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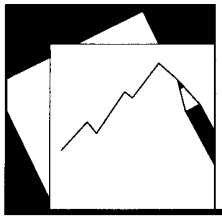

IMF Working Paper

Tax Revenue Downturns: Anatomy and Links to Imports

Kun Li and Pablo Lopez-Murphy

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Fiscal Affairs Department

Tax Revenue Downturns: Anatomy and Links to Imports

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Authorized for distribution by Mark Horton

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Abstract

We study historical tax revenue downturn episodes—where tax revenue-to-GDP ratios decline sharply—and explore the link between tax revenues and imports. We document that downturn episodes of at least 1 percentage point of GDP in one year are common. The tax types that account for these episodes are different in advanced, emerging and developing, and oil producing countries. We find that tax revenue downturns and import contractions have a statistically significant link. Finally, we show that changes in imports are a statistically significant determinant of changes in tax revenues even when controlling for changes in the output gap and in the terms of trade.

JEL Classification Numbers: H11; H20

Keywords: tax revenue, downturns, imports

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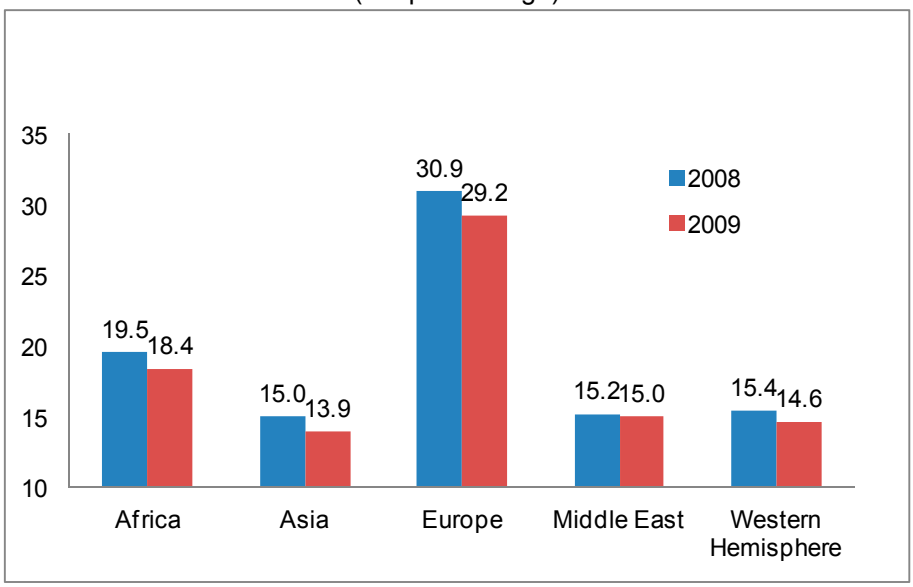
I. Introduction

The tax-revenue-to-GDP ratio declined in several countries around the world in 2009. Figure 1 shows that tax revenue downturns were more pronounced in Africa, Asia, and Europe, where the average tax-revenue-to-GDP ratio fell by more than 1 percent of GDP and less significant in the Middle East, where it fell by 0.2 percent of GDP.

Figure 1. Tax-Revenue-to-GDP Ratios
(Simple Average)

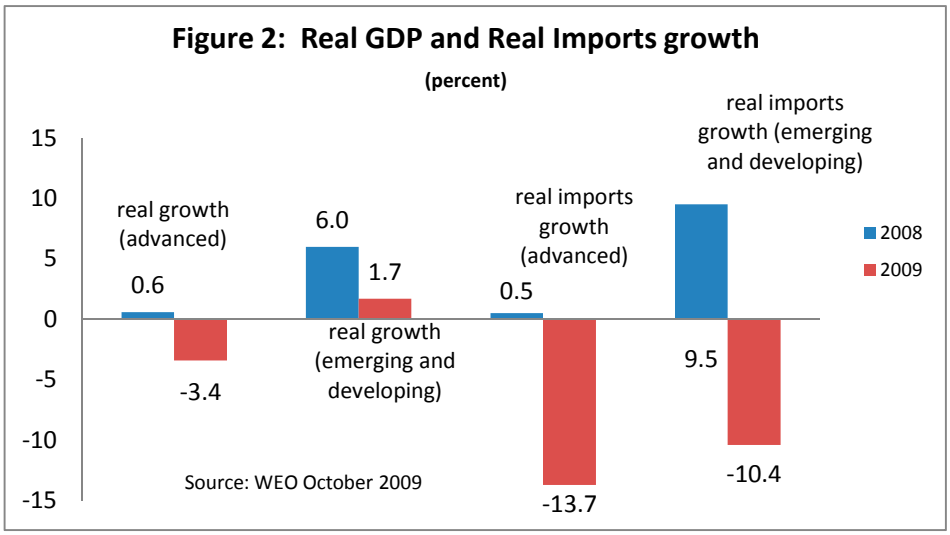


Source: IMF staff estimates based on a sample of 54 countries.

Real economic activity slowed in emerging and developing countries and fell in advanced countries in 2009. Figure 2 shows that the average growth rate in emerging and developing countries went from 6 percent in 2008 to 1.7 percent in 2009 and from 0.6 percent to -3.4 percent in advanced countries. Although it is natural to expect lower tax revenues when economic activity goes down, it may be surprising that the overall tax-revenue-to-GDP ratio should go down in those circumstances.[2]

[2] Escolano (2010) observes that in practice, the elasticity of overall tax revenues with respect to the output gap is typically found to be slightly above, but close to, one. Girouard and Andre (2005) present elasticity estimates for four categories of revenues for OECD countries: corporate and personal income taxes, indirect taxes, and social security contributions. On average, the elasticity of revenues with respect to the output gap is greater than one for income taxes, equal to one for indirect taxes, and lower than one for social security contributions.

The tax-revenue-to-GDP ratio may decline for several reasons. One possibility is a weakening of tax compliance. Brondolo (2009) argues that tax compliance may decline in a crisis, if credit-constrained taxpayers delay or evade payments as a financing source.



Source: World Economic Outlook, October 2009.

A second possible explanation is a reduction in tax rates. Several countries introduced significant tax policy changes during the crisis, for example, countries as diverse as the United Kingdom and the Kyrgyz Republic reduced value-added tax rates, while other countries provided targeted tax rebates or cuts. A third possible explanation, and the one we want to explore, is that specific tax bases shrank by more than GDP. One of the key tax bases in many emerging and developing countries is imports, which are relatively easy to tax at the border and may also make up a sizable share of consumption of key products.

Real imports declined sharply in advanced and emerging and developing countries in 2009. Some have argued that the proximate cause of the collapse in international trade (as well as an amplifying mechanism) was the global slowdown. Baldwin (2009) claims that a fundamental cause of the trade collapse was the fall in commodity prices (explaining lower production and trade of commodities) and uncertainty after the fall of Lehman Brothers, which induced wait-and-see behavior among consumers and firms (explaining lower production and trade of manufactured goods). Figure 2 shows that the growth rate of real imports in emerging and developing economies went from 9.5 percent in 2008 to -10.4 percent in 2009 and from 0.5 percent to -13.7 percent in advanced economies. So, the fall in imports was much more dramatic than the fall in economic activity in 2009.[3] This

[3] Real export growth also fell sharply in 2009, from 4.6 percent to -7.2 percent in emerging and developing countries and from 1.9 percent to -13.7 percent in advanced countries.

remarkable fall in imports could be an important consideration when trying to explain the fall in tax-revenue-to-GDP ratios that were observed in 2009, because in many countries, imports are a key component of the tax base.

Motivated by these facts, this paper has two objectives. The first is to document the anatomy of tax-revenue-to-GDP downturns. How common are tax revenue downturns? What is their typical size? Which tax types account for the downturns? How do tax revenue downturns in emerging and developing countries differ from those in advanced economies? The second objective is to study links between changes in tax revenue and changes in imports and to draw some policy implications.

Based on a sample of 63 countries during 1977–97 and a sample of 26 countries during 1995–2007 our main findings are the following:

- Tax-revenue-to-GDP ratios in emerging and developing countries are almost twice as volatile as in advanced economies;

- import-to-GDP ratios in emerging and developing countries are significantly more volatile than in advanced countries;

- substantial tax revenue downturns (i.e., reductions in tax-revenue-to-GDP ratios by more than 1 percent in one year) are common;

- income taxes account for the large bulk of substantial tax revenue downturns in advanced economies;

- expenditure taxes account for the large bulk of substantial tax revenue downturns in emerging and developing economies;

- corporate income tax (CIT) accounts for the large bulk of substantial tax revenue downturns in oil producing countries;[4]

- substantial tax revenue downturns have a statistically significant link with import contractions in emerging and developing countries; and

- changes in import-to-GDP ratios are a statistically significant determinant of changes in the tax-revenue-to-GDP ratio even when controlling for changes in real output and the terms of trade.

[4] In line with Ossowski and others (2008), oil-producing countries are defined as countries in which fiscal oil revenue accounted for at least 20 percent of total fiscal revenue in 2007. Note that in some countries fiscal oil revenues are also part of nontax revenues (especially under production-sharing regimes).

The rest of the paper is organized as follows. In Section II, we discuss the related literature. In Section III, we study historical tax-revenue-to-GDP ratio trends and volatility using the two cross-country samples. We assess import-to-GDP ratios to see if there is scope for a link between both variables. In Section IV, we assess the frequency of substantial tax revenue downturns to check whether they are a rare or common phenomenon. We also document which tax types account for tax revenue downturns. In Section V, we use case control methodology to see whether there is a statistically-significant link between tax revenue downturns and import contractions. In Section VI, we run regressions to study whether changes in import-to-GDP ratios help to explain changes in tax-revenue-to-GDP ratios, controlling for other factors that might also play a role. Section VII concludes.

II. Related Literature

A strand of the literature studies the determinants of tax revenue at a particular point of time. Early studies include Bahl (1971), Tait, Eichengreen, and Gratz (1979), and Tanzi (1992). More recent studies include Bird, Martinez-Vazquez, and Torgler (2004) and Gupta (2007). These papers estimate a hypothetical tax ratio for a specific country based on the average economic structure for a broader set of countries and compare this with the actual tax ratio in order to measure "tax effort." Explanatory variables used include per capita income, the share of agriculture output in GDP, the share of mineral exports in GDP, and the openness of the economy.

Another strand of the literature studies determinants of tax revenue over time. Sancak, Velloso, and Xing (2010) study the tax revenue response to changes in output and find that the short-run elasticity is higher than long-run elasticity during booms, with the opposite holding during busts. Other work examines how revenue and expenditure respond to the business cycle. Gavin and Perotti (1997) find evidence of procyclical fiscal policy in Latin American countries and IMF (2005) finds evidence of procyclical fiscal policy in advanced and emerging and developing countries. More specifically, a 1 percent increase in the output gap results in a deterioration of 0.2 percentage point of GDP in the cyclically-adjusted fiscal balance in advanced economies countries and a deterioration of 0.5 percentage point of GDP in emerging and developing economies. Explanatory variables used in these studies include the output gap and changes in the terms of trade.

This paper shares with the first strand of the literature the focus on determinants of the tax-revenue-to-GDP ratio and the focus on variability across time with the second strand. Motivated by developments observed during the current crisis, we want to see the role played by import variation in explaining changes in the tax-revenue-to-GDP ratio.

III. PRELIMINARY DATA ANALYSIS

We study the evolution of central government tax-revenue-to-GDP ratios relying on IMF Government Finance Statistics (GFS) data both in 1986 and 2001 formats.[5] *GFS 1986* data cover 1977–97 while *GFS 2001* data cover 1995–2007. However, for some countries, the existing time series are discontinuous with missing data in several years. We constrained our analysis to tax revenue time series that had at least 15 consecutive observations in the *GFS 1986* data set and at least 12 observations in the *GFS 2001* dataset.

Tax-revenue-to-GDP ratios are higher in advanced economies than in emerging and developing countries.[6] Table 1 shows that the average tax-revenue-to-GDP ratio in advanced economies is 27.2 percent compared to 17.3 percent in emerging and developing countries in the GFS 1986 data set. A similar difference is observed in the *GFS 2001* dataset. The average tax-revenue-to-GDP ratio in oil-producing countries is 12.3 percent. We analyze oil producing countries separately because the volatility of oil prices (and GDP) makes the interpretation of standard fiscal indicators like the tax-revenue-to-GDP ratio more complicated. The average tax-revenue-to-GDP ratio is higher in European countries than in the rest of the regions.

Table 1. Average Tax-Revenue-to-GDP Ratio

GFS 1986; 1977–97							
Region	# Countries	Min	Max	Range	Mean	SD	Varcoeff
Advanced	25	23.6	30.6	7.0	27.2	2.0	0.08
Emerging and Developing	32	13.7	21.1	7.4	17.3	2.2	0.14
Oil producers	6	8.1	18.2	10.1	12.3	2.7	0.30
Africa	6	17.3	27.5	10.2	22.3	3.0	0.14
Asia and Pacific	13	10.7	16.8	6.0	13.6	1.7	0.14
Europe	21	26.1	34.2	8.1	30.4	2.4	0.08
Middle East and Central Asia	8	11.1	18.0	6.9	14.3	1.9	0.21
Western Hemisphere	15	13.1	20.3	7.2	16.3	2.1	0.13
GFS 2001; 1995–2007							
Region	# Countries	Min	Max	Range	Mean	SD	Varcoeff
Advanced	11	24.1	28.6	4.6	25.8	1.3	0.05
Emerging and Developing	15	14.6	19.7	5.2	16.6	1.6	0.10
Africa	2	14.3	19.7	5.3	16.3	1.7	0.10
Asia and Pacific	11	11.8	16.6	4.8	13.6	1.5	0.11
Europe	7	24.7	29.5	4.8	26.5	1.4	0.05
Middle East and Central Asia	4	17.9	23.9	5.9	20.4	1.7	0.08
Western Hemisphere	2	14.5	17.6	3.0	15.9	1.0	0.06

Source: Government Financial Statistics, IMF.

[5] *GFS 2001* differs from *GFS 1986* in that fiscal statistics are recorded on an accrual instead of a cash basis, and fiscal flows are closely integrated with stocks. See paragraphs 1.21-1.30 of the *GFS Manual 2001*for further discussion.

[6] We follow the country classification in the IMF World Economic Outlook that divides the world into two major groups: advanced economies, and emerging and developing economies. In Appendices 1 and 2, we list countries in each category.

Tax-revenue-to-GDP ratios are almost twice as volatile in emerging and developing countries. Although the average tax-revenue-to-GDP ratio is substantially higher in advanced countries, the range of variation (i.e., the difference between the maximum and the minimum value) is almost the same in advanced and in emerging and developing countries. In fact, the variation coefficient (i.e., the standard deviation normalized by the mean) in emerging and developing countries is 0.13 compared to 0.08 in advanced economies in the *GFS 1986* data set and 0.10 compared to 0.05 in the *GFS 2001* data set. The volatility of tax-revenue-to-GDP ratios is highest in oil-producing countries because of the high volatility of oil prices and oil GDP.

It is not immediately obvious why the volatility of tax-revenue-to-GDP ratios should be higher in emerging and developing countries, as one would expect that the volatility of tax revenues mimics the volatility of GDP. The fact that GDP is more volatile in emerging and developing countries likely implies higher volatility in tax revenues, but not necessarily implies a more volatile tax-revenue-to-GDP ratio. The volatility of tax rates and the volatility of tax bases are possible candidates to explain the volatility of tax-revenue-to-GDP ratios. As there is limited information on the volatility of tax rates, we focus on the volatility of tax bases.

Import-to-GDP ratios are substantially more volatile in emerging and developing countries. This is likely explained by relatively higher volatility in the terms of trade coupled with constrained access to financing. Table 2 shows that the average import-to-GDP ratio in both advanced and emerging and developing countries are very similar. However, the range of variation in emerging and developing countries is much wider. In fact, the variation coefficient in emerging and developing countries is 0.20 compared to 0.10 in advanced economies in the earlier data set (1977–97) and 0.13 compared to 0.11 in the data set covering the latter period (1995–2007).

Changes in import-to-GDP ratios could be driving changes in tax-revenue-to-GDP ratios. Imports are usually an important component of the tax base not only because of taxes on international trade but also because of consumption taxes that are applied on imports. Since we observe that import-to-GDP ratios are more volatile in emerging and developing countries and there are channels through which imports affect tax revenues, then the volatility of import-to-GDP ratios seems to be a promising channel to account for the relatively high volatility of tax-revenue-to-GDP ratios in emerging and developing countries.

IV. Anatomy of Tax Revenue Downturns

In this section, we examine substantial tax revenue downturn episodes. We define a tax revenue downturn as a fall in the tax-revenue-to-GDP ratio and a *substantial* downturn as a fall of this ratio of at least 1 percentage point. We want to answer the following questions:

Table 2. Average Import-to-GDP Ratio

WDI; 1977–97							
Region	# Countries	Min	Max	Range	Mean	SD	Varcoeff
Advanced	25	20.5	27.8	7.4	24.1	2.0	0.09
Emerging and Developing	32	26.3	47.4	21.1	36.0	6.0	0.20
Oil producers	6	27.2	66.8	39.6	40.8	9.6	0.25
Africa	6	36.0	59.5	23.4	47.1	6.5	0.17
Asia and Pacific	13	23.9	42.0	18.1	31.7	5.4	0.21
Europe	21	33.5	47.8	14.3	40.0	3.9	0.10
Middle East and Central Asia	8	29.1	60.2	31.1	39.8	7.8	0.20
Western Hemisphere	15	20.9	41.7	20.8	30.6	5.9	0.20
WDI; 1995–2007							
Region	# Countries	Min	Max	Range	Mean	SD	Varcoeff
Developed	11	32.6	45.7	13.1	38.6	4.2	0.11
Developing	15	34.2	50.4	16.2	40.9	5.3	0.13
Africa	2	29.8	41.4	11.6	34.3	3.8	0.11
Asia and Pacific	11	37.2	53.2	16.0	44.3	5.1	0.13
Europe	7	34.0	49.4	15.3	41.0	5.0	0.12
Middle East and Central Asia	4	35.2	52.0	16.8	41.7	5.3	0.12
Western Hemisphere	2	18.2	26.4	8.2	20.9	2.9	0.13

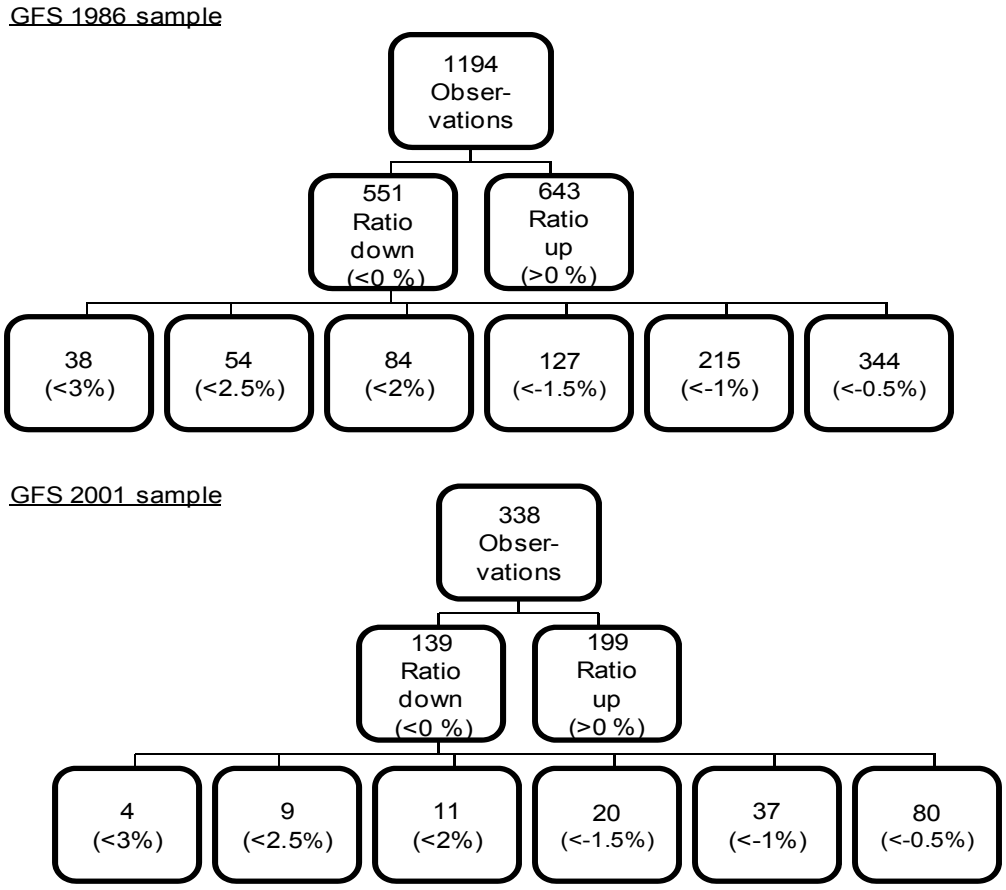
Source: World Development Indicators, World Bank.

How common are tax revenue downturn episodes? What is their typical size? Which tax types account for them? How do tax revenue downturns in emerging and developing economies differ from those in advanced economies?

Tax revenue downturn episodes are common. Tax revenue downturns happen in more than 45 percent of the total observations in the *GFS 1986* sample and in more than 41 percent of the observations in the *GFS 2001* sample (Figure 3). Substantial tax revenue downturns happen in more than 18 percent of the observations in the *GFS 1986* sample, spread across advanced (38 percent), emerging and developing (48 percent), and oil-producing (14 percent) countries. Substantial downturns happen in more than 11 percent of the observations in the *GFS 2001* sample, spread across advanced (25 percent) and emerging and developing (75 percent) economies.

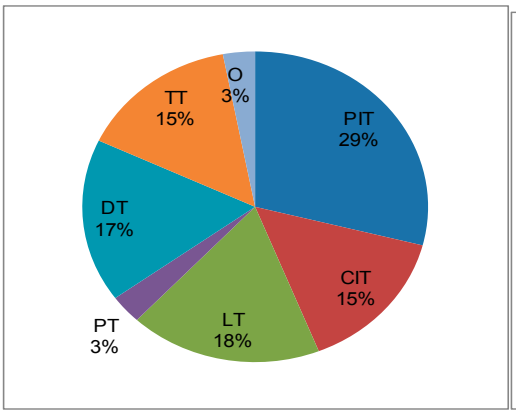
Income taxes account, on average, for the large bulk of substantial tax revenue downturns in advanced countries. Figure 4a shows that in the GFS 1986 sample, income taxes account for 44 percent of substantial downturns (personal income tax (PIT)) for 29 percent and CIT for 15 percent), expenditure taxes for 33 percent (domestic taxes (DT) for 17 percent and trade taxes (TT) for 15 percent), and labor taxes for 18 percent. In the *GFS 2001* sample, income taxes account for about 70 percent of substantial downturns in advanced economies (Figure 4b), expenditure taxes (only DT) for 16 percent, property taxes for 7 percent, and labor taxes also for 7 percent.

Figure 3. Tax Revenue Downturns: Size and relative frequency



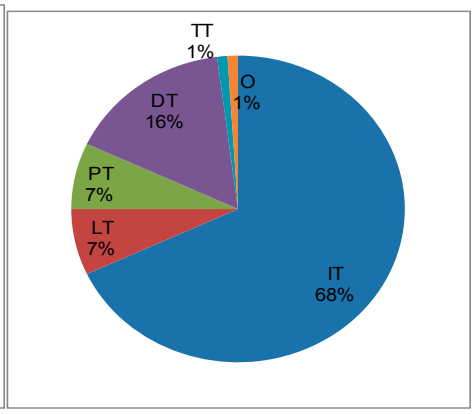
Source: Government Financial Statistics, IMF.

Figure 4a. What Accounts for Substantial Tax Downturns
(Advanced, GFS 1986)



Source: *GFS 1986*.

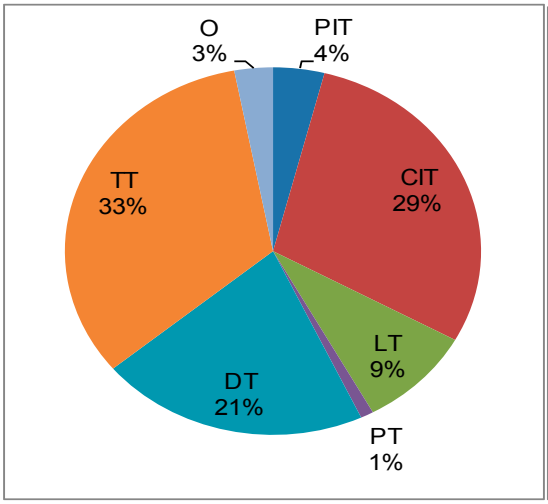
Figure 4b. What Accounts for Substantial Tax Downturns
(Advanced, GFS 2001)



Source: *GFS 2001*.

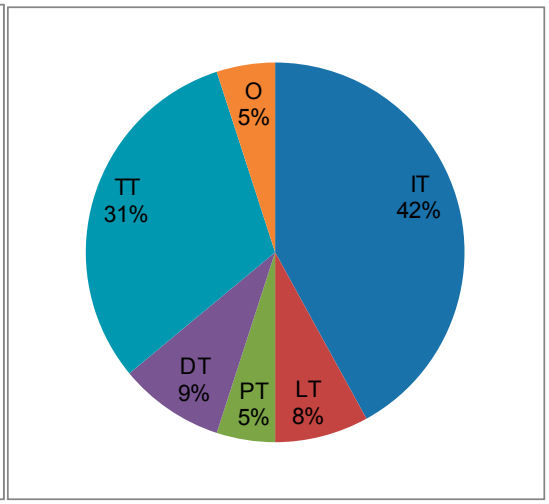
Expenditure taxes account on average for a large share of substantial tax revenue downturns in emerging and developing countries. Figure 5a shows that in the *GFS 1986* sample, income taxes account for 33 percent of substantial downturns (PIT for 4 percent and CIT for 29 percent), expenditure taxes for 54 percent (DT for 21 percent and TT for 33 percent), and labor taxes for 9 percent. In the *GFS 2001* sample (Figure 5b), income taxes account for 42 percent of substantial downturns, expenditure taxes for 40 percent (DT for 9 percent and TT for 31 percent), and labor taxes for 8 percent.

Figure 5a. What Accounts for Substantial Tax Downturns
(Emerging and Developing, *GFS 1986*)



Source: *GFS 1986*.

Figure 5b. What Accounts for Substantial Tax Downturns
(Emerging and Developing, *GFS 2001*)

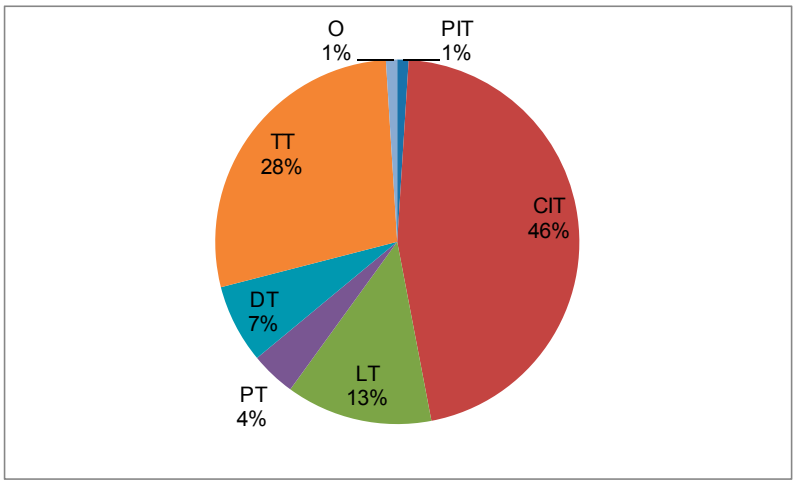


Source: *GFS 2001*.

In oil-producing countries, CIT accounts on average for a large share of substantial tax revenue downturns. Figure 6 shows that in the *GFS 1986* sample CIT accounts for nearly 50 percent of substantial downturns, expenditure taxes for 35 percent (DT for 7 percent and TT for 28 percent), and labor taxes for about 15 percent. There are no data for oil-producing countries in the *GFS 2001* sample.

The different structure of tax systems in advanced and emerging and developing countries helps to shed light on these findings. The collection of tax revenue in emerging and developing economies is characterized by relatively weak administrative capacity. Income taxation plays a more limited role in emerging and developing countries than in

Figure 6. What Accounts for Substantial Tax Downturns
(Oil Producers)



Source: *GFS 1986*.

advanced economies, as documented by Gordon and Li (2009) and others.[7] Tax structures of emerging and developing countries rely more heavily on consumption taxes. As noted previously, elasticities of CIT and PIT revenues with respect to the output gap tend to be higher than for other taxes. Within income taxes, the share of tax revenue raised from corporations tends to be larger than that from individuals in emerging and developing countries, whereas the reverse is observed in advanced countries.

V. Tax Revenue Downturns and Import Contractions

We apply a case-control approach to see whether there is a statistically-significant link between tax revenue downturns and import contractions. The case-control approach has been widely used in epidemiological studies and has also been applied to economic issues. Several studies have used case-control methodology to examine the relationship between smoking and lung cancer, finding a much higher proportion of smokers in lung cancer cases than in noncases. In economics, the methodology has also been employed, for example, in the currency crisis literature. Edwards (2002) applied case-control methodology to explore links between current account reversals and currency crises.[8]

[7] Keen and Simone (2004) also document extensively the structures of tax systems in emerging and developing and advanced countries.

[8] Edwards defined current account reversals as a reduction of the current account balance of at least 3 percentage points of GDP in one year and a currency crisis as a depreciation of the exchange rate of at least 25 percent. Using a sample of 147 countries during 1970–97, he rejects the hypothesis that current account reversals trigger currency crisis. Edwards (2000) also applies the case-control methodology to study financial contagion.

The case-control methodology is straightforward. We first divide and count the total number of observations of the variable of interest—changes in the tax-revenue-to-GDP ratio—in a "case" group (tax revenue downturns) and a "control" group (no downturns). We then divide and count the total number of observations in each group, according to the second variable of interest—changes in the import-to-GDP ratio—and two further subgroups: import contraction and no import contraction. The number of tax revenue downturns and import contraction is "a", "b" is the number of tax revenue downturns with no import contractions, "c" is the number of no tax revenue downturns and import contractions, and "d" is the number of no tax revenue downturns and no import contractions (see matrix).

	Import contraction	No import contraction	Total
Tax revenue downturn	a	b	a + b
No tax revenue downturn	c	d	c + d
Total	a + c	b + d	a + b + c + d

The approach compares the odds of having a tax revenue downturn if an import contraction takes place (a/c) with the odds of having a tax revenue downturn if an import contraction does not take place (b/d). If these odds are very close to each other—if the odds ratio is close to unity—then it is hard to link tax revenue downturns with import contractions. More precisely, if (a/c)/(b/d) is approximately equal to unity it would be difficult to reject the hypothesis that tax revenue downturns and import contractions are statistically independent using a chi-squared test.

We find a statistically significant link between tax revenue downturns and import contractions for the full sample of countries. If we define a tax revenue downturn as a fall in the tax-to-GDP ratio of at least 1 percent and an import contraction as a fall in the import-to-GDP ratio of 2 percent, and we use the *GFS 1986* sample we obtain the following contingency table (Table 3):[9]

For the full sample of countries, the odds ratio is 1.71 and the chi-squared statistic is 8.94, and the null hypothesis of independent tax revenue downturns and import contractions is rejected at a 1 percent level of significance. However, this sample contains very different countries in which the role of import contractions might be different.

[9] We chose a threshold of 1 percent for tax revenue downturns because we wanted to focus on substantial tax revenue downturn episodes. The threshold of 2 percent for import contractions was chosen because it made the number of import contraction episodes similar to the number of tax revenue downturn episodes. We did not want to bias the results obtained by having a substantially different number of episodes.

Table 3a. Tax Revenue Downturns and Import Contractions, Full Sample

	Import contraction	No import contraction	Total
Tax revenue downturn	53	151	204
No tax revenue downturn	161	786	947
Total	214	937	1151

Source: Government Financial Statistics, IMF.

The link between tax revenue downturns and import contractions is not significant in the case of advanced countries. If we use the same definitions for tax revenue downturns and for import contractions, we obtain the following contingency table:

Table 3b. Tax Revenue Downturns and Import Contractions, Advanced Countries

	Import contraction	No import contraction	Total
Tax revenue downturn	15	52	67
No tax revenue downturn	52	355	407
Total	67	407	474

Source: Government Financial Statistics, IMF.

For the advanced countries, the odds ratio is 1.96 and the chi-squared statistic is 4.38, and the null hypothesis of independent tax revenue downturns and import contractions cannot be rejected at a 1 percent level of significance. This could be explained by the fact that advanced economies rely more on income taxes in their tax systems, and as we saw in the previous section, income taxes are the main driver of substantial tax revenue downturns in advanced countries.

The link between tax revenue downturns and import contractions is stronger in the case of emerging and developing economies. If we use the same definitions for tax revenue downturns and for import contractions, we obtain the following contingency table:

Table 3c. Tax Revenue Downturns and Import Contractions, Emerging and Developing Countries

	Import contraction	No import contraction	Total
Tax revenue downturn	29	80	109
No tax revenue downturn	74	384	458
Total	103	464	567

Source: Government Financial Statistics, IMF.

For the emerging and developing countries, the odds ratio is 1.89 and the chi-squared statistic is 6.47; however, the null hypothesis of independent tax revenue downturns and import contractions is rejected at a 1 percent level of significance. This could be explained by the fact that emerging and developing countries rely more on expenditure taxes in which imports are typically a large fraction of their base and, as we saw in the previous

section, expenditure taxes are the main driver of substantial tax revenue downturns in emerging and developing countries.

Finally, the link between tax revenue downturns and import contractions is nonexistent in oil producing countries. If we use the same definitions for tax revenue downturn and for import contractions we obtain the following contingency table:

Table 3d. Tax Revenue Downturns and Import Contractions, Oil Producing Countries

	Import contraction	No import contraction	Total
Tax revenue downturn	9	19	28
No tax revenue downturn	35	47	82
Total	44	66	110

Source: Government Financial Statistics, IMF.

For oil-producing countries, the odds ratio is 0.63 and the chi-squared statistic is 0.97, and the null hypothesis of independent tax revenue downturns and import contractions cannot be rejected at a 1 percent level of significance. This could be explained by the fact that oil-producing countries typically rely more heavily on taxes on the oil sector, and as we saw in the previous section, CIT is the main driver of substantial tax revenue downturns in oil-producing countries.

These results hold when we use the *GFS 2001* sample, including when we split the sample between advanced and emerging and developing economies.

The case-control methodology has a disadvantage. It is a bivariate approach while the norm in econometrics is to look at the marginal contribution of each variable conditioning on the others. But the methodology has attractive features, as it imposes no parametric structure on the data, and it is accessible and informative.

VI. Determinants of Changes in Tax Revenues

This section presents an econometric analysis to assess the impact of changes in imports on tax revenues. As we saw in the previous section, there is a statistically significant link between tax revenue downturns and import contractions, especially in emerging and developing countries. The goal of the econometric analysis is to check whether changes in imports are a statistically significant determinant of changes in tax revenue when we control for other factors that might also be influencing tax revenue.

The econometric analysis focuses on the quantitative impact of changes in the import-to-GDP ratio on changes in the tax-revenue-to-GDP ratio, controlling for changes in real GDP growth and in terms of trade growth. The regressions also include lagged

changes in tax-revenue-to-GDP ratios to account for persistence of the tax revenue-to-GDP ratio. In symbols, we estimate:

$$\Delta (T/Y) = \beta_0 + \beta_1 \Delta (M/Y) + \beta_2 (T/Y)_{-1} + \beta_3 GDPg + \beta_4 TOTg + \beta_5 bad + \beta_6 bad*GDPg + u$$

The econometric model follows Gavin and Perotti (1997) who explain changes in fiscal outcomes (in percent of GDP) using real GDP growth, terms of trade growth, and lagged changes in fiscal outcomes as explanatory variables. We augment their specification by including changes in the import-to-GDP ratio as an additional explanatory variable for changes in the tax-revenue-to-GDP ratio. We have used actual real GDP growth in the equation; this might be seen as a proxy of cyclical real GDP growth and avoids complications concerning the calculation of trend real GDP growth.[10] We interact growth with a dummy variable to distinguish good times from bad times.[11] The idea is to allow for an asymmetric response of tax revenues in good times and bad times.

The regression estimates suggest that changes in import-to-GDP ratios have a statistically significant positive impact on changes in the tax-revenue-to-GDP ratio. As Table 4 shows, the estimates indicate that an increase in the import-to-GDP ratio by 1 percent results in an increase in the tax-revenue-to-GDP ratio of approximately 0.1 percent under all the alternative specifications and estimation methods.

In column (1), we present fixed effects estimates to allow for unobserved country heterogeneity. We find that changes in the import-to-GDP ratio are a statistically significant determinant of changes in the tax-revenue-to-GDP ratio. More precisely, we find that an increase of 1 percent in the import-to-GDP ratio increases the tax-revenue-to-GDP ratio by 0.09 percent. We also find that real GDP growth and changes in the terms of trade have a statistically significant positive relationship with the tax-revenue-to-GDP ratio, as expected.[12] Finally, we see that lagged changes in tax revenue-to-GDP ratios have a statistically significant negative relationship with changes in the tax-revenue-to-GDP ratio implying some form of mean reversion (e.g., changes in the tax-revenue-to-GDP are cyclical).

In column (2) we present GMM estimates using the Arellano Bond methodology to obtain estimates that are more efficient. We find again that changes in the import-to-GDP ratio are a statistically significant determinant of changes in the tax-revenue-to-GDP ratio. In this case,

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[10] Actual real GDP growth is a combination of cyclical real GDP growth and trend real GDP growth. We expect that actual real GDP growth and cyclical real GDP growth are positively correlated.

[11] Good times are those years in which real GDP growth is higher than average and bad times are the opposite.

[12] The positive relationship between the output gap and the tax revenue-to-GDP ratio suggests an overall elasticity of tax revenue higher than unity.

Table 4. Determinants of Changes in Tax-Revenue-to-GDP Ratio

	Full Sample		Advanced		Emerging and Developing	
	(1) FE	(2) GMM	(3) FE	(4) GMM	(5) FE	(6) GMM
Change in imports-to-GDP ratio	0.089***	0.108***	0.106	0.113***	0.0847***	0.100***
	(0.0198)	(0.0253)	(0.0404)	(0.0404)	(0.0222)	(0.0269)
Lagged tax revenue ratio	-0.513***	-0.368***	-0.760***	-0.403***	-0.346***	-0.333***
	(0.0408)	(0.0618)	(0.0586)	(0.0971)	(0.0534)	(0.0601)
Real GDP growth	0.107***	-0.0147	0.0980	0.0125	0.108**	0.0760
	(0.0383)	(0.0556)	(0.0746)	(0.0751)	(0.0447)	(0.0580)
Terms of trade growth	0.0837***	0.0936***	0.0616	0.0327	0.00908***	0.09988***
	(0.00934)	(0.0109)	(0.0409)	(0.0418)	(0.00961)	(0.0107)
Bad times	0.328	-0.410	-0.00722	-0.0651	0.499	0.275
	(0.230)	(0.364)	(0.342)	(0.348)	(0.320)	(0.416)
Bad times*real GDP growth	-0.0674	0.0310	-0.0750	0.0718	-0.0629	-0.0598
	(0.0594)	(0.0924)	(0.121)	(0.121)	(0.0666)	(0.0951)
Constant	10.03***		19.22***		5.214***	
	(0.826)		(1.509)		(0.866)	
Observations	308	282	131	120	177	162
R-squared	0.507		0.0606		0.519	

standard errors in parenthesis
***p<0.01, ** p<0.05, * p<0.1

an increase in 1 percent in the import to GDP ratio increases the tax-revenue-to-GDP ratio by 0.108 percent. The only difference with the results presented in column (1) is that real GDP growth is no longer a statistically significant determinant of changes in the tax-revenue-to-GDP ratio.

In columns (3) and (4) we estimate the previous regressions but focus only on advanced economies, while in columns (5) and (6) we focus on emerging and developing countries. In all cases, we find that changes in the-import-to-GDP ratio are a statistically significant determinant of changes in the tax-revenue-to-GDP ratio, and an increase in 1 percent in the import-to-GDP ratio increases the tax-revenue-to-GDP ratio by approximately 0.1 percent. The only difference between advanced and emerging and developing countries is that, in the advanced economies, changes in the terms of trade are not a statistically significant determinant of changes in the tax-revenue-to-GDP ratio.

VII. CONCLUSION

Tax revenue downturns are challenging for policymakers because they reduce discretionary fiscal space, if any, and typically generate higher financing needs. In theory, temporary tax revenue downturns should be accommodated, with higher fiscal deficits allowing policy makers to avoid disruptions in the provision of important public goods (e.g., education, health, national security). In many emerging and developing countries, however, financing opportunities are slim in bad times, and this leaves governments with few options other than to cut expenditures.

In this paper, we find that changes in imports drive changes in tax revenues. So when imports accelerate, tax revenues also strengthen, and when imports decelerate, tax revenues decline. Since imports are volatile in some country groups, tax revenues might be temporarily high when imports accelerate and temporarily low when imports decelerate. The main policy implication that follows from this finding is that countries should allow fiscal balances to tighten at times when imports and tax revenues accelerate—not allowing expenditures to increase—and thereby accumulate fiscal space that could be used when imports and tax revenues decelerate, provided that these trends appear to be relatively short-lived and the use of fiscal space can be financed while not crowding out other activities. Emerging and developing economies should closely monitor developments in imports and be prepared to adjust fiscal policy, as needed. At the same time, tax policy changes might be considered to reduce exposure to volatile tax bases. An extension of the paper could involve compilation of a more comprehensive data set, which would facilitate further econometric work.

Appendix Table 1. Countries in the Sample GFS1986

Asian Pacific	European	Africa	Middle East & Central Asia	Western Hemisphere
13	21	6	8	15
Australia	Austria	Cameroon	Bahrain, Kingdom of	Argentina
Bhutan	Belgium	Lesotho	Egypt	Bahamas, The
India	Cyprus	Mauritius	Iran, I.R. of	Canada
Indonesia	Denmark	South Africa	Kuwait	Chile
Japan	Finland	Zambia	Morocco	Colombia
Korea	France	Zimbabwe	Pakistan	Costa Rica
Malaysia	Germany		Syrian Arab Republic	Dominican Republic
Maldives	Hungary		Tunisia	Jamaica
Myanmar	Iceland			Mexico
Nepal	Ireland			Panama
Singapore	Israel			Paraguay
Sri Lanka	Italy			Peru
Thailand	Luxembourg			United States
	Malta			Uruguay
	Norway			Venezuela
	Portugal			
	Spain			
	Sweden			
	Switzerland			
	Turkey			
	United Kingdom			

Appendix Table 2. Countries in the Sample GFS2001

Asian Pacific	European	Africa	Middle East & Central Asia	Western Hemisphere
7	11	2	4	2
India	Austria	Kenya	Algeria	Peru
Korea	Bulgaria	Cote d'Ivoire	Jordan	Uruguay
Maldives	Finland		Pakistan	
Nepal	France		Tunisia	
Sri Lanka	Germany			
Thailand	Greece			
Philippines	Ireland			
	Italy			
	Netherlands			
	Spain			
	Sweden			

Appendix Table 3. Country Groups

GFS1986			GFS2001	
Advanced	Emerging and Developing	Oil Producer	Advanced	Emerging and Developing
25	32	6	11	15
Australia	Argentina	Bahrain, Kingdom of	Austria	Algeria
Austria	Bahamas, The	Egypt	Finland	Bulgaria
Belgium	Bhutan	Iran, I.R. of	France	Cote D Ivoire
Canada	Cameroon	Kuwait	Germany	India
Cyprus	Chile	Syrian Arab Republic	Greece	Jordan
Denmark	Colombia	Venezuela, Rep. Bol.	Ireland	Kenya
Finland	Costa Rica		Italy	Maldives
France	Dominican Republic		Korea	Nepal
Germany	Hungary		Netherlands	Pakistan
Iceland	India		Spain	Peru
Ireland	Indonesia		Sweden	Philipines
Israel	Jamaica			Sri Lanka
Italy	Lesotho			Thailand
Japan	Malaysia			Tunisia
Korea	Maldives			Uruguay
Luxembourg	Mauritius			
Malta	Mexico			
Norway	Morocco			
Portugal	Myanmar			
Singapore	Nepal			
Spain	Pakistan			
Sweden	Panama			
Switzerland	Paraguay			
United Kingdom	Peru			
United States	South Africa			
	Sri Lanka			
	Thailand			
	Tunisia			
	Turkey			
	Uruguay			
	Zambia			
	Zimbabwe			

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