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 cyclicality 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. 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 hypothesis have been put forth in the literature to explain the procyclical behavior of government spending in developing countries, ranging from limited access to international credit markets (Riascos and Vegh, 2003, Cuadra, Sanchez, and Sapriza, 2010) 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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1 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.  

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 typically 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

\footnote{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 cyclicality of tax policy. 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 suggests 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 cyclicality of tax policy since positively-related tax revenues are

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3 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.\footnote{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).} 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 cyclicality 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 cyclicality of tax policy based on the use of policy instruments as opposed to tax revenues (or tax-revenue-based measures). To this end, we 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
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 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 no be a good proxy for the personal income tax policy (ideally measured using the average marginal personal income tax rate). To address these valid concerns, we also use, for a subset of countries, reduced value-added tax rates, effective value-added tax rates (i.e., average VAT taxes 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 answer.

Using this novel tax rate data, we compute the degree of cyclicality 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.\textsuperscript{5}

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 cyclicality of tax policy using alternative statistical and econometric methods, addressing endogeneity concerns, and using

\textsuperscript{5}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 cyclicity 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 1960-2013.6,7,8

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.9 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

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6See 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.

7Corporate 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.

8The website http://www.guillermovuletin.com/ provides a detailed list of the sample period for every country, the specific source, and the dataset.

9Appendix 3 reports the year in which the value-added tax was introduced in each country included in our study.
value-added and average marginal personal income tax rates, respectively.\textsuperscript{10,11}

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.

\textsuperscript{10}The data on reduced value-added tax rates covers Austria, Belgium, France, Germany, Greece, Italy, Portugal, Spain, and Sweden.

\textsuperscript{11}We would like to thank Ethan Ilzetzki for sharing his average marginal personal income tax rates dataset. The data covers Australia, Belgium, Canada, France, Germany, United Kingdom, and United States.
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. While changes in government spending take place continuously throughout the budget cycle, changes in tax 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.

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

\footnote{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).}

\footnote{See Appendix 4, Table 4A, columns 1-3 for the corresponding country statistics.}
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-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 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. The tax burden, defined as government 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.\footnote{See Appendix 4, Table 3A, column 1 for the corresponding country statistics.} 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 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).\footnote{See Appendix 4, Table 3A, columns 2-6 for individual country statistics.}

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, thresholds, etc.) 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).\footnote{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.}

To address these concerns, we will also use in our analysis below (i) 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 our 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 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 9 economies for which we have data on reduced value-added tax rates for at least 20 years. 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.

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

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17 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.

18 We should also note that reduced tax rates typically apply to particular goods, such as some food categories and child and elderly care.
each value-added statutory tax rate with its corresponding share of transactions (as a percentage of taxable base).\textsuperscript{19} Formally – and following Mathis (2004) – we compute the effective value-added tax rate as

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\text{effective value-added tax rate}_{it} = \sum_{j} w^j_{it} \times VAT^j_{it},
\]

where \( w^j \) denotes the share of transactions associated with tax rate \( j \) as a percentage of taxable base (i.e., \( \sum_{j} w^j_{it} = 1 \)) and \( VAT^j \) is the value-added tax rate \( j \).\textsuperscript{20} 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.\textsuperscript{21} 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.\textsuperscript{22}

While the raw data is not shown for brevity (see Tables A1, A2, A3, A4, A5 in Mathis (2004) for details) two basic empirical regularities are worth noting. First, for the 10 countries included in this sub-section, 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.

\textsuperscript{19}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 the potential tax base); see European Commission (2011, 2012, and 2013).

\textsuperscript{20}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.

\textsuperscript{21}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.

\textsuperscript{22}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.
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 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 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.\footnote{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).}

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

$$\Delta \text{tax index}_{it} = w_i^{PIT} \times \Delta PIT_{it} + w_i^{CIT} \times \Delta CIT_{it} + w_i^{VAT} \times \Delta VAT_{it},$$  \hspace{1cm} (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 $w_i^{VAT}$ 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.$^{24}$

4 Cyclicality of tax policy

This section presents our main findings on the cyclicality of tax policy. To this end, we use several statistical and econometric methods including 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.$^{25}$

4.1 Preliminary analysis

We start by performing a preliminary analysis of the cyclicality 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. While industrial countries reduce personal income tax rates both in good and bad times, developing economies sharply decrease them in good times. This suggests that personal income tax policy is acyclical in industrial countries and procyclical in developing ones. Corporate income tax rates also fall both in good and bad times in industrial countries, but increase in bad times in developing economies, which suggests that corporate income tax policy is acyclical in industrial countries and procyclical in developing ones. Value-added tax

$^{24}$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.

$^{25}$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.
rates decrease in good times in industrial countries and increase in bad times in developing economies. Therefore, both industrial and developing countries appear to be procyclical. The tax index, as defined in equation (1), decreases both in good and bad times in industrial countries. On the other hand, the tax index falls in good times and increases in bad times in developing economies. Tax policy thus appears to be acyclical in industrial countries and procyclical in developing countries.

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 cyclicality 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 cyclicality 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 cyclicality 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 countercyclicality 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), acycicality 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, acyclic 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 cyclical 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 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):

\[ Shock_{JP_i} = \frac{X_i}{GDP_i} \sum_j \phi_{ij,t-1} RGDPR_{j,t}, \]  

(2)

where \(RGDPR_j\) 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.\(^{26}\) The index \(Shock_{JP_i}\) 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; Ilzetzki and Vegh, 2008). The effective change of prices of exports is measured as follows:

\[ Shock_{PX_i} = \frac{X_i}{GDP_i} PXGR_{it}, \]  

(3)

where \(PXGR_i\) measures price of exports growth rate in country \(i\). The variable \(Shock_{PX_i}\) thus attempts to capture the effective change of prices of exports.\(^{27}\) Lastly, we use an instrument proposed by Ilzetzki and Vegh (2008) who suggest using the change of real returns on U.S. Treasury bills to capture global liquidity conditions.\(^{28}\)

\(^{26}\)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.”

\(^{27}\)When using \(Shock_{JP_i}\) (see equation (2)), Ilzetzki 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 \(Shock_{PX_i}\).

\(^{28}\)Since global liquidity conditions may also have direct effects on governments’ fiscal decisions, we include
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 dependent variables and regressors.

Table 9 shows instrumental variables panel regressions. 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 5 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, columns 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, columns 2).

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

\footnote{In order to make appropriate comparisons, we only use observations for which we have data for all tax rates.}
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.

### 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 variations in the 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.

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.

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 10, panel A).

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30 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.

31 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 7 (Table 5) to 6 countries (Table 10, panel A).
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 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 really 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 Cyclicality of spending and tax policies

Up to now, we have focused our analysis on the cyclicality 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 cyclicality of tax policy and that of spending. In particular, we would like to know whether there exists a link between the cyclicality of spending and tax policies over the business cycle.

Figure 15 shows the country relationship between the cyclicality of tax (y-axis) and gov-
ernment spending policies (x-axis).\textsuperscript{32} While far from perfect, Figure 15 indeed supports the idea that countries with more procyclical spending policy (i.e., more positive values of Corr(G, RGDP)) typically have more procyclical tax policy (i.e., more negative values of Corr(tax index, RGDP)) and viceversa. In other words, tax and spending policies are typically conducted in a symmetric way over the business cycle.\textsuperscript{33}

6 Determinants of tax policy cyclicality

While the existing literature on the cyclicality of government spending typically distinguishes between industrial and developing countries, our findings suggest that “deeper” factors may be at the heart of the matter 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 cyclicality 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 underling theories regarding the determination of fiscal cyclicality, 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).\textsuperscript{34} The institutional quality index ranges between 0 (lowest institutional quality) and

\textsuperscript{32}We use the tax index as a proxy for tax policy.

\textsuperscript{33}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.

\textsuperscript{34}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.
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).

Table 11 shows instrumental variable panel regressions only for data points for which we have both institutional quality and financial integration data. Column 1 shows that, on average, tax policy is acyclical. Table 11, 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. 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.

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 hinder the 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.

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.

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.

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

When all three interaction terms are included together, the significance disappears due to high multicollinearity.
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 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.

References


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.

**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)**

**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.

**Institutional quality**
International Country Risk Guide (ICRG) was the source of data. Institutional quality is a normalized index that ranges between 0 (lowest institutional quality) and 1 (highest institutional quality). The index was calculated by the authors as the average of four components: investment profile, corruption, law and order, bureaucracy quality. Data period covers 1984-2008.

**Capital account openness**
Capital account openness using the Chinn-Ito index (KAOPEN) de jure measure of f restrictions on cross-border financial transaction.

**Foreign assets and liabilities**
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
Appendix 2. Countries in the tax rate sample

<table>
<thead>
<tr>
<th>Industrial countries (20)</th>
<th>Developing countries (42)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>Argentina</td>
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<tr>
<td>Austria</td>
<td>Barbados</td>
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<tr>
<td>Belgium</td>
<td>Bolivia</td>
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<tr>
<td>Canada</td>
<td>Botswana</td>
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<td>Denmark</td>
<td>Brazil</td>
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<td>Finland</td>
<td>Bulgaria</td>
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<td>France</td>
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<td>Hungary</td>
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<td>United States</td>
<td>India</td>
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<td></td>
<td>Jamaica</td>
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</tbody>
</table>

Note: Total number of countries is 62.
### Appendix 3. Tax period coverage

#### TABLE 2A

<table>
<thead>
<tr>
<th>Country</th>
<th>Corporate income tax rate</th>
<th>Personal income tax rate</th>
<th>Value-added tax rate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Period of coverage</td>
<td>Period of coverage</td>
<td>Year of introduction</td>
</tr>
<tr>
<td>Brazil</td>
<td>1979-2013</td>
<td>1974-2013</td>
<td></td>
</tr>
<tr>
<td>Chile</td>
<td>1979-2013</td>
<td>1974-2013</td>
<td>1975</td>
</tr>
<tr>
<td>France</td>
<td>1960-2013</td>
<td>1960-2013</td>
<td>1948</td>
</tr>
</tbody>
</table>
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

<table>
<thead>
<tr>
<th>Revenues (as % of GDP)</th>
<th>Tax revenue on income, profits, and corporations (as % of total tax revenues)</th>
<th>Personal income tax revenues (as % of total tax revenues)</th>
<th>Corporate income tax revenues (as % of total tax revenues)</th>
<th>Good and services tax revenues (as % of total tax revenues)</th>
<th>Value-added tax revenues (as % of total tax revenues)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Argentina</td>
<td>15.50</td>
<td>21.44</td>
<td>6.73</td>
<td>14.70</td>
<td>61.88</td>
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<td>Australia</td>
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<td>72.87</td>
<td>44.06</td>
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Tax revenue structure: Country tax burden and tax revenue composition

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<td>11.44</td>
<td>55.45</td>
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<td>15.85</td>
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<td>34.17</td>
<td>9.29</td>
<td>43.96</td>
<td>29.71</td>
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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.

| Table 4A: Tax rate data: Country characteristics |
|-------------------------------|------------------|-----------------|-----------------|
| Percentual absolute change in tax rates. Including zero changes |
| PIT | CIT | VAT |
| PIT | CIT | VAT |
| (1) | (2) | (3) |
| (4) | (5) | (6) |
| Argentina | 1.55 | 3.10 | 4.37 |
| Australia | 0.88 | 1.77 | 0.00 |
| Austria | 0.48 | 2.13 | 0.59 |
| Barbados | 1.46 | 1.75 | 1.04 |
| Belgium | 1.02 | 2.17 | 0.94 |
| Bolivia | 3.22 | 0.00 | 0.00 |
| Botswana | 2.29 | 3.61 | 1.82 |
| Brazil | 5.54 | 0.81 | 0.00 |
| Bulgaria | 6.13 | 7.71 | 1.65 |
| Canada | 1.54 | 2.59 | 1.41 |
| Chile | 1.54 | 7.08 | 1.00 |
| China | 0.00 | 1.28 | 0.00 |
| Colombia | 2.50 | 27.3 | 2.36 |
| Costa Rica | 2.65 | 1.50 | 4.46 |
| Czech Rep. | 6.82 | 4.12 | 1.41 |
| Denmark | 11.48 | 2.78 | 2.28 |
| Dominican Rep. | 3.54 | 3.71 | 4.56 |
| El Salvador | 1.57 | 19.9 | 1.43 |
| Ethiopia | 0.00 | 2.60 | 0.00 |
| Fiji | 2.35 | 1.77 | 2.14 |
| Finland | 3.39 | 3.31 | 0.49 |
| France | 2.55 | 0.74 | 1.57 |
| Georgia | 10.40 | 3.23 | 2.52 |
| Germany | 0.92 | 2.47 | 1.50 |
| Ghana | 3.17 | 2.87 | 1.67 |
| Greece | 2.62 | 3.30 | 1.93 |
| Honduras | 1.23 | 6.26 | 0.00 |
| Hungary | 5.55 | 4.58 | 2.12 |
| India | 2.86 | 2.71 | 1.00 |
| Italy | 1.18 | 2.54 | 1.49 |
| Jamaica | 4.24 | 2.29 | 3.04 |
| Japan | 2.45 | 1.35 | 2.78 |
| Kenya | 2.55 | 7.42 | 0.85 |
| Korea | 1.60 | 1.67 | 0.00 |
| Latvia | 3.19 | 2.22 | 3.62 |
| Lithuania | 4.14 | 5.95 | 0.85 |
| Luxembourg | 1.99 | 1.66 | 1.63 |
| Malta | 1.44 | 1.34 | 1.11 |
| Mauritius | 4.37 | 2.12 | 3.00 |
| Mexico | 2.86 | 1.89 | 4.24 |
| Namibia | 2.29 | 0.85 | 0.00 |
| New Zealand | 2.77 | 2.25 | 1.73 |
| Norway | 6.83 | 0.03 | 0.54 |
| Pakistan | 2.96 | 3.88 | 2.32 |
| Papua New Guinea | 3.20 | 2.28 | 0.00 |
| Paraguay | 0.00 | 2.45 | 0.00 |
| Peru | 4.14 | 3.93 | 8.07 |
| Philippines | 1.73 | 0.98 | 0.80 |
| Portugal | 2.33 | 2.13 | 2.24 |
| Romania | 5.06 | 4.29 | 3.27 |
| Russia | 7.35 | 3.41 | 3.19 |
| South Africa | 0.96 | 2.30 | 1.90 |
| Spain | 3.64 | 1.03 | 2.21 |
| Sweden | 1.66 | 2.02 | 2.58 |
| Switzerland | 0.75 | 0.29 | 1.22 |
| Tanzania | 4.47 | 1.26 | 0.67 |
| Thailand | 1.30 | 1.41 | 3.47 |
| Turkey | 2.61 | 3.80 | 3.60 |
| United Kingdom | 2.67 | 1.95 | 4.24 |
| United States | 3.15 | 1.17 | 0.00 |
| Uruguay | 0.00 | 1.99 | 1.81 |
| Zambia | 3.21 | 1.88 | 1.17 |

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.
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.

### TABLE 5A
Tax rate data: Country characteristics

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<tr>
<th>Country</th>
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<th>CIT</th>
<th>VAT</th>
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<td>10.54</td>
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</table>

Percentual absolute change in tax rates. Without including zero changes.
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 $\frac{\pi}{1+\pi}\times100$, 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

![Graph showing standard and reduced VAT 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

![Graph showing relationship between standard and effective VAT rates]

effective VAT rate = -5.7\,*** + 1.1\,*** \times \text{standard VAT rate}

$R^2 = 0.85 \quad n=30$
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 cyclicality of tax and government spending policies

\[ \text{Corr(tax index, RGDP)} = -0.23^{**} \text{ Corr}(G, \text{RGDP}) - 0.10^{***} \]

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

<table>
<thead>
<tr>
<th></th>
<th>Inflation tax</th>
<th>Revenues</th>
<th>Revenues/GDP</th>
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</thead>
<tbody>
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<td></td>
<td>Industrial</td>
<td>Developing</td>
<td>Industrial</td>
</tr>
<tr>
<td>RGDP cycle</td>
<td>14.86^{***}</td>
<td>1.92</td>
<td>0.97^{***}</td>
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<tr>
<td>[3.7]</td>
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<td>[7.5]</td>
<td>[16.7]</td>
</tr>
<tr>
<td>Number of observations</td>
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<td>3841</td>
<td>901</td>
</tr>
<tr>
<td>Number of countries</td>
<td>22</td>
<td>86</td>
<td>21</td>
</tr>
</tbody>
</table>

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.

* Significant at the 10 percent level.
** Significant at the 5 percent level.
*** Significant at the 1 percent level.
### TABLE 2
Direction of tax rates changes

<table>
<thead>
<tr>
<th>Tax rate increases</th>
<th>Personal income tax</th>
<th>Corporate income tax</th>
<th>Value-added tax</th>
</tr>
</thead>
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<tr>
<td></td>
<td>Industrial (1)</td>
<td>Developing (2)</td>
<td>Industrial (3)</td>
</tr>
<tr>
<td></td>
<td>79</td>
<td>34</td>
<td>44</td>
</tr>
<tr>
<td></td>
<td>126</td>
<td>156</td>
<td>123</td>
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<tr>
<td>Total tax rate changes</td>
<td>205</td>
<td>190</td>
<td>167</td>
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</table>

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

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<td>(3)</td>
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<td>Personal income tax</td>
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<td>Corporate income tax</td>
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<tr>
<td>Value-added tax</td>
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<td>0.11</td>
</tr>
</tbody>
</table>

**PANEL A: Frequency of tax rate changes**

**PANEL B: Percentual absolute change in tax rates. Including zero changes**

| Personal income tax | 2.64 | 3.01 | -0.37 |
| Corporate income tax | 1.87 | 2.85 | -0.98*** |
| Value-added tax | 1.58 | 2.04 | -0.46 |

**PANEL C: Percentual absolute change in tax rates. Without including zero changes**

| 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.

* Significant at the 10 percent level.
** Significant at the 5 percent level.
*** Significant at the 1 percent level.
<table>
<thead>
<tr>
<th>TABLE 4</th>
</tr>
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<tbody>
<tr>
<td><strong>Tax revenue structure: Tax burden and tax revenue composition</strong></td>
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</table>

<table>
<thead>
<tr>
<th></th>
<th>Industrial (1)</th>
<th>Developing (2)</th>
<th>Difference ≡ (1) - (2)</th>
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</thead>
<tbody>
<tr>
<td><strong>PANEL A: Tax burden</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tax revenues (as % of GDP)</td>
<td>25.5</td>
<td>18.8</td>
<td>6.7***</td>
</tr>
<tr>
<td><strong>PANEL B: Tax revenue composition (as % of total tax revenues)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Tax revenue on income, profits, and corporations</td>
<td>50.1</td>
<td>31.0</td>
<td>19.1***</td>
</tr>
<tr>
<td>1.1. Personal income tax revenues</td>
<td>35.4</td>
<td>12.6</td>
<td>22.8***</td>
</tr>
<tr>
<td>1.2. Corporate income tax revenues</td>
<td>14.4</td>
<td>16.3</td>
<td>-1.9***</td>
</tr>
<tr>
<td>2. Good and services tax revenues</td>
<td>44.2</td>
<td>46.5</td>
<td>-2.3**</td>
</tr>
<tr>
<td>2.1. Value-added tax revenues</td>
<td>28.8</td>
<td>31.6</td>
<td>-2.8***</td>
</tr>
<tr>
<td>3. Others</td>
<td>5.7</td>
<td>22.5</td>
<td>-16.8***</td>
</tr>
</tbody>
</table>

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.
* Significant at the 10 percent level.
** Significant at the 5 percent level.
*** Significant at the 1 percent level.

<table>
<thead>
<tr>
<th>TABLE 5</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Correlation between highest and average marginal personal income tax rates</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Country</th>
<th>Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>0.79***</td>
</tr>
<tr>
<td>Belgium</td>
<td>0.88***</td>
</tr>
<tr>
<td>Canada</td>
<td>0.99***</td>
</tr>
<tr>
<td>France</td>
<td>0.97***</td>
</tr>
<tr>
<td>Germany</td>
<td>0.44*</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>0.83***</td>
</tr>
<tr>
<td>United States</td>
<td>0.88***</td>
</tr>
</tbody>
</table>

Notes:
* Significant at the 10 percent level.
** Significant at the 5 percent level.
*** Significant at the 1 percent level.
### TABLE 6

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

<table>
<thead>
<tr>
<th>Country</th>
<th>Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>0.76***</td>
</tr>
<tr>
<td>Belgium</td>
<td>0.58***</td>
</tr>
<tr>
<td>France</td>
<td>-0.03</td>
</tr>
<tr>
<td>Germany</td>
<td>0.79***</td>
</tr>
<tr>
<td>Greece</td>
<td>0.98***</td>
</tr>
<tr>
<td>Italy</td>
<td>0.53***</td>
</tr>
<tr>
<td>Portugal</td>
<td>0.60***</td>
</tr>
<tr>
<td>Spain</td>
<td>0.03</td>
</tr>
<tr>
<td>Sweden</td>
<td>0.57***</td>
</tr>
</tbody>
</table>

Notes:
* Significant at the 10 percent level.
** Significant at the 5 percent level.
*** Significant at the 1 percent level.

### TABLE 7

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

<table>
<thead>
<tr>
<th>Personal income tax</th>
<th>Corporate income tax</th>
<th>Value-added tax</th>
<th>Tax index</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Industrial</td>
<td>Developing</td>
<td>Industrial</td>
</tr>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
</tr>
<tr>
<td></td>
<td>(5)</td>
<td>(6)</td>
<td>(7)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Good times</th>
<th>Normal times</th>
<th>Bad times</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personal income tax</td>
<td>-0.54</td>
<td>0.49</td>
<td>-0.53</td>
</tr>
<tr>
<td>Developing</td>
<td>-0.59</td>
<td>0.26</td>
<td>0.47</td>
</tr>
<tr>
<td>Corporate income tax</td>
<td>-0.20</td>
<td>0.11</td>
<td>-0.19</td>
</tr>
<tr>
<td>Developing</td>
<td>0.07</td>
<td>-0.41</td>
<td>0.86</td>
</tr>
<tr>
<td>Value-added tax</td>
<td>-0.97</td>
<td>0.33</td>
<td>0.28</td>
</tr>
<tr>
<td>Developing</td>
<td>-0.56</td>
<td>-0.24</td>
<td>0.98</td>
</tr>
<tr>
<td>Tax index</td>
<td>-0.54</td>
<td>0.39</td>
<td>-0.32</td>
</tr>
<tr>
<td>Developing</td>
<td>-0.34</td>
<td>-0.15</td>
<td>0.56</td>
</tr>
</tbody>
</table>

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

**Cyclicality of tax policy: Panel regressions.** Dependent variable is percentage change in tax rate

<table>
<thead>
<tr>
<th>Personal income tax</th>
<th>Corporate income tax</th>
<th>Value-added tax</th>
<th>Tax index</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Industrial</td>
<td>Developing</td>
<td>Industrial</td>
</tr>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
</tr>
<tr>
<td></td>
<td>(5)</td>
<td>(6)</td>
<td>(7)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Percentage change in RGDP</th>
<th>Industrial</th>
<th>Developing</th>
<th>0.09</th>
<th>-0.19**</th>
<th>0.06</th>
<th>-0.11**</th>
<th>-0.27**</th>
<th>-0.46***</th>
<th>-0.16</th>
<th>-0.28***</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>[-0.6]</td>
<td>[-2.6]</td>
<td>0.06</td>
<td>-0.11**</td>
<td>0.06</td>
<td>-0.11**</td>
<td>-0.27**</td>
<td>-0.46***</td>
<td>-0.16</td>
<td>-0.28***</td>
</tr>
<tr>
<td>Number of observations</td>
<td>740</td>
<td>1147</td>
<td>922</td>
<td>1441</td>
<td>629</td>
<td>853</td>
<td>618</td>
<td>781</td>
<td>20</td>
<td>42</td>
</tr>
<tr>
<td>Number of countries</td>
<td>20</td>
<td>42</td>
<td>20</td>
<td>42</td>
<td>19</td>
<td>41</td>
<td>20</td>
<td>42</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes: Estimations are performed using country fixed-effects. t-statistics are in square brackets. Constant term is not reported.
* Significant at the 10 percent level.
** Significant at the 5 percent level.
*** Significant at the 1 percent level.
TABLE 9
Cyclicality of tax policy: Instrumental variable panel regressions. Dependent variable is percentage change in tax rate

<table>
<thead>
<tr>
<th></th>
<th>Personal income tax</th>
<th>Corporate income tax</th>
<th>Value-added tax</th>
<th>Tax index</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Industrial (1)</td>
<td>Developing (2)</td>
<td>Industrial (3)</td>
<td>Developing (4)</td>
</tr>
<tr>
<td></td>
<td>(5)</td>
<td>(6)</td>
<td>(7)</td>
<td>(8)</td>
</tr>
<tr>
<td>Percentage change in RGDP</td>
<td>0.17 [-0.02]</td>
<td>0.04 [-0.39*]</td>
<td>0.11 [-0.28**]</td>
<td>0.13 [-0.22***]</td>
</tr>
<tr>
<td>[0.6]</td>
<td>[0.3]</td>
<td>[1.4]</td>
<td>[1.0]</td>
<td>[-3.1]</td>
</tr>
</tbody>
</table>

STATISTICS

<table>
<thead>
<tr>
<th></th>
<th>Over-identification test</th>
<th>Weak-identification test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(p-value)</td>
<td>(F-statistic)</td>
</tr>
<tr>
<td>Percentage change in RGDP</td>
<td>0.61 0.14 0.99 0.17 0.68 0.20 0.42 0.09</td>
<td>21.0*** 14.2*** 21.0*** 14.2*** 21.0*** 14.2*** 21.0*** 14.2***</td>
</tr>
<tr>
<td>Number of observations</td>
<td>522 702 522 702 522 702 522 702</td>
<td></td>
</tr>
<tr>
<td>Number of countries</td>
<td>19 39 19 39 19 39 19 39</td>
<td></td>
</tr>
</tbody>
</table>

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.

* Significant at the 10 percent level.
** Significant at the 5 percent level.
*** Significant at the 1 percent level.
<table>
<thead>
<tr>
<th>Percentage change in RGDP</th>
<th>Basic panel regressions</th>
<th>Instrumental variable panel regressions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td></td>
<td>(3)</td>
<td>(4)</td>
</tr>
<tr>
<td>highest rate</td>
<td>-0.28 [-0.9]</td>
<td>-0.44 [-0.4]</td>
</tr>
<tr>
<td>AMITR</td>
<td>-0.11 [-0.9]</td>
<td>-0.23 [-0.5]</td>
</tr>
</tbody>
</table>

**STATISTICS**

- 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

<table>
<thead>
<tr>
<th></th>
<th>Basic panel regressions</th>
<th>Instrumental variable panel regressions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1) standard rate</td>
<td>(2) av. reduce rate</td>
</tr>
<tr>
<td>Percentage change in RGDP</td>
<td>-0.35*** [-2.8]</td>
<td>0.04 [-0.31]</td>
</tr>
<tr>
<td></td>
<td>-0.04* [-1.7]</td>
<td></td>
</tr>
</tbody>
</table>

**STATISTICS**

<table>
<thead>
<tr>
<th></th>
<th>Basic panel regressions</th>
<th>Instrumental variable panel regressions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Over-identification test</td>
<td>0.75 (p-value)</td>
<td>0.27</td>
</tr>
<tr>
<td>Weak-identification test</td>
<td>15.2*** (F-statistic)</td>
<td>15.2***</td>
</tr>
<tr>
<td>Number of observations</td>
<td>315</td>
<td>315</td>
</tr>
<tr>
<td>Number of countries</td>
<td>9</td>
<td>9</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th></th>
<th>Basic regressions</th>
<th>Instrumental variable regressions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1) standard rate</td>
<td>(2) effective rate</td>
</tr>
<tr>
<td>Percentage change in RGDP</td>
<td>-0.67** [-2.8]</td>
<td>-0.41* [-1.3]</td>
</tr>
</tbody>
</table>

**STATISTICS**

<table>
<thead>
<tr>
<th></th>
<th>Basic regressions</th>
<th>Instrumental variable regressions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Over-identification test</td>
<td>0.26 (p-value)</td>
<td>0.14</td>
</tr>
<tr>
<td>Weak-identification test</td>
<td>1.3† (F-statistic)</td>
<td>1.3†</td>
</tr>
<tr>
<td>Number of observations</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Number of countries</td>
<td>10</td>
<td>10</td>
</tr>
</tbody>
</table>

Notes: AMITR stands for average marginal personal income tax rate. The excluded instruments are ShockPX and ShockJP. Errors in instrumental variable regressions 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.

† Significant at the 35 percent level.
* Significant at the 25 percent level.
* Significant at the 10 percent level.
** Significant at the 5 percent level.
*** Significant at the 1 percent level.
**TABLE 11**

*Determinants of tax policy cyclicality: Instrumental variable panel regressions*

Dependent variable is percentage change in tax index

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percentage change in RGDP</td>
<td>-0.32</td>
<td>-1.18*</td>
<td>-1.94*</td>
<td>-0.95*</td>
</tr>
<tr>
<td></td>
<td>[-0.9]</td>
<td>[-1.9]</td>
<td>[-1.9]</td>
<td>[-1.5]</td>
</tr>
<tr>
<td>Percentage change in RGDP ×</td>
<td></td>
<td>1.16*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Institutional quality</td>
<td></td>
<td>[1.6]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percentage change in RGDP ×</td>
<td></td>
<td></td>
<td>0.42*</td>
<td></td>
</tr>
<tr>
<td><em>de jure</em> financial integration</td>
<td></td>
<td></td>
<td>[1.7]</td>
<td></td>
</tr>
<tr>
<td>Percentage change in RGDP ×</td>
<td></td>
<td></td>
<td></td>
<td>0.24*</td>
</tr>
<tr>
<td><em>de facto</em> financial integration</td>
<td></td>
<td></td>
<td></td>
<td>[1.6]</td>
</tr>
</tbody>
</table>

**STATISTICS**

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Over-identification test</td>
<td>0.07</td>
<td>0.21</td>
<td>0.66</td>
<td>0.06</td>
</tr>
<tr>
<td><em>(p-value)</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weak-identification test</td>
<td>3.6**</td>
<td>2.4*</td>
<td>2.4*</td>
<td>5.6***</td>
</tr>
<tr>
<td><em>(F-statistic)</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of observations</td>
<td>833</td>
<td>833</td>
<td>833</td>
<td>833</td>
</tr>
<tr>
<td>Number of countries</td>
<td>52</td>
<td>52</td>
<td>52</td>
<td>52</td>
</tr>
</tbody>
</table>

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.

* Significant at the 15 percent level.
* Significant at the 10 percent level.
** Significant at the 5 percent level.
*** Significant at the 1 percent level.