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THE SIZE AND EFFECTIVENESS OF AUTOMATIC FISCAL STABILIZERS IN LATIN AMERICA

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Abstract

This paper measures the size of automatic fiscal revenue stabilizers and evaluates their role in Latin America. The paper introduces a relatively rich tax structure into a dynamic, stochastic, multi-sector small open economy inhabited by rule-of-thumb consumers (who consume their wages and do not save or borrow) and Ricardian households to study the stabilizing properties of different parameters of the tax code. The economy faces multiple sources of business cycle fluctuations: 1) world capital market shocks; 2) world business cycle shocks; 3) terms of trade shocks; 4) government spending shocks; and 5) nontradable and 6) tradable sector technology innovations. Calibrating the model economy to a typical Latin American economy allows the evaluation of its ability to mimic the region's observed business cycle frequency properties and the assessment of the quantitative relationship between tax code parameters, business cycle forcing variables and business cycle behavior. The model captures many of the salient features of Latin America's business cycle facts and finds that the degree of smoothing provided by the automatic revenue stabilizers - described by various properties of the tax system - is negligible. Moreover, government size - measured by the GDP ratio of government spending - plays the role of an automatic stabilizer but its smoothing effect is very weak.

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1. INTRODUCTION

A climate of mistrust towards discretionary fiscal policy is growing in Latin America. De Ferranti, Perry, Gill and Servén (2000) found that a significant fraction of Latin America's excess volatility vis-à-vis industrial economies is due to fiscal policy volatility. The underlying reason is that fiscal policy tends to be procyclical in the region and, instead of smoothing economic fluctuations as in textbook macroeconomics, it contributes to exacerbating them. The destabilizing conduct of fiscal policy has been documented in various cross-country studies (Gavin et al., 1996; Gavin and Perotti, 1997). Furthermore, Fatás and Mihov (2004), using an enlarged sample of countries, including some in Latin America, demonstrated a discernable positive relationship between discretionary fiscal policy changes and macroeconomic volatility and a negative one between the latter and economic growth.

The distrust of fiscal activism is a widespread phenomenon in the developed world nowadays as is the concomitant focus, in public policy and academic circles, on an alternative type of fiscal policy - a non-discretionary one - based on the built-in flexibility of taxation and automatic stabilization. *Let the fiscal automatic stabilizers work* seems to be the new mantra being chanted in the felt need for protection from discretionary fiscal management. Auerbach and Feenberg (2000) and Auerbach (2002) recommend heavier reliance on automatic stabilizers for macroeconomic stabilization purposes for the U.S. given the difficulties in conducting countercyclical fiscal policy. The authors claim that there is little evidence that discretionary fiscal policy has been effective in smoothing shocks and contend that active policy changes suffer from information, political and economic lags. Romer and Romer (1994) reached a similar conclusion in a study of the contribution of monetary and fiscal policies to the ending of eight U.S. postwar recessions. Their study documented the fact that discretionary fiscal impulses have been too small to have had a significant role in ending downturns while automatic fiscal policy seemingly exhibited the magnitude, timing and consistency to have had a stabilizing influence in all recoveries. Taylor (2000) espoused monetary policy to do the countercyclical task, 'taking as given the workings of the automatic stabilizers.' The comparative advantage of monetary policy is attributed to shorter implementation lags, greater flexibility to adjust the policy stance and lower political constraints. Following the same line of reasoning, the institutional arrangement of the EMU has been set up to hold a strong stance against the use of discretionary fiscal policy to fine-tune the economy. The fiscal apparatus of the Maastricht Treaty and the Stability and Growth Pact require a medium-term fiscal position of 'close to balance or in surplus' and relies on the operation of automatic stabilizers as the main tool for dealing with country-specific shocks.

The emerging public policy consensus appears to have some additional backing in the empirical work of Fatás and Mihov (2003), who show that fiscal policy discretion has harmed macroeconomic stability and caused the deterioration of long-term growth in a sample of OECD countries while Fatás and Mihov (2001) found a strong negative correlation between automatic stabilizers, proxied by government size, and output volatility for the same sample of OECD countries given above and for the states in the U.S.

A natural policy question then arises. Should Latin American countries follow the lead of developed countries in giving up the use of activist fiscal policy and focusing on automatic stabilization? Chile, for instance, has answered the question in the affirmative with the adoption of a medium-term structural surplus target of 1% of GDP. Similarly, according to Hemming and Ter-Minassian (2004), the IMF is proposing the adoption of such rules to restrict discretionary actions and protect infrastructure spending. The unsolved issue, however, is the degree of automatic stabilization that can be effectively embedded in the cyclical position of the government budget. The stakes for Latin America are quite high. If automatic stabilizers are weak or ineffective, various economies in the region will be at the mercy of a myriad of domestic and external shocks that frequently hit individual economies, or the region as a whole, with no stabilization instrument at their disposal. This would be true for fully dollarized economies such as Ecuador, El Salvador and Panama, or for the member countries of the Organization of Eastern Caribbean States (OECS) - grouped around a monetary union - since they have certainly lost their control over monetary policy. The numerous highly de facto dollarized countries (Bolivia, Costa Rica, Jamaica, Peru, Paraguay, Uruguay, etc.) will depend heavily on an undermined monetary policy to dampen business cycle fluctuations while most of the other countries in the region that have the potential to run independent monetary policies may find themselves in a similar situation due to procyclical capital flows, financial sector inefficiencies, financial repression, banking crises, illiquid domestic markets, etc., or simply because monetary policy is committed to maintaining price stability.

Two broad components of the government budget display the capacity to smooth out fluctuations in disposable income and consumption: the tax system and the unemployment insurance system. In most Latin American countries, automatic fiscal expenditure stabilizers are virtually shut down due to a lack of well-established welfare programs and/or due to a poor countercyclical design. The design of an unemployment compensation scheme is beyond the scope of this paper. Rather, the focus is automatic fiscal revenue stabilizers or the tax system's built-in flexibility. The relevant literature is sparse and not very informative. In the first place, I know of no previous attempt to measure the size of automatic stabilizers in the LAC region or even in developing countries. The literature has singled out just one feature of the region's fiscal management: the countercyclical nature of discretionary fiscal policy, but little is known about the non-discretionary component. Consequently, one of the objectives of this paper is to provide a broader understanding of fiscal policy by quantitatively characterizing the main features of the non-discretionary component.

Moreover, according to the existing literature, the most important determinant of the cyclical sensitivity of the budget is the size of the government sector. Van den Noord (2000) documented a strong positive relationship between the cyclical sensitivity of the fiscal position and government size in the OECD area, a result that makes clear why the existing empirical work has focused on that variable (government size), as measured by the expenditure or tax revenue to GDP ratio, to epitomize the overall level of stabilization provided by fiscal policy (Galí, 1994; Fatás and Mihov, 2001; Andrés et al., 2004; Guo and Harrison, 2004). The striking observation for Latin America and the Caribbean (LAC) countries is that larger governments are associated with more volatile business cycles. Figure 1 shows the differing effect of government size (primary expenditures to GDP ratio) on the amplitude of the business cycle in developed and LAC countries. Regardless of the volatility measure (standard deviation of the Hodrick-Prescott filtered log-GDP or the volatility of the growth rate of GDP) larger governments in the LAC region tend to be correlated with more volatile macroeconomic environments while exactly the opposite is observed in the developed world.

The lack of understanding of the workings of automatic revenue stabilizers in developing countries is aggravated by the fact that the stabilizing properties of other dimensions of a tax system are also practically unknown. It is generally believed, for example, that a progressive income tax reduces fluctuations in after-tax income, but the size of its smoothing effect and the nature of the relationship between the degree of smoothing and the degree of progressivity of the income tax schedule have not been established. Furthermore, there are other alternative ways to introduce progressivity into a tax system in addition to changes in the slope of the personal income tax schedule. The personal exemption level exempts low-income households from paying taxes and induces a positive association between income and the tax-income ratio. VAT exemptions (spending on goods of basic necessity, for instance) may induce a similar pattern. Is this type of progressivity stabilizing? Tax revenue composition or more generally, the revenue sensitivity properties of different taxes, may play a smoothing role too, but their structural relationship with the business cycle has not been clarified. My reading of the existing empirical work is that the effect of all these variables has been hidden behind the (government) size variable. This acts as a summarizing measure of various stabilizing properties of the tax system, but the independent roles of each one have not been disentangled. An attempt will be made in this paper to identify those features of a tax system that enhance the operation of automatic stabilizers. In this sense, this paper is the first attempt to look into the microfoundations of automatic revenue stabilization in developing countries. In particular, the paper tries to answer a normative question: How can policymakers improve automatic stabilization? Is it plausible to make automatic stabilizers in developing countries more effective?

Automatic revenue stabilizers are also commonly measured as a weighted sum of elasticities of specific tax categories with respect to a change in income with weights given by the relative size of the corresponding tax collection. If elasticities are unitary, the measure boils down to the tax/GDP ratio. Both the government's size indicator and this weighted sum of elasticities - the so-called cyclical sensitivity of the budget - are associated, in a mechanistic fashion, in the minds of policy makers as well as in the existing literature with the capacity of fiscal policy to offset fluctuations since an augmented smoothing power is attributed to a higher cyclical responsiveness of the budget. Note also that these measures remain invariant with respect to the sources of business cycle fluctuations, implying that automatic stabilizers, of a certain size, should work at all times and everywhere with the same effectiveness. However, there is no research backing up this conjecture. In principle, a traditional Keynesian argument would provide a rationale for that hypothesis: any demand shock triggers automatic responses in taxes representing a countercyclical demand impulse via after-tax income. As originally conceived by Keynesians, a pure demand-driven business cycle is the ideal environment for the smooth operation of the fiscal revenue stabilizers. But, how do automatic stabilizers operate when other forces drive the business cycle, as is the case of Latin America? What happens when shocks have relevant demand as well as supply dimensions? Mendoza (1995), in a study of the relationship between terms of trade shocks and business cycles, found that 56% of the observed volatility of GDP in developing countries was explained by terms of trade shocks. Kose (2002), also within an intertemporal general equilibrium framework, assessed the role of world prices in driving business cycles fluctuations in developing countries and found that shocks to the world real interest rate along with shocks to the world prices of capital, intermediate and primary goods account for 88% of aggregate output fluctuations. The question is: Do automatic stabilizers work equally well under any cyclical circumstances, as the summary indicators of the cyclical sensitivity of the budget seem to suggest? What does "*Let the fiscal automatic stabilizers work"* mean in an economy facing multiple sources business cycle fluctuations?

To answer the questions that have been posed, a relatively rich tax structure is introduced into a stochastic, dynamic, multi-sector, small open economy model to study the stabilizing properties of different parameters of the tax code. The tax structure partially builds upon Jonsson and Klein (1996), Guo and Lansing (1998) and Cassou and Lansing (2004) who attempted to provide a reasonable portrayal of income taxation by introducing tax progressivity into a representative-agent dynamic general equilibrium setting. Some of the features of the modeled tax system are the following: 1) three general types of government revenue: consumption, personal income and business income taxes; 2) different rates applied to personal and business income; 3) graduated personal income tax rates; 4) expensing of new physical capital investment; 5) personal income exemption level and 6) a level exemption in the consumption tax base. At the same time, an attempt is made to capture the major features of the region's business cycle by including six sources of fluctuations: 1) world capital market shocks; 2) world business cycle shocks; 3) terms of trade shocks; 4) government spending shocks and 5) nontradable and 6) tradable sector technology innovations. Calibrating the model economy to a typical LAC economy allows an evaluation of its ability to mimic the region's observed business cycle fluctuations and an assessment of the quantitative relationship between tax code parameters, business cycle forcing variables and business cycle behavior. In related work, Galí (1994), Andrés et al. (2004) and Guo and Harrison (2004) developed dynamic general equilibrium models to evaluate the role of automatic stabilizers in much the same vein as the exercise proposed here. However, in those models there was only one source of business fluctuations (technology shocks), only one property of the tax system being analyzed (government size), and the economy is closed. A richer menu of tax parameters is evaluated by Andrés and Doménech (2003) in a closed economy version of a representative European economy driven solely by technology shocks.

In contrast to standard small open economy models (Mendoza, 1991; Correia et al., 1995; Senhadji, 1998; Kose, 2002; etc.) an economy is presented where decision-making is decentralized into the hands of households and firms. This modeling choice allows the effect of distortionary corporate taxation on businesses and the effect of both the level and slope of the personal income tax schedule on household behavior to be appraised. Standard small open economy models with a government sector generally prevent the government from borrowing or allow for lump-sum taxation in which case, by a Ricardian Equivalence type of argument, government debt is irrelevant. A version of Ricardian equivalence holds true in the present model as well. The standard small open economy model is also extended to introduce agent heterogeneity along the lines of Mankiw's (2000) Savers-Spenders Theory of Public Finance. In the economy, spenders or low-wealth households who follow the rule-of-thumb of consuming their disposable income every period and do not save or borrow thus rendering consumption smoothing unfeasible, and savers or Ricardian consumers or high-wealth households who smooth their consumption over time by trading in physical and financial assets, and act in an optimizing, forward-looking manner coexist. Mankiw (2000) introduces this sort of heterogeneity to overcome the failure of the Barro-Ramsey model (and the Diamond-Samuelson model) to explain why consumption closely follows the evolution of current income and the fact that the net worth of many households is near zero. LAC countries are also confronted with these undeniable facts. There is also a growing body of literature showing that this form of heterogeneity provides insights into the effect of macroeconomic policies which happens to be consistent with other observed facts at the macro level (see Galí et al., 2004; Andrés et al., 2004; Matsen et al., 2004).

The outline of the paper is the following. Section 2 briefly describes the methodology and provides estimates of the size of the automatic fiscal revenue stabilizers in Latin America. In order to facilitate the comparison, the same approach is used to compute developed country indicators. Section 3 describes the model economy and Section 4 discusses calibration. Section 5 performs simulations and evaluates the stabilization role of different tax code parameters by comparing the volatility of output under alternative tax structures and sources of fluctuations with the volatility of an economy with lump-sum taxation. Finally, Section 6 provides some conclusions.

2. THE SIZE OF AUTOMATIC REVENUE STABILIZERS IN LATIN AMERICA

The focus in this section is on the measurement of the sensitivity of the budget balance to the cycle in the LAC region and this is compared with figures for developed countries. The European Commission, the IMF, the OECD, as well as various national authorities, routinely compute budget sensitivities in order to facilitate the evaluation of budgetary policies and, for that specific endeavor, have developed a number of widely differing methodologies. Two measures are presented here. The first loosely builds upon the OECD approach and relies on the estimates of tax proceeds and tax base elasticities, henceforth referred to as the "SBB" indicator. The second loosely builds upon Pechman's (1973) measure of a tax system's built-in flexibility, henceforth abbreviated as "PI".

The sensitivity of the budget balance to the cycle (SBB) is operationally defined as the change in the primary budget balance (relative to potential GDP) in response to a 1% cyclical deviation of GDP from trend:

$$SBB = \frac{\frac{B_t^y - B_t^*}{Y_t^*}}{\frac{Y_t - Y_t^*}{Y_t^*}}$$

where starred variables represent potential or trend levels. B_t^y stands for the cyclically disturbed primary budget balance. The budget balance variable included in the preceding definition (B_t^y and B_t^*) can be expressed in terms of its defining revenue and expenditure categories where, in principle, each budgetary category may or may not be cyclically sensitive. After simple manipulations, the preceding semi-elasticity can be rewritten in terms of a weighted sum of elasticities associated with cyclically sensitive budgetary items alone:

$$SBB = \sum_{i=1}^{n} \varepsilon_{R_i} \cdot \eta_{R_i} \cdot \left(\frac{R_i}{Y}\right)^* - \sum_{j=1}^{m} \varepsilon_{E_j} \cdot \eta_{E_j} \cdot \left(\frac{E_j}{Y}\right)^*$$

where ε_{R_i} (ε_{E_j}) is the elasticity of the corresponding budgetary category (R_i, $i = 1,...,n$, for revenues and E_j, $j = 1,...,m$, for expenditures) with respect to its base and η_{R_i} (η_{E_j}) is the elasticity of the corresponding macroeconomic base with respect to (cyclical) economic activity. n revenue categories and m expenditure categories are found to be cyclically responsive. $(R_i/Y)^*$ ($(E_j/Y)^*$) represents the average size of the corresponding budgetary category relative to the size of the economy (GDP). In the ensuing analysis, the second term on the right-hand side of the equation is dropped because cyclically-sensitive expenditures in the LAC region (mainly unemployment-related expenditures) are poorly designed or very small or time series data are lacking. This choice also reflects the concern here for the stabilizing role of the tax system and not that of the benefit system. For the sake of comparison, developed country sensitivities are calculated the same way.[1]

Based on the definitions adopted in the IMF Government Finance Statistics database, five revenue categories are acknowledged to be dependent upon the cycle: 1) taxes on income, profits and capital gains; 2) taxes on goods and services; 3) taxes on international trade; 4) social security contributions and 5) other taxes.[2] Fiscal elasticities are obtained from country-by-country regressions for each revenue category i (in real terms) as:

$$d(\log(R_{i,t})) = \alpha + \varepsilon_{R_i} d(\log(b_{i,t})) + \gamma^T Z_t + \zeta_t \qquad i = \{1,...,5\}$$

[1] Unemployment-related expenditures are small in developed countries. For instance, this budget category amounts to 1.3% of GDP in the Euro area and 1.4% in the EU-15 countries in 1999. However, it is highly responsive to cyclical variations in output (Bouthevillain et al., 2001).

[2] Zero elasticity with respect to the business cycle is implicitly attached to other government revenue categories.

where $b_{i,t}$ is the relevant, real economic base of the tax and Z is a vector of other explanatory variables. Data availability restricts the choice of tax bases. The GDP is assumed to be the relevant macroeconomic base for tax categories $i = \{1, 4, 5\}$; final household consumption, the base for $i = \{2\}$ and total imports, for $i = \{3\}$. The vector Z includes other determinants of the rate of growth of real tax proceeds such as the inflation rate[3] (in logs or log difference) and terms of trade (in logs or log difference). Unfortunately, due to data limitations on tax law changes over time, the regression does not control for discretionary policy measures thus rendering elasticity estimates not completely reliable.[4] An additional potential source of bias is the use of the OLS estimation technique, which ignores the effect of the fiscal position on the cyclical behavior of macroeconomic aggregates thus yielding biased estimates. To deal with the endogeneity problem, the instrumental variable estimation procedure is used. This uses the U.S. GDP (log difference) and the first lag of the inflation rate and terms of trade variables as instruments.

Annual tax data series generally spanning the period from 1972 to 2000 and generally comprising what the IMF defines as 'consolidated central government' come from the Government Finance Statistics database and IMF country reports. The remaining data were retrieved from the World Development Indicators database (World Bank). Output elasticities of various macroeconomic bases were obtained from OLS regressions of $d(\log(b_{i,t}))$ on $d(\log(Y_t))$ with no correction for the potential endogeneity of the right-hand side variable.[5]

In the other methodology, Pechman (1973) estimates the responsiveness of the U.S. tax system to fluctuations in income using a sample of historical individual federal income tax returns to simulate the impact on tax liabilities of a dollar increase in personal income. Pechman refers to this measure as the tax system's "built-in flexibility" and Auerbach and Feenberg (2000), as the "normalized tax change." Lacking the specific information needed to perform a similar calculation for LAC countries, an aggregate version of the relationship between tax revenue and income is computed here by defining it as the mean of the yearly ratios of the absolute increase in total tax revenue to the absolute increase in GDP. The PI indicator is computed as

$$PI = N^{-1} \sum_{i=1}^{N} \frac{\Delta(R_t)}{\Delta(Y_t)}$$

where $N+1$ is the sample size and $\Delta(R_t)$ is the absolute change in total tax revenue between periods $t-1$ and t. Unfortunately, the PI indicator is also tainted by the problem

[3] The inflation rate is defined as inflation rate/(1+inflation rate).

[4] In stricto sensu, this is not a tax elasticity measure but a tax buoyancy measure. The latter incorporates the impact of any discretionary changes in tax rates on revenue collection data. By definition, buoyancy does not control for discretionary changes in the tax structure.

[5] In some cases the described general methodology to compute SBB did not work satisfactorily. In those cases Hodrick-Prescott filtered (logged) series (budget categories, tax bases and output) are used to estimate elasticities.

of tax law changes. Figure 2 depicts the two measures of the cyclical sensitivity of the fiscal position. The figure relates both statistics with the government size variable (primary expenditures to GDP ratio) - which is generally used as a proxy for the size of automatic stabilizers - for 16 Latin American[6] and 24 developed countries[7]. The figure corroborates Van den Noord's (2000) finding of a strong positive correlation in developed countries, indicating that the size of government is the key force determining the cyclical sensitivity of the fiscal position. Though a note of caution is in order based on what was discussed in the preceding paragraphs, both indicators are suggestive of much weaker automatic fiscal revenue stabilizers in Latin America than in the developed world.

This message is broadly consistent with two additional pieces of widely known information which, by definition, are incorporated into the construction of the preceding indicators: government size (figure 3) and the structure of taxation (figure 4). Figure 3 shows that governments (tax revenue or primary expenditures to GDP ratio) are bigger in developed countries and figure 4 shows that the relative share of taxation of cyclically-sensitive tax bases and/or the degree of progressivity of the tax system, proxied by the share of income taxes, is greater in developed countries. These figures also indicate that automatic stabilizers should tend to be stronger in developed countries than in the LAC region. All in all, a new piece of evidence has been added to the small stack of evidence on LAC fiscal policy. Not only has discretionary fiscal policy been reported to be procyclical, but automatic fiscal stabilizers have also been found to be weak by two alternative methods and ancillary indicators.

Based on the existing evidence, it is possible to draw a corollary, that discretionary fiscal policy and automatic stabilizers move in opposite directions along the business cycle in the LAC region. In developed countries, both types of fiscal policy probably tend to reinforce each other. A time series of automatic revenue stabilizers (AS_t) is obtained from the automatic response of the budget to changing cyclical conditions, as $(B_t^y - B_t^*)/Y_t^*$:

$$AS_t = \frac{B_t^y - B_t^*}{Y_t^*} = \sum_{i=1}^{n} \varepsilon_{R_i} \cdot \left(\frac{b_{i,t} - b_{i,t}^*}{b_{i,t}^*} \right) \cdot \left(\frac{R_{i,t}^*}{Y_t^*} \right)$$

where $b_{i,t}$ is the relevant macroeconomic base for tax category i and $b_{i,t}^*$, $R_{i,t}^*$ and Y_t^* are Hodrick-Prescott trend components of the tax base, tax revenue and GDP, respectively. A time series of discretionary fiscal policy is obtained by subtracting the automatic stabilizers estimate from the observed primary budget surplus (relative to potential GDP),

[6] The sample of LAC countries includes 16 countries: Argentina, Bolivia, Brazil, Chile, Costa Rica, Dominican Republic, Ecuador, El Salvador, Guatemala, Mexico, Nicaragua, Panama, Paraguay, Peru, Uruguay and Venezuela.

[7] The sample of industrial countries includes: Australia, Austria, Belgium, Canada, Cyprus, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Luxembourg, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Turkey, United Kingdom and United States.

$$\frac{B_t - B_t^*}{Y_t^*} = \underbrace{\left[\frac{B_t - B_t^y}{Y_t^*}\right]}_{\text{discretionary policy}} + \underbrace{\left[\frac{B_t^y - B_t^*}{Y_t^*}\right]}_{\text{automatic component}}$$

A shortcoming in this methodology lies in attributing to discretionary policy all changes in the budgetary position that are not associated with the business cycle. Therefore, results should be taken with a grain a salt. Figure 5 does provide support in favor of the stated conjecture. As shown in Figure 5, there is a negative correlation between the two components of fiscal policy in 16 out of the 17 LAC countries in the sample. Within the developed world positive correlations are more commonly observed though, in a number of these countries, discretionary fiscal policy also exhibits a procyclical pattern.

Finally, an additional intuition about the strength of automatic stabilization or the degree of flexibility embedded in the tax system can be gained by looking at the responsiveness of the automatic fiscal revenue stabilizers to changes in cyclical conditions. To that end, a variant (including terms of trade) of the policy rule used by Galí and Perotti (2003) is estimated on a country-by-country basis:

$$AS_t = \alpha + \beta \cdot CY_t + \gamma_P \cdot P_t + \gamma_D \cdot D_{t-1} + \gamma_L \cdot AS_{t-1} + \zeta_t$$

where CY_t represents the output gap measured by the Hodrick-Prescott cyclical component of log-GDP; P_t stands for the terms of trade (in level, in log or in log difference, depending on unit root tests); D_t is the stock of outstanding public debt in ratio to potential GDP and where the potential GDP is in turn obtained from the Hodrick-Prescott trend component. The public debt time series for each country is estimated by using information on the debt-GDP ratio at a given point in time and using time series data on the overall budget balance and GDP along with the law of motion of government debt to reconstruct the entire path. The government debt-GDP ratio at a given point in time is retrieved from the FitchResearch database and Moody's. The coefficient β measures the size of automatic movements in the revenue ledger accounts of the government budget in response to changes in cyclical conditions. The simultaneity bias associated with the potential problem of endogeneity of the output gap variable is addressed by instrumenting for it with its lagged value and the first lag of the U.S. output gap (or the first lag of the three major European economies' output gap for the U.S. regression).

Figure 6 depicts country-specific estimates of the output gap coefficient of the fiscal reaction function. Without exception, all industrial countries exhibit a statistically significant response from the revenue budget items to automatically counteract domestic cyclical fluctuations. In Latin America very few countries exhibit a significant response. When it is significant, it is much weaker than in the developed country sample. In general, the region as a whole tends to have a barely acyclical non-discretionary fiscal policy.

3. THE MODEL

The model economy to be studied is open, small and stochastic. Consider an economy populated by a continuum of infinitely lived households uniformly distributed on the unit interval $[0,1]$, a continuum of identical firms and a government sector. A fraction π of households with names on the interval $[0,\pi)$, referred to as spenders and identified by the subscript $_r$, choose current labor supply at the competitive wage rate and consume their disposable labor income in order to maximize period-by-period utility. The remaining share $(1-\pi)$ of households with names on $[\pi,1]$, referred to as optimizing households and identified by the subscript $_o$, maximize their lifetime expected utility by transferring resources across periods and from one generation to another by using capital markets. Two goods are produced in the economy: nontradables, identified by the superscript ^{n}, and exportables, identified by ^{x}. Two goods are consumed: nontradables and importables, ^{m}. The importable good, which plays the role of numéraire, can be used for final household consumption and investment and for intermediate consumption in the production process. The volume of exports depends on relative prices (terms of trade) and on the GDPs of LAC trading partners and thus on the international business cycle. The Ricardian households have access to the world financial market for one-period real bonds. The representative LAC economy takes the world prices of exports and imports as well as the world interest rate as given parametrically. The world interest rate, the world business cycle and the terms of trade, as well as other additional forcing processes to be introduced shortly, are assumed to follow a stationary, first order, vector Markov process.

The following model economy is expressed in per capita terms and no population growth is allowed. Following convention, economy wide, per capita aggregates are represented by capital letters while variables under the household's control, not including prices, are denoted by lower case letters. In equilibrium individual choices and the corresponding aggregate counterparts should be identical. Time is discrete and indexed by t, $t = 0, 1, 2, \ldots, \infty$.

3.1 Optimizing Households

The representative optimizing household has preferences over sequences of consumption and leisure and maximizes the present discounted value of momentary utility functions:

$$E_0 \sum_{t=0}^{\infty} \beta^t u(c_{o,t}, l_{o,t}) = E_0 \sum_{t=0}^{\infty} \beta^t \left\{ \log(c_{o,t}) - \frac{\kappa}{\xi}(1-l_{o,t})^{\xi} \right\}$$

$$c_{o,t} = \left\{ \alpha (c^n_{o,t})^{-\upsilon} + (1-\alpha)(c^m_{o,t})^{-\upsilon} \right\}^{-\frac{1}{\upsilon}}$$

The representative household draws utility from a composite consumption good $c_{o,t}$ and from leisure time $l_{o,t}$. The composite consumption good is a combination of two goods treated as imperfect substitutes by a CES Armington aggregator: consumption of nontradable goods $c^n_{o,t}$ and consumption of importable goods $c^m_{o,t}$. The parameter α is a preference weight on nontradable goods and υ, $\upsilon > -1$, determines the elasticity of substitution between domestic and importable consumption goods given by $1/(1+\upsilon)$. β is a subjective discount factor and ξ governs the intertemporal elasticity of substitution in labor supply. E_0 is the mathematical expectations operator conditional on information available at time 0.

The Ricardian household faces the following flow budget constraint:

$$d_{o,t+1} - b_{o,t+1} = (1+r^d_r)d_{o,t} - (1+r^b_r)b_{o,t} + p^n_t\left(c^n_{o,t} + \sum_{j\in\{n,x\}} i^{nj}_{o,t}\right) + \left(c^m_{o,t} + \sum_{j\in\{n,x\}} i^{mj}_{o,t}\right) + t_{o,t}$$
$$- \sum_{j\in\{n,x\}} p^j_t w^j_t n^j_{o,t} - \sum_{j\in\{n,x\}} p^j_t r^j_t k^j_{o,t} + \Psi^d[d_{o,t}] + \Psi^b[b_{o,t}] - TR_t$$

where $i^{nn}_{o,t}$ $(i^{mn}_{o,t})$ and $i^{nx}_{o,t}$ $(i^{mx}_{o,t})$ represent the investment of the nontradable (importable) good in the nontradable and exportable producing sectors, respectively. w^n_t (w^x_t) and r^n_t (r^x_t) are the wage rate and the rental price of capital in the nontradable (exportable) sector. $n^j_{o,t}$, $j = \{n, x\}$, denotes labor input allocated to producing sector j. $k^n_{o,t}$ $(k^x_{o,t})$ is the stock of physical capital owned exclusively by optimizing households and allocated to firms in the nontradable (exportable) sector. p^n_t and p^x_t are the relative price of nontradables and the terms of trade, respectively. $t_{o,t}$ stands for tax payments to the government, to be described in detail below. TR_t is a time t lump-sum government transfer to the household. $b_{o,t}$ is the beginning-of-period holdings of government bonds with an endogenous rate of return r^b_t. $d_{o,t}$ is net foreign debt at the beginning of period t and r^d_t is the interest rate, in terms of imports, charged on foreign debt. The interest rate charged on world capital markets is expressed as

$$r^d_t = r^* + s_t$$

where r^* is the constant world interest rate and s_t is an exogenous stochastic borrowing premium. All assets and debts are held by Ricardian households (and the government).

It is well known that the equilibrium dynamics of a small open economy, with asset trading restricted to a noncontingent bond, exhibit a random walk property that prevents the use of local approximation methods to study the business cycle behavior of the economy around a stationary growth path. To induce stationarity in the equilibrium dynamics, convex portfolio adjustment costs, which help to pin down the steady state level of foreign debt, are introduced. Adjustment costs are represented by the term $\Psi^d[d_{o,t}]$ and the following parametric specification is used:

$$\Psi^{d}[d_{o,t}] = \frac{\psi^{d}}{2}(d_{o,t} - D_{o})^{2}$$

where D_o is the steady state aggregate level of foreign debt in the hands of the representative Ricardian household.[8]

The household's total time endowment is normalized to unity per period and time spent in employment is subject to the constraint:

$$1 = l_{o,t} + \sum_{j\in\{n,x\}} n^{j}_{o,t}$$

Holdings of physical capital obey the following law of motion:

$$k^{j}_{o,t+1} = (1-\delta^{j})k^{j}_{o,t} + i^{j}[i^{nj}_{o,t}, i^{mj}_{o,t}] - \Psi^{kj}[k^{j}_{o,t+1}, k^{j}_{o,t}] \qquad j = \{n, x\}$$

where δ^j is the depreciation rate of capital in sector j, $\Psi^{kj}[\cdot]$ is a standard quadratic adjustment cost function in investment, characterized by a single parameter ψ^{kj}

$$\Psi^{kj}[k^{j}_{o,t+1}, k^{j}_{o,t}] = \frac{\psi^{kj}}{2}(k^{j}_{o,t+1} - k^{j}_{o,t})^{2} \qquad j \in \{n, x\}$$

Gross investment in sector j is a composite of nontradable and foreign goods which are considered imperfect substitutes according to an Armington aggregator expressed in the CES form:

$$i^{j}_{o,t} = i^{j}[i^{nj}_{o,t}, i^{mj}_{o,t}] = \chi^{j}\left\{\varphi^{j}(i^{nj}_{o,t})^{-\nu^{j}} + (1-\varphi^{j})(i^{mj}_{o,t})^{-\nu^{j}}\right\}^{-\frac{1}{\nu^{j}}} \qquad j \in \{n, x\}$$

where χ^j is a scaling factor, φ^j is a weight specifying the relative nontradable content of investment and ν^j, $\nu^j > -1$, governs the elasticity of substitution between domestic and foreign goods in investment.

3.2 Spenders

The restricted households solve a simple static problem since they live hand-to-mouth and hence do not make intertemporal decisions. Formally, consumption allocations between domestic and importable goods and labor supply are chosen so as to solve this problem

[8] Schmitt-Grohé and Uribe (2003) prove that alternative stationarity-inducing approaches (for instance, endogenous discount factor or debt-elastic interest-rate premium) yield exactly the same dynamics at business cycle frequencies. It remains to be shown, however, whether their result carries over into richer environments than the canonical small open economy model simulated in their paper.

$$\max \quad u(c_{r,t}, l_{r,t}) = \left\{ \log(c_{r,t}) - \frac{\kappa}{\xi}(1 - l_{r,t})^{\xi} \right\}$$

where

$$c_{r,t} = \left\{ \alpha (c^{n}_{r,t})^{-\upsilon} + (1-\alpha)(c^{m}_{r,t})^{-\upsilon} \right\}^{-\frac{1}{\upsilon}}$$

subject to

$$p^{n}_{t} c^{n}_{r,t} + c^{m}_{r,t} + t_{r,t} = \sum_{j \in \{n,x\}} p^{j}_{t} w^{j}_{t} n^{j}_{r,t} + TR_{t}$$

$$1 = l_{r,t} + \sum_{j \in \{n,x\}} n^{j}_{r,t}$$

The notation and setup of the problem are quite straightforward. Savers and spenders have identical period utility functions and because their labor effort is perfectly substitutable, they earn the same wage.

3.3 Firms

The two sectoral technologies have a CES specification given by

$$Y^{j}_{t} = \lambda^{j} Z^{j}_{t} (N^{j}_{t})^{\gamma^{j}} \left\{ \zeta^{j} (K^{j}_{t})^{-\omega^{j}} + (1-\zeta^{j})(S^{mj}_{t})^{-\omega^{j}} \right\}^{-\frac{(1-\gamma^{j})}{\omega^{j}}} \qquad j = \{n, x\}$$

so they exhibit constant returns to scale. λ^{j} is a sectoral scale parameter. S^{mj}_{t} represents imported intermediate inputs in sector j and ζ^{j} is the relative weight on capital in the aggregation of capital and intermediate input services. The elasticity of substitution between intermediate inputs and capital is controlled by ω^{j}. γ^{j} is the labor income share in sector j output. Z^{j}_{t} is an exogenous technology shock affecting total factor productivity in sector j at time t.

Firms solve a static program

$$\max \qquad p^{j}_{t} Y^{j}_{t} - p^{j}_{t} w^{j}_{t} N^{j}_{t} - p^{j}_{t} r^{j}_{t} K^{j}_{t} - S^{mj}_{t} \qquad j = \{n, x\}$$

The optimization problem of the firms yields the usual condition that the marginal productivity of primary and intermediate inputs must be equal to their rental prices:

$$w^{j}_{t} = \gamma^{j} \lambda^{j} Z^{j}_{t} (N^{j}_{t})^{\gamma^{j}-1} \left\{ \zeta^{j} (K^{j}_{t})^{-\omega^{j}} + (1-\zeta^{j})(S^{mj}_{t})^{-\omega^{j}} \right\}^{-\frac{(1-\gamma^{j})}{\omega^{j}}} \qquad j = \{n, x\}$$

$$r_t^j = \zeta^j (1-\gamma^j)\lambda^j Z_t^j (N_t^j)^{\gamma^j} \left\{\zeta^j (K_t^j)^{-\omega^j} + (1-\zeta^j)(S_t^{mj})^{-\omega^j}\right\}^{-\frac{(1-\gamma^j)}{\omega^j}-1} (K_t^j)^{-\omega^j-1} \qquad j=\{n,x\}$$

$$\frac{1}{p_t^j} = (1-\zeta^j)(1-\gamma^j)\lambda^j Z_t^j (N_t^j)^{\gamma^j} \left\{\zeta^j (K_t^j)^{-\omega^j} + (1-\zeta^j)(S_t^{mj})^{-\omega^j}\right\}^{-\frac{(1-\gamma^j)}{\omega^j}-1} (S_t^{mj})^{-\omega^j-1} \qquad j=\{n,x\}$$

3.4 Government and Tax Structure

In per-capita terms, the government's budget constraint is

$$B_{t+1} = (1+r_t^b)B_t + p_t^n G_t^n - T_t + TR_t$$

where B_t is an economywide aggregate obtained by adding up over all government bond holders, $B_t = (1-\pi)B_{o,t}$. Government expenditures include public consumption of nontradable goods, G_t^n, lump-sum transfers to households and outlays associated with domestic government borrowing. The government only issues domestic bonds. The distinction between government bonds issued domestically and those issued abroad is inconsequential because households have unconstrained access to international borrowing. Households borrow on behalf of the government when they attempt to arbitrage away any difference between domestic and world interest rates. Government nontradable consumption is assumed to follow an exogenous stochastic process.

Taxes paid by the two types of households $(t_{o,t}, t_{r,t})$ and aggregate per-capita taxes collected by the government (T_t) are given by the following expressions:

$$t_{o,t} = \tau^c\left(p_t^n c_{o,t}^n + c_{o,t}^m - \varepsilon^c\left(p^n C^n + C^m\right)\right) + \tau_t^p\left(\sum_{j\in\{n,x\}} p_t^j w_t^j n_{o,t}^j - \varepsilon^p \sum_{j\in\{n,x\}} p_t^j w_t^j N_t^j\right) + \tau^k\left(\sum_{j\in\{n,x\}} p_t^j r_t^j k_{o,t}^j - \mu \sum_{j\in\{n,x\}} (p_t^n i_{o,t}^{nj} + i_{o,t}^{mj})\right)$$

$$t_{r,t} = \tau^c\left(p_t^n c_{r,t}^n + c_{r,t}^m - \varepsilon^c\left(p^n C^n + C^m\right)\right) + \tau_t^p\left(\sum_{j\in\{n,x\}} p_t^j w_t^j n_{r,t}^j - \varepsilon^p \sum_{j\in\{n,x\}} p_t^j w_t^j N_t^j\right)$$

$$T_t = \pi\, t_{r,t} + (1-\pi)\, t_{o,t}$$

$$T_t = \tau^c\left(p_t^n C_t^n + C_t^m - \varepsilon^c (p^n C^n + C^m)\right) + \tau_t^p (1-\varepsilon^p) \sum_{j\in\{n,x\}} p_t^j w_t^j N_t^j + \tau^k\left(\sum_{j\in\{n,x\}} p_t^j r_t^j K_t^j - \mu \sum_{j\in\{n,x\}} (p_t^n I_t^{nj} + I_t^{mj})\right)$$

where aggregate variables are computed as a weighted average of the corresponding magnitudes for each household type:

$$C_t^n = \pi C_{r,t}^n + (1-\pi) C_{o,t}^n \qquad C_t^m = \pi C_{r,t}^m + (1-\pi) C_{o,t}^m$$

$$N_t^j = \pi N_{r,t}^j + (1-\pi) N_{o,t}^j \qquad j \in \{n,x\} \qquad K_t^j = (1-\pi) K_{o,t}^j \qquad j \in \{n,x\}$$

$$I_t^{nj} = (1-\pi) I_{o,t}^{nj} \qquad j \in \{n,x\} \qquad I_t^{mj} = (1-\pi) I_{o,t}^{mj} \qquad j \in \{n,x\}$$

The tax structure is determined by the government and described by a 7-dimensional vector $\wp$ of parameters, $\wp = \left\{\tau^c, \tau^p, \tau^k, \varepsilon^c, \varepsilon^p, \mu, \eta\right\}$. τ^c is the consumption tax rate, τ^p is the personal tax rate and τ^k is the corporate tax rate. $\varepsilon^c \in [0,1]$ determines the fraction of consumption expenditures exempted from paying consumption taxes. The amount of exempted expenditures does not vary over the business cycle and it is taken as given by the representative household. This captures the fact that spending on basic necessities, which is the type of spending generally exempted from VAT, does not change over the business cycle for the average household. $\varepsilon^p \in [0,1]$ determines the personal exemption level which is modeled as a fraction ε^p of the average pre-tax labor income and taken as given by the representative household. The personal deduction changes with per-capita labor income. μ is the fraction of investment in physical capital that can be deducted from corporate income. In the steady state, $\mu = 1$ implies that the amount 'expensed' is equal to the usual depreciation allowance for physical capital.

The level and slope of the personal income tax schedule are controlled by τ^p and $\eta \geq 0$ respectively. The graduated-rate personal tax function is given by

$$\tau_t^p = \tau^p \left\{ \frac{\sum_{j\in\{n,x\}} p_t^j w_t^j n_{h,t}^j - \varepsilon^p \sum_{j\in\{n,x\}} p_t^j w_t^j N_t^j}{(1-\varepsilon^p)\sum_{j\in\{n,x\}} p_t^j w_t^j N_t^j} \right\}^{\eta} \qquad h \in \{r,o\}$$

When $\eta = 0$ the tax schedule is flat and the personal income tax system does not exhibit progressivity. For $\eta > 0$, households with above-average (below-average) wage incomes confront a higher (lower) tax rate. In equilibrium the average personal tax rate is τ^p, lower than or equal to the marginal tax rate given by $\tau^p(1+\eta)$.

3.5 Resource Constraints

Feasibility must be satisfied in equilibrium. The market clearing condition in the nontradable sector is dictated by

$$Y_t^n = C_t^n + \sum_{j\in\{n,x\}} I_t^{nj} + G_t^n$$

And changes in the net foreign asset position determine the current account:

$$D_{t+1} = (1+r_t^d) D_t + C_t^m + \sum_{j\in\{n,x\}} (I_t^{mj} + S_t^{mj}) - p_t^x X_t$$

The aggregate level of net foreign debt is obtained by aggregating debts in the hands of the Ricardian households: $D_t = (1-\pi)D_{o,t}$. Aggregate exports X_t are demand determined. Foreign demand for LAC export commodities is assumed to depend on world economic activity Y_t^* and the relative world price of exports, p_t^x:

$$X_t = X\,(p_t^x)^{\varpi^{p^*}}\,(Y_t^*)^{\varpi^{y^*}}$$

where X is the steady state level of exports, and ϖ^{p^*} and ϖ^{y^*} represent the price and income elasticity of the export demand function, respectively. Without loss of generality, p_t^x and Y_t^* are assumed to fluctuate around their unconditional means equal to unity.

4. STEADY STATE, CALIBRATION AND SOLUTION METHOD

4.1 Parameter Values and Steady State Structure

The model economy is parameterized in such a way that its long-run features mimic those of the representative or average LAC economy during the 1990-2000 period. In the steady state of the model economy, the expenditure side of the national income accounts matches the average LAC structure: household consumption represents 73.6% of GDP $(C_{va} = 0.736)$, total investment 17.6% $(I_{va} = 0.176)$, government purchases of goods and services 14.5% $(G_{va}^n = 0.145)$ and net exports of goods and services approximately -5.7% of GDP (see table 1). The model economy also matches the level and composition of imports. Total imports amount to 24.8% of GDP (see table 2) and are made up of imports of consumption goods (7% of GDP, $C_{va}^m = 0.07$), capital goods (6.1% of GDP, $I_{va}^{mn} + I_{va}^{mx} = 0.061$) and intermediate goods (11.7% of GDP, $S_{va}^{mn} + S_{va}^{mx} = 0.117$). According to the model, total output, on the production side, is obtained by adding the market value of goods and services produced in the nontradable and exportable sectors and excluding the value of (imported) goods and services used up in intermediate stages of production. It is assumed that the relative sectoral use of intermediate goods is equal to the relative sectoral contribution to value added. On the production side then, 82.9% of GDP is produced by the nontradable sector $(VA_{va}^n = 0.829)$ and the rest, 17.1%, by the exportable producing sector $(VA_{va}^x = 0.171)$.

The level and composition of government revenue are similar, under the benchmark parameterization of the model economy, to what is observed in Latin America (table 3). Total tax revenue in the model amounts to 15.7% of GDP, and is made up of consumption taxes (8.8% of GDP - very close to what is observed in the data - $CTR_{va} = 0.088$), corporate taxes (2.5% of GDP, or $KTR_{va} = 0.025$) and personal income taxes (4.4% of GDP, including social security contributions, $PTR_{va} = 0.044$). The steady state government debt-GDP ratio (B_{va}), the economy's external debt-GDP ratio (D_{va}) and the total stock of physical capital to GDP ratio (K_{va}) are set at 0.56, 0.60

and 2.78, respectively, which replicate their average counterparts in the LAC region during the 1990s (Table 4).

Due to lack of information about cross-sectoral resource allocation in the LAC region, total nontradable investment, importable investment and labor input are split between the two producing sectors in proportion to these sectors' steady state contributions to total value added. The fraction of time devoted to market activities is generally set to $1/3$ in real business cycle studies. Ellery et al. (2002), using the National Household Survey found that Brazilian households spent, on average, exactly $1/3$ of their nonsleeping hours working. The sectoral allocation of labor effort is based on sectoral contributions to total value added, as was just mentioned.

The steady state interest rate that the representative economy is charged on world capital markets is set at 9.5% which is the sum of two components: the exogenously given world interest rate (r^*), proxied by the U.S. interest rate (4% according to Prescott, 1986, and Backus et al., 1994), and a borrowing premium measured by the JP Morgan Latin American Eurobond Index (LEI) spread. The average LEI spread amounted to 550 basis points $(s = 0.055)$ over the 1994-2001 period. The parameter β can be set to 0.913 by exploiting the relationship between the subjective discount rate and the interest rate that arises from the steady state version of the household's first order conditions $(1 = \beta(1 + r^* + s))$. Note that the length of a model period is one year.

For a sample of developing countries, Ostry and Reinhart (1992) estimate the elasticity of substitution between nontradables and importables in consumption to be 1.279. This implies a value for υ equal to -0.22. From the equilibrium versions of the household's first order conditions for c_t^n and c_t^m, evaluated at the steady state, and setting relative prices at equal to unity in the steady state, an expression for α can be obtained:

$$\alpha = \frac{1}{1 + \left(\dfrac{C_{va}^m}{C_{va}^n}\right)^{1+\upsilon}}$$

where C_{va}^m and C_{va}^n are the average shares of imported and nontradable consumption expenditures in total value added respectively. All the information on the right-hand side is known, in particular, the structure of the model economy described above. Then set $\alpha = 0.853$. Lacking specific evidence on the elasticity of substitution between nontradable and importable goods in investment, I use Ostry and Reinhart's (1992) consumption elasticity estimate as an alternative. This implies $\nu^n = \nu^x = -0.22$.

Using the first order conditions for i_t^{nn}, i_t^{nx}, i_t^{mn} and i_t^{mx}, evaluated at the steady state, it is possible to express φ^n and φ^x in terms of known magnitudes:

$$\varphi^j = \frac{1}{1+\left(\frac{I_{va}^{mj}}{I_{va}^{nj}}\right)^{1+\nu^j}} \qquad j = \{n, x\}$$

Thus, set $\varphi^n = \varphi^x = 0.62$. The split of investment aggregates between the two producing sectors is based on sectoral contributions to total value added. Using the specification of the Armington investment function, the scaling parameter can be computed from this expression:

$$\chi^j = \frac{I_{va}^j}{\left[\varphi^j (I_{va}^{nj})^{-\nu^j} + (1-\varphi^j)(I_{va}^{mj})^{-\nu^j}\right]^{-\frac{1}{\nu^j}}} \qquad j = \{n, x\}$$

This implies $\chi^n = \chi^x = 1.926$. By exploiting standard properties of the production function, an expression for the labor share of output can be obtained:

$$\gamma^j = \frac{VA_{va}^j - r^j K_{va}^j}{VA_{va}^j + S_{va}^{mj}} \qquad j = \{n, x\}$$

The marginal product of capital in sector j, r^j, can be computed from the steady state version of the first order condition for k_{t+1}^j. This calculation, in turn, requires information on the depreciation rate. An average depreciation rate is obtained from the steady state version of the law of motion of the aggregate stock of physical capital: $\delta = I_{va}/K_{va} = 0.063$. Assume $\delta = \delta^n = \delta^x$. K_{va}^j is obtained from the corresponding sectoral law of motion of physical capital: $K_{va}^j = I_{va}^j/\delta^j$. Hence set $\gamma^n = \gamma^x = 0.50$.

Using the first order condition for S_t^{mj}, $j = \{n, x\}$, of the firm's optimization problem, the following expression for the weight parameter of capital in the CES-type aggregator of capital and imported, intermediate input services, ζ^j, can be found:

$$\zeta^j = \frac{1}{1+\left(\frac{1}{r^j}\right)\left(\frac{S_{va}^{mj}}{K_{va}^j}\right)^{1+\omega^j}} \qquad j = \{n, x\}$$

The unknown parameter ω^j is calibrated using Berndt and Wood's (1975) estimate of the Allen elasticity of substitution between intermediate inputs and capital goods $(\sigma_{ks} = 0.58)$. Then, ω^j is given by (see Sato, 1967):

$$\omega^j = \frac{1-(\gamma^j + \sigma_{ks} - \gamma^j \sigma_{ks})}{\gamma^j + \sigma_{ks} - \gamma^j \sigma_{ks}} \qquad j \in \{n, x\}$$

$\omega^n = \omega^x$ is set at 0.265. As a result, set $\zeta^n = \zeta^x = 0.90$.

The preference parameter ξ governing the intertemporal elasticity of substitution in labor supply is set equal to 1.60, consistent with an elasticity of 1.7 adopted by Greenwood et al. (1988) as a reasonable compromise. The parameter κ was calibrated from the conditions with respect to n_t^n and n_t^x:

$$\kappa = \frac{\alpha(1-(1+\eta)\tau^p)\gamma^n(N^n + N^x)^{1-\xi}(VA_{va}^n + S_{va}^{mn})(C_{va}^n)^{-\upsilon-1}[\alpha(C_{va}^n)^{-\upsilon} + (1-\alpha)(C_{va}^m)^{-\upsilon}]^{-1}}{(1+\tau^c)N^n}$$

Note that this expression includes various tax code parameters. The benchmark tax structure is calibrated as follows. Implicit effective tax rates are calculated using these accounting and model definitions:

$$\tau^c = \frac{CTR_{va}}{(1-\varepsilon^c)C_{va}}$$

$$\tau^k = \frac{KTR_{va}}{r^n K_{va}^n + r^x K_{va}^x - \mu I_{va}}$$

$$\tau^p = \frac{PTR_{va}}{(1-\varepsilon^p)(N^n + N^x)w_{va}^n}$$

Due to the lack of detailed and reliable data about important features of the tax codes in the region, it is necessary to assign somewhat arbitrary, though plausible, values to various policy parameters. However, the objective of the study in the next section is to try to remedy this faulty calibration procedure by assessing, on the basis of a thorough sensitivity analysis, how the business cycle properties of the economy change along with changes in the different parameters of the tax code. The slope of the personal income tax schedule for the representative LAC economy, η, is set equal to 0.[9] The tax code parameters ε^p and ε^c, which represent the fractions of personal income and consumption that are tax deductible or exempted from taxation are set at $\varepsilon^p = 0.50$ and $\varepsilon^c = 0.20$, respectively. μ, the fraction of physical investment that can be deducted from taxable business income, is set equal to 1. Once these parameter values are set, the remaining fiscal parameters can be calibrated. Set $\tau^c = 0.15$, $\tau^k = 0.095$ and $\tau^p = 0.157$. After putting this information together, set κ as equal to 3.24. The computation of the real wage to output ratio in the preceding expression defining τ^p is based on the definition of the labor income share in output.

The scaling parameter λ^j is calibrated by using the specified production technology and

[9] For comparison, Cassou and Lansing (2003) econometrically estimate the parameters for the U.S. income tax schedule. Their results yield a slope parameter of $\eta = 0.214$.

an assumption about the size of the economy. Thus, total value added is normalized at 100. This merely amounts to a choice of units and does not affect the cyclical properties of the model. Set $\lambda^n = \lambda^x = 14.86$. Export demand elasticities are taken from Senhadji and Montenegro (1999) who report estimates for individual developing countries. Table 5 summarizes their estimates for LAC countries. The average long-run price and income elasticities are -1.25 and 1.06, respectively.

The proportion of restricted households (π) is taken from López et al. (2000). These authors provide panel data estimates for the proportion of non-Ricardian consumers in developing countries in the range of 60%-64%. Set $\pi = 0.60$. To compute the steady state allocations of the two types of households, labor effort and consumption are treated symmetrically: $N^j = N_o^j = N_r^j$, $j \in \{n, x\}$, $C^n = C_o^n = C_r^n$ and $C^m = C_o^m = C_r^m$. Table 6 summarizes the results of the calibration exercise.

It remains to calibrate the stochastic structure of the economy. Shocks are jointly covariance-stationary stochastic processes. The vector of exogenous shocks, represented by $Z_t = \left[Y_t^*, p_t^x, s_t, Z_t^n, Z_t^x, G_t^n\right]^T$, has the following time series representation:

$$\log Z_{t+1} = (I - \Xi)\log Z + \Xi \log Z_t + \varsigma_{t+1} \qquad \text{with} \qquad E_t \varsigma_{t+1} = 0, \qquad E_t \varsigma\varsigma^T = \Omega$$

The elements of ς_t are normally distributed and uncorrelated with ς_{t-q}, $q > 0$, and the eigenvalues of Ξ all lie inside the unit circle. Z is the vector of unconditional means given by $Z = [1, 1, 0.055, 1, 1, 14.5]^T$. The autocorrelation matrix Ξ and the variance-covariance matrix of innovations Ω are computed individually for nine LAC countries (Argentina, Brazil, Chile, Colombia, Costa Rica, Ecuador, Honduras, Mexico and Peru) and then averaged to get a representative estimates for the region. The entries in the autocorrelation matrix and in the main diagonal of matrix Ω are obtained from fitting univariate AR(1) processes. The remaining parameters - the off-diagonal elements of Ω - are computed by using the residual terms of these regressions. The exceptions are the covariances associated with the LEI spread s_t for which there is not sufficiently long, annual time series information. Y_t^* is measured by the U.S. per capita GDP and taken from the World Bank World Development Indicators (WDI) database; s_t is the average LAC LEI spread taken from the JP Morgan bond database; individual country data for the terms of trade (p_t^x) and government spending (G_t^n) as well as the data required to compute sectoral Solow residuals (Z_t^n, Z_t^x) are retrieved from the WDI database. Solow residuals are estimated as in Kose (2002). The set of yearly data generally spans the period from 1972 to 2000. The results of this parameterization strategy are summarized by the following matrices:

$$\Xi = \begin{bmatrix} 0.96 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0.67 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0.76 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0.86 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0.93 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0.91 \end{bmatrix}$$

$$\Omega = \begin{bmatrix} 0.0259^2 & & & & & \\ 0.0170^2 & 0.1005^2 & & & & \\ 0 & 0 & 0.2253^2 & & & \\ 0.0084^2 & -(0.0388)^2 & 0 & 0.0688^2 & & \\ 0.0144^2 & 0.0335^2 & 0 & -(0.0220)^2 & 0.0636^2 & \\ -(0.0130)^2 & 0.0326^2 & 0 & 0.0406^2 & 0.0106^2 & 0.1850^2 \end{bmatrix}$$

4.2 Solution Method

There is no analytical solution to the described optimization problem. To obtain an approximate solution, the system of first order conditions is log-linearized around its deterministic steady state and the resulting multivariate, linear, rational expectations equation system is solved numerically with the Quadratic Determinantal Equation method developed by Binder and Pesaran (1995, 1997).

5. SIMULATION RESULTS

5.1 Cyclical Properties

Before using an experimental simulation of the model economy to assess the stabilizing role of different parameters of the tax code, I first address the question of whether the model is able to mimic the observed cyclical behavior of the economies in the LAC area. The purpose of this section is to compare the cyclical behavior of the simulated economies with that of the representative LAC economy. Table 7 presents the statistics summarizing the cyclical properties of three economies: the representative LAC economy which has a cyclical behavior that is simply the average of the observed behavior across LAC economies and two artificial economies: the benchmark economy where Ricardian and myopic consumers coexist and a Barro-Ramsey type economy inhabited by fully optimizing households. The artificial model economies are subject to all six sources of business cycle fluctuations.

As usual in this literature, the business cycle properties are described by a set of unconditional second moments: 1) the relative amplitude of fluctuations in aggregate variables (relative standard deviation of each aggregate to the standard deviation of GDP); 2) the contemporaneous correlations of aggregate variables with output and 3) the persistence of macroeconomic aggregates, measured by the first order autocorrelation. To compute statistics, all variables, except GDP ratios, are expressed in per capita terms and logged and then, all are filtered using the Hodrick-Prescott filter with the smoothing parameter set at 100, the value commonly used for annual data. Statistics for the simulated economies are the means of statistics computed for each of 200 replications. Each simulation is 228 periods long and the first 200 observations are dropped so that the results do not depend on initial conditions. Second moments are computed using the remaining 28 observations - equal to the average sample size of 28 yearly periods of the database used to compute Latin America's business cycle facts.

In general, the benchmark model economy matches the core of business cycle frequency properties for the typical LAC economy. The ability of the benchmark model economy to mimic key qualitative aspects related to persistence and comovements in actual cyclical behavior is remarkable. The model correctly predicts that disposable income, consumption and investment are strongly procyclical while the trade balance to output ratio as well as the government debt to output ratio behave countercyclically. Even from a quantitative point of view, the model is quite successful in replicating some of these cyclical correlations. The model also accounts for the strong persistence observed in most macroeconomic aggregates.

The model matches the relative volatility of disposable income but does not quite succeed in reproducing the volatility of consumption and tax revenue.[10] However, the inability to mimic these features cannot be considered a major failure of the model. The volatility of consumption is overestimated in the data because it includes durable goods consumption which tends to behave more like investment and, therefore, to exhibit much higher volatility. Tax revenue volatility is understated because the model does not allow for tax disturbances. WoldeMariam and Stotsky (2002) report significant changes in the region's tax systems over the last two decades. As a result, the inclusion of stochastic tax changes may not only increase the predicted volatility of tax revenue but also that of consumption. This avenue is not pursued here because the primary objective of the paper is to evaluate the automatic stabilization role of a given tax structure.

Interestingly, the model economy inhabited exclusively by Ricardian households yields very similar unconditional second moments. There is only one important difference to underscore. When the fraction of low-wealth households is 0.60 $(\pi = 0.60)$, the (benchmark) model economy counterfactually predicts that tax revenues are countercyclical. Instead, the Ricardian economy $(\pi = 0)$ displays a significantly larger procyclicality of tax proceeds, roughly in line with observed behavior in the region. As shown below, the volatility levels predicted by the two economies are quite different and conditioned by both the tax structure and the source of fluctuations.

As in the data, the model correctly predicts a high positive correlation between government spending and output. This prediction remains unchanged when using the first difference filter instead of the Hodrick-Prescott filter to detrend simulated government

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[10] The capital adjustment cost parameter ψ^{kx} is calibrated so as to match the volatility of investment generated by the model to that of aggregate investment in the data.

spending and output. The match of this feature is very interesting not only because some authors have claimed that the "procyclicality of fiscal policy is a puzzle in search of explanation" (Talvi and Végh, 2000) but also because this type of evidence has been reported as proof of the destabilizing conduct of fiscal policy. For instance, based on a positive correlation between the growth rate of real government spending and output, Gavin et al. (1996) concluded that the volatility of the LAC economies had been augmented by highly procyclical fiscal responses. Agénor et al. (1999), Stein et al. (1999) and Talvi and Végh (2000) reported a positive correlation between Hodrick-Prescott filtered components of government spending and output in order to draw conclusions on how fiscal policy behaves over the business cycle. The striking result generated by the model economy is that the presence of such a feature says nothing about how polices are conducted over the business cycle. In the model economy, government spending follows an exogenous Markov process, which, by definition, does not take into account the endogenous state of the economy. The model proves that attributing intentionality to fiscal policy (i.e., policymakers increase government consumption during expansions and decrease it during recessions) on the basis of the above mentioned correlation is incorrect. This sheds doubt on how well-grounded the generally accepted claim that fiscal policy is procyclical in the developing world is.

Lane (2003) proposes a regression-based measure of cyclicality of fiscal policy for OECD countries. To that end, he estimated an OLS regression of the growth rate of government spending against the growth rate of output (and a constant). I used Monte Carlo experiments to assess the power of this approach. A total of 1200 sets of time series were created by simulations, following the general procedure described before. Using unfiltered data, Lane's regression was estimated as many times and a significance test was repeatedly applied to examine whether the approach rejects the hypothesis of no response of government spending to cyclical conditions, as should be the case in our model. The average estimated regression coefficient was 0.87 (0.62) and in 48% (37%) of the 1200 trials, it turned out to be significantly different from zero using a t-test with a nominal size of 5 percent for the economy populated by both Ricardian and non-Ricardian (Ricardian) households. This exercise suggests - based on the difference between the nominal and empirical sizes of the t-test - that Lane's approach fails to make the correct inference more often than expected. Additional Monte Carlo experiments indicated that regression-based measures of cyclicality are correct when current output growth is instrumented to control possible endogeneity bias. This methodology has not been employed until recently (see Galí and Perotti, 2003, for industrial countries; Fatás and Mihov, 2004, for a sample of industrial and developing countries).

5.2 Automatic Stabilizers in the LAC Area

Automatic Revenue Stabilizers

The issue of the degree of stabilization provided by the tax structure is addressed by comparing the volatility of aggregate output in an economy with a given tax structure to that of an economy with lump-sum taxation (i.e., with $\wp = 0$). In each simulated economy (including the reference economy with non-distortionary taxation), the level of tax collection is the same (15.7% of GDP, as in the benchmark parameterization). This implies that economies under alternative tax structures combine distortionary taxation with lump-sum taxation (or transfers) to ensure a constant level of tax proceeds. The unconditional mean of government spending is also held constant. Notice that the ensuing discussion focuses exclusively on stabilization issues while disregarding efficiency and distribution implications, to use Musgrave's (1959) famous division of the state into its three functional branches.

Figures 7 and 8 depict relative output volatilities when a given parameter of the tax code is changed, while keeping the other tax parameters constant at their baseline calibration values and when the business cycle is driven by alternative forcing processes. In the economy depicted by Figure 7, households are fully optimizing while the economy of Figure 8 is inhabited by both Ricardian and non-Ricardian households. In the Barro-Ramsey economy, income taxes are strongly destabilizing in the sense that tax rate increases rapidly translate into higher output volatilities across most sources of business fluctuations. However, when the business cycle is driven by technology shocks to the nontradable sector and to a lesser extent by technology shocks to the exportable sector, the positive relationship lessens considerably - to the point where the destabilizing effect practically disappears. In other words, tax rates are more destabilizing when the business cycle is driven primarily by fluctuations such as terms of trade shocks, lending spread shocks, world business cycle shocks and government spending shocks and much less so when driven by technology shocks. The same applies to the parameter determining the slope of the personal tax schedule, e.g., the degree of progressivity of the personal income tax is more destabilizing when the business cycle is driven primarily by terms of trade shocks, lending spread shocks, world business cycle shocks and government spending shocks and much less so when driven by technology shocks.

Other features of the tax code to consider are the personal exemption level and the level exemption in the consumption tax base. Both features are unrelated to the business cycle, e.g., they neither smooth nor destabilize the business cycle. Regarding the deduction of new investment expenses, simulation results show that relative output volatilities are a decreasing function of the fraction of investment in physical capital that can be deducted from corporate income. This is the only feature of the tax code that, in an economy inhabited by fully optimizing households and hit by multiple shocks, operates like an automatic stabilizer.

The introduction of non-optimizing households (Figure 8) flattens the relative volatility schedules quite dramatically (note the difference in the scale of the y-axes in Figures 7 and 8). Under most alternative sources of business fluctuations, relative volatilities do not respond or respond only slightly to changes in tax code parameters. There is one salient exception to this. The consumption tax, the personal income tax rate and the degree of progressivity of the income tax tend to increase the volatility of the economy when the business cycle is driven mainly by terms of trade shocks. Otherwise, results seem to suggest an invariance property: the amplitude of the business cycle is independent of the tax structure. The obvious consequence is that business cycle swings are not dampened by the automatic revenue stabilizers. A cursory look at the LAC data reveals that a case can be made for this. Figure 9 relates the two measures of the size of the automatic revenue stabilizers (see section 2: the sensitivity of the budget balance to the cycle, SBB, and Pechman's indicator, PI) to two measures of GDP volatility (standard deviation of the Hodrick-Prescott filtered log-GDP and the volatility of the growth rate of GDP). The figure seems to support the view that automatic revenue stabilizers in the LAC region do not smooth nor exacerbate business cycle fluctuations.

Figures 10 and 11 depict the ratio of consumption volatility to GDP volatility for each household group respectively. The spenders or non-Ricardian households exhibit much lower consumption volatility than savers, but nonetheless, relative volatilities in both groups are unrelated to the features of the tax code.

The Stabilizing Role of Government Size

Figure 12 plots relative output volatilities when the unconditional mean ratio of government spending to GDP is changed in the benchmark economy, while the tax parameters remain constant at their baseline calibration values and when the business cycle is driven by alternative forcing processes. Government size indeed plays the role of an automatic stabilizer that works across most sources of business fluctuations except if the source of fluctuations is government spending innovations. However, its smoothing effect is very weak.

Greater effects are observed when the business cycle is mainly a result of lending spread and world business cycle innovations. In these cases, the doubling of the government sector share in the economy from 15% to 30% of GDP will reduce relative output volatilities by 25% and 18% respectively. For the remaining shocks, other than government spending shocks, the reduction in volatility is lower than 9%.

An increase in the size of government has the annoying effect of making the economy more vulnerable to the government shock process. The government size variable is destabilizing when the business cycle is mainly due to government spending shocks. Simulations with multiple shocks ("all shocks" curve in figure 12) indicate that relative output volatilities slowly decrease until the size of government reaches about 12% of GDP. Thereafter, the destabilizing effect of government shocks starts to dominate other stabilizing forces and relative volatilities slowly increase with government size.

At first glance the overall results seem to be at odds with Figure 1 which shows that, in the LAC region, there is a positive relationship between government size and output volatility. Figure 13 shows that, in a broader sample of developing countries, the relationship between government size and volatility is weak, as the model predicts. The model's predictions provide a rough and reasonable portrait of what is observed in middle-income countries.

6. CONCLUDING REMARKS

Earlier work on LAC fiscal policy is complemented and extended in this paper in several key respects. Previous work has singled out the issue of procyclicality of discretionary policy as its main focus. Here, the existing characterization has been enriched by focusing on the non-discretionary component of fiscal policy. To do so, the size of the automatic revenue stabilizers in Latin America has been measured following standard methodologies and the analysis has found that they are small relative to developed economies and not very responsive to cyclical conditions.

Despite the small size of the stabilizers, policymakers as well as analysts attribute - in a mechanistic fashion - a certain capacity to offset fluctuations to automatic stabilizers of a given size. In this paper, the smoothing role of the automatic revenue stabilizers has been assessed within a dynamic, stochastic, small open economy model with multiple shocks, capturing the fact that the region's business cycle is far from being driven by purely demand shocks. This paper has shown that standard measures of the size of the automatic stabilizers do not provide useful information about the potential stabilizing role of the tax system. It was also shown that, in a typical LAC economy, in contrast to Keynesian predictions, the degree of smoothing provided by the automatic revenue stabilizers, described by various properties of the tax system, is negligible. All in all, the simulation results seem to suggest an invariance property for middle-income countries: the amplitude of the business cycle is independent of the tax structure.

The model economy also lent itself to evaluating the stabilizing effect of government size as measured by the GDP ratio of primary government spending. Simulation results suggest that government size indeed plays the role of an automatic stabilizer that works across most sources of business fluctuations, but the overall smoothing effect is very weak. In addition, as the size of government increases, government spending shocks become a very strong destabilizing force which ends up offsetting its smoothing effect.

The usual policy claim that the adoption of a given structural fiscal rule lets the automatic fiscal stabilizers work is vacuous in practice. Fiscal rules of the type embedded in the Maastricht Treaty and SGP, for instance, when adopted by an average LAC economy, will not allow the public sector non-discretionary finances to play a countercyclical role in the economy. The design of fiscal rules or the design of an institutional framework for the region's fiscal policy that can provide the required discipline while preserving enough flexibility is still an open question. This is likely to be an important direction for future research.

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Figure 1
The Stabilizing Role of Government Size

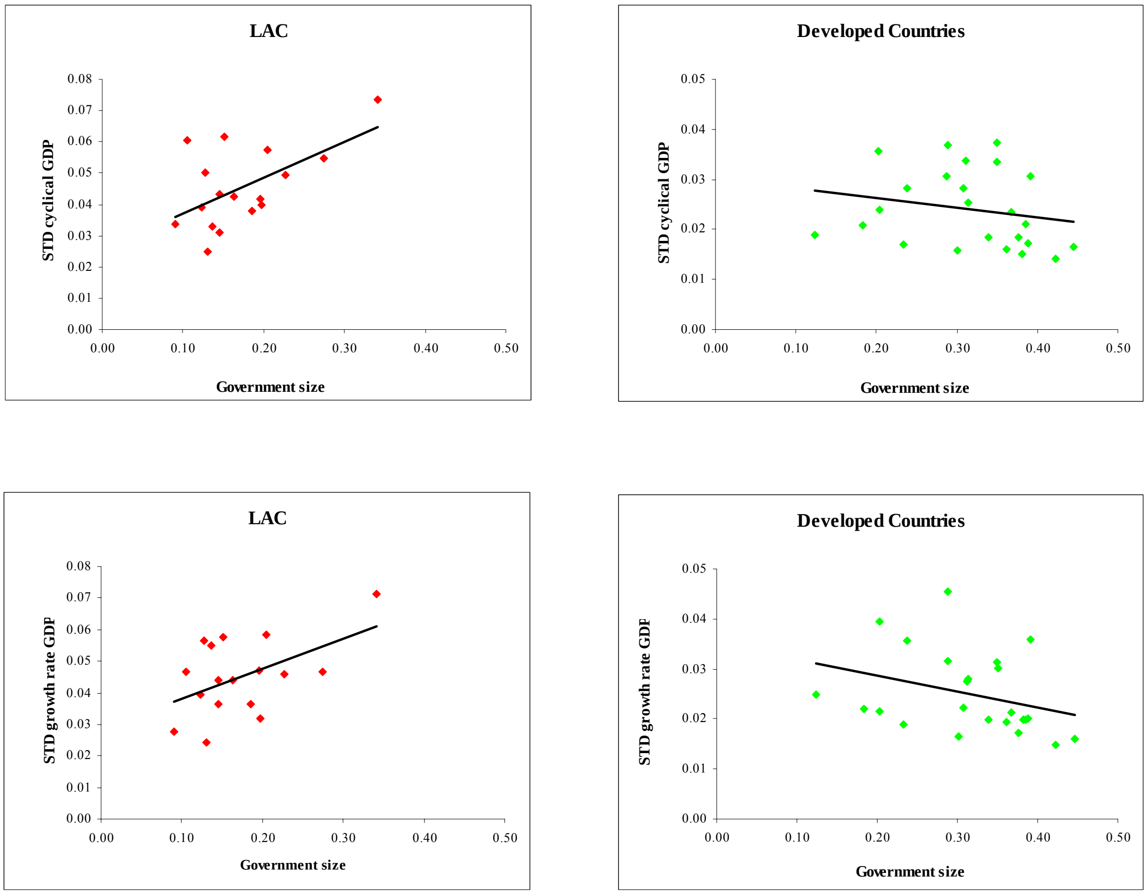
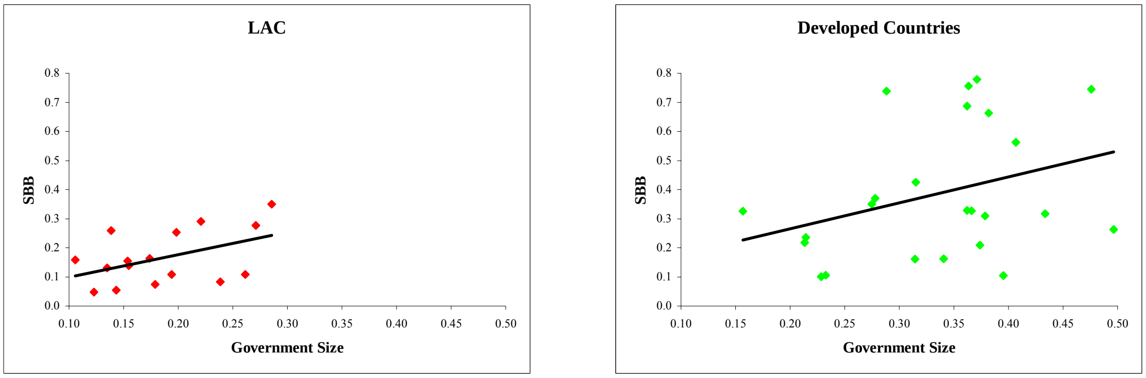


Figure 2
Cyclical Sensitivity of the Fiscal Position

A. Cyclical Sensitivity of the Budget (SBB)



B. Pechman's Indicator of a Tax System's Built-in Flexibility (PI)

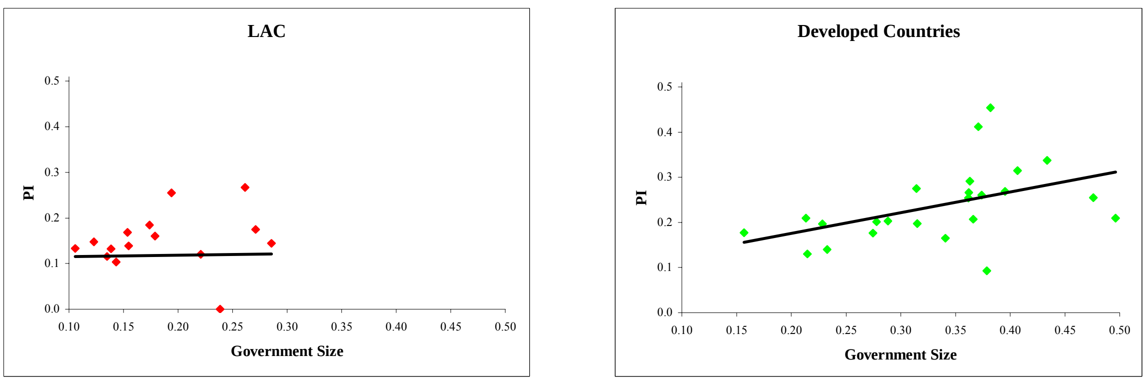
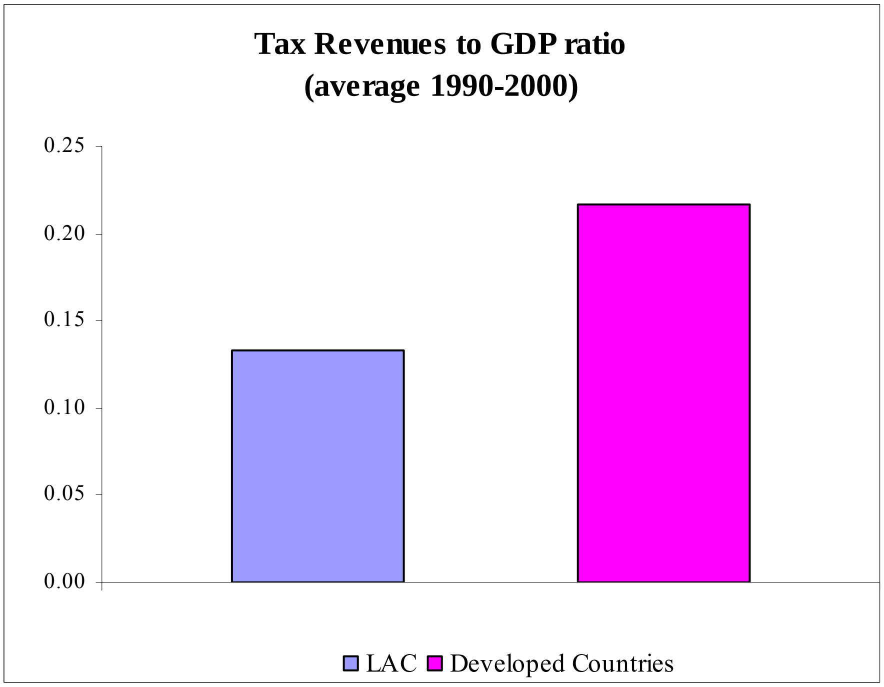


Figure 3
Government Size in LAC and Developed Countries



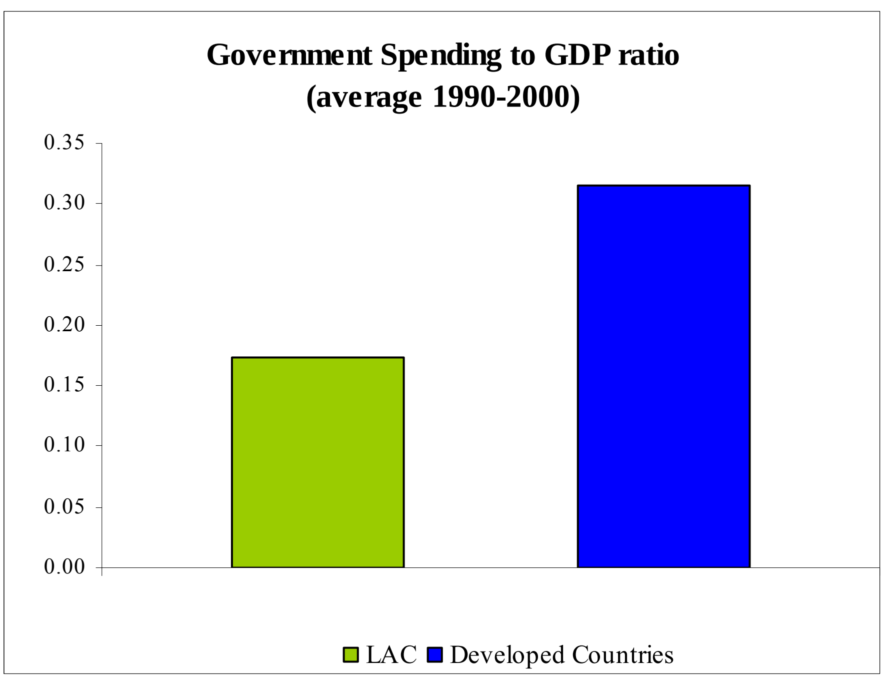


Figure 4
Tax Structure in LAC and Developed Countries

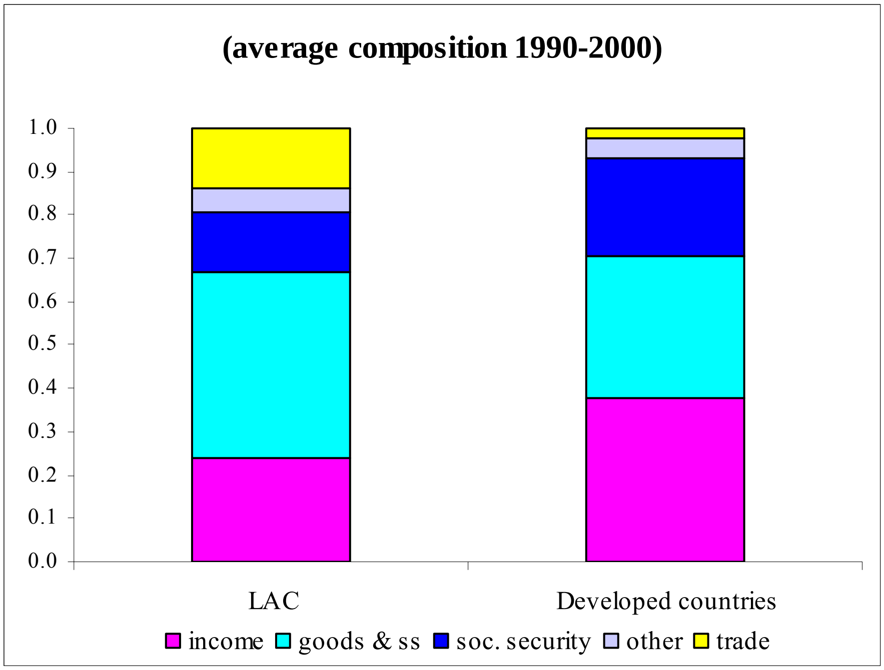
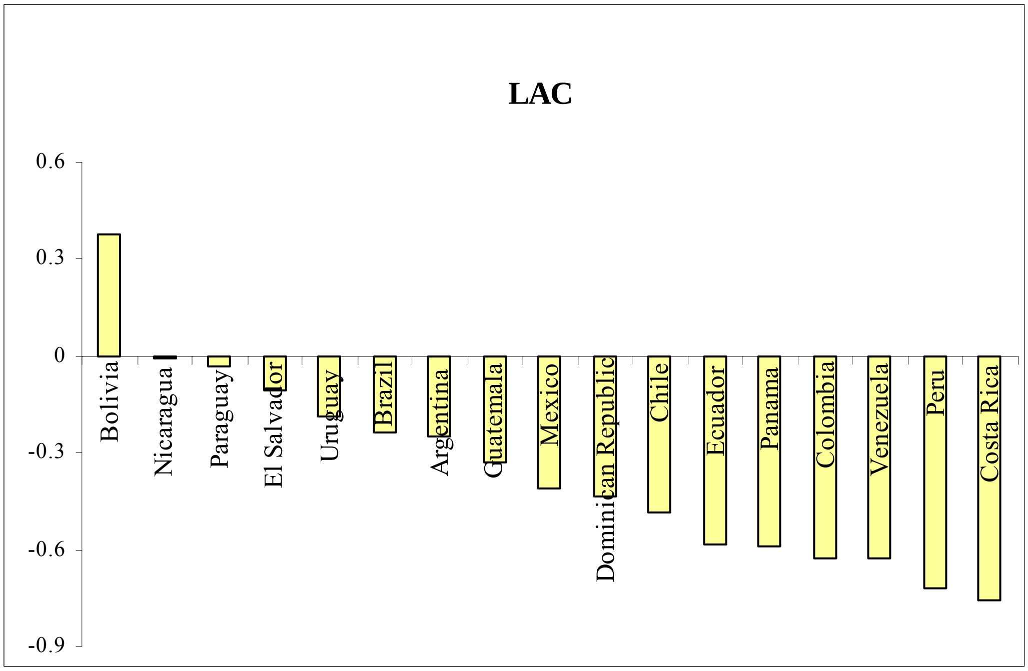


Figure 5
Correlation between Discretionary Primary Surplus and Automatic Stabilizers



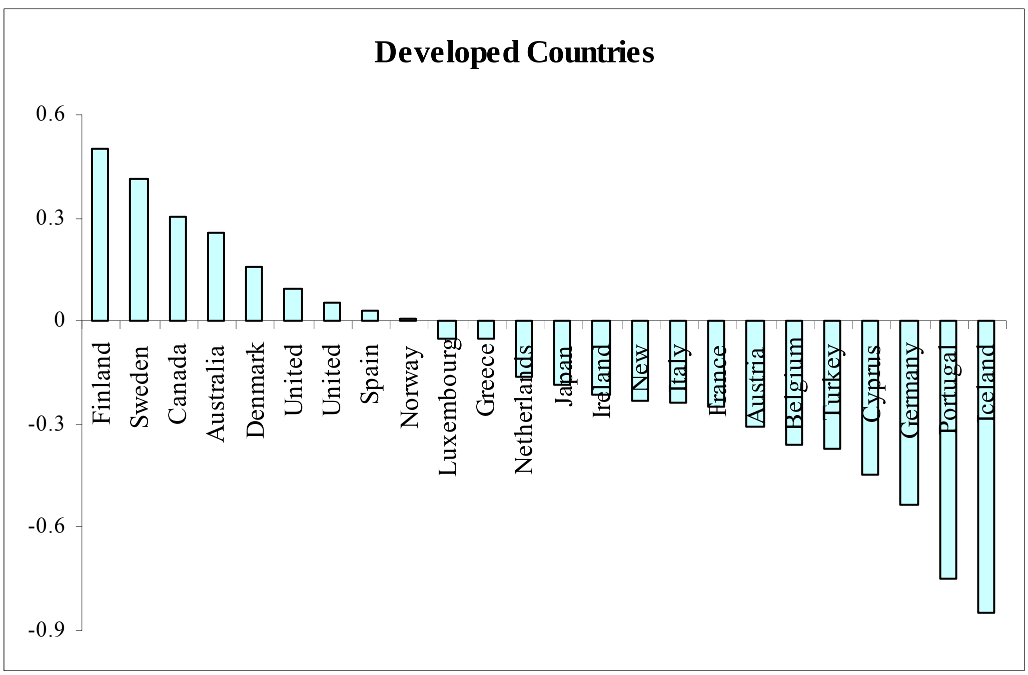
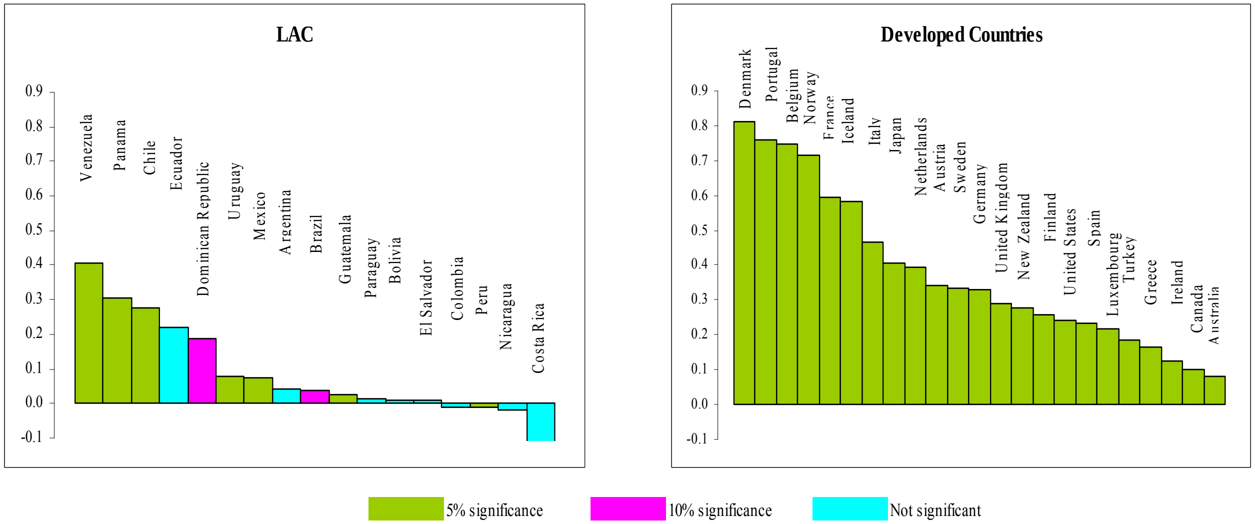


Figure 6
Automatic Stabilizers Response to Cyclical Conditions



Note: Figures depict the coefficient β associated with the output gap variable in the following (country-by-country) regression:

$$AS_t = \alpha + \beta CY_t + \gamma_P P_t + \gamma_D D_{t-1} + \gamma_L AS_{t-1} + \zeta_t$$

where AS = automatic stabilizers; CY = cyclical GDP; P = terms of trade; D = government debt to potential GDP ratio.

Figure 7
Simulation Results: Relative Output Volatilities with Only Ricardian Households

$\left(\sigma_{y\ (\text{distortionary})} / \sigma_{y\ (\text{lump-sum taxation})}\right)$

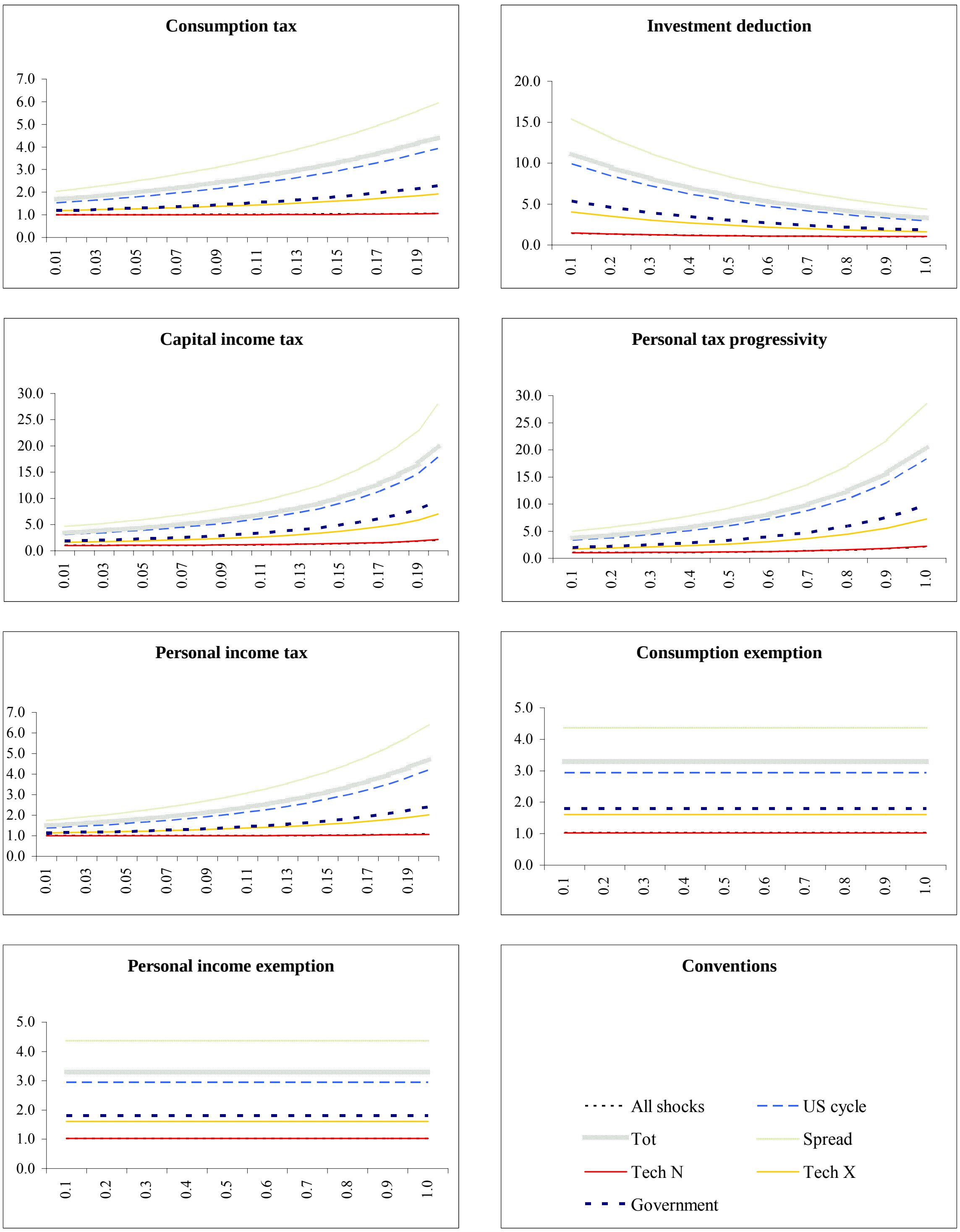


Figure 8
Simulation Results: Tax Structure and Relative Output Volatilities

$\left(\sigma_{y\ (\text{distortionary})} / \sigma_{y\ (\text{lump-sum taxation})}\right)$

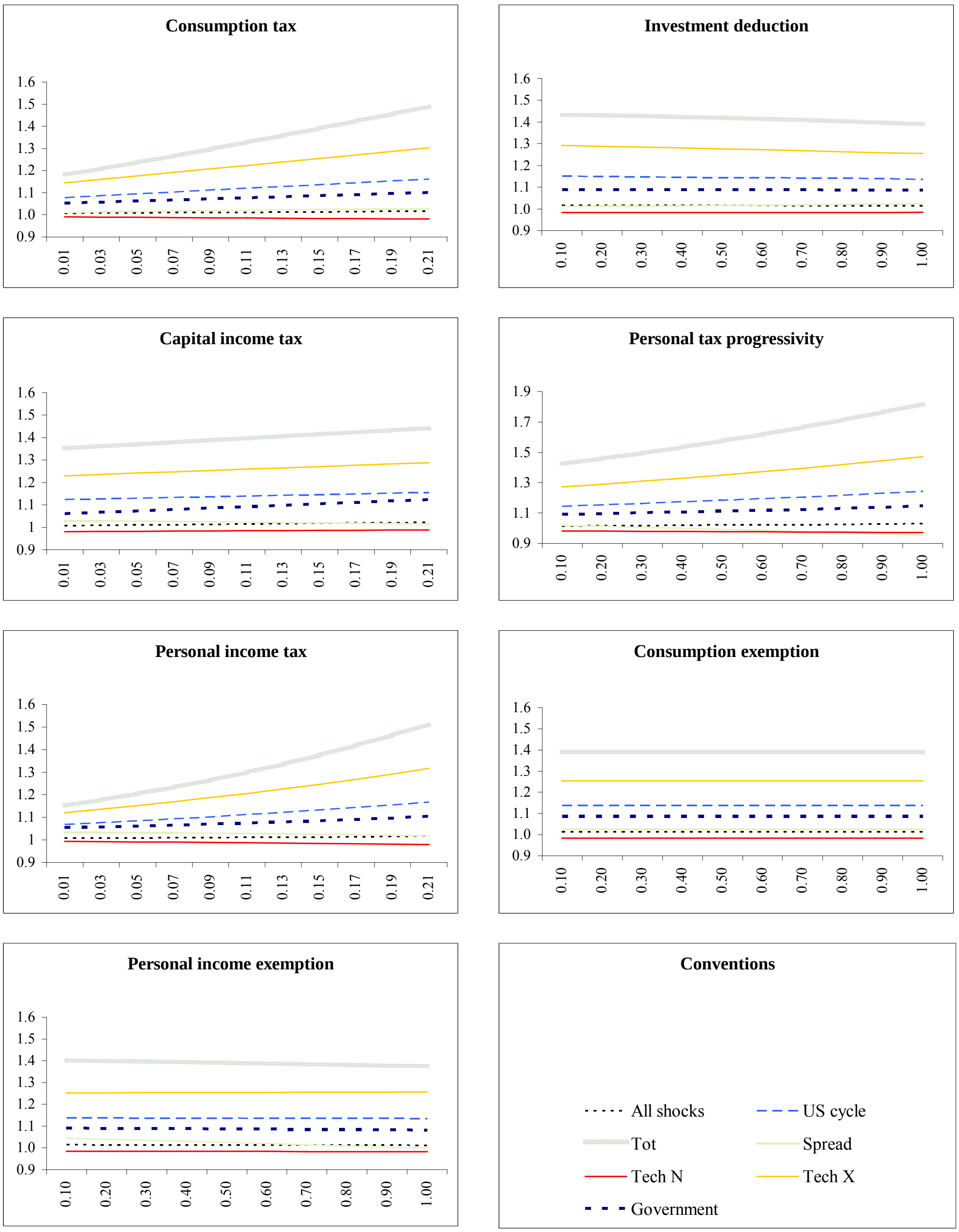
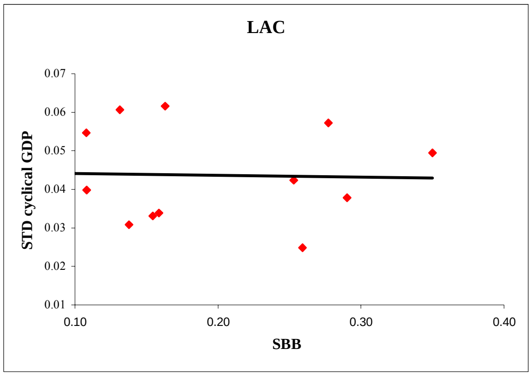
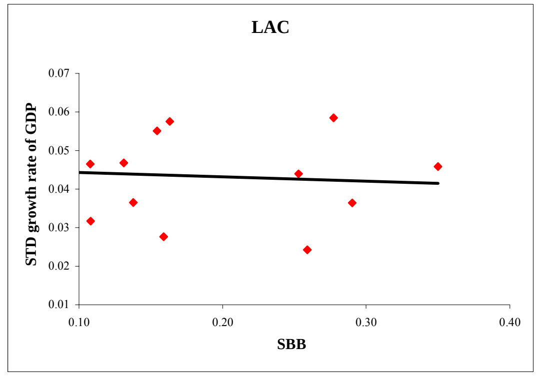


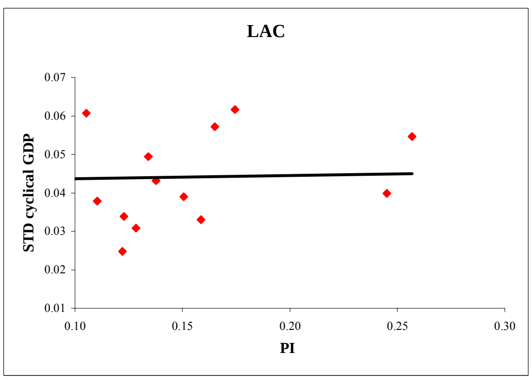
Figure 9
Automatic Revenue Stabilizers and Business Cycle Volatility

A. Cyclical Sensitivity of the Budget (SBB)





B. Pechman's Indicator of a Tax System's Built-in Flexibility (PI)



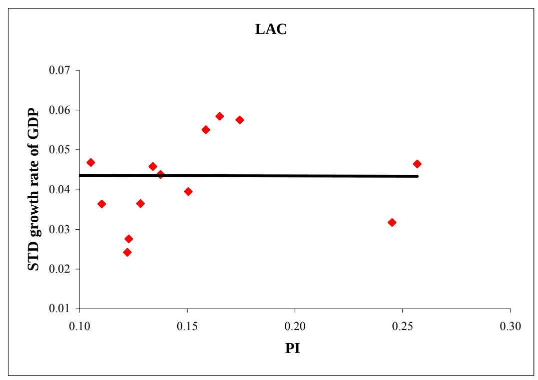


Figure 10
Simulation Results: Relative Consumption Volatilities of Non-Ricardian Households
(σ_c / σ_y)

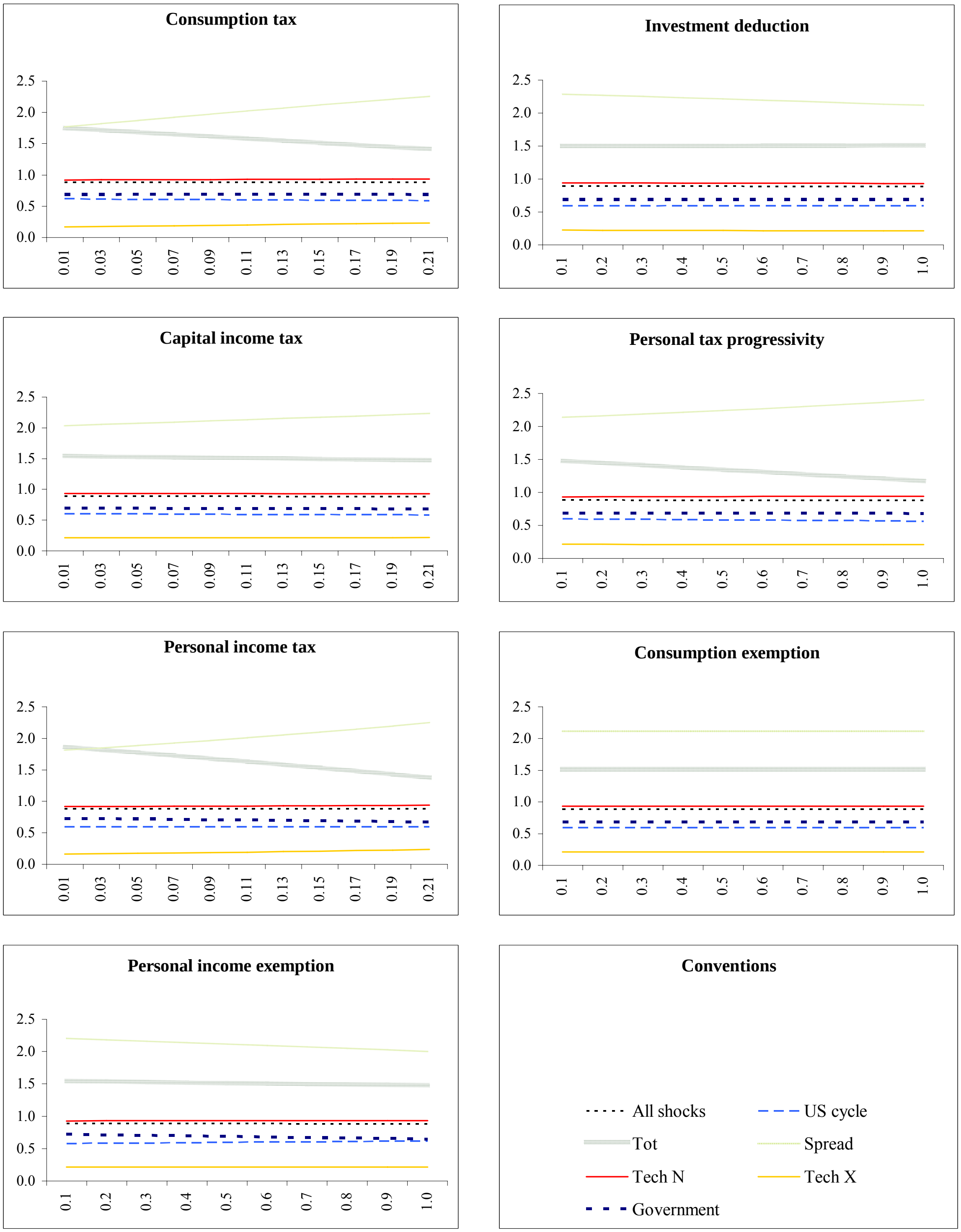


Figure 11
Simulation Results: Relative Consumption Volatilities of Optimizing Households
(σ_c/σ_y)

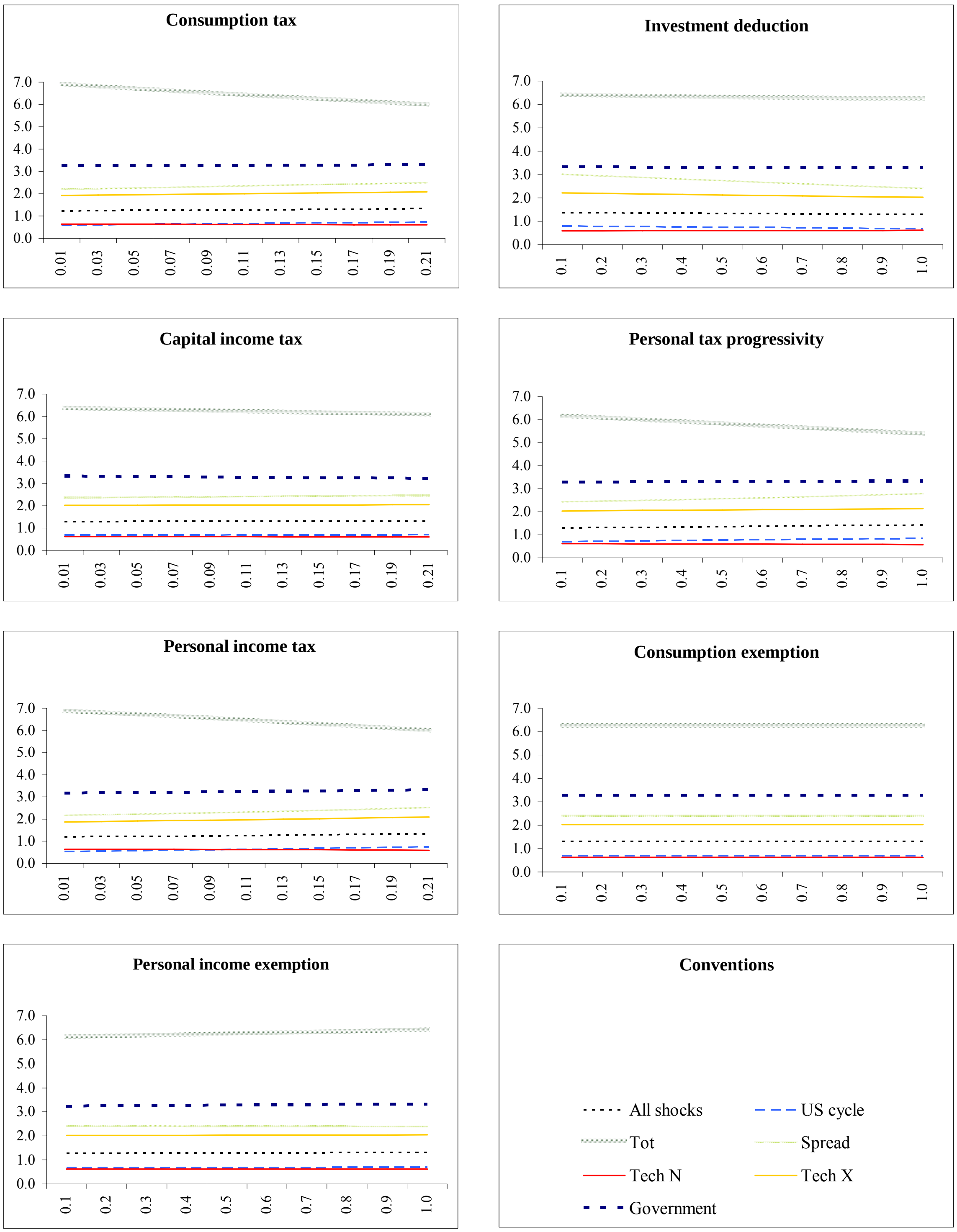


Figure 12
Simulation Results: Government Spending and Relative Output Volatilities
$\left(\sigma_{y\text{ (distortionary)}} / \sigma_{y\text{ (lump-sum taxation)}}\right)$

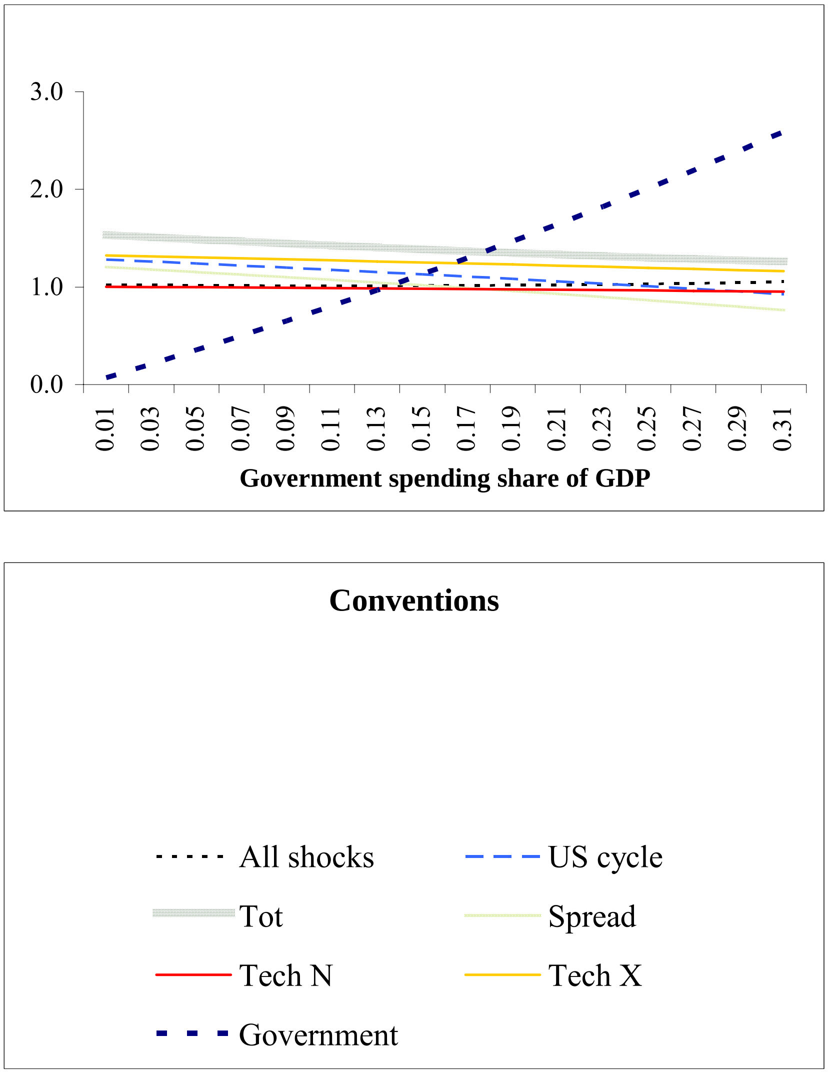
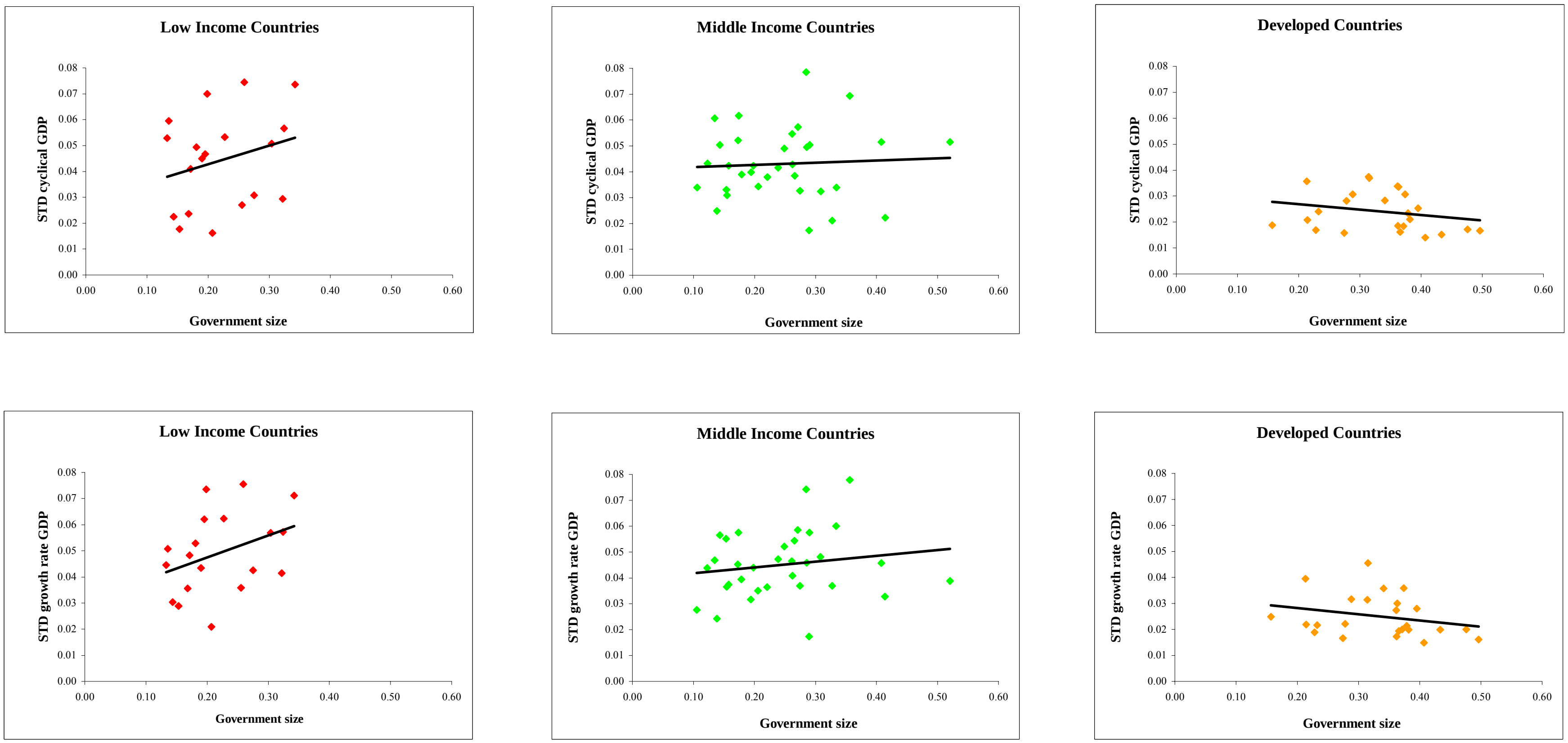


Figure 13
The Stabilizing Role of Government Size in a Broader Sample



LOW INCOME COUNTRIES: Burkina Faso, Burundi, Cameroon, Congo Democratic Republic, Ethiopia, Ghana, India, Indonesia, Kenya, Malawi, Mozambique, Myanmar, Nepal, Nicaragua, Pakistan, Papua New Guinea, Sierra Leone, Zambia, Zimbabwe
MIDDLE INCOME COUNTRIES: Argentina, Bolivia, Botswana, Brazil, Chile, Colombia, Costa Rica, Dominican Republic, Ecuador, Egypt, El Salvador, Fiji, Guatemala, Hungary, Iran, Jordan, Malaysia, Malta, Mauritius, Mexico, Morocco, Panama, Paraguay, Peru, Philippines, Singapore, South Africa, SriLanka, Swaziland, Thailand, Tunisia, Uruguay, Venezuela
DEVELOPED COUNTRIES: Australia, Austria, Belgium, Canada, Cyprus, Denmark, Finland, Germany, Greece, Iceland, Ireland, Italy, Japan, Luxembourg, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Turkey, United Kingdom, United States

Table 1
LAC: GDP Composition
(average 1990-2000 shares of GDP)

	Private Consumption	Government Expenditures	Private Investment	Trade Balance
Argentina	0.727	0.113	0.167	-0.007
Bolivia	0.768	0.174	0.131	-0.073
Brazil	0.611	0.193	0.201	-0.005
Chile	0.646	0.134	0.217	0.003
Colombia	0.663	0.191	0.160	-0.013
Costa Rica	0.698	0.159	0.171	-0.029
Dominican Republic	0.790	0.116	0.168	-0.073
Ecuador	0.674	0.138	0.178	0.010
El Salvador	0.874	0.125	0.139	-0.138
Guatemala	0.851			-0.067
Haiti	0.888	0.089	0.161	-0.138
Honduras	0.665			-0.081
Mexico	0.685	0.123	0.210	-0.017
Nicaragua	0.875	0.278	0.192	-0.346
Panama	0.625	0.161	0.231	-0.016
Paraguay	0.822	0.105	0.207	-0.133
Peru	0.731	0.121	0.181	-0.032
Uruguay	0.722	0.140	0.133	0.004
Venezuela	0.676	0.109	0.148	0.067
mean	0.736	0.145	0.176	-0.057
median	0.722	0.104	0.203	-0.029
min	0.611	0.059	0.150	-0.346
max	0.888	0.200	0.305	0.067

Source: World Development Indicators (World Bank)

Table 2
LAC: Import Composition
(average 1990-2000 shares of GDP)

	Consumption Goods	Capital Goods	Intermediate Goods	Total
Argentina	0.014	0.036	0.031	0.081
Bolivia	0.042	0.076	0.090	0.208
Brazil	0.012	0.021	0.037	0.069
Chile	0.043	0.059	0.141	0.242
Colombia	0.025	0.050	0.068	0.142
Costa Rica	0.080	0.067	0.229	0.376
Dominican Republic	0.101	0.055	0.134	0.290
Ecuador	0.041	0.065	0.097	0.203
El Salvador	0.081	0.068	0.122	0.272
Guatemala	0.062	0.061	0.107	0.230
Haiti	0.112	0.025	0.063	0.200
Honduras	0.120	0.105	0.201	0.425
Mexico	0.025	0.034	0.178	0.237
Nicaragua	0.162	0.152	0.264	0.578
Panama	0.052	0.064	0.186	0.302
Paraguay	0.238	0.084	0.086	0.408
Peru	0.034	0.038	0.060	0.132
Uruguay	0.048	0.052	0.061	0.161
Venezuela	0.032	0.054	0.069	0.154
mean	0.070	0.061	0.117	0.248
median	0.048	0.059	0.097	0.230
min	0.012	0.021	0.031	0.069
max	0.238	0.152	0.264	0.578

Source: LDB and World Development Indicators (World Bank)

Table 3
LAC: Tax Revenue Composition
(average 1990-2000 shares of GDP)

	Consumption Taxes	Social Security Contributions	Taxes on Income	Taxes on Corporate Income	Taxes on Personal Income	Other Taxes	Total
Argentina	0.057	0.045	0.014			0.006	0.121
Bolivia	0.080	0.016	0.010			0.016	0.122
Brazil	0.072	0.061	0.042			0.040	0.215
Chile	0.124	0.015	0.040			0.009	0.187
Colombia	0.062		0.046			0.002	0.109
Costa Rica	0.097	0.058	0.022			0.002	0.179
Dominican Republic	0.108	0.006	0.026			0.002	0.142
Ecuador	0.065		0.089			0.003	0.157
El Salvador	0.074		0.028			0.003	0.104
Guatemala	0.061		0.019			0.003	0.084
Haiti							
Honduras							
Mexico	0.089	0.019	0.048			0.003	0.159
Nicaragua	0.179	0.034	0.034			0.007	0.255
Panama	0.070	0.049	0.048			0.010	0.177
Paraguay	0.070	0.007	0.018			0.012	0.107
Peru	0.096	0.015	0.026			0.011	0.147
Uruguay	0.111	0.081	0.028			0.032	0.253
Venezuela	0.055	0.007	0.083			0.004	0.149
mean	0.086	0.032	0.037	0.025	0.012	0.010	0.157
median	0.074	0.019	0.028			0.006	0.149
min	0.055	0.006	0.010			0.002	0.084
max	0.179	0.081	0.089			0.040	0.255

Source: Government Finance Statistics database (IMF) and World Development Indicators

Consumption taxes = Taxes on goods and services + Taxes on international trade

Taxes on corporate income = Taxes on income*0.68. Where the fraction 0.68 is the average share of corporate income in income taxes in a sample of 7 LAC economies

Taxes on personal income = Taxes on income*0.32

Table 4
LAC: Total Government Debt, External Debt and Physical Capital Stock
(share of GDP)

	Public Debt General Government	Long-Term External Debt	Capital Stock
Argentina	0.380	0.319	2.54
Bolivia	0.595	0.696	3.17
Brazil	0.466	0.252	3.11
Chile	0.395	0.387	2.49
Colombia	0.361	0.295	2.38
Costa Rica	0.345	0.333	2.44
Dominican Republic	0.275	0.335	2.95
Ecuador	0.773	0.727	3.14
El Salvador	0.301	0.273	2.24
Guatemala	0.160	0.218	2.10
Haiti	0.000	0.303	
Honduras	0.957	1.046	2.34
Mexico	0.380	0.304	3.06
Nicaragua	3.130	3.934	2.41
Panama	0.731	0.544	2.86
Paraguay	0.216	0.246	3.08
Peru	0.525	0.474	3.50
Uruguay	0.283	0.253	2.62
Venezuela	0.328	0.463	3.62
mean	0.558	0.600	2.781
median	0.380	0.333	2.741
min	0.000	0.218	2.103
max	3.130	3.934	3.621

Source: for public debt: Moody's
for external debt: World Development Indicators
for capital stock: Loayza, et al. (2002)
Public debt figures correspond to averages over the 1995-2000 period
Chile and Mexico data correspond to the 1999-2000 period average
External debt figures correspond to averages over the 1990-2000 period

Table 5
LAC: Export Demand Elasticities

	Price Elasticity	Income Elasticity
Argentina	-0.24	1.28
Bolivia		
Brazil		
Chile	-1.39	1.29
Colombia	-1.73	1.39
Costa Rica		
Dominican Republic	-0.85	1.29
Ecuador	-2.51	0.16
El Salvador		
Guatemala	-0.92	0.29
Haiti	-0.44	1.44
Honduras		
Mexico		
Nicaragua		
Panama	-1.07	0.47
Paraguay	-2.80	2.96
Peru	-0.02	0.54
Uruguay	-1.77	0.59
Venezuela		
mean	-1.25	1.06
median	-1.07	1.28
min	-2.80	0.16
max	-0.02	2.96

Source: Senhadji and Montenegro (1999)

Table 6
Calibrated Parameter Values

Parameter	Description	Value
r^*	foreign interest rate	0.04
β	subjective discount factor	0.9132
υ	parameter determining elasticity of substitution between consumption goods	-0.22
α	share parameter in CES consumption aggregator	0.8529
$\nu^n = \nu^x$	parameter determining elasticity of substitution between investment goods	-0.22
$\phi^n = \phi^x$	share parameter in CES investment function	0.6212
$\chi^n = \chi^x$	scale parameter in Armington-type CES investment function	1.9260
$\delta^n = \delta^x$	rate of depreciation of the stock of physical capital	0.0633
$\gamma^n = \gamma^x$	labor share parameter in the production function	0.5013
$\omega^n = \omega^x$	parameter determining elasticity of substitution between capital and intermediate inputs	0.2650
$\zeta^n = \zeta^x$	relative weight of capital in CES aggregator of capital-intermedite input services	0.8970
ξ	parameter determining intertemporal elasticity of substitution in labor supply	1.60
κ	weighting parameter for the disutility of working time	3.2350
$\lambda^n = \lambda^x$	production function scaling parameter	14.8627
ϖ^{p^*}	export demand function price elasticity	-1.25
ϖ^{y^*}	export demand function income elasticity	1.06
π	fraction of constrained households	0.60

Benchmark Tax Code Parameters

Parameter	Description	Value
τ^c	consumption tax rate	0.1495
τ^k	corporate income tax rate	0.0947
τ^p	personal income average tax rate	0.1572
μ	fraction of physical investment deducted from business taxable income	1.0
η	parameter determining the slope of the personal income tax schedule	0.0
ε^c	fraction of consumption exempted from the consumption tax	0.2
ε^p	fraction of personal income exempted from the income taxation	0.5

Table 7
Cyclical Properties of the Representative LAC and Model Economies

Variable (x)	LAC Averages			Model (Benchmark parameterization)*			Economy of Ricardian Households*		
	Relative Volatility σ_x/σ_y	Output Correlation $corr(x,y)$	First Order Autocorrelation $corr(x_t, x_{t-1})$	Relative Volatility σ_x/σ_y	Output Correlation $corr(x,y)$	First Order Autocorrelation $corr(x_t, x_{t-1})$	Relative Volatility σ_x/σ_y	Output Correlation $corr(x,y)$	First Order Autocorrelation $corr(x_t, x_{t-1})$
Output (y = GDP)	1.00	1.00	0.63	1.00	1.00	0.38	1.00	1.00	0.41
Disposable income	1.04	0.95	0.61	1.08	1.00	0.37	1.09	1.00	0.40
Consumption	1.26	0.76	0.51	0.92	0.55	0.44	0.91	0.43	0.49
Investment	4.16	0.76	0.46	4.16	0.71	0.30	4.16	0.67	0.26
Trade balance-output ratio	0.71	-0.52	0.35	0.24	-0.21	0.30	0.36	-0.20	0.28
Primary government spending	2.83	0.50	0.38	2.83	0.32	0.37	2.83	0.32	0.37
Tax revenue	2.71	0.49	0.41	0.69	-0.49	0.32	0.74	0.71	0.53
Government debt-output ratio	1.23	-0.75	0.73	1.23	-0.47	0.38	1.00	-0.54	0.36

Source: LAC averages are taken from tables 8, 9 and 10.

* The model's second moments are means of statistics computed for each of 200 simulations. Each simulation is 228 periods long and to compute statistics the first 200 observations are discarded. 28 periods is the average number of observations in the sample of LAC countries. Before computing second moments, each simulated time series (except for GDP ratios) is logged and then HP filtered following the same procedure applied to compute LAC statistics.

Table 8
LAC: Standard Deviations (Volatilities) Relative to Output

	Disposable Income	Consumption	Investment	Trade Balance to GDP	Government Spending	Tax Revenue	Government Debt to GDP
Argentina	0.94	1.10	2.73	0.32	3.41	3.99	0.82
Bolivia	0.94	1.01	4.62	0.66	outlier	outlier	3.07
Brazil	1.00	1.28	3.10	0.24	4.00	2.88	1.64
Chile	1.06	1.84	3.85	0.96	1.67	1.43	1.62
Colombia	1.11	1.08	5.64	1.00	3.06	2.95	1.24
Costa Rica	1.12	1.43	4.17	0.93	3.12	1.98	0.97
Dominican Republic	0.98	1.45	3.93	0.74	3.65	3.47	0.71
Ecuador	1.28	1.00	3.94	0.79	3.44	3.06	1.53
El Salvador	0.91	1.44	3.25	0.65	2.24	2.34	0.64
Guatemala	0.96	0.87	4.62	0.43	3.31	4.02	0.44
Mexico	0.98	1.17	3.58	0.71	3.19	1.62	1.17
Nicaragua	1.06	1.44	outlier	0.86	3.31	2.34	2.21
Panama	0.86	1.50	6.91	0.70	1.61	2.65	1.22
Paraguay	0.95	1.44	3.28	0.98	2.61	2.49	0.83
Peru	1.00	0.97	3.32	0.34	1.46	1.97	0.55
Uruguay	0.93	1.24	3.79	0.56	2.12	2.19	0.73
Venezuela	1.53	1.16	5.78	1.15	3.01	4.02	1.50
Average	1.04	1.26	4.16	0.71	2.83	2.71	1.23
Median	0.98	1.24	3.93	0.71	3.12	2.65	1.17
Max	1.53	1.84	19.07	1.15	7.29	7.90	3.07
Min	0.86	0.87	2.73	0.24	1.46	1.43	0.44

Disposable income = GDP-taxes revenue; consumption = household final consumption; investment =gross capital formation; trade balance = exports of goods and services - imports of goods and services. All variables except net exports and government debt are in per capita terms and in logaritms; all variables filtered with the Hodrick_Prescott filter. Volatility is the percentage deviation from the Hodrick-Prescott trend. Tax data are from the IMF Government Finance Statistics database. Government debt figures are constructed as indicated in the text. The remaining data are taken from the World Development Indicators database.

Table 9
LAC: Output Correlations

	Disposable Income	Consumption	Investment	Trade Balance to GDP	Government Spending	Tax Revenue	Government Debt to GDP
Argentina	0.97	0.93	0.91	-0.88	0.68	0.59	-0.94
Bolivia	0.90	0.74	0.43	0.02	0.15	0.40	-0.48
Brazil	0.91	0.30	0.83	-0.64	0.38	0.51	-0.55
Chile	0.97	0.93	0.72	-0.90	0.51	0.60	-0.91
Colombia	0.96	0.84	0.68	-0.49	-0.01	0.18	-0.79
Costa Rica	0.97	0.83	0.87	-0.64	0.63	0.23	-0.87
Dominican Republic	0.91	0.53	0.69	-0.26	0.61	0.53	-0.67
Ecuador	0.91	0.86	0.68	-0.44	0.51	0.01	-0.92
El Salvador	0.98	0.89	0.84	-0.65	0.36	0.78	-0.59
Guatemala	0.95	0.98	0.67	-0.24	0.66	0.52	-0.88
Mexico	0.98	0.95	0.85	-0.66	0.62	0.76	-0.46
Nicaragua	0.88	0.27	0.59	-0.17	0.34	0.47	-0.48
Panama	0.98	0.51	0.83	-0.60	0.63	0.85	-0.88
Paraguay	0.98	0.64	0.92	-0.52	0.52	0.69	-0.94
Peru	0.97	0.95	0.70	-0.51	0.80	0.56	-0.71
Uruguay	0.95	0.92	0.91	-0.79	0.54	0.73	-0.86
Venezuela	outlier	0.82	0.82	-0.55	0.56	-0.03	-0.81
Average	0.95	0.76	0.76	-0.52	0.50	0.49	-0.75
Median	0.96	0.84	0.77	-0.53	0.53	0.53	-0.80
Max	0.98	0.98	0.92	0.02	0.80	0.85	-0.46
Min	0.82	0.27	0.43	-0.90	-0.01	-0.03	-0.94

Disposable income = GDP-taxes revenue; consumption = household final consumption; investment = gross capital formation; trade balance = exports of goods and services - imports of goods and services. All variables except net exports and government debt are in per capita terms and in logaritms; all variables filtered with the Hodrick-Prescott filter. Output correlation is the contemporaneous correlation with GDP. Tax data are from the IMF Government Finance Statistics database. Government debt figures are constructed as indicated in the text. The remaining data are taken from the World Development Indicators database.

Table 10
LAC: Persistence of Macroeconomic Aggregates

	GDP	Disposable Income	Consumption	Investment	Trade Balance to GDP	Government Spending	Tax Revenue	Government Debt to GDP
Argentina	0.43	0.32	0.46	0.50	0.48	0.48	0.43	0.60
Bolivia	0.84	0.79	0.74	0.26	0.47	0.40	0.42	0.76
Brazil	0.64	0.52	0.49	0.56	0.37	0.28	0.43	0.72
Chile	0.58	0.52	0.47	0.26	0.50	0.60	0.56	0.61
Colombia	0.67	0.61	0.53	0.61	0.71	0.34	0.48	0.82
Costa Rica	0.64	0.71	0.53	0.56	0.50	0.39	0.19	0.73
Dominican Republic	0.47	0.52	-0.02	0.40	-0.05	0.46	0.30	0.66
Ecuador	0.48	0.50	0.63	0.18	0.08	0.26	0.04	0.67
El Salvador	0.80	0.77	0.74	0.60	0.51	0.56	0.65	0.83
Guatemala	0.83	0.80	0.82	0.47	0.29	0.54	0.64	0.80
Mexico	0.64	0.59	0.62	0.44	0.54	0.46	0.48	0.83
Nicaragua	0.54	0.56	0.30	outlier	-0.08	0.29	0.49	0.79
Panama	0.61	0.61	0.16	0.38	0.12	0.08	0.39	0.61
Paraguay	0.73	0.70	0.27	0.67	0.20	0.60	0.55	0.81
Peru	0.62	0.57	0.67	0.51	0.51	0.47	0.33	0.80
Uruguay	0.68	0.66	0.58	0.77	0.56	0.20	0.41	0.66
Venezuela	0.54	outlier	0.66	0.26	0.16	0.09	0.14	0.66
Average	0.63	0.61	0.51	0.46	0.35	0.38	0.41	0.73
Median	0.64	0.60	0.55	0.45	0.42	0.40	0.42	0.75
Max	0.84	0.80	0.82	0.77	0.71	0.60	0.65	0.83
Min	0.43	0.50	-0.02	-0.05	-0.08	0.08	0.04	0.61

Disposable income = GDP-taxes revenue; consumption = household final consumption; investment = gross capital formation; trade balance = exports of goods and services - imports of goods and services. All variables except net exports and government debt are expressed in per capita terms and in logaritms; all variables filtered with the Hodrick-Prescott filter. Persistence is defined as first order autocorrelation.

Tax data are from the IMF Government Finance Statistics database. Government debt figures are constructed as indicated in the text. The remaining data are taken from the World Development Indicators database.