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Abstract

Against the background of a notoriously high macroeconomic instability and the need to raise tax revenues to meet the demands of public spending, this paper analyzes the tradeoff between growth and volatility of tax revenues in Latin America. We use a two-step Engle-Granger-type model to estimate short-run and long-run elasticities, accounting for state-dependent asymmetric reactions of short-run elasticities over the business cycle. Due to its dependence on commodities exploitation Latin America is in general susceptible to the boom-bust cycles of its natural riches. Controlling for the composition of revenue sources and other idiosyncrasies of Latin American economies, we find revenues above (below) its long-run equilibrium to react stronger (weaker) to business cycle dynamics. This "tax revenue channel" represents an indirect argument for counter-cyclical discretionary fiscal policy in the region. Our detailed elasticity estimates can give some orientation on how to reach necessary higher tax levels without creating disincentives and inequities through business cycle instabilities on the way to develop an adequate internal tax system.

JEL-Code: H200, O100, E600.

Keywords: tax policy, developing countries, regime-dependent elasticity.

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1. Introduction

In general, collecting taxes is justified by the generation of revenue to finance public goods and services like education, health and other social programs. Providing these prerequisites for economic performance is crucial, especially in developing economies, to foster growth and to reduce inequality and poverty. Given a notoriously high macroeconomic instability of Latin American economies (Catão 2007) and resultant capital market constraints tax revenues need to be both stable and growing in order to meet these prerequisites. This need is all the more obvious given the fact that Latin American economies generally are dependent on the shackles of commodities exploitation, which provides the livelihoods of their citizens but leaves their economies perennially susceptible to boom-bust cycles and currency fluctuations.

As state governments in the U.S. are also constrained in their external financing and habitually tend to suffer from cyclical budget contractions, the vast majority of the existing literature on tax revenue growth and volatility is concerned with U.S. federal states. It dates back to the seminal study by Groves and Kahn (1952). Early studies that followed (e.g., Wilford 1965, Legler and Shapiro 1968) analyzed state and local tax revenue, conditioning revenues on income using standard OLS and not distinguishing between the long and short run. By the early 1970s, Williams *et al.* (1973) demonstrated that two taxes can follow the same growth trend while experiencing a distinct variability around it. Their findings suggest that a single statistic for revenue elasticity can not be used to analyze growth and variability at the same time and that a possible trade-off between growth and stability exists. The succeeding studies by White (1983) and Fox and Campbell (1984), therefore, considered different taxes and tax structures, confirming this trade-off and finding personal income tax (PIT) and corporate income tax (CIT) to be the fastest growing but also the most unstable taxes. While, for example, White (1983) restricted his analysis to one state, Dye and McGuire (1991) applied White's methodology to all federal states. Sobel and Holcombe (1996) further improved this methodology by accounting for problems of residual variability, serial correlation, and non-stationarity of revenue series. The latest development in this row is Bruce *et al.* (2006) who combine the structured approach of Fox and Campbell (1984) with the refined methodology proposed by Sobel and Holcombe (1996). For our estimates, we will widely adhere to their approach.

To the best of our knowledge, these latest techniques by now have —besides for U.S. federal states— only been used to study a few other countries; see Wolswijk (2009) for the Netherlands and Acquaah and Gelardi (2008) for British Colombian revenues.

Although some tax revenue elasticity estimates for Latin American economies can be found in the literature (usually intended to calculate cyclically adjusted bal-

ances), the evidence remains scattered across the different nations and mostly stems from researchers located in governmental organizations in the region (e.g., Basso 2006, Cárdenas *et al.* 2008, De Mello and Moccero 2006, Rincón *et al.* 2003, Salazar and Prada 2003, Schenone and De la Torre 2005, Tapia 2003). With few exceptions (Antelo 2003, Fuentes and Tobar 2003) this literature is focused on a long-run relationship, i.e., the growth aspect of tax revenues. Neither is the issue of growth and stability of revenues analyzed jointly nor is a potential trade-off examined.

The present study contributes to the literature by applying the latest techniques to estimate short-run and long-run elasticities of tax revenues in Latin America, accounting for asymmetric reactions of short-run elasticities over the business cycle. Considering the composition of revenues of personal and corporate income tax (PIT, CIT), value added tax (VAT), social security contributions, and revenues from commodities exploitation, we find revenues above (below) its long-run equilibrium to react stronger (weaker) to business cycle dynamics. Our detailed elasticity estimates can give some orientation on how to reach necessary higher tax levels without creating disincentives and inequities through business cycle instabilities on the way to develop an adequate internal tax system.

The remainder of the paper is organized as follows. Section 2 describes the recent development of tax collection in Latin American economies. Section 3 gives an outline of the data and methodology we use. In Section 4 we present and discuss our findings. Finally, Section 5 concludes.

2. Some recent development in tax collection across Latin America

Throughout Latin America the tax burden has been relatively low. In 2008, central governments on average collected only 17.9% of gross domestic product (GDP).[1] Even though this amount is a considerable increase over the 12.5% collected in 1990, it remains well under revenues collected in developed countries: The OECD reports a corresponding 35.2% on average in 2008.[2] Similarly, Tanzi and Zee (2000) and Bahl and Bird (2006) document a level of taxation in industrialized countries by the end of the 20th century that was about twice that in developing countries. Historically, this rather small amount of tax revenues proved insufficient to meet the demands of public spending in the region. Only in 2006 and 2007 did revenues exceed spending, making

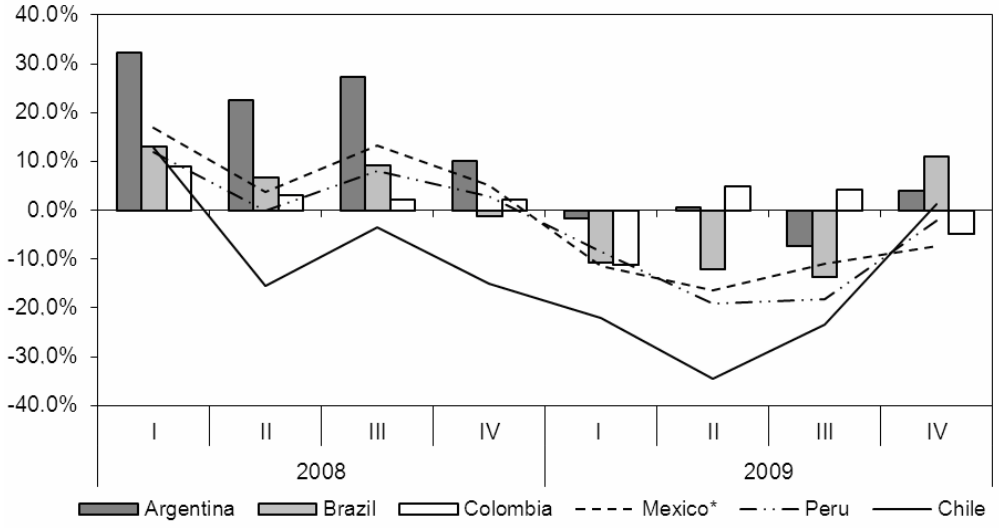
[1] As can be seen from the figures reported in Tanzi and Zee (2000, p. 303), this average level of tax revenue for all developing countries in the Western Hemisphere taken together has been fairly stable, lying between 17.6-18%, for approximately the second half of the 1980s and 1990s, respectively.

[2] Within the region the tax burden is rather heterogeneous. While Brazil and Argentina collect more than 30% of GDP, Mexico and Haiti do not reach 10% in 2008. For the vast majority, however, the respective share lies between 10 and 20%.

it look like governments are now more "fiscally conservative" and suggesting "strongly that on the whole this is a good thing for their people;" see Bahl and Bird (2008, p. 295). This period, however, came to a sudden end in 2008 when the intertional financial crisis began to hit the region.

Besides comparably low levels of taxation, macroeconomic volatility in Latin America has been higher than in developed countries and in emerging economies in Asia and East Europe (Catão 2007). Fluctuations in macroeconomic activity have caused major losses in tax revenues. The recent crisis has demonstrated how vulnerable these revenues are to contractions in economic activity (Figure 1). As shown in Figure 1, tax revenues sharply fell at the end of 2008 and during 2009. For example, in the second quarter of 2009 Chilean revenues decreased by as much as 34.6% in comparison to the previous year. While this drop was not as pronounced as in other countries, it was still severe.

Figure 1: Evolution of Tax Collection during the Recent Crisis [a)]
(constant values, variation t/t-4)



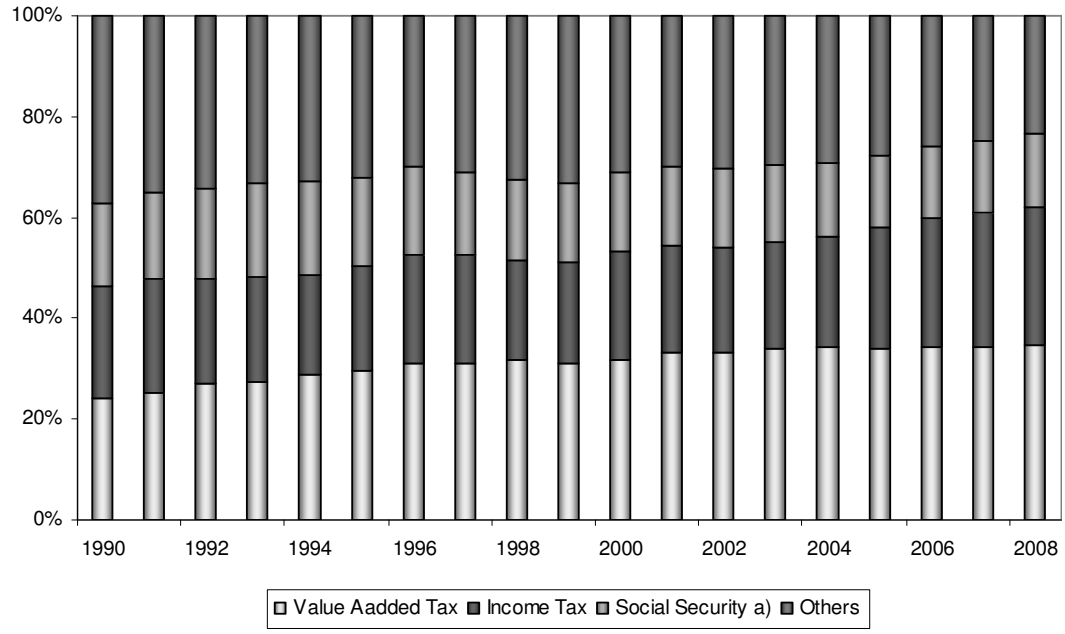
Source: ECLAC (2008)
a) Without social security contributions

The interplay between structurally low tax burden and temporary busts in tax revenues has forced several governments in the region to cut down on public services and fall back on external financing in unfavorable conditions. The margin for countercyclical policies narrowed for some countries (ECLAC 2008, Fanelli 2009). A tax structure with positive revenue growth is not sufficient to ensure solvency each year. Transitory fluctuations can lead to resource shortages even though tax revenues grow in the long run, rendering accurate year-to-year budget planning a most difficult task. Among other factors such as poor tax administration (cf. Bahl and Bird 2008) this

makes tax policy in developing countries in general "the art of the possible rather than the pursuit of the optimal" (Tanzi and Zee 2000, p. 300).

Under the presumption that the Latin American economies seek to become fully integrated with the world economy like countries such as Canada and Australia that were seen as "regions of recent settlement" a century ago and succeeded in installing an adequate internal tax system (Bahl and Bird 2008, p. 279) they will as Tanzi and Zee (2000, p. 320) put it in the *long run* "probably need a higher tax level, because of the need to pursue a government role closer to that of industrial countries." *Long-run* elasticity estimates capture tax revenue growth, as they measure the relationship between the cumulative development of tax revenues and aggregate income or the respective commodity price for the total period of observation. Short-run elasticity estimates give an answer to the question of how revenues respond to the ups and downs of the business cycle or of commodity prices. In this sense, they capture the volatility of revenues. However, there might be a trade-off, inasmuch as faster growing tax revenue sources might react more strongly to macroeconomic fluctuations and, thus, prove to be less stable. If this is the case, policy makers face the problem of finding a balance between policy goals of revenue expansion and maintaining revenue stability.

Figure 2: Major Tax Revenue Sources in Latin America
(% of total tax revenue, 19 countries)



Source: own calculations based on ECLAC (2008)
a) Average for social security contributions does not include Haiti.

Our analysis will focus on major sources of revenues in Latin America: VAT, income tax (IT), social security contributions, and revenue from commodities. In 2008, IT, VAT, and social security contributions make up 76.8% of total tax revenues. As shown in Figure 2, VAT is the fastest growing tax. IT revenue grows more moderately over the last two decades. Social security contributions have decreased slightly from 16.6% to 14.8% with a minor increase in the first half of the 1990s. It is noteworthy, however, that there are considerable differences in the composition of these revenue sources across countries in the region. For example, in Bolivia VAT accounts for 46.2% of total tax revenues in 2008, while in Panama it amounts to only 13.8%.

Going further into detail, we differentiate (i) personal income tax (PIT) from corporate income tax (CIT) and (ii) external VAT from domestic VAT. Figure 3 and Figure 4 show the sample variation of PIT and CIT as well as the one of the two VAT components for the Peruvian economy during the financial crisis. Obviously, PIT revenue growth slowed gradually until revenue fell slightly in the second quarter of 2009 and only recovered slowly afterwards. Ups and downs of CIT revenues are more pronounced and somewhat lag the cycle. In fact, CIT revenue growth actually accelerated at the end of 2008 before falling in 2009. Possible explanations for the differences include the fact that wages are usually more stable in the short-run due to labor market frictions, while companies face a profound negative impact on profits during a trough.

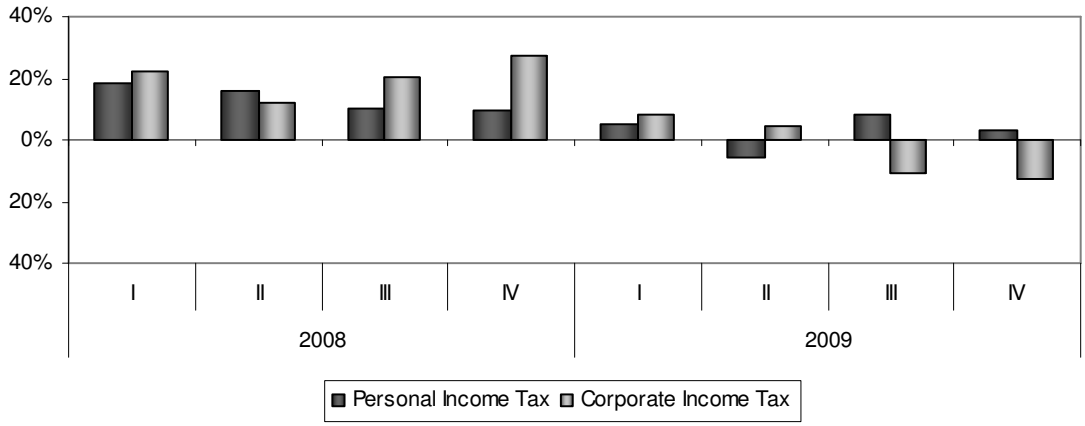
In the case of domestic and external VAT the difference is even more pronounced. While domestic VAT revenue is only slightly affected by the drop in economic activity, external VAT revenue grew much faster during 2008 but fell by as much as 34.9% in the third quarter of 2009. Imports in the region mainly consist of durable (and luxury) goods, while domestic production satisfies basic consumer needs, which are generally less elastic. Therefore, a contraction of national income will likely be reflected in a decreased demand for imported goods and, consequently, a drop in revenue from taxes levied on imports. In the Peruvian case, domestic VAT (PIT) seems to react less to changes in economic activity than external VAT (CIT).

As argued above, a peculiarity of most Latin American economies lies in their dependence on commodities exploitation. In Venezuela, Bolivia, Chile, Colombia, Ecuador, and Mexico[3] non-renewable commodities and natural resources account for over 20% of exports. Considering exports of renewable commodities, the list also includes Argentina as well as several other countries in Central America. In these economies, tax revenues and non-tax revenues from these sectors generate a sizable

[3] For simplicity reasons, we will refer to the Plurinational State of Bolivia as Bolivia and to the Bolivarian Republic of Venezuela as Venezuela.

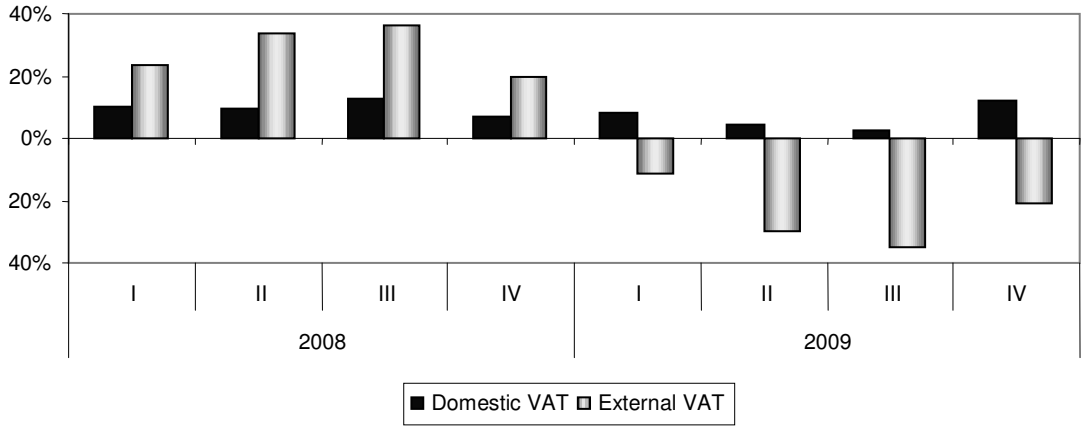
share of total fiscal revenue. During 2008, shares of revenue from commodities in total revenue ranged from 11.3% in Peru to 49.6% in Venezuela.

Figure 3: Variation of PIT and CIT in Peru
(*t*/*t*-4, constant values)



Source: own calculations

Figure 4: Variation of Domestic and External VAT in Peru
(*t*/*t*-4, constant values)



Source: own calculations

As commodity sectors mainly produce for exports, revenues are crucially dependent on the price of the commodities in question. Moreover, tax and non-tax revenue are usually linked to the performance of the sector and as a result depend on the commodity's price.[4] Jiménez and Tromben (2006) find that revenues from commodities, in general, show a higher standard deviation than non-commodity revenue series. For this reason, we will analyze revenue from commodities and non-commodity revenue separately: the first with respect to the particular commodity price and the latter

[4] Jiménez and Tromben (2006) give an overview of tax regimes for non-renewables.

with respect to GDP as a measure for aggregate income. The existing literature is focused on measuring the long-run responses of tax revenues, whereas the short-run has been widely neglected. Most of the estimates stem from cyclical adjusted balances (CAB) and thus are not estimated to explicitly analyze growth or volatility. Existing studies so far also have concentrated either solely on one country or, if they considered several countries, on total tax revenues only. The present study will be the first to estimate long-run and short-run elasticities of the most important tax revenue sources for Argentina, Bolivia, Brazil, Chile, Colombia, the Dominican Republic, Ecuador, Mexico, Peru, Uruguay, and Venezuela.

3. Data and Methodology

3.1 Data

In principle there are two options when quantifying the responsiveness of taxation to changes in national income: either to use tax base (cf. Dye and McGuire 1991, Sobel and Holcombe 1996, Nichols and Tosun 2008) or tax revenue (cf. Bruce *et al.* 2006, Acquaah and Gelardi 2008, Felix 2008) data. If the relationship between the two is proportional then tax base and tax revenue elasticities would be equivalent. However, due to progressivity of the tax schedule, tax exemptions, or tax evasion, there usually is no such equivalence. In practice, both approaches have advantages and disadvantages. Estimates of tax revenue elasticities can be biased if tax code changes altering the definition of tax base or tax rates are not controlled for in the empirical model's specification.[5] Tax base based estimates do not suffer from this bias. Tax base data, however, is in general not readily available and has to be hypothetically constructed with the help of proxies (Dye and McGuire 1991, Sobel and Holcombe 1996), which do not necessarily coincide with the legal tax base definition (Dye 2004). In fact, we know only about one study, Nichols and Tosun (2008), where the authors use exact tax base data by analyzing gambling taxes, for which gross casino revenues represent the actual tax base.

Due to data limitations and for the sake of comparability, we follow the recent studies of Bruce *et al.* (2006), Acquaah and Gelardi (2008), and Felix (2008) by relying on tax revenue data and by controlling for policy changes like tax rate or tax base changes (Appendix B) in our empirical model. As not for all Latin American economies disaggregate data on revenues is available, we have to limit our analysis in these

[5] In this context, the literature distinguishes between tax buoyancy and tax elasticity. Tax buoyancy measures the total response of tax revenues including discretionary policy, that is, the response if tax code changes are not controlled for in the empirical model. Tax elasticity, in contrast, isolates built-in responsiveness to changes in national income.

cases to aggregate data on IT and VAT. Our series are of quarterly frequency and range for most of the series from the first quarter of 1990 to the first quarter of 2009. To deflate the revenue series we employ a corresponding GDP deflator. If the latter is not available, we resort to the respective CPI. To express commodity prices in real terms, we use the U.S. Producer Price Index (PPI).[6] All series were deseasonalized applying the standard ARIMA X-12 method. Detail along with data sources is given in Appendix A.

With regard to revenues from commodities we consider tax as well as non-tax revenues. Non-tax revenues from commodities, such as transfers, are usually linked to sector performance. The latter rather depends on commodity prices than on economic activity. As a result, we expect non-tax revenues from commodities to react to changes in the commodity price. In the case of Peru and Argentina, revenue from commodities is, in contrast to the other economies in the region, not primarily raised from a single good. We, therefore, construct Peruvian and Argentinean price indices as weighted averages of prices for commodities with a substantial share in exports.[7] Argentinean taxes on basic goods exports are considered commodity revenues rather than taxes. As each product is taxed with a different rate, an approximation of the share in total export tax revenue is used as weight instead of the share in export volume.

3.2 Methodology

Following the method proposed in Sobel and Holcombe (1996), we estimate long-run elasticities relying on dynamic OLS (DOLS) techniques (Stock and Watson 1993). A standard error correction model (ECM) is used to estimate short-run elasticities (Engle and Granger 1987). Additionally, we allow short-run elasticities to vary for different states of economic conditions. Following Bruce *et al*. (2006), state-dependent asymmetry is taken into account according to the position of actual revenue to respective long-run value. Tax revenue measures and cyclical variables are analyzed in natural log expression. To control for changes in legislation, tax rates are included in the empirical models as independents. They capture variations in the schedule and have been considered for IT (PIT, CIT) and VAT (domestic VAT, external VAT) series. Other changes in the tax code like changes in the definition of legal tax bases are controlled

[6] Note, the standard measure to deflate commodity prices is the Manufactures Unit Value Index (MUV) provided by the IMF or the Worldbank (e.g., Cashin *et al.* 2000). However, for the period under consideration it has not been constructed in quarterly or monthly form. Labys (2006) suggests the PPI provided by the U.S. Department of Commerce as an alternative due to the fact that it shows a high correlation as well as structural and behavioral similarities with the Worldbank's MUV.

[7] For Peru, the price index is computed on the base of prices for copper, gold, zinc, and crude petroleum. Each price is weighted according to its share in the export volume of these four goods. For Argentina, the price index we used is based on the prices of beef, soybeans, soybean oil, and crude petroleum.

for by use of dummy variables.

As we presume the existence of a long-run equilibrium in order to quantify the long-run relationship between revenue and macroeconomic conditions, the two variables must be cointegrated and trending together, in the sense of following a common stochastic trend. This implies that for the two non-stationary series a linear combination exists that is I(0). To assess these technical conditions, we conduct standard ADF and PP tests for the series in levels, first differences, and for the residuals from regressing revenue on cyclical variable, respectively. Several of the revenue series are found to be trend stationary, while the vast majority of cyclical variables is found to be stationary in first differences (detailed ADF and PP test results are available on request).[8] Thus, we decided to follow a two-track strategy. First, we interpret these test results as being the product of small sample bias and notoriously low power of unit root tests and treat the trend stationary series as sharing a stochastic trend with the business cycle. This part of our strategy corresponds for example to the approach followed by Wolswijk (2009).

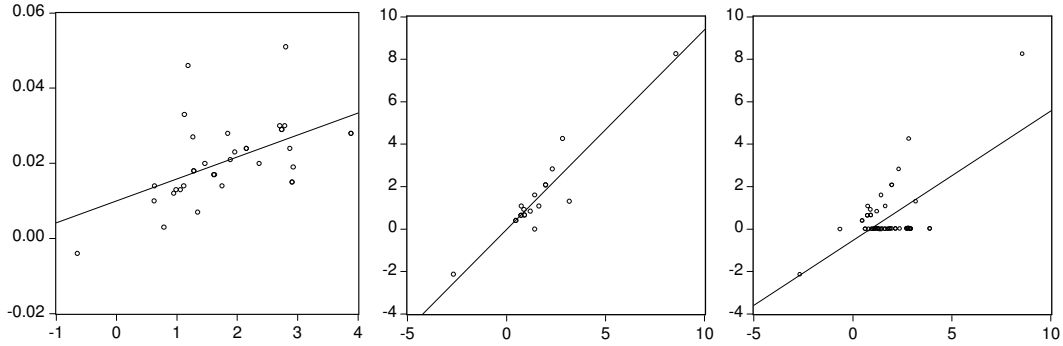
Additionally, we also considered another strategy for series tested to be trend stationary by estimating a deterministic trend instead of a long-run multiplier in the first step of our analysis (White 1983). It measures, how much tax revenue grows each period without considering a relation to a particular macroeconomic base. In a second step, symmetric short-run elasticities are estimated using standard OLS in differences without including an error correction term. In the final step, asymmetric reactions are taken into account by allowing short-run elasticities to vary according to the position of current revenue relative to deterministic trend. Using White's approach, we estimate 35 long-run and 19 short-run elasticities across countries and taxes as being statistically different from zero. Do these estimates substantially differ from the results we would have obtained by treating the trend stationary tested series as sharing a stochastic trend with the business cycle (cf. Wolswijk 2009) and applying the methods proposed by Bruce *et al.* (2006) to estimate elasticities? Figure 5 gives the answer by plotting these estimates on the ordinate against the ones that we obtain by adhering to the method of Bruce *et al.* (2006) on the abscissa.

If we center the elasticity estimates obtained from the respective method and regress them on each other, we find the correlation coefficient for the long-run elasticity estimates to amount to 0.53, the one for short-run elasticities to 0.94, and the one for all elasticities to 0.64. Throughout, these correlations are significant at all conventional levels of significance. This finding leads us to abstract in the following from discussing estimates resultant from the method proposed by White (1983). Detailed

[8] Due to the fact that we are after pecularities and national idiosyncrasies in the relationship between revenues and cyclical variables and, hence, do not treat the series in an unbalanced panel framework, it hardly makes sense to resort to more powerful panel unit root tests such as Maddala and Wu (1999).

estimates based on White's approach for all trend stationary tested series are available on request from the authors. Therefore, in what follows, we report results obtained from the method of Bruce *et al.* (2006) throughout.

Figure 5: Elasticity estimates: White's method (ordinate) vs. Bruce *et al.*'s method (abscissa)
(left scatter: long-run elasticities, middle scatter: short-run elasticities, right scatter: all elasticities)



Notes: Shown estimates are statistically significant estimates for which $p \leq 0.1$; pooled over all considered economies and taxes. In fact, White-results represent quasi-elasticities measuring a certain percentage that respective revenues grow each period.

In our baseline regressions, the DOLS-model is used to estimate the long-term elasticity β_1 from single equation cointegration relationships of the following form for every economy

$$\ln T_t^i = \beta_0^i + \beta_1^i \ln Y_t + \sum_{g=-j}^{j} \gamma_g \Delta \ln Y_{t+g} + \left(X_t^i\right)' \alpha + \eta_t^i \qquad (1)$$

$$\ln R_t = \beta_0 + \beta_1 \ln P_t + \beta_2 \ln E_t + \sum_{g=-j}^{j} \sum_{h=-s}^{s} \left(\gamma_g \Delta \ln P_{t+g} + \phi_h \Delta \ln E_{t+h}\right) + X_t' \alpha + v_t, \qquad (2)$$

where T^i denotes revenues from tax i and Y real GDP, respectively. Covariates contained in X^i are tax rates[9] as well as dummy variables indicating changes in the tax code for respective tax i (Appendix B). The lag- and lead-operator, i.e., the summation of first order differences Δ for different forward and backward shifts of Y (as well as of P and E), is employed to adjust for problems of endogeneity and autocorrelation. Length j (s) of this operator is chosen by means of the Schwarz-Bayesian information criterion (BIC), where we allow for a maximum length $j = 3$ ($s = 3$) except for series of less than 50 observations, for which the maximum length is set to one. In equation (2), R denotes revenues from commodities, P the commodity price in US Dollars, and E the respective exchange rate. Long-run elasticities of revenues from tax i are given by estimates of β_1^i – long-run elasticities of commodity revenues by estimates of β_1. Errors η^i and v are assumed to represent i.i.d. normal random shocks.

Two short-term effects can occur in each period: Revenues may react to changes in real GDP (or, in case of commodity revenues, to commodity prices) and/or may adjust towards their long-term equilibrium level, based on the assumption that a disequilibrium (ε) exists at the beginning of a period, where

$$\varepsilon_t^i = \ln T_t^i - \beta_0^i - \beta_1^i \ln Y_t - \left(X_t^i\right)'\alpha \tag{3}$$

$$\varepsilon_t = \ln R_t - \beta_0 - \beta_1 \ln P_t - \beta_2 \ln E_t - X_t'\alpha . \tag{4}$$

These effects can be considered in terms of an error correction model (ECM)

$$\Delta \ln T_t^i = \theta_0^i + \theta_1^i \left(y_t - y_{t-1}\right) + \theta_2^i \varepsilon_{t-1}^i + \in_t^i \tag{5}$$

$$\Delta \ln R_t = \theta_0 + \theta_1 \left(p_t - p_{t-1}\right) + \theta_2 \left(e_t - e_{t-1}\right) + \theta_3 \varepsilon_{t-1} + \in_t \tag{6}$$

where (dummy-type) covariate expressions have been dropped for reasons of notational convenience; although not shown, they are included above and in the following; minor letters denote variables in natural log; $\in_t^i$ and $\in_t$ represent i.i.d. random variables. Coefficients θ_1^i and θ_1 indicate intra-period effects, i.e., short-term adjustment effects to changes in real GDP and commodity prices, respectively. Thus, they can be interpreted as measures of short-run elasticities. A major concern of our study is to unravel differences between short-term and long-term effects of GDP (and commodity prices) on revenues. The selected econometric specification allows a direct comparison of both effects. The short-term reaction of revenues to income (or, in case of commodity revenues, to commodity prices) is smaller or larger than the long-term reaction, depending on whether the respective θ_1 is smaller or larger than the respective β_1. A further interesting question is how fast revenues move to their (new) long-run equilibrium, which may result due to the changes in real GDP (or, in case of commodity revenues, in commodity prices). Coefficients θ_2^i, θ_3 assess the speed of adjustment of revenues towards their long-term level, i.e., the proportion of disequilibrium, which is reduced in each period. Thus, the larger the absolute value of θ_2^i (in case of commodity revenues, θ_3) is, the faster revenues equilibrate to the new conditions and move to their long-term equilibrium level, respectively.

In equations (5) and (6) the short-run elasticity of revenues with respect to changes in real GDP (in commodity prices) is the same regardless of whether revenues are above ($\varepsilon_t > 0$) or below ($\varepsilon_t < 0$) their long-term equilibrium level. A symmetric reaction is implicitly assumed. To allow the reaction to depend on the particu-

[9] In case of PIT and CIT showing progressive structure, only maximum rates are considered.

lar state of the business cycle, the ECM can be modified to account for possible asymmetries

$$\Delta \ln T_t^i = \theta_0^i + \theta_1^i \Delta y_t + \lambda_1^i \left(D_t^i \Delta y_t \right) + \theta_2^i \varepsilon_{t-1}^i + \lambda_2^i \left(D_{t-1}^i \varepsilon_{t-1}^i \right) + \upsilon_t^i \qquad (7)$$

$$\Delta \ln R_t = \theta_0 + \theta_1 \Delta p_t + \lambda_1 \left(D_t \Delta p_t \right) + \theta_2 \Delta e_t + \theta_3 \varepsilon_{t-1} + \lambda_3 \left(D_{t-1} \varepsilon_{t-1} \right) + \upsilon_t \ , \qquad (8)$$

where the υ vectors represent i.i.d. random variables, and *D* denote dummy variables, which indicate the respective position of revenues relative to their long-run equilibrium. These dummies will take on a zero value if revenues are below their steady state level and a value of one else.

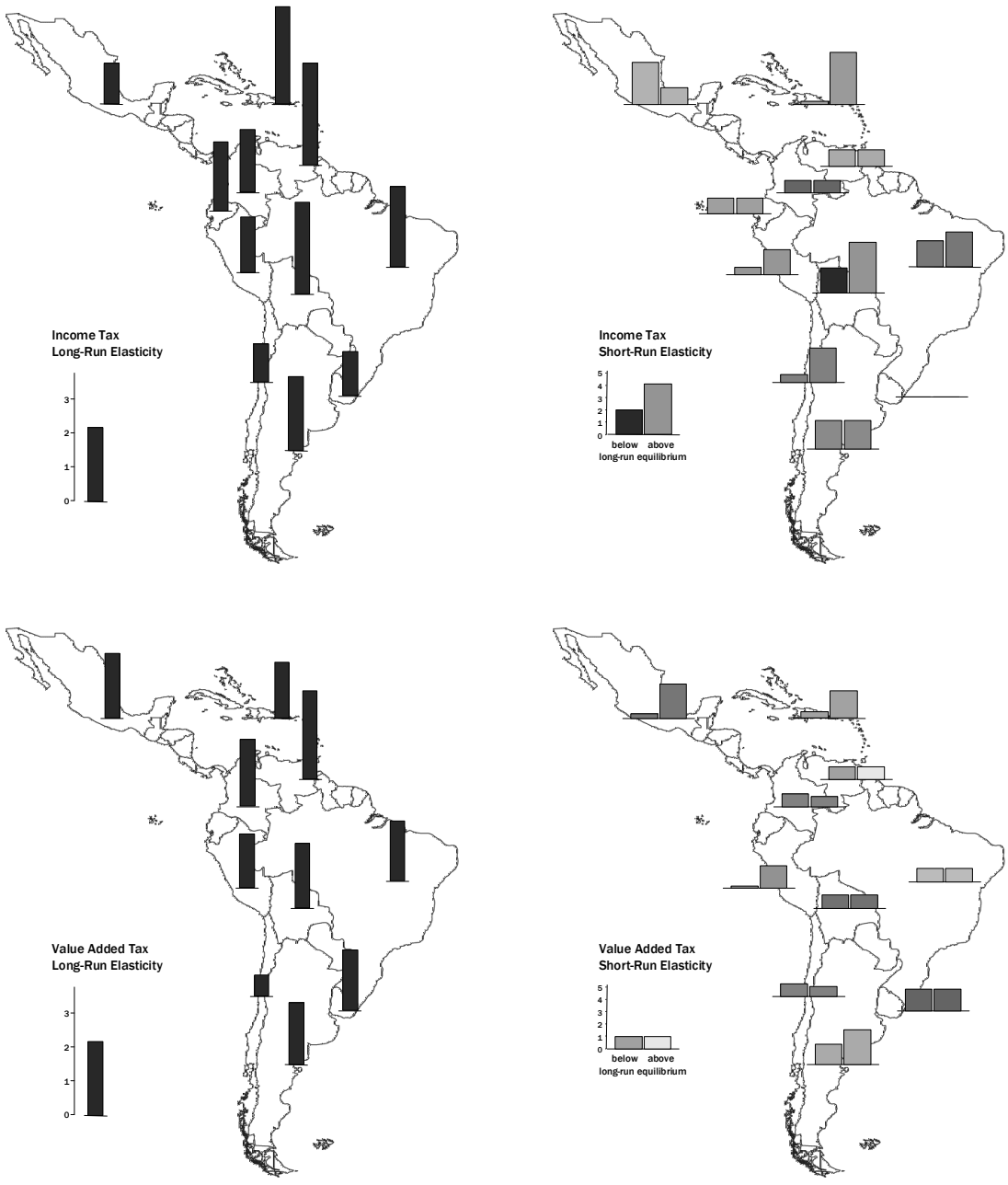
4. Findings and Discussion

Figure 5 summarizes our long-run and short-run elasticity estimates of aggregate IT and VAT series in the region. The first row of maps visualizes our IT elasticity estimates for the long run and short run, respectively. The second row of maps does so for VAT elasticity estimates. The size of bars in the first column of maps visualizes the size of estimated long-run elasticities, which typically is larger than the corresponding elasticity estimates in the short run when revenues are below their long-run equilibrium level and smaller when above it (second column of maps). The latter are represented by a pair of bars, where the size of bars is identical for symmetric elasticity estimates (eq. 5 and 6) and differs for statistically significant asymmetric elasticity estimates (eq. 7 and 8). The smaller the bars are, the less volatility is implied. The shading of the bars displays the adjustment speed to the new long-run equilibrium in case of a short-run deviation from long-run equilibrium as measured by λ_2^i and λ_3 in the above specifications. The darker the shading, the faster this re-adjustment takes place.

For our IT short-run elasticities six out of ten estimates are estimated as clearly asymmetric, while four out of ten show symmetry over the business cycle. In the case of VAT elasticity estimates, four out of ten are symmetric, two out of ten show some weak asymmetry, and another four are characterized by a clear-cut asymmetry. To highlight the strength of our single equation approach, let us consider the results country by country. The first thing to note is that we cannot estimate all four elasticities for Uruguay and Ecuador. Thus, we have to abstract from these economies in the detailed interpretation of our results, implying concrete policy recommendations. A second remarkable finding is that only Mexican IT revenues react stronger when below their long-run equilibrium. For all other statistically significant asymmetric elasticity estimates the opposite applies, that is, revenues are found to be more elastic in the short

run when above their long-run equilibrium level. Corresponding exact figures of our elasticity estimates can be found in Table 1.

Figure 5: Long-Run and Short-Run Elasticity Estimates: IT and VAT



Notes: Own estimates in absolute values; for detailed figures see Table 1; for data sources and detail on time series see Appendix A.

Size of bars corresponds to size of elasticity estimates (according to scale shown in lower left corner); shading of bars for short-run elasticity estimates reflects adjustment speed to long-run equilibrium: the darker the shading, the faster the adjustment.

Overall, the Mexican economy has clearly more growth potential in VAT than in IT revenues. Obviously, revenues from VAT also adjust faster in the short run. However,

there is some danger of "overheating" as Mexican VAT revenues are more susceptible to contractions when above their long-run equilibrium level. The opposite holds for Mexican IT revenues in the short run. Argentina and the Dominican Republic show a higher growth potential in IT compared to VAT revenues. But this advantage comes, in the case of the Dominican Republic, at the cost of IT revenues being relatively more prone to overheating. In the case of Venezuela, neither VAT is strictly preferable to IT, nor the other way around as the growth potential is fairly high and the susceptibility to short-run fluctuations fairly low for both revenue types. Similarly on the bubble are Colombia and Peru, where the latter is characterized by an asymmetric elasticity over the short run for both VAT and IT revenues. The economies of Brazil, Bolivia, and Chile face a clear-cut trade-off, in the sense that tax revenues with the higher growth potential are found to be more volatile in the short and medium run and vice versus.[10]

In order to identify the most promising revenue sources more exactly, we also consider the disaggregate IT components, PIT and CIT, as well as domestic VAT, external VAT, social security contributions, and revenues from commodities. Ad hoc, disregarding a potential trade-off between growth and (asymmetric) volatility, we find that long-run elasticites for CIT revenues outweigh the ones for PIT in any case (see second column of sub-tables on PIT and CIT revenue elasticity estimates in Table 1). The same applies to VAT components. Estimated long-run elasticities of external VAT revenues throughout outweigh the corresponding ones of internal VAT revenues. For Ecuador the long-run elasticity estimate of social security contributions stands out and tops the one of any other considered revenue series (see the "social security" part of Table 1). Not surprisingly, we clearly find the highest growth potential for the Chilean economy in its revenues from commodities.

With the exception of Argentina, the above assessment remains untouched if we consider a possible trade-off between growth potential and susceptibility of revenues to cyclical fluctuations. For our estimates based on disaggregate revenue components, we find for Argentine external VAT revenues to show both the highest growth potential (corresponding long-run elasticity estimate is 3.64) but also the highest cyclical volatility (corresponding symmetric long-run elasticity estimate is 4.28). Against the background of the recent Argentine crisis of 1999-2002, when severe riots and social unrest were triggered by growing recession and persistent unemployment in late 2001,[11] the relatively high susceptibility of external VAT revenues to macroeconomic

[10] Note, negative values for short-run coefficients estimates suggest a countercyclical reaction of revenues (cf. some of the entries in Table 1). Although not in accordance with our intuition, countercyclical responses are, for example, also estimated by Bruce *et al.* (2006) and Nichols and Tosun (2008).

[11] In contrast, the similar episode of political instability in the late 1980s was triggered by hyperinflation hitting the Argentine private sector.

downturns and busts may suggest to extend and rather count on CIT and/or PIT as primary – and in the short run more stable – source of revenues.

Table 1. Long-Run and Short-Run Revenue Elasticity: Detailed Estimates

	LR Elasticity	SR Elasticity		Adjustment Speed	
		below LR equilibrium	above LR equilibrium	below LR equilibrium	above LR equilibrium
IT					
Argentina	2.166***	2.323**	2.323**	-0.640***	-0.640***
Bolivia	2.703***	-2.017	4.115**	-1.594***	-0.542**
Brazil	2.361***	-2.133**	2.836***	-0.825***	-0.825***
Chile	1.114***	-0.656	2.828***	-0.738***	-0.738***
Colombia	1.841***	0.990	0.990	-0.996***	-0.996***
Dominican Rep.	2.869***	-0.300	4.262***	-0.482***	-0.482***
Ecuador	2.034***	-1.275	-1.275	-0.434***	-0.434***
Mexico	1.205***	-3.410***	1.370***	-0.254***	-0.254***
Peru	1.642***	-0.650	2.037**	-0.525***	-0.525***
Uruguay	1.297***	0.013	0.013	-1.382***	-1.382***
Venezuela	3.011***	1.307***	1.307***	-0.330***	-0.330***
PIT					
Argentina	1.265***	2.350*	2.350*	-0.372***	-0.372***
Bolivia	-0.650***	-3.118***	1.864*	-0.738***	-0.738***
Brazil	2.927***	-0.758	6.244***	-0.644***	-0.644***
Chile	0.964***	-1.218	1.779*	-0.653***	-0.653***
Peru	1.591***	0.474**	0.474**	-0.830***	-0.830***
CIT					
Argentina	2.774***	3.263*	3.263*	-0.408***	-0.408***
Bolivia	2.735***	-3.357	5.396*	-1.084***	-1.084***
Brazil	3.883***	1.920	6.792***	-0.940***	-0.940***
Chile	1.279***	-1.181*	3.051***	-0.710***	-0.710***
Dominican Rep.	2.150***	0.830	8.255***	-0.648***	-0.648***
Peru	1.732***	-1.371	3.322**	-0.091	-0.837***
Uruguay	2.907***	0.087	0.087	-1.183***	-1.183***
VAT					
Argentina	1.822***	1.606***	2.792***	-0.327***	-0.327***
Bolivia	1.882***	1.090*	1.090*	-0.874***	-0.874***
Brazil	1.747***	1.088***	1.088***	-0.165**	-0.165**
Chile	0.621***	-1.042**	0.837**	-0.735***	-0.735***
Colombia	1.957***	0.175	3.326***	-1.220***	-1.220***
Dominican Rep.	1.637***	0.497	2.210***	-0.406***	-0.406***
Mexico	1.910***	-0.370	2.791***	-0.842***	-0.842***
Peru	1.583***	-0.175	1.830***	-0.561***	-0.561***
Uruguay	1.783***	1.799***	1.799***	-1.019***	-1.019***
Venezuela	2.590***	1.024**	1.024**	-0.418***	0.265**
Domestic VAT					
Argentina	1.207***	1.498***	1.498***	-0.348***	-0.348***
Bolivia	1.621***	-0.627	2.004*	-1.523***	-0.654***
Chile	0.959***	-0.813**	0.607*	-0.274***	-0.274***
Colombia	1.462***	-0.640	3.119***	-1.310***	-1.310***
Peru	1.106***	-0.076	1.366***	-0.651***	-0.651***
Uruguay	1.609***	1.677***	1.677***	-1.678***	-0.293

Table 1 (cont'ed)

	LR Elasticity	SR Elasticity		Adjustment Speed	
		below LR equilibrium	above LR equilibrium	below LR equilibrium	above LR equilibrium
External VAT					
Argentina	3.641***	4.275***	4.275***	-0.803***	-0.803***
Bolivia	2.397***	0.249	2.691***	-0.742***	-0.742***
Chile	1.057***	-0.757	3.187**	-0.711***	-0.711***
Colombia	2.787***	2.081***	2.081***	-0.555***	-0.555***
Peru	2.088***	-0.424	2.659***	-0.541***	-0.541***
Uruguay	2.311***	2.501***	2.501***	-0.492***	-0.492***
Social Security					
Argentina	0.170	0.568	1.876***	-0.048	-0.048
Brazil	1.718***	0.291	1.291***	-0.682***	-0.682***
Chile	0.947***	-0.546*	0.921***	-0.194***	-0.194***
Ecuador	3.545***	2.222*	2.222*	-0.381***	-0.381***
Mexico	1.473***	1.092***	1.092***	-0.256***	-0.256***
Peru	0.986***	-2.377***	1.059	-0.963***	-0.963***
Commodities Rev					
Argentina	1.183***	0.658***	0.658***	-0.578***	-0.578***
Bolivia	-0.026	-0.539*	0.177	-0.604***	-0.604***
Chile	2.802***	0.336	0.336	-0.342***	-0.342***
Ecuador	0.784***	-0.297	1.602***	-0.415***	-0.415***
Mexico	0.629***	0.400***	0.400***	-0.843***	-0.843***
Peru	1.123**	0.831	0.831	-0.986***	-0.986***
Venezuela	1.341***	0.643***	0.643***	-1.204***	-0.513***

Notes: SR, LR denote short-run and long-run, respectively; *, **, *** denote significance at the 10, 5, 1% level.

LR elasticity estimates: IT components: due to missing information no legislative changes controlled for Ecuador and Venezuela; VAT components: due to missing information no legislative controls for Venezuela, for Brazil no rate changes included (state tax) as control, no estimation for Ecuador due to lack of cointegration; Social security contributions: due to missing information no legislative controls for Ecuador, no estimation for Uruguay due to lack of cointegration; Revenues from commodities: due to missing information (or too many changes to control for) no legislative controls for Ecuador, Venezuela (and Argentina);

SR elasticity estimates: For above-equilibrium coefficients the tested hypothesis is the joint hypothesis of the sum of below-equilibrium coefficient and difference equaling zero; shortfall of controls applies analogously to LR elasticity estimates.

Argentine PIT revenues, for example, clearly show a lower growth potential but are at the same time less prone to economic fluctuations than are revenues from external VAT. The latter, however, adjust about twice as fast back to the long-run equilibrium path as do the former. Hence, seen from an incumbent government the possibly existential business cycle stability of revenues comes at a cost.

For similar reasons, considering the Brazilian crisis of 1992 that ended with the demise of the president, a focus on revenues from VAT rather income taxes seems to be the more reasonable as the more cautious strategy. As noted earlier (see footnote 2), both, Argentina and Brazil, have in contrast to other Latin American economies nearly caught up with the OECD average tax collection. Today both governments col-

lect taxes amounting to about one third of GDP, suggesting a lower weight on growth compared to volatility aspects of revenues.

5. Conclusion

The years before the economic and financial crisis of 2008 the perennially boom-bust cycle susceptible Latin American economies witnessed for the first time a short period of excess (tax) revenues. This period came to a sudden end in 2008. Decreasing revenues led to cuts in public services and social programs. They implied a falling back on external financing, a narrowed scope for discretionary policies, and problems of solvency in some of the countries of the region. Our study by using latest econometric techniques tried to give some orientation for what Tanzi and Zee (2000) called "the art of the possible rather than the pursuit of the optimal," that is, for the creation of growing and at the same time stable tax revenues in the Latin American economies. We find that about half of the analyzed economies face a clear-cut trade-off between growth and volatility of revenues. In more than half of the cases, we find revenues to react asymmetrically to macroeconomic conditions in the short and medium run: Above their long-run equilibrium level they react stronger to economic fluctuations. Below it, they react weaker. Given enough scope with regard to solvency, this finding is suggestive for counter-cyclical discretionary fiscal policy as a minor stimulus in a phase of above average macro-conditions might be already quite efficient in stabilizing revenues, while a major stimulus would be needed in a phase of contraction.

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Appendix A: Data Detail and Sources

[Table is continued on the following 6 pages.]

Argentina	
Income Tax	
Period	Q1 1993 - Q1 2009
Source	Ministerio de Economía y de Finanzas Públicas, Administración Federal de Ingresos Públicos
Notes	Includes withholding taxes
Personal Income Tax	
Period	Q1 1997 - Q1 2009
Source	Administración Federal de Ingresos Públicos
Notes	Does not include withholding taxes
Corporate Income Tax	
Period	Q1 1997 - Q1 2009
Source	Administración Federal de Ingresos Públicos
Notes	Does not include withholding taxes
Value Added Tax	
Period	Q1 1993 - Q1 2009
Domestic Value Added Tax	
Period	Q1 1993 - Q1 2009
Source	Ministerio de Economía y de Finanzas Públicas, Administración Federal de Ingresos Públicos
External Value Added Tax	
Period	Q1 1993 - Q1 2009
Source	Ministerio de Economía y de Finanzas Públicas, Administración Federal de Ingresos Públicos
Social Security	
Period	Q1 1993 - Q1 2009
Source	Ministerio de Economía y de Finanzas Públicas
Revenue from Commodities	
Period	Q2 2000 - Q1 2009
Source	Administración Federal de Ingresos Públicos
Notes	Export duties
Real GDP	
Source	Banco Central de la República Argentina
Notes	In Pesos of 1993
Current GDP	
Source	Banco Central de la República Argentina
Commodity Prices	
Beef, Australia & New Zealand, frozen boneless, U.S. import price FOB port of entry (¢/lb.)	
Soybeans, United States, n° 2 yellow, CIF Rotterdam	
Soybean oil, The Netherlands, FOB ex-mill	
Crude petroleum, average of Dubai/Brent/Texas equally weighted ($/barrel)	
Source	IMF: International Financial Statistics
Notes	Price index weighted with share in total export duties
Exchange Rate	
Source	ECLAC
Deflator	GDP – Deflator

Bolivia	
Income Tax	
Period	Q1 1990 - Q1 2009
Source	Ministerio de Economía y de Finanzas Públicas
Personal Income Tax	
Period	Q1 1990 - Q1 2009
Source	Ministerio de Economía y de Finanzas Públicas
Corporate Income Tax	
Period	Q1 1990 - Q1 2009
Source	Ministerio de Economía y de Finanzas Públicas
Value Added Tax	
Period	Q1 1990 - Q1 2009
Source	Ministerio de Economía y de Finanzas Públicas
Domestic Value Added Tax	
Period	Q1 1990 - Q1 2009
Source	Ministerio de Economía y de Finanzas Públicas
External Value Added Tax	
Period	Q1 1990 - Q1 2009
Source	Ministerio de Economía y de Finanzas Públicas
Revenue from Commodities	
Period	Q1 1990 - Q1 2009
Source	Ministerio de Economía y de Finanzas Públicas
Notes	Includes special tax on hydrocarbons, direct tax on hydrocarbons and utility tax on mining industry
Real GDP	
Source	Banco Central de Bolivia
Notes	In Bolivianos of 1990
Current GDP	
Source	Banco Central de Bolivia
Commodity Price	
Russian Natural Gas, in Germany U.S. Dollars per Thousand Cubic Meters (FMI)	
Source	IMF: International Financial Statistics
Exchange Rate	
Source	ECLAC
Deflator	GDP – Deflator

Brazil	
Income Tax	
Period	Q1 1994 - Q1 2009
Source	Tesouro Nacional
Notes	Witholding taxes are included
Personal Income Tax	
Period	Q1 1994 - Q1 2009
Source	Tesouro Nacional
Notes	Witholding taxes are excluded
Corporate Income Tax	
Period	Q1 1994 - Q1 2009
Source	Tesouro Nacional
Notes	Witholding taxes are excluded
Value Added Tax	
Period	Q1 1998 - Q1 2009
Source	Receita Federal

Notes	State tax
Social Security	
Period	Q1 1998 - Q1 2009
Source	Tesouro Nacional
Real GDP	
Source	Instituto Brasileiro de Geografia e Estatística
Notes	Index 1995=100
Deflator	Consumer Price Index
Source	ECLAC
Notes	Dec1993=100
Chile	
Income Tax	
Period	Q1 1993 - Q1 2009
Source	Servicio de Impuestos Internos
Notes	Includes CIT from the private mining sector, net values
Personal Income Tax	
Period	Q1 1993 - Q1 2009
Source	Servicio de Impuestos Internos
Notes	Gross values
Corporate Income Tax	
Period	Q1 1993 - Q1 2009
Source	Servicio de Impuestos Internos
Notes	Includes CIT from the private mining sector, gross values
Value Added Tax	
Period	Q1 1993 - Q1 2009
Source	Servicio de Impuestos Internos
Notes	Net values
Domestic Value Added Tax	
Period	Q1 1993 - Q1 2009
Source	Servicio de Impuestos Internos
Notes	Gross values
External Value Added Tax	
Period	Q1 1993 - Q1 2009
Source	Servicio de Impuestos Internos
Notes	Gross values
Social Security	
Period	Q1 1990 - Q1 2009
Source	Servicio de Impuestos Internos
Revenue from Commodities	
Period	Q1 1993 - Q1 2009
Source	Servicio de Impuestos Internos
Notes	Specific tax and provisional payments of income tax and net transfers from CODELCO, does not include CIT from private mining sector
Real GDP	
Source	Banco Central de Chile
Notes	In Pesos of 2003
Current GDP	
Source	Banco Central de Chile
Commodity Price	
Copper, wire bars, U.S. producer, FOB refinery (¢/lb.)	
Source	IMF: International Financial Statistics
Exchange Rate	
Source	ECLAC

Deflator	GDP – Deflator
Colombia	
Income Tax	
Period	Q1 1998 - Q4 2008
Source	Consejo Superior de Política Fiscal
Notes	Includes CIT from the mining sector
Value Added Tax	
Period	Q1 1998 - Q4 2008
Source	Consejo Superior de Política Fiscal
Domestic Value Added Tax	
Period	Q1 1998 - Q4 2008
Source	Consejo Superior de Política Fiscal
External Value Added Tax	
Period	Q1 1998 - Q4 2008
Source	Consejo Superior de Política Fiscal
Real GDP	
Source	Banco de la República Colombia
Notes	In Pesos of 2000, already deseasonalized, linked series
Deflator	Consumer Price Index
Source	ECLAC
Notes	Dec2008=100
Dominican Republic	
Income Tax	
Period	Q1 1992 - Q1 2009
Source	Banco Central de la República Dominicana
Personal Income Tax	
Period	Q1 1997 - Q1 2009
Source	Dirrección General de Impuestos Internos
Notes	Shortfall in time series does not allow application of econometric model
Corporate Income Tax	
Period	Q1 1997 - Q1 2009
Source	Dirrección General de Impuestos Internos
Value Added Tax	
Period	Q1 1992 - Q1 2009
Source	Banco Central de la República Dominicana
Real GDP	
Source	Banco Central de la República Dominicana
Notes	In Dominican Republic Dollars of 1991
Current GDP	
Source	Banco Central de la República Dominicana
Deflator	GDP – Deflator
Ecuador	
Income Tax	
Period	Q1 1994 - Q1 2009
Source	Dirección General Adjunta de Estadística de la Hacienda Pública
Value Added Tax	
Period	Q1 1994 - Q1 2009
Source	Dirección General Adjunta de Estadística de la Hacienda Pública
Social Security	
Period	Q1 1996 - Q1 2009
Source	Dirección General Adjunta de Estadística de la Hacienda Pública

Revenue from Commodities	
Period	Q1 1994 - Q1 2009
Source	Dirección General Adjunta de Estadística de la Hacienda Pública
Real GDP	
Source	Banco Central del Ecuador
Notes	In U.S. Dollars of 2000
Commodity Price	
Crude petroleum, average of Dubai/Brent/Texas equally weighted ($/barrel)	
Source	IMF: International Financial Statistics
Exchange Rate	
Source	ECLAC
Deflator	Consumer Price Index
Source	ECLAC
Notes	2004=100
Mexico	
Income Tax	
Period	Q1 1993 - Q1 2009
Source	Secretaría de Hacienda y de Crédito Público
Value Added Tax	
Period	Q1 1993 - Q1 2009
Source	Secretaría de Hacienda y de Crédito Público
Social Security	
Period	Q1 1993 - Q1 2009
Source	Secretaría de Hacienda y de Crédito Público
Revenue from Commodities	
Period	Q1 1993 - Q1 2009
Source	Secretaría de Hacienda y de Crédito Público
Real GDP	
Source	Banco de México
Notes	In Pesos of 2003, linked series
Commodity Price	
Crude petroleum, average of Dubai/Brent/Texas equally weighted ($/barrel)	
Source	IMF: International Financial Statistics
Exchange Rate	
Source	ECLAC
Deflator	Consumer Price Index
Source	ECLAC
Notes	2nd fortnight Jun2002 = 100
Peru	
Income Tax	
Period	Q1 1998 - Q1 2009
Source	Superintedencia Nacional de Administración Tributaria
Notes	Gross values
Personal Income Tax	
Period	Q1 1998 - Q1 2009
Source	Superintedencia Nacional de Administración Tributaria
Notes	Gross values
Corporate Income Tax	
Period	Q1 1998 - Q1 2009
Source	Superintedencia Nacional de Administración Tributaria
Notes	Gross values

Value Added Tax	
Period	Q1 1998 - Q1 2009
Source	Superintedencia Nacional de Administración Tributaria
Notes	Gross values
Domestic Value Added Tax	
Period	Q1 1998 - Q1 2009
Source	Superintedencia Nacional de Administración Tributaria
Notes	Gross values
External Value Added Tax	
Period	Q1 1998 - Q1 2009
Source	Superintedencia Nacional de Administración Tributaria
Notes	Gross values
Social Security	
Period	Q3 1999 - Q1 2009
Source	Superintedencia Nacional de Administración Tributaria
Notes	Supportive contributions for pension plans are not included
Revenue from Commodities	
Period	Q1 1998 - Q1 2009
Source	Superintedencia Nacional de Administración Tributaria
Notes	Includes CIT on the mining and hydrocarbon sectors and transfer from the mining sector, gross values
Real GDP	
Source	Banco Central de Reserva del Perú
Notes	In Nuevos Soles of 1994
Current GDP	
Source	Banco Central de Reserva del Perú
Commodity Prices	
Copper, wire bars, U.S. producer, FOB refinery (¢/lb.)	
Zinc, special high grade, LME, cash settlement	
Gold, 99.5% fine, afternoon fixing London ($/troy ounce)	
Crude petroleum, average of Dubai/Brent/Texas equally weighted ($/barrel)	
Source	IMF: International Financial Statistics
Notes	Price index weighted with share in total exports
Exchange Rate	
Source	ECLAC
Deflator	GDP – Deflator
Uruguay	
Income Tax	
Period	Q1 1999 - Q1 2009
Source	Ministerio de Economía y de Finanzas
Personal Income Tax	
Source	Ministerio de Economía y de Finanzas
Notes	Not used (as implemented not before 2007, replacing various taxes)
Corporate Income Tax	
Period	Q1 1999 - Q1 2009
Source	Ministerio de Economía y de Finanzas
Value Added Tax	
Period	Q1 1999 - Q1 2009
Source	Ministerio de Economía y de Finanzas
Notes	Does not include tax on social security contribution
Domestic Value Added Tax	
Period	Q1 1999 - Q1 2009
Source	Ministerio de Economía y de Finanzas

External Value Added Tax	
Period	Q1 1999 - Q1 2009
Source	Ministerio de Economía y de Finanzas
Social Security	
Period	Q1 1999 - Q1 2009
Source	Ministerio de Economía y de Finanzas
Real GDP	
Source	Banco Central del Uruguay
Notes	In Pesos of 2005
Current GDP	
Source	Banco Central del Uruguay
Deflator	GDP - Deflator
Venezuela	
Income Tax	
Period	Q1 1993 - Q1 2009
Source	Ministerio del Poder Popular de Planificación y de Finanzas
Value Added Tax	
Period	Q4 1993 - Q1 2009
Source	Ministerio del Poder Popular de Planificación y de Finanzas
Revenue from Commodities	
Period	Q1 1993 - Q1 2009
Source	Ministerio del Poder Popular de Planificación y de Finanzas
Real GDP	
Source	Banco Central de Venezuela
Notes	In Bolívares of 1997, linked series
Commodity Price	
Crude petroleum, average of Dubai/Brent/Texas equally weighted ($/barrel)	
Source	IMF: International Financial Statistics
Exchange Rate	
Source	ECLAC
Deflator	Consumer Price Index
Source	ECLAC
Notes	Dec2007=100

Appendix B: Controls for exogenous changes in tax schedules, commodity sectors, and in social security systems

Table B.1

	LR Elasticities (LR-E)		Symmetric SR-E		Asymmetric SR-E	
Argentina						
IT	Law 26287 Decree 1426/08	Q2 07 - Q1 09 Q1 08 - Q1 09				
PIT			Law 25239	Q1 00	Law 25239	Q1 00
CIT	Decree 1426/08	Q1 08 - Q1 09				
VAT	Law 20631 Decree 493/01 Law 25710, 25717 Law 26346	Q4 97 - Q1 09 Q3 01 - Q1 09 Q1 03 - Q1 09 Q1 08 - Q1 09				
Domestic VAT	Decree 493/01	Q3 01 - Q1 09				
External VAT	Law 20631 Decree 493/01 Law 25710, 25717 Law 26346	Q4 97 - Q1 09 Q3 01 - Q1 09 Q1 03 - Q1 09 Q1 08 - Q1 09			Law 25710, 25717	Q1 03
Social Security	Law 25453, Decree 1009/01 General Resolution 1750/04 Decree 1346/07, General Resolution 2055/07 Decree 279/08, General Resolution 2431, 08	Q3 01 - Q1 09 Q4 04 - Q1 09 Q4 07 - Q1 09 Q2 08 - Q1 09				
Bolivia						
IT	Law 1606 Law 2493, 2196	Q1 95 - Q1 09 Q3 01 - Q1 09			Law 2493, 2196	Q3 01
PIT	Law 2493, 2196	Q3 01 - Q1 09	Law 2493, 2196	Q3 01	Law 2493, 2196	Q3 01
CIT	Law 1606	Q1 95 - Q1 09	Law 1606	Q1 95	Law 1606	Q1 95
VAT			Law 1606	Q1 95	Law 1606	Q1 95
Domestic VAT	Law 2064	Q3 00 - Q1 09	Law 1606	Q1 95	Law 1606	Q1 95
External VAT	Law 2064	Q3 00 - Q1 09	Law 1606 Law 2064	Q1 95 Q3 00	Law 1606	Q1 95
Commodities	Law 1606 Law 1981 Law 3058	Q1 95 - Q1 09 Q1 00 - Q1 09 Q2 05 - Q1 09	Law 1981	Q1 00	Law 1981 Law 3058	Q1 00 Q2 05

Note: SR, LR denote short-run and long-run, respectively; Q1,…, Q4 denote first to fourth quarter, respectively;

[a] D.O.F. denotes *Diario Oficial de la Federacion*

[Table is continued on the following 3 pages.]

[continued]	LR-E		Symmetric SR-E		Asymmetric SR-E	
Brazil						
IT	Law 8981/95	Q1 95 - Q1 09	Law 9249/95, 9778/98	Q1 98	Law 9249/95, 9778/98	Q1 98
	Law 9249/95, 9778/98	Q1 98 - Q1 09				
CIT	Law 8981/95	Q1 95 - Q1 09				
Social Security	Provisional Measure 413/08	Q3 08 - Q1 09				
Chile						
IT	Law 20170	Q1 07 - Q1 09				
PIT	Law 19506	Q4 97 - Q1 09			Law 20255	Q1 09
	Law 19578	Q3 05 - Q1 09				
CIT	Law 19506	Q4 97 - Q1 09				
	Law 20170	Q1 07 - Q1 09				
VAT	Law 19398	Q4 95 - Q1 09				
	Law 19633	Q4 94 - Q1 09				
	Law 19738	Q1 02 - Q1 09				
	Law 19888	Q4 03 - Q1 09				
	Law 20190	Q2 07 - Q1 09				
Domestic VAT	Law 19738	Q1 02 - Q1 09	Law 19888	Q4 03	Law 19888	Q4 03
External VAT	Law 19738	Q1 02 - Q1 09				
	Law 20190	Q2 07 - Q1 09				
Colombia						
IT	Law 488	Q1 01 - Q4 08				
	Law 863	Q1 04 - Q4 08				
VAT	Law 488	Q1 01 - Q4 08				
	Law 1111	Q1 07 - Q4 08				
Domestic VAT	Law 488	Q1 01 - Q4 08				
External VAT	Law 488	Q1 01 - Q4 08			Law 1111	Q1 07
	Law 1111	Q1 07 - Q4 08				
Dominican Republic						
IT	Law 288-04	Q4 04 - Q1 09				
VAT	Law 147-00	Q1 01 - Q1 09	Law 11-92	Q3 09	Law 11-92	Q3 09
	Law 557-05	Q1 06 - Q1 09			Law 557-05	Q1 06
	Law 495-06	Q1 07 - Q1 09				
	Law 172-07	Q4 07 - Q1 09				
Mexico						
IT	D.O.F.[a)] 01-01-2002	1Q 02 - Q1 09				
	D.O.F. 26-11-2005, 08-12-2005, 23-12-2005	1Q 06 - Q1 09				
VAT	D.O.F. 28-12-1994	1Q 95 - Q1 09	D.O.F. 28-12-1994	1Q 95	D.O.F. 30-12-2002	1Q 03
	D.O.F. 30-12-2002	1Q 03 - Q1 09	D.O.F. 30-12-2002	1Q 03		

[continued]	LR-E		Symmetric SR-E		Asymmetric SR-E	
Social Security	D.O.F. 21-12-1995	1Q 95 - Q1 09	D.O.F. 21-12-1995	1Q 95	D.O.F. 20-12-2001	1Q 03
	D.O.F. 20-12-2001	1Q 03 - Q1 09	D.O.F. 20-12-2001	1Q 03		
Commodities	D.O.F. 21-12-2005	1Q 06 - Q1 09				
Peru						
IT	Law 27356	Q1 01 - Q1 09	Law 27356	Q1 01	Law 27356	Q1 01
	Law 27804	Q1 03 - Q1 09	Law 27804	Q1 03	Law 27804	Q1 03
	Legislative Decree 945	Q1 04 - Q1 09	Law 28655	Q1 06		
	Law 28655	Q1 06 - Q1 09				
PIT	Law 27356	Q1 01 - Q1 09	Law 27356	Q1 01	Law 27356	Q1 01
	Law 27804	Q1 03 - Q1 09	Law 27804	Q1 03	Law 27804	Q1 03
	Legislative Decree 945	Q1 04 - Q1 09				
CIT	Law 27356	Q1 01 - Q1 09	Law 27356	Q1 01	Law 27356	Q1 01
	Law 27804	Q1 03 - Q1 09	Law 27804	Q1 03		
	Legislative Decree 945	Q1 04 - Q1 09	Law 28655	Q1 06		
	Law 28655	Q1 06 - Q1 09				
VAT			Supreme Decree 024-2004, Legislative Decree 950	Q2 04		
Domestic VAT			Supreme Decree 024-2004, Legislative Decree 950	Q2 04		
External VAT	Supreme Decree 024-2004, Legislative Decree 950	Q2 04 - Q1 09	Supreme Decree 024-2004, Legislative Decree 950	Q2 04		
Commodities	Law 27356	Q1 01 - Q1 09	Law 27804	Q1 03	Law 27804	Q1 03
	Law 27804	Q1 03 - Q1 09				
	Legislative Decree 945	Q1 04 - Q1 09				
	Law 28258	Q2 05 - Q1 09				
Uruguay						
IT	Law 17453	Q2 02 - Q2 07				
	Law 18083	Q3 07 - Q1 09				
CIT	Law 17453	Q2 02 - Q2 07				
VAT	Law 17296	Q2 01 - Q1 09				
	Law 17453, 17503	Q2 02 - Q1 09				
	Law 17615, 17651	Q2 03 - Q1 09				
	Law 18083	Q3 07 - Q1 09				
	Law 18341	Q2 08 - Q1 09				

[continued]	LR-E		Symmetric SR-E	Asymmetric SR-E
Domestic VAT	Law 17453, 17503	Q2 02 - Q1 09	Law 17453, 17503	Q2 02
	Law 18341	Q2 08 - Q1 09		
External VAT	Law 17296	Q2 01 - Q1 09		
	Law 17615, 17651	Q2 03 - Q1 09		
	Law 18083	Q3 07 - Q1 09		