IDB WORKING PAPER SERIES No. IDB-WP-348

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August 2012

Inter-American Development Bank
Institutions for Development (IFD)

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2012

Cataloging-in-Publication data provided by the
Inter-American Development Bank
Felipe Herrera Library

Perry, Guillermo.
The effects of oil and mineral taxation on non-commodity fiscal revenues / Guillermo Perry, Sebastián Bustos.
p. cm. (IDB working paper series ; 348)
Includes bibliographical references.
1. Petroleum—Taxation. 2. Mines and mineral resources—Taxation. 3. Revenue. 4. Fiscal policy. 5. Finance, Public. I. Bustos, Sebastián. II. Inter-American Development Bank. Institutions for Development Sector. III. Title. IV. Series.
IDB-WP-348

http://www.iadb.org

Abstract[*]

This paper shows, first, that non-commodity revenues are more volatile in oil- and mineral-rich countries and that quality of institutions is associated with lower volatility. We investigate the channels through which oil and mineral revenue volatility lead to non-commodity revenues volatility, and find that when oil and fiscal revenues increase (decrease), non-commodity revenues are reduced (increased) discretionally, and that this substitution effect is larger and faster than an indirect positive income effect through increased public expenditures and GDP. Latin American oil- and mineral-rich countries appear, though, to behave differently. In particular, most of them show increased non-commodity revenues *pari passu* with increased oil and mineral revenues during the last decade. These findings have consequences for the overall volatility of public expenditures and the effectiveness of automatic tax stabilizers in oil- and mineral-rich countries.

JEL codes: E61, F43, H21, H25, H50, H63, O11, Q30, Q33

Keywords: Natural resources**,** Windfall public revenues, Natural resource curse, Optimal fiscal policy

[*] Prepared for the IADB Research Network Project "The Future of Taxation in Latin America and the Caribbean" (RG-K1198), Sub Project 1:"Understanding the Cyclical Behavior of Fiscal Revenues."

1. Introduction

This paper assesses the effects of oil and mineral wealth on the volatility of non-commodity revenues. For this purpose, we use panel data for 139 countries, 41 of which are characterized as oil or mineral rich according to International Monetary Fund (IMF) criteria (see IMF, 2007). Previous work (Bornhorst et al., 2009; Perry, Bustos, and Ho, 2011) show that in oil- and mineral-rich countries, non-commodity revenues tend to be lower than in other countries, by around 20 to 22 percent of the value of fiscal revenues derived from oil and minerals, thus reducing the size of automatic stabilizers. This paper analyzes whether oil and mineral wealth, in addition, tend to render non-commodity revenues, and hence automatic stabilizers, more volatile. These issues are of special interest given the increase in commodity prices observed in the last decade and the subsequent increase in the share of natural resource fiscal revenue to total revenues in several countries.

We find evidence that non-commodity revenues are indeed more volatile in oil- and mineral-rich countries. Further, the richer the country is in oil and minerals (as measured by its net oil and mineral exports per capita) or the more fiscally dependent on oil and mineral taxation (as measured by the ratio of oil and mineral fiscal revenues to GDP or to total fiscal revenues), the higher the volatility of non-commodity revenues will be. We also find that the quality of institutions mitigates this effect to some extent, especially in lower-income countries, which tend to exhibit higher volatility of non-commodity revenues.

The paper explores the channel through which the high volatility of oil and mineral fiscal revenues appears to be transmitted to a higher volatility of non-commodity revenues. There is robust evidence that the discretionary direct substitution effect of non-commodity revenues for oil and mineral revenues, found in previous work, dominates over the positive indirect effect through higher public expenditures and GDP volatility. The indirect effect is not only smaller, but has a lag of about a year. In other words, when oil and fiscal revenues go up, non-commodity revenues are reduced discretionally, and this effect is larger and faster than the indirect positive effect through increased GDP, as a consequence of higher public expenditures. The opposite happens when commodity-related fiscal revenues go down.

This finding is both good and bad news. It is good news insofar as the dominant direct substitution effect reduces the volatility of total fiscal revenues that would take place in its absence, and thus mitigates to some extent the higher volatility of public expenditures observed in oil- and mineral-rich countries. On the other hand, the substitution effect is also bad news, as the size of automatic stabilizers, which depend on the size of non-commodity-related fiscal revenues, is reduced precisely when they are most needed.

We should caution, however, that our results do not hold when we limit the sample to Latin American countries. The direct substitution effect between oil and mineral fiscal revenues and non-commodity fiscal revenues is on average smaller in this region than the average result we find using the complete sample, and does not dominate the indirect effect through increased public expenditures and augmented GDP. As a matter of fact, we observe that in several natural resource-rich Latin American countries, non-commodity fiscal revenues have increased since 2003 *pari passu* with the commodity-related fiscal revenues due to rising commodity prices. Policy conclusions for individual countries require country-specific analyses of these trends.

Finally, we tested for asymmetries in these estimated effects. We find that non-commodity revenue income elasticities are generally higher when GDP variations are above trend than when they are below trend, while direct substitution effects of non-commodity revenues for oil and mineral revenues are higher when oil and mineral revenues drop than when they increase. These asymmetric effects are probably due to government attempts to avoid deep expenditure cuts when GDP or oil and mineral revenues fall. Further, the asymmetry of substitution effects is more pronounced as countries are more fiscally dependent on oil and mineral revenues (that is, as oil and mineral revenues represent a higher fraction of their total fiscal revenues).

2. Conceptual Framework

Countries rich in oil and minerals experienced a large positive shock in recent years, to which they reacted in different ways. The resulting higher fiscal revenues derived from these activities could have been used for three different purposes: increased public expenditures, lower taxes on other activities, and/or reductions in the level of net public debt (or accumulation of public sector financial assets) with respect to the levels they would have had otherwise. The optimal use of the increased revenue depends on the relative values of the marginal social value of public

expenditures, the marginal social cost of general taxes and of public debt, and the marginal social rate of return of accumulated financial assets. In an optimal growth path, all of these social costs and returns should be equated in the margin at any point in time. The optimal short-term mix would depend on the level of development and the quality of institutions in each country, which determine the relative value of these social returns. Papers that explore these issues include van der Ploeg and Venables (2011), Collier et al. (2010), and Cárdenas, Ramirez, and Tuzemen (2011).[1] In practice, however, decisions on how to use the increased revenues may deviate from optimality due to political economy considerations. In a previous paper, Perry, Bustos, and Ho (2011) tested these hypotheses regarding the use of higher commodity revenues empirically.

What countries do in the short run with increased fiscal revenues derived from these activities may increase macroeconomic volatility and exacerbate the effect of oil and mineral price shocks (see van der Ploeg, 2010; van der Ploeg and Venables, 2011). This increased volatility may occur if increased revenues derived from higher prices are used mostly to boost public expenditures, which consequently would increase aggregate demand and GDP growth depending on the effectiveness of fiscal multipliers. Such an effect will in turn also increase non-commodity fiscal revenues depending on the value of their income elasticity. The opposite may occur when oil and mineral fiscal revenues fall due to an adverse external shock. This is an indirect channel through which the high volatility that characterizes oil and mineral resources may be transmitted to high volatility of non-commodity revenues, and the cycles of commodity and non-commodity revenues would be positively correlated.

On the other hand, using increased fiscal revenues derived from taxing these activities to keep general taxes lower or to reduce them would have the effect of reducing automatic stabilizers. Hence, through this direct substitution channel, the commodity boom experiences since the mid-2000s may also have contributed to increased macroeconomic volatility in natural resource-rich countries.

If governments reduce (or increase) other taxes whenever fiscal revenues from oil and minerals rise (or fall), then the high volatility of oil and mineral fiscal revenues will be directly transmitted to non-commodity related fiscal revenues, though in such a way that it will attenuate the effect on the volatility of overall revenues. The net impact on non-commodity revenues will

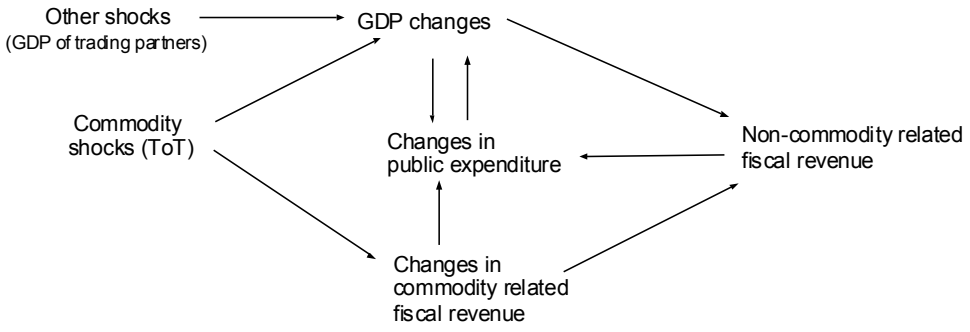
[1] Perry and Olivera (2009) explore whether countries benefitted from rents generated from natural resources and show that the effects depend on the quality of institutions. Using data from Colombia, they also show that a local resource curse can be mitigated through better institutions.

depend on the response of private demand to the reduction of taxes and the effects of this increase in aggregate demand on non-commodity revenues.

In practice, as mentioned before, countries may use increased oil and mineral revenues to increase public expenditures, reduce other taxes and debt, or accumulate financial assets. Notice that the direct substitution effect on non-commodity revenues just discussed would go in the opposite direction to the indirect income effect through increased expenditures and increased GDP volatility described above. Which effect dominates will depend on the relative magnitudes of increased public expenditures and reduction of general taxes, as well as on the effectiveness of public expenditure, tax multipliers, and the income elasticity of non-commodity-related revenues. The two effects may cancel each other out and we may thus fail to find meaningful empirical statistical relations in our econometric estimates.

These direct and indirect channels are indicated in Figure 1. Direct effects will depend on the choice of governments to use higher oil and minerals revenues to reduce other taxes in the short run. The direct effect will depend also on private demand responses to the reduction in taxes. Indirect effects, of a contrary sign, will depend on the degree to which governments uses increased oil and mineral revenues to boost public expenditures, as well as on the fiscal multiplier of these expenditures and the income elasticity of other taxes.

Figure 1. Direct and Indirect Effects of Shocks on Non-commodity-related and Non-related Fiscal Revenues



3. The Data

We constructed a dataset consisting of 139 countries, 41 of which are characterized as oil or mineral rich according to IMF criteria. Data on hydrocarbon-rich countries comes from Villafuerte and Lopez-Murphy, 2010. We augmented this data set with fiscal revenues derived

from mining activities for countries that fulfilled the IMF criteria. Our sources of data were the IMF Article IV consultations done for each country. Unfortunately we do not have data for countries that did not fulfill the IMF criteria of natural-resource dependency. The dataset has most fiscal indicators starting in 1991.

The difficulty in calculating the fiscal revenue associated with commodities for each country comes from the fact that resources are collected by governments at least in three different ways: 1) revenues from natural resources could come from specific taxes (royalties), 2) public companies exploit the natural resources and the profits are transferred to the governments, and 3) corporate taxes are levied on private and publicly owned companies that exploit the resources. The IMF requires resource-rich countries to calculate overall revenues from oil and minerals, and these figures are informed in the IMF Article IV consultations. Unfortunately, they are not disaggregated into their components.

Table 1 presents the summary statistics of the data used. We notice, first, that oil- and mineral-rich countries have much lower non-commodity revenues than other countries (19.2 percent versus 30.4 percent of GDP, or 23.8 percent versus 30.4 percent of non-oil non-mineral GDP), as found in previous studies. As their fiscal revenues from oil and minerals amount on average to 16.4 percent of GDP, these figures suggest that the presence of the latter is used to a significant degree to lower general taxes. Second, non-commodity revenues are significantly more volatile (as measured by the standard deviation of the detrended series) in oil and mineral countries (0.20 versus 0.09 in the rest) and almost as high as the volatility of oil and mineral fiscal revenues (0.26). These figures further suggest that the high volatility of oil and mineral revenues is largely transmitted to the volatility of non-commodity fiscal revenues. As oil- and mineral-rich countries do not appear to have significantly more volatile GDP (0.3 for both samples), the transmission of volatility would appear to happen mostly through direct substitution between these types of fiscal revenues. Further, these traits are just slightly more pronounced in countries that are more dependent on oil and mineral fiscal revenues, indicating that they are characteristic of all oil- and mineral-rich countries.

Before examining our hypothesis econometrically, we briefly describe the data for the Latin American oil- and mineral- rich countries in recent decades, as this region is found to have a different behavior than the rest in our econometric estimates.

Table 1. Summary Statistics

Dependent variables:	All			Non resource-rich countries			Resource-rich countries		
Variable	Obs.	Mean	Std. Dev.	Obs.	Mean	Std. Dev.	Obs.	Mean	Std. Dev.
NRFR/GDP	2,771	3.4	9.6	2,197	0.0	0.3	574	16.4	15.2
non-NRFR/GDP	2,897	27.7	19.7	2,197	30.4	20.8	700	19.2	12.4
non-NRFR/GDP(non-NR)	2,553	29.3	14.0	2,088	30.4	14.2	445	23.8	11.5
Net natural resource exports	2,635	666	2,537	1,971	124.0	375.0	664	2,275.0	4,657.0
GDP per capita	2,772	6,800	9,758	2,099	7,195	10,078	673	5,570	8,577
NRFR cycle	2,689	0.0	0.1	2,168	0.0	0.0	521	0.0	0.3
non-NRFR cycle	2,715	0.0	0.1	2,084	0.0	0.1	631	0.0	0.2
GDP cycle	2,735	0.0	0.0	2,084	0.0	0.0	651	0.0	0.0

Table 1. Summary Statistics

	Resource-rich countries with commodity-related fiscal revenues above 40 Percent of total fiscal revenues		
Variable	**Obs.**	**Mean**	**Std. Dev.**
NRFR/GDP	334	24.53	15.10
non-NRFR/GDP	460	17.23	13.12
non-NRFR/GDP(non-NR)	277	20.85	9.54
net natural resource exports	431	2,939	5,211
GDP per capita	433	6,069	8,045
NRFR cycle	291	0.04	0.20
non-NRFR cycle	395	0.00	0.23
GDP cycle	415	0.00	0.03

4. Econometric Estimates: Methodological Approach

This section presents the equations and the econometric strategy employed. In particular, it discusses the alternative ways in which we dealt with endogeneity of the GDP cycle to oil and mineral shocks in natural resource-rich countries.

The two basic equations that we use are the following:

$$volatility(nonNRFR)_i = \alpha + \varphi \cdot log(GDP)_i + \omega \cdot abundance_i + \epsilon_i \quad (1)$$

$$Non - NRFR^*_{i,t} = \alpha + \beta \cdot GDP^*_{i,t} + \gamma \cdot abundance_i \cdot GDP^*_{i,t} + \theta \cdot abundance_i \cdot NRVAR^*_{i,t} + \mu_i + \epsilon_{i,t} \quad (2)$$

where:

- $NonNRFR^*_{i,t}$ stands for variations around trend or logarithmic change of the non-commodity-related taxes in country i at time t
- $GDP^*_{i,t}$ is non-commodity GDP variations around trend or output gap in country i at time t. We used both total GDP and non-oil non-mineral GDP for all estimations, but because most non-commodity taxes are not direct taxes on other activities, but taxes on goods and services and international trade that are more responsive to total GDP, as discussed in

Section 5.2 below, the results turn out to be more robust when using total GDP. As a consequence, we report mostly results using total GDP.

- $abundance$ is alternatively:
    - Average oil and mineral fiscal revenues to GDP in country i over the period.
    - Average oil and mineral fiscal revenues to total fiscal revenues in country i over the period.
    - Average level of net oil and mineral exports per capita, in logs.

The last of these measures is more properly a measure of abundance while the other two are measures of fiscal dependence from oil and mineral revenue.[2]

- $NRVAR^{*}_{i,t}$ is, alternatively:
    - Variations around trend (or changes) of oil and mineral fiscal revenues in country i at time t.
    - Variations around trend (or changes) of net oil and mineral exports per capita, as a measure of resource abundance in country i at time t.
- μ_i is the country fixed effects and $\epsilon_{i,t}$ is the error term.

Equation 1 is the basic equation used to analyze whether the volatility of non-commodity fiscal revenues is higher for oil and mineral-abundant or fiscally dependent countries, while equation 2 is used to explore the channels through which changes in oil and mineral fiscal revenues affect non-commodity revenues.

In equation 1, coefficient φ captures the relationship between the level of income of the country and the volatility of non-natural resource fiscal revenue. We expect richer countries, which are more diversified and have more developed institutions and domestic financial systems, to have less macro volatility (as commonly found in the literature) and hence lower non-commodity revenue volatility. Coefficient ω captures the effect of oil and mineral abundance on non-commodity fiscal revenue volatility.

In equation 2, coefficient γ captures the income elasticity of non-commodity revenues (e.g., the response of changes or variations around trend of non-commodity revenues to changes or variations around trend of non-commodity or total GDP), and whether it differs from the level

[2] It is the proposed Leamer revealed comparative advantage index (see Lederman and Maloney, 2003).

of commodity abundance. Coefficient θ tests if changes or variations around trend of non-commodity revenues respond to changes or variations around trend of oil and mineral revenues, in addition to their response to changes or variations around trend of non-commodity or total GDP. We expect coefficient γ to be larger than θ when non-commodity or total GDP changes or variations around trend are closely correlated with oil and mineral price changes or variations around trend.

In addition, we augmented equations 1 and 2 to include alternative indexes of quality of institutions, in order to test if country responses differ depending on the quality of the institutional framework of countries.

As mentioned above, we use two ways to define the fluctuations in the variables used in the estimations. The first one assumes that variables fluctuate around a linear trend. Thus, we use differences in the variables and control for country fixed effects to capture this trend. The second way is to assume a more flexible trend, for which we detrended the variables using a Hodrick-Prescott filter. For example, "GDP cycle" is calculated as the deviations of the output (in logs) from the trend calculated using smoothness parameter of the Hodrick-Prescott filter equal to 6.25, following Ravn and Uhlig's (2002) recommendation for annual data. We use these two measures of fluctuations to show that the results are robust to the definition used.

Since there is potential endogeneity between non-commodity fiscal revenues and the non-commodity or total GDP cycle, we instrumented GDP cycles using exogenous demand shocks.[3] These shocks could come from shocks to international prices or shocks to the demand from trading partners. To capture the shock from prices, we calculated the following variable,

$$Shock\ to\ Terms\ of\ Trade_{i,t} = \left(\frac{1}{5}\cdot\sum_{j=0}^{4}\left(\frac{EXP}{GDP}\right)_{i,t-j}\right)\cdot log(terms\ of\ trade)^{*}_{\mathrm{i,t}}$$

The first part of the expression is the average exports over output for the last five years, to weight the effect by the relative importance of international demand shocks on the economic output. The second part of the expression is the terms of trade cycle, calculated from deviations from Hodrick-Prescott trend.

[3] Our instrument strategy is similar to the one use by Panizza and Jaimovich (2007) and Alesina, Campante, and Tabellini (2008).

To proxy for the changes to the demand from trading partners, we calculated the following variable:,

$$Trade\ shock_{i,t} = \left(\frac{1}{5} \cdot \sum_{j=0}^{4} \left(\frac{EXP}{GDP}\right)_{i,t-j}\right) \cdot \left(\sum_{w=1}^{N} \emptyset_{i,t} \cdot \Delta \log\left(GDP\right)_{w,t}\right)$$

where the first part of the expression is the same as the previous variable, and the second part of the expression is the change in the real GDP growth of the trade partners, weighted by their share in total exports of country, which is represented by the term $\emptyset_{i,t}$.

We also estimated a reduced form of the inter-relations indicated in the diagram above by estimating directly the effects on changes and variations around trend of non-commodity fiscal revenues of changes and variations around trend of oil and mineral revenues, of terms of trade and of main commodity export prices (the latter for the reduced sample of oil- and mineral-rich countries).

Finally, we tested for asymmetric responses of non-commodity revenues variations around trend to positive and negative variations around trend of non-commodity GDP and oil and mineral fiscal revenues.

5. Results

5.1 Is Volatility of Non-commodity Fiscal Revenues Higher in Oil- and Mineral-rich Countries?

Table 3 shows our estimates of equation 1. Columns 1 to 4 use the standard deviation of changes of non-commodity fiscal revenues as dependent variable, while columns 5 to 8 use as dependent variable the standard deviation of their deviations from trend. The results indicate that the volatility of non-commodity fiscal revenues is higher in natural resource-abundant countries and that it increases with higher values of our measures of natural resource abundance or fiscal dependence. The estimates also suggest that countries with higher per capita income have less volatile non-commodity fiscal revenues. This result is consistent with the common finding that higher per capita income is associated with lower levels of macroeconomic volatility.

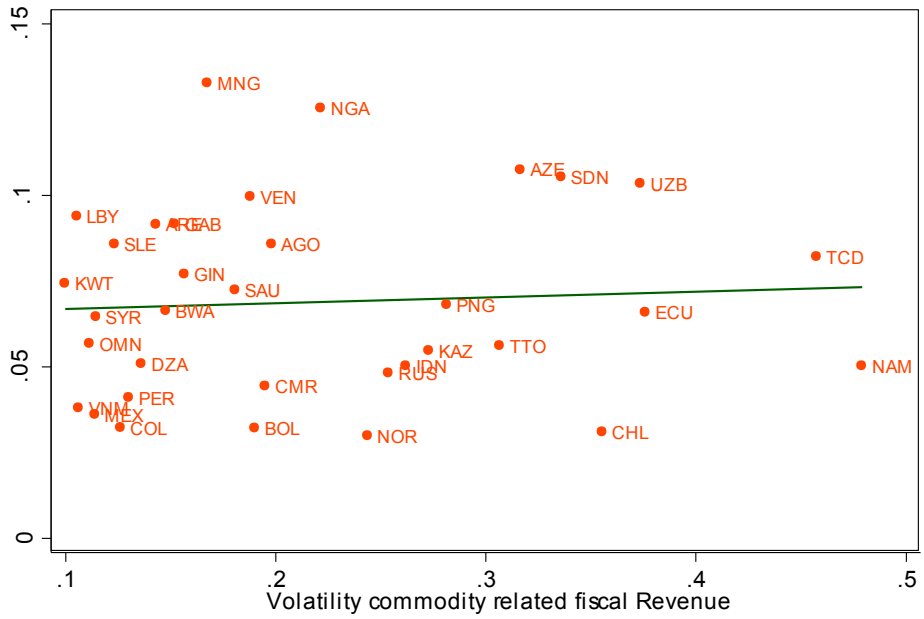
Table 3. Volatility of Non-NR Fiscal and NR Abundance

Dependent variables:	Standard deviation of Δlog(non-NR fiscal revenue)				Standard deviation of log(non-NR fiscal revenue) cycle			
Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
log(GDP pc)	-0.030***	-0.035***	-0.033***	-0.049***	-0.016***	-0.019***	-0.018***	-0.028***
	(0.006)	(0.005)	(0.005)	(0.006)	(0.004)	(0.003)	(0.003)	(0.004)
Average NRFR/GDP		0.007***				0.004***		
		(0.001)				(0.001)		
Average NRFR/FR			0.282***				0.173***	
			(0.049)				(0.027)	
log(average net NR exports per capita)				0.019***				0.011***
				(0.004)				(0.002)
Constant	0.369***	0.382***	0.360***	0.454***	0.206***	0.214***	0.201***	0.257***
	(0.050)	(0.047)	(0.048)	(0.049)	(0.029)	(0.027)	(0.027)	(0.028)
Observations	136	135	135	136	136	135	135	136
R-squared	0.152	0.327	0.380	0.285	0.133	0.328	0.392	0.276

Notes: Sample limited to countries with at least 7 observations. *Significant at 10%; **significant at 5%; ***significant at 1%.

The volatility of commodity-related fiscal revenue could be linked to GDP volatility through government expenditures. Figure 2 shows the relationship between volatility of government expenditures and commodity related fiscal revenue. The figure shows that there is no relation between the two variables. However, we think that this is misleading since the impact of the volatility of revenues on expenditures depends on the relative importance of non-commodity revenues as a share of total revenues. To explore this we estimated a regression of the volatility of government expenditure as a function of the volatility of commodity-related fiscal revenue and its relative importance. The estimates are shown in Table 4. Column 1 of Table 4 shows the result of running the regression for the 1990–2009 period controlling only for the volatility of commodity fiscal revenue, finding that the relationship is statistically not different from zero, confirming what is shown in Figure 2. In column 2 we include as an additional control the interaction between volatility of commodity-related fiscal revenue and the average share in total fiscal revenue over the period. The results of column 2 indicate that there is a positive relationship between the volatility of commodity-related revenues and the volatility of government expenditures. Since the last decade experienced considerable volatility in commodity prices, we are interested in examining whether there was a change in the relationship between commodity-related revenues and government expenditures. Thus, in columns 3 and 4 of Table 4, we repeat the exercise restricting the sample to the last decade. We find that the previous results hold and that the positive correlation between volatility of commodity-related revenues and volatility of government expenditures increased in the last 10 years.

Figure 2. Volatility of Government Expenditure and Commodity-related Fiscal Revenue 1990–2009



Note: Volatility is measured as the standard deviation of the cycle of the variables around a Hodrick-Prescott trend.

Table 4. Volatility of Government Expenditure

	Volatility of government expenditure			
	1990–2009		2000–2009	
Variables	**(1)**	**(2)**	**(3)**	**(4)**
Volatility NRFR cycle	0.017	-0.021	-0.019	-0.060***
	(0.040)	(0.043)	(0.038)	(0.021)
Volatility NRFR cycle x (NNRR/FR)		0.226**		0.316***
		(0.102)		(0.069)
Constant	0.065***	0.056***	0.071***	0.055***
	(0.010)	(0.011)	(0.009)	(0.009)
Observations	34	34	34	34
R-squared	0.004	0.169	0.006	0.388

Notes: Sample limited to countries with at least 7 observations. *Significant at 10%; **significant at 5%; ***significant at 1%.

Tables 5 and 6 present the results of expanding equation 1 by including additional control variables that proxy for quality of institutions. These two tables only differ in how we measure volatility of non-commodity revenues. Table 5 measures it as the standard deviation of changes, while Table 6 measures it as the standard deviation of deviations from trend. The general conclusions from Table 3 hold. Our estimates indicate that government effectiveness, regulatory quality, and rule of law indexes are significantly associated with less volatility of non-commodity fiscal revenues, though this effect decreases with the level of income of the country. This is not the case, however, for other measures of institutional quality, such as political stability or control of corruption.

Table 5. Volatility of Non-NR Fiscal Revenue Growth and Institutions

Dependent variable:	Standard deviation of Δlog(non-NR fiscal revenue)					
Variables	(1)	(2)	(3)	(4)	(5)	(6)
log(GDP pc)	-0.033***	-0.043***	-0.019	-0.042***	-0.030**	-0.019
	(0.005)	(0.014)	(0.013)	(0.009)	(0.012)	(0.012)
Average NRFR/FR	0.282***	0.304***	0.269***	0.305***	0.284***	0.255***
	(0.049)	(0.052)	(0.056)	(0.049)	(0.054)	(0.052)
Control of Corruption		0.020				
		(0.072)				
Control of Corruption x log(GDP pc)		0.000				
		(0.007)				
Government Effectiveness			-0.160***			
			(0.047)			
Government Effectiveness x log(GDP pc)			0.016***			
			(0.004)			
Political Stability				-0.012		
				(0.049)		
Political Stability x log(GDP pc)				0.005		
				(0.006)		
Rule of Law					-0.095*	
					(0.051)	
Rule of Law x log(GDP pc)					0.011**	
					(0.005)	
Regulatory Quality						-0.137***
						(0.046)
Regulatory Quality x log(GDP pc)						0.013***
						(0.005)
Observations	135	135	135	135	135	135
R-squared	0.380	0.387	0.408	0.394	0.392	0.411

Notes: Sample limited to countries with at least 7 observations. *Significant at 10%; **significant at 5%; ***significant at 1%. Constant term is not shown.

Table 6. Volatility of Non-NR Fiscal Revenue Cycle and Institutions

Dependent variable:	Standard deviation of log(non-NR fiscal revenue) cycle					
Variables	(1)	(2)	(3)	(4)	(5)	(6)
log(GDP pc)	-0.018***	-0.023***	-0.011	-0.023***	-0.016**	-0.011
	(0.003)	(0.008)	(0.008)	(0.005)	(0.007)	(0.007)
Average NRFR/FR	0.173***	0.184***	0.166***	0.185***	0.173***	0.158***
	(0.027)	(0.029)	(0.030)	(0.027)	(0.029)	(0.029)
Control of Corruption		0.012				
		(0.041)				
Control of Corruption x log(GDP pc)		-0.000				
		(0.004)				
Government Effectiveness			-0.081***			
			(0.027)			
Government Effectiveness x log(GDPpc)			0.008***			
			(0.003)			
Political Stability				-0.002		
				(0.027)		
Political Stability x log(GDPpc)				0.002		
				(0.003)		
Rule of Law					-0.049*	
					(0.029)	
Rule of Law x log(GDP pc)					0.005*	
					(0.003)	
Regulatory Quality						-0.066**
						(0.026)
Regulatory Quality x log(GDP pc)						0.006**
						(0.003)
Observations	135	135	135	135	135	135
R-squared	0.392	0.397	0.414	0.403	0.402	0.415

Notes: Sample limited to countries with at least 7 observations. *Significant at 10%; **significant at 5%; ***significant at 1%.

5.2 Channels of Transmission of Oil and Mineral Fiscal Revenue Volatility to Non-commodity Fiscal Revenue Volatility

We now turn to the channels through which natural resource fiscal revenues cause higher volatility of non-commodity revenues. For this purpose, we estimate equation 2 as discussed above. As mentioned previously, there is a likely endogeneity between the fluctuations of non-commodity fiscal revenue and non-commodity GDP or total GDP cycle. For this reason, in all of the following estimations we instrumented the GDP cycles using shocks from terms of trade and changes in GDP growth of the trading partners as instrumental variables. The first stage estimates are shown in Appendix 2, and the instrumental variables fulfill the common requirements.

Tables 7 to 8 show results for two alternative measures of our dependent variable: changes and variations around trend of non-commodity fiscal revenues. Table 7 explores whether the income elasticity of non-commodity revenues is higher or lower in oil- and mineral-rich countries by interacting the instrumented GDP cycle with NRFR/FR, the latter used as a measure of fiscal dependence on oil and mineral revenues.[1] The GDP elasticity of non-commodity-related fiscal revenues turns out to be lower in countries dependent on oil and mineral fiscal revenues: we obtain a negative coefficient for NRFR/FR*GDP cycle in columns (2) and (6) of Table 7, indicating the potential presence of a mitigating direct substitution effect. Note, however, that this coefficient becomes non-significant when we estimate equation 1 only for Latin American countries (Table 7b): that is, the income elasticity of non-commodity revenues is not significantly different for oil- and mineral-rich and poor countries within Latin America, in contrast to what we find for the global sample.

We also split the global sample following the IMF's definition of natural resource-rich countries. The coefficient of GDP cycle for non-resource-rich countries is positive (columns 3 and 7) while the same estimate using the sample of resource-rich countries is not statistically different from zero (columns 4 and 8). These results reinforce the results of columns 2 and 6 by showing that countries that are not rich in natural resources have a high and significant income elasticity of non-commodity fiscal revenues, while resource-rich countries have non-commodity fiscal revenues that do not seem to react to the GDP cycle, on average. This result suggests that

[1] The results hold when we use other NRFR/GDP or log(net natural resource exports per capita) as measures of abundance.

for these countries the negative direct substitution effects shown in Figure 1 compensate the positive effects of their potential income elasticity.

Table 7. Non-commodity Fiscal Revenue Fluctuations

Dependent variables:	**Δlog(non-NR fiscal revenue)**				**log(non-NR fiscal revenue) cycle**			
Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
GDP cycle	1.90***	2.95***	3.00***	-0.57	0.95**	2.10***	2.11***	-1.67*
	(0.558)	(0.370)	(0.373)	(1.435)	(0.477)	(0.373)	(0.393)	(0.933)
Average NRFR/FR x GDP cycle		-6.94**				-7.59***		
		(3.504)				(1.746)		
Observations	1,910	1,896	1,412	498	1,971	1,956	1,458	513
R-squared	0.006	0.012	0.020	0.000	0.004	0.024	0.028	0.009
Sample	All	All	Not-NR rich	NR rich	All	All	Not-NR rich	NR rich

Notes: IV regression, "Growth of export partners and terms of trade shocks as instrument for the GDP cycle; cluster-robust standard errors by countries in parentheses. *Significant at 10%; **significant at 5%; ***significant at 1%.

Table 7b shows that the elasticity of non-commodity revenues to GDP cycle appears to be higher in Latin America and, more importantly, that this elasticity is not reduced in oil- and mineral-rich countries.

Table 7b. Non-commodity Fiscal Revenue Fluctuations I: Latin American Countries Sample

Dependent variables:	Δlog(non-NR fiscal revenue)		log(non-NR fiscal revenue) cycle	
Variables	(1)	(2)	(3)	(4)
GDP cycle	4.09***	5.17***	2.49***	2.56**
	(1.018)	(1.604)	(0.872)	(1.193)
Average NRFR/FR x GDP cycle		-8.85		-0.51
		(5.134)		(5.189)
Observations	313	313	328	328
R-squared	0.032	0.036	0.031	0.031
Sample	LAC	LAC	LAC	LAC

Notes: IV regression, "Growth of export partners and terms of trade shocks as instrument for the GDP cycle; cluster-robust standard errors by countries in parentheses. *Significant at 10%; **significant at 5%; ***significant at 1%.

The direct substitution effect between oil and mineral and other fiscal revenues is shown more clearly in Table 8. In this table, we obtain a significant negative coefficient on most terms that include fluctuations of NRFR. We use two measures for NRFR fluctuations, one that considers changes in NRFR (ΔNRFR) and a second one using the deviations from a Hodrick-Prescott trend (NRFR cycle). Columns 2 and 5 of Table 8 suggest that, with either measure of fluctuations, oil and mineral fiscal revenues and non-commodity fiscal revenues move in opposite directions.

In columns 3 and 6 of Table 8 we do an interaction of the fluctuations of NRFR (measured in either of the two ways indicated above) with the average NRFR/FR. The results suggest that the higher the intensity of natural resources in the fiscal budget is, the stronger the direct substitution effect of oil and mineral fiscal revenues on non-commodity fiscal revenues will be. Thus, oil- and mineral-rich countries appear to reduce (increase) discretionary non-commodity fiscal revenues in response to increases (reductions) in oil and mineral fiscal revenues. The short-term elasticity of substitution appears to be on average between 14 and 17 percent (coefficients on ΔNRFR or NRFR cycle), though it can increase to nearly 50 percent in countries with very high dependence on oil and minerals (coefficients on NRFR/FR x ΔNRFR or NRFR/FR x NRFR cycle), as can be seen in Figure 3. As a reference, the average long-term

substitution effect found by Bornhorst et al. (2009) for oil-rich countries and by Perry, Bustos, and Ho (2011) for oil- and mineral-rich countries ranged from 20 to 24 percent.

We obtain a similar though weaker result when we estimate equation 2 only for Latin American countries (Table 8b). The short term elasticity of substitution between oil and mineral fiscal revenues and non-commodity fiscal revenues appears to be on average only between 5 and 7 percent for Latin American oil- and mineral-rich countries, and it varies less with the level of fiscal dependence than in the global sample.

Table 8. Non-commodity Fiscal Revenue Fluctuations II

Dependent variables:	**Δlog(non-NR fiscal revenue)**			**log(non-NR fiscal revenue) cycle**		
Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
GDP cycle	1.902***	2.544***	2.795***	0.946**	1.548***	1.696***
	(0.558)	(0.476)	(0.453)	(0.477)	(0.414)	(0.380)
Δlog(NRFR)		-0.141***	0.083*			
		(0.044)	(0.047)			
Average NRFR/FR x Δlog(NRFR)			-0.632***			
			(0.159)			
log(NRFR) cycle					-0.168***	0.032
					(0.047)	(0.045)
Average NRFR/FR x log(NRFR) cycle						-0.583***
						(0.165)
Observations	1,910	1,783	1,783	1,971	1,881	1,881
R-squared	0.006	0.029	0.048	0.004	0.036	0.052
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	No	No	No	No	No	No

Notes: IV regression, "Growth of export partners and terms of trade shocks as instrument for the GDP cycle; cluster-robust standard errors by countries in parentheses. *Significant at 10%; **significant at 5%; ***significant at 1%.

Figure 3. Substitution Effect (Derived from Table 7)

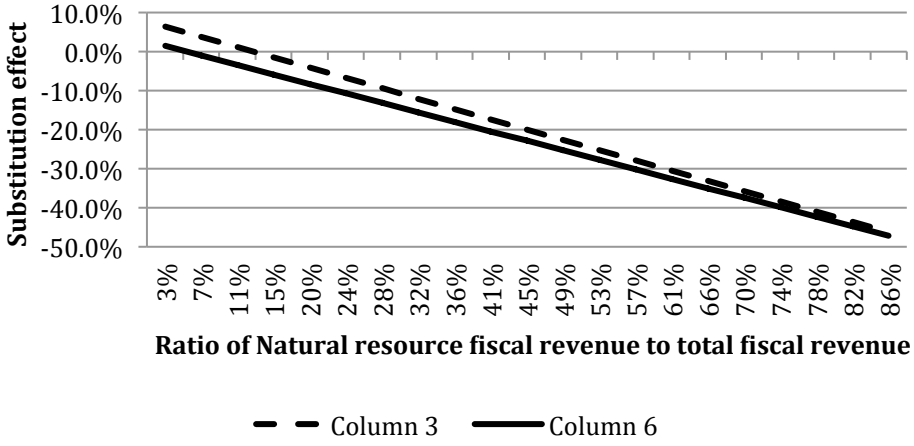


Table 8b. Non-commodity Fiscal Revenue Fluctuations – Latin American Countries Sample

Dependent variables:	**Δlog(non-NR fiscal revenue)**			**log(non-NR fiscal revenue) cycle**		
	(1)	(2)	(3)	(4)	(5)	(6)
GDP cycle	4.09***	5.11***	5.13***	2.49***	3.18***	3.18***
	-1.01	-1.37	-1.38	-0.87	-1.07	-1.09
Δlog(NRFR)		-0.050**	-0.03			
		-0.01	-0.02			
Average NRFR/FR x Δlog(NRFR)			-0.06			
			-0.05			
log(NRFR) cycle					-.068***	-0.04
					-0.01	-0.02
Average NRFR/FR x log(NRFR) cycle						-0.11*
						-0.05
Observations	313	282	282	328	302	302
R-squared	0.032	0.061	0.061	0.031	0.057	0.058
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	No	No	No	No	No	No

Notes: IV regression, "Growth of export partners and terms of trade shocks as instrument for the GDP cycle; cluster-robust standard errors by countries in parentheses. *Significant at 10%; **significant at 5%; ***significant at 1%.

As the Latin American oil- and mineral-rich countries appear to behave somewhat different than the rest, we show in more detail below their recent behavior. Latin American countries in the last 20 years have been less dependent on commodities to finance their governments than other resource-rich countries in the world. However, the importance of commodities for fiscal revenues has been increasing steadily in the last decade. Figures 4 and 5 show the evolution of non-commodity and commodity-related fiscal revenues, comparing the resource-rich countries of Latin America and the Caribbean (LAC) to the other countries in the sample. Figure 4 shows non-commodity-related fiscal revenue as a share of GDP (Panel A) and also as an index (Panel B). From this figure it is clear that, on average, the resource-rich LAC countries have a level of non-commodity fiscal revenue as a share of GDP that is higher than other resource-rich countries. Non-commodity revenue in LAC countries has been increasing for the last 15 years, while in other resource-rich countries, non-commodity fiscal revenue has been more volatile.

Figure 5 shows the average commodity-related fiscal revenue as a share of total fiscal revenue over time for LAC countries and the other resource-rich countries in our sample. Over the period studied, in LAC countries, on average, 15 percent of fiscal revenues were related to commodities, a low figure compared to 47 percent in the other countries. However, the dependency of LAC countries on commodity-related fiscal revenues has been increasing steadily since 2002, reaching a record high of 30 percent of total fiscal revenue in 2008.

Figure 4. Trend of Non-commodity-related Fiscal Revenue to GDP: Latin America vs. Other Resource-rich Countries

Panel A: Average Non-commodity-related Fiscal Revenue as a Share of GDP (%)

Panel B: Average Non-commodity-related Fiscal Revenue as a Share of GDP (Index 1995=100)

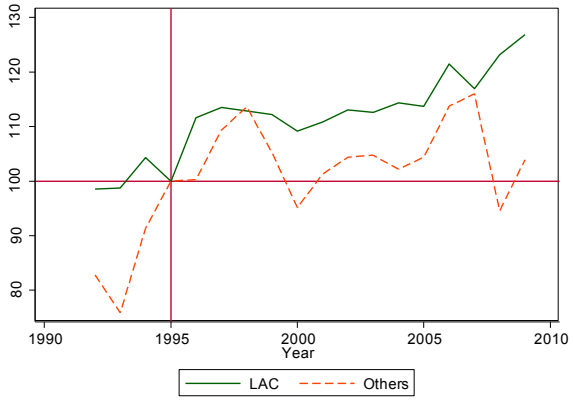


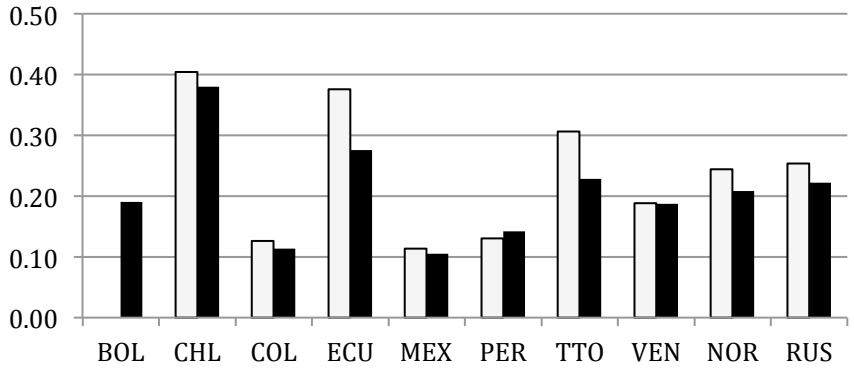
Figure 5. Trend of Commodity-related Fiscal Revenue to Total Fiscal Revenue: Latin America vs. Other Resource-rich Countries

Panel A: Average Commodity-related Fiscal Revenue as a Share of Total Fiscal Revenue (%)

Panel B: Average Commodity-related Fiscal Revenue as a Share of Total Fiscal Revenue (Index 1995=100)

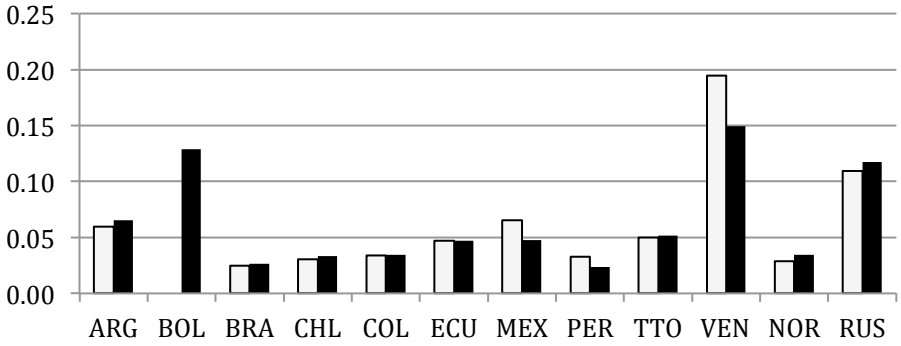
Figure 6 shows the volatility of oil and mineral fiscal revenues in Latin American oil- and mineral-rich countries (measured as the standard deviation of the detrended series). These fiscal revenues have been especially volatile in Chile, Ecuador, Trinidad and Tobago, Venezuela, and Bolivia, in that order. Figure 7 show that non-commodity-related revenues have also been quite volatile in Venezuela and Bolivia. Comparisons of Figures 6 and 7 suggest that non-commodity-related revenues have been more volatile in countries where GDP has been more volatile.

Figure 6. Latin America: Volatility of Oil and Mineral Revenues



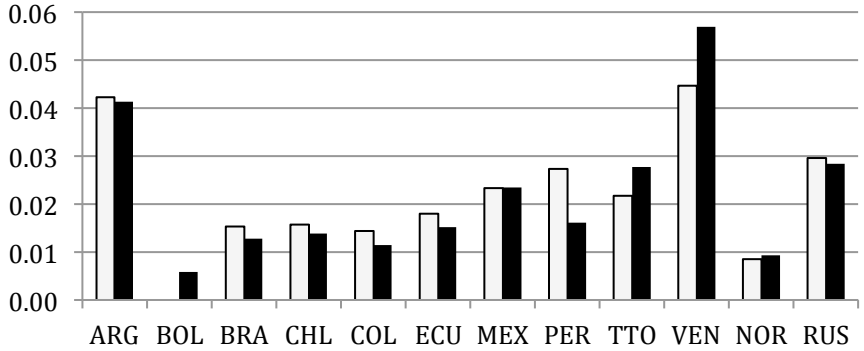
Note: Gray bars: average for 2000/2009; black bars: average for 1990/2009. Norway and Russia are included for comparison.

Figure 7. Latin America: Volatility of Non-commodity Fiscal Revenues



Note: Gray bars: average for 2000/2009; black bars: average for 1990/2009. Norway and Russia are included for comparison.

Figure 8. Latin America: Volatility of GDP Cycle



Note: Gray bars: average for 2000/2009; black bars: average for 1990/2009. Norway and Russia included for comparison.

The previous figures show significant differences across Latin American countries. These differences are summarized in Table 9.[2] Further, the GDP cycle closely follows the cycle of oil and mineral fiscal revenues in most countries. Their co-movement is especially strong in Bolivia and Venezuela (where spending out from volatile oil and mineral fiscal revenues are probably a major determinant of the GDP cycles), but also, in descending order, in Peru, Chile, Colombia, and Trinidad and Tobago.

Table 9. Bilateral Correlations between Oil and Mineral Revenues, Non-commodity Revenues, and GDP Variations around Trend

Country	Correlation (NRFR cycle, non-NRFR cycle)	Correlation (NRFR cycle, GDP cycle)	Correlation (non-NRFR cycle, GDP cycle)
Bolivia	0.37	0.44	0.02
Chile	-0.28	0.22	0.39
Colombia	0.10	-0.12	0.42
Ecuador	-0.46	-0.33	0.13
Mexico	-0.05	-0.02	0.40
Peru	-0.20	0.24	0.47
Trinidad and Tobago	0.15	0.12	0.48
Venezuela	-0.14	0.35	-0.01

However, the detrended components of non-commodity revenues and oil and mineral revenues are positively related only in some countries (especially in Bolivia and less so in Trinidad and Tobago and Colombia), where indirect effects in Figure 1 seem to dominate over direct substitution effects. However, they are negatively related in the rest (especially in Ecuador, but also significantly in Chile, Peru, and Venezuela), where direct substitution effects seem to dominate over indirect effects. In this last group we probably have, however, very different cases: thus, Venezuela is likely to have both very large positive indirect and negative direct substitution effects, while Chile, which saves a large fraction of the copper fiscal booms, is likely to have both modest positive indirect and negative direct effects, though in both cases the negative direct substitution effect appears to be larger than the positive indirect effect through higher expenditures.

[2] In Appendix 1 we show the behavior of these variables from 1990 onward in oil- and mineral-rich Latin American countries. In most countries, detrended non-commodity revenues are closely associated with detrended GDP (exceptions are Venezuela, Bolivia and, to a lesser extent, Ecuador, where tax substitution effects are probably large).

In summary, we should caution that the stylized facts that come out from the econometric exercises presented below for a global panel of countries should not be applied uncritically to all oil- and mineral-rich Latin American countries. More detailed country-specific studies are required to assess specific country relationships among these variables.

5.2.1 Robustness Checks

Table 10 expands the analysis done in Table 8 by using different measures to capture the intensity of natural resources. We control for the interaction between the fluctuation of natural resource fiscal revenues (NRFR) with the average NRFR/FR, NRFR/GDP, and the average net natural resource exports per capita for each country. Results using NRFR/GDP are equivalent to those using NRFR/FR in Table 8.

Table 10. Non-commodity Fiscal Revenue Fluctuations

Dependent variables:	**Δlog(non-NR fiscal revenue)**			**log(non-NR fiscal revenue) cycle**		
Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
GDP cycle	2.795***	2.835***	2.510***	1.696***	1.712***	1.496***
	(0.453)	(0.449)	(0.479)	(0.380)	(0.384)	(0.413)
Δlog(NRFR)	0.083*	-0.003	-0.220			
	(0.047)	(0.054)	(0.200)			
Average NRFR/FR x Δlog(NRFR)	-0.632***					
	(0.159)					
Average NRFR/GDP x Δlog(NRFR)		-0.014***				
		(0.005)				
log(average Net NR exports pc) x Δlog(NRFR)			0.014			
			(0.030)			
log(NRFR) cycle				0.032	-0.062	-0.364*
				(0.045)	(0.059)	(0.206)
Average NRFR/FR x log(NRFR) cycle				-0.583***		
				(0.165)		
Average NRFR/GDP x log(NRFR) cycle					-0.011**	
					(0.005)	
log(average Net NR exports pc) x log(NRFR) cycle						0.034
						(0.031)
Observations	1,783	1,783	1,783	1,881	1,881	1,881

R-squared	0.048	0.042	0.030	0.052	0.043	0.038
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	No	No	No	No	No	No

Notes: IV regression, "Growth of export partners and terms of trade shocks as instrument for the GDP cycle; cluster-robust standard errors by countries in parentheses. *Significant at 10%; **significant at 5%; ***significant at 1%.

A concern is whether the results shown above are driven by the natural resource sector of the economy. To answer this question we repeat the estimations in Table 11 to see if there are significant changes when estimating these equations with adjusted GDP (subtracting from GDP oil and mineral GDP). Coefficients on changes and variations around trend of oil and mineral fiscal revenues remain almost identical as before. However, the coefficients on changes and variations of adjusted GDP become very large (almost double the previous ones) and unstable. The estimated elasticities of around 3.8 to 4.2 are, in our opinion, misleading. Indeed, indirect taxes—on consumption (VAT and specific taxes) or on imports (tariffs)—are a significant proportion of non-commodity fiscal revenues, especially in countries with a high dependence on oil and mineral fiscal revenue, as shown in Figure 9. Since the revenue from these taxes is proportional to overall income, consumption, or GDP, it is misleading to measure them (or their response) exclusively with respect to non-oil, non-mineral GDP. Indeed, in Table 12, where the estimates are restricted to the sample for only oil- and mineral-rich countries, we find that the elasticity of non-commodity revenues with respect to non-commodity GDP becomes insignificant or negative, reinforcing our argument. As a consequence, in what follows we continued to use unadjusted GDP figures.

Table 11. Testing Robustness using Non-oil, Non-mineral GDP instead of Total GDP

Dependent variables:	Δlog(non-NR fiscal revenue)					log(non-NR fiscal revenue) cycle				
Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**
GDP-non NR cycle	8.79***	9.88***	2.14	10.22***	2.18	3.76***	4.15***	-1.25	4.23***	-1.23
	(1.708)	(1.484)	(4.04)	(1.34)	(4.043)	(0.957)	(0.869)	(1.976)	(0.824)	(1.946)
Δlog(NR-FR)		-0.12**	-0.12**							
		(0.053)	(0.052)							
Average NRFR/FR x Δlog(NR-FR)				-0.36**	-0.36**					
				(0.182)	(0.180)					
ln(NR-FR) cycle							-0.12*	-0.14**		
							(0.064)	(0.063)		
Average NRFR/FR xlog(NR-FR) cycle									-0.32	-0.37
									(0.231)	(0.231)
Observations	2,285	2,285	2,285	2,285	2,285	2,372	2,372	2,372	2,372	2,372
R-squared	0.013	0.022	0.043	0.027	0.047	0.007	0.015	0.053	0.017	0.056
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	No	No	Yes	No	Yes	No	No	Yes	No	Yes

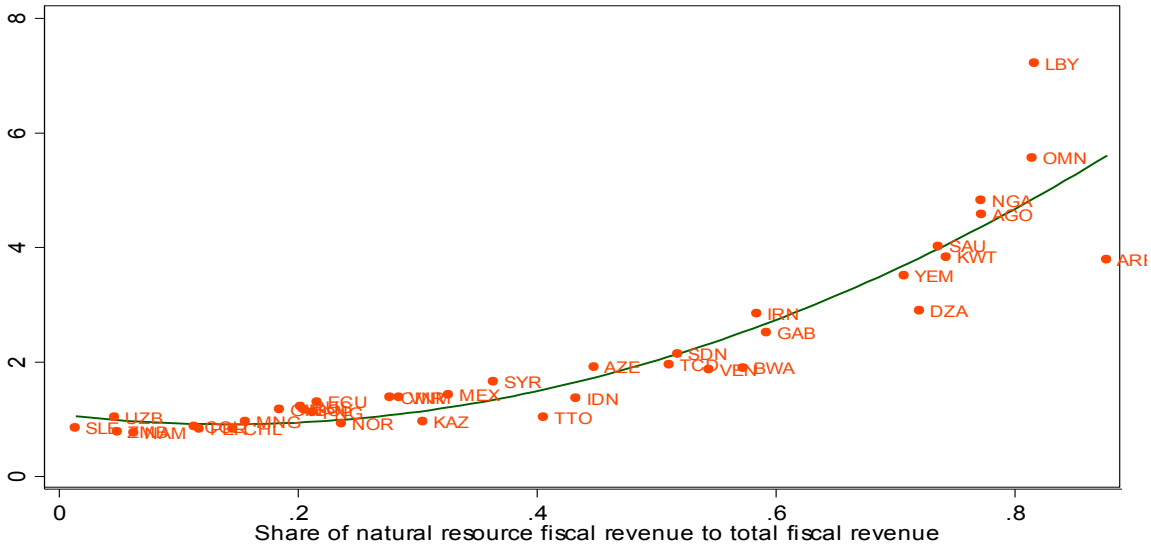
Notes: IV regression, "Growth of export partners" as instrument for the GDP cycle; cluster-robust standard errors by countries in parentheses. Sample limited to countries with at least 7 observations. *Significant at 10%; **significant at 5%; ***significant at 1%.

Table 12. Testing Robustness using Non-oil, Non-mineral GDP instead of Total GDP
Restricted Sample: Countries Classified as Oil- and Mineral-rich

Dependent variables:	**Δlog(non-NR fiscal revenue)**					**log(non-NR fiscal revenue) cycle**				
Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**
GDP non-NR cycle	0.63	3.88	-16.23	5.06	-15.89	-0.57	0.59	-8.56*	0.85	-8.41*
	(4.407)	(3.927)	(10.235)	(3.228)	(10.423)	(1.993)	(1.586)	(4.522)	(1.295)	(4.530)
Δlog(NR-FR)		-0.11**	-0.12**							
		(0.048)	(0.053)							
Average NRFR/FR x Δlog(NR-FR)				-0.36**	-0.37**					
				(0.170)	(0.161)					
ln(NR-FR) cycle							-0.11*	-0.13**		
							(0.061)	(0.059)		
Average NRFR/FR xlog(NR-FR) cycle									-0.30	-0.37
									(0.228)	(0.232)
Observations	451	451	451	451	451	462	462	462	462	462
R-squared	0.000	0.013	0.078	0.022	0.085	0.000	0.012	0.091	0.016	0.094
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	No	No	Yes	No	Yes	No	No	Yes	No	Yes

Notes: IV regression, "Growth of export partners" as instrument for the GDP cycle; cluster-robust standard errors by countries in parentheses. Sample limited to countries with at least 7 observations. *Significant at 10%; **significant at 5%; ***significant at 1%. Constant coefficient is not shown.

Figure 9. Share of Indirect Taxes on Non-commodity Fiscal Revenues



Note: Indirect taxes were estimated using WDI data.

5.2.2 Controlling for the Quality of Institutions

- The type and quality of institutions could explain why some countries manage to reduce the impact of commodity shocks on their economies. We explore empirically this question expanding equation 2 by controlling for alternative indices of quality of institutions. The estimates of this exercise are shown in Tables 13 to 15 and the results are very consistent: countries with better-quality institutions (as measured by alternative World Bank indicators) have higher elasticities of non-commodity revenues to unadjusted GDP. This result suggests that countries with better institutions and political stability design and better enforce (more elastic) non-commodity taxes.
- Countries with higher political stability have lower direct substitution effects between oil and mineral fiscal revenues and non-commodity fiscal revenues, compared to other countries. This suggests that governments in countries with less political stability have more incentives to reduce non-commodity revenues when oil and mineral revenues increase. This result, however, does not hold for other indices of institutional quality (government effectiveness or regulatory quality).

- Previous results were robust to interpolation of indices of institutional quality for the years in which these were not available (which permit a fuller exploitation of panel variations).
- International Country Risk Guide (ICRG) indices (not shown) did not render any significant results.

Table 13. Non-commodity Fiscal Revenue Fluctuations: Controlling for Government Effectiveness

Dependent variables:	**Δlog(non-NR fiscal revenue)**				**log(non-NR fiscal revenue) cycle**			
Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
GDP cycle	4.12***	4.13***	4.56***	4.60***	1.77***	1.75***	1.88***	1.92***
	(0.801)	(0.789)	(0.687)	(0.674)	(0.449)	(0.428)	(0.402)	(0.382)
Δlog(NR-FR)			-0.10*	-0.10*			-0.10	-0.10
			(0.058)	(0.058)			(0.071)	(0.071)
Gov. Effectiveness		-0.00	-0.00	-0.00		0.00	-0.00	-0.00
		(0.007)	(0.007)	(0.007)		(0.003)	(0.003)	(0.003)
Gov. Eff. x GDP cycle		1.50**		1.22**		0.83**		0.74**
		(0.702)		(0.609)		(0.336)		(0.312)
Gov. Eff. x Δlog(NR-FR)			0.05	0.04			0.04	0.04
			(0.049)	(0.047)			(0.053)	(0.053)
Observations	2,285	2,261	2,261	2,261	2,372	2,348	2,348	2,348
R-squared	0.013	0.015	0.023	0.025	0.007	0.008	0.016	0.017
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	No	No	No	No	No	No	No	No

Notes: IV regression, "Growth of export partners" as instrument for the GDP cycle; cluster-robust standard errors by countries in parentheses. Sample limited to countries with at least 7 observations. *Significant at 10%; **significant at 5%; ***significant at 1%.

Table 14. Non-commodity Fiscal Revenue Fluctuations: Controlling for Regulatory Quality

Dependent variables:	**Δlog(non-NR fiscal revenue)**					**log(non-NR fiscal revenue) cycle**			
Variables	(1)	(2)	(3)	(4)	VARIABLES	(5)	(6)	(7)	(8)
GDP cycle	4.12***	4.12***	4.55***	4.60***	GDP cycle	1.77***	1.78***	1.88***	1.95***
	(0.801)	(0.780)	(0.685)	(0.661)		(0.449)	(0.410)	(0.401)	(0.359)
Δlog(NR-FR)			-0.11*	-0.11*	ln(NR-FR) cycle			-0.11	-0.11
			(0.058)	(0.058)				(0.071)	(0.070)
Regulatory Quality		-0.01	-0.01	-0.01	Regulatory Quality		-0.00	-0.00	-0.00
		(0.009)	(0.008)	(0.009)			(0.003)	(0.003)	(0.003)
Regulatory Quality x Δlog(NR-FR)			0.02	0.02	Regulatory Quality xlog(NR-FR) cycle			0.02	0.02
			(0.034)	(0.033)				(0.042)	(0.041)
Regulatory Quality X GDP cycle		1.76***		1.60***	Regulatory Quality X GDP cycle		1.25***		1.20***
		(0.642)		(0.604)			(0.365)		(0.363)
Observations	2,285	2,261	2,261	2,261	Observations	2,372	2,348	2,348	2,348
R-squared	0.013	0.016	0.023	0.025	R-squared	0.007	0.010	0.015	0.018
Country FE	Yes	Yes	Yes	Yes	Country FE	Yes	Yes	Yes	Yes
Year FE	No	No	No	No	Year FE	No	No	No	No

Notes: IV regression, "Growth of export partners" as instrument for the GDP cycle; cluster-robust standard errors by countries in parentheses. Sample limited to countries with at least 7 observations. *Significant at 10%; **significant at 5%; ***significant at 1%.

Table 15. Non-commodity Fiscal Revenue Fluctuations: Controlling for Political Stability

Dependent variables:	Δlog(non-NR fiscal revenue)					log(non-NR fiscal revenue) cycle			
Variables	(1)	(2)	(3)	(4)	VARIABLES	(5)	(6)	(7)	(8)
GDP cycle	4.12***	4.29***	4.68***	4.75***	GDP cycle	1.77***	1.86***	1.96***	2.02***
	(0.801)	(0.792)	(0.685)	(0.687)		(0.449)	(0.432)	(0.399)	(0.392)
Δlog(NR-FR)			-0.07	-0.07	ln(NR-FR) cycle			-0.07	-0.07
			(0.059)	(0.059)				(0.071)	(0.071)
Political stability		0.00	0.00	0.00	Political stability		0.00	-0.00	-0.00
		(0.008)	(0.008)	(0.008)			(0.003)	(0.004)	(0.004)
Political stability x GDP cycle		2.21**		1.44**	Political stability x GDP cycle		1.35***		1.12***
		(0.927)		(0.724)			(0.457)		(0.412)
Political stability x Δlog(NR-FR)			0.10*	0.09*	Political stability xlog(NR-FR) cycle			0.09*	0.09
			(0.054)	(0.051)				(0.056)	(0.055)
Observations	2,285	2,249	2,249	2,249	Observations	2,372	2,335	2,335	2,335
R-squared	0.013	0.017	0.030	0.032	R-squared	0.007	0.010	0.022	0.024
Country FE	Yes	Yes	Yes	Yes	Country FE	Yes	Yes	Yes	Yes
Year FE	No	No	No	No	Year FE	No	No	No	No

Notes: IV regression, "Growth of export partners" as instrument for the GDP cycle; cluster-robust standard errors by countries in parentheses. Sample limited to countries with at least 7 observations. *Significant at 10%; **significant at 5%; ***significant at 1%.

5.2.3 Which Channel Dominates? Estimating Reduced Form Equations

We estimated reduced forms for both changes and variations around trend of non-commodity-related revenues (see Table 16). The main result is that these variables *are negatively related to contemporary changes* and variations around trend of oil and mineral revenues, except when we estimate the equations only for LAC countries, and *positively related with one-year lag*s in these variations (though with a smaller coefficient). Thus, it seems that, on average, the direct substitution effects of oil and mineral revenues on non-commodity fiscal revenues dominate over the positive indirect effect through increased public expenditures and augmentation of the GDP cycle, although this effect reverts in the following period. Thus, the indirect effect of oil and mineral fiscal revenues on non-commodity fiscal revenues (through increased public expenditures and GDP) is not only weaker but takes more time to operate than the direct substitution effect.

Consistent with this result, we did not get reduced form significant effects of terms of trade or commodity price shocks on non-commodity revenue changes and variations around trend. On the contrary, as expected, terms of trade or commodity price shocks have significant positive effects on oil and mineral revenues change and variations around trend (see Table 17). However, we must caution once more that these average global trends may not represent the reality of particular Latin American countries, as discussed in Section 3.

Table 16. Reduced Form Equations for Changes in Non-commodity Revenues

	Dependent variable: Δlog(non-NRFR)							
	All countries		Only Resource-rich countries			Only LAC countries		
Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
Δlog(NRFR)	-0.135***		-0.135***			-0.027		
	(0.043)		(0.044)			(0.020)		
Δlog(NRFR) t-1	0.038**		0.038**			0.033**		
	(0.018)		(0.018)			(0.010)		
Terms of trade cycle		-0.002		-0.129			0.357***	
		(0.095)		(0.117)			(0.124)	
Terms of trade cycle t-1		0.072		0.422***			-0.114	
		(0.108)		(0.140)			(0.217)	
Commodity cycle					0.00035			0.00025
					(0.000)			(0.000)
Commodity cycle t-1					0.00001			0.00007
					(0.000)			(0.001)
Observations	1,894	1,867	418	481	591	279	307	143
R-squared	0.020	0.001	0.060	0.028	0.001	0.010	0.029	0.002
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Cluster-robust standard errors by countries in parentheses. Sample limited to countries with at least 7 observations. *Significant at 10%; **significant at 5%; ***significant at 1%.

Table 17. Effects of Terms of Trade and Commodity Price Shocks on Oil and Mineral Fiscal Revenues

	Dependent variable: Δlog(non-NRFR)			
Variables	**(1)**	**(2)**	**(3)**	**(4)**
Terms of trade cycle	0.963***			
	(0.270)			
Terms of trade cycle (weighted)		1.283*		
		(0.688)		
Natural resource exports cycle			0.337***	
			(0.116)	
Main Commodity Cycle				0.0009*
				(0.001)
Observations	437	435	491	530
R-squared	0.060	0.027	0.060	0.003
Country FE	Yes	Yes	Yes	Yes
Year FE	No	No	No	No

Notes: Sample restricted to resource rich countries. Cluster-robust standard errors by countries in parentheses. Sample limited to countries with at least 7 observations. *Significant at 10%; **significant at 5%; ***significant at 1%.

5.3 Testing for Asymmetric Responses

We finally tested for asymmetric effects of changes and variations around trend of GDP and of oil and mineral revenues on changes and variations around trend of non-commodity revenues. Table 17 shows that GDP elasticities and substitution effects are asymmetric. Elasticities are higher when GDP variations are above trend than when they are below trend, while substitution effects are higher when oil and mineral revenues drop than when they increase. These asymmetric effects are probably due to Government attempts to avoid deep expenditure cuts when GDP or oil and mineral revenues fall. Further, the asymmetry of substitution effects is larger as countries are more dependent on oil and mineral revenues (that is, as oil and mineral revenues are a higher fraction of their total fiscal revenues).

Table 18. Asymmetric Response of Non-commodity Revenues

	Dependent Variable: Δlog(non-NR fiscal revenue)	
Variables	**(1)**	**(2)**
GDP cycle – Positive	6.28***	6.51***
	(1.848)	(1.836)
GDP cycle – Negative	5.48***	5.72***
	(1.061)	(1.042)
Δlog(NR-FR) – Positive	-0.10**	
	(0.040)	
Δlog(NR-FR) – Negative	-0.20***	
	(0.060)	
Average NRFR/FR x Δlog(NR-FR) – Positive		-0.29***
		(0.101)
Average NRFR/FR x Δlog(NR-FR) - Negative		-0.58***
		(0.130)
Constant	0.04***	0.04***
	(0.004)	(0.004)
Observations	2,504	2,504
R-squared	0.032	0.043
Country FE	Yes	Yes

Notes: Cluster-robust standard errors by countries in parentheses. Sample limited to countries with at least 7 observations. *Significant at 10%; **significant at 5%; ***significant at 1%.

1. Conclusions

This paper assesses the effects of oil and mineral wealth on the volatility of non-commodity revenues We showed evidence that non-commodity revenues are more volatile in oil- and mineral-rich countries and that the quality of institutions is associated with lower volatility.

In explaining this fact, we show that that the discretionary direct substitution effect of non-commodity revenues for oil and mineral revenues dominates over the positive indirect effect through higher public expenditures and GDP. That is, when oil and fiscal revenues increase, non-commodity revenues are reduced discretionally, and this effect is larger and faster than the indirect positive effect of the increase in GDP. This is not the case in oil- and mineral-rich Latin

American countries. The substitution effect is lower in this region and does not dominate the indirect income effect through increased public expenditures and GDP. These findings are both good and bad news. They are good news insofar as the dominant direct substitution effect reduces the volatility of total fiscal revenues that would take place in its absence, and thus, mitigates to some extent the higher volatility of public expenditures observed in oil- and mineral-rich countries. On the other hand, the substitution effect is also bad news, as the size of automatic stabilizers, which depends on the size of non-commodity-related fiscal revenues, is reduced precisely when they are most needed.

Finally, we find that non-commodity revenue income elasticities are generally higher when GDP variations are above trend than when they are below trend, while direct substitution effects of non-commodity revenues for oil and mineral revenues are higher when oil and mineral revenues drop than when they rise. These asymmetric effects are probably due to government attempts to avoid deep expenditure cuts when GDP or oil and mineral revenues fall. Further, the asymmetry of substitution effects is more pronounced in countries that are more fiscally dependent on oil and mineral revenues (that is, where oil and mineral revenues represent a higher fraction of their total fiscal revenues).

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Appendix 1. Definition of Variables

Variable	Definition
Δlog(non-NR fiscal revenue)	Change in the log of fiscal revenue net of natural resource fiscal revenue in constant dollars
log(non-NR fiscal revenue) cycle	Log of fiscal revenue net of natural resource fiscal revenue in constant dollars minus its Hodrick-Prescott trend
Δlog(NR-FR)	Change in the log of natural resource fiscal revenue in constant dollars
log(NR-FR) cycle	Log of natural resource fiscal revenue in constant dollars minus its Hodrick-Prescott trend
GDP cycle	log of real GDP minus its Hodrick-Prescott trend (output gap)
Average NRFR/FR	Average for the period of natural resource fiscal revenues over total fiscal revenues
Growth of export partners	Real growth of export partners calculated using bilateral trade (COMTRADE)
GDP-non NR cycle	log of real GDP net of natural resources minus its Hodrick-Prescott trend. Value added of natural resources is proxied with the rents of oil and minerals calculated by the World Bank
Terms of trade cycle	Log of terms of trade minus its Hodrick-Prescott trend
Cycle commodity	Log of the price of the main commodity exported by each country minus its Hodrick-Prescott trend
Natural resource exports cycle	log of natural resource exports (hydrocarbons and mining from COMTRADE) minus its Hodrick-Prescott trend

Appendix 2. First-stage Results of the IV Estimations

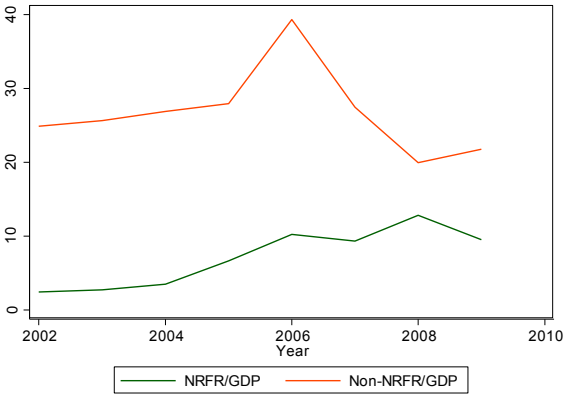
The following table shows the estimations using the variables to instrument the GDP cycle. Column 3 is the estimation that was used as the first stage for the IV estimation of all of the results throughout the paper.

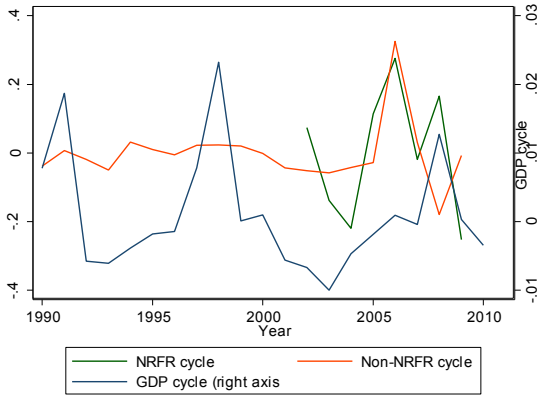
	GDP Cycle		
Variables	**(1)**	**(2)**	**(3)**
Growth of export partners (weighted by EXP/GDP)	1.519***		1.441***
	(0.191)		(0.181)
Terms of trade cycle (weighted by EXP/GDP)		0.130***	0.086**
		(0.035)	(0.033)
Observations	2,208	2,354	2,208
R-squared	0.067	0.014	0.073

Notes: *Significant at 10%; **significant at 5%; ***significant at 1%. Growth of exports partners and Terms of trade cycle are weighted by the average exports to GDP for each country.

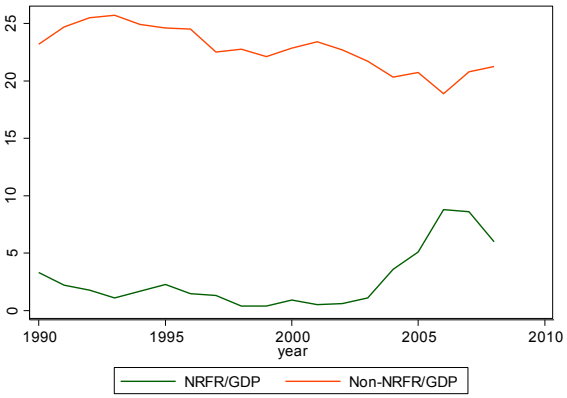
Appendix 3. Latin America: Oil and Mineral Revenues, Non-commodity Fiscal Revenues, and GDP (1990–2010)

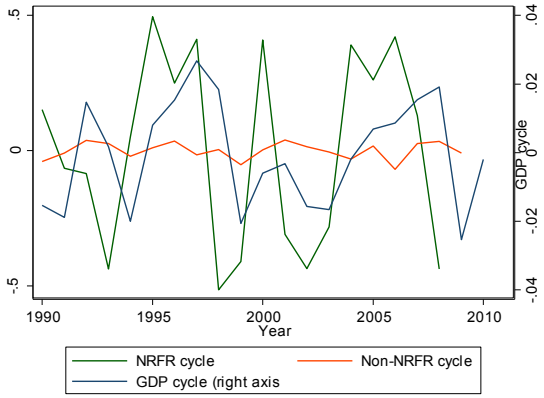
Bolivia



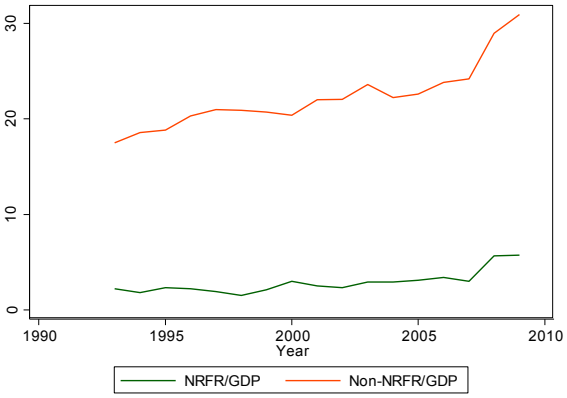


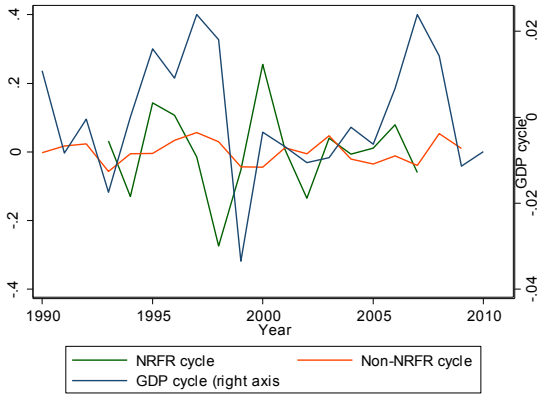
Chile



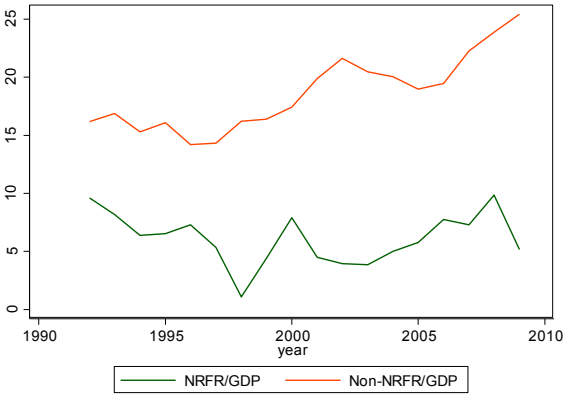


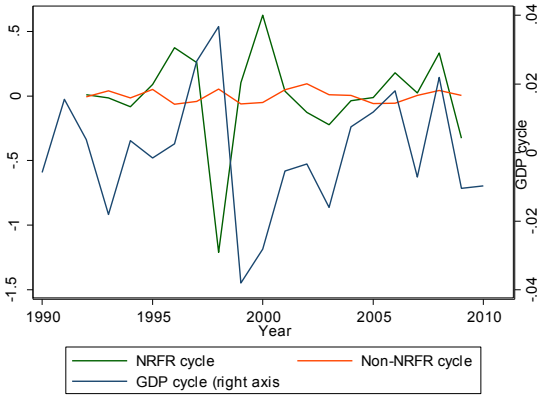
Colombia



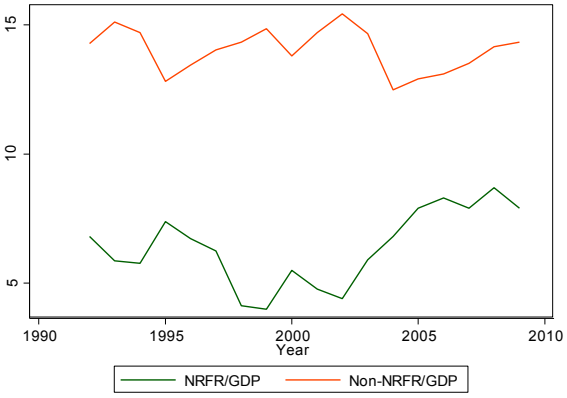


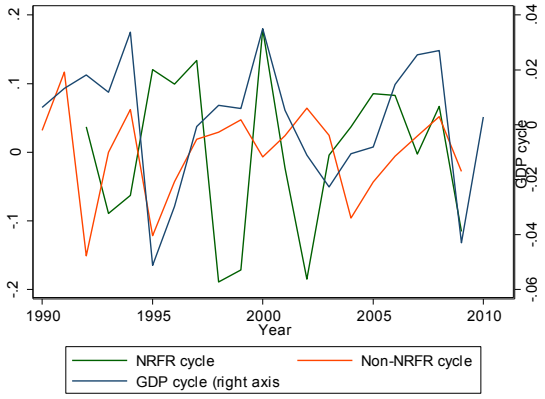
Ecuador



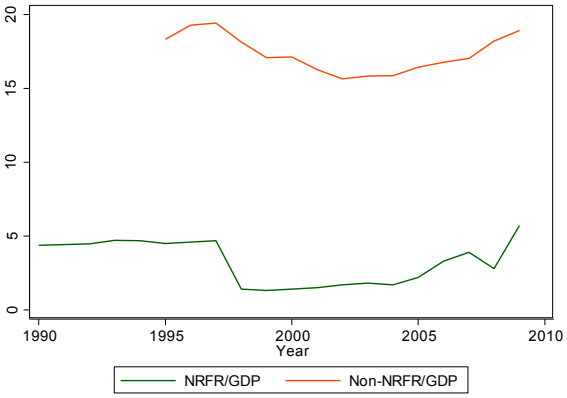


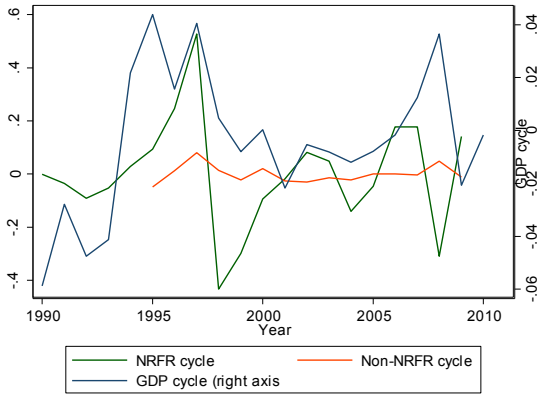
Mexico



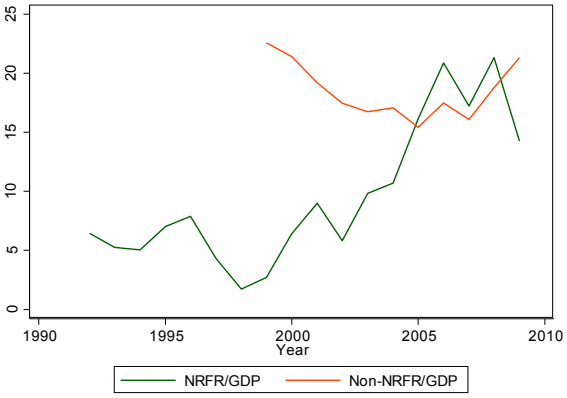


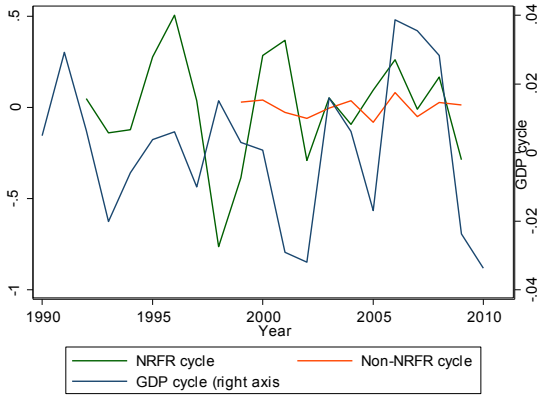
Peru





Trinidad and Tobago





Venezuela