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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 developing 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 cyclical behavior of tax policy). We build a novel dataset on tax rates for 62 countries for the period 1960-2013 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 mostly procyclical in developing countries. Further, tax policy in countries with better institutions and/or more integrated with world capital markets tends to be less procyclical/more countercyclical.

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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.<sup>1</sup> Figure 1 – from Frankel, Vegh, and Vuletin (2013) – illustrates this phenomenon by plotting the correlation between the cyclical components of government spending and output for 94 countries during the period 1960-2009. Yellow (or light) bars depict developing countries while black bars indicate industrial economies. The visual impression is striking: while a majority of black bars lie to the left of the figure (indicating a negative correlation and hence countercyclical government spending in industrial countries), the majority of yellow bars lie to the right (indicating a positive correlation and hence procyclical government spending in developing countries). In fact, the average correlation is -0.17 for industrial countries and 0.35 for developing countries.

Several hypotheses 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 (Riascos and Vegh, 2003, Cuadra, Sanchez, and Sapriza, 2010, Bauducco and Caprioli, 2014) to political distortions and institutional weaknesses that tend to encourage “excessive” public spending during boom periods (Tornell and Lane, 1999, Talvi and Vegh, 2005). While, as argued by Frankel, Vegh, and Vuletin (2013), some emerging economies have switched from being procyclical to countercyclical over the last decade (i.e., have “graduated”), fiscal procyclicality remains a pervasive phenomenon in the developing world, which tends to reinforce – rather than mitigate – the underlying business cycle volatility.

The other pillar of fiscal policy is, of course, taxation. An obvious, yet critical, observation on the taxation side is that in this case policymakers control (i) the statutory tax rate and (ii) to a large extent, the tax base (i.e., the coverage and/or threshold of each tax rate). The tax rate and the tax base ultimately determine the so-called effective (or average marginal) tax rate. In other words, policymakers do not control tax revenues, which vary endogenously with output fluctuations and changes in the tax base due to non-policy factors, such as changes in agents’ willingness to evade taxes, ability to bribe, structural breaks and/or changes in agents’ behavior over the business cycle, changes in income distribution, and “bracket-creeping” due

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<sup>1</sup>See, for example, Kaminsky, Reinhart, and Vegh (2004), Ilzetzki and Vegh (2008), Frankel, Vegh, and Vuletin (2013) and the references therein.

to inflation. Since we are interested in understanding how tax policy is conducted over the business cycle, we want to focus on policy variables under the control of policymakers (i.e., policy *instruments*), and not on tax revenues or any tax revenue-based measure such as the tax burden (ratio of revenues to GDP), which will reflect policy *outcomes* that are heavily influenced by endogenous changes in macroeconomic variables and non-policy factors.<sup>2</sup> In other words, to identify changes in tax policy, it is critical to distinguish between changes in policy *instruments* that indeed reflect the policymakers' intent and endogenous changes in tax revenues that may simply reflect the business cycle or other non-policy factors. As an obvious example, it is perfectly possible to see tax revenues fall during a recession even if policymakers have increased tax rates as long as the reduction in the size of the tax base (due to lower income or consumption) dominates the effect of higher tax rates. Any assessment of tax policy based on tax revenues would thus erroneously conclude that tax policy has been countercyclical when the reality is exactly the opposite.

In this context – and in contrast to the analysis of the spending side, where changes in government consumption (or its cyclical component) capture, in principle, the appropriate policy instrument – the analysis of tax policy proves to be much more challenging due to the presence of multiple taxes (e.g., value-added, personal income, and corporate, among others) and the above-mentioned endogeneity problems associated with the main observable variable (tax revenues). The personal income tax, for example, typically involves multiple tax rates and income brackets. As a result, researchers have often resorted to computing the so-called average marginal personal income tax rate, which captures the income-weighted average of individual-level marginal tax rates and is calculated based on the tax structure (tax rates and thresholds) and income distribution. In a similar vein, the value-added tax has generally a single standard rate applicable to most goods but also a single or multiple reduced tax rate(s), including in some cases exempted goods, which typically apply to particular goods such as some food categories and child and elderly care.

Unfortunately – and leaving aside a few studies focusing on individual countries such as Barro (1990), Huang and Lin (1993), Strazicich (1997), Barro and Redlick (2011), and Romer and Romer (2010) for the United States, Maihos and Sosa (2000) for Uruguay, and

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<sup>2</sup>Even cyclically-adjusted revenues have severe limitations in this regard due to the inherent difficulty of truly controlling for the business cycle, as discussed in detail in Riera-Crichton, Vegh, and Vuletin (2012) in the context of estimation of tax multipliers.

Strawczynski (2013) for Israel – there is no systematic international evidence regarding the cyclicity of tax policy.<sup>3</sup> The main reason is, of course, the absence of readily-available cross-country data on effective tax rates. To get around this limitation, the literature has relied on the use of (i) the inflation tax (Talvi and Vegh, 2005; Kaminsky, Reinhart, and Vegh, 2004) or (ii) tax revenues, either in absolute terms or as a proportion of GDP (Gavin and Perotti, 1997; Braun, 2001; Sorensen, Wu, and Yosha, 2001; and Sturzenegger and Werneck, 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 and Kehoe (1999)), there is little, if any, empirical support (Roubini and Sachs, 1989; Poterba and Rotemberg, 1990; Edwards and Tabellini, 1991; and Roubini, 1991). Indeed, Delhy Nolivos and Vuletin (2014) 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. For whatever is worth, Figure 2 and Table 1, columns 1 and 2 confirm that the inflation tax comoves positively with the business cycle in most industrial countries while it is, on average, acyclical in developing countries. Hence, if anything, one would conclude that tax policy in developing countries is not procyclical which, as will become clear below, would be the incorrect conclusion to draw.

On the other hand, the use of tax revenues is fundamentally flawed because, as mentioned above, tax revenues constitute a policy outcome (as opposed to a policy instrument) that endogenously responds to the business cycle and is also influenced by non-policy factors. Indeed, tax revenues almost always increase during booms and fall in recessions as the size of 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 the cyclicity of tax policy since positively-related tax revenues are

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<sup>3</sup>An important clarification on terminology. We will say that tax policy is procyclical (countercyclical) when tax rates are negatively (positively) correlated with GDP suggesting that tax policy is amplifying (smoothing) the underlying business cycle. An acyclical tax policy captures the case of zero correlation (i.e., no systematic relation between tax policy and the business cycle).

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 one may infer that tax policy is procyclical.<sup>4</sup> 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 cyclicity of tax policy.

To correct for the fact that tax revenues are higher (lower) in good (bad) times, some authors have used tax revenues as a ratio of GDP, referring to it as an “average tax rate.” While appealing at first, this normalization simply compounds the above-mentioned endogeneity problems. Specifically, fluctuations in output not only affect the numerator of this ratio (i.e., tax revenues) indirectly through the size of the tax base, but also directly through the denominator (i.e., output). As a result, it is unclear what we can infer about tax policy by examining the correlation between (the cyclical components of) this ratio and GDP. 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. On this basis, one would (erroneously) conclude that tax policy is acyclical in industrial 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 simply no good substitute for having data on tax policy instruments (i.e., statutory tax rates, coverage, and thresholds) when it comes to evaluating the cyclical properties of tax policy. This is precisely the purpose of this paper. To our knowledge, this is the first paper to show systematic international evidence regarding the cyclicity of tax policy based on the use of policy instruments as opposed to tax revenues (or tax-revenue-based measures). To this end, we have built 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 1960-2013. While governments also resort to other taxes (e.g., social security, trade, wealth, and financial transactions taxes), we should note that value-added, corporate, and personal income taxes represent around 65 percent of total tax revenues in developing countries and almost 80 percent in industrial countries. Given the extensive country and time coverage, we collected mainly standard value-added and highest marginal personal income tax

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<sup>4</sup>Notice that, since tax revenues move positively with the business cycle, negatively-related tax revenues must imply lower tax rates during the booms (assuming all else equal of course).

rates. Corporate and highest marginal personal income tax rates were obtained primarily from the World Development Indicators (World Bank), World Tax Database (University of Michigan, Ross School of Business), and international tax advisory firms. On the other hand, standard value-added tax rates were obtained from various primary sources, including countries' revenue agencies and national libraries, books, newspapers, tax law experts, as well as research and policy papers. 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). We believe that this significant effort in collecting value-added tax rates is crucial for any study analyzing tax policy in the developing world as well as Europe, where indirect/value-added taxation is the main tax revenue instrument.

As already emphasized, using tax policy instruments in the form of tax rates (as opposed to tax policy outcomes) to analyze tax policy is, in our view, a clear improvement on the existing literature. Having said that, our approach is not problem-free either. In particular, one might have concerns related to the fact that, due to data limitations, (i) the standard value-added tax rate may not be a good proxy for the overall value-added tax policy (which also comprises the reduced value-added tax rate(s)); (ii) changes in the coverage of different goods may affect the tax base of the value-added tax (VAT), which would constitute a genuine change in tax policy that we would miss by focusing only on changes in tax rates; and (iii) the highest marginal personal income tax rate may not be a good proxy for the personal income tax policy (ideally measured using the average marginal personal income tax rate). To address these concerns, we also use, for a subset of countries, reduced value-added tax rates, effective value-added tax rates (i.e., average VAT rates that take into account goods coverage) and average marginal personal income tax rate data. We find that the results summarized below remain valid because there is a high correlation between the standard VAT rate and either the reduced VAT rate or the effective VAT rate and between the highest marginal personal income tax rate and the average marginal income tax rate. In sum, while not perfect, our main idea of using tax rates to capture overall changes in tax policy seems to deliver the right answers.

Using this novel tax rate data, we compute the degree of cyclicity of each tax and of a tax index. From an identification point of view, we also control for potential endogeneity

problems by using instrumental variables.<sup>5</sup>

We can summarize our main empirical findings as follows:

1. Tax policy is more volatile in developing countries than in industrial economies in the sense that developing countries change their tax rates by larger amounts than industrial economies. In particular, the volatility of tax policy in developing economies is about 35 to 100 percent higher than in industrial countries. This pattern matches the one observed on the spending side (Gavin and Perotti, 1997; Singh, 2006). Annual average variation in real government spending is about 60 percent higher in developing countries than in industrial economies.
2. Tax policy is acyclical in industrial countries and mostly procyclical in developing economies. This empirical regularity is robust to a wide set of statistical and econometric methods (including instrumental variables) and to concerns related to our possibly missing changes in tax policy that do not involve changes in tax rates.
3. Countries with more (less) procyclical spending policy typically have more (less) procyclical tax policy. In other words, tax and spending policies are typically conducted in a symmetric way over the business cycle.
4. Much like the procyclicality on the spending side (see, for example, Frankel, Vegh, and Vuletin, 2013), tax policy is less procyclical/more countercyclical the better is institutional quality (e.g., less corruption and more bureaucratic quality) and the higher is financial integration.

The paper proceeds as follows. Section 2 presents the tax rate data used in the study and documents several empirical regularities, particularly regarding the frequency and average magnitude of tax changes and the volatility of tax policy. Using a smaller set of countries, Section 3 computes some alternative tax rates that will be used in the subsequent empirical analysis. Section 4 presents our main findings about the cyclicity of tax policy using alternative statistical and econometric methods, addressing endogeneity concerns, and using

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<sup>5</sup>See Rigobon (2004) and Jaimovich and Panizza (2007) who challenge the idea that fiscal policy is procyclical in developing countries based on endogeneity problems. Ilzetzki and Vegh (2008), however, argue that even after addressing endogeneity concerns, there is causality running from the business cycle to government spending.



alternative tax rate measures. Section 5 explores the relationship between cyclicalities of tax and spending policies. Section 6 confirms that, as in the case of government spending, better institutions induce less procyclical/more countercyclical tax policies and limited access to international capital markets hinder governments' ability to pursue countercyclical policies. Section 7 closes the paper with some final remarks.

## 2 Tax data

### 2.1 Database

Part of this paper's contribution is the creation of a novel tax rate database that combines existing – but dispersed – data on corporate and personal income tax rates with newly-collected data on value-added taxes. Our main database comprises annual data on corporate, highest marginal personal income, and standard value-added tax rates for 62 countries – 20 industrial and 42 developing – for the period 1960-2013.<sup>6,7</sup>

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). The widespread adoption observed since the early 1990s is mainly explained by developing countries, particularly in Africa, Asia, and transition economies.<sup>8</sup> While unbalanced, the tax rate data coverage is quite broad and comprises a long time span. In fact, corporate, highest marginal personal income, and value-added tax rates coverage (as percentage of largest possible coverage) is 80, 70, and 94 percent, respectively. For a smaller sample of 9 and 7 countries we also have (for at least 20 years) reduced value-added and average marginal personal income tax rates, respectively.<sup>9,10</sup>

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<sup>6</sup>See Appendix 1 for the definition of the various variables and data sources, Appendix 2 for the list of countries in our sample, and Appendix 3 for the period coverage for each tax in each country. We excluded from our analysis major oil-producer countries such as Algeria, Angola, Azerbaijan, Bahrain, Ecuador, Gabon, Iran, Kuwait, Libya, Nigeria, Oman, Qatar, Saudi Arabia, Sudan, United Arab Emirates, Venezuela, and Yemen. For this group of countries, oil revenues typically represent more than 60 percent of fiscal revenues. These revenues are raised in different ways; directly via state-owned enterprises and indirectly through various taxes and royalties.

<sup>7</sup>Corporate tax rates generally are the same for differing types and levels of profits. When this is not the case, we use the highest marginal tax rate.

<sup>8</sup>Appendix 3 reports the year in which the value-added tax was introduced in each country included in our study.

<sup>9</sup>The data on reduced value-added tax rates covers Austria, Belgium, France, Germany, Greece, Italy, Portugal, Spain, and Sweden.

<sup>10</sup>We would like to thank Ethan Ilzetzki for sharing his average marginal personal income tax rates dataset.

## 2.2 Long-run trends

Long-run tax rate trends differ across taxes. About two thirds of personal and corporate income tax rates changes are negative, both in industrial and developing countries (Table 2, columns 1 to 4). The opposite trend occurs with value-added tax rates; about 75 percent of such changes are positive (Table 2, columns 5 and 6). These changes reflect a downward trend of personal and corporate income tax rates and a slow but persistent upward trend of value-added tax rates. The highest personal income tax rates fell from about 50 percent in the early 1980s to 30 percent in the late 2000s. Similarly, corporate tax rates decreased from about 40 percent in the early 1980s to 25 percent in the late 2000s. On the other hand, standard value-added tax rates increased moderately from 15 percent in the early 1980s to about 17 percent in the late 2000s.

## 2.3 Short-run patterns

In spite of the above-mentioned differences in the long-run trends across tax rates, changes are somewhat synchronized in the short-run. We should first notice, though, that about half of increases or decreases in the rate of one tax tend to occur in the absence of changes in other tax rates. For example, out of all reductions in the personal income tax rate, 48 percent are associated with no change in the corporate or value-added tax rates. Having said that, reductions (increases) in the rate of one tax tend to be more associated –about two times– with reductions (increases) in the other taxes than with increases (decreases). Following the previous example of reductions in personal income tax rate, 37 percent are associated with reductions in corporate and/or value-added tax rates, and only 15 percent are associated with increases in corporate and/or value-added tax rates.

## 2.4 Frequency of changes

A key difference between government spending – and for that matter most macroeconomic variables – and tax *rates* is that the latter rarely vary every year.<sup>11</sup> While changes in government spending take place continuously throughout the budget cycle, changes in tax

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The data covers Australia, Belgium, Canada, France, Germany, United Kingdom, and United States.

<sup>11</sup>In this sense, changes in tax rates are reminiscent of the time profile observed in price changes for individual goods; see, for instance, Bils and Klenow (2004).

rates do not occur every year presumably because they typically require explicit approval from congress/parliament. Indeed, the frequency of tax rate changes in our sample is 0.20, 0.18, and 0.12 for personal, corporate, and value-added taxes, respectively. Put differently, tax rates change, on average, about every 5 years for corporate and personal income taxes and every 8 years for value-added taxes.

Table 3, panel A also shows that, with the exception of the personal income tax rates, which vary more frequently in industrial countries, the frequency of tax rate changes is quite similar across industrial and developing countries.

## 2.5 Average magnitude of changes

Both industrial and developing countries exhibit similar average variation in tax rates (Table 3, panel B) of between 1.7 and 3 percent. The annual average change in tax rates, however, varies significantly across countries and taxes. For example, Norway's annual average change in personal income tax rate is about 7 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 value-added tax rate (of 10 percent) since its introduction in 1978.<sup>12</sup>

## 2.6 Tax policy volatility

The similarity across groups of countries regarding the *average* magnitude of tax rate changes described in the previous subsection hides important differences on the intensity/magnitude of tax rate changes. When focusing only on tax rate changes different from zero (i.e., when tax policy is active), developing economies show larger magnitude of tax rate changes than industrial countries across the board (Table 3, panel C). The percentage change in tax rates in developing countries is about 100, 50, and 35 percent higher for the personal, corporate, and value-added taxes, respectively, than that of industrial economies. In other words, tax policy is more volatile in developing countries than in industrial economies.

For example, since its introduction in January 1, 1986 Portugal has changed its value-

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<sup>12</sup>See Appendix 4, Table 4A, columns 1-3 for the corresponding country statistics.

added tax rate by relatively small amounts: from 16 to 17 percent (February 1, 1988), from 17 to 16 percent (March 24, 1992), from 16 to 17 percent (January 1, 1995), from 17 to 19 percent (June 5, 2002), from 19 to 21 percent (July 1, 2005), from 21 to 20 percent (July 1, 2008), from 20 to 21 percent (July 1, 2010), and from 21 to 23 percent (January 1, 2011). In other words, Portugal’s average absolute percentage change was 8.6 percent. On the other hand, since its introduction on January 1, 1980, Mexico has changed its value-added tax rate four times: from 10 to 15 percent (December 31, 1982), from 15 to 10 percent (November 21, 1991), from 10 to 15 percent (March 27, 1995), and from 15 to 16 percent (January 1, 2010). In other words, Mexico’s average absolute percentage change was 35 percent, about 4 times that of Portugal.

This regularity regarding tax policy volatility is consistent with the one observed on the government consumption side; developing countries show more volatile spending policy than industrial economies (Gavin and Perotti, 1997; Singh, 2006). Indeed, in our sample annual average variation in real government spending is about 60 percent higher in developing countries than in industrial economies.

## 2.7 Frequency of change versus volatility of tax policy

The three panels in Figure 6 plot for every country in the sample the frequency of changes of each of our three tax rates against tax policy volatility (measured as the percentage absolute change in tax rates without including zero changes). The figures strongly support a negative relationship between the frequency of tax rate changes and tax policy volatility. Countries where changes in tax rates are relatively infrequent (i.e., low frequency of change) typically show high tax policy volatility (i.e., high intensity/magnitude of tax rate changes). In other words, frequency and magnitude of changes seems to act as substitutes: in countries where tax rates change regularly (infrequently), taxes vary by small (large) magnitudes.

## 2.8 Tax revenue structure

In this subsection, we briefly characterize the tax revenue structure – both in terms of size and composition – of countries around the world.<sup>13</sup> The tax burden, defined as government

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<sup>13</sup>This sample consists of ??? countries.

revenue expressed as percentage of GDP, varies significantly across countries, ranging from 42.1 percent for Norway to 7.3 percent for the Democratic Republic of Congo.<sup>14</sup> The average tax burden in industrial countries is 25.5 percent of GDP, compared to 18.8 percent for developing countries (Table 4, panel A).

The relative importance of income – both corporate and personal – and value-added taxes varies significantly across countries and groups of countries. Generally speaking, industrial countries rely more heavily on direct taxation, particularly on personal income taxation. In contrast, developing economies rely more on indirect taxation, particularly the value-added tax (Table 4, panel B).<sup>15</sup>

### 3 Alternative measures of tax rates

As discussed in the Introduction, moving away from the use of tax *revenues* as a way of inferring changes in tax policy and towards the use of tax policy *instruments* (such as statutory tax rates, coverage, and thresholds) is, in our view, a clear improvement in methodology. Having said that, one might still have concerns about our reliance on the standard value-added tax rate (hence ignoring reduced value-added tax rates and/or exempted goods, as well as possible changes in the goods covered by the different rates) and the highest marginal personal income tax (and hence ignoring lower income tax rates and possible changes in the average marginal income tax rate brought about by changes in coverage).<sup>16</sup>

To address these concerns, we will also use in our analysis below (i) the average marginal personal income tax rate, (ii) reduced value-added tax rates, and (iii) effective value-added tax rates (i.e., average VAT rates that take into account goods coverage). While, due to data availability, we can only carry out this analysis for a subset of countries, our results strongly suggest that our main results are robust to the concerns raised above. In essence, our results

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<sup>14</sup>See Appendix 4, Table 3A, column 1 for the corresponding country statistics.

<sup>15</sup>See Appendix 4, Table 3A, columns 2-6 for individual country statistics.

<sup>16</sup>While the average marginal personal income tax rate is the typical measure used by most studies – particularly those focused on the United States – we should note that such measure is not free of conceptual problems either. As discussed in detail by Barro and Redlick (2011), changes in the average marginal personal income tax rate, such as the one observed from 1971 to 1978 in the United States, may reflect the shift of households into higher brackets due to high inflation in the context of an unindexed tax system (and not because of explicit policy changes). This concern seems to be particularly relevant in the case of the developing world as well as industrial countries with a long history of moderate/high and persistent levels of inflation, such as Greece, Italy, Portugal, and Spain.

will remain valid because there is a high correlation between (i) standard value-added tax rates and reduced or effective value-added tax rates and (ii) the highest personal income tax rate and the average marginal income tax rate.

### 3.1 Personal income tax rate

In the case of the personal income tax rate, Table 5 shows the correlation between highest and average marginal personal income tax rates for seven economies for which we have data on average marginal personal income tax rates for at least 20 years. The correlation is always statistically positive and ranges between 0.44 and 0.99. A visual inspection of Figure 7, which shows both personal income tax rate measures for the United States, indeed indicates a striking similar profile between highest and average marginal personal income tax rates.

### 3.2 Reduced value-added tax rate

We obtain similar findings when turning to the value-added tax. Table 6 shows the correlation between the standard and average reduced value-added tax rates for nine economies for which we have data on reduced value-added tax rates for at least 20 years.<sup>17</sup> With only two exceptions, the correlation is larger than 0.5 and statistically significant at the one percent level. As an illustration of this high correlation, Figures 8 and 9 show both standard and average reduced value-added tax rates for Germany and Greece, respectively. Moreover, in the case of Greece (which has two reduced value-added tax rates) both the lowest and highest reduced rates show a similar profile.<sup>18</sup>

### 3.3 Effective value-added tax rate

To complement our evidence regarding the correlation between the standard and average reduced value-added tax rates, we also calculate the *effective* value-added tax rate by weighing each value-added statutory tax rate with its corresponding share of transactions (as a percentage of the taxable base).<sup>19</sup> Formally – and following Mathis (2004) – we compute the

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<sup>17</sup>In most cases, countries have one, or at most two, reduced VAT rates. However, for some countries and during certain periods of time, there have been up to 5 reduced VAT rates.

<sup>18</sup>We should also note that reduced tax rates typically apply to particular goods, such as some food categories and child and elderly care.

<sup>19</sup>Unfortunately, effective tax rates are not readily available even for EU countries, where most measures refer to tax burdens, the so-called *implicit* tax rates (calculated as aggregate tax revenues as a percentage of

effective value-added tax rate as

$$\text{effective value-added tax rate}_{it} = \sum_j w_{it}^j \times VAT_{it}^j,$$

where  $w^j$  denotes the share of transactions associated with tax rate  $j$  as a percentage of taxable base (i.e.,  $\sum_j w_{it}^j = 1$ ) and  $VAT_j$  is the value-added tax rate  $j$ .<sup>20</sup> The computation of  $w^j$  is not trivial as it requires mapping the coverage for statutory tax rates to national account data (see Mathis (2004) for details). The closer the standard rate and the effective average value-added tax rates are, the smaller the impact of the non-standard rates (e.g., reduced, zero, and parking rates) as well as changes in the tax base.<sup>21</sup> In the extreme case of Denmark, where there is a single statutory rate, both the standard and the effective tax rates are identical. Unfortunately, the required  $w^j$ 's are only available for the nine industrial countries listed in Table 6 and Denmark for the years 1996, 1998, and 2000.<sup>22</sup>

While the raw data is not shown for brevity (see Tables A1 through A5 in Mathis (2004) for details) two basic empirical regularities are worth noting. First, for the 10 countries included in this subsection, the share of transactions associated with the standard value-added tax rate is on average 70 percent (of total tax base). The share of transactions covered by reduced tax rates is about 26 percent, while super-reduced, parking, and zero value-added rates cover the remaining 4 percent of transactions. As we would expect, these averages show some cross country variation, ranging from a standard rate tax base of 50 percent in Spain to 100 percent in Denmark.

Second, these shares of transactions associated with different statutory tax rates do not vary much over time in any given country. Between 1996 and 2000, most changes are about 1 or 2 percentage points. While the data used are not fully comparable, similar findings

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the potential tax base); see European Commission (2011, 2012, and 2013).

<sup>20</sup>In particular, we distinguish between standard, reduced, super-reduced, parking, and zero value-added rates and bases. Super-reduced tax rates refer to tax rates lower than 5 percent.

<sup>21</sup>As discussed above for the case of the average marginal personal income tax, we should note that the effective value-added tax rate may, in principle, reflect non-policy changes. In this case, such non-policy changes would reflect changes in  $w^j$  due to the rebalancing of consumption among taxed goods rather than legislative changes. For example, some recent reports by the European Commission (e.g., European Commission, 2011) argue that this might have been the case in the aftermath of the global financial crisis because of a shift in consumption patterns towards basic goods, which are normally subject to lower VAT rates.

<sup>22</sup>We work with the nine countries specified in Table 6 plus Denmark. Denmark was not included in the analysis underlying Table 6 because it does not have reduced rates.

obtain if one uses also the 2011 shares from Borselli, Chiri, and Romagnano (2012). In other words, while there is some within-country variation in the shares of transactions associated with different tax rates, they are not quantitatively important.

Figure 10 shows standard and effective value-added tax rates for the 30 data points for which we have data (10 countries and 3 years). This figure aims at replicating, in a pooled data framework, Figure 7 comparing the highest and the average marginal personal income tax rates in the United States. Two observations are worth making. First, the degree of association is positive and very high with an  $R^2$  of 0.85, indicating that the variability of the standard value-added tax rate explains about 85 percent of the effective value-added tax rate. Second, we cannot reject the null hypothesis that the coefficient that relates these two alternative measures (i.e., 1.1) is, statistically speaking, different from 1. This would imply that a one percentage-point increase in the standard rate would be associated, on average, with a one percentage-point increase in the effective rate.<sup>23</sup> These findings are not surprising given the high relative importance of the standard tax rate (in terms of its relevance in the tax base) as well as the relative constancy of the goods covered by each statutory tax rate over time.

### 3.4 Tax index

In our analysis below, it will prove convenient to study the behavior of a tax index, which combines the personal income, corporate, and value-added tax rates. While there is really no substitute for the study of the behavior of individual tax rates over the business cycle, such an index will provide us with a single indicator that may be suggestive of the overall cyclical behavior of tax policy in any given country.

To construct this index, we simply take a weighted average of each tax rate, given by

$$\Delta tax\ index_{it} = w_i^{PIT} \times \Delta PIT_{it} + w_i^{CIT} \times \Delta CIT_{it} + w_i^{VAT} \times \Delta VAT_{it}, \quad (1)$$

where  $\Delta PIT$ ,  $\Delta CIT$ , and  $\Delta VAT$  are the percentage changes of the personal income, corporate income, and value-added tax rates, respectively. The weights  $w_i^{PIT}$ ,  $w_i^{CIT}$ , and  $w_i^{VAT}$

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<sup>23</sup>Similar results obtain if we use instead country fixed effects (even though these results should be taken with a grain of salt given that we have only 3 data points per country).



capture the average importance of each tax in each country as a proportion of total tax revenues. The use of a country’s average avoids short-term fluctuations in shares due to non-policy changes.<sup>24</sup>

## 4 Cyclicalities of tax policy

This section presents our main findings on the cyclicalities of tax policy. To this end, we use several statistical and econometric methods such as computing the behavior of tax rates across different stances of the business cycle, cross-country correlation plots, and panel data regressions. While using the cyclical component of the fiscal variable is the typical approach when focusing on government consumption (which is a “continuous” variable), the choice of this strategy is less obvious when focusing on a fiscal variable, such as tax rates, which changes less frequently (as discussed in Subsection 2.4). For this reason we use the percentage change in tax rates.<sup>25</sup>

### 4.1 Preliminary analysis

We start by performing a preliminary analysis of the cyclicalities of tax policy using some simple statistics and cross-country correlation plots. Table 7 shows the average percentage tax rate change evaluated at different points in the business cycle for industrial and developing countries. When considering the individual tax rates, we see that, in general, industrial countries reduce tax rates in both good and bad times whereas developing countries reduce them in good times and increase them in bad times. This suggests that, based on individual taxes, tax policy is acyclical in industrial countries and procyclical in developing ones.

In the same vein, the tax index – as defined in equation (1) – decreases both in good and bad times in industrial countries, whereas it falls in good times and increases in bad times in developing economies. Based on this index, therefore, tax policy also appears to be acyclical in industrial countries and procyclical in developing countries.

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<sup>24</sup>Needless to say, taking fixed weights may hide genuine tax policy changes that may result in a change in the relative importance of each tax rate. For this reason, we will use the tax index only as suggestive and not as a substitute for the analysis of individual tax rates and the corresponding robustness tests carried out below.

<sup>25</sup>Similar results obtain if, instead of using tax rates changes, we detrend the original series using the Hodrick-Prescott filter with a smoothing parameter of 6.5 (Ravn and Uhlig, 2002) or the Baxter-King filter.

We now analyze tax behavior at the country level. For this purpose we show country correlations between the percentage changes of each tax rate and real GDP. Figure 11 shows the correlations for the personal income tax rate. While about twice as many industrial countries exhibit a negative correlation (14 relative to 6, with many of the negative correlations being very small in absolute value), the ratio for developing countries is close to 3 (28 relative to 10). It is also interesting to point out that countries such as Spain and Portugal are among the most procyclical industrial economies. Figure 12 reports analogous results for the case of the corporate income tax. While the distribution of industrial countries is about even (9 negative and 11 positive correlations), 26 developing countries exhibit negative correlations (and many quite large in absolute value) compared to just 15 with a positive correlation. In contrast, Figure 13 for the case of the value-added tax rate looks quite similar across industrial and developing countries with negative correlations about twice as many as positive correlations (12 and 6, respectively, for industrial countries and 22 and 11 for developing countries).

Finally, Figure 14 shows country correlations between the percentage changes of the tax index, as defined in equation (1), and real GDP. In some cases, a country's tax policy cyclicity reflects similar behavior of different types of tax rates over the business cycle. For example, personal and corporate income as well as value-added tax rates are procyclical in Ghana and Bulgaria. Conversely, all taxes are countercyclical in Norway and Germany. When the cyclicity of tax rates varies across types of taxes, the overall behavior of the tax index naturally reflects that of the key taxes. For example, the tax index of Mexico shows a procyclical tax policy. While the value-added tax is strongly procyclical, corporate and personal income taxes are quite acyclical. Given that value-added tax revenues constitute about 40 percent of total tax revenues, the cyclicity of the tax index reflects that of the value-added tax rate. In a similar vein, on the whole New Zealand exhibits a countercyclical tax policy. While personal and corporate income are countercyclical, the value-added tax is procyclical. In this case, the countercyclicity of the tax system captured by the tax index reflects the fact that direct taxation represents 75 percent of revenues.

As an overall summary of tax policy, Figure 14 shows the correlation between the tax index and real GDP and shows that the eight most procyclical countries (i.e., those with the largest negative correlations in absolute values) are all developing countries. In fact the average correlation for developing countries is -0.16 compared to -0.08 for industrial countries.

Perhaps not surprisingly (given their dismal recent performance, which is reminiscent of older crisis in Latin America), the three most procyclical industrial countries are Spain, Portugal, and Greece. If these were excluded from the industrial group, the correlation would be essentially zero. This clearly suggests some heterogeneity even within industrial countries, which may be due to more fundamental factors, an issue that we explore in Section 6 below.

## 4.2 Regression analysis

We now exploit the panel nature of our dataset. Table 8 shows panel country fixed-effects regressions. Tax policy is mostly acyclical for industrial countries. With the exception of the value-added tax (column 5), acyclicity is found for both personal (column 1) and corporate (column 3) income taxes as well as for the tax index (column 7). In sharp contrast, tax policy is procyclical in developing countries across the board (columns 2, 4, 6, and 8). In sum, our analysis strongly supports the idea that tax policy is, broadly speaking, acyclical in industrial countries and 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 concerns.

## 4.3 Addressing endogeneity

The panel data regression analysis of the previous subsections characterized the degree of pro/counter cyclicity of tax policy – both at the individual tax level and aggregate tax index – by exploiting the comovements between the percentage changes in tax rates and real GDP. This implicitly assumes that there is no reverse causality; that is, causality runs from output fluctuations to tax policy changes and not the other way around. While this has been the traditional approach in the fiscal procyclicality literature, more recent studies (Rigobon, 2004; Jaimovich and Panizza, 2007; Ilzetzki and Vegh, 2008) have shown that ignoring the problem of endogeneity can potentially lead to a misleading picture. In other words, the alleged procyclicality of tax policy identified in Subsections 4.1 and 4.2 could just reflect the effect of tax multipliers: when tax rates increase (decrease) output decreases (increases).

This subsection addresses such 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):

$$ShockJP_{it} = \frac{X_i}{GDP_i} \sum_j \phi_{ij,t} RGDPGR_{j,t}, \quad (2)$$

where  $RGDPGR_j$  measures real GDP growth rate in country  $j$ ,  $\phi_{ij}$  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.<sup>26</sup> The index  $ShockJP_i$  is thus a weighted real GDP growth of trading partners and is meant to capture an external shock.

Second, we 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, 1994; Ilizetzi and Vegh, 2008). The effective change of prices of exports is measured as follows:

$$ShockPX_{it} = \frac{X_i}{GDP_i} PXGR_{it}, \quad (3)$$

where  $PXGR_i$  measures the growth rate in the price of exports in country  $i$ . The variable  $ShockPX_i$  thus attempts to capture the effective change of prices of exports.<sup>27</sup> Lastly, we use an instrument proposed by Ilizetzi and Vegh (2008) who suggest using the change of real returns on U.S. Treasury bills to capture global liquidity conditions.<sup>28</sup>

In this subsection we also take into account concerns regarding the structure of errors in the regression analysis. We allow errors to exhibit 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 percentage changes of both

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<sup>26</sup>As rightly remarked by 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.”

<sup>27</sup>When using  $ShockJP_i$  (see equation (2)), Ilizetzi and Vegh (2008, page 20) argue that while it is unlikely that current government spending of smaller economies has an effect on the growth rates of their trading partners, which include mainly larger economies, this could be true in the case of larger economies in the sample and hence suggest that results for high-income/industrial countries should be taken with a grain of salt. Similar concerns may apply to  $ShockPX_i$ .

<sup>28</sup>Since global liquidity conditions may also have direct effects on governments' fiscal decisions, we include our measure of U.S. interest rates as an instrument for output as well as a determinant of the behavior of tax policy. Since this instrument might be endogenous in the case of the United States, we exclude this country from the instrumental variables analysis.

dependent variables and regressors.

Table 9 shows instrumental variables panel regressions.<sup>29</sup> Before analyzing the regression results, two issues are worth noting. First, for both groups of countries we can reject that instruments are weak (i.e., instruments are good predictors of the business cycle) at standard five percent confidence. Second, 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. These findings strongly support the validity and strength of our instrumental variable estimates.

Our instrumental variable regressions (Table 9) generally support the findings from the previous section (i.e., Table 8). As expected, instrumental variable estimates are less efficient (i.e., standard errors are a little bit larger). Two differences are worth noting. First, while developing countries pursue procyclical value-added tax policy, industrial countries' procyclicality vanishes once endogeneity concerns are addressed (Table 9, column 5). The latter occurs because (i) there is a shift in the coefficient distribution function to the right (from -0.27 in Table 8 to 0.11 in Table 9) and (ii) there is a widening in the coefficient distribution function (from an absolute t-statistic value of 2.4 in Table 8 to 1.4 in Table 9). The latter feature is typical of IV regressions; estimates are less efficient. The first change supports the presumption regarding the relevance of reverse causality. That is to say, an increase (decrease) in value-added tax rates decreases (increases) output in industrial countries and not the other way around. The second difference with our findings in the previous section is that developing countries' procyclicality in personal income taxation vanishes once endogeneity concerns are addressed (Table 9, column 2).

To sum up, after addressing endogeneity concerns, we find that tax policy is acyclical in industrial countries. Such acyclicity is present not only at an aggregate level (i.e., tax index) but also for personal and corporate income tax rates as well as value-added taxation. 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 personal income taxation.

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<sup>29</sup>In order to make appropriate comparisons, we only use observations for which we have data for all tax rates.

#### 4.4 Evidence from alternative tax rate data

Section 3 discussed the extent to which standard value-added taxes provide a good proxy for overall value-added tax policy and whether the highest marginal personal income tax rate captures the most important changes in personal income tax policy (which is ideally captured by the average marginal personal income tax rate). Specifically – and using a smaller group of industrial countries – we found that (i) the highest marginal personal income tax rate is a good approximation for the average marginal income tax rate, and (ii) the standard value-added tax rate seems to typically move in the same direction as either the reduced value-added tax rates or the effective value-added tax rate. This subsection tests the cyclical properties of these alternative measures (marginal personal income tax rates, reduced value-added rate, and effective value-added rate) relative to the ones used in this study (highest personal income tax rates and standard value-added rate).

Table 10 shows the results. Columns 1 and 2 report panel regressions (as in Subsection 4.2) and columns 3 and 4 instrumental variable panel regressions (as in Subsection 4.3). Panel A focuses on the personal income tax, and panels B and C focus on the value-added tax.<sup>30</sup> When making each comparison, we restrict the number of observations so as to compare the same data points. Panel A, column 2 shows that average marginal personal income tax rates are acyclical. The same finding is obtained when focusing on the highest personal income tax rate (panel A, column 1). These results coincide with those of personal income tax rates of Subsection 4.2 for industrial countries (Table 8, column 1). Panel A, column 4 shows that average marginal personal income tax rates are acyclical when using instrumental variables.<sup>31</sup> The same finding is obtained when focusing on the highest personal income tax rate (panel A, column 3). These results coincide with those of Subsection 4.3 for industrial countries (Table 9, column 1).

We now turn to value-added tax policy. Panel B, column 2 shows that average reduced tax rates are procyclical. The same finding is obtained when focusing on the standard value-added tax rate (panel B, column 1). These results coincide with those of value-added tax rates of

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<sup>30</sup>The sample for these regressions corresponds to the six countries listed in Table 5 (all except the United States, for the reasons discussed in Subsection 4.3) for the case of the personal income tax and the nine countries listed in Table 6 (plus Denmark in the case of the effective value-added tax) for the value-added tax case.

<sup>31</sup>As in subsection 4.3, United States is excluded from the analysis because the U.S. interest rate instrument might be endogenous in the case of the United States. For this reason, the sample size is reduced from seven (Table 5) to six countries (Table 10, panel A).

Subsection 4.2 for industrial countries (Table 8, column 5). Panel B, column 4 shows that average reduce tax rates are acyclical when using instrumental variables. The same finding is obtained when focusing on the standard value-added tax rate (panel A, column 3). These results coincide with those of Subsection 4.3 for industrial countries (Table 9, column 5). All these results, together with those of Subsection 3, support the use of standard value-added and highest personal income tax rates as a proxy for value-added and personal income tax policies, respectively.

Finally, we turn to the effective value-added tax rate. Unfortunately, our sample is very small in this case so our results need to be taken with a big grain of salt. Specifically, we have only 20 observations (2 observations per country) and, furthermore, these observations are changes in non-contiguous years (given that we have observations only for the years 1996, 1998, and 2000, as explained in Subsection 3.3). For what is worth then, Panel C, Columns 1 and 2 show that both the standard and the effective tax rate are procyclical (although the latter is only significant at the 25 percent level) in standard OLS regressions. When instrumental variables are used, however, they both become insignificant. These results coincide with those presented in Table 9, column 5 for industrial countries.

## 5 Cyclicity of spending and tax policies

Up to now, we have focused our analysis on the cyclicity of tax policy. We have found fairly strong evidence to the effect that, in line with the behavior of government spending, industrial countries follow acyclical policies while developing countries are mostly procyclical. We now focus on the relationship between the cyclicity of tax policy and that of spending. In particular, we would like to know whether there exists a link between the cyclicity of spending and tax policies over the business cycle.

Figure 15 shows the country relationship between the cyclicity of tax (y-axis) and government spending policies (x-axis).<sup>32</sup> While far from perfect, Figure 15 indeed supports the idea that countries with more procyclical spending policy (i.e., more positive values of  $\text{Corr}(G, \text{RGDP})$ ) typically have more procyclical tax policy (i.e., more negative values of  $\text{Corr}(\text{tax index}, \text{RGDP})$ ) and viceversa. In other words, tax and spending policies are typically conducted

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<sup>32</sup>We use the tax index as a proxy for tax policy.

in a symmetric way over the business cycle.<sup>33</sup>

## 6 Determinants of tax policy cyclicity

While the existing literature on the cyclicity of government spending typically distinguishes between industrial and developing countries, our findings suggest that “deeper” factors may be at the heart of the matter rather than just the distinction between these two groups of countries. While, on average, industrial countries show an acyclical behavior and developing countries a procyclical one, tax policy cyclicity varies quite a bit within these two groups of countries. For example, Figure 14 shows that while New Zealand, Canada, and Norway show the expected pattern of countercyclical tax policy for industrial countries, Spain, Portugal, and Greece show correlations similar to those of Uruguay and Mexico, thus behaving more like a developing country.

This is perhaps not surprising given structural (or highly inertial) differences in terms of underlying theories regarding the determination of fiscal cyclicity, such as the importance of institutional quality and the degree of financial integration. For this reason, we analyze the role of institutional quality and financial integration. We measure institutional quality using a comprehensive measure calculated as the average of four normalized variables from the International Country Risk Guide (investment profile, corruption, law and order, bureaucratic quality).<sup>34</sup> The institutional quality index ranges between 0 (lowest institutional quality) and 1 (highest institutional quality). We measure *de jure* financial integration using the Chinn-Ito financial openness index (Chinn and Ito, 2006) and *de facto* financial integration using total foreign assets and liabilities over GDP (Lane and Milesi-Ferretti, 2007).<sup>35</sup>

Table 11 shows instrumental variable panel regressions only for data points for which we

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<sup>33</sup>Of course, the specific implications of cyclical changes in government spending and tax policy need not be the same, an important issue to note but that falls outside the scope of this paper. While both may affect GDP via standard spending and tax multipliers, cyclical changes in, say, value-added taxes may affect the choice between private consumption and investment. A cyclical change in government spending, on the other hand, would not have in principle such substitution effects.

<sup>34</sup>Investment profile is an assessment of factors affecting investment risk that are not covered by other political, economic and financial risk components. The risk rating assigned is the sum of three subcomponents: contract viability/expropriation, profits repatriation, and payment delays. Corruption is an indicator of corruption within the political system. Law and order is an indicator of the strength and impartiality of the legal system and the popular observance of the law. Bureaucratic quality is an indicator of the strength and expertise to govern without drastic changes in policy or interruptions in government services.

<sup>35</sup>We should note that, in our formulation, both the Chinn-Ito index and the *de facto* financial integration index have zero as the minimum value.



have both institutional quality and financial integration data. Column 1 shows that, on average, tax policy is acyclical. Columns 2, 3, and 4 add, one-at-a-time, interaction terms with institutional quality, *de jure* financial integration, and *de facto* financial integration, respectively.<sup>36,37</sup> Column 2 then shows that when institutional quality is the lowest (i.e., value of institutional quality = 0), tax policy is procyclical. It also shows that as institutional quality increases, tax policy becomes less procyclical/more countercyclical.

In the same vein, columns 3 and 4 show that when financial integration is the lowest (which, by construction, means that the indicator takes a value of 0), tax policy is procyclical. Further, when either *de jure* or *de facto* financial integration increases, tax policy becomes less procyclical/more countercyclical.<sup>38</sup>

Overall, the evidence just presented coincides with Frankel, Vegh, and Vuletin’s (2013) findings on the spending side. The authors also find that (i) better institutions induce less procyclical/more countercyclical spending policies and (ii) limited access to international capital markets hinders policymakers’ ability to pursue countercyclical policies. Putting all the evidence together, we thus conclude that, not surprisingly, fiscal policy (both on the spending and taxation side) is subject to the same key determinants and hence we should expect countries that pursue procyclical policies on the spending side to also engage in procyclical policies on the tax side. This is, of course, consistent with the evidence presented in Figure 15.

## 7 Conclusions

There is by now a strong consensus in the literature that government spending has been typically procyclical in developing countries and countercyclical or acyclical in industrial economies. The evidence on the taxation side is, however, almost non-existent due to the lack of data on tax rates. To analyze the cyclical properties of tax rate policy, we have built a novel dataset on tax rates for 62 countries for the period 1960-2013 that comprises corporate

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<sup>36</sup>Naturally, we also include the institutional quality and financial integration variables alone as individual regressors whenever they are used in the interaction terms. Such coefficients are not reported for the sake of brevity.

<sup>37</sup>In order to deal with potential endogeneity problems, we include institutional quality and financial integration lagged one year.

<sup>38</sup>When all three interaction terms are included together, the significance disappears due to high multicollinearity.

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. Moreover, much like the procyclicality on the spending side (see Frankel, Vegh, and Vuletin, 2013), we also find that tax policy is less procyclical/more countercyclical the better is institutional quality (e.g., less corruption and more bureaucratic quality) and the more financially integrated is the economy. It is also the case that countries with more procyclical spending policy typically have more procyclical tax policy and vice-versa. In other words, tax and spending policies are typically conducted in a symmetric way over the business cycle.

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## **Appendix 1. Definition of variables and sources**

### **1.1 Macroeconomic data**

#### **Gross Domestic Product**

World Economic Outlook (WEO) and International Financial Statistics (IFS), both from the IMF, were the main data sources. Series NGDP (gross domestic product, current prices) from WEO and 99B from IFS. Data period covers 1960-2013.

#### **Government expenditure**

WEO was the main data source, series GCENL (central government, total expenditure and net lending). For Brazil, data from Instituto de Pesquisa Econômica Aplicada (IPEA). Data period covers 1960-2009.

#### **Private consumption**

WEO was the main data source, series NCP (Private consumption expenditure, current prices). Data period covers 1960-2009.

#### **Government total revenue**

WEO was the main data source, series GCRG (central government, total revenue and grants). Data period covers 1960-2009.

#### **GDP deflator**

WEO and IFS were the main data sources. Series NGDP\_D (gross domestic product deflator) from WEO and 99BIP from IFS. Data period covers 1960-2013.

#### **Consumer price index**

WEO and IFS were the main data sources. Series PCPI (consumer price index) from WEO and 64 from IFS. Data period covers 1960-2013.

#### **Government tax structure data**

Government Finance Statistics (GFS) from the IMF was the main data source. For Australia, data 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 percent of GDP)**

WEO and World Development Indicators (WDI) from the World Bank were the main data sources, series BX and NGDPD (WEO) and NE.EXP.GNFS.ZS (WDI). Data period covers 1960-2013.

#### **Global real interest rate**

Global real interest rate was calculated by deflating the returns on U.S. Treasuries by the CPI inflation rate of the previous year. As Ilzetzki and Vegh (2008), we use an adaptive-expectations measure of real interest rates. These variables were obtained from IFS. Data period covers 1960-2013.

#### **Real external shock (ShockJP)**

In the construction of real external shock, export weights data were obtained from Robert Feenstra and Robert Lipsey, NBER-United Nations Trade Data, 1962-2000 (<http://cid.econ.ucdavis.edu/>) for the period 1962-1985 and from Direction of Trade Statistics database (DOTS-IMF) for the period 1986-2013. Data period covers 1962-2013.

#### **Real external shock (ShockPX)**

In the construction of index of price of exports, WEO and IFS were the main data sources for price of exports. Series TXG\_D (price deflator for exports of goods) from WEO and 74 from IFS. Data period covers 1962-2013.

## 1.2. Tax rate data

### Personal income tax

Highest marginal personal income tax rate. WDI and World Tax Database (University of Michigan, Ross School of Business), with updates from local sources and international consulting firms. Data period covers 1960-2013.

### Corporate income tax

Maximum corporate income tax rate. WDI and World Tax Database, with updates from local sources and international consulting firms. Data period covers 1960-2013.

### Value added tax rate

VAT standard tax rate. Data period covers 1960-2013. See appendix online at [www.guillermovuletin.com](http://www.guillermovuletin.com)

## Appendix 2. Countries in the tax rate sample

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**TABLE 1A**

**Countries in the tax sample**

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Industrial countries (20)	Developing countries (42)	
Australia	Argentina	Kenya
Austria	Barbados	Korea
Belgium	Bolivia	Latvia
Canada	Botswana	Lithuania
Denmark	Brazil	Malta
Finland	Bulgaria	Mauritius
France	Chile	Mexico
Germany	China	Namibia
Greece	Colombia	Pakistan
Italy	Costa Rica	Papua New Guinea
Japan	Czech Rep.	Paraguay
Luxembourg	Dominican Rep.	Peru
New Zealand	El Salvador	Philippines
Norway	Ethiopia	Romania
Portugal	Fiji	Russia
Spain	Georgia	South Africa
Sweden	Ghana	Tanzania
Switzerland	Honduras	Thailand
United Kingdom	Hungary	Turkey
United States	India	Uruguay
	Jamaica	Zambia

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Note: Total number of countries is 62.

## Appendix 3. Tax period coverage

TABLE 2A

Tax period coverage

	Corporate income tax rate	Personal income tax rate	Value-added tax rate		
	Period of coverage	Period of coverage	Year of introduction	Period of coverage	Coverage (as % of maximum possible)
Argentina	1979-2013	1976-2013	1974	1974-2013	100
Australia	1960-2013	1974-2013	2000	2000-2013	100
Austria	1973-2013	1973-2013	1973	1973-2013	100
Barbados	1960-2013	1974-2013	1997	1997-2013	100
Belgium	1960-2013	1975-2013	1971	1971-2013	100
Bolivia	1979-2013	1976-2013	1973	1994-2013	47.5
Botswana	1960-2013	1974-2013	2002	2002-2013	100
Brazil	1979-2013	1974-2013			
Bulgaria	1993-2013	1996-2013	1994	1994-2013	100
Canada	1981-2013	1981-2013	1991	1991-2013	100
Chile	1979-2013	1974-2013	1975	1975-2013	100
China	1994-2013	1994-2013	1994	1994-2013	100
Colombia	1979-2013	1976-2013	1989	1989-2013	100
Costa Rica	1979-2013	1974-2013	1975	1999-2013	36.8
Czech Rep.	1993-2013	1991-2013	1993	1993-2013	100
Denmark	1962-2013	1975-2013	1967	1967-2013	100
Dominican Rep.	1979-2013	1979-2013	1983	1992-2013	70.0
El Salvador	1979-2013	1974-2013	1992	1992-2013	100
Ethiopia	1995-2013	2002-2013	2003	2003-2013	100
Fiji	1960-2013	1979-2013	1992	1992-2013	100
Finland	1960-2013	1974-2013	1995	1995-2013	100
France	1960-2013	1960-2013	1948	1968-2013	70.0
Georgia	1992-2007	1992-2013	1992	1992-2013	100
Germany	1960-2013	1975-2013	1968	1968-2013	100
Ghana	1960-2013	1991-2013	1998	1998-2013	100
Greece	1961-2013	1975-2013	1987	1987-2013	100
Honduras	1979-2013	1979-2013	1976	2000-2013	35.1
Hungary	1989-2013	1990-2013	1988	1988-2013	100
India	1966-2013	1974-2013	2005	2005-2013	100
Italy	1974-2013	1975-2013	1973	1973-2013	100
Jamaica	1960-2013	1974-2013	1991	1991-2013	100
Japan	1960-2013	1972-2013	1989	1989-2013	100
Kenya	1960-2013	1974-2013	1990	2000-2013	56.5
Korea	1980-2013	1974-2013	1978	1978-2013	100
Latvia	1992-2013	1995-2013	1992	1992-2013	100
Lithuania	1994-2013	1994-2013	1994	1994-2013	100
Luxembourg	1963-2013	1974-2013	1970	1970-2013	100
Malta	1960-2013	1981-2013	1995	1995-2013	100
Mauritius	1960-2013	1988-2013	1998	1998-2013	100
Mexico	1980-2013	1974-2013	1980	1980-2013	100
Namibia	1991-2013	1991-2013	2000	2000-2013	100
New Zealand	1960-2013	1974-2013	1987	1987-2013	100
Norway	1960-2013	1974-2013	1970	1970-2013	100
Pakistan	1960-2013	1974-2013	1995	1995-2013	100
Papua New Guinea	1960-2013	1976-2013	1999	1999-2013	100
Paraguay	1979-2013	1979-2013	1991	1991-2013	100
Peru	1979-2013	1976-2013	1973	1982-2013	77.5
Philippines	1980-2013	1979-2013	1988	1988-2013	100
Portugal	1981-2013	1976-2013	1986	1986-2013	100

**TABLE 2A cont.****Tax period coverage**

	Corporate income tax rate	Personal income tax rate	Value-added tax rate		
	Period of coverage	Period of coverage	Year of introduction	Period of coverage	Coverage (as % of maximum possible)
Romania	1993-2013	1994-2013	1994	1994-2013	100
Russia	1990-2013	1990-2013	1992	1992-2013	100
South Africa	1960-2013	1974-2013	1992	1992-2013	100
Spain	1965-2013	1975-2013	1986	1986-2013	100
Sweden	1960-2013	1960-2013	1969	1969-2013	100
Switzerland	1960-2013	1975-2013	1995	1995-2013	100
Tanzania	1976-2013	1988-2013	1998	1998-2013	100
Thailand	1975-2013	1974-2013	1992	1992-2013	100
Turkey	1983-2013	1960-2013	1985	1985-2013	100
United Kingdom	1973-2013	1973-2013	1973	1973-2013	100
United States	1960-2013	1960-2013			
Uruguay	1979-2013	1976-2013	1969	1969-2013	100
Zambia	1964-2013	1981-2013	1995	1995-2013	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. Personal income tax rate corresponds to the highest marginal personal income tax rate. Value-added tax rate corresponds to standard value-added tax rate.

**Appendix 4. Individual country revenue and tax statistics****TABLE 3A****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



TABLE 3A 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)
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	.
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 3A 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

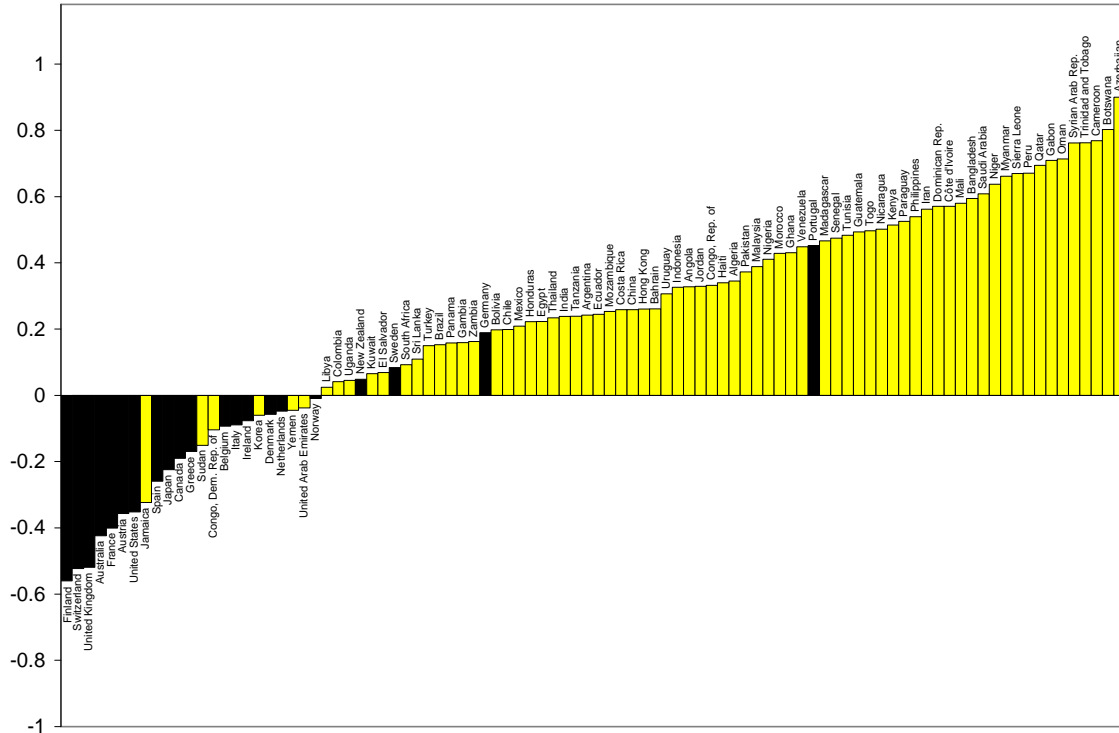
TABLE 4A

## Tax rate data: Country characteristics

	Percentual absolute change in tax rates. Including zero changes			Frequency of tax rate changes			Percentual absolute change in tax rates. Without including zero changes		
	PIT (1)	CIT (2)	VAT (3)	PIT (4)	CIT (5)	VAT (6)	PIT (7)	CIT (8)	VAT (9)
Argentina	1.55	3.10	4.37	0.12	0.12	0.23	13.14	26.36	18.92
Australia	0.88	1.77	0.00	0.18	0.21	0.00	4.99	8.54	.
Austria	0.48	2.13	0.59	0.03	0.08	0.05	19.35	28.42	11.81
Barbados	1.46	1.75	1.04	0.12	0.13	0.06	12.40	13.23	16.67
Belgium	1.02	2.17	0.94	0.16	0.15	0.14	6.54	14.36	6.55
Bolivia	3.22	0.00	0.00	0.07	0.00	0.00	48.33	.	.
Botswana	2.29	3.61	1.82	0.14	0.13	0.09	16.02	27.33	20.00
Brazil	5.54	0.81	.	0.21	0.06	.	26.90	13.81	.
Bulgaria	6.13	7.71	1.65	0.24	0.40	0.11	26.06	19.28	15.66
Canada	1.54	2.59	1.41	0.25	0.34	0.09	6.16	7.53	15.48
Chile	1.54	7.08	1.00	0.23	0.35	0.08	6.60	20.07	12.69
China	0.00	1.28	0.00	0.00	0.05	0.00	.	24.24	.
Colombia	2.50	2.73	2.36	0.16	0.29	0.08	16.01	9.27	28.33
Costa Rica	2.65	1.50	4.46	0.06	0.06	0.07	45.00	25.56	62.50
Czech Rep.	6.82	4.12	1.41	0.32	0.55	0.20	21.42	7.49	7.06
Denmark	11.48	2.78	2.28	0.39	0.25	0.11	29.65	11.11	20.96
Dominican Rep.	3.54	3.71	4.56	0.19	0.24	0.14	18.86	15.76	31.94
El Salvador	1.57	1.99	1.43	0.06	0.12	0.05	28.33	16.90	30.00
Ethiopia	0.00	2.60	0.00	0.00	0.17	0.00	.	15.60	.
Fiji	2.35	1.77	2.14	0.18	0.19	0.10	13.31	9.39	22.50
Finland	3.39	3.31	0.49	0.47	0.25	0.11	7.17	13.51	4.45
France	2.55	0.74	1.57	0.25	0.13	0.16	10.38	5.60	10.11
Georgia	10.40	3.23	2.52	0.19	0.10	0.10	54.58	33.93	26.43
Germany	0.92	2.47	1.50	0.16	0.15	0.16	5.84	16.35	9.67
Ghana	3.17	2.87	1.67	0.13	0.23	0.07	25.32	12.34	25.00
Greece	2.62	3.30	1.93	0.22	0.27	0.15	11.96	12.38	12.55
Honduras	1.23	6.26	0.00	0.06	0.18	0.00	20.83	35.50	.
Hungary	5.55	4.58	2.12	0.39	0.21	0.12	14.19	21.97	17.67
India	2.86	2.71	1.00	0.17	0.40	0.13	17.16	6.71	8.00
Italy	1.18	2.54	1.49	0.19	0.21	0.15	6.06	12.40	9.94
Jamaica	4.24	2.29	3.04	0.13	0.13	0.23	33.90	17.32	13.35
Japan	2.45	1.35	2.78	0.15	0.23	0.04	16.74	5.96	66.67
Kenya	2.55	7.42	0.85	0.21	0.19	0.08	11.92	39.33	11.11
Korea	1.60	1.67	0.00	0.21	0.21	0.00	7.46	7.87	.
Latvia	3.19	2.22	3.62	0.28	0.14	0.19	11.49	15.56	18.99
Lithuania	4.14	5.95	0.85	0.26	0.21	0.11	15.71	28.27	8.04
Luxembourg	1.99	1.66	1.63	0.39	0.20	0.07	5.06	8.29	23.33
Malta	1.44	1.34	1.11	0.03	0.06	0.06	46.15	23.68	20.00
Mauritius	4.37	2.12	3.00	0.20	0.11	0.13	21.86	19.10	22.50
Mexico	2.86	1.89	4.24	0.32	0.36	0.12	8.84	5.21	35.00
Namibia	2.29	0.85	0.00	0.32	0.18	0.00	7.20	4.67	.
New Zealand	2.77	2.25	1.73	0.23	0.15	0.08	11.99	14.91	22.50
Norway	6.83	0.33	0.54	0.47	0.06	0.09	14.64	5.76	5.76
Pakistan	2.96	3.88	2.32	0.13	0.25	0.28	23.71	15.82	8.34
Papua New Guinea	3.20	2.28	0.00	0.19	0.17	0.00	16.89	13.40	.
Paraguay	0.00	2.45	0.00	0.00	0.06	0.00	.	41.67	.
Peru	4.14	3.93	8.07	0.19	0.18	0.39	21.91	22.25	20.85
Philippines	1.73	0.98	0.80	0.12	0.15	0.04	14.71	6.50	20.00
Portugal	2.33	2.13	2.24	0.23	0.28	0.26	9.97	7.58	8.63
Romania	5.06	4.29	3.27	0.16	0.15	0.16	32.04	28.59	20.72
Russia	7.35	3.41	3.19	0.22	0.22	0.24	33.79	15.68	13.41
South Africa	0.96	2.30	1.90	0.19	0.24	0.05	5.10	9.57	40.00
Spain	3.64	1.03	2.21	0.41	0.10	0.19	8.97	9.85	11.91
Sweden	1.66	2.02	2.58	0.79	0.11	0.14	2.09	17.86	18.90
Switzerland	0.75	0.29	1.22	0.12	0.02	0.17	6.27	13.27	7.33
Tanzania	4.47	1.26	0.67	0.24	0.08	0.07	18.62	15.50	10.00
Thailand	1.30	1.41	3.47	0.05	0.08	0.10	24.06	16.89	36.43
Turkey	2.61	3.80	3.60	0.19	0.13	0.21	13.86	28.50	16.81
United Kingdom	2.67	1.95	4.24	0.13	0.28	0.15	21.34	7.10	28.23
United States	3.15	1.17	.	0.21	0.17	.	15.16	6.92	.
Uruguay	0.00	1.99	1.81	0.00	0.12	0.18	.	16.90	9.93
Zambia	3.21	1.88	1.17	0.13	0.18	0.11	24.62	10.24	10.54

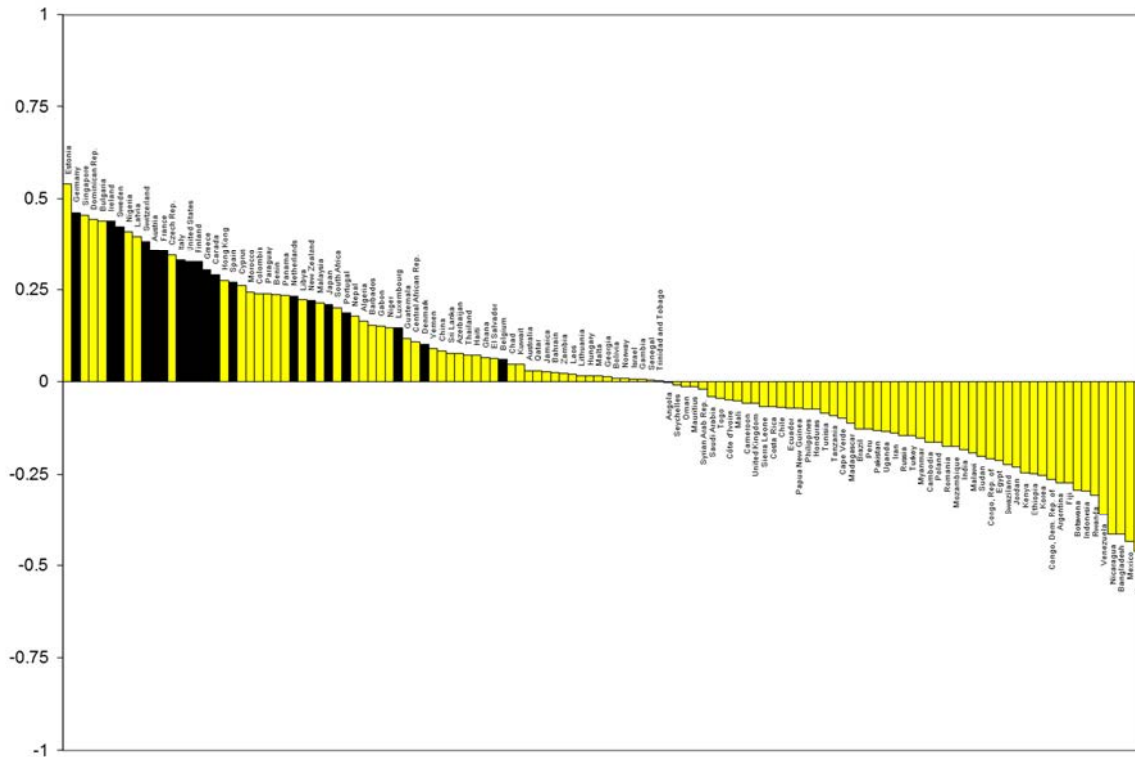
Notes: PIT, CIT and VAT stand for personal income tax, corporate income tax and value-added tax respectively. Total number of countries is 62. The value-added tax in Brazil is levied by states (for goods) and by municipalities (for services). The United States does not have a value-added tax. The sales tax in the United States is levied by states. Personal income tax rate corresponds to the highest marginal personal income tax rate. Value-added tax rate corresponds to standard value-added tax rate.

**Figure 1. Country correlations between the cyclical components of real government expenditure and real GDP.**



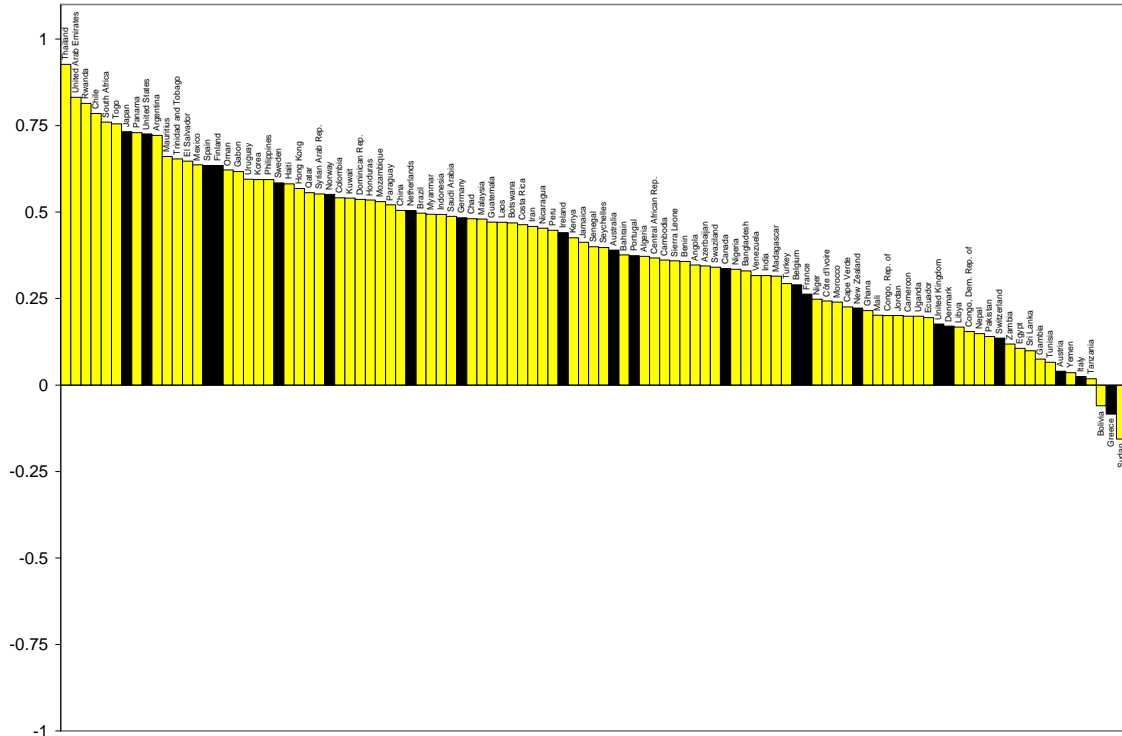
Notes: Dark bars denote industrial countries and light ones denote developing countries. The cyclical components have been estimated using the Hodrick-Prescott filter. Real government expenditure is defined as central government expenditure and net lending deflated by the GDP deflator. A positive (negative) correlation indicates procyclical (countercyclical) fiscal policy. Sample includes 94 countries for period 1960-2009. Source: Frankel, Vegh and Vuletin (2013).

**Figure 2. Country correlations between the cyclical components of the inflation tax and real GDP.**



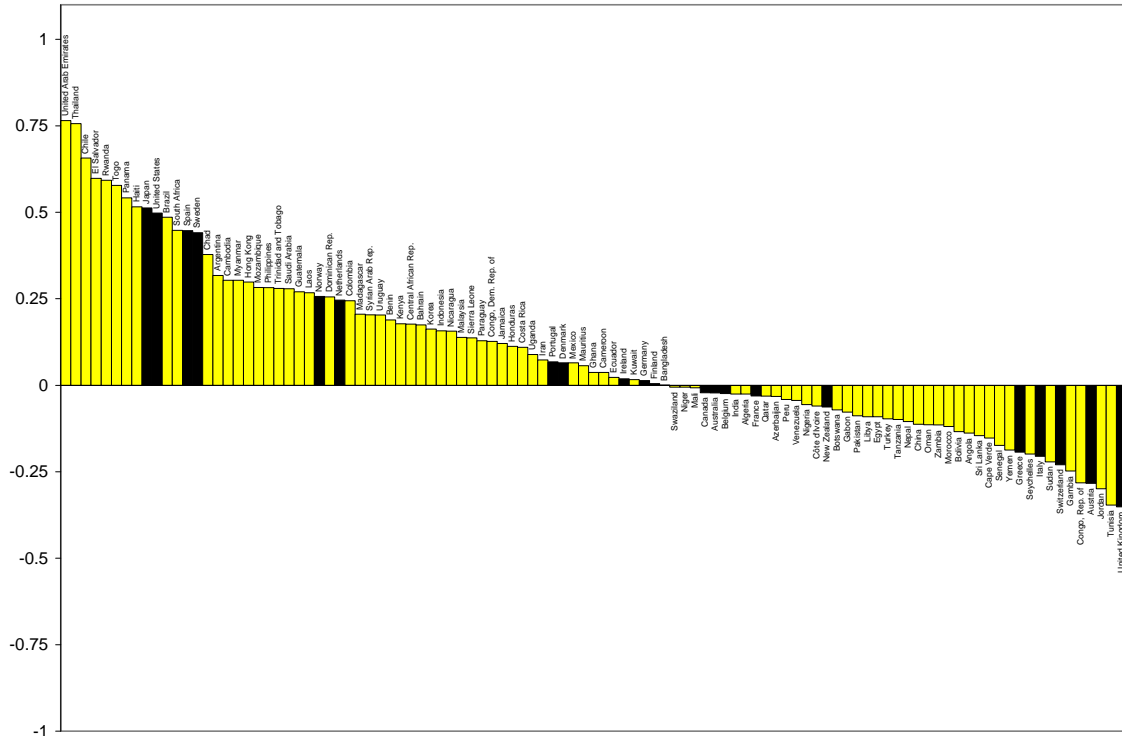
Notes: Dark bars denote industrial countries and light ones denote developing countries. The cyclical components have been estimated using the Hodrick-Prescott filter. Inflation tax is defined as  $(\pi/(1+\pi)) \times 100$ , where  $\pi$  is inflation rate. Sample includes 124 countries for the period 1960-2013.

**Figure 3. Country correlations between the cyclical components of the real government revenue and real GDP.**



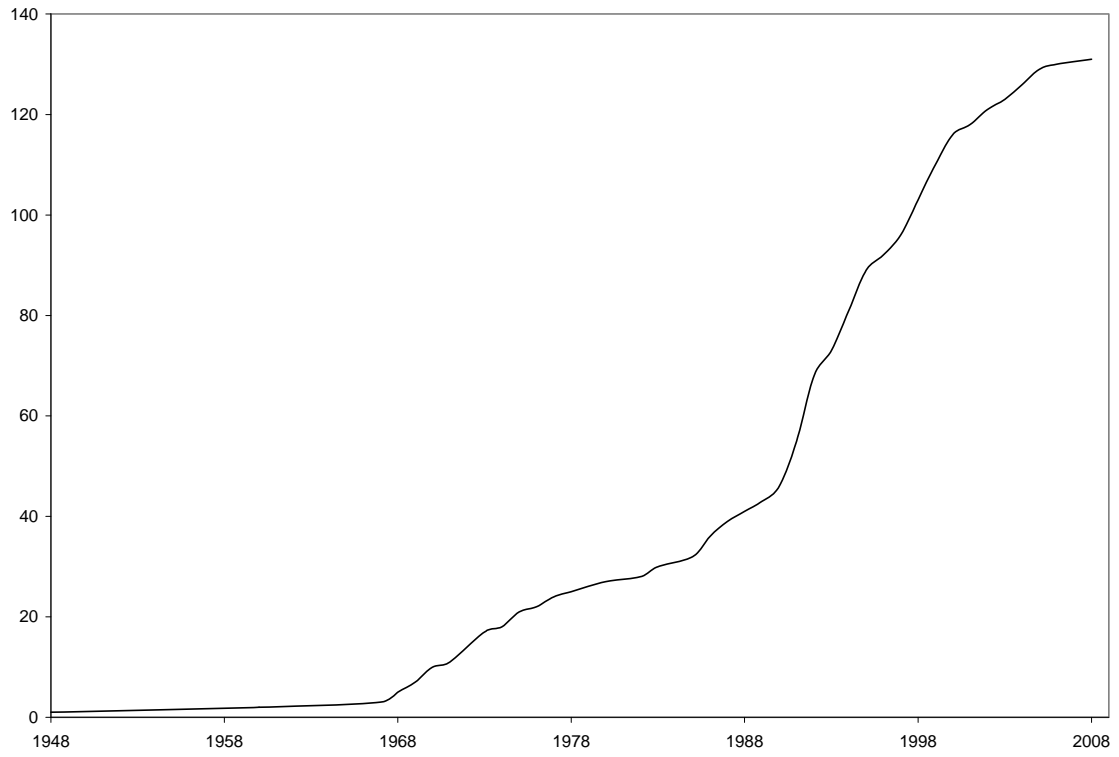
Notes: Dark bars denote industrial countries and light ones denote developing countries. The cyclical components have been estimated using the Hodrick-Prescott filter. Real government revenue is defined as central government total revenue and grants deflated by the GDP deflator. Sample includes 105 countries for the period 1960-2009.

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



Notes: Dark bars denote industrial countries and light ones denote 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 for the period 1960-2009.

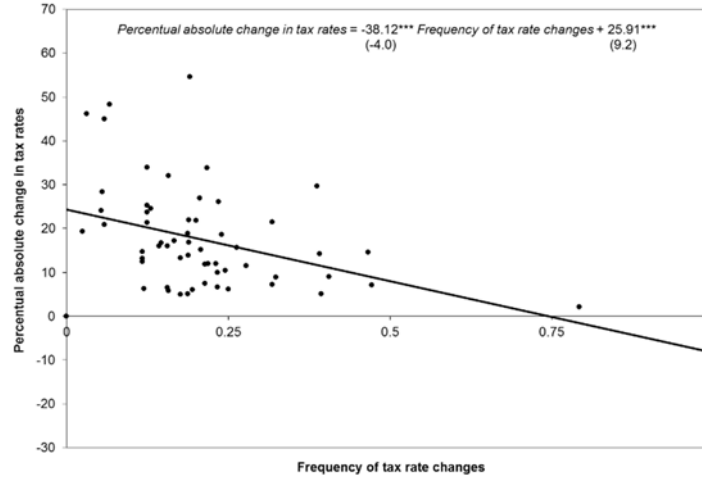
**Figure 5. Number of countries with value-added tax, 1948-2009**



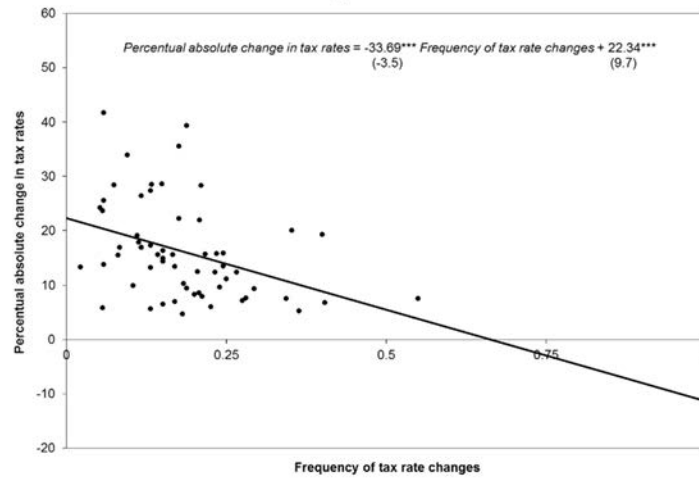
Sources: Oldman and Schenk (2007) and local sources.

**Figure 6. Country relationship between the frequency of tax rate changes and percentage absolute change in tax rates (without including zero changes), 1960-2013**

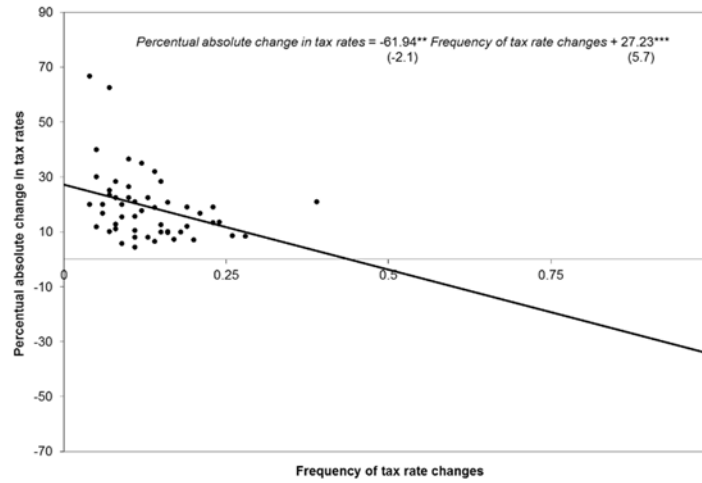
**Panel A. Personal income tax**



**Panel B. Corporate income tax**



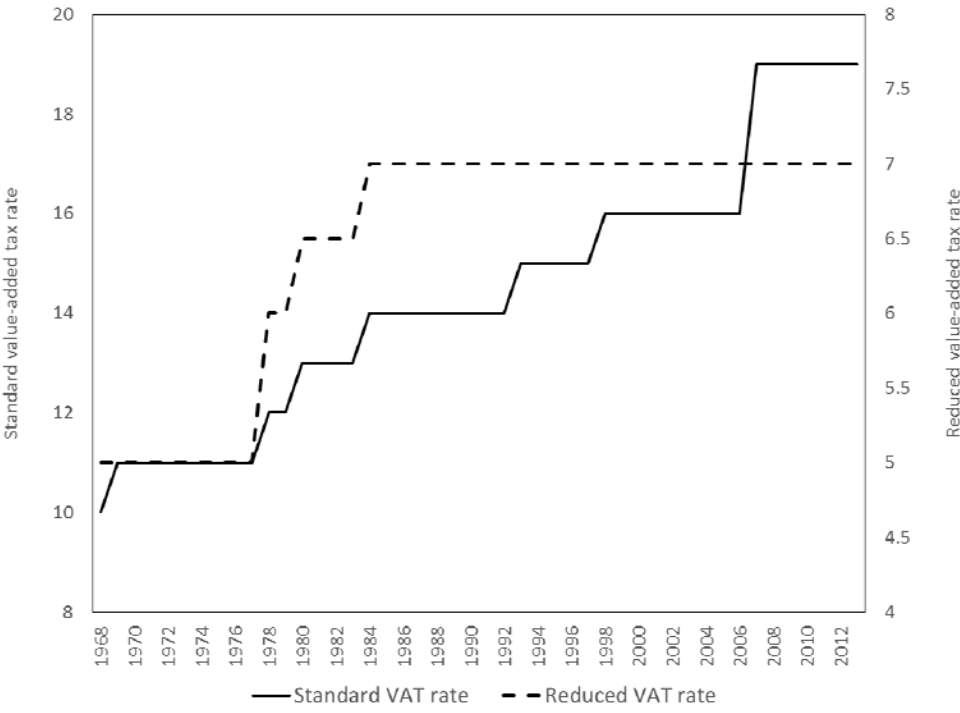
**Panel C. Value-added tax**



**Figure 7. Highest and average personal income tax rates for the United States, 1981-2008**

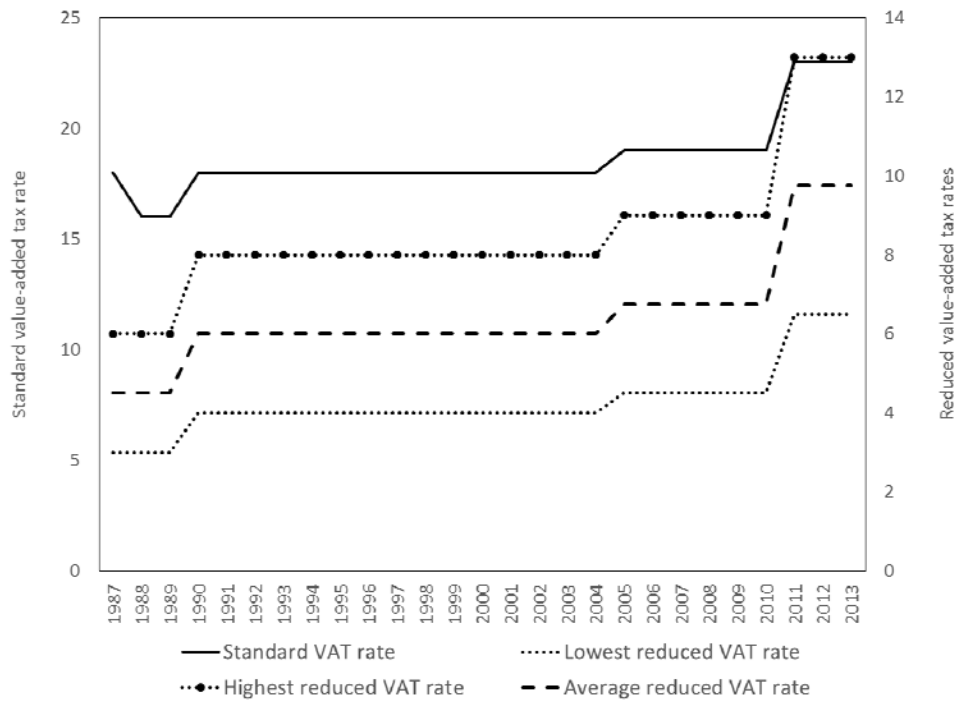


**Figure 8. Standard and reduced value-added tax rate for Germany, 1968-2013**



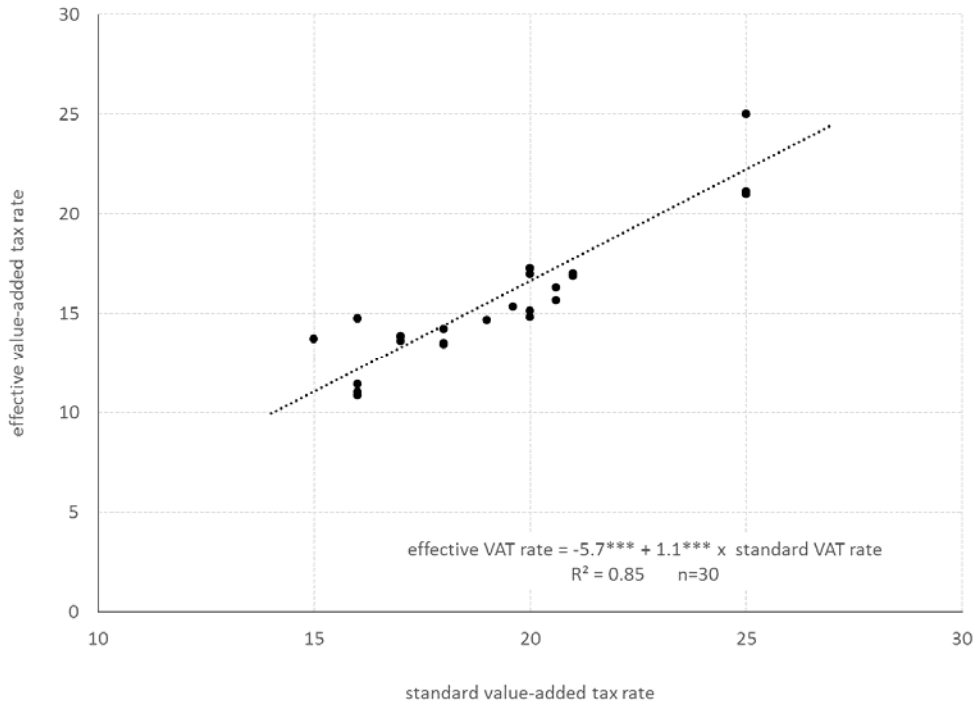


**Figure 9. Standard and reduced value-added tax rates for Greece, 1987-2013**

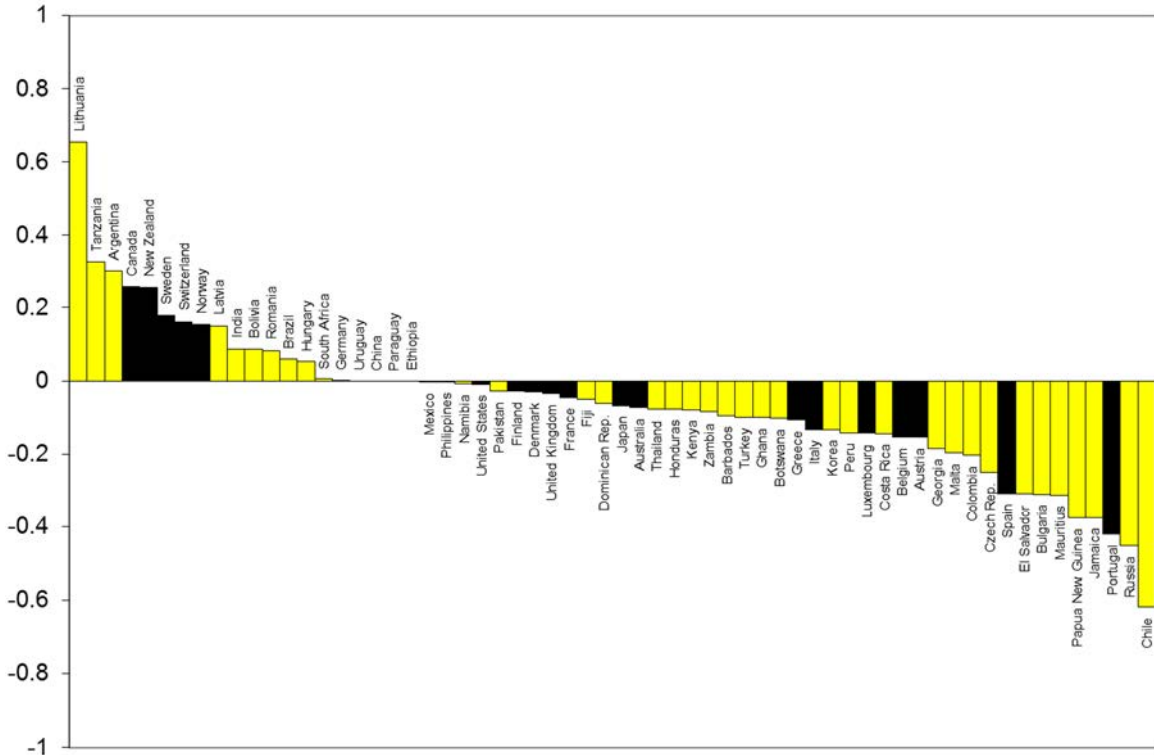


Note: Greece has two reduced value-added tax rates.

**Figure 10. Standard and effective value-added tax rates, 1996, 1998, 2000**

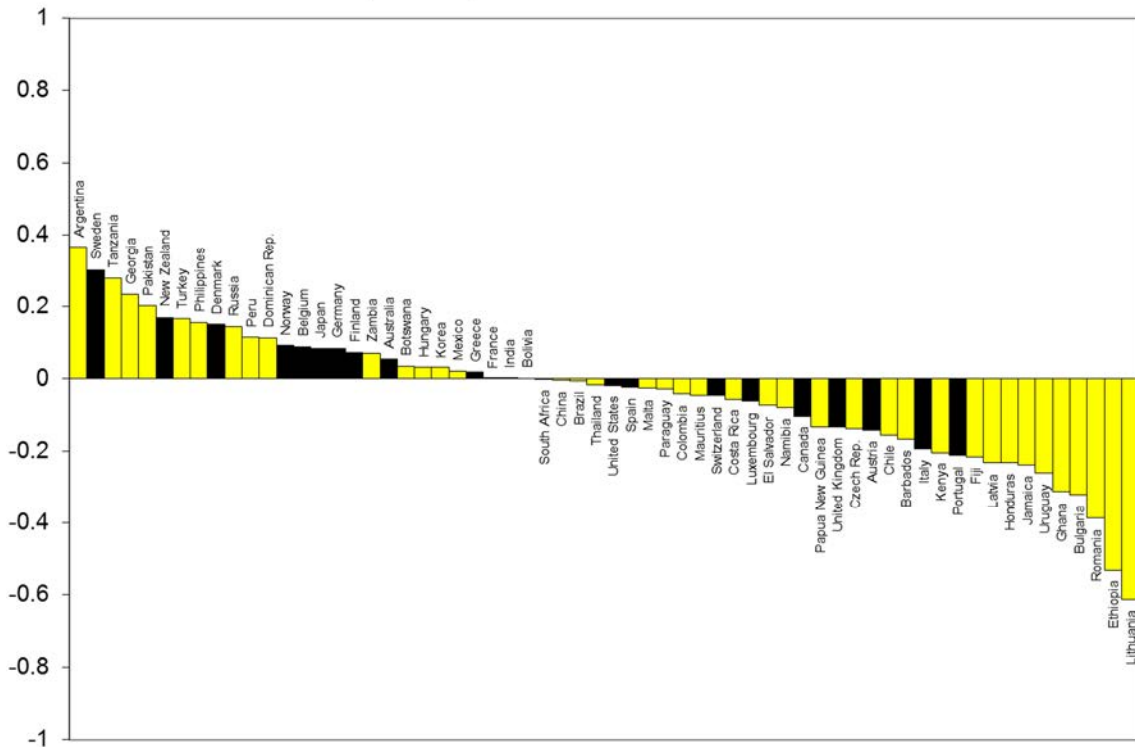


**Figure 11. Country correlations between the percentage changes of personal income tax rate and real GDP.**



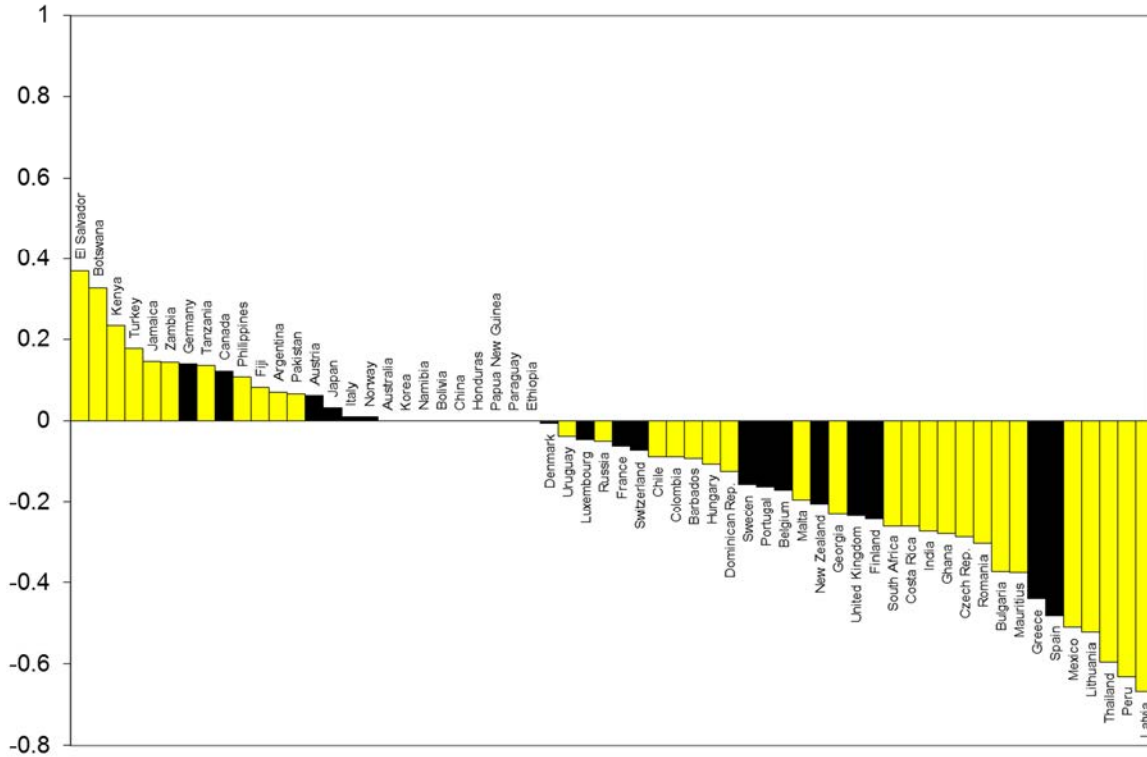
Notes: Dark bars denote industrial countries and light ones denote developing countries. Personal income tax rate corresponds to the highest marginal personal income tax rate. A negative (positive) correlation indicates procyclical (countercyclical) fiscal policy. Sample includes 62 countries for the period 1960-2013.

**Figure 12. Country correlations between the percentage changes of corporate income tax and real GDP.**



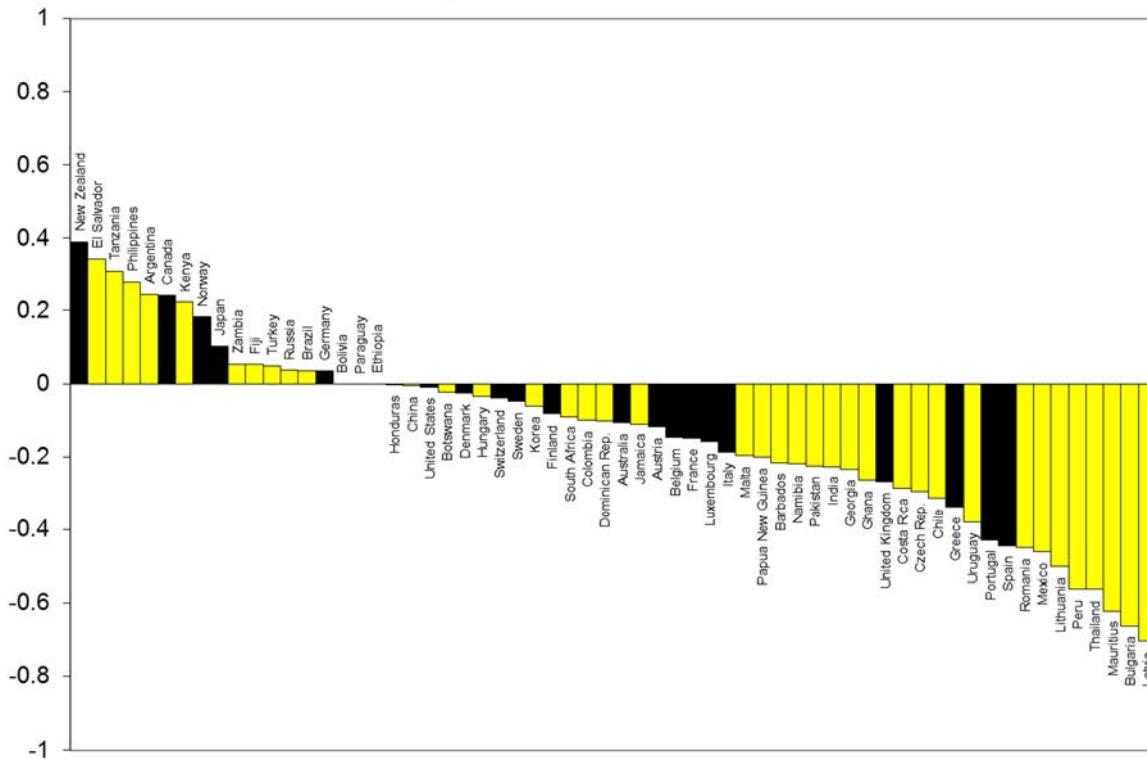
Notes: Dark bars denote industrial countries and light ones denote developing countries. A negative (positive) correlation indicates procyclical (countercyclical) fiscal policy. Sample includes 62 countries for the period 1960-2013.

**Figure 13. Country correlations between the percentage changes of value-added tax and real GDP.**



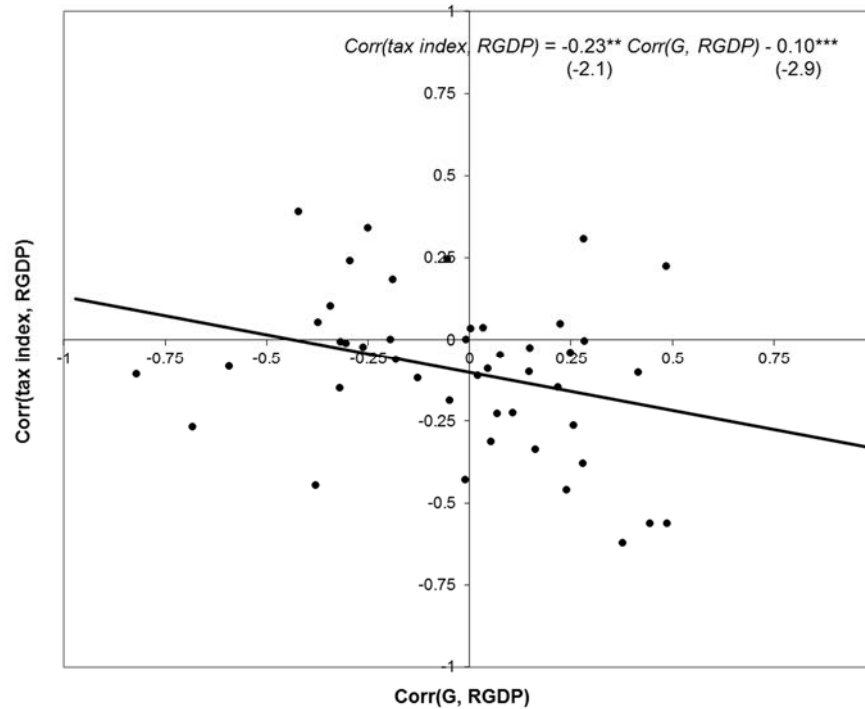
Notes: Dark bars denote industrial countries and light ones denote developing countries. Value-added tax rate corresponds to standard value-added tax rate. A negative (positive) correlation indicates procyclical (countercyclical) fiscal policy. Sample includes 60 countries for the period 1960-2013.

**Figure 14. Country correlations between the percentage changes of tax index and real GDP.**



Notes: Dark bars denote industrial countries and light ones denote developing countries. A negative (positive) correlation indicates procyclical (countercyclical) fiscal policy. Sample includes 62 countries for the period 1960-2013.

**Figure 15. Country relationship between the cyclicity of tax and government spending policies**



Notes: A positive (negative) Corr(tax index, RGDP) indicates countercyclical (procyclical) fiscal policy. A positive (negative) Corr(G, RGDP) indicates procyclical (countercyclical) fiscal policy. Sample includes 45 countries.

**TABLE 1**

**Cyclicity 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	14.86*** [4]	1.92 [0.4]	0.97*** [7.5]	1.50*** [16.7]	0.02 [0.2]	0.59*** [6.2]
Number of observations	1118	3841	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  $\pi$  is inflation rate. 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.

\*, \*\*, and \*\*\* indicate statistical significance at the 15%, 10%, 5% and 1% levels, respectively.

**TABLE 2****Direction of tax rates changes**

	Personal income tax		Corporate income tax		Value-added tax	
	Industrial	Developing	Industrial	Developing	Industrial	Developing
	(1)	(2)	(3)	(4)	(5)	(6)
Tax rate increases	79	36	44	85	65	68
Tax rate decreases	126	156	123	179	13	33
Total tax rate changes	205	192	167	264	78	101

Notes: Personal income tax rate corresponds to the highest marginal personal income tax rate. Value-added tax rate corresponds to standard value-added tax rate.

**TABLE 3****Frequency and magnitude of tax rate changes**

	Industrial	Developing	Difference $\equiv$ (1) - (2)
	(1)	(2)	(3)
<b>PANEL A: Frequency of tax rate changes</b>			
Personal income tax	0.28	0.16	0.12***
Corporate income tax	0.18	0.18	0.00
Value-added tax	0.12	0.12	0.00
<b>PANEL B: Percentual absolute change in tax rates. Including zero changes</b>			
Personal income tax	2.64	3.01	-0.37
Corporate income tax	1.87	2.85	-0.98***
Value-added tax	1.73	2.18	-0.45
<b>PANEL C: Percentual absolute change in tax rates. Without including zero changes</b>			
Personal income tax	9.52	18.40	-8.88***
Corporate income tax	10.62	16.07	-5.45***
Value-added tax	13.91	18.55	-4.64**

Notes: Personal income tax rate corresponds to the highest marginal personal income tax rate. Value-added tax rate corresponds to standard value-added tax rate. \*, \*\* and \*\*\* indicate statistical significance at the 10%, 5% and 1% levels, respectively.

**TABLE 4****Tax revenue structure: Tax burden and tax revenue composition**

	Industrial (1)	Developing (2)	Difference $\equiv$ (1) - (2) (3)
<b>PANEL A: Tax burden</b>			
Tax revenues (as % of GDP)	25.5	18.8	6.7***
<b>PANEL B: Tax revenue composition (as % of total tax revenues)</b>			
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***
1.2. 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.  
\*, \*\* and \*\*\* indicate statistical significance at the 10%, 5% and 1% levels, respectively.

**TABLE 5****Correlation between highest and average marginal personal income tax rates**

Country	Correlation
Australia	0.79***
Belgium	0.88***
Canada	0.99***
France	0.98***
Germany	0.44*
United Kingdom	0.83***
United States	0.84***

Notes: \*, \*\* and \*\*\* indicate statistical significance at the 10%, 5% and 1% levels, respectively.

**TABLE 6****Correlation between standard and average reduced value-added tax rates**

Country	Correlation
Austria	0.76***
Belgium	0.58***
France	-0.03
Germany	0.79***
Greece	0.98***
Italy	0.53***
Portugal	0.60***
Spain	0.03
Sweden	0.57***

Notes: \*, \*\* and \*\*\* indicate statistical significance at the 10%, 5% and 1% levels, respectively.

**TABLE 7****Percentage tax rate changes across different stances of the business cycle**

	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)
Good times	-0.54	-0.59	-0.20	0.07	-0.97	-0.56	-0.54	-0.34
Normal times	0.49	0.26	0.11	-0.41	0.33	-0.24	0.39	-0.15
Bad times	-0.53	0.47	-0.19	0.86	0.28	0.98	-0.32	0.56

Notes: Percentage tax rate changes 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 8****Cyclical policy of tax policy: Panel regressions. Dependent variable is percentage change in tax rate**

	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)
Percentage change in RGDP	-0.09 [-0.6]	-0.19*** [-2.6]	0.06 [0.9]	-0.11** [-2.0]	-0.27** [-2.4]	-0.46*** [-6.5]	-0.16 [-1.6]	-0.28*** [-5.2]
Number of observations	740	1147	922	1441	629	853	618	781
Number of countries	20	42	20	42	19	41	20	42

Notes: Estimations are performed using country fixed-effects. t-statistics are in square brackets. Constant term is not reported. \*, \*\*, \*\*\* indicate statistical significance at the 15%, 10%, 5% and 1% levels, respectively.

**TABLE 9****Cyclicity of tax policy: Instrumental variable panel regressions. Dependent variable is percentage change in tax rate**

	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)
Percentage change in RGDP	0.17 [0.6]	-0.02 [-0.1]	0.04 [0.3]	-0.39* [-1.8]	0.11 [1.4]	-0.28** [-2.4]	0.13 [1.0]	-0.22*** [-3.1]
<b>STATISTICS</b>								
Over-identification test (p-value)	0.61	0.14	0.99	0.17	0.68	0.20	0.42	0.09
Weak-identification test (F-statistic)	21.0***	14.2***	21.0***	14.2***	21.0***	14.2***	21.0***	14.2***
Number of observations	522	702	522	702	522	702	522	702
Number of countries	19	39	19	39	19	39	19	39

Notes: The excluded instruments are ShockPX and ShockJP. Errors are allowed to present arbitrary heteroskedasticity and arbitrary intra-country correlation (i.e., clustered by country). t-statistics are in square brackets. Constant term and global interest rate 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 weak-identification test is the F-statistic of the excluded instruments test. \*, \*\*, \*\* and \*\*\* indicate statistical significance at the 15%, 10%, 5% and 1% levels, respectively.

**TABLE 10****Cyclicity of tax policy: Panel regressions using alternative tax rate measures****PANEL A: Dependent variables are percentage change in highest and average marginal personal income tax rates**

	Basic panel regressions		Instrumental variable panel regressions	
	(1)	(2)	(3)	(4)
	highest rate	AMITR	highest rate	AMITR
Percentage change in RGDP	-0.28 [-0.9]	-0.11 [-0.9]	-0.44 [-0.4]	-0.23 [-0.5]
<b>STATISTICS</b>				
Over-identification test (p-value)			0.23	0.11
Weak-identification test (F-statistic)			5.6*	5.6*
Number of observations	100	100	96	96
Number of countries	6	6	6	6



**TABLE 10 cont.**

**Cyclicality of tax policy: Panel regressions using alternative tax rate measures**

**PANEL B: Dependent variables are percentage change in standard and average reduce value-added tax rates**

	Basic panel regressions		Instrumental variable panel regressions	
	(1)	(2)	(3)	(4)
	standard rate	av. reduce rate	standard rate	av. reduce rate
Percentage change in RGDP	-0.35*** [-2.8]	-0.04* [-1.7]	0.04 [0.31]	0.002 [0.05]
<b>STATISTICS</b>				
Over-identification test (p-value)			0.75	0.27
Weak-identification test (F-statistic)			15.2***	15.2***
Number of observations	315	315	293	293
Number of countries	9	9	9	9

**PANEL C: Dependent variables are percentage change in standard and effective value-added tax rates**

	Basic regressions		Instrumental variable regressions	
	(1)	(2)	(3)	(4)
	standard rate	effective rate	standard rate	effective rate
Percentage change in RGDP	-0.67** [-2.8]	-0.41 <sup>†</sup> [-1.3]	0.09 [0.1]	0.72 [0.3]
<b>STATISTICS</b>				
Over-identification test (p-value)			0.38	0.14
Weak-identification test (F-statistic)			0.4	1.7 <sup>†</sup>
Number of observations	20	20	20	20
Number of countries	10	10	10	10

Notes: AMITR stands for average marginal personal income tax rate. The excluded instruments are ShockPX and ShockJP. Errors are allowed to present arbitrary heteroskedasticity and arbitrary intra-country correlation (i.e., clustered by country). t-statistics are in square brackets. Constant term and global interest rate 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 weak-identification test is the F-statistic of the excluded instruments test. <sup>†</sup>, \*, \*\*, \*\*\* indicate statistical significance at the 25%, 15%, 10%, 5% and 1% levels, respectively.

**TABLE 11****Determinants of tax policy cyclical: Instrumental variable panel regressions**  
**Dependent variable is percentage change in tax index**

	(1)	(2)	(3)	(4)
Percentage change in RGDP	-0.32 [-0.9]	-1.18* [-1.9]	-1.94* [-1.9]	-0.95* [-1.5]
Percentage change in RGDP × Institutional quality		1.16* [1.6]		
Percentage change in RGDP × <i>de jure</i> financial integration			0.42* [1.7]	
Percentage change in RGDP × <i>de facto</i> financial integration				0.24* [1.6]
<b>STATISTICS</b>				
Over-identification test (p-value)	0.07	0.21	0.66	0.06
Weak-identification test (F-statistic)	3.6**	2.4*	2.4*	5.6***
Number of observations	833	833	833	833
Number of countries	52	52	52	52

The excluded instruments are ShockPX and ShockJP. Errors are allowed to present arbitrary heteroskedasticity and arbitrary intra-country correlation (i.e., clustered by country). t-statistics are in square brackets. Constant term, institutional quality, *de jure* and *de facto* financial integration, and global interest rate 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 weak-identification test is the F-statistic of the Anderson-Rubin Wald test. \*, \*\*, \*\*\* and \*\*\*\* indicate statistical significance at the 15%, 10%, 5% and 1% levels, respectively