

Fiscal Policy and Debt Dynamics in Developing Countries

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Abstract

Utilizing a new database of tax rates, tax revenues and tax income-elasticities we contribute to the debate on the effects of fiscal policy on economic activity in a number of ways. First, using both panel GMM and panel VAR methods, we find that the effects of tax cuts on GDP growth are significant in developing countries. A tax cut that lowers the personal income tax rate by one percentage point, or cuts revenues by one percent of GDP causes an increase in GDP of 0.3-0.4% on impact and approximately 0.8% in the long run. Consistent with earlier studies using Structural VAR methods, the tax multiplier in high-income countries is small. We find that cuts in the personal income tax are more effective in stimulating growth than cuts in corporate or VAT rates. Second, using the methods of Favero and Giavazzi, 2007 (FG) to incorporate debt dynamics into a fiscal VAR, we find that debt dynamics significantly alter estimates of the impact of fiscal policy on GDP in some countries. In other countries, as in FG's study of the United States, the effects are negligible. Finally, we find that estimates of the multiplier on government consumption are in

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line with the findings of Ilzetzi, Mendoza and Végh, 2010 (multipliers are larger in high-income-, closed-, and fixed-exchange-rate economies than in developing-, open-, and flexible-exchange rate economies, respectively) even after controlling for the effects of taxes in a panel VAR.

1 Introduction

In recent years, the debate on the use of fiscal policy as a countercyclical stabilization tool has been central to the agenda of macroeconomic policymakers to the extent not seen for a generation or more. Several governments responded rapidly and aggressively to the most significant financial crisis in recent memory. One of the first acts of the newly-elected Obama administration in February 2009 was to pass a \$787 billion stimulus package through the U.S. Congress. More recently, in December 2010, President Obama proposed a bill, receiving bipartisan support, prolonging both the Bush administration's tax cuts and his own administration's extension of unemployment-benefit duration. A major justification of these measures was as additional stimulus to economic activity. Similar policies have been pursued in the U.K., with significant increases in government spending and cuts in the VAT rate during 2009-10. Even in the developing world, governments made similar efforts, with the Chilean government increasing its expenditures by close to 3 percent of Chile's gross domestic product, for example.

More recently, the debate has swung from stimulus to austerity. Concerns about the solvency of a number of European governments, most prominently in Greece and Ireland, have reversed the policy trend. Governments throughout Europe have been legislating significant increases in taxation and cuts in public expenditure. Most recently, the Irish government, facing a loss in market confidence for its sovereign debt, took measures to increase public

savings by more than 3 percent of GDP. Concern of similar debt selloffs led the incoming Parliament in the UK to take decisive measures to cut public expenditures. In the U.S., Congressional Republicans have vowed to cut discretionary government spending by \$100 billion.

How effective are packages of fiscal stimulus in fueling economic recovery? How costly are austerity measures in deepening recessions? To what extent does a country's degree of indebtedness affect the impact of stimulus and austerity? What are the merits of using tax policy relative to expenditure measures in using fiscal policy for stabilization- or debt-reduction purposes?

These important policy questions have stimulated a significant revival of the empirical study of the effects of fiscal policy on economic activity. This literature has focused primarily on the United States or other OECD countries.

In a recent contribution, Ilzetki, Mendoza and Végh (2010) (IMV) assembled high-frequency data on government purchases for a large sample of countries. IMV then estimate the effects of government expenditure on output using structural vector autoregressive (SVAR) methods. We extend their evidence along two dimensions. First, we present a new dataset on tax revenues, tax rates, and tax elasticities for a sample of 28 countries, most of which are less-developed. This new dataset allows us to jointly estimate the effects of taxes and government purchases on output using panel time-series econometric methods. Second, using methods introduced by Favero and Giavazzi (2007), we explore the degree to which government indebtedness affects the impact of fiscal policy.

An outline of the paper, and its main findings, can be summarized as follows. In Section 2, we outline the new dataset and discuss the methodology used to calculate average marginal tax rates and tax elasticities. Section 3 is a preliminary exploration of the data, where we use panel data methods

(OLS and Arellano-Bond GMM estimates) to estimate the effects of tax cuts on economic output. We find that a **cut in personal income taxes by 1 percentage point increases GDP by 0.16%**. The effect is more substantial in **developing countries**, where **GDP increases by close to 0.4%** in response to a similar tax cut. Results regarding corporate- and value-added-taxes are less clear.

Section 4 uses Structural Vector-Autoregressive (SVAR) methods, as in Blanchard and Perotti (2002) to estimate the effects of fiscal policy in a number of country groupings. We re-affirm the results in IMV: **government expenditure is more potent in expanding output in high-income countries than in developing countries; in closed economies than in open economies; and under fixed than under flexible exchange rates**. These results are robust to the inclusion of taxes as an additional control. We find, however, that **the tax multiplier is virtually zero** in most country-groupings. This is consistent with previous findings using SVAR methods. The exception is **developing countries** where **the tax multiplier is 0.3 on impact and close to 0.8 in the long run**.

Finally, in Section 5 we use methods developed by Favero and Giavazzi (2007) (FG) to incorporate debt dynamics into SVAR estimates of the impact of fiscal policy in a number of developing countries. In contrast to FG's findings for the United States, we find that **debt dynamics significantly dampen the effects of fiscal policy in Brazil and Estonia, and** to a lesser extent in **South Africa**. The main channel identified is that of fiscal reversals. Increases in government expenditure or tax cuts lead to higher debt levels. These lead to reversals—decreases in government expenditure and increases in taxation—within several years. These policy reversals diminish the long-run expansionary effect of the initial fiscal stimulus. In the case of Estonia, we find moreover that higher debt has a direct negative impact on

output growth. However, the mitigating effects of debt on the impact of fiscal policy is not uniform. We do not find that incorporating debt dynamics in SVAR regressions for Chile and Malaysia affect estimates of the impact of fiscal policy on output.

The final section, section 6 concludes.

2 The data

A major challenge in estimating the effects of fiscal policy in developing countries using VAR methods is the availability of reliable data. This paper continues the efforts made by IMV to catalogue quarterly fiscal data for developing countries. While the focus in IMV is on the expenditure side of the fiscal ledger, we assemble data on tax revenues in this project. We also introduce new series (these at an annual frequency) of average marginal tax rates for a sample of 28 countries. This extends work such as Barro and Sahasakul (1983) to a broader set of countries, including a number of developing countries. Finally, for the purpose of our SVAR analysis, we estimate tax elasticities for the countries in our sample. To our knowledge, this is the first attempt to assemble time series of average marginal tax rates for a cross-section of developing countries. It is also the first to estimate the output elasticities of tax revenues, using macroeconomic data, for a number of developing countries.

We outline a few of the steps involved in obtaining the time series used in the analysis. We obtained the entire distribution of corporate, personal, and value added tax rates from the OECD tax database for OECD members, and from PricewaterhouseCoopers' "Individual Taxes Worldwide Summaries" for non-OECD countries. As an example, Figure 1 compares the marginal personal income tax rate schedules for Peru in 1993 and in 1994: directly before

and directly after, respectively, a major tax reform intended at simplifying the tax system. Due to historically high rates of inflation, tax brackets in Peru are based on income in “tax units” rather than in local currency.

We then followed the OECD’s methodology, outlined in Giorno et al (1995) and Van den Noord (2000), for calculating the average marginal tax rate for each country and year. We calculated the earnings elasticity of the personal income tax by following the OECD’s assumption that income distribution is lognormal, and allowing for a distribution of income based on each country’s Gini coefficient (taken in most cases from the World Bank’s Povcal database) around average wage income (taken from national sources).¹ We then located within this stylized income distribution the tax brackets as outlined in the tax code. The average marginal tax rate is the average across tax brackets of marginal tax rates weighted by total income in each bracket.

As an example, Figure 2 illustrates the calculation of the average marginal income tax rate for Brazil in 2008. The figure shows the approximated cumulative distribution function (CDF) of earnings. At each wage rate along the X-axis, the CDF gives the percentage of total earnings in Brazil earned by workers with wages below the indicated wage. There were three income-tax brackets in Brazil in 2008: 0%, 15%, and 27.5%. Although 78% of workers in Brazil fell into the lowest tax bracket, their earnings comprised only 39% of total earnings. Similarly, 14% of the working population faced a 15% marginal tax rate; this group earned 25% of Brazilian income. Finally, the remaining 7% of the population, and 36% of national income, faced the highest marginal rate. The average marginal tax rate in Brazil in 2008 was

¹Saez (2001) and others have argued that the Pareto distribution better characterizes the actual income distribution in the United States than does the lognormal distribution. Lopez and Serven (2006), in contrast, cannot reject a lognormal distribution of income in a large sample of countries. To allow a direct comparison with the income elasticities of tax revenues estimated by the OECD, we follow their methodology and assume a lognormal income distribution.

calculated as the sum of the three marginal rates, each multiplied by the share of total wage income that faced that marginal rate.

To assure the reader that our methodology is consistent with earlier estimates in the literature, Figure 3 compares the time series of the average marginal income tax rate calculated by Barro and Redlick (2009), to that obtained using our methodology. The two series are broadly similar, with some differences (of the order of one to two percentage points) in the 1984-5 and 1993-2000 periods.

Armed with average marginal income tax rates for each country in the sample, we were then able to estimate the (wage-) income elasticity of tax revenues. An increase in income that is distributed equally among current wage earners would increase tax revenues by precisely the average marginal tax rate. The wage elasticity of tax revenues is therefore the average marginal tax rate divided by the average tax rate (which is tax revenues deriving from labor income taxes divided by wage income).² The first two columns of Table 1 show our estimates of the earnings elasticity of tax revenues for the countries in our sample in column A for income taxes and in column B for social security taxes. The first two columns of Table 3 compare our estimates with the OECD's, for overlapping countries; they are virtually identical.

VAT rates are flat, while corporate income taxes are flat in most countries, with some exceptions (such as Brazil). A single rate therefore summarizes both the average and marginal rates for these taxes. The elasticity of these taxes with respect to their respective tax bases is therefore 1. Figure 4 shows all three average marginal tax rates for the countries in the sample.³

We then followed Giorno et al (1995) directly in using the elasticities of tax revenues with respect to specific tax bases to obtain an overall output-

²This measure varies, of course, from year to year. We average this measure across years for each country.

³In Brazil and the United States we show the sales tax rather than the VAT.

elasticity of tax revenues. Table 1 outlines the calculation of the output elasticity of tax revenues in detail. The employment elasticity of wages is shown in column D; the output elasticity of employment is presented in column E. As shown in detail in Giorno et al (1995) and Van den Noord (2000), these two elasticities can be combined with the earnings elasticities to obtain the output elasticity of income taxes. As the GDP identity, using income accounting, implies that total profits are equal to GDP excluding wage earnings, we can use the same elasticities to estimate the output elasticity of the corporate income tax. Again, we follow the formulae in Giorno et al (1995) and Van den Noord (2000) in calculating this elasticity.

The output elasticities of personal income taxes, social security taxes, corporate income taxes and sales/VAT taxes are then summarized in columns F to I. Finally, the output elasticities of specific taxes are weighted by their share of total tax revenue to give the output elasticity of tax revenues.

Table 2 shows our estimates of elasticities using *annual* data. Table 3 compares our estimates of the output elasticity of tax revenues—using annual data—with those of the OECD, for the seven countries that appear in both samples. As noted earlier, our estimates of the personal income tax elasticity are virtually identical. Thus all differences in estimates of the final elasticities are due to differences in estimates of macroeconomic elasticities, such as the output elasticity of employment.

3 The effects of tax cuts: A panel estimate

We begin our analysis with a simple panel regression, which attempts to determine the effects of tax changes on output. In doing so, we follow the specification in Barro and Redlick (2009) who estimate the effects of a lagged change in the tax rate on current output. They argue that tax changes at a

one-year lag are more likely to have an effect on output than contemporaneous changes and less likely to be affected by reverse causation.

These regressions are an illustration of the data available in the collected dataset. The methodology used here does not fully control for the possibility of reverse causation: tax rates, particularly average marginal ones, respond endogenously to business cycle conditions. For this reason, we address identification more seriously in the following section, using an SVAR approach. An alternative tack would be to use a narrative of changes in tax policies in the spirit of Romer and Romer (2010). To date, however, a historical narrative of the changes in tax policy, together with the rationale for their change (endogenous/exogenous to economic conditions) is not available for a large sample of countries.⁴

We estimate the following equation

$$\Delta y_{n,t} = \alpha + \beta \Delta \tau_{n,t-1} + \gamma Z_{n,t} + \varepsilon_{n,t}, \quad (1)$$

where $\Delta y_{n,t}$ is the growth rate of (the change in log) real GDP, $\Delta \tau_{n,t-1}$ is the lagged change in the tax rate in country n , and $Z_{n,t}$ is a vector of controls, some dated t and some $t - 1$. We include the lagged unemployment rate ($UR(-1)$); Barro and Redlick (2010) also argue for including an exogenous shock as a covariate. In their case they include the (squared) spread between long-maturity Baa-rated bonds and Treasury bonds of similar maturity as a measure of tightness of credit conditions. For our sample, including smaller countries, we found it more appropriate to consider an external shock. We include a trade shock variable, defined as the weighted average of the GDP growth of each country's trading partners. Each country's trade shock is then scaled by the country's exports-to-GDP ratio, as a shock to trade might have

⁴In addition to the US narrative by Romer and Romer (2010), Cloyne (2011) compiled a similar narrative for the UK.

a larger effect on countries more open to trade. Results are also robust to inclusion of the lagged growth of government expenditure, although unlike Barro and Redlick (2009), who include military expenditure only, inclusion of total government expenditure raises concerns of reverse causation.

We estimate (1) in a panel of 28 countries, of which 19 are developing and 9 are high-income, based on World Bank classifications. Estimates reported in Table 4 are from OLS estimates of (1) including fixed effects, and from an Arellano-Bond GMM estimator. We include all three tax rate variables in our regressions: the personal income tax rate (PITR), the corporate income tax rate (CITR) and the VAT rate (or sales tax rate for the US and Brazil).

The first two columns of Table 4 give estimates for the entire sample. We are particularly interested in estimates for developing countries—as their inclusion is novel to this dataset; we therefore show estimates for the developing countries within the sample in the third and fourth columns.

We find a negative relation between increases in the average marginal personal income tax rate and GDP growth in the following period. For the entire sample, a one-percentage-point cut in the average marginal tax rate increases GDP growth in the following period by 0.16%. The effect is larger for developing countries, where a tax cut of similar magnitude increases output by close to 0.4%. This result is statistically significant at the 95% confidence level for all specifications, and the 99% confidence level for almost all specifications. It is possible that the tax codes in developing countries are more distortionary than those in high-income countries. This is a possible explanation for the higher effect of personal income tax changes in developing countries.

Results for the corporate income tax rate and the VAT rate are less clear. The effect of changes in the corporate income tax rate are never statistically significant. The effect of VAT increases are statistically significant at the

95% confidence level only in the OLS regression for the entire sample, and of an unexpected sign. A potential explanation for this last result is that there is very little time-series variability in the VAT, which gives the regression less power to identify the effects of VAT changes. Moreover, VATs have frequently been introduced, and phased in, in the context of broader tax reforms or other economic reforms. Thus the positive coefficient on the VAT rate may reflect the positive impacts of these reforms as a whole, rather than a reliable prediction of the effects of a cut in the VAT rate.

Other covariates generally have the expected signs and are statistically significant. Higher lagged GDP growth predicts higher growth in the current period and growth in trading-partners' GDP has a positive effect on GDP. Lagged unemployment, however, flips signs in the different specifications and is not statistically significant in some cases.

In summary, we find preliminary evidence that cuts in personal income taxes may have a stimulative effect on GDP growth. This effect is larger in developing countries. These results should be interpreted cautiously, however. As mentioned, this is an illustrative regression that does not fully identify changes in tax rates independently of changes in economic activity. Insofar as tax policy is countercyclical in high-income countries, tax rates are likely to increase during periods of high economic growth in this group of countries. Thus estimates of the tax multiplier might be understated in the case of high income countries. Insofar as tax policy is procyclical in developing countries, and considering that the tax code tends to be less progressive in developing countries, our estimates of the tax multiplier may be overstated in this group of countries. On the other hand, the widespread prevalence of tax evasion in developing countries might mean that actual tax rates are less relevant for economic activity. In this case, our estimates of the tax multiplier reflect the degree to which tax policy affects economic outcomes only after filtering

through tax evasion. The results of Table 4 are then biased downwards, if interpreted as the economic effects of actual effective reductions in tax policy. To address these problems, we now turn to a more detailed study of the effects of taxes and government expenditure on output using structural VAR methods.

4 The effects of taxes and government expenditures: An SVAR approach

4.1 Approach

A major difficulty in estimating the effects of government expenditure and taxes on output at business cycle frequency is the identification of fiscal shocks. While fiscal policy may affect economic activity, it also responds to business cycle conditions. Disentangling this bicausal relation has been the primary challenge for the empirical study of the macroeconomics of fiscal policy, and the main source of methodological debate.

Two main approaches have been pursued in the estimation of the effects of fiscal policy on GDP. First, Barro (1981) suggested that large military buildups in the U.S. could be viewed as exogenous increases in government expenditure that should have no other immediate impact on economic activity. Ramey and Shapiro (1998) and Ramey (2009) extended this methodology, adding a narrative approach to the identification of fiscal shocks. They document, through private forecasts and Business Week reporting, the time at which the public began to anticipate increases in military expenditures. Fisher and Peters (2009) use the stock prices of military contractors in a similar attempt to detect when the private sector had internalized the news of an impending government expenditure shock. Nakamura and Steinsson (2010)

use shocks to military expenditure as an instrument for military procurement in U.S. states, while exploiting heterogeneity in the size of the military industries across states. Shoag (2011) uses shocks to the value of pension plans for state workers as an instrument for state-level public spending to estimate the government-expenditure multiplier. In a novel effort to extend this approach outside the OECD, Kraay (2010) uses disbursement lags of World Bank projects to isolate exogenous changes in public expenditures from those endogenously responding to the state of the business cycle..

Romer and Romer (2010) also adopt a narrative approach and document the time of legislative changes to the U.S. tax code in an attempt to identify tax policy shocks and classify whether tax changes were anticipated and whether they were explicitly aimed at addressing business cycle conditions.

The second approach is the Structural Vector Autoregression (SVAR) methodology introduced by Blanchard and Perotti (2002). They identify fiscal shocks using information about fiscal institutions. On the expenditure side, their identifying assumption is that discretionary government expenditure requires at least one quarter to respond to business cycle conditions. For taxes, they use the output elasticities of tax revenues, estimated from information about tax codes, to differentiate between the endogenous reactions of tax revenues to output fluctuations and unanticipated shocks to tax revenues.

There has been much debate as to the relative merits of these two approaches. Perotti (2004) and Ramey (2009) have extensive comparisons of the SVAR and narrative approaches to identifying government expenditure shocks. Ilzetki, Mendoza and Végh (2010) discuss extending the two approaches to countries outside the OECD. Favero and Giavazzi (2010) and Perotti (2011) compare and attempt to reconcile the very different results arising from Romer and Romer's (2010) and the SVAR approaches to iden-

tifying tax policy shocks. Our study does not innovate on identification of fiscal shocks; we rather take off the shelf the Blanchard and Perotti (2002) methodology. But it is worth making two points on identification.

First, whatever the merits of the narrative and natural experiment approaches in general, when studying a broad cross-section of countries, these methods are difficult to implement. While Barro (1981) and others have shown that military expenditure is the main source of volatility in U.S. government expenditure, this is not the case in all developing countries. In fact, for some developing countries, military expenditure is a negligible portion of budgetary expenditure. And in those developing countries whose expenditures are driven by large swings in military spending, it is hard to argue that these war buildups have little direct impact on GDP. Moreover, there is a growing literature arguing that either business cycle conditions or swings in natural resource prices are major drivers of public expenditure in developing countries⁵. This makes it difficult to find a general econometric instrument that drives public spending in developing countries, but which has no direct effect on economic activity. On the tax side, there is to date no comprehensive documentation of tax changes as in Romer and Romer (2010) for countries other than the U.S. and the U.K.

Second, the SVAR approach may be more effective at identifying unanticipated fiscal shocks in developing countries than in high-income countries. While Ramey (2010) has presented evidence that SVAR shocks were forecasted by the private sector, this is less likely to be the case in developing countries. As IMV discuss, government expenditure is very volatile on a quarter-to-quarter basis in developing countries. Fiscal planning is poor and not credible. Quarterly fiscal data is subject to large revisions even a year or

⁵See for example Kaminsky, Reinhart and Végh (2004), Ilzetzki and Végh (2008) for stylized facts; Talvi and Végh (2005), Alesina, Campante, and Tabellini (2008) and Ilzetzki (forthcoming) for political economy theories of this phenomenon.

two after the fact. It is therefore unlikely that the public will have foreseen many of the fiscal shocks identified by an SVAR, and even less likely that their exact timing at a quarterly frequency will have been known in advance. Moreover, if the volatility of public expenditures is driven largely by political pressures to increase expenditures when resources are abundant, a VAR should be able to pick up on this relationship, as long as it is relatively systemic, and does not lead to a contemporaneous relationship between output and public expenditures (due to implementation lags).

In addition, there are particular merits to the Blanchard and Perotti (2002) approach to identification of shocks to tax policy in developing countries. As noted in Section 3, estimates of the fiscal multiplier from changes in statutory rates may understate the economic effect of effective changes in tax payments, when tax evasion is prevalent. As the Blanchard-Perotti SVAR backs out shocks to tax revenues, it captures effective changes in tax payments, not only changes that are on the books. To illustrate the relevance of this point, consider a government that improves the enforcement of tax payments. However desirable this may be for fiscal management, this improved enforcement also entails an effective increase in the tax burden. Improved enforcement leads to a de-facto increase in effective tax rates, the omission of which may understate the effects of tax policy. In contrast, backing out shocks to tax policy from tax revenues captures changes in the actual incidence of taxes.

We now detail the SVAR approach used in this study. We estimate the following panel vector autoregression (PVAR):

$$A_n Y_t^n = \sum_{k=1}^K C_k Y_{n,t-k} + B u_{n,t}, \quad (2)$$

where $Y_{n,t}$ is a vector of J macroeconomic variables. In this section $J = 3$

and this vector includes—from top to bottom—government expenditure $g_{n,t}$, tax revenues $T_{n,t}$, and *GDP* $y_{n,t}$. The $J * J$ matrices C_k trace the k -order autoregressive process of the macroeconomic system, while $u_{t,t}$ is a $J*1$ vector of structural shocks to the macroeconomic observables. Structural shocks are assumed to be distributed $N(0, 1)$ and such that $E[u_{n,t}(i)u_{n,t}(j)] = 0 \forall i \neq j$. The diagonal matrix B rescales these shocks to units of the macroeconomic variables, based on their respective variances. A_n allows for contemporaneous relations amongst these variables.

The matrix A_n is allowed to vary from country to country. We use the tax revenue elasticities shown in Table 1 to obtain heterogeneous values of $A_n(2, 3)$. However, in order to maximize the estimation’s sample size, we do not allow heterogeneity in the other values of the A matrix.

A reduced-form version of (2), where both sides of this equation are multiplied by A_n^{-1} , can be estimated via OLS. This provides us with estimates of $A_n^{-1}C_k$ and of the error terms $\varepsilon_{n,t} \equiv A_n^{-1}Bu_{n,t}$.

The estimated variance-covariance matrix of $\varepsilon_{n,t}$ gives $J(J - 1)$ equations for the estimation of the unknown parameters in A_n and B :

$$E[\hat{\varepsilon}_{n,t}\hat{\varepsilon}'_{n,t}] = A_n^{-1}BB'(A_n^{-1})'$$

There are $J(J - 1)$ unknowns in A_n and an additional J in B_n . J restrictions are required on the elements of A_n to estimate the remaining elements. To summarize the structural restrictions, let

$$A_n \equiv \begin{bmatrix} 1 & a_{Tg} & a_{yg} \\ a_{gT}^n & 1 & a_{yt} \\ a_{gy} & a_{Ty} & 1 \end{bmatrix}.$$

The parameters of greatest interest are a_{gy} and a_{ty} , as they determine the

effects of government expenditure and taxes on output. We leave them unrestricted. We use our tax elasticity estimates to determine $a_{y\tau}$. Following Blanchard and Perotti (2002) we also note that government purchases (as opposed to transfers) have no automatically stabilizing components and set $a_{yg} = 0$. (In the PVAR estimation of this section, we use data on government consumption as g_t^n .)

Finally, Blanchard and Perotti (2002) and Favero and Giavazzi (2007) show that results are not sensitive to assuming $a_{Tg} = 0$, $a_{gT} = 0$ or setting both to zero. Estimates presented here set $a_{gT} = 0$, but any of the alternative assumption leads to essentially identical results.

4.2 Results

Following IMV, we pool countries in several ways, based on country characteristics. In Figures 5 and 6 we show results for high income and developing countries, respectively. Figures 7 and 8 present results for open and closed economies, defined as in IMV as countries with ratios of trade (imports plus exports) exceeding, or below, 60% of GDP, respectively. Finally, using the classification in Ilzetzki, Reinhart and Rogoff (2011), we divide the sample into country-episodes where the exchange rate was fixed and those where it was flexible in Figures 9 and 10, respectively. The upper panel of each of these figures gives the cumulative multiplier to a shock to government consumption at horizons ranging from one to twenty quarters. The lower panel gives the cumulative multiplier in response to a shock to taxes. Point estimates are presented in a solid line and the boundaries of the 90% confidence interval, estimated using Monte Carlo simulations with bootstrapped standard errors and 500 repetitions, are shown in dotted lines. Reported regressions include 4 lags.

A number of results emerge from Figures 5 and 6. First, in high-income countries the response of output to a \$1 increase in government consumption is estimated at approximately \$0.8. The response is statistically different from zero, but not from one, at every forecast horizon. The long run multiplier slightly exceeds 1, but error bands are wide at longer forecast horizons. In developing countries, the response of output to increases in government consumption is more muted. On impact, output increases by merely 0.2 cents for every dollar spent by the government, implying that more than 80% of government expenditure is crowded out by other components of GDP (consumption, investment or net exports). This estimate is statistically different from zero, but is lower by a statistically significant margin from our estimate of the fiscal multiplier in high-income countries. In the long run, government consumption appears to be almost fully crowded out, with the long run multiplier for developing countries estimated at 0.15. This estimate is not different from zero by a statistically significant margin, but can be said to be lower than 1 with 99% confidence.

Long-run estimates of the government expenditure multiplier are similar to those found in IMV, but the impact multipliers in both these groups of countries are larger in this study. There are different reasons for these divergent results in the case of high-income countries and in the case of developing countries. In high-income countries, the current sample is significantly smaller than that used in IMV, with only 6 of the 19 countries from IMV included in this sample. A bivariate regression with government consumption and GDP as in IMV yields similar results as those reported here, when only including the six countries that are in both studies.

While the sample of developing countries is not perfectly overlapping with that of IMV (only 17 of the 20 countries in IMV are included here), this is not the main cause for the difference in the estimates of fiscal multipliers.

The exclusion of tax revenues from the regression in IMV may have understated the short-run impact of government consumption on GDP (and lead to estimation of a negative impact multiplier). In fact, as shown in Figure 11, taxes are found to rise in response to government consumption increases, which may bias results of estimations that exclude taxes.

Turning to the effects of taxes on output, Figure 5 re-affirms results seen elsewhere in SVAR estimates of taxes on output for industrialized countries. As in Perotti (2004), the effects are small and not statistically significant. See also Caldara (2011) on the range of tax multipliers that are plausible given reasonable assumptions on tax elasticities; these estimates are clustered around zero as well. However, Favero and Giavazzi (2010) and Perotti (2011) show that once narrative information from Romer and Romer (2010) is incorporated into SVAR estimations, tax multipliers may be larger than in standard SVAR estimates.

In contrast to high-income countries, we find that tax cuts in developing countries do have the ability to stimulate output. A tax cut that decreases revenues by \$1 increases output by approximately \$0.3, a multiplier that is statistically different from zero. In the long run, the tax multiplier increases to exceed 0.8, although error bands are wide around this estimate.

Figures 7-10 reaffirm additional results from IMV. Long-run government consumption multipliers are large, statistically different from zero, and estimated to exceed one in closed economies and when exchange rates are fixed. In contrast, multipliers are essentially zero in open economies or those operating under flexible exchange rates.

In all these country groupings, tax multipliers appear to exceed zero only slightly on impact, but to be zero or negative in the long run. One exception is closed economies, where the long-run tax multiplier appears to exceed one (although it is not statistically different from zero). Figure 12 shows,

however, that a simple interpretation of this result as implying that tax policy is effective in stimulating output in closed economies is slightly misleading. Government consumption decreases significantly in response to tax increases in this group of countries. As the government consumption multiplier is large in this group of economies, the estimated decrease in output in the long run conflates the effects of government spending cuts with tax increases. Once these are accounted for, the multiplier is close to zero in this group of countries as well.

In conclusion, in a Panel SVAR analysis of the effects of government consumption and taxes on output in several country groupings, we find results on government expenditure that are similar to those in IMV: the multiplier is substantially larger in high income countries than in developing countries, in closed economies than in open economies, and under fixed- than under flexible-exchange arrangements. We also re-affirm results from earlier SVAR studies on the macroeconomic effects of taxes: the tax multiplier is close to zero in high-income countries. We also report a new finding: tax policy is more effective at stimulating short-run output in developing countries. The impact multiplier there is approximately 0.3 and statistically different from zero. The tax multiplier in the long run is estimated at 0.8.

5 Fiscal policy and debt dynamics

In the previous section we estimated fiscal multipliers for a broad range of countries and found very heterogeneous responses to fiscal shocks. But in some cases, the fiscal multiplier was found to be sizable. Active counter-cyclical fiscal policy would seem to have some benefit in terms of stimulated output in these cases. However, as recent experiences in Europe and many past experiences in developing countries have made all too clear, active fiscal

management may have large costs as well. Increases in government expenditures and tax cuts imply higher deficits, which in turn imply higher debt. Will markets tolerate the higher debt levels caused by fiscal stimulus? Will governments be forced to implement sharp and sudden fiscal reversals, as appears to currently be the case in several European countries?

Recent studies have attempted to address these questions. Reinhart and Rogoff (2010), for example, show in a panel of high-income and developing-countries that high levels of sovereign debt lead to lower GDP growth in subsequent years. A recent debate has emerged, also, on the effectiveness of fiscal policy when debt levels are high, or conversely whether fiscal *contractions* may at times be *expansionary*, as claimed, for example by Alesina and Ardagna (2010). The IMF (2010) critiqued this result and concluded that fiscal contractions, while perhaps necessary at times, come at a short-run cost.

In an important contribution, Favero and Giavazzi (2007) show that not only may current SVAR estimates be biased due to the omission of debt as a control variable, but also that its inclusion in a VAR analysis is non-trivial. After all, the debt stock relates to the endogenous VAR variables—government expenditure, taxes, GDP, interest rates, and inflation—in a highly non-linear way. So while it may be problematic to omit debt from the regression, it is also inappropriate to include debt as an exogenous control variable.

To fix ideas, consider augmenting (2) with a variable d_t , measuring the debt-to-GDP ratio, as suggested by Favero and Giavazzi (2007):

$$AY_t = \sum_{k=1}^K [C_k Y_{t-k} + D_k d_{t-k}] + Bu_t, \quad (3)$$

where the estimation is for an individual country, and where D_k are $J * 1$ vectors representing the feedback from debt to endogenous variables in Y_t .

As mentioned, d_t is itself an endogenous variable that relates to current and past values of the endogenous variables. Favero and Giavazzi (2007) describe the following debt-accumulation identity:

$$d_t \equiv \frac{1 + i_t}{(1 + \Delta p_t)(1 + \Delta y_t)} d_{t-1} + \frac{\exp g_t - \exp T_t}{\exp y_t}, \quad (4)$$

where i_t is the nominal interest rate and p_t the price level. The first term indicates that past debt incurs interest, but its ratio to GDP depreciates due to GDP growth and inflation. The second term is the primary deficit as a percentage of GDP. (The variables g_t , T_t , and y_t are all in natural logarithms.)

In adapting this approach to developing countries, one must remember that a large proportion of emerging-market debt is denominated in foreign currency. We therefore adapt the debt accumulation identity (4) to the case of developing countries:

$$d_t \equiv \frac{(1 + i_t)[\delta(1 + \Delta s_t) + 1 - \delta]}{(1 + \Delta p_t)(1 + \Delta y_t)} d_{t-1} + \frac{\exp g_t - \exp T_t}{\exp y_t}, \quad (5)$$

where s_t is the nominal exchange rate and δ is the share of debt denominated in foreign currency, assumed here to be constant.⁶ The additional term indicates that debt denominated in foreign currency may accumulate also due to exchange rate depreciation.

As outlined in Favero and Giavazzi (2007), we can now estimate (3) by OLS and estimate the structural shocks u_t using the same identification as in Section 4. However, in charting impulse responses, we track debt accumulation according to (5) and allow for debt feedback to the endogenous variables

⁶In reality, in many emerging market countries the currency denomination of debt has changed significantly over time. However, the currency composition of foreign debt is unlikely to be directly related to the endogenous variables in this study in the short run, but rather determined by foreign appetite for domestic currency debt and technocratic decisions within the Finance Ministry.

through D_k .

We augment our VAR to include the additional variables in (5), so that now $Y_t = (g_t, T_t, y_t, \Delta p_t, i_t, \Delta s_t)'$. g_t , T_t , and y_t are (log) government primary expenditure, tax revenues, and GDP, respectively; Δp_t and Δs_t are the inflation rate and the rate of depreciation of the nominal exchange rate. i_t is the nominal interest rate faced by the government. As in Favero and Giavazzi (2007) we use instead the ratio of interest payments to the debt stock, which is the appropriate interest rate for (5) to hold as an identity.

5.1 Debt feedback: A conceptual framework

There are at least three ways how debt feedback might affect the impact of fiscal policy. First, governments may respond to high levels of debt by increasing tax rates or lowering government expenditures. In other words $D_k(1) < 0$ or $D_k(2) > 0$ for some k . There is some evidence that governments do respond in such a stabilizing way. Bohn (1998) shows that fiscal surpluses in the U.S. have responded to the debt-to-GDP ratio. Mendoza and Ostry (2008) show that developing countries respond in a similar stabilizing manner. If this is a correct characterization of government behavior, a standard SVAR estimate using (2) might understate the degree of future fiscal consolidation caused by current fiscal stimulus. It might therefore overstate the long-run effects of fiscal stimulus on output, as it fails to recognize that fiscal stimulus is followed by fiscal consolidation.

Second, higher debts may imply higher borrowing rates i_t . In other words $D_k(5) > 0$ for some k . If this is the case, a standard SVAR estimate would again overstate the effects of fiscal policy on output. It would fail to recognize that current fiscal expansions increase the debt-to-GDP ratio, which may cause higher interest rates. Higher interest rates may in turn crowd out

output.

Finally, high levels of debt may have direct impacts on output not (or only partially) accounted for by the factors above. This is suggested by the empirical results of Reinhart and Rogoff (2010), for example. One possible theoretical channel for these results was suggested by Drazen and Helpman (1990), who outline a theory where current fiscal stimulus creates expectations of—or uncertainty about—future fiscal or monetary policy. These expectations may have an *immediate* effect on output or prices. As the VAR cannot identify expectations, these effects will be estimated as a direct effect of debt on output.

5.2 Estimation and results

Favero and Giavazzi (2007) estimate the system (3) and (4), but found only minor changes in the macroeconomic effects of shocks to government expenditure and tax revenues. Here we estimate (3) and (5) using data from five developing countries and contrast our results with Favero and Giavazzi's (2007). The five countries—Brazil, Chile, Estonia, Malaysia and South Africa—were selected based on data availability and consistency. The estimation of the system (3) and (5) is only valid if data on the endogenous VAR variables in Y_t are consistent with time series for sovereign debt d_t in equation (5). As time series for sovereign debt are usually compiled using different methods and sources from high-frequency fiscal and macroeconomic data, (5) does not obtain consistent estimates for most developing countries. The selected sample of countries were the only five in our sample of developing countries for which data were consistent.⁷ These countries represent a variety of regions (Asia, Africa, Eastern Europe, and Latin America), degrees of openness to

⁷We included countries whose simulated debt series deviated from actual debt by 2 percentage points of GDP or less, on average.

trade and exchange rate regimes.

5.2.1 Consistency of debt series

Figure 13 shows the evolution of the debt-to-GDP ratio for the five countries studied, together with the evolution of debt-to-GDP implied by the high-frequency macroeconomic time series. Solid lines in Figure 13 represent the left-hand side of (5) and the dotted lines its right-hand side. A number of factors complicate this calculation. First, time series for sovereign debt were available only at annual frequency. We interpolate these series using piecewise quadratic polynomials. Second, a significant proportion of revenues for most developing countries come from non-tax sources. Ignoring this factor, the right hand side of (5) exceeds its left hand side. The dotted lines in Figure 13 therefore contain non-tax revenues as well as tax revenues.⁸ Third, time series on δ —the share of debt that is denominated in foreign currency—are not available for most countries in the sample. However, we were able to obtain one or two observations on the shares of foreign-denominated debt for each country. When only one observation was available, we used the single observation and treated δ as constant. When more than one observation was available, we created a series of debt shares δ_t based on a linear interpolation between the observations. The values of δ used are summarized in Table 5. In all five cases (perhaps with the exception of South Africa), the synthetic debt series closely match the realized debt series, indicating the validity of debt accumulation equation (5) and the consistency of other macroeconomic time series with debt series.

⁸In the cases of Brazil and South Africa, we use the average of net non-tax revenues over the entire time period, due to data limitations.

5.2.2 Results

We run a VAR(1) in order to conserve degrees of freedom in the short time series used in this section. (This is in fact the lag order selected by the Schwartz information criterion.) Figures 14 to 18 give the impulse responses of the seven endogenous variables (including debt) to shocks to government expenditure and tax revenues. The dashed lines show responses ignoring debt feedback with 90% confidence intervals indicated in dotted lines. The solid lines give the impulse responses with debt feedback. Each figure gives responses for one of the five countries, and each is divided into three panels. Panel (a) gives the response to shock to government expenditure and panel (b) to a shock to tax revenues. Panel (c) shows the dynamics of debt in response to both shocks.

We first observe that the baseline responses of GDP to government expenditure (in the lower left-hand corner of panel (a) in each figure) differ significantly across countries. While error bands are wide, given the short sample for each country, the response of GDP to a government expenditure shock appears positive in Brazil and South Africa, but zero or negative in Chile, Estonia, and Malaysia. This corresponds exactly with the observation in section 4 that the multiplier on government expenditure is larger in relatively closed economies than in relatively open ones. (Brazil and South Africa are classified as closed and the remaining as open).

Turning to Figure 14a, the responses for Brazil highlight the importance of incorporating debt dynamics into SVAR estimates of the effects of fiscal policy. Not surprisingly, responses are similar on impact—with or without debt feedback—as the effects of debt dynamics affect impulse responses only at longer horizons. Looking at the response of GDP in the lower left-hand panel, however, shows a significant difference within the first year following the initial shock. While the response of output in the traditional VAR

converges gradually to zero, giving a cumulative increase in GDP of 4%, the response including debt feedback becomes *negative* after approximately a year, yielding a cumulative *decrease* in GDP exceeding 3%. After a year it also departs from the 90% confidence interval of the traditional SVAR, indicating that the traditional VAR would place a probability of less than 5% that the best unbiased estimate of the VAR incorporating debt dynamics reflect the true response. We acknowledge, however, that the standard errors of the debt-dynamics impulse responses are large enough that we cannot reject the hypothesis that the responses are identical.

The reason for this difference are immediately apparent from the other responses on the left hand side of Figure 14a. First, the response of government expenditure to its own shock converges to zero in the traditional SVAR, but here becomes negative after five quarters (and exits the 90% confidence bounds of the traditional SVAR estimate after seven quarters). As predicted, the government decreases expenditure in response to higher debt, so that the initial government expenditure stimulus is followed by a fiscal consolidation within two years. Similarly, tax revenues increase slightly for the entire forecast horizon of the debt-feedback responses, but decline after several quarters when debt feedback is ignored. This is an implied tax *rate* increase in the debt-feedback response: with declining output, higher tax revenues imply higher tax rates.⁹

As pointed out by Favero and Giavazzi (2007) for the case of the United States, in Brazil too, the VAR with debt-dynamics predicts a counter-intuitive *decline* in interest rates following an increase in government expenditure. In both cases, this is potentially due to the fact that the interest rate used is the one implied from interest payments, rather than a market interest rate.

⁹An alternative explanation is that the higher inflation predicted by the impulses with debt feedback is generating higher tax revenues through tax bracket creep.

Fiscal stimulus increases the debt stock immediately; but rising interest rates affect actual interest payments only with a lag. With the debt stock increasing and interest payments constant, the interest rate implied from interest payments is likely to go down in the short run.

Figure 14b shows the responses of variables in Y_t to a 1% of GDP shock to tax revenues. (The shock is an unanticipated *increase* in taxes.) The long-run dynamics are very different once debt-feedback is accounted for. While GDP declines on impact due to the increase in taxation in the traditional SVAR—with the effects gradually dying out, GDP begins to *rise* in the debt-feedback responses in less than a year. In fact, the long run effect of the tax increase is *positive*. This is caused partially by the increase in government expenditure that is observed in the upper left-hand panel of Figure 14b. The response of GDP in the debt-dynamics regressions exits the 90% confidence interval of the traditional VAR within a year.

We also see a difference in the effects of tax increases on GDP on impact: GDP declines by 0.2% without- but only by 0.1% with- debt dynamics. This gives some evidence of the direct channel suggested in Section 5.1, where the contractionary effects of tax increases are diminished on impact. This is perhaps because of expectations of government expenditure increases—and therefore higher GDP—identified in the upper-left-hand and lower-right-hand responses of Figure 14a. A shock to tax revenues implies a permanently lower level of debt, which leaves room for increases in public expenditure in the long run.

The importance of accounting for debt dynamics is further apparent in Figure 14c, which gives the dynamics of the (cumulative change) in the debt-to-GDP ratio following each of the two fiscal shocks. As is apparent in both panels, the traditional SVAR implies permanent increases in the debt-to-GDP ratio due to fiscal stimuli. Once we account for the actual historical

response of fiscal policy to changes in sovereign debt in the regressions incorporating debt dynamics, we find that fiscal stimulus was followed by fiscal consolidation within 1-2 years of the initial loosening of fiscal policy.

In Brazil, we find evidence that fiscal stimulus is followed by consolidation within a relatively short forecast horizon, while fiscal consolidation leaves room for future fiscal expansion. As we noted, we find no evidence of the interest rate crowding-out channel through which debt feedback was predicted to affect output, but some potential indication of a direct channel from higher debt to lower GDP.

Further evidence of the direct channel can be found in the case of Estonia, in Figure 16a. The traditional VAR finds a response of GDP to increases in government expenditure that is not significantly different from zero. The regressions with debt dynamics indicate, however, that this may *overstate* the effects of government expenditure on output in Estonia. In fact, once debt dynamics have been accounted for, GDP declines significantly in the medium term in response to increases in government expenditure. In contrast, in Figure 16b, a tax increase causes a *greater* decline in GDP once debt dynamics have been accounted for. This unintuitive result, can be explained by a glance at the right-hand panel of Figure 16c. The increase in taxation decreases the debt-to-GDP ratio only temporarily. Debt then increases in the upcoming years. This is because government expenditure shows a persistent increase following the increase in tax revenues, as can be seen in the upper-left-hand panel of Figure 16a. In Estonia, the fiscal space freed by increases in taxation is more-than-fully used to increase government expenditures in subsequent years. These increases in government expenditures increase debt levels, which have a deleterious effect on GDP.

In the remaining three countries, as in the Favero and Giavazzi's (2007) exploration of the United States, we find little difference between the regres-

sions with and without debt dynamics. Only in the case of South Africa do debt dynamics appear to diminish the effects of fiscal policy, due to future policy reversals, but this effect is not statistically significant.

6 Conclusion

This paper explores the effects of fiscal policy—government expenditure and taxes—on output in a sample of 28 developing- and high-income countries. Its main new findings, using OLS, GMM and SVAR estimates are that the effects of taxes on output appear moderate in high-income countries, but significant in developing countries. Specifically, we find that cuts in personal income tax rates have a significant impact on economic growth in the following year in developing countries. In contrast to findings in SVAR studies of high-income countries, we find that tax policy appears more effective at stimulating output than increases in government expenditures.

The paper also incorporates debt dynamics into a Structural VAR estimation and concludes that in some cases—Brazil and Estonia in the current study—incorporating debt dynamics into a fiscal SVAR can have a substantial effect on estimates of the effects of taxes and government expenditure on output.

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Figure 1: Marginal Income Tax Rate - Peru

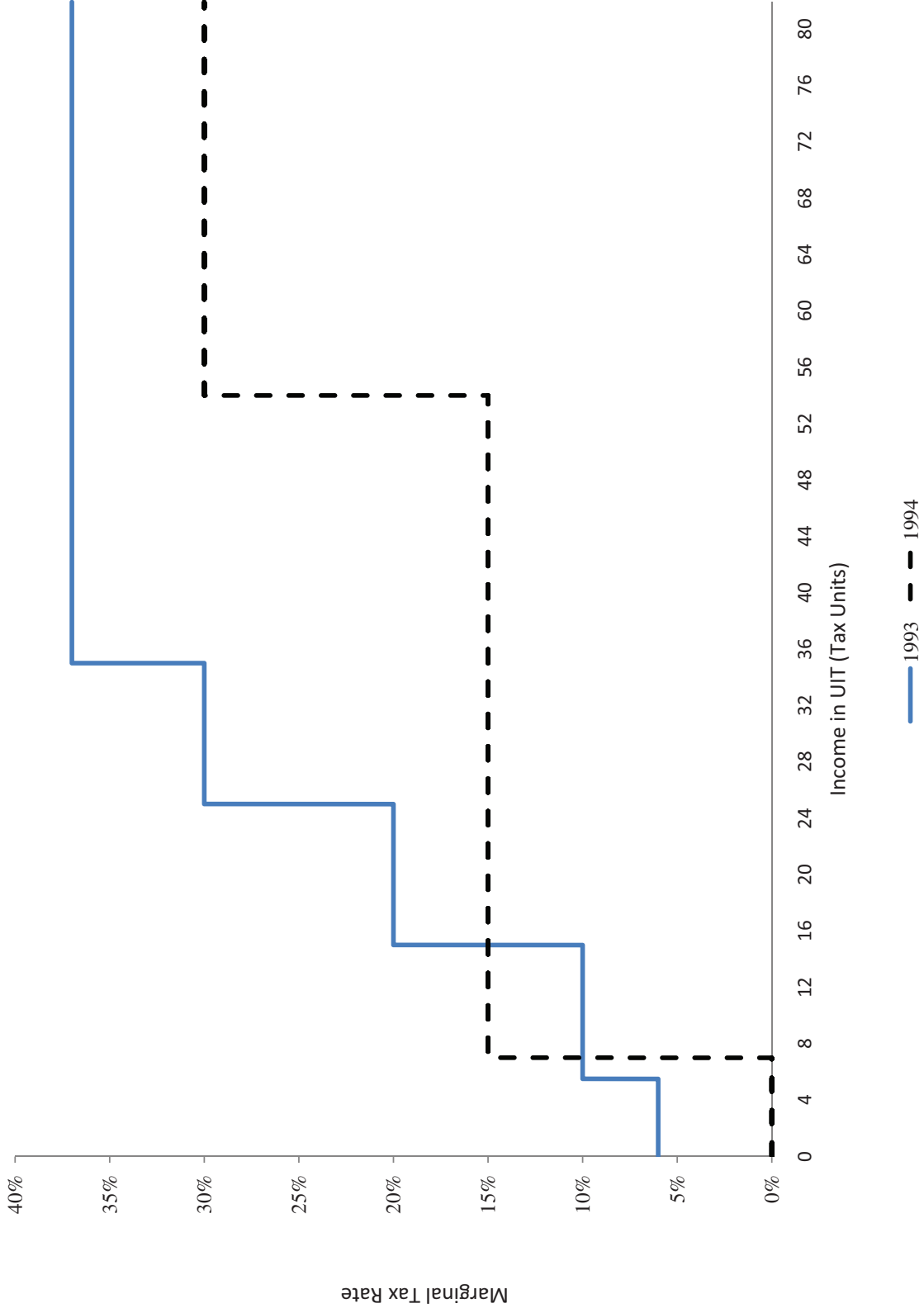
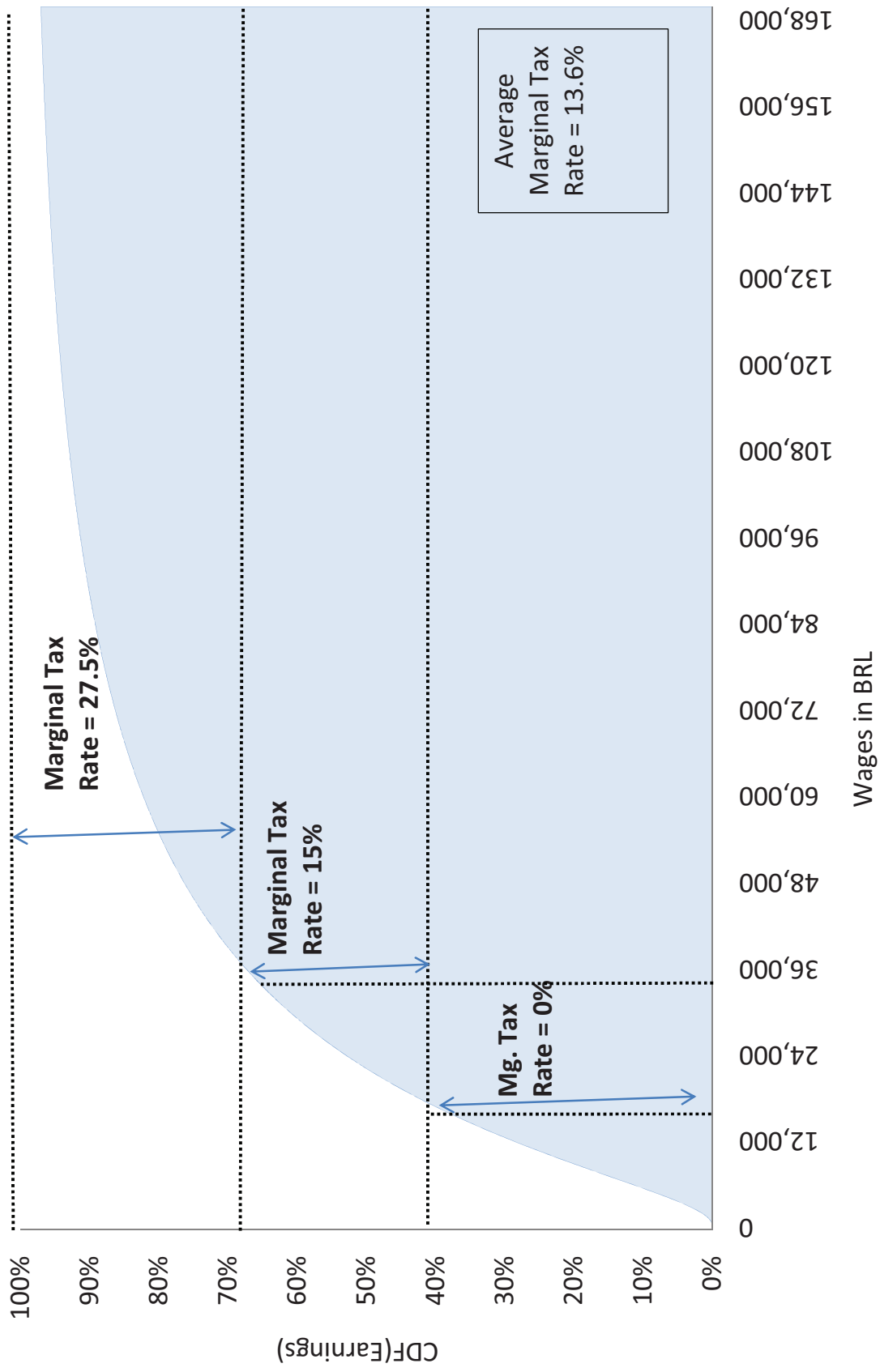


Figure 2: Calculating the Average Marginal Tax Rate, Brazil 2008



**Figure 3: Average Marginal Personal Income Tax Rate
Comparison with Barro and Redlick (2009)**

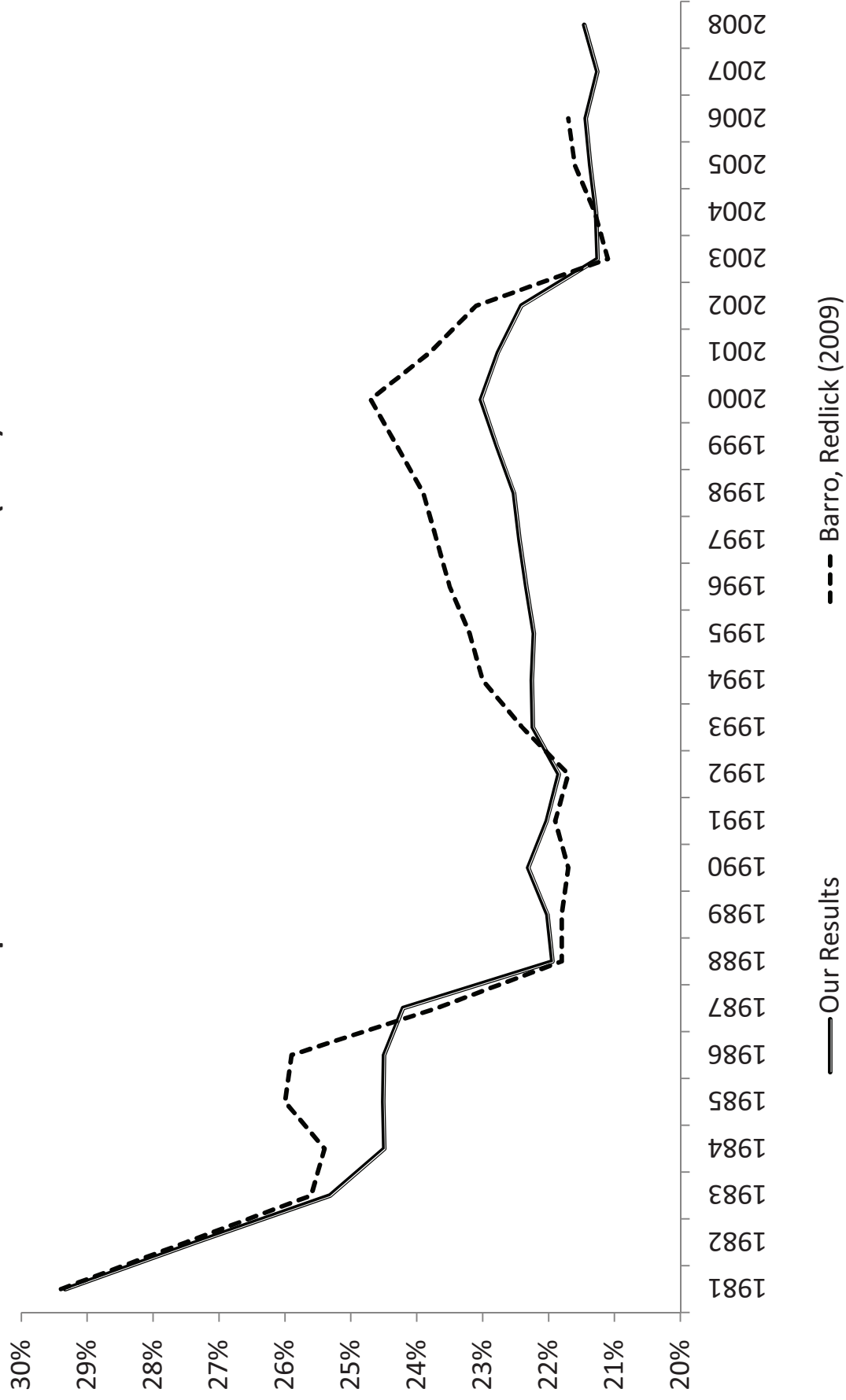


Figure 4a: Tax Rates

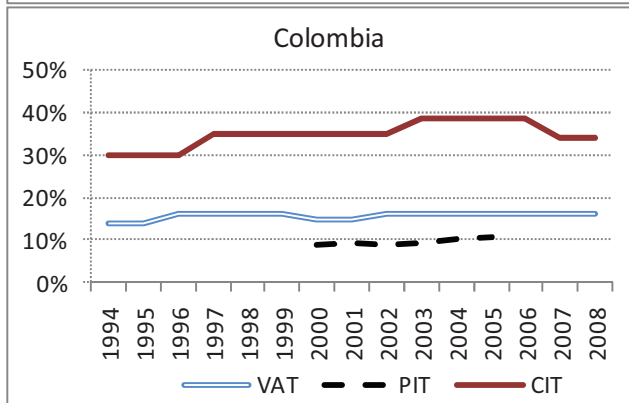
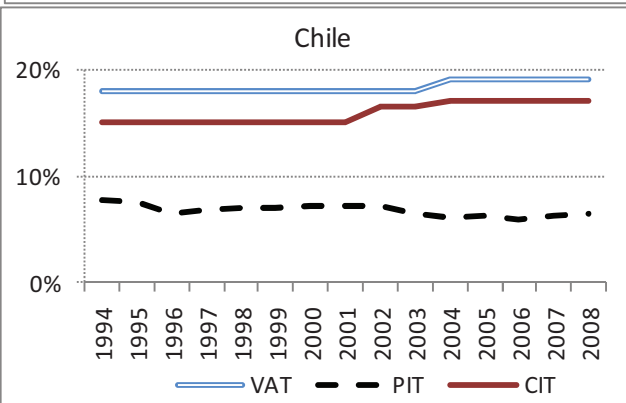
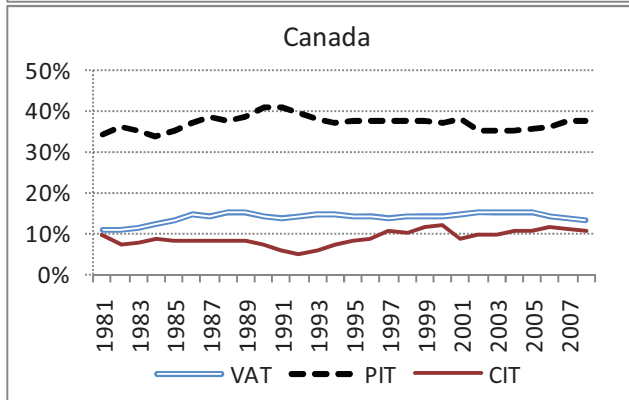
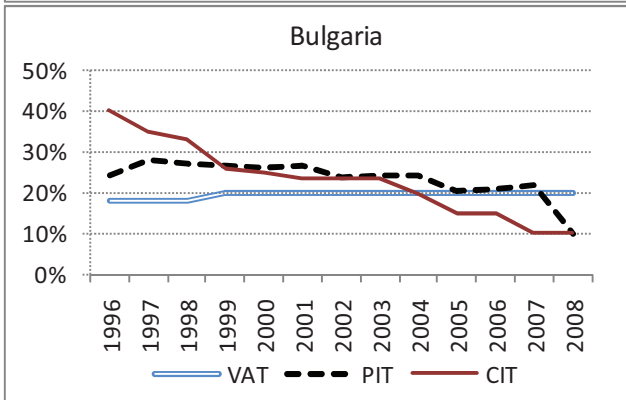
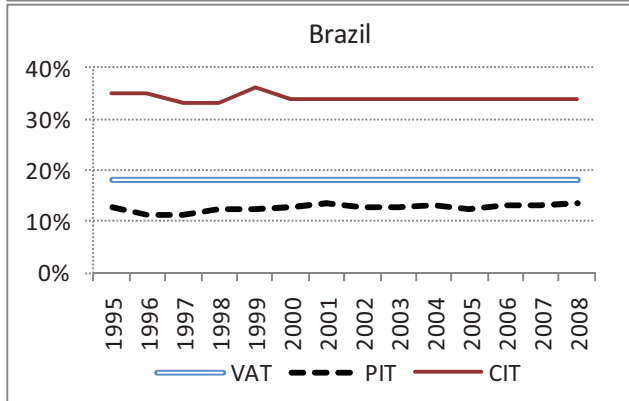
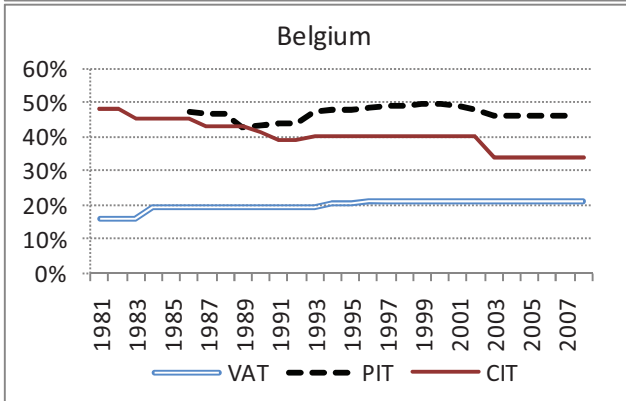
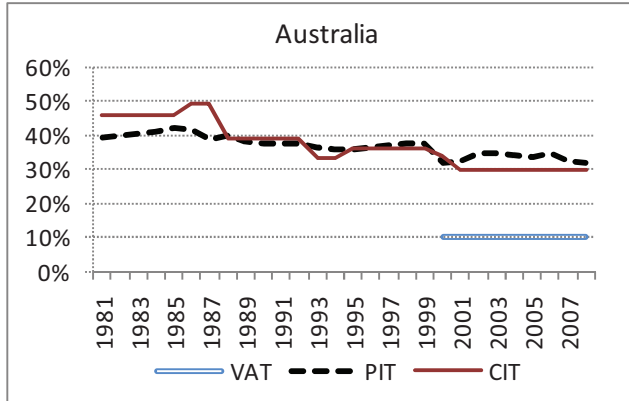
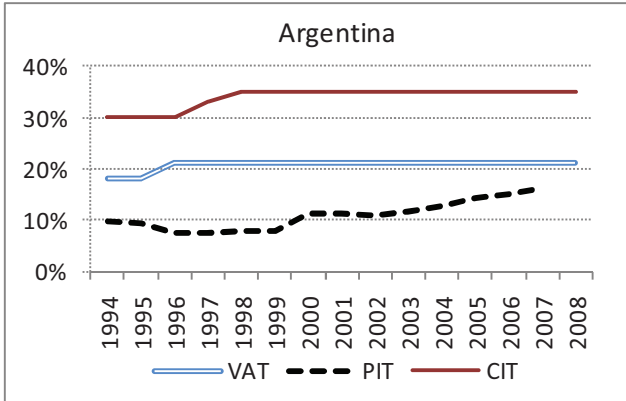


Figure 4b: Tax Rates

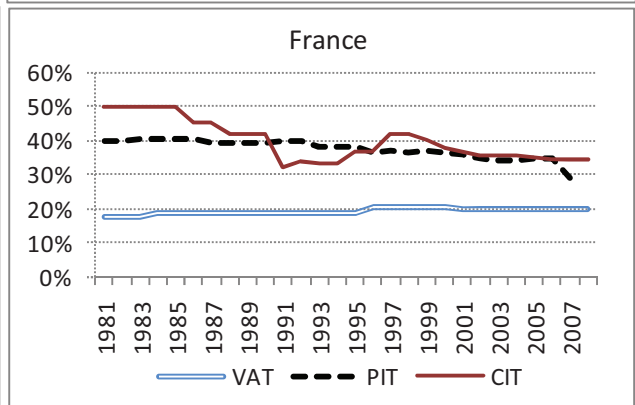
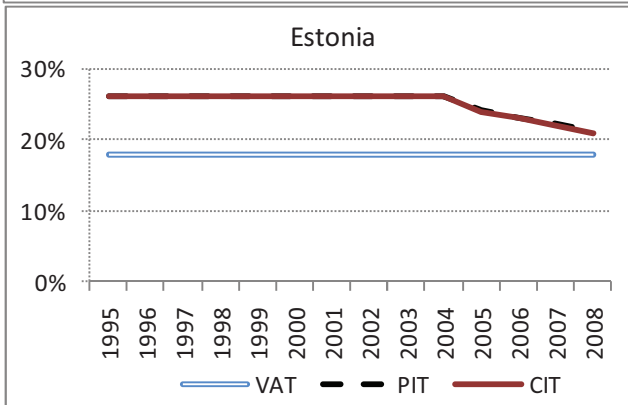
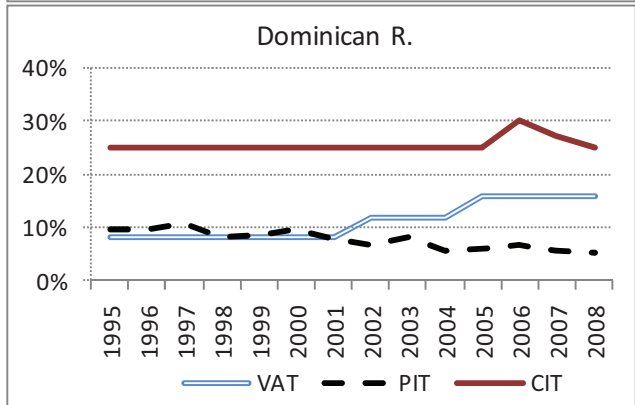
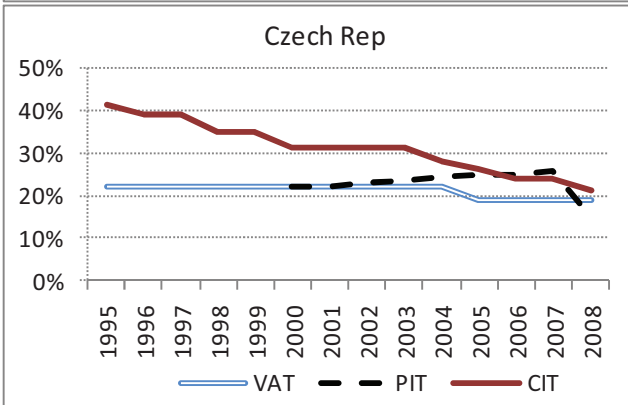
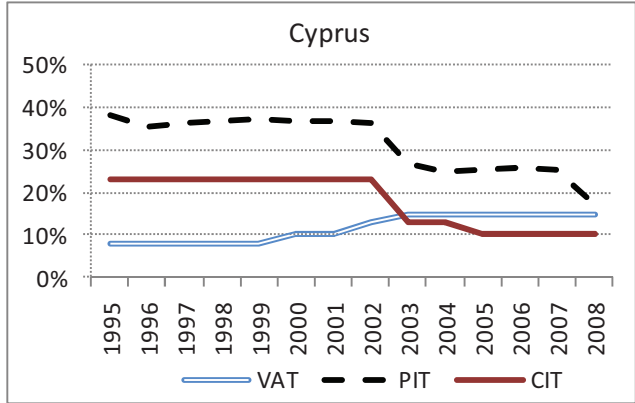
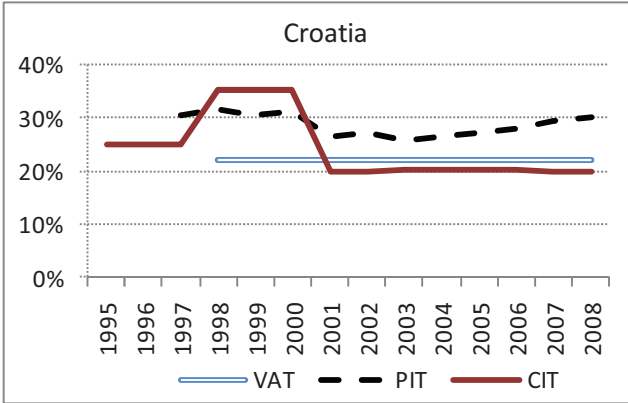


Figure 4c: Tax Rates

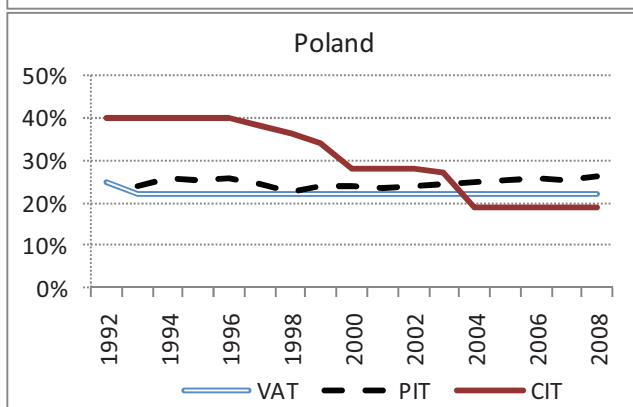
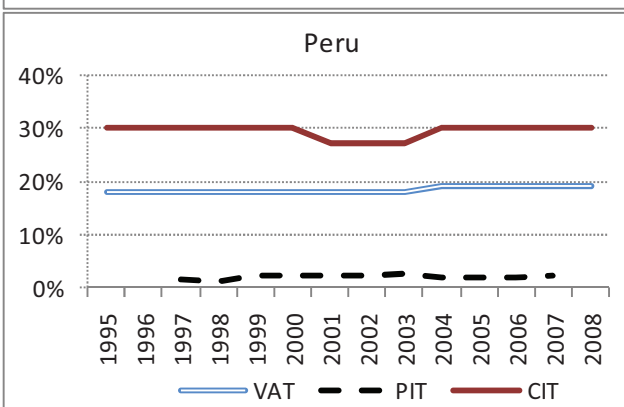
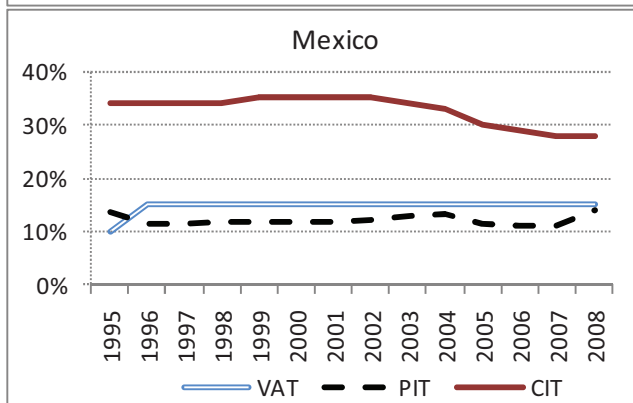
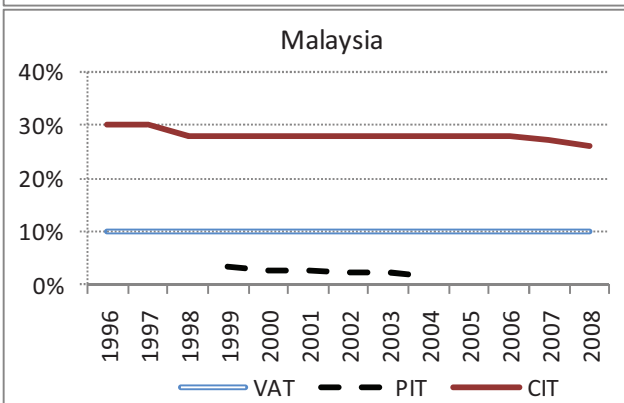
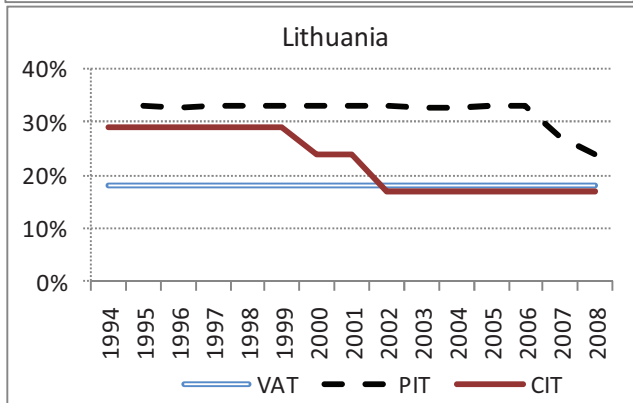
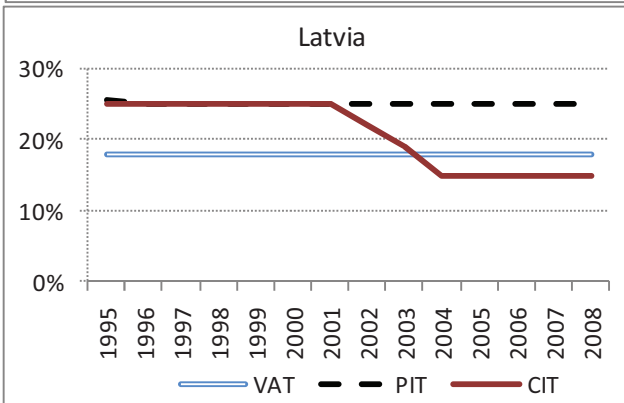
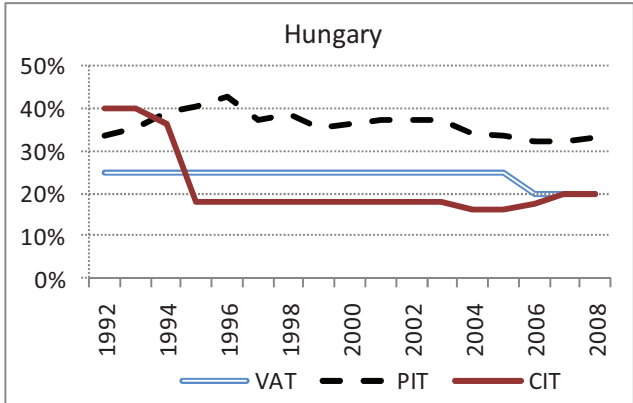
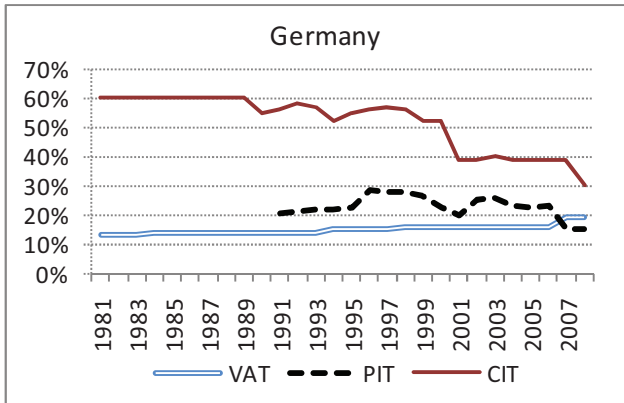


Figure 4d: Tax Rates

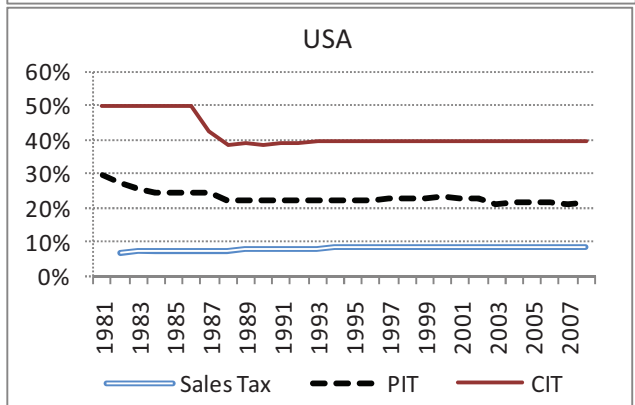
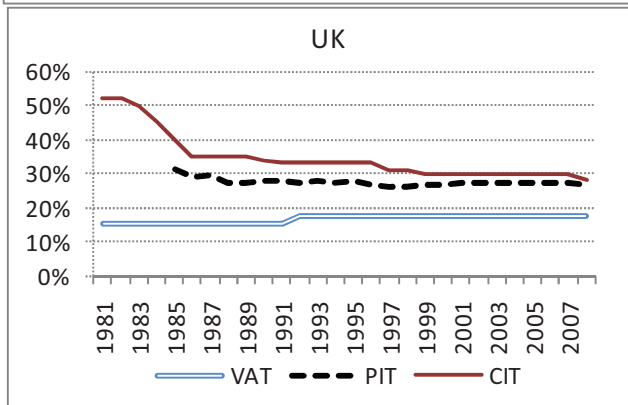
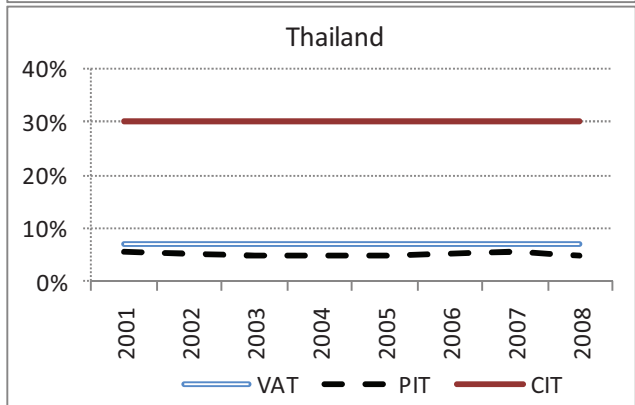
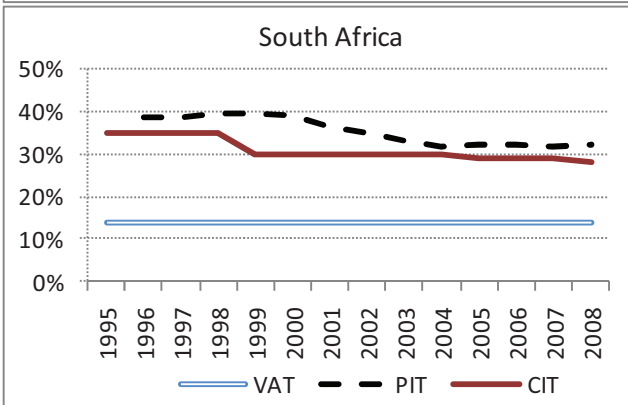
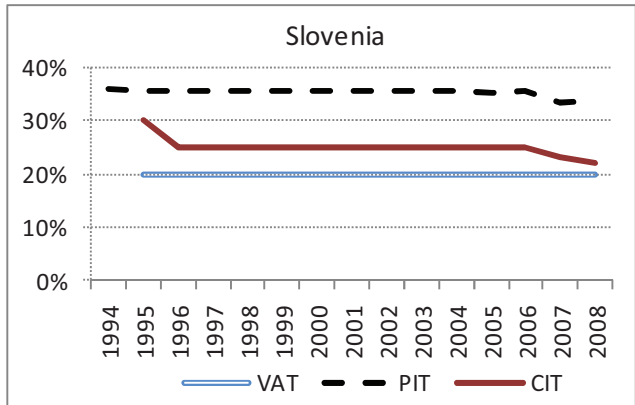
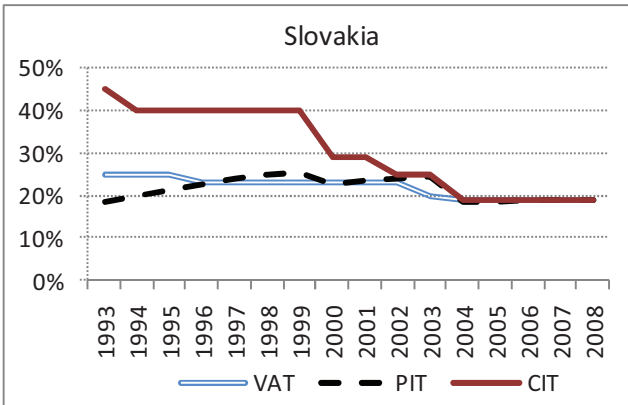


Figure 5: Fiscal Multipliers in High-Income Countries

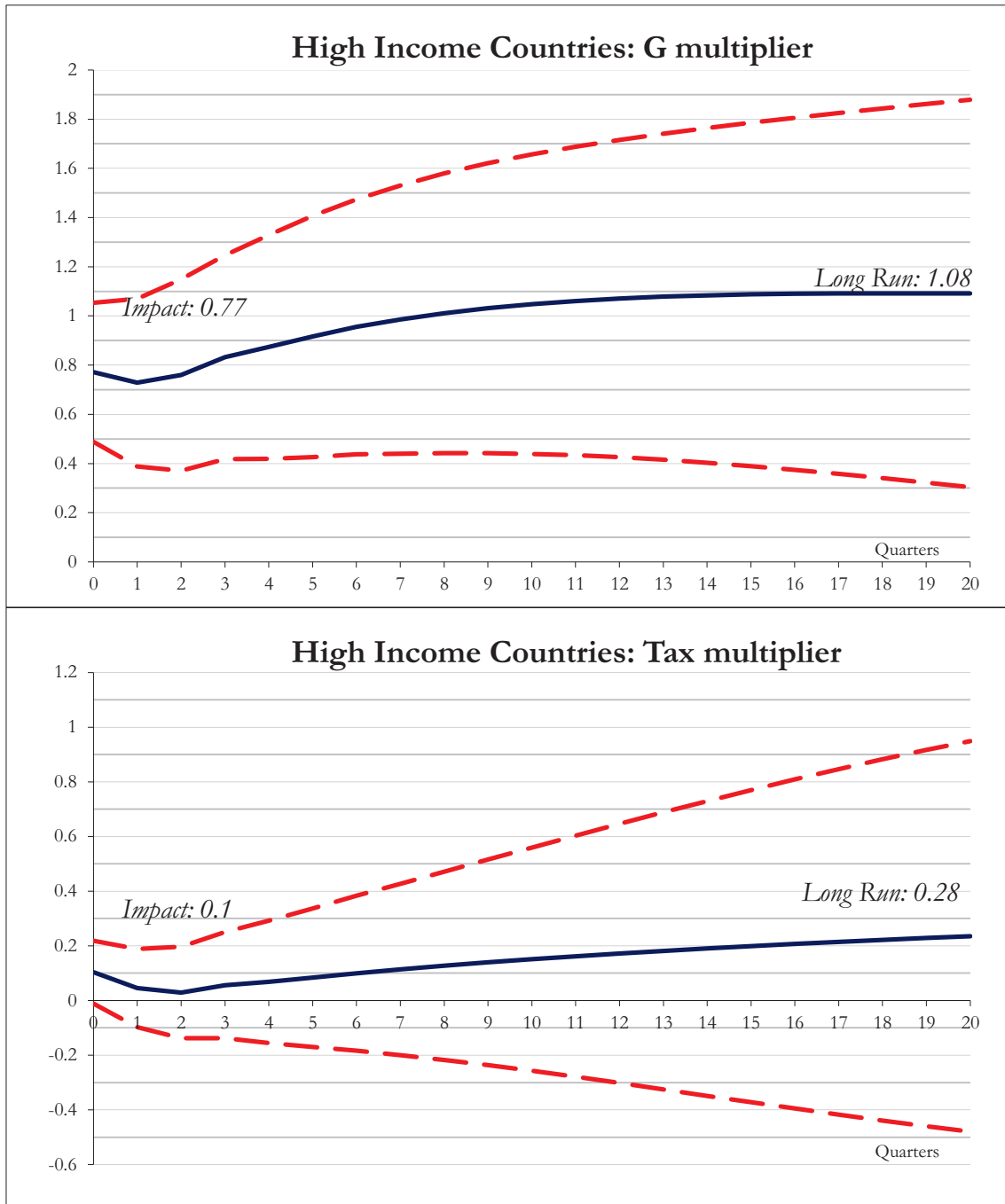


Figure 6: Fiscal Multipliers in Developing Countries

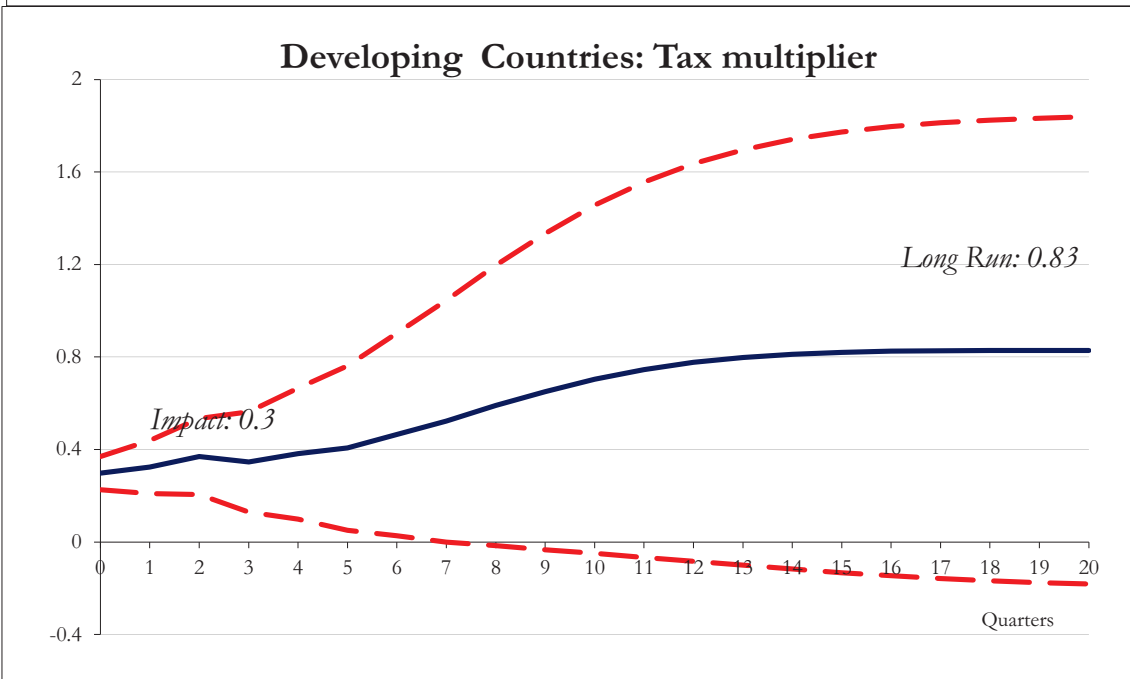
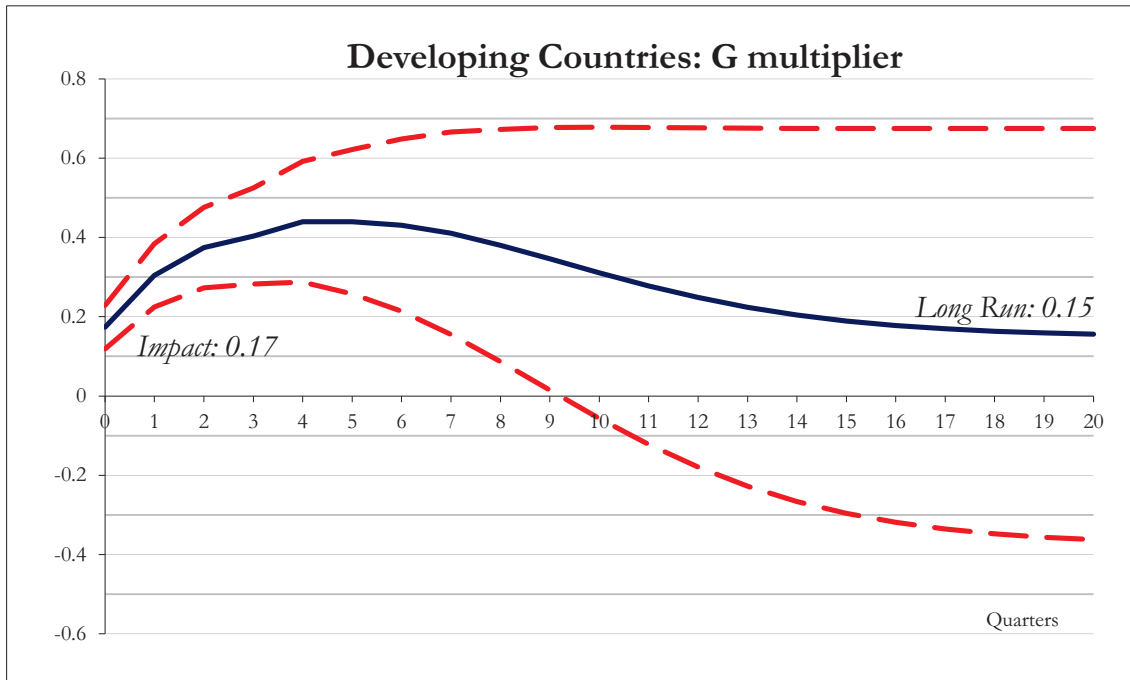


Figure 7: Fiscal Multipliers in Open Economies

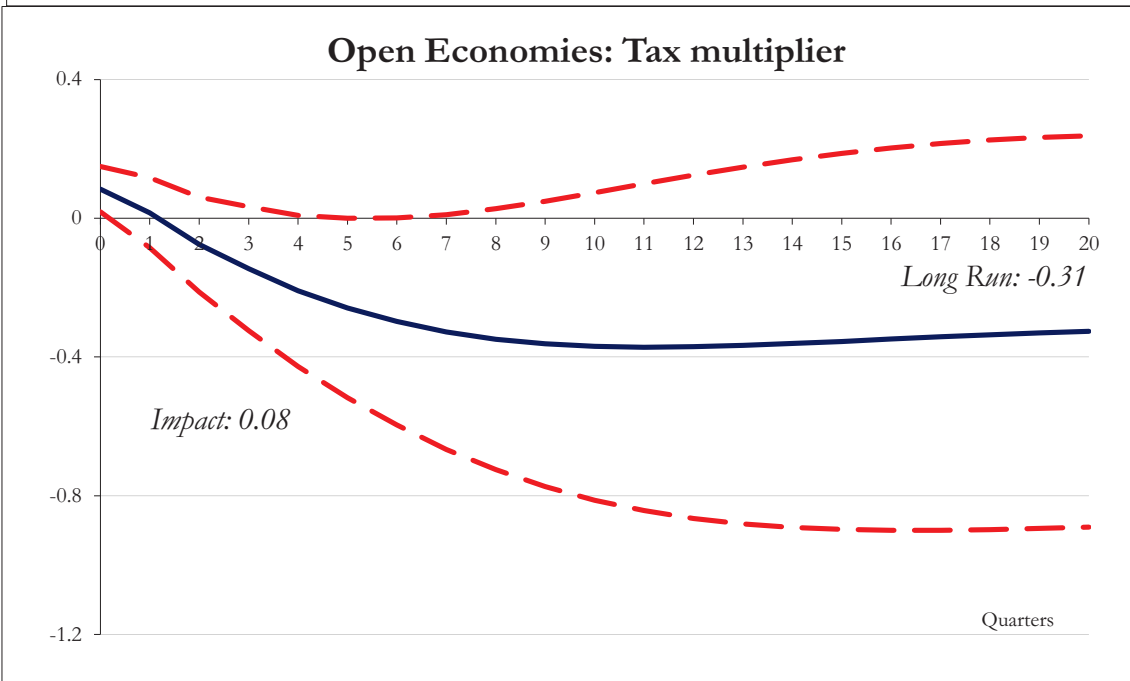
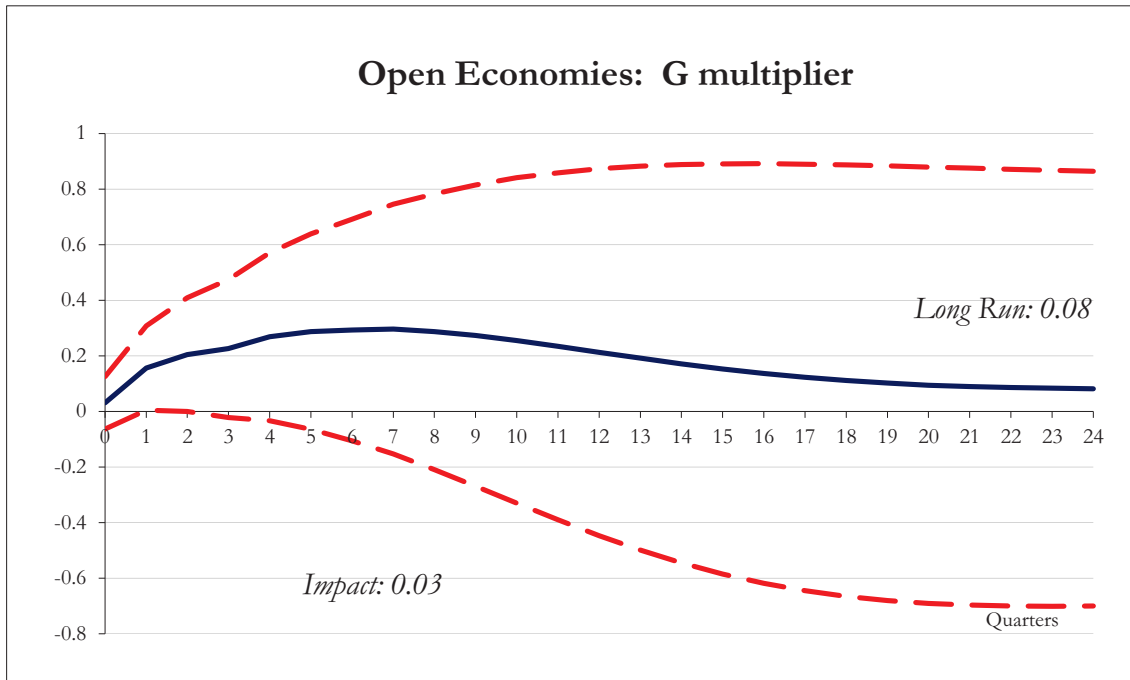


Figure 8: Fiscal Multipliers in Closed Economies

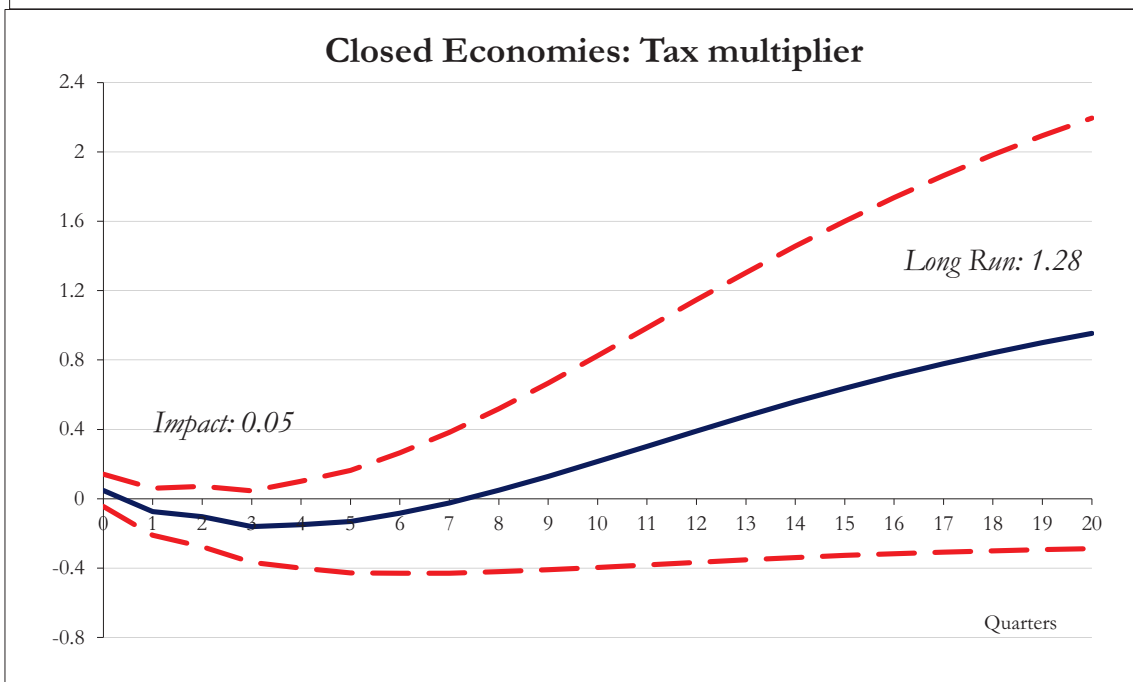
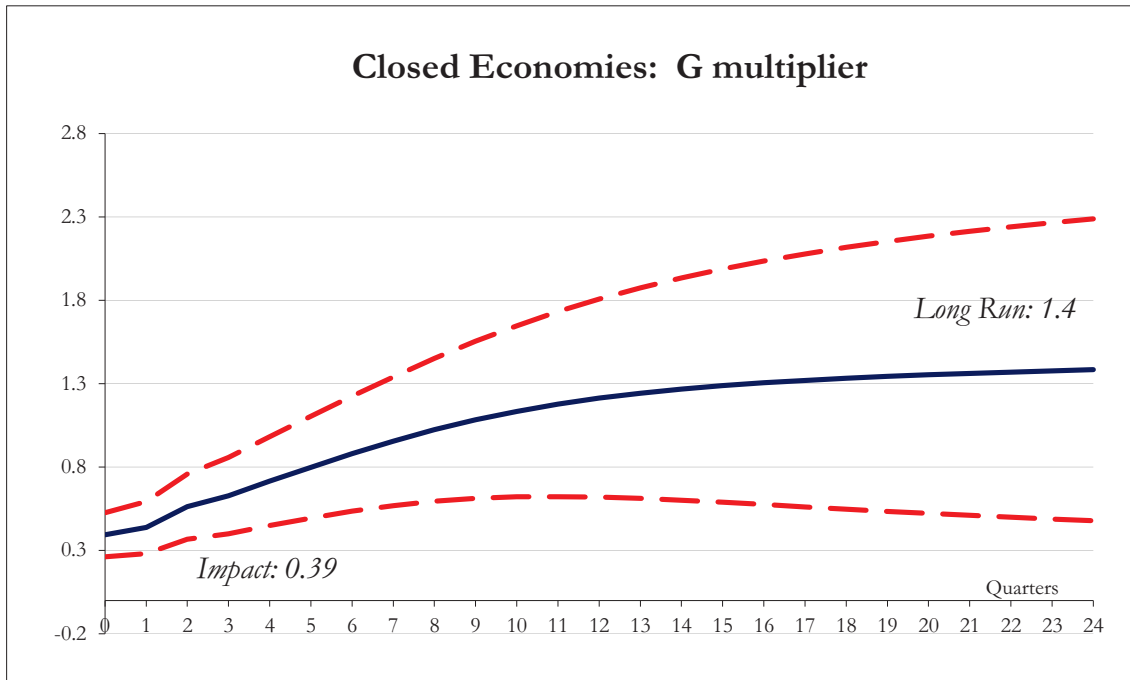


Figure 9: Fiscal Multipliers under Fixed Exchange Rates

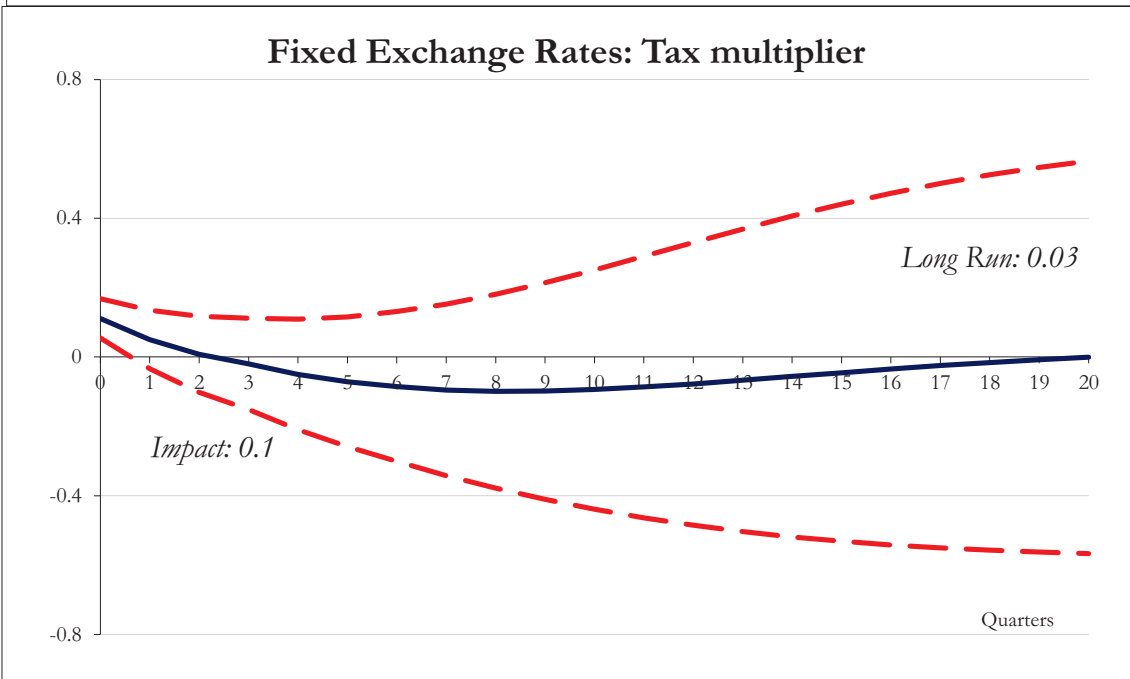
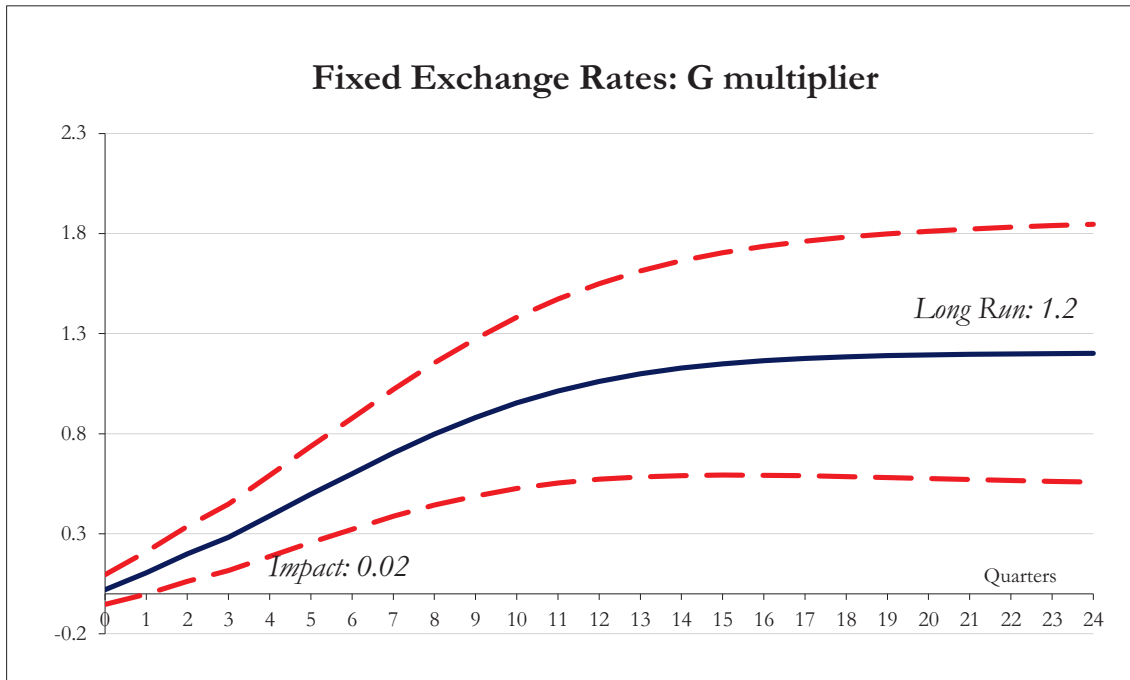


Figure 10: Fiscal Multipliers under Flexible Exchange Rates

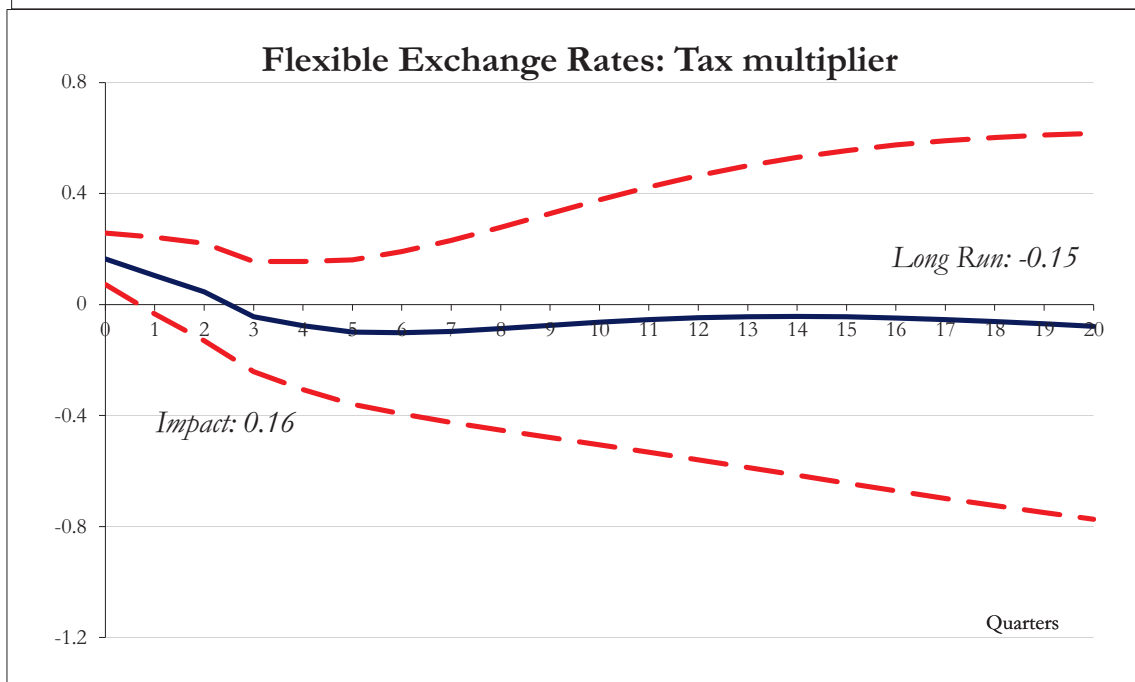
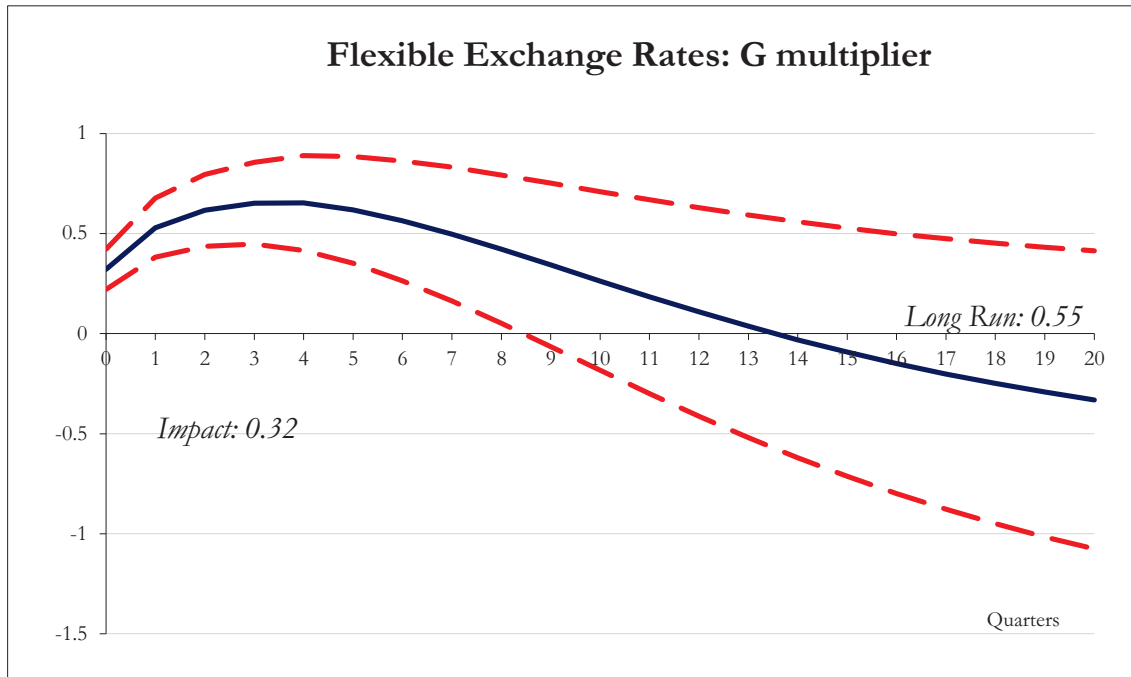


Figure 11: Impulse Responses in Developing Countries

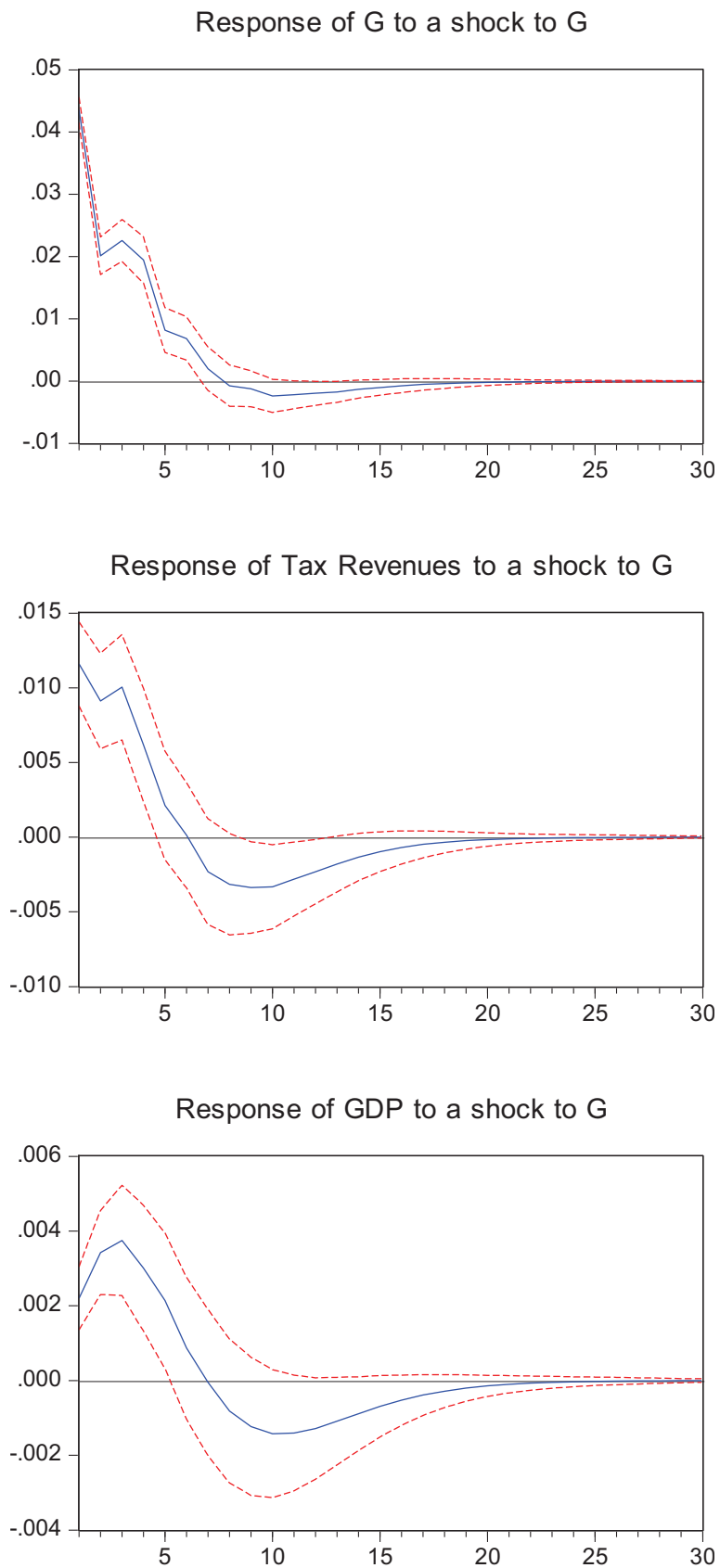


Figure 12: Impulse Responses in Closed Economies

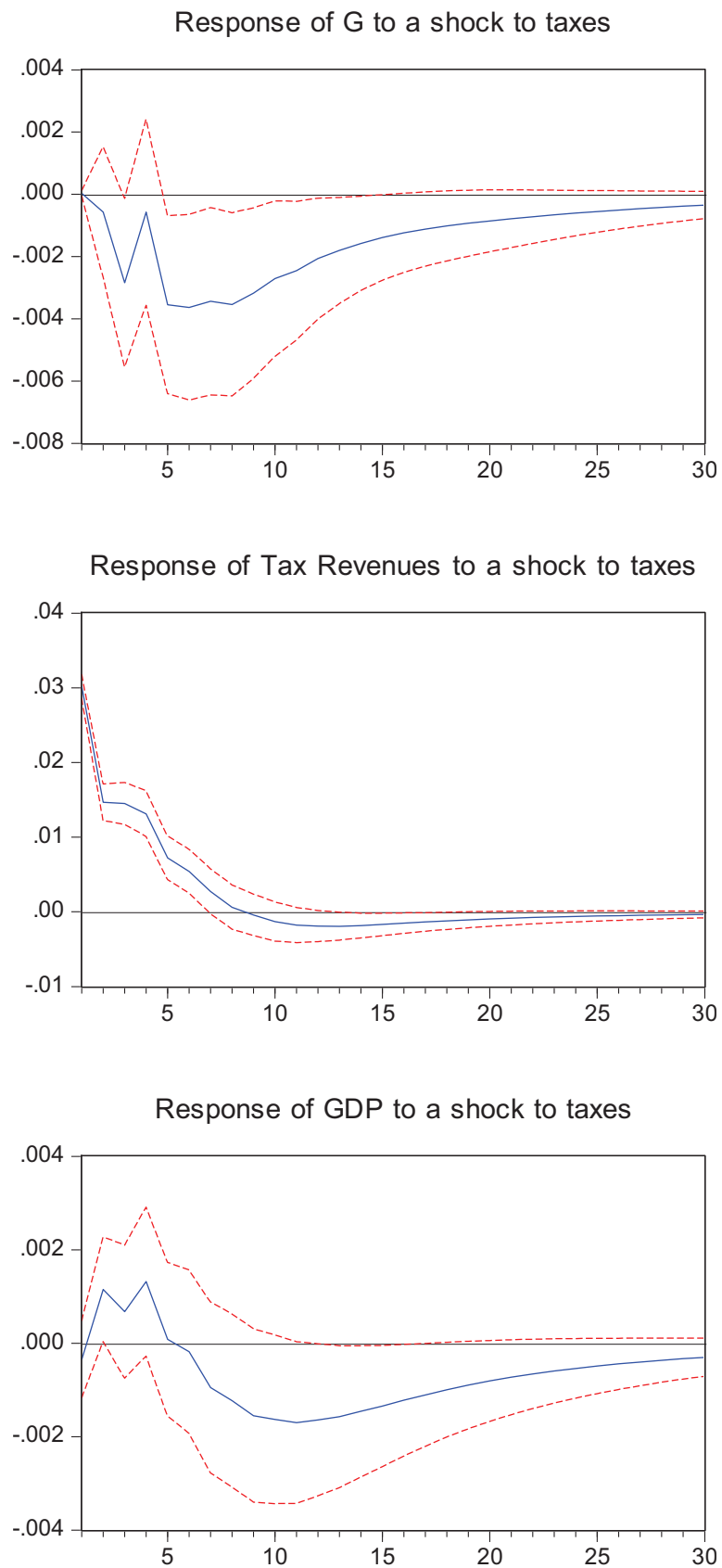


Figure 13: Actual and Synthetic Debt Series

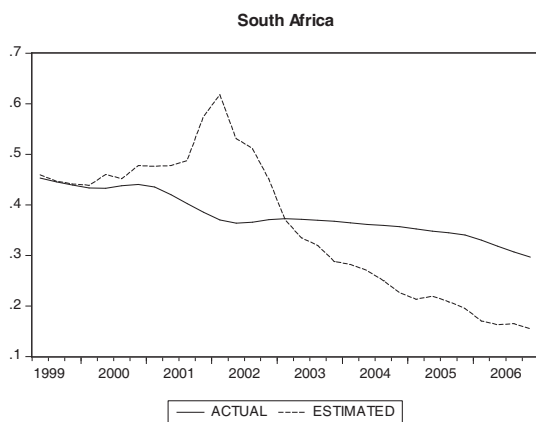
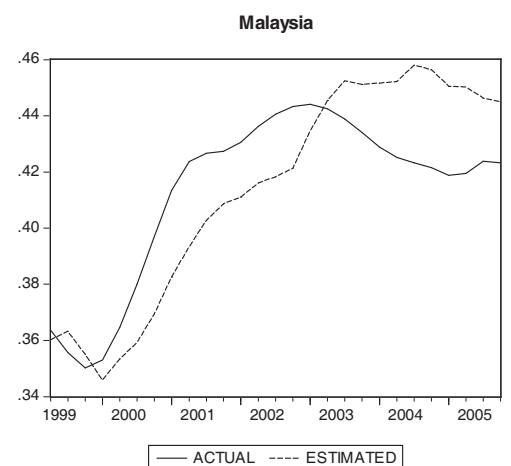
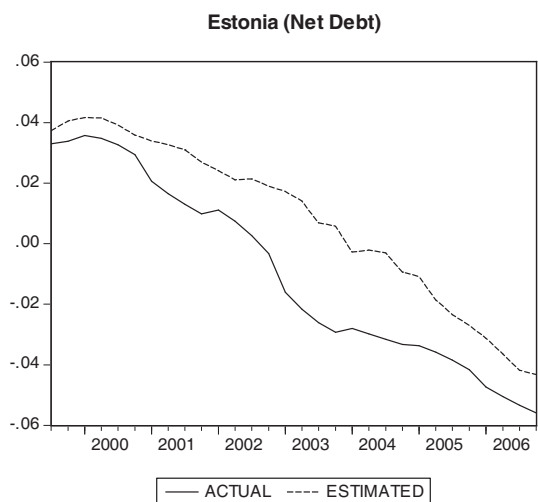
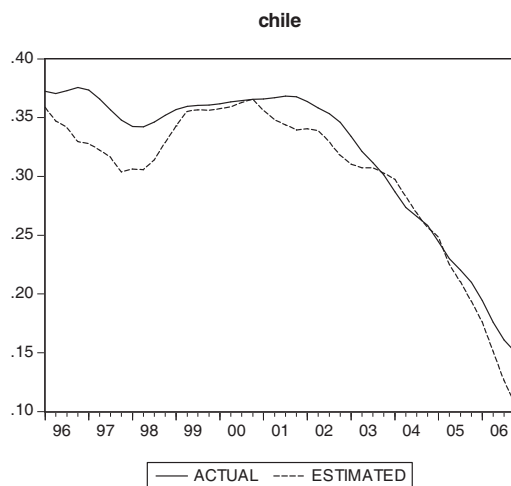
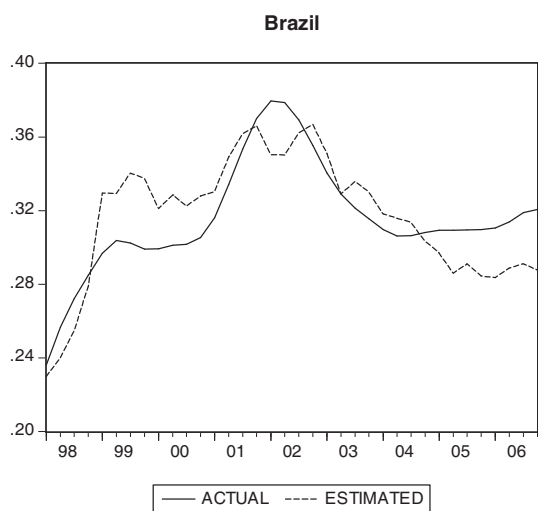


Figure 14a: Responses to a shock to government expenditure, Brazil

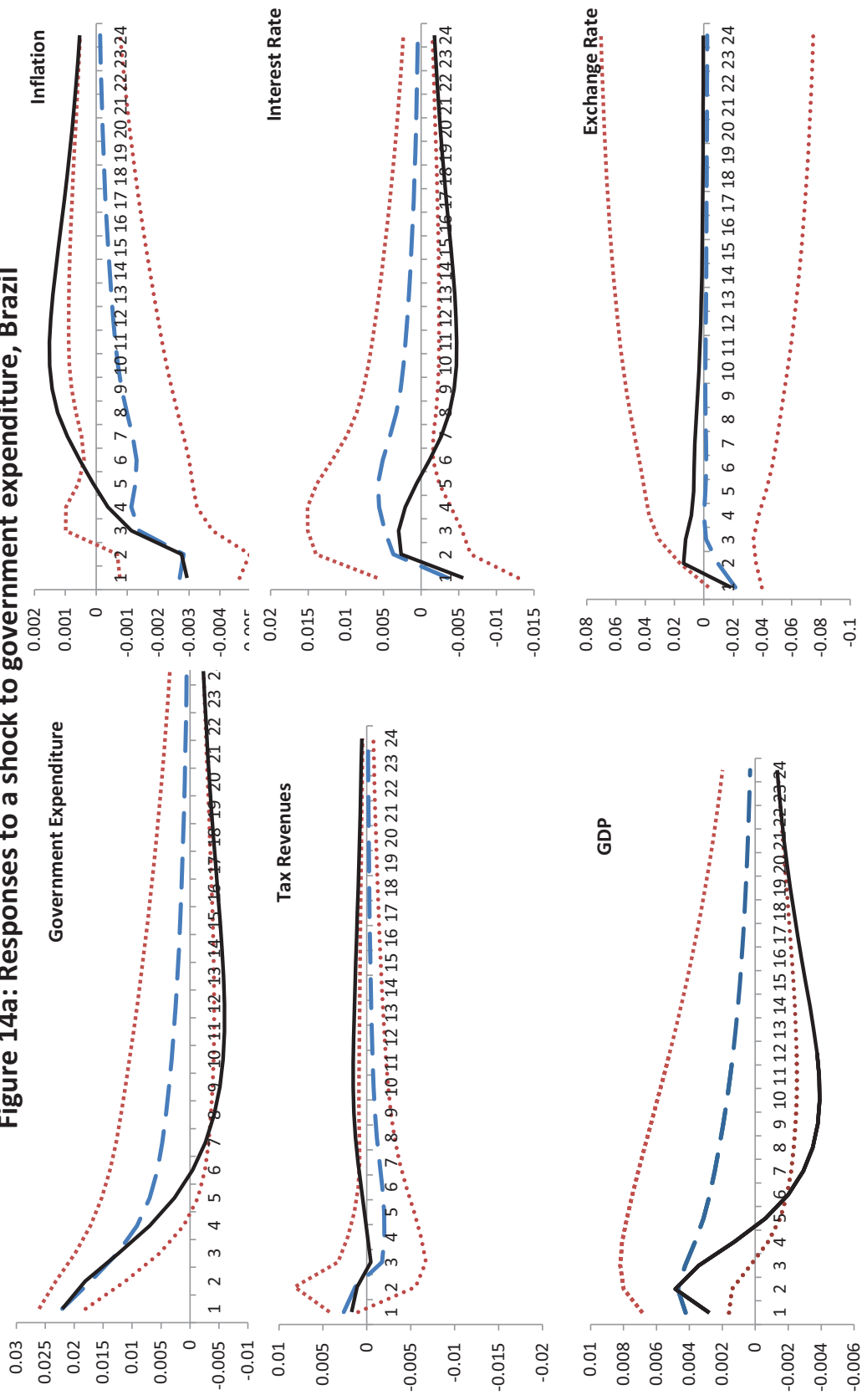


Figure 14b: Responses to a shock to tax revenues, Brazil

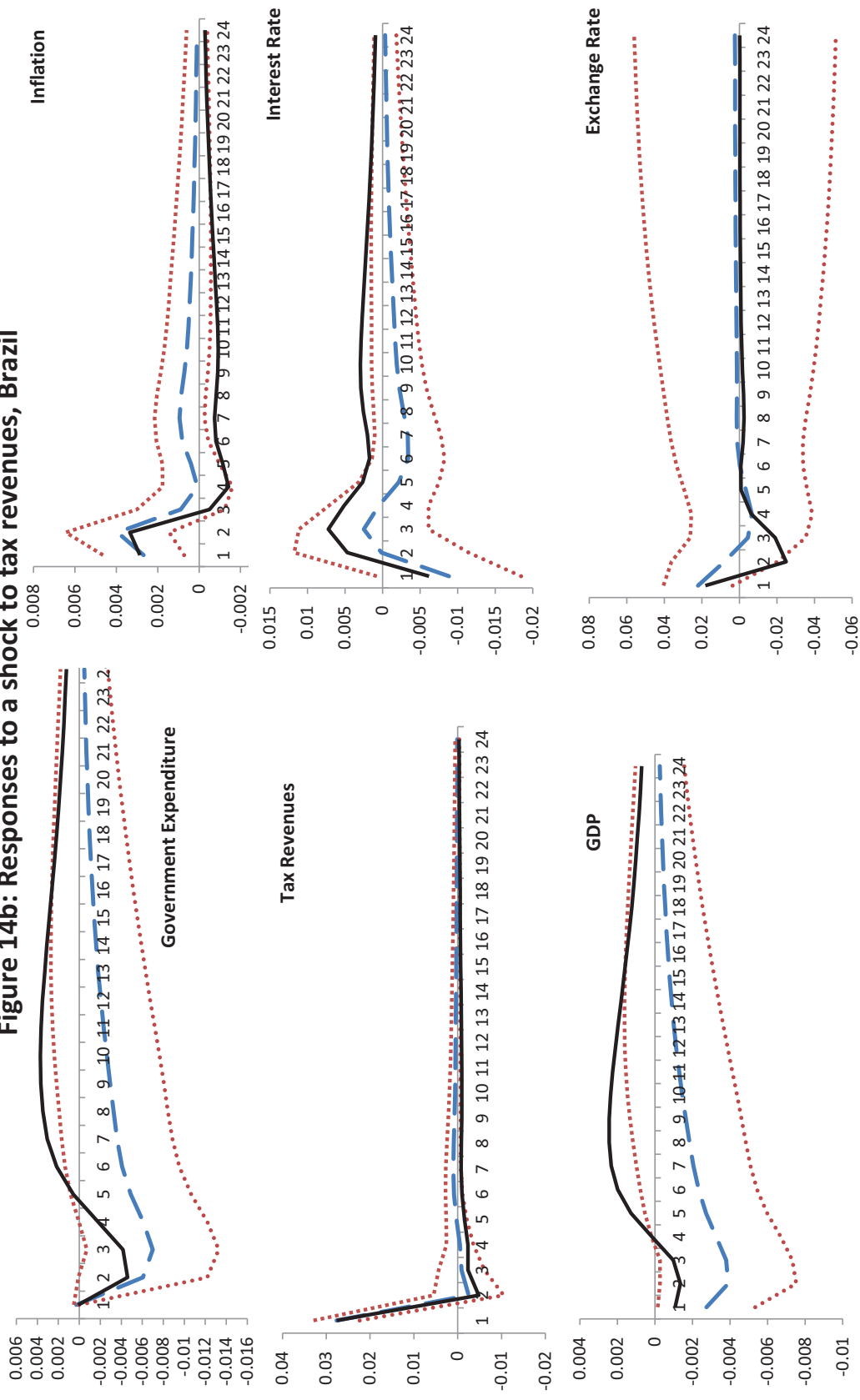


Figure 14c: Implied Changes in Debt-to-GDP ratio in BP (dotted) and FG (solid) VARs, Brazil

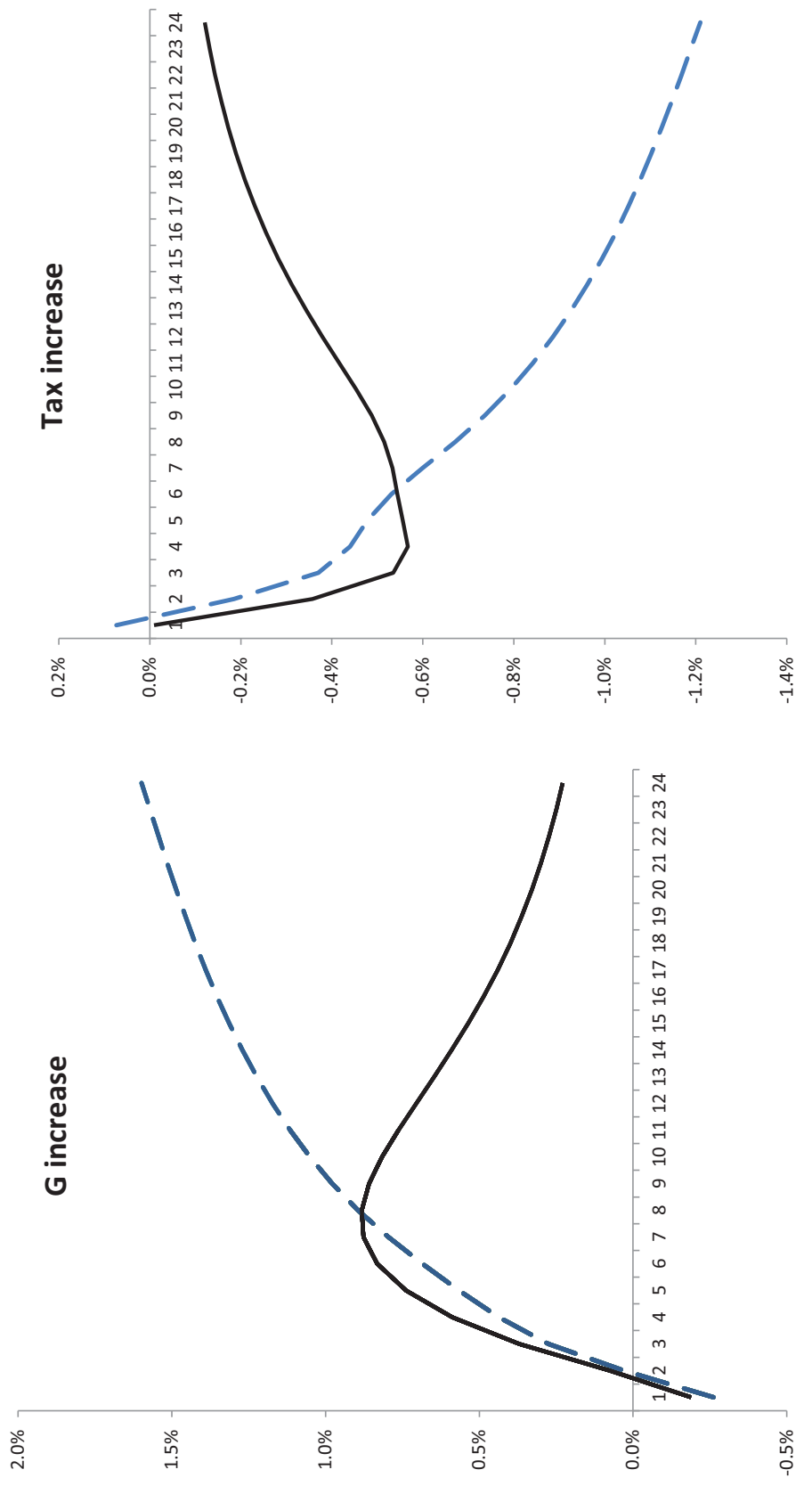


Figure 15a: Responses to a shock to government expenditure, Chile

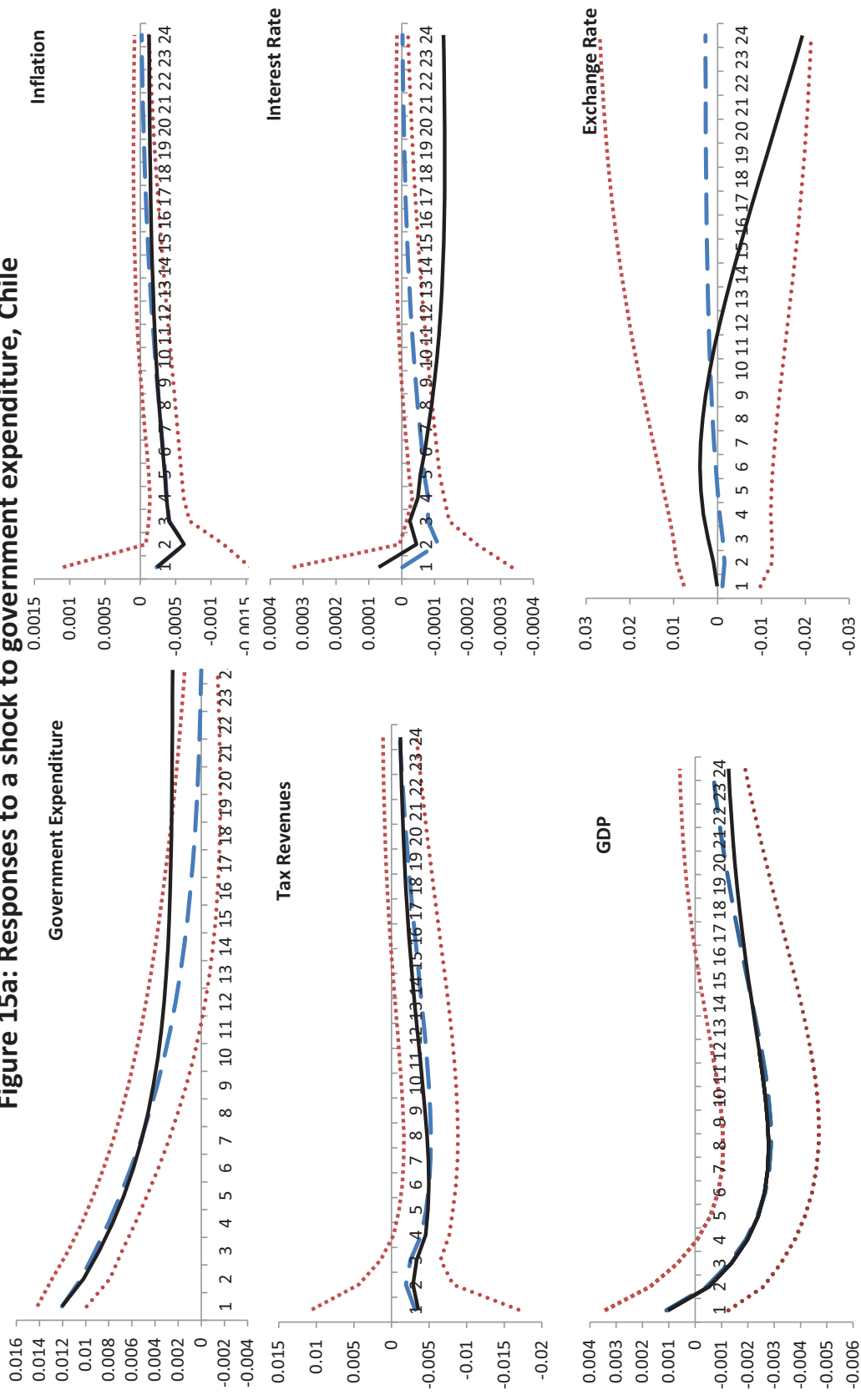


Figure 15b: Responses to a shock to tax revenues, Chile

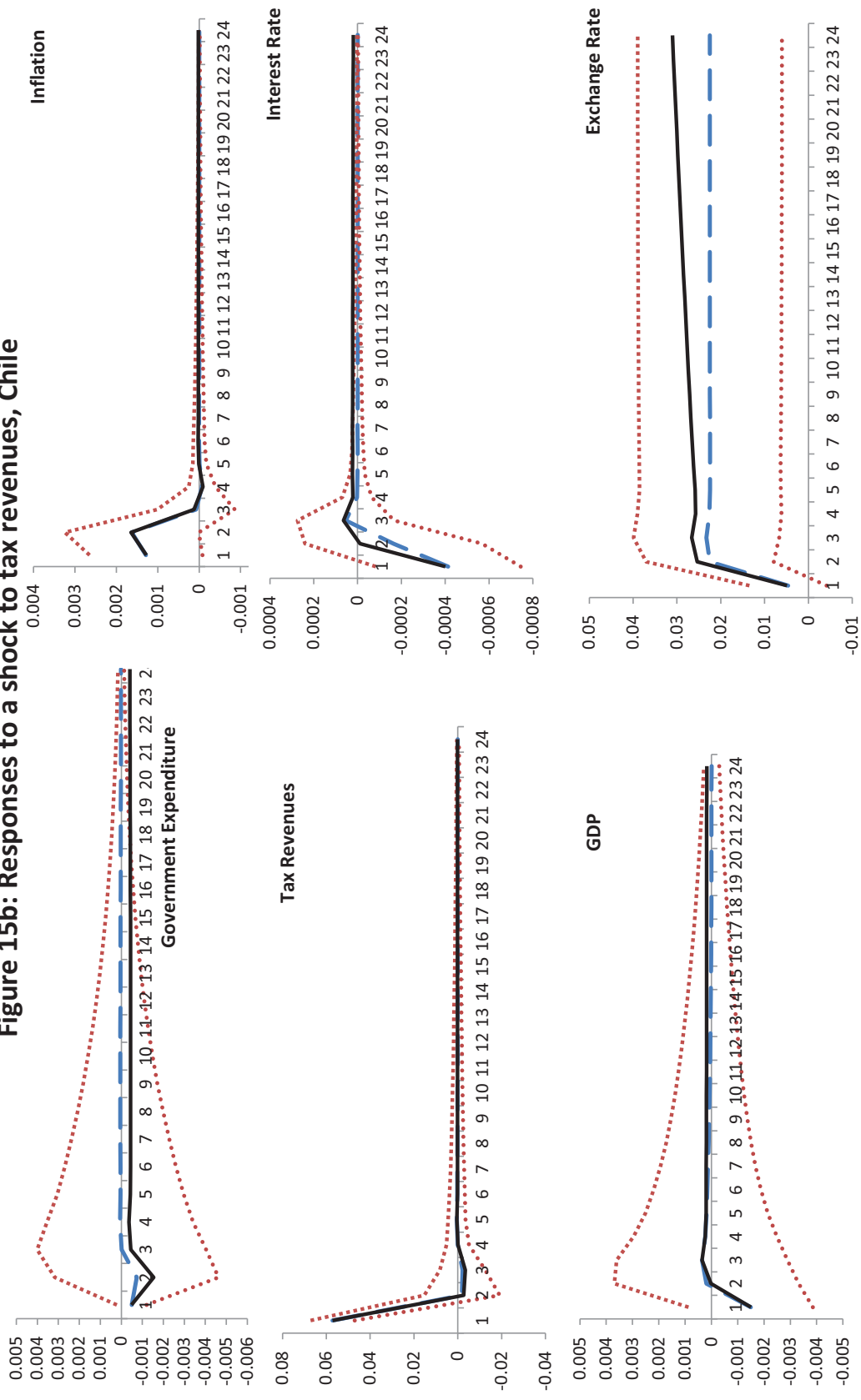


Figure 15c: Implied Changes in Debt-to-GDP ratio in BP (dotted) and FG (solid) VARs, Chile

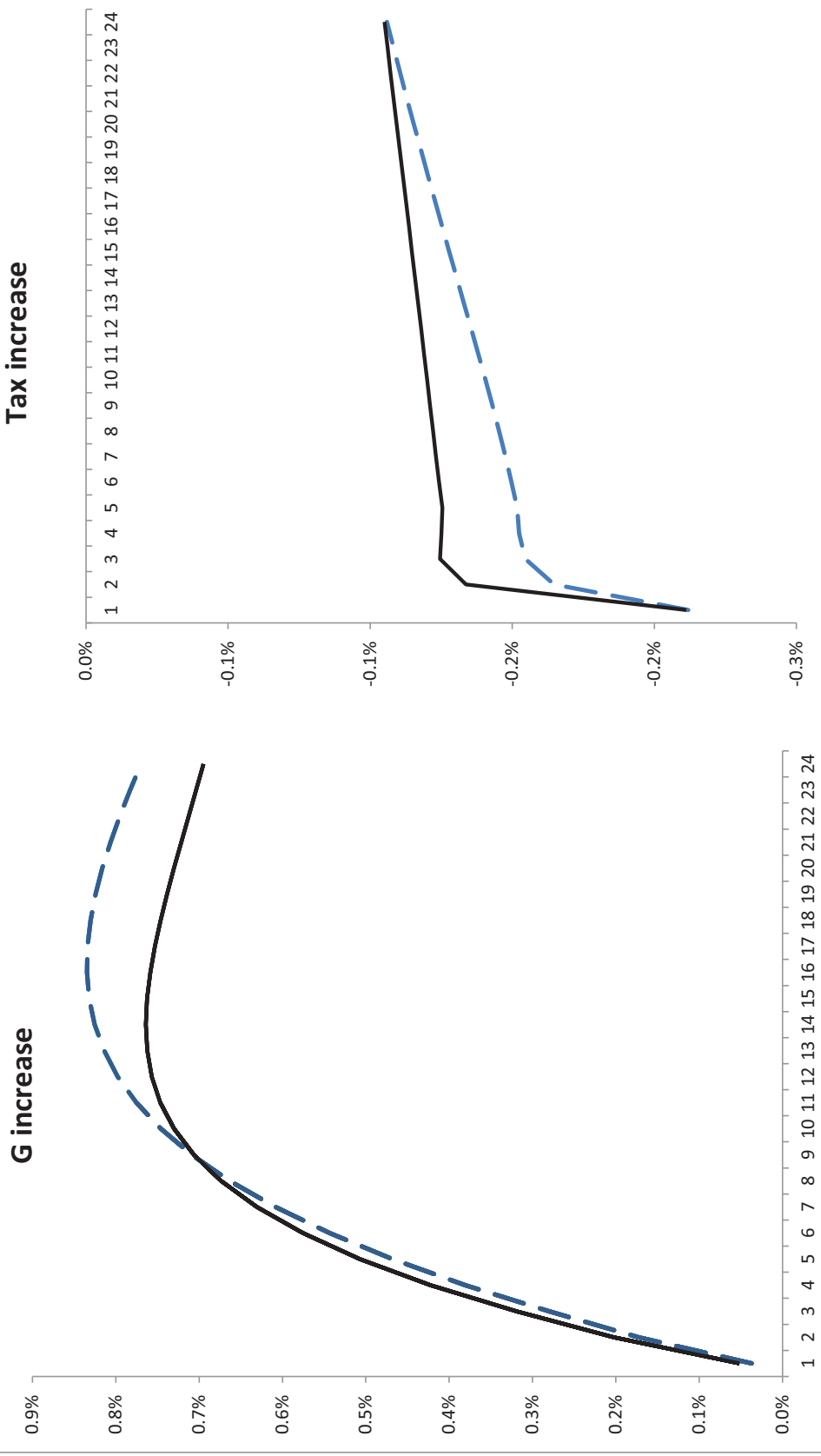


Figure 16a: Responses to a shock to government expenditure, Estonia

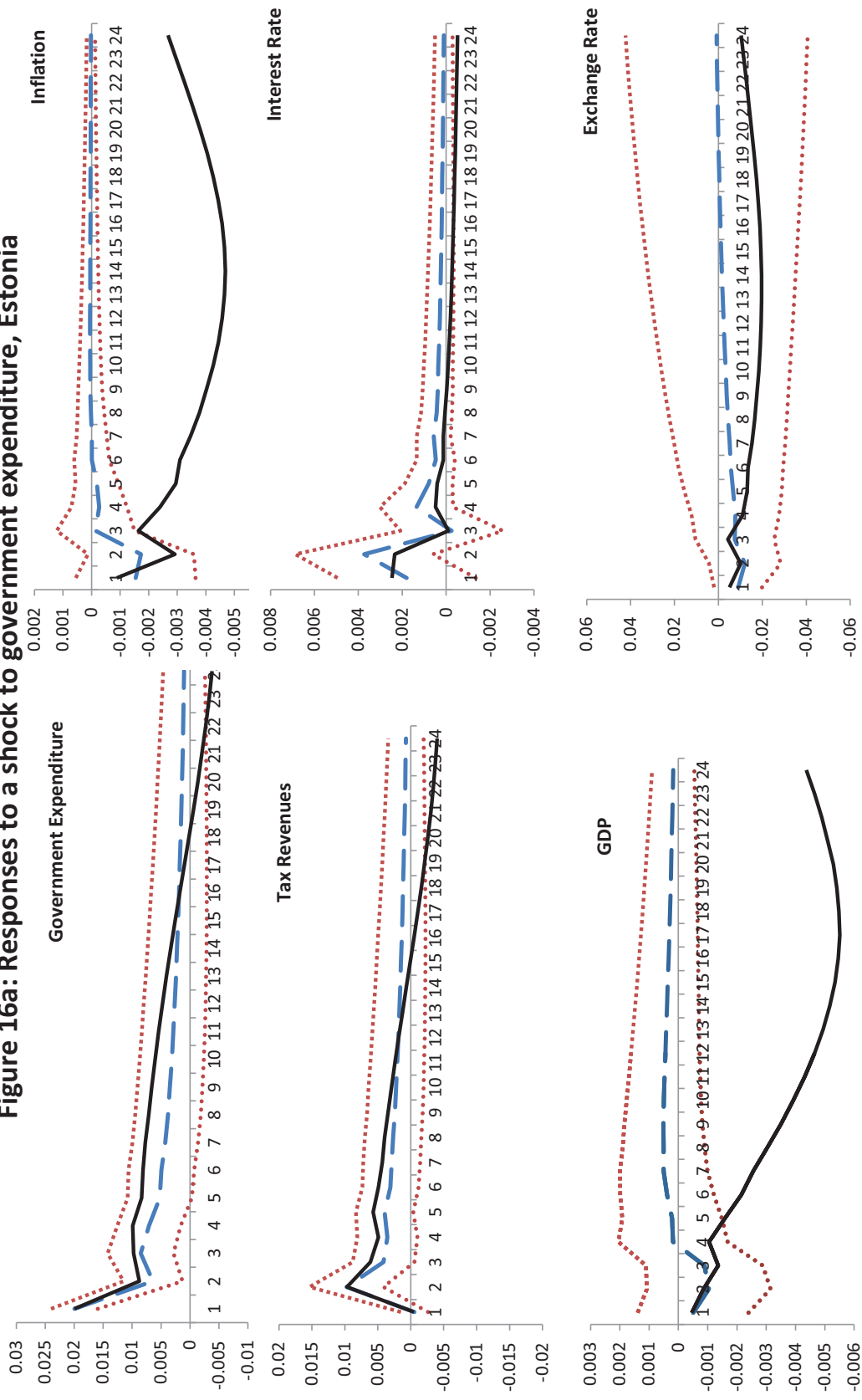


Figure 16b: Responses to a shock to tax revenues, Estonia

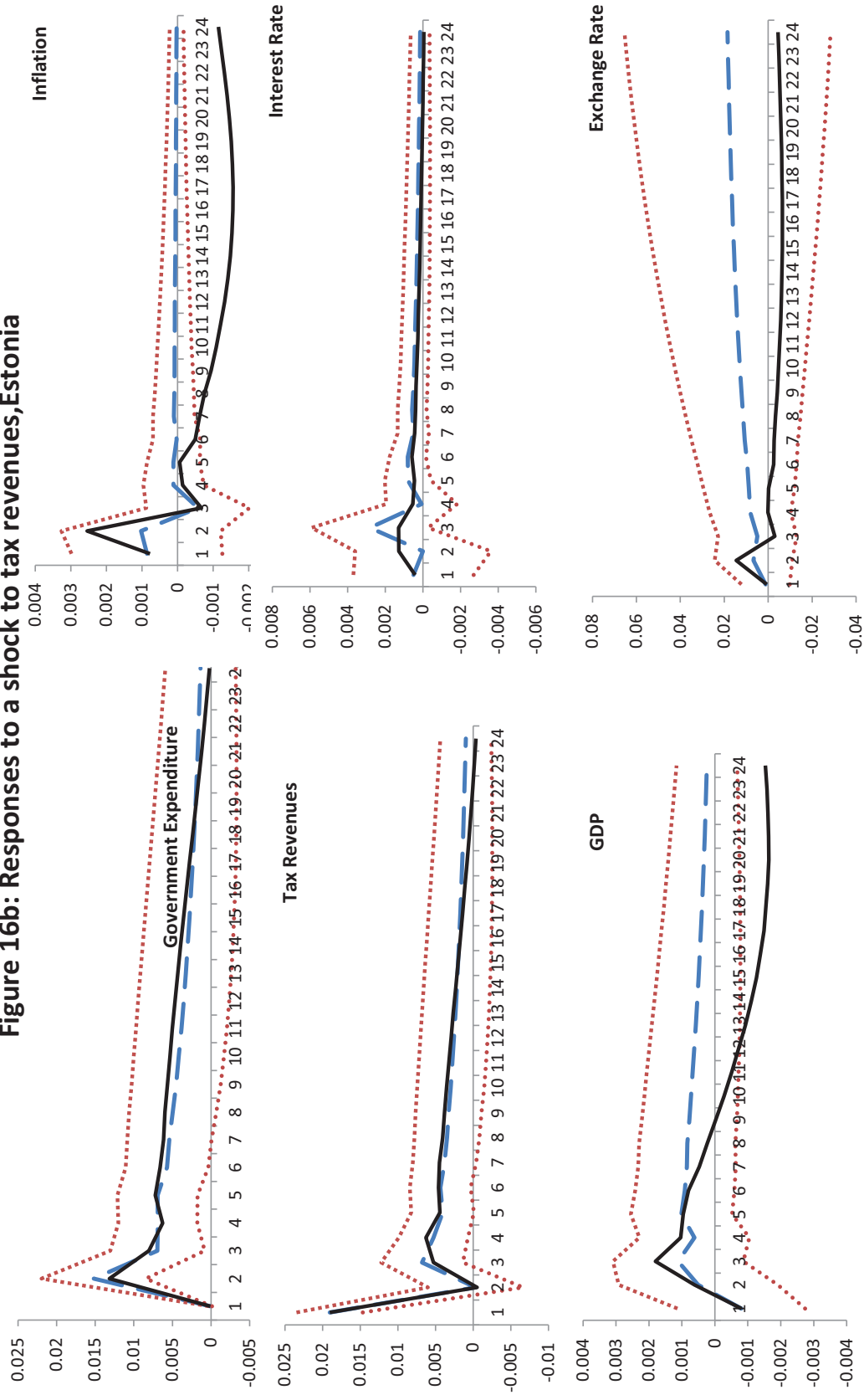


Figure 16c: Implied Changes in Debt-to-GDP ratio in BP (dotted) and FG (solid) VARs, Estonia

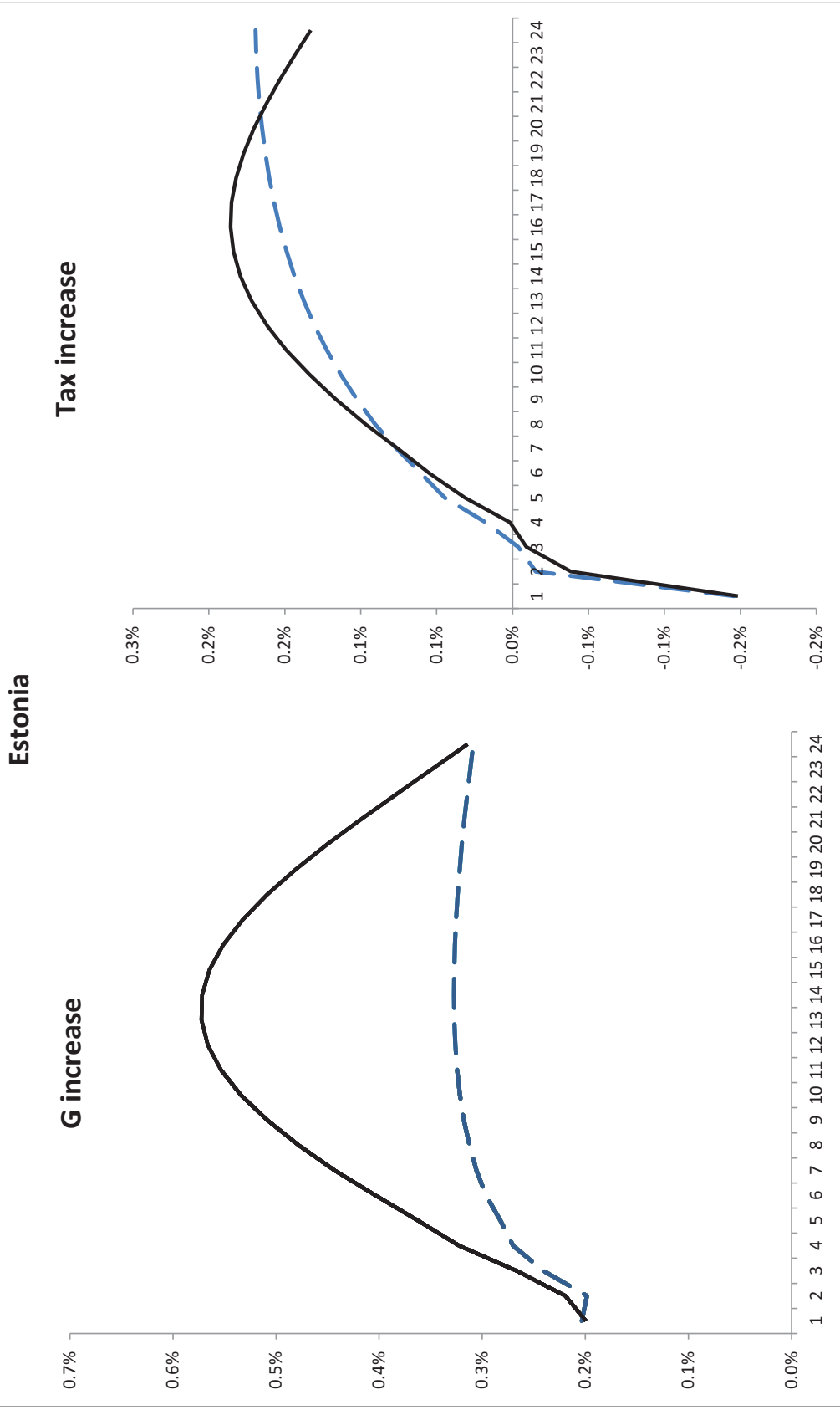


Figure 17a: Responses to a shock to government expenditure, Malaysia

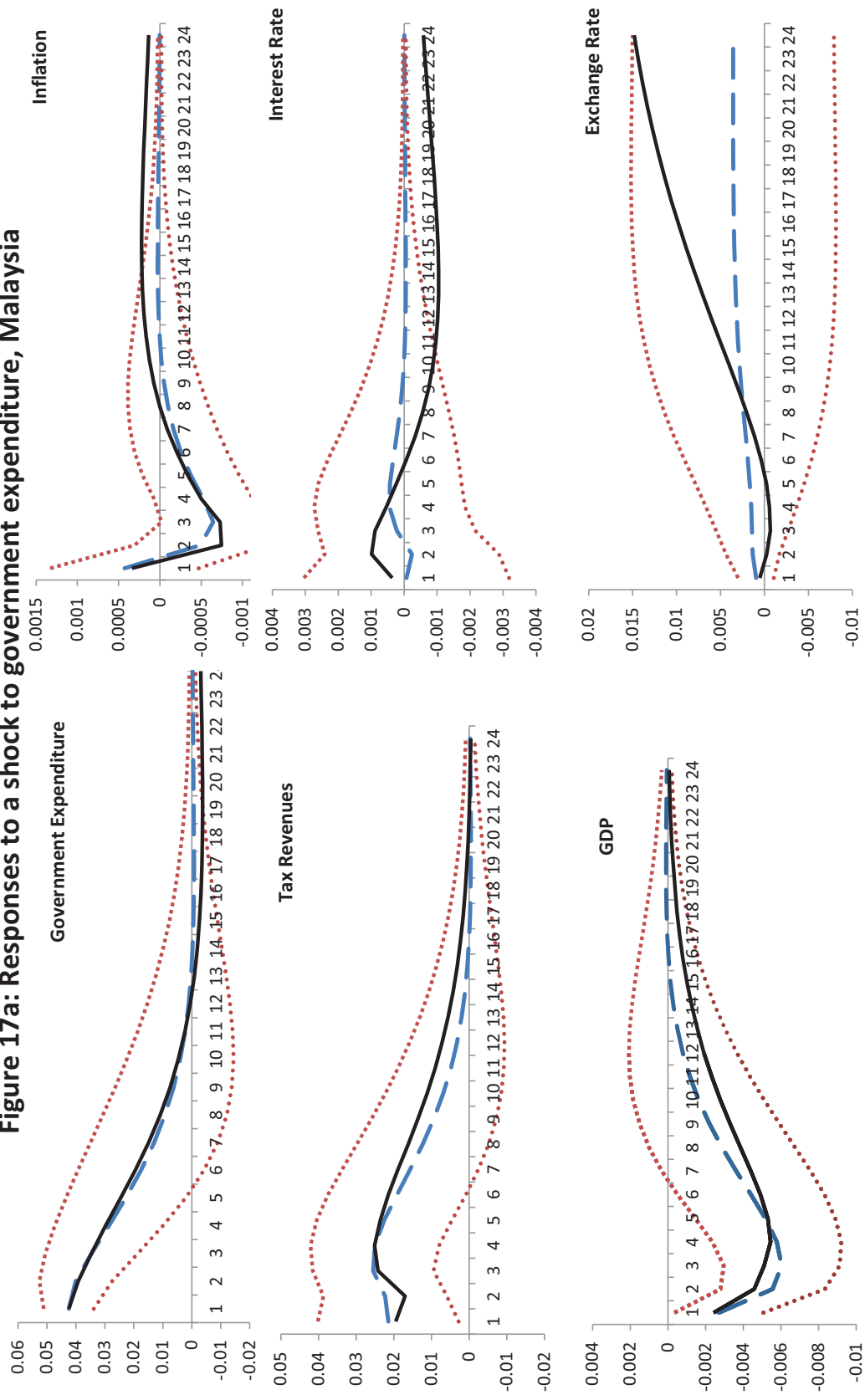


Figure 17b: Responses to a shock to tax revenues, Malaysia

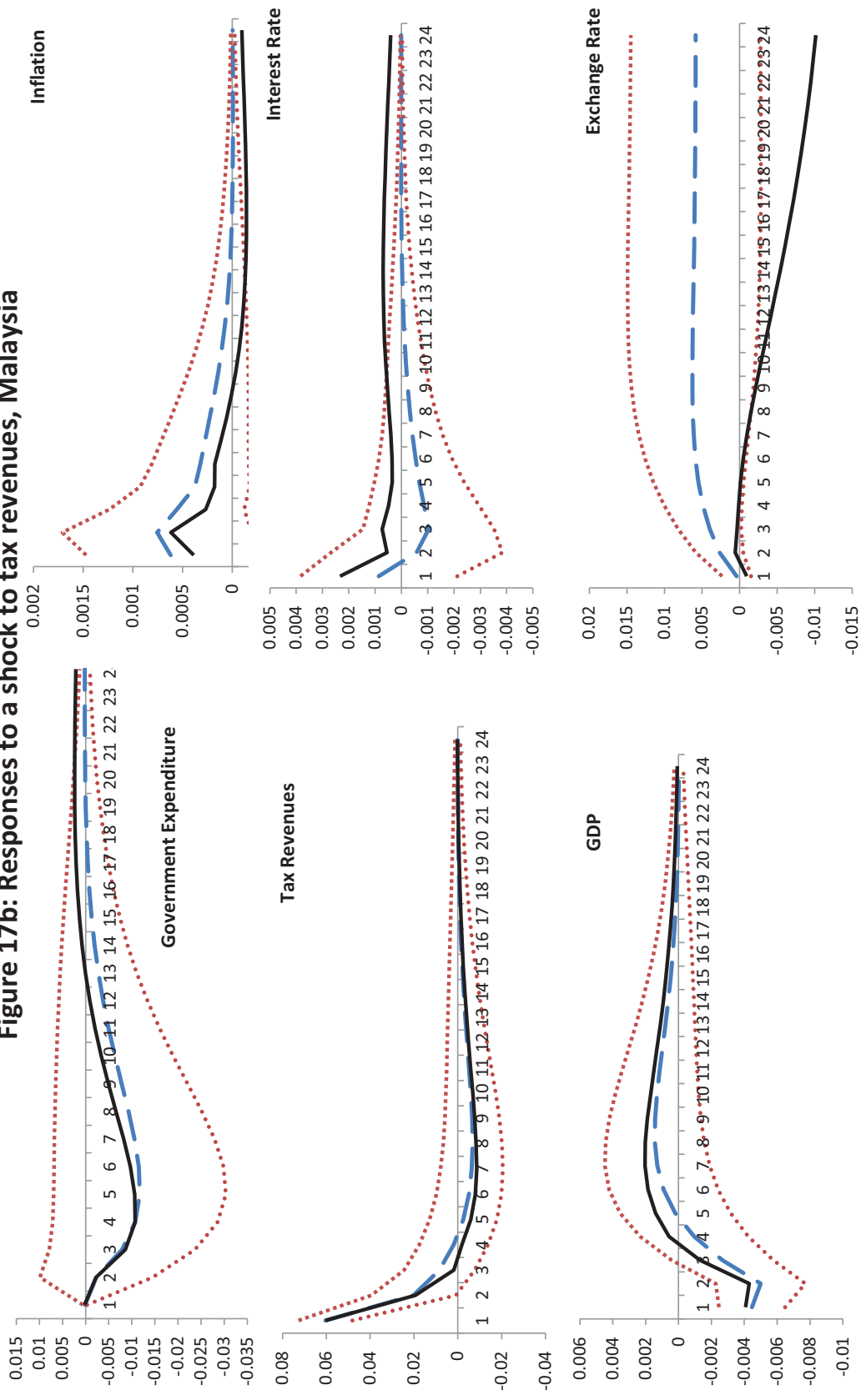


Figure 17c: Implied Changes in Debt-to-GDP ratio in BP (dotted) and FG (solid) VARs, Malaysia

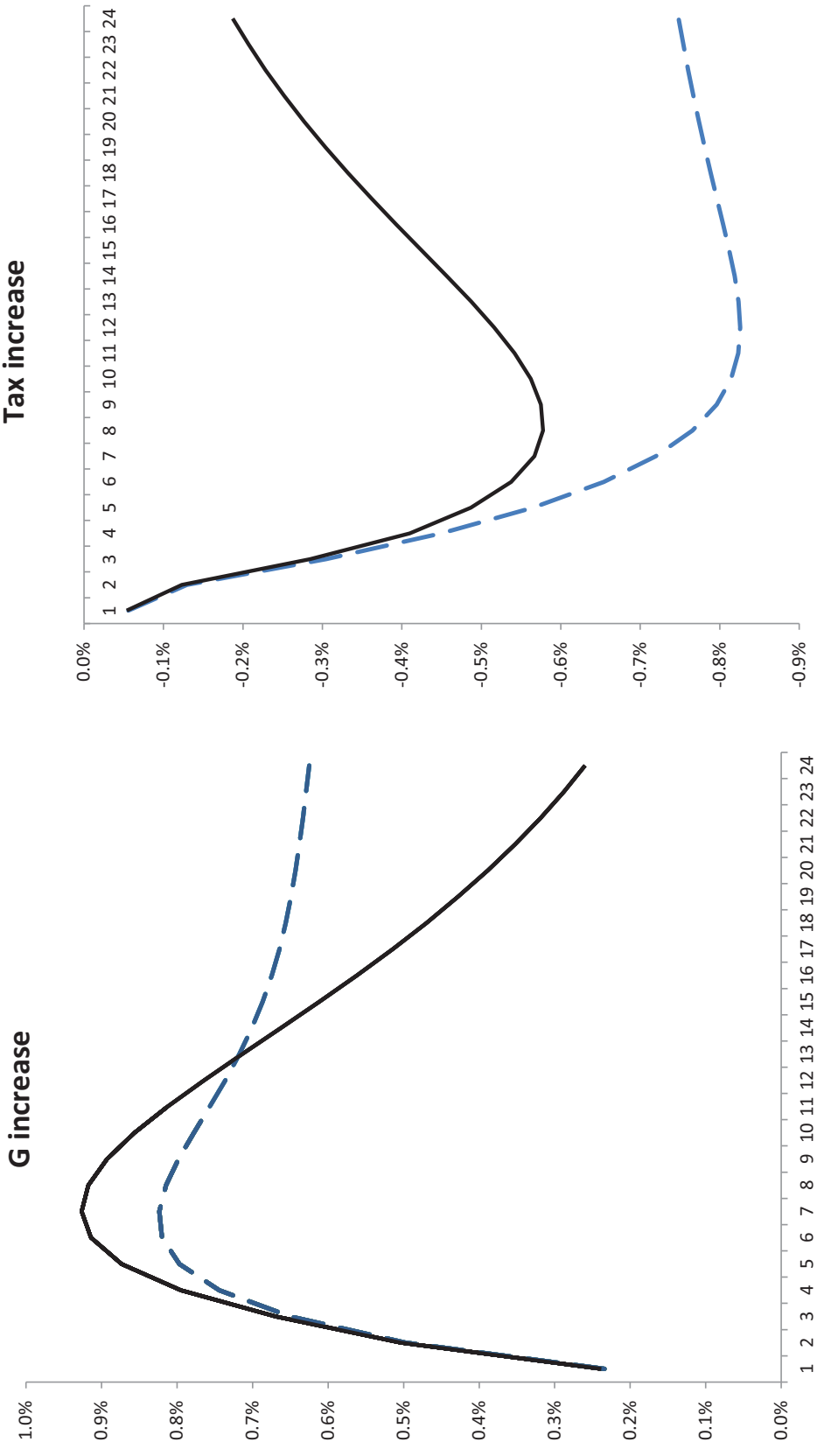


Figure 18a: Responses to a shock to government expenditure, South Africa

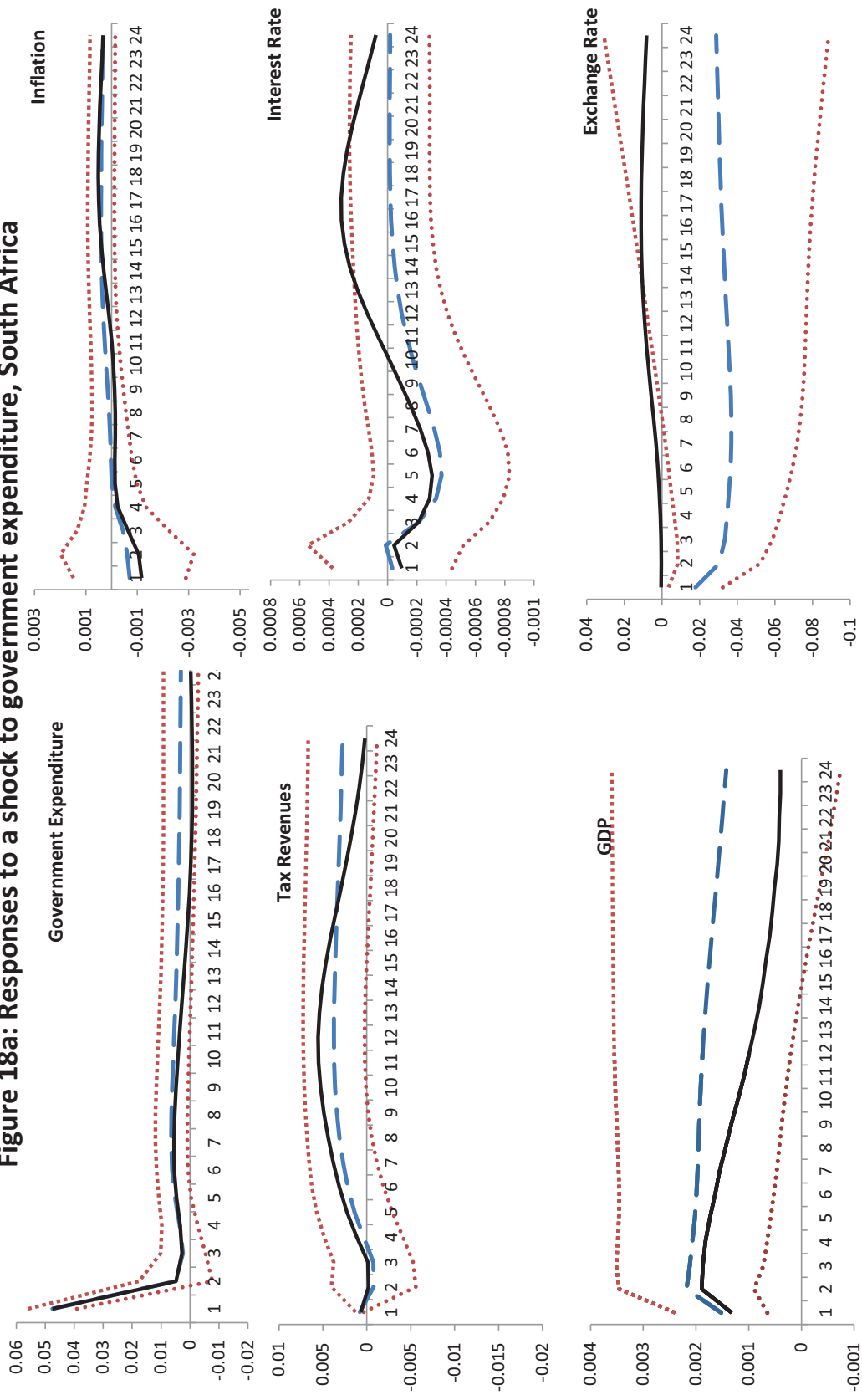


Figure 18b: Responses to a shock to tax revenues, South Africa

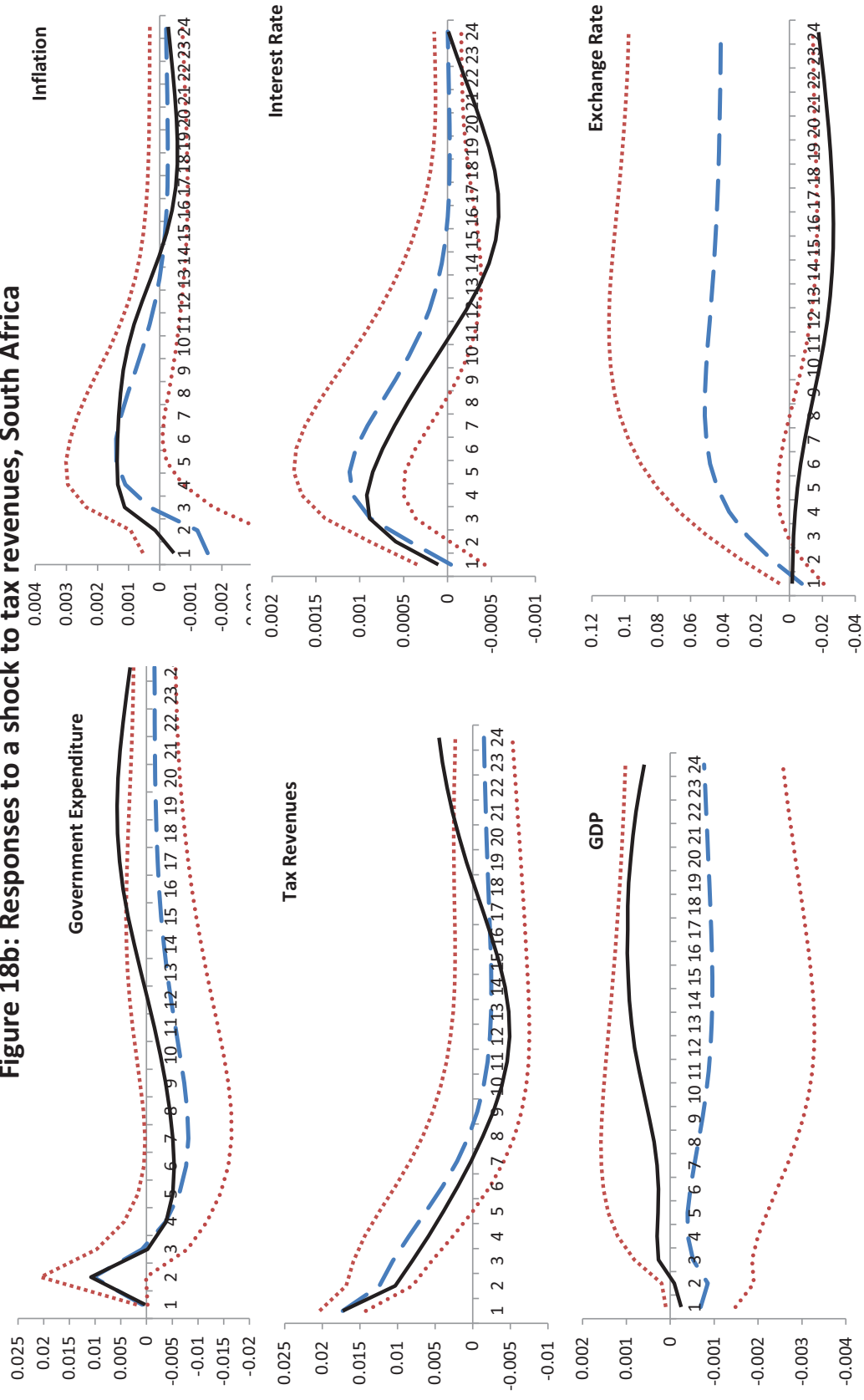


Figure 18c: Implied Changes in Debt-to-GDP ratio in BP (dotted) and FG (solid) VARs, South Africa

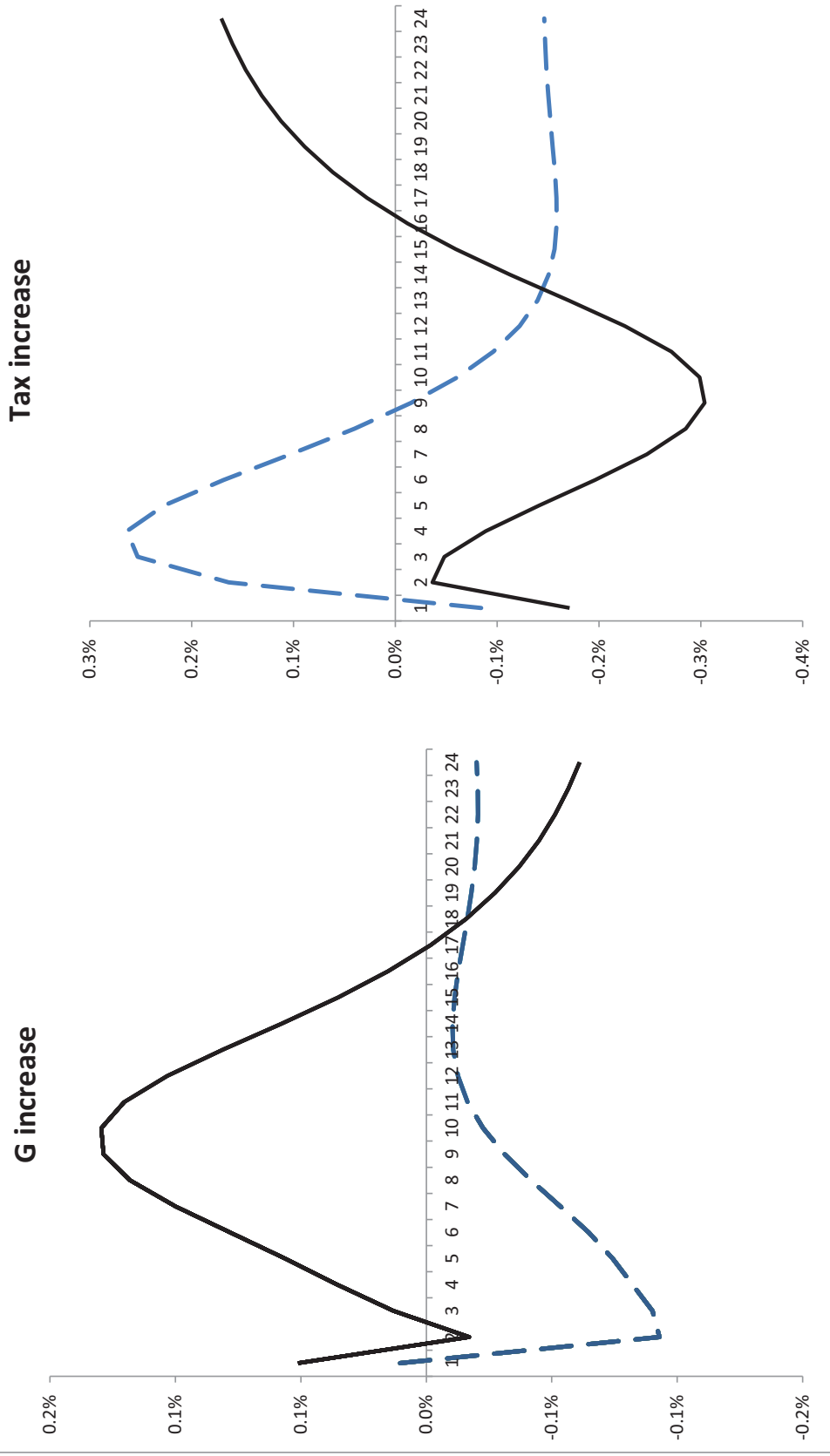


Table 1: Tax Revenue Elasticities: Quarterly Estimates

	Wage elasticity of		Profit share of GDP	Employment	Output	Output elasticity of			Tax Revenue share of				Average
	PIT	SS		Elasticity of Wages	Elasticity of Employment	PIT	SS	CIT	PIT	SS	CIT	Sales	Output Elasticity of Tax Revenue
	A	B	C	D	E	$F = E(1 + AD) \quad G = E(1 + BD) \quad H = \frac{[1 - E(1 - C)(1 + D)]}{C}$			J	K	L	M	FJ + GK + HL + IM
<i>Argentina</i>	1.82	0.95	0.52	0.590 (0.41)	0.400 (0.23)	0.83	0.62	0.00 ¹	6.5%	20.6%	12.9%	60.0%	0.78
<i>Australia</i>	1.58	-	0.40	0.033 (0.06)	0.370 (0.14)	0.39	-	0.00 ¹	57.0%	-	17.2%	25.8%	0.48
<i>Brazil</i>	1.95	0.92	0.45	0.00 ⁵ -	0.010 (0.07)	0.01	0.01	2.21	11.9%	34.0%	17.9%	36.2%	0.76
<i>Belgium</i>	1.49	1.00	0.38	1.690 (0.81)	0.090 (0.05)	0.32	0.24	1.27 ³	33.7%	33.3%	6.2%	26.8%	0.53
<i>Bulgaria</i>	1.64	0.98	0.51	0.044 (0.09)	0.681 (0.17)	0.73	0.71	0.00 ¹	11.4%	31.9%	9.4%	47.3%	0.78
<i>Canada</i>	1.28	0.75	0.31	0.170 (0.19)	0.530 (0.09)	0.64	0.59	5.43 ²	42.7%	15.8%	10.4%	31.0%	1.24
<i>Chile</i>	2.25	0.77	0.36	0.00 ⁵ -	0.080 (0.09)	0.08	0.08	2.64	7.5%	8.5%	23.0%	60.9%	1.23
<i>Colombia</i>	2.23	1.01	0.31	0.00 ⁵ -	0.210 (0.51)	0.21	0.21	2.76	34.2%	20.7%	7.1%	38.1%	0.69
<i>Croatia</i>	1.62	1.00	0.35	0.00 ⁵ -	0.171 (0.06)	0.17	0.17	0.00 ¹	9.3%	35.0%	6.7%	49.0%	0.57
<i>Cyprus</i>	1.96	1.00	0.43	0.426 (0.23)	0.100 -	0.18	0.14	1.75 ³	11.8%	35.2%	15.9%	37.2%	0.72
<i>Czech Rep</i>	1.47	1.00	0.29	0.158 (0.30)	0.220 (0.39)	0.27	0.25	0.00 ¹	12.4%	43.6%	12.2%	31.8%	0.46
<i>Estonia</i>	1.20	1.00	0.30	0.795 (0.29)	0.112 (0.12)	0.22	0.20	4.02 ²	24.1%	39.3%	5.6%	31.0%	0.67
<i>France</i>	1.72	0.92	0.35	0.140 (0.06)	0.290 (0.22)	0.36	0.33	0.00 ¹	16.0%	46.8%	6.4%	30.8%	0.52
<i>Germany</i>	1.43	0.83	0.34	0.380 0.581	0.110 0.046	0.17	0.14	2.26 ³	27.4%	39.4%	4.7%	28.5%	0.49
<i>Hungary</i>	1.39	0.98	0.35	0.227 (0.23)	0.239 (0.37)	0.31	0.29	1.92 ³	15.3%	37.9%	6.6%	40.2%	0.69
<i>Latvia</i>	1.18	1.00	0.46	0.00 ⁵ -	0.343 (0.70)	0.34	0.34	0.86 ³	20.3%	34.1%	7.4%	38.3%	0.63
<i>Lithuania</i>	1.29	1.00	0.40	0.029 (0.14)	0.867 (0.27)	0.90	0.89	0.00 ¹	28.0%	34.4%	6.6%	31.0%	0.87
<i>Mexico</i>	1.55	0.97	0.60	0.105 (0.05)	0.040 (0.10)	0.05	0.04	1.64	17.3%	13.9%	22.2%	46.5%	0.84
<i>Peru</i>	2.96	1.00	0.59	0.00 ⁵ -	0.390 (0.12)	0.39	0.39	1.42	7.8%	12.1%	16.0%	64.1%	0.95
<i>Poland</i>	1.29	0.95	0.49	0.012 (0.70)	0.342 (0.20)	0.35	0.35	4.40 ³	17.4%	38.0%	8.2%	36.3%	0.92
<i>Slovakia</i>	1.64	0.97	0.49	0.604 (0.31)	0.241 (0.10)	0.48	0.38	1.21 ³	10.2%	42.7%	9.1%	38.0%	0.70
<i>Slovenia</i>	1.54	1.00	0.47	0.00 ⁵ -	0.129 (0.08)	0.13	0.13	1.80 ³	17.0%	41.5%	4.8%	36.7%	0.53
<i>South Africa</i>	1.26	-	0.29	0.001 (0.05)	0.427 (0.31)	0.43	-	2.40	42.7%	-	30.1%	27.2%	1.18
<i>UK</i>	1.53	1.02	0.30	0.470 (0.21)	0.140 (0.04)	0.24	0.21	1.43 ⁴	32.0%	20.6%	10.5%	36.9%	0.64
<i>USA</i>	1.35	0.85	0.30	0.190 (0.18)	0.300 (0.03)	0.38	0.35	3.86 ²	42.3%	27.7%	10.0%	19.9%	0.84

¹ Elasticities equal to zero due because tax payments and realization of profits are not contemporaneous.

² Output elasticities of quarterly gross operating surplus.

³ Output elasticities of profits.

⁴ Output elasticity of profits factored by the share of profit income that pays tax at quarterly frequency (75%)

⁵ Elasticities set to zero as estimated parameter is negative.

Table 2: Tax Revenue Elasticities: Annual Estimates

	Wage elasticity of		Profit	Output	Output	Output elasticity of				Tax Revenue share of				Average
	PIT	SS	Elasticity of CIT	Elasticity of Wages	Elasticity of Profits	PIT	SS	CIT	VAT	PIT	SS	CIT	VAT	Output Elasticity of Tax Revenue
	A	B	C	D	E	F=AD	G=BD	H=FC	I	J	K	L	M	FJ+GK+HL+IM
<i>Argentina</i>	1.82	0.95	1.00	1.325 (0.26)	0.578 (0.18)	2.41	1.26	0.58	1.206 (0.12)	7.5%	23.6%	14.8%	54.1%	1.22
<i>Australia</i>	1.58	-	1.00	0.905 (0.12)	1.263 (0.18)	1.43	-	1.26	0.835 (0.07)	61.9%	-	18.5%	5.5%	1.48
<i>Brazil</i>	1.95	0.92	1.15	1.238 (0.19)	1.274 (0.17)	2.42	1.14	1.46	1.001 (0.14)	13.9%	39.5%	20.5%	-	1.33
<i>Belgium</i>	1.49	1.00	1.00	0.782 (0.12)	1.163 (0.30)	1.17	0.78	1.16	0.787 (0.08)	46.2%	45.6%	8.5%	22.9%	0.95
<i>Bulgaria</i>	1.64	0.98	1.02	0.960 (0.24)	0.571 (0.15)	1.57	0.94	0.58	0.993 (0.27)	15.3%	42.9%	12.7%	45.4%	0.80
<i>Canada</i>	1.28	0.75	1.00	0.817 (0.68)	1.167 (0.62)	1.02	0.58	1.16	0.810 (0.07)	50.0%	19.0%	12.0%	19.0%	0.92
<i>Chile</i>	2.25	0.77	1.00	0.996 (0.12)	1.692 (0.66)	2.24	0.77	1.69	1.038 (0.09)	9.1%	10.3%	27.8%	60.3%	1.28
<i>Colombia</i>	2.23	1.01	0.95	0.868 (0.10)	1.623 (0.31)	1.93	0.88	1.54	0.992 (0.10)	46.8%	28.3%	9.7%	46.8%	1.34
<i>Croatia</i>	1.62	1.00	1.00	1.104 (0.40)	1.623 (0.51)	1.79	1.10	1.62	0.873 (0.33)	12.8%	48.2%	9.2%	49.3%	1.12
<i>Cyprus</i>	1.96	1.00	1.07	0.931 (0.07)	1.481 (0.22)	1.82	0.93	1.58	1.229 (0.15)	15.1%	45.3%	20.4%	28.1%	1.25
<i>Czech Rep</i>	1.47	1.00	1.00	0.950 (0.15)	1.132 (0.18)	1.39	0.95	1.13	0.843 (0.16)	17.5%	61.2%	17.1%	25.6%	1.02
<i>Dominican Rep.</i>	2.40	0.00	1.00	1.062 (0.00)	1.324 (0.00)	2.55	-	1.32	0.993 (0.15)	18.8%	0.0%	39.1%	15.1%	1.57
<i>Estonia</i>	1.20	1.00	1.00	0.993 (0.14)	1.223 (0.22)	1.19	0.99	1.22	1.105 (0.10)	30.1%	49.1%	7.0%	37.9%	1.09
<i>France</i>	1.72	0.92	1.00	0.678 (0.10)	1.487 (0.26)	1.17	0.62	1.49	0.918 (0.07)	19.8%	58.0%	7.9%	25.4%	0.85
<i>Germany</i>	1.43	0.83	1.00	0.515 (0.15)	1.267 (0.29)	0.74	0.43	1.27	0.602 (0.12)	38.1%	54.6%	6.5%	24.7%	0.60
<i>Hungary</i>	1.39	0.98	1.00	0.768 (0.27)	1.153 (0.00)	1.06	0.75	1.15	0.985 (0.25)	20.6%	51.3%	9.0%	32.2%	0.91
<i>Latvia</i>	1.18	1.00	1.00	1.421 (0.25)	1.176 (0.17)	1.67	1.41	1.18	1.233 (0.16)	27.1%	45.5%	9.8%	35.8%	1.40
<i>Lithuania</i>	1.29	1.00	1.10	1.287 (0.16)	1.310 (0.27)	1.66	1.29	1.44	1.020 (0.11)	33.9%	41.6%	8.0%	36.3%	1.32
<i>Malaysia</i>	3.58	1.00	1.10	0.971 (0.00)	1.288 (0.00)	3.48	0.97	1.42	1.131 (0.12)	18.9%	0.0%	47.8%	14.6%	1.84
<i>Mexico</i>	1.55	0.97	1.00	1.151 (0.13)	1.401 (0.26)	1.79	1.11	1.40	1.379 (0.16)	22.4%	17.9%	28.7%	40.0%	1.47
<i>Peru</i>	2.96	1.00	1.00	0.796 (0.10)	1.376 (0.12)	2.35	0.80	1.38	0.797 (0.05)	9.1%	14.1%	18.7%	58.8%	0.82
<i>Poland</i>	1.29	0.95	1.00	1.001 (0.18)	1.106 (0.20)	1.29	0.95	1.11	0.871 (0.09)	22.9%	49.9%	10.8%	28.5%	1.01
<i>Slovakia</i>	1.64	0.97	1.00	0.796 (0.18)	1.153 (0.00)	1.30	0.77	1.15	0.763 (0.09)	13.9%	58.7%	12.5%	32.1%	0.87
<i>Slovenia</i>	1.54	1.00	1.00	1.298 (0.11)	1.153 (0.00)	2.00	1.30	1.15	0.772 (0.12)	22.1%	53.9%	6.2%	36.8%	1.26
<i>South Africa</i>	1.26	-	1.00	1.104 (0.10)	1.874 (0.28)	1.39	-	1.87	1.267 (0.15)	51.7%	-	36.4%	23.0%	1.52
<i>Thailand</i>	2.46	0.72	1.05	0.773 (0.08)	1.068 (0.32)	1.90	0.55	1.12	0.883 (0.04)	19.5%	-	30.5%	37.2%	1.07
<i>UK</i>	1.53	1.02	1.00	0.831 (0.09)	1.391 (0.32)	1.28	0.85	1.39	1.056 (0.09)	39.6%	25.5%	13.0%	25.2%	1.13
<i>USA</i>	1.35	0.85	1.00	0.809 (0.05)	1.638 (0.52)	1.09	0.69	1.64	0.930 (0.06)	52.9%	36.6%	13.1%	16.6%	1.00

Table 3: Output Elasticities: Comparison with OECD estimates

	PI Elast		Output Elasticity of			OECD: Output Elasticity of			Final Elasticity	
	Iizetcki	OECD	PIT	SS	CIT	PIT	SS	CIT	Iizetcki	OECD
<i>Australia</i>	1.6	1.6	1.4	-	1.3	0.6	0.6	1.6	1.48	0.87
<i>Belgium</i>	1.5	1.4	1.2	0.8	1.2	1.3	1.0	0.9	0.95	1.08
<i>Canada</i>	1.2	1.4	1.0	0.6	1.2	1.2	0.9	1.0	0.92	1.02
<i>France</i>	1.7	1.7	1.2	0.6	1.5	0.6	0.5	1.8	0.85	0.65
<i>Germany</i>	1.4	1.5	0.7	0.4	1.3	1.3	1.0	0.8	0.60	1.07
<i>UK</i>	1.5	1.5	1.3	0.8	1.4	1.4	1.2	0.6	1.13	1.18
<i>USA</i>	1.3	1.3	1.1	0.7	1.6	0.6	0.6	1.8	1.00	0.78

Table 4: Tax Changes and GDP
 Dependent Variable: Change in GDP

	Full Sample		Developing countries	
	OLS	Arellano-Bond	OLS	Arellano-Bond
PIT	-0.14 (.055)	-0.16 (.081)	-0.20 (.080)	-0.37 (.091)
CIT	0.043 (.028)	-0.084 (.063)	0.018 (.060)	0.034 (.061)
VAT	0.38 (.129)	0.51 (.55)	0.44 (.24)	0.55 (.33)
Lagged GDP		0.35 (.043)		0.37 (.10)
UR	-0.0079 (.00036)	0.0035 (0.0011)	-0.015 (.0012)	0.003 (.0017)
Trading Partners' Growth	1.52 (.31)	2.95 (.23)	1.62 (.34)	2.77 (.44)
n	335	308	188	166

Significant at 1%
Significant at 5%
Significant at 10%

Table 5: Shares of Debt Denominated in Foreign Currency

Selected years

Country	Year	Share
Brazil	2001	40%
	2008	23%
Chile	2002	93%
	2009	37%
Estonia	2004	100%
Malaysia	2003	20%
South Africa	1994	20%
	2008	42%

Data Appendix

1. **Quarterly Public Finance Database:** This dataset includes quarterly time series for total government revenue, tax revenue, revenues from social security, total expenditures (current and capital), interest payments and transfers. The data refer to the consolidated general government or the consolidated central government (including social security), depending on the existence of quarterly accounts for the general government in each country. Data are from national sources, with the exception of the UK and Canada from the OECD Economic Outlook and Belgium, Bulgaria, Czech Republic, Cyprus, France, Germany, Hungary, Poland, Slovakia and Slovenia from Eurostat. Links to these sources are provided below. For the Latin American and Asian countries in the sample the data correspond to central government accounts. For the remaining countries the data refers to the Consolidated General Government.
2. **Annual Tax Revenue Breakdown:** This dataset contains the breakdown of tax revenues by their components: Personal Income Tax Revenue, Corporate Income Tax Revenue, Value Added Tax Revenues (or Sales Tax Revenues, for countries with no VAT) and Social Security Contribution Revenues. This database was constructed separately from the Quarterly Public Finance Dataset since these series are not always reported together and, many times, the tax revenue breakdown is in annual frequency. For Latin American and Asian countries, where Central Government is being considered, only federal tax revenues are included. Data was taken from national sources, with the exception of Argentina, Chile, Colombia and Mexico from ECLAC; Canada, UK, France, Germany, Belgium, Czech Republic, Poland, Slovakia and Hungary from OECDstats and Cyprus from the IMF's IFS.
3. **Statutory Tax Rates:** The data related to the statutory tax rates, comprised by tax brackets and rates of Personal Income Tax, Corporate Income Tax, Social Security and VAT, comes from the OECD Tax Database for OECD countries (www.oecd.org/tax); from the annually tax books "Individual Taxes: Worldwide Summaries" and "Corporate Taxes: Worldwide Summaries", published by *PriceWaterhouseCoopers* until 2005; from the *PWC* tax webpage which has the latest statutory tax information (www.pwc.com/gx/en/worldwide-tax-summaries); and also from the *KPMG* Individual and Corporate Tax Rate Survey from 2006-2009.
 - a. **Personal Income Tax** is generally progressive and composed by several brackets, but there are a few exceptions of countries and years in which a flat rate applies (Bulgaria and Czech Republic after 2008).
 - b. **Corporate Income Tax** is usually given by a flat rate on profits, although there are also a few exceptions. Brazil has a progressive tax schedule with two brackets and Bulgaria had a progressive tax schedule in the years 1999-2001. For Lithuania (after 2003), Cyprus (1995-2004), Malaysia and Thailand have different tax rates according to the firm size. In Argentina and Colombia, if the resulting chargeable corporate tax is small enough, there is a complementary tax on assets. According to the perceived regressiveness/progressiveness of the tax schedule the imputed profit elasticities in those cases vary from 1.0 to 1.1.
 - c. **VAT (or Sales Tax)** although there are many deductions according to the nature of each product, we consider the standard flat rate. In the USA, where there are State, County and Municipal sales taxes, we consider the national average sales-tax rate.
 - d. **Social Security** usually has regressive tax rates with several brackets. UK is the only exception, since a high tax credit offsets the effect of regressiveness from the tax brackets. The income elasticities of social security tax revenues, computed in a similar way to the personal income tax elasticities, range from 0.75-1.10.
4. **Gini Coefficients:** The Gini Coefficients were used to log-normalize of the labor earnings distribution for the computation of personal income tax and social security elasticities. Series on Gini coefficients were taken from the World Bank's Povcal Net database for developing countries and national sources for high-income countries with the exception of France, Germany and Belgium, taken from Eurostat. Complementary data from the World Bank's World Development Indicators were also been used to fill in missing observations and check for consistency. We interpolated remaining missing observations by a regression of the Gini coefficient on GDP for existing years. This allows for predictable shifts in the income distribution due to cyclical conditions to further inform the output elasticity of tax revenues.

5. **Average labor earnings:** Data is taken from national household income surveys with the exception of Croatia and the UK from the Eurostat and the ILO; Malaysia from the Povcal Net database; and Hungary, Poland, Slovenia and South Africa from the ILO.

6. **Complementary Data for the Panel Analysis**

- a. Trade Shock: The trade shock series are based on data from the IMF's Direction of Trade database.
- b. Unemployment Rate: The Unemployment rate data have been collected in the IMF's World Economic Outlook database.

Useful Links for Data Sources

Argentina	www.mecon.gov.ar/hacienda www.indec.gov.ar	Mexico	www.apartados.hacienda.gob.mx www.inegi.org.mx
Australia	www.abs.gov.au	Peru	www.bcrp.gob.pe www.mef.gob.pe www.inei.gob.pe
Belgium	statbel.fgov.be/en	Slovakia	www.statistics.sk
Brazil	www.tesouro.fazenda.gov.br www.receita.fazenda.gov.br www.ipeadata.gov.br	Slovenia	www.stat.si www.mf.gov.si
Bulgaria	www.nsi.bg	South Africa	www.reservebank.co.za
Canada	www.statcan.gc.ca	Thailand	nso.go.th/en
Chile	www.dipres.cl www.bcentral.cl	UK	www.ifs.org.uk
Colombia	www.banrep.gov.co www.dane.gov.co	USA	www.bea.gov www.dol.gov
Croatia	www.mfin.hr/en	World Economic Outlook	www.imf.org/weo
Cyprus	www.mof.gov.cy	Direction of Trade	www.imfstatistics.org/DOT
Czech Rep	www.czso.cz	Povcal Net	www.worldbank.org/poverty
Dominican R.	www.hacienda.gov.do www.one.gob.do	World Development Indicators	data.worldbank.org
Estonia	www.stat.ee/en	Eurostat	epp.eurostat.ec.europa.eu
France	www.insee.fr/en	International Finance Statistics	www.imfstatistics.org
Latvia	www.csb.gov.lv	OECDstats	stats.oecd.org
Lithuania	www.stat.gov.lt/en	CEPALstats	websie.eclac.cl/sisgen
Malaysia	www.statistics.gov.my www.anm.gov.my	LABORsta	laborsta.ilo.org
		OECD Economic Outlook	www.sourceoecd.org

Time Series Coverage for the SVAR

Argentina	1993Q1 - 2009Q3	Germany	1999Q1 - 2009Q1
Australia	1959Q3 - 2009Q3	Hungary	1999Q1 - 2009Q3
Belgium	1991Q1 - 2009Q3	Latvia	1999Q1 - 2009Q3
Brazil	1997Q1 - 2009Q3	Lithuania	1999Q1 - 2009Q3
Bulgaria	1999Q1 - 2009Q3	Malaysia	1999Q1 - 2009Q3
Canada	1970Q1 - 2009Q3	Mexico	1993Q1 - 2009Q3
Chile	1989Q1 - 2009Q3	Peru	1993Q1 - 2009Q3
Colombia	1995Q1 - 2009Q3	Poland	1993Q1 - 2009Q3
Croatia	2004Q3 - 2009Q3	Slovakia	1993Q1 - 2009Q3
Cyprus	1995Q1 - 2009Q3	Slovenia	1993Q1 - 2009Q3
Czech Rep	1999Q1 - 2009Q3	South Africa	1990Q1 - 2009Q3
Dominican Rep	2002Q1 - 2009Q3	Thailand	1993Q4 - 2009Q3
Estonia	1999Q1 - 2009Q3	United Kingdom	1970Q1 - 2009Q3
France	1991Q1 - 2009Q1	United States	1947Q1 - 2009Q3
