	1979-2009	1976-2009	1969	1969-2009	100
Zambia	1963-2009	1974-2004	1995	1995-2009	100

Notes: Total number of countries is 62. The value-added tax in Brazil is levied by states (for goods) and by municipalities (for services). The United States does not have a value-added tax. The sales tax in the United States is levied by states.

Appendix 4. Individual country statistics

TABLE 1A

Tax revenue structure: Country tax burden and tax revenue composition

	Revenues (as % of GDP)	Tax revenue on income, profits, and corporations (as % of total tax revenues)	Personal income tax revenues (as % of total tax revenues)	Corporate income tax revenues (as % of total tax revenues)	Good and services tax revenues (as % of total tax revenues)	Value-added tax revenues (as % of total tax revenues)
	(1)	(2)	(3)	(4)	(5)	(6)
Argentina	15.50	21.44	6.73	14.70	61.88	44.55
Australia	23.86	72.87	44.06	22.63	27.13	15.50
Austria	23.42	46.35	36.18	8.74	45.19	27.84
Bangladesh	8.08	18.27	9.99	8.28	37.29	35.50
Barbados	37.10	36.15	17.52	16.45	45.19	32.04
Belgium	31.38	59.54	47.13	12.16	38.04	26.15
Benin	16.17	22.48	9.89	12.18	43.02	41.33
Bolivia	16.55	12.86	0.00	12.86	66.33	35.74
Botswana	33.28	57.98	7.60	44.95	6.98	6.45
Brazil	14.28	42.00	2.74	11.30	52.41	17.49
Bulgaria	35.64	23.78	11.43	11.62	73.19	47.93
Cambodia	8.24	10.83	2.51	8.32	53.55	33.85
Cameroon	15.49	27.76	12.91	14.86	31.08	.
Canada	16.82	74.80	55.00	16.93	23.40	17.89
Cape Verde	28.83	29.82	16.95	12.87	54.15	36.98
Central African Rep.	14.62	22.62	13.39	8.66	38.82	29.42
Chad	22.45	.	.	.	.	.
Chile	22.51	36.75	12.25	24.50	55.02	44.94
China	21.47	25.92	7.18	18.73	77.73	62.54
Colombia	9.58	40.45	2.19	38.25	49.35	43.50
Congo, Dem. Rep. of	7.30	27.63	12.05	15.17	23.50	.

TABLE 1A cont.

Tax revenue structure: Country tax burden and tax revenue composition

	Revenues (as % of GDP) (1)	Tax revenue on income, profits, and corporations (as % of total tax revenues) (2)	Personal income tax revenues (as % of total tax revenues) (3)	Corporate income tax revenues (as % of total tax revenues) (4)	Good and services tax revenues (as % of total tax revenues) (5)	Value-added tax revenues (as % of total tax revenues) (6)
Congo, Rep. of	26.42	12.84	6.57	6.27	62.70	18.15
Costa Rica	11.39	20.03	6.02	14.02	56.57	34.46
Cyprus	37.94	39.75	16.95	22.12	50.03	29.39
Czech Rep.	32.05	42.25	20.30	21.95	55.51	31.65
Côte d'Ivoire	25.00	27.32	12.86	14.46	13.80	6.97
Denmark	36.82	43.75	35.06	8.69	48.54	30.98
Dominican Rep.	12.06	22.06	5.70	10.86	53.82	28.85
Egypt	27.64	41.54	10.19	31.35	39.09	28.28
El Salvador	14.64	31.77	15.27	16.50	58.27	53.04
Estonia	32.06	27.15	17.82	9.33	72.73	50.47
Ethiopia	14.29	30.65	8.67	19.72	25.09	2.73
Fiji	25.08	33.40	16.88	13.21	45.46	38.25
Finland	25.23	37.23	25.65	11.39	59.87	35.87
France	19.49	36.42	22.15	14.27	55.61	39.95
Gambia	22.52	14.00	5.28	8.62	40.29	.
Georgia	15.21	11.55	4.97	6.58	80.52	62.76
Germany	14.11	44.45	38.63	5.17	55.55	27.59
Ghana	15.74	26.64	11.16	13.89	41.45	19.28
Greece	30.82	37.59	22.48	14.25	57.02	32.94
Guatemala	10.53	27.15	2.11	17.68	60.28	46.34
Haiti	10.26	.	.	.	.	.
Honduras	13.09	27.59	14.12	13.47	62.78	36.77
Hong Kong	15.84	.	.	.	.	.
Hungary	38.14	34.61	24.36	10.25	58.15	36.82
India	9.44	34.85	14.69	19.72	38.89	0.21
Indonesia	14.65	57.25	21.17	34.76	35.22	.
Ireland	34.68	49.48	35.62	13.81	41.11	27.41
Israel	38.87	47.18	31.87	13.43	44.14	29.95
Italy	27.66	55.55	43.24	12.29	35.83	23.45
Jamaica	23.00	40.22	15.65	17.39	39.68	33.78
Japan	11.76	67.40	41.34	26.06	22.17	10.48
Jordan	25.88	15.86	4.46	11.06	42.36	0.00
Kenya	17.94	39.59	21.29	18.33	47.78	28.56
Korea	18.81	39.97	20.46	19.51	42.51	27.31
Laos	11.90	25.39	.	.	60.44	.
Latvia	26.73	25.24	9.61	15.64	73.00	49.64
Lithuania	27.70	28.23	15.33	12.90	71.17	47.31
Luxembourg	38.56	46.34	28.30	18.04	47.47	22.39
Madagascar	14.25	17.62	5.49	9.17	26.99	.
Malaysia	26.82	57.51	14.11	43.20	30.55	.
Mali	16.64	20.85	6.39	13.60	54.17	40.47
Malta	38.29	43.01	23.47	19.28	50.00	27.65
Mauritius	21.53	17.53	7.37	9.94	52.09	35.78

TABLE 1A cont.

Tax revenue structure: Country tax burden and tax revenue composition

	Revenues (as % of GDP)	Tax revenue on income, profits, and corporations (as % of total tax revenues)	Personal income tax revenues (as % of total tax revenues)	Corporate income tax revenues (as % of total tax revenues)	Good and services tax revenues (as % of total tax revenues)	Value-added tax revenues (as % of total tax revenues)
	(1)	(2)	(3)	(4)	(5)	(6)
Mexico	13.79	43.26	14.42	28.84	73.18	27.59
Morocco	20.75	37.11	18.78	18.01	44.07	29.55
Mozambique	16.62	31.42	16.47	14.79	58.36	38.34
Myanmar	9.33	30.11	30.11	0.00	49.77	.
Namibia	31.21	39.27	23.90	15.37	21.92	21.15
Nepal	10.66	18.46	1.33	14.19	46.60	34.91
Netherlands	30.24	46.68	29.66	17.02	47.77	30.04
New Zealand	34.80	66.33	51.26	15.07	30.29	21.80
Nicaragua	21.62	27.93	.	.	65.54	41.58
Niger	21.48	17.84	6.20	10.90	27.17	19.78
Norway	42.13	53.55	18.25	35.20	44.24	29.54
Pakistan	13.73	24.28	4.21	22.10	39.97	26.51
Panama	19.15	38.02	1.84	12.27	33.07	.
Papua New Guinea	23.68	54.14	26.56	26.86	12.41	12.41
Paraguay	12.70	18.52	0.00	18.52	59.06	42.94
Peru	13.68	29.91	9.57	20.34	54.40	40.74
Philippines	15.13	45.32	15.73	23.37	29.95	14.29
Poland	31.66	27.82	17.07	10.75	70.49	43.69
Portugal	20.70	40.13	26.02	14.11	55.90	33.26
Romania	25.68	28.88	5.99	22.62	66.26	40.19
Russia	29.94	10.75	0.03	10.56	60.64	49.19
Rwanda	13.87	19.49	9.40	4.81	39.04	.
Senegal	18.98	23.21	12.27	7.94	32.03	32.03
Seychelles	36.01	19.95	1.24	18.71	26.99	31.23
Sierra Leone	17.22	25.11	11.15	13.23	26.81	0.00
Singapore	.	46.59	.	.	32.52	12.32
South Africa	20.75	57.29	30.75	26.54	35.16	26.70
Spain	18.53	58.75	37.09	21.66	40.76	26.79
Sri Lanka	18.70	16.09	5.33	8.72	60.43	34.89
Swaziland	24.68	27.68	16.74	9.95	17.00	.
Sweden	31.65	24.44	11.47	12.97	56.48	37.39
Switzerland	9.48	33.53	22.30	11.23	59.66	38.48
Syrian Arab Rep.	23.28	33.99	.	.	42.42	.
Tanzania	15.96	24.00	12.00	7.00	65.00	36.00
Thailand	16.55	45.93	12.74	33.20	46.11	22.10
Togo	23.81	22.21	6.68	11.28	50.42	40.86
Trinidad and Tobago	32.51	54.36	23.00	26.48	34.41	.
Tunisia	24.37	28.86	15.87	11.95	42.41	31.58
Turkey	15.98	44.48	34.20	9.19	46.10	29.85
Uganda	12.77	22.16	8.53	11.44	55.45	31.83
United Kingdom	33.82	49.82	37.58	12.24	40.54	22.88
United States	18.66	89.80	73.96	15.85	6.03	0.00
Uruguay	20.22	17.40	6.28	10.48	60.65	39.97
Zambia	29.51	43.46	34.17	9.29	43.96	29.71

Notes: Major oil producer countries are not included.

TABLE 2A

Tax rate data: Country characteristics

	Annual average % change in tax rates			Frequency of change in tax rates			% change in tax rates		
	PIT (1)	CIT (2)	VAT (3)	PIT (4)	CIT (5)	VAT (6)	PIT (7)	CIT (8)	VAT (9)
Argentina	1.75	3.40	4.87	0.13	0.13	0.26	13.14	26.36	18.92
Australia	1.00	2.11	0.00	0.20	0.24	0.00	4.99	8.84	.
Austria	0.57	2.30	0.66	0.03	0.09	0.06	19.35	24.72	11.81
Barbados	1.65	1.85	1.19	0.13	0.14	0.07	12.40	13.23	16.67
Belgium	1.05	2.39	1.03	0.15	0.17	0.16	6.81	14.36	6.55
Bolivia	4.20	0.00	0.00	0.09	0.00	0.00	48.33	.	.
Botswana	2.58	2.25	2.50	0.16	0.10	0.13	16.02	22.52	20.00
Brazil	6.28	2.29	0.00	0.23	0.10	0.00	26.90	23.65	.
Bulgaria	8.38	9.07	2.09	0.33	0.47	0.13	25.14	19.28	15.66
Canada	1.33	3.28	1.72	0.08	0.23	0.11	17.28	14.32	15.48
Chile	1.74	7.87	0.46	0.25	0.31	0.06	6.96	25.57	7.78
China	0.00	2.31	0.00	0.00	0.10	0.00	.	23.07	.
Colombia	2.86	2.51	2.83	0.18	0.31	0.10	16.01	8.09	28.33
Costa Rica	3.00	1.65	6.25	0.07	0.06	0.10	45.00	25.56	62.50
Czech Rep.	5.95	4.99	1.12	0.36	0.63	0.13	16.66	7.91	8.99
Denmark	12.76	2.96	2.49	0.37	0.27	0.12	34.44	11.11	20.96
Dominican Rep.	3.30	3.55	4.90	0.14	0.23	0.12	24.22	15.72	41.67
El Salvador	2.58	1.54	1.76	0.09	0.10	0.06	28.33	15.87	30.00
Ethiopia	0.00	3.12	0.00	0.00	0.20	0.00	.	15.60	.
Fiji	1.48	1.30	1.47	0.15	0.16	0.06	9.62	8.14	25.00
Finland	3.52	3.40	0.00	0.44	0.24	0.00	8.05	14.15	.
France	2.40	0.79	1.73	0.30	0.18	0.17	7.88	4.37	10.11
Georgia	2.94	2.86	2.94	0.06	0.07	0.11	50.00	42.86	26.43
Germany	0.82	3.40	1.65	0.13	0.16	0.17	6.60	21.24	9.67
Ghana	3.17	3.09	2.27	0.13	0.25	0.09	25.32	12.34	25.00
Greece	2.26	3.23	1.33	0.15	0.29	0.14	14.67	11.29	9.72
Honduras	1.49	5.04	0.00	0.07	0.13	0.00	20.83	39.08	.
Hungary	3.51	6.86	0.95	0.37	0.25	0.05	9.52	27.45	20.00
India	2.79	6.58	0.00	0.15	0.34	0.00	18.13	19.35	.
Italy	1.38	4.73	1.55	0.20	0.16	0.11	6.88	29.57	13.95
Jamaica	2.39	1.93	3.06	0.07	0.12	0.17	33.51	16.05	18.33
Japan	2.67	1.30	3.33	0.14	0.22	0.05	19.75	5.91	66.67
Kenya	2.65	7.87	1.11	0.22	0.20	0.10	11.92	39.33	11.11
Korea	1.51	1.84	0.00	0.21	0.23	0.00	7.24	7.87	.
Latvia	2.61	3.11	3.92	0.14	0.20	0.12	18.29	15.56	33.33
Lithuania	5.24	3.22	0.37	0.33	0.12	0.07	15.71	27.37	5.56
Luxembourg	0.99	1.74	1.79	0.24	0.22	0.08	4.13	7.84	23.33
Malta	1.65	1.42	1.43	0.04	0.06	0.07	46.15	23.68	20.00
Mauritius	4.26	2.19	4.09	0.16	0.10	0.18	26.98	23.05	22.50
Mexico	2.99	2.08	4.60	0.30	0.40	0.10	9.97	5.21	44.44
Namibia	2.80	0.68	0.00	0.39	0.11	0.00	7.20	6.45	.
New Zealand	2.69	2.25	1.14	0.20	0.14	0.05	13.47	16.09	25.00
Norway	6.12	0.35	0.59	0.55	0.06	0.10	11.22	5.76	5.76
Pakistan	3.39	4.11	0.00	0.14	0.26	0.00	23.71	15.82	.
Papua New Guinea	3.58	2.41	0.00	0.21	0.18	0.00	16.89	13.40	.
Paraguay	9.09	2.69	0.00	0.06	0.06	0.00	100.00	41.67	.
Peru	3.69	2.42	9.07	0.23	0.16	0.41	16.35	15.03	22.27
Philippines	1.84	1.08	0.95	0.13	0.17	0.05	14.71	6.50	20.00
Portugal	2.15	4.88	1.98	0.15	0.30	0.26	13.99	16.51	7.57
Romania	6.41	5.05	2.39	0.20	0.18	0.13	32.04	28.59	17.93
Russia	8.89	3.30	3.95	0.26	0.25	0.29	33.79	13.18	13.41
South Africa	0.74	2.44	2.35	0.15	0.26	0.06	4.79	9.57	40.00
Spain	4.12	1.09	1.32	0.38	0.11	0.13	10.70	9.85	10.13
Sweden	7.28	2.87	2.84	0.63	0.12	0.15	11.65	23.89	18.90
Switzerland	0.90	7.32	1.19	0.14	0.07	0.14	6.27	104.92	8.36
Tanzania	5.32	9.21	0.00	0.29	0.16	0.00	18.62	57.87	.
Thailand	1.46	0.43	4.29	0.06	0.03	0.12	24.06	14.29	36.43
Turkey	3.83	4.22	3.33	0.33	0.15	0.04	11.48	28.50	80.00
United Kingdom	1.04	1.85	3.85	0.03	0.25	0.11	33.33	7.39	34.61
United States	3.53	1.25	0.00	0.31	0.18	0.00	11.54	6.92	.
Uruguay	0.00	2.18	2.49	0.03	0.13	0.15	.	16.90	16.60
Zambia	3.21	2.22	1.40	0.13	0.21	0.13	24.62	10.42	10.54

Notes: PIT, CIT and VAT stand for personal income tax, corporate income tax and value-added tax respectively.