

ON THE SUSTAINABILITY AND SYNCHRONIZATION OF FISCAL POLICY IN LATIN AMERICA*

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This paper explores the sustainability of fiscal policy for a panel of Latin American countries over the period 1990–2012. We extend the literature on the causal relationship between government expenditure (GX) and revenue (GR) in the short run and long run. Our results show a significant long-run relationship between GX and GR, suggesting that fiscal policies are consistent with their intertemporal budget constraints. We establish bidirectional causality between revenue and expenditure in the long run, indicating a contribution from both GX and GR in establishing steady state equilibrium following substantial deviations. Our data also uphold the fiscal synchronization thesis.

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1. INTRODUCTION

The sustainability of fiscal policy and its implications has received considerable attention in the academic literature and policymaking circles for many years. It is a highly relevant subject because of the role sustainability plays in ensuring financial and macroeconomic stability. Also, a number of financial crisis episodes since the Great Depression of the 1930s have been preceded by rising public debt and fiscal imbalances, notably the debt crisis in Latin America in the early 1980s leading to the so-called “lost decade,” and the more recent Eurozone debt crises.

Due to the fundamental relevance of sustainable government spending and restraint to budget deficit financing, the sustainability of fiscal positions has featured in the convergence criteria of a number of monetary and economic pacts. The Maastricht Treaty of 1992 explicitly pegged member governments’ public debt and deficit obligation at 60% and 3% of their

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GDP, respectively. The convergence criteria for the establishment of the West African Monetary Zone (WAMZ) also capped the budget deficit at 3% of GDP (see Alagidede *et al.*, 2008 and 2012).

Subsequent to the soaring debt levels of Latin American countries that led to the debt crisis in the 1980s, most governments adopted policies characterized by fiscal rules to guide economic policy. A common feature of the latter part of the 1990s through the early 2000s was the introduction of measures to enhance transparency through a combination of balanced budget targets and/or numerical spending caps. Several authors contend that Latin American countries have generally performed much better in terms of fiscal discipline due to improved fiscal institutional frameworks (Filc and Scartascini, 2007; Eslava, 2012).

In spite of the existence of a plethora of empirical studies on fiscal sustainability in advanced countries and other regions, our knowledge of the subject is far from perfect. Also, given the nature of the debt crisis that hit Latin America in the 1980s and increasing concern about the negative consequences of rising government debt and fiscal deficits, it is imperative that we revisit the question of debt and fiscal sustainability/solvency. The aim of this paper is thus to empirically assess and present lessons on fiscal policy sustainability for a panel of Latin American countries by applying recent advances in the unit root and cointegration literature.

The paper fills a gap by extending the literature on the short-run as well as the long-run causal relationship between government expenditure (GX) and revenue (GR). Using advanced estimation techniques, the relationship is further explored to establish whether countries in Latin America are characterized by either the tax-spend, spend-tax or fiscal synchronization hypothesis, which has critical implications for fiscal sustainability in the region. We employ the Westerlund (2007) panel cointegration tests that impose no common factor restriction, account for possible cross-country dependence, and solve the problems associated with Pedroni's (1999) residual-based tests. Furthermore, a more flexible pooled mean-group (PMG) estimator proposed by Pesaran *et al.* (1999) is specified. This enables us to explore both short-run dynamics and long-run equilibrium relationships among the variables of interest, accounting for non-stationarity in the data and heterogeneity across countries in their short-run dynamic relationships. We compare these with the results obtained using restrictive dynamic fixed effects (DFE) methods, and the more flexible but information-intensive mean-group (MG) approach.

Quite understandably, the causal behavior or relationship between GX and GR may provide practical insights into the dynamics and processes involved in fiscal policy adjustments and how policymakers should approach budget deficits in the future. More importantly, the period under review (1990-2012) captures exactly two decades following the debt crisis. This enables us to assess the effectiveness of the fiscal rules implemented after the crisis and infer how they have shaped the sustainability of the long-run fiscal stance in the region. We report that although GX and GR are non-stationary, they share a common trend. The results show that there is significant causality between the variables in the short run as well as a long-run fiscal synchronization, suggesting that both GX and GR help push the budget towards equilibrium should there be deviations from the long-run relationship.

The remaining sections of this paper are set out as follows: Section 2 reviews the theoretical and empirical literature, while Section 3 presents a description of the data and methodology. In Section 4 the different unit root tests along with the battery of cointegration techniques are explained. The results of the statistical analysis, coupled with the short-run and long-run dynamics of the relationships, are explored. Concluding remarks and policy recommendations are contained in Section 5.

2. REVIEW OF EMPIRICAL LITERATURE

2.1. Sustainability of fiscal policy

The ability of a government to sustain its current spending, taxation, and other policies in the long run without threatening default on some of its liabilities or promised expenditures has long occupied economists' attention. A conventional approach applied to establish fiscal policy sustainability has been built around the government's intertemporal budget constraint (IBC) mechanism. If the IBC holds in present value terms, the fiscal policy is considered sustainable. For this to hold, current debt levels must be expected to be compensated by the present value of surpluses garnered from the expected future primary budget. There is a vast literature on this subject but most of the empirical research has focused on the experiences of the United States and other advanced countries (Cuddington, 1997; Chalk and Hemming, 2000), although the conclusion is still not clear (Hakkio and Rush, 1991).

One strand of the literature involves the present value budget constraint (PVBC) approach. The methodology involves testing of the PVBC

or the non-Ponzi game (NPG) condition for data on government revenue, expenditure, or fiscal balance. This condition is one of the key assumptions considered within the IBC of the government. Also known as the transversality condition, NPG necessitates that the public debt not grow at a rate greater than the interest rate. If this condition is fulfilled, then the IBC will result in equality between the market value of public debt and the sum of discounted future budget surpluses. If this condition is valid, the theory predicts that the government's fiscal policy will be sustainable. According to Hamilton and Flavin (1986), who pioneered the approach for analyzing the concept of fiscal sustainability, if the present value borrowing constraint is not satisfied, fiscal policy is said to be unsustainable in the long run. Thus, there is sustainability if the PVBC is fulfilled without a significant and sudden shift in the balance of revenue and expenditure to avoid potential liquidity and solvency problems. Most of these studies employ time-series unit root and cointegration analysis to explore whether the present value of IBC is effectively respected. The customary practice in the literature is to examine whether past fiscal balance follows a stationary process or if there is cointegration between government expenditures and revenues (see Hakkio and Rush, 1991 and Trehan and Walsh, 1991).

A number of papers have concentrated on examining the stationarity of fiscal balance (Holmes *et al.*, 2010; Wilcox, 1989; and Hamilton and Flavin, 1986). A stationarity result implies that the sustainability hypothesis holds, whereas a non-stationarity result implies the opposite. Disappointingly, evidence obtained by applying the stationarity approach to fiscal balance has not been found to support the sustainability hypothesis (for example, Vanhorebeek and Rompuy, 1995 and Caporale, 1995). Given that expenditure and revenue exhibit integrated behavior, the second methodology tests for cointegration between these variables (Westerlund and Prohl, 2010; Afonso and Rault, 2010; Ehrhart and Llorca, 2008; Quintos, 1995; Hakkio and Rush, 1991). According to this method, if the series are cointegrated, the sustainability hypothesis is upheld (Prohl and Schneider, 2006; MacDonald, 1992; Haug, 1991).

Recent empirical studies hang on testing for stationarity in the fiscal balance series or cointegration between government expenditure and revenue. Nevertheless, the unit root and cointegration tests used do not normally reject the null of a unit root in the series if there is reason to believe that a country has experienced a structural break in its fiscal policies during the sample period. Additionally, such tests

are often said to be of low power in small samples and are suspected of providing poor evidence (Perron, 2006).

The disappointing conclusions from these studies have turned more recent research away from the stationarity approach towards a more flexible econometric test based on cointegration. Under this framework, if government expenditures and revenue are found to be cointegrated with a unit slope coefficient on expenditures, fiscal policy is said to be strongly sustainable. Also, when the slope is less than unity, it is described as being weakly sustainable (Quintos, 1995). Although this attempt has brought some flexibility, the results obtained from this approach have been mixed at best (see, for example, Afonso, 2005; Bravo and Silvestre, 2002; and Papadopoulos *et al.*, 1999).

There have been debates surrounding the causes of failure to establish fiscal sustainability. For their part, Westerlund and Prohl (2007) claim that this failure could be attributed to at least two types of flaws in most previous studies. Since the majority of studies apply techniques designed to test the null of a unit root, they argue that low power in the tests could be one reason why cointegration has been difficult to establish. Again, they contend that most studies employ a country-by-country approach, which doesn't contribute more information to the analysis and essentially disregards the information contained in the cross-sectional dimension. However, they concede that when conventional cointegration tests are applied to each country separately, the results are comparable across countries.

In an attempt to correct these flaws, Westerlund and Prohl (2007) suggest the use of panel unit root and panel cointegration methodologies to generate more precise tests. In the case of the European Union, recent studies based on panel cointegration have provided strong evidence for fiscal sustainability (see Westerlund and Prohl, 2007; Afonso and Rault, 2007; Prohl and Schneider, 2006). Most of these studies have focused on the EU 15 and some have properly accounted for the existence of structural breaks.

There is also some evidence relating to member countries of the Organization for Economic Cooperation and Development (OECD). A study by Ehrhart and Llorca (2007) applied panel cointegration to assess fiscal policy sustainability in a sample of 20 OECD countries. They report that expenditure and revenue are co-integrated, implying consistency in fiscal policies with the intertemporal budget constraint for 1975 to 2005. Again, using quarterly data that covers eight wealthy

OECD countries from 1977 to 2005, they applied panel techniques to establish that the fiscal sustainability hypothesis could not be rejected.

Other regions have also benefited from recent advances in the literature. For example, Adedeji and Thornton (2010) and Lau and Baharumshah (2005) consider Asian countries. These studies have found that although fiscal sustainability could be established for the region, the evidence indicates that such sustainability is “weak” and the authors suggest implementation of policy measures to create a more sustainable basis for public finances. For the Southern Mediterranean region, Ehrhart and Llorca (2006) use recent econometric methodology for panel data to test whether there is long-run sustainability in the fiscal policies in six countries—Egypt, Israel, Lebanon, Morocco, Tunisia and Turkey—establishing that fiscal policies are sustainable in these countries.

2.2. Causal relationships between expenditure and revenue

Another dimension of the empirical literature has focused on the causal relationship between government expenditure and revenue through four different theoretical propositions. If no cointegration is detected, we say that there is no evidence of causality between the variables, implying spending and revenue are not related in the long run. However, if cointegration is established, three different outcomes are possible since causality implies that a change in one variable necessitates or drives a change in the other variable (Engle and Granger, 1987). We can assess whether causality runs from revenue to expenditure, from expenditure to revenue, or in both directions. The tax-spend hypothesis is based on evidence of a unidirectional causality running from revenue to expenditure as championed by Friedman (1978). Friedman argues that tax cuts lead to higher deficits, and if a government cares about the implications of this, it will reduce its level of spending to equal the level of tax revenue or possibly lower.

An alternative version of this hypothesis was advanced by Wagner (1976) and Buchanan and Wagner (1978). Contrary to Friedman (1978), they find that taxes unidirectionally induce negative changes in expenditure. This means that increased taxes would lead to spending cuts. The thrust of the Buchanan and Wagner (1978) argument is that taxpayers suffer from fiscal illusion. The authors point out that when taxes are cut, the taxpayer will assume that the cost of providing goods and services has fallen, and will therefore demand more

government programs. If such programs are undertaken, this will result in an increase in government spending. So, while tax changes induce changes in spending, the relationship is an inverse one as postulated by Buchanan and Wagner (1978); this hypothesis prescribes increased taxes as the cure for budget deficits.

The spend-tax hypothesis advanced by Peacock and Wiseman (1979) and Barro (1979) is based on causality directed from expenditure to revenue. Here, the fiscal illusion problem does not apply and proponents argue that an increase in government spending induces tax hikes. On this basis, they suggest that spending cuts are the solution to budget deficit problems. Yet another hypothesis, termed fiscal synchronization, based on Musgrave's (1966) classical view of public finance, argues that there is a bidirectional causal relationship between revenue and expenditure. Under this theory, revenue and expenditure are determined simultaneously and the public is said to understand the benefits of government services in relation to their costs (Musgrave, 1966). The implication of this theory is that the best strategy for dealing with problems of fiscal deficit is to cut spending and undertake intensive measures to increase revenues.

The empirical evidence on this aspect is mixed; studies based on the United States have provided results that are open to debate. While some researchers provide support for the tax-spend hypothesis (Hoover and Shefrin, 1992; Bohn, 1991; Ram, 1988; Blackley, 1986), others have reported findings that sustain the spend-tax hypothesis (Ross and Payne, 1998; Jones and Joulfain, 1991; Anderson *et al.*, 1986). Interestingly, while Owoye (1995), Miller and Russek (1990) and Manage and Marlow (1989) suggest that the fiscal synchronization hypothesis holds, Baghestani and McNown (1994) find no causal association between the variables.

The case of Latin American countries has not been different. Ewing and Payne (1998) find evidence of the fiscal synchronization hypothesis for Chile and Paraguay and report findings of causality from revenue to expenditure for Colombia, Ecuador, and Guatemala. Baffes and Shah (1990, 1994) find similar results of strong bidirectional causality for Brazil and Mexico, while for Chile and Argentina support was identified for causality from expenditure to revenue. A study of eight countries in Latin America by Cheng (1999) reports on feedback causality for Brazil, Chile, Panama, and Peru to suggest that expenditure and revenue are jointly determined. The same study, however, found causality from revenue to expenditure in some countries—Colombia,

the Dominican Republic, Honduras, and Paraguay. This is evidence that the question is empirically unresolved.

Although an extensive theoretical and empirical literature has surfaced on the topic in recent years, not much has focused on Latin American countries. There is a large body of academic writing on this subject in Latin America exploring the stabilization programs and political or institutional factors affecting the region's fiscal performance. Interestingly, little work exists on the sustainability of fiscal policies in the region from the panel econometric point of view.

This article follows recent advances in the application of econometrics to fiscal sustainability, employing recently developed linear panel unit root and cointegration techniques to analyze data on government expenditure and revenue for Latin American countries. In order to overcome problems caused by small sample size, we make use of alternative long-run panel estimation techniques.

3. DATA AND METHODOLOGY

Annual data on government expenditure (GX) and revenue (GR) as a percentage of gross domestic product (GDP) are extracted from the World Development Indicators (WDI) database published by the World Bank (2015). The publisher indicates the source organizations as the International Monetary Fund, Government Finance Statistics Yearbook and data files, and World Bank and OECD GDP estimates. The data for government revenue exclude grants (percentage of GDP). Revenue consists of cash receipts from taxes, social contributions, and other revenue such as fines, fees, rent, and income from property or sales. Expenses consist of cash payments for the government's operating activities in providing goods and services. It includes compensation of employees (such as wages and salaries), interest and subsidies, grants, social benefits, and other expenses such as rent and dividends. The available data enable the construction of a balanced panel for six countries in Latin America and the Caribbean—the Bahamas, Brazil, Guatemala, Nicaragua, Peru, and Uruguay—for the period 1990–2012. We do not conduct the analysis on a country basis given the relatively short span of the sample. Also, given the strong links among economies in the region, a panel approach is more appropriate in this context. Some countries in the region have been excluded due to lack of consistent data for a balanced panel structure. Figures 1 and

2 are the graphs of revenue/GDP and expenditure/GDP, respectively, for the countries under consideration.

The countries in the panel have generally recorded negative cash balances as a ratio of GDP. Since 2001, only Nicaragua and Peru have had a few instances of positive fiscal balances, defined as revenue (including grants) minus expenditure and net acquisition of nonfinancial assets. From a record deficit of 34.24% in 1990, Nicaragua recorded the highest surplus of 6.1% in 1991, when Brazil, Guatemala, and Uruguay also recorded surplus cash balances. Subsequently, the performance of these economies has not been encouraging, since most of them have experienced negative budget balances.

Although there have been record fiscal deficits and high public debt levels in Latin America, there were markedly favorable conditions during the period 2003–2007. This resulted from an unusual combination of a financial boom, exceptionally high commodity prices, and strong remittances from migrant workers. Since the year 2002, there has been a general upward trend in revenue with the exception of the general and marked dip in 2008–2009. Interestingly, a number of the region's economies were already experiencing a substantial slowdown over the course of 2008, with only Peru recording a surplus balance of 2.1%. However, in 2009 all of the countries experienced a sharp dip in revenue, which was outstripped by higher expenditure and led to deficit balances. To a great extent, the dip can be attributed to the 2008–2009 financial crisis, which gave rise to a general upswing in government spending levels in 2009. Peru's performance has been very impressive in recent years but the country recorded a deficit of approximately 1.1% in 2009 due to the financial crisis.

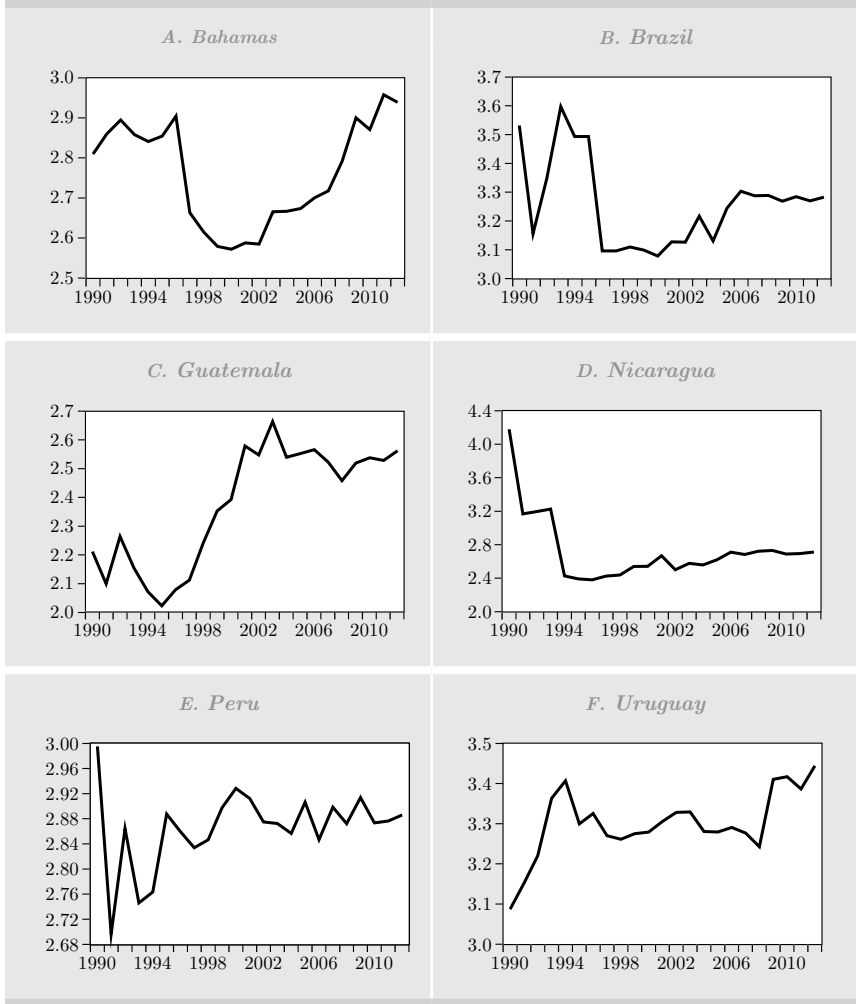
The crisis of 2009 affected all of the economies to the extent that primary surpluses declined significantly and pushed up the ratio of outstanding public debt to GDP. Ocampo (2009) argues that the crisis manifested in complex ways over time and had different effects on the different countries in the region. According to the author, the initial impact came around the third quarter of 2007, and consisted of a large decline in capital flows and bond issues, a modest increase in financing costs, and a similarly moderate decline in stock market values. However, most of the economies had recovered to pre-crisis revenue levels by 2010. All of the economies under consideration have seen an upward trend in their revenue, with Brazil, Nicaragua, Peru, and Uruguay recording one of the highest revenue/GDP ratios in 2012 since 1990.

Figure 1. Revenue/GDP of individual countries (in logs)



Source: Based on raw figures from World Development Indicators (online version).

Figure 2. Expenditure/GDP of individual countries (in logs)



Source: Based on raw figures from World Development Indicators (online version).

3.1. Panel unit root and stationarity tests

This section involves the application of a battery of panel unit root and stationarity tests to analyze the properties of the data generation process and verify whether the properties are integrated. Five distinct panel unit root techniques are employed: LLC (Levin *et al.*, 2002), Breitung, IPS (Im *et al.*, 2003), ADF-Fisher, and PP-Fisher (Maddala and Wu, 1999). These tests have been proposed based on different sets of assumptions. Each of these tests has a null hypothesis of unit root. The LLC and Breitung tests are based on a common unit root process hypothesis that the autocorrelation coefficients of the variables are homogeneous across cross sections. On the other hand, the IPS, PP-Fisher and ADF-Fisher techniques are based on the assumption that the autocorrelation coefficients across the sections are heterogeneous. To minimize problems arising from cross-sectional dependence, the cross-sectional means are subtracted in the LLC, IPS and Maddala and Wu tests. The Breitung test allows for cross-sectional dependence. In terms of the country-specific maximum number of lags used for the ADF regressions with respect to the LLC, Breitung and IPS tests, this is determined by the Schwarz-Bayesian information criterion. Also, the long-run variance for the LLC and the maximum lags are determined using the Bartlett kernel and Newey-West bandwidth selection algorithm, respectively.

In addition to the unit root tests, one panel stationarity test proposed by Hadri (2000) is employed. According to Baltagi (2008), the residual-based Lagrange multiplier (LM) test is in fact a panel generalization of the KPSS test proposed by Kwiatkowski *et al.* (1992) for time series data. Maddala and Wu (1999) highlight that the ADF regression tests are sensitive to the choice of lag lengths. Furthermore, both tests assume cross-section independence and therefore constrain the associated AR coefficient so that it is homogeneous across sections. If this strong assumption of cross-sectional independence fails, the results of the tests become misleading. Therefore, the Hadri test uses residuals from individual OLS regressions on deterministic components to compute the LM statistic. The null hypothesis is that the panel data is stationary (i.e., no unit root in any of the time series), versus the alternative of non-stationarity for at least some cross-sections. The test can also allow for a general form of dependence over time and for the disturbance component to be heteroskedastic across individual sections. Table 1 gives a summary of other characteristics of the tests.

Table 1. Properties of panel unit root and stationarity tests

| | ADF-Fisher | PP-Fisher | IPS | Breitung | Hadri | LLC |
|----------------------------|------------------|------------------|------------------|----------|---------------|---------|
| Type of test | Individual | Individual | Individual | Common | Common | Common |
| H0 hypothesis | UR | UR | UR | UR | Stationary | UR |
| H1 hypothesis | No UR in some CS | No UR in some CS | No UR in some CS | No UR | UR in some CS | No UR |
| Assumptions | N, F, T | N, F, T | F, T | T | F, T | N, F, T |
| Autocorrelation correction | Lags/kernel | Lags/kernel | Lags | Lags | Kernel | Lags |
| Cross-section dependence | Demean | Demean | Demean | Robust | Robust | Demean |
| Unbalanced panel | Yes | Yes | Yes | No | No | No |

Source: Compiled from Eviews Users Guide (Version 8.1) QMS (2014:510-511).
 Notes: N = number of exogenous variables; F = individual/fixed effects; T = individual time effects; individual linear trends; CS = Cross-sections; UR = unit root

3.2. Panel cointegration tests

This study tests for cointegration between government expenditure and revenue in the panel of Latin American countries. Three different methodologies composed of tests with different assumptions are employed. Two of these tests—Pedroni (1999, 2004) and Kao (1999)—are based on the two-step cointegration approach of Engle and Granger (1987) for estimating cointegration of heterogeneous panels. Pedroni uses the residuals from the long-run regression to construct four panel cointegration test statistics that assume homogeneity of the autoregressive (AR) term (“panel statistic” or within-dimension tests) and three panel cointegration test statistics that allow for heterogeneity of the AR term (“group statistics” or between-dimension tests). The panel v -statistic and the panel rho-statistic are comparable to the long-run variance ratio statistic for time series and the semi-parametric rho statistic of Phillips and Perron (1988), respectively. The other two—panel PP-statistic and panel ADF-statistic—are extensions of the non-parametric Phillips-Perron and parametric ADF t -statistics, respectively. The tests are valid for only $I(1)$ variables. They also allow for heterogeneous slope coefficients, fixed effects, and individual specific deterministic trends. The critical values for the null hypothesis of no cointegration are derived by Pedroni (1999).

The Kao test also includes residual-based DF and ADF tests similar to Pedroni’s seven tests. However, Kao (1999) specifies the initial regression with individual fixed effects, no deterministic trend, and homogeneous regression coefficients. Although both the Pedroni and Kao tests assume the presence of a single cointegrating vector, the Pedroni tests assume heterogeneity of the vector across individual sections (i.e., countries).

Finally, this study employs the structural panel cointegration methodology developed by Westerlund (2007). The four tests proposed are an extension of Banerjee *et al.* (1998) that allow for heterogeneity in a cointegrating vector for $I(1)$. Westerlund’s ECM panel cointegration does not impose any common parameter constraint, unlike the residual-based tests. According to the alternative hypothesis one can distinguish between group-mean tests (Gt and Ga) and panel tests (Pt and Pa).

4. EMPIRICAL RESULTS

4.1. Panel unit root testing

Since panel cointegration methodologies assume panel data to be integrated of order 1, we analyze the data generating process (dgp) to ascertain the stationarity properties using the LLC, Breitung, IPS, Hadri, ADF- and PP-Fisher tests. A rejection of the null hypothesis of unit root indicates a stationary process whereas a rejection of the null of stationarity under the Hadri test would indicate presence of unit root. Table 2 shows the results of all the tests, which provide evidence that we cannot reject the hypothesis of unit root processes in both the GX and GR variables for the panel of seven Latin American countries. In addition, the Hadri tests strongly reject the null hypothesis of stationarity. This provides strong evidence that the variables have unit roots (i.e., they are integrated processes).

Table 2. Panel unit root tests for Latin America

| | Tests assuming individual unit root process | | | Tests assuming common unit root process | | |
|-------------|---|---------------------|--------------------|---|-----------------|-----------------|
| | IPS w-stat | ADF-Fisher χ^2 | PP-Fisher χ^2 | LLC t*-stat | Breitung t-stat | Hadri z-stat |
| GX | -1.00 [0.16] | 13.57 [0.33] | 44.51* [0.00] | 7.64 [1.00] | -0.77 [0.22] | 4.01* [0.00] |
| GR | 0.14 [0.56] | 5.91 [0.92] | 12.68 [0.39] | 5.41 [1.00] | -0.53 [0.30] | 3.82* [0.00] |
| Δ GX | -8.66 [0.00] | 74.33 [0.00] | 329.55 [0.00] | -6.44 [0.00] | -3.98 [0.00] | 4.16 [0.00] |
| Δ GR | -3.97 [0.00] | 35.68 [0.00] | 48.44 [0.00] | -3.86 [0.00] | -5.01 [0.00] | 3.22 [0.00] |

Source: Authors' calculations.
 Notes: Max lag for LLC, Breitung and IPS is 4. *, ** and *** represent significance at the 1%, 5% and 10% levels, respectively. Values in parenthesis denote p-values. Δ represents first difference of the variables.

The presence of unit root in GX and GR series indicates that the variables are not stationary in levels. Further tests to confirm the order of integration indicate that the variables are difference-stationary. This random walk behavior implies that revenue and expenditure grow without bounds over time and that random shocks to the data-generating process have a permanent effect on the variables. Some have argued that because fiscal sustainability requires that

government expenditure and revenue are integrated of order zero, it can be said that fiscal policies do not satisfy the IBC conditionality and for that matter, the strong form of fiscal sustainability would not hold (Shinnick, 2008). However, strictly speaking what is required is that the fiscal balance be stationary so that public debt does not grow beyond the repayment limit, which can be achieved as long as the debt is stationary. This in turn would indicate that all that is needed for sustainability is that revenue and expenditure cointegrate (Munawar-Shah and Abdul-Majid, 2014).

4.2. Panel cointegration testing

After establishing the data-generation process of the variables, we proceed to test whether the logarithm of revenue (GR) and its covariates as well as the logarithm of expenditure (GX) and its associated covariates share a common stochastic trend. Three alternative panel cointegration techniques are employed for this purpose. They include two tests based on the residuals of the long-run static regression (Pedroni and Kao) and the Westerlund ECM panel cointegration tests. The Bayesian information criterion is used to automatically select the appropriate lag length for Pedroni and Kao tests. We include deterministic time trends in all specifications and select the Bartlett kernel bandwidth with the Newey-West algorithm.

The results in Table 3 provide strong support for the presence of cointegration when both GR and GX are used as the dependent variable, at least at the 5% significance level. This evidence further indicates the possibility of a somewhat bi-directional long-run equilibrium

Table 3. Pedroni and Kao residual cointegration tests

(Dependent variable: GR)

| Test | Panel test | | Test | Group test | |
|-----------|------------|--------|-----------|------------|--------|
| | statistics | Prob. | | statistics | Prob. |
| Panel v | 3.08** | [0.01] | Group rho | -3.62* | [0.00] |
| Panel rho | -5.33* | [0.00] | Group PP | -6.03* | [0.00] |
| Panel PP | -6.18* | [0.00] | Group ADF | -7.01* | [0.00] |
| Panel ADF | -6.63* | [0.00] | Kao | -9.86* | [0.00] |

Source: Authors' calculations.

Notes: Test results were generated by Eviews 8. Pedroni's panel statistics are weighted. Values in [] are *p*-values. *, **, and *** indicate significance at 1%, 5% and 10%, respectively.

Table 4. Westerlund ECM panel cointegration tests

| Statistic | Dependent variable: GR | | | Dependent variable: GX | | | |
|-----------|------------------------|---------|---------|------------------------|---------|---------|--------|
| | Value | Z-value | P-value | Value | Z-value | P-value | |
| Gt | -1.74 | -1.80** | [0.04] | Gt | -2.09 | -2.62* | [0.00] |
| Ga | -5.33 | -0.82 | [0.21] | Ga | -8.05 | -2.29** | [0.01] |
| Pt | -4.68 | -2.94* | [0.00] | Pt | -4.43 | -2.72* | [0.00] |
| Pa | -6.27 | -4.43* | [0.00] | Pa | -8.14 | -6.02* | [0.00] |

Source: Authors' calculations.
 Note: Results generated by Stata 12. P-values are in parenthesis. *, ** and *** indicate significance at 1%, 5% and 10% significance level, respectively.

relationship between revenue and expenditure. Table 4 reports the results of the Westerlund tests, which take into account cross-sectional dependencies. It also provides evidence of cointegration, suggesting that fiscal policies in the region for the period under review are sustainable.

4.3. Panel cointegration estimation

The study proceeds to estimate the short-run and long-run coefficients to investigate the causal relationship between GR and GX after establishing the existence of a cointegration relationship between the variables. We also address possible reverse causality between the two variables. In order to ensure a robust analysis, the results of four alternative estimation strategies are reported—the dynamic OLS (DOLS), mean group, pooled mean group, and dynamic fixed effects. Saikkonen (1991) and Stock and Watson (1993) originally proposed the DOLS estimator, which was later generalized by Kao and Chiang (2000). The estimation involves augmenting a static long-run relation by leads and lags of first-differenced explanatory variables. This strategy improves the efficiency of the long-run estimates, although it does not capture the short-run dynamics. Therefore, we include the PMG estimator proposed by Pesaran *et al.* (1999). The estimator is a panel extension of the single equation autoregressive distributed lag (ARDL) model, which has the advantage of the error correction representation. It provides information about the contemporaneous impacts and the speed of adjustment towards the long-run equilibrium state after a disturbance. Furthermore, while the long-run coefficients are assumed to be identical across panels (homogeneous), the short-run coefficients are allowed to vary across the sections of the panel (heterogeneous) (see Bangake and Eggoh, 2012). Also, the MG estimator which allows

the long-run parameters to be heterogeneous is employed. The DFE estimator which assumes homogeneity for both the short- and long-run parameters is included.

4.4. Comparing the results of PMG, MG and DFE estimates

Since the cointegration estimators have different assumptions and impose different restrictions there is an important test used to measure and compare the efficiency and consistency of the PMG, MG, and DFE estimations. Another reason to do this is that the estimators usually report different and sometimes contradictory results along with the restrictions. Given our results for the GX model in Table 5, we realize that although the signs (or directions) of causality are consistent among the three estimators, the magnitude (or size) as well as the degrees of significance differ slightly. For instance, whereas both the MG and DFE give a convergence coefficient of more than 0.60, the PMG estimator reports that it is 0.51. Also, we find that whereas the PMG and DFE estimators show much higher long-run coefficients of GX–0.97 and 0.94, respectively—the MG produces a lower coefficient of 0.86. Again, when the results for the GR model are compared, the DFE estimates are quite similar to the PMG results. In the long run, both PMG and DFE produce coefficients of around 0.70 whereas the MG gives a GR coefficient of 0.21. On the basis of this finding, it becomes imperative that we choose the one that is more efficient and consistent for the analysis.

We apply the Hausman *h*-test to examine the efficiency of the PMG estimator compared to the other estimators and the validity of the long-run homogeneity restriction across countries. The test has a null hypothesis that the difference between the PMG and MG estimation or the PMG and DFE estimation is not systematic. A failure to reject the null indicates that the PMG estimator is recommended, as it is more efficient under the null hypothesis. If the alternative applies—that there is a significant difference between PMG and MG or PMG and DFE—the null is rejected. If the results indicate that the *p*-value is insignificant at the 5% level, then the PMG will be used. However, if the *p*-value becomes significant, then the use of MG or DFE estimator is deemed appropriate.

In the GX model, the test indicates that the PMG estimator is favored since the null hypothesis cannot be rejected at the 1% significance level. Also, between PMG and DFE, the PMG is favored. Hence, our

analysis for this model is based on the PMG estimations. The test further indicates that the PMG is the preferred estimator among the other GR specifications, so it is employed for our subsequent analysis.

4.5. Short-run causality and convergence dynamics

The results indicate that the lag of the expenditure variable has a positive impact on the current values of revenue. This means that an increase in expenditure causes a hike in revenue. Similarly, the lag of the revenue variable has a positive impact on the current values of expenditure; we find that an increase in revenue causes a rise in expenditure. In both cases the p -values indicate that the coefficients are significant. This means that the effect of either expenditure or revenue on the other variable is statistically significant in the short run, which suggests strong evidence to support the claim that there is short-run causality between GX and GR.

In all three instances, the error correction terms or convergence coefficients that capture the speed of adjustment are statistically significant at the 1% level. This strong significance lends more support to the evidence of a long-run relationship or causality between the variables. This means further evidence of cointegration is established by the error correction term (convergence coefficient), which is statistically significant. The error correction terms are negative, which is expected as it implies that, for any deviations of expenditure in the previous period from the long-run equilibrium, the error correction term stimulates a positive change in revenue to revert back to the original equilibrium. In the same manner, if revenue in the past period overshoots the equilibrium, then it is forced to come back towards equilibrium. Also, the somewhat large magnitudes imply that the model returns to its equilibrium state quickly after an unexpected shock or deviation; both GX and GR adjust in response to deviations and approach the long-run equilibrium condition. This has actually been the case since most Latin American countries implemented fundamental fiscal-institutional reforms and adopted fiscal frameworks in the form of numerical rules that placed constraints on debt, deficits and/or expenditure and procedural rules and transparency rules aimed at establishing fiscal consolidation and budgetary discipline (see Hallerberg and Scartascini (2011) for details). There have been claims that the significant progress made in fiscal discipline in the mid-1980s, as pointed out by Edwards (1995), has had important positive consequences for Latin America (Sanchez,

2003). The main thrust of fiscal adjustment took place in the first half of the 1990s (Sanchez, 2003). In essence, since this study covers the period during which most of the reforms were implemented, we posit that the institutional and fiscal policy reforms in the region may have been effective in ensuring the high speed of adjustment towards fiscal sustainability.

4.6. Long-run fiscal synchronization

Table 5 indicates that the long-run coefficients are positive and statistically significant, which indicates that GR and GX have a significant positive impact on each other and an increase in GR or GX would bring about a response from the other variable in a similar direction. This supports the evidence of long-run fiscal synchronization hypothesis. The fiscal synchronization hypothesis asserts that expenditure and revenue decisions are made simultaneously by national authorities. It implies that, in an attempt to tackle the problem associated with persistent, rising levels of budget deficit, Latin American governments need to be cautious, as pointed out by Manage and Marlow (1986), about simply cutting expenditures, increasing revenue, or simply altering both revenues and expenditures without taking into consideration the dependence of one variable on the other.

Our evidence lends support to similar studies such as Owoye (1995), Bhat *et al.* (1993), Manage and Marlow (1986), Joulfaian and Mookerjee (1990), and Nyamongo *et al.* (2007). For Latin American countries, the finding is in line with Ewing and Payne (1998), Baffes and Shah (1990, 1994), and Cheng (1999) who provide evidence for feedback causality between expenditure and revenue in support of the fiscal synchronization hypothesis.

4.7. Evidence of weak-form sustainability in the long run

According to Quintos (1995), there is a difference between strong sustainability and a weak form of fiscal sustainability. Hence, we estimate the coefficient of the long-run relation between GR and GX. A strong solvency occurs if there is cointegration and the slope coefficient β of GX is unity. Also, a weak solvency is confirmed when β is less than unity. In this context only the strong condition is appropriate to assess fiscal sustainability (Hakkio and Rush, 1991). This is because the weak condition may be satisfied even as the governments face challenges

Table 5. Panel cointegration estimation results

| Dependent variable | GX | | | |
|--------------------------|-----------------|------------------|------------------|------------------|
| | DOLS | MG | PMG | DFE |
| Convergence coefficients | N/A | -0.68* (0.00) | -0.51* (0.00) | -0.65* (0.00) |
| Long-run coefficients | 0.99* (0.06) | 0.86* (0.15) | 0.97* (0.08) | 0.94* (0.07) |
| Short-run coefficients | N/A | 0.16 (0.17) | 0.25** (0.11) | 0.24* (0.09) |
| Dependent variable | GR | | | |
| Convergence coefficients | N/A | -0.45* (0.00) | -0.46* (0.00) | -0.47* (0.00) |
| Long-run coefficients | 0.85* (0.05) | 0.21 (0.53) | 0.73* (0.05) | 0.75* (0.07) |
| Short-run coefficients | N/A | 0.27** (0.10) | 0.24** (0.11) | 0.28* (0.05) |
| Hausman test | GX | GR | | |
| MG vs. PMG | 0.86 (0.36) | 0.61 (0.44) | | |
| PMG vs. DFE | 0.52 (0.47) | 0.23 (0.63) | | |

Source: Authors' calculations.
 Notes: Values in () are standard errors. The xtpmg command in Stata 12 is used for MG, PMG and DFE estimators. *, **, and *** indicate significance at the 1%, 5% and 10% levels, respectively. For the Hausman test and convergence coefficients, values in () are p-values for [ec] and X2, respectively.

financing fiscal deficits, if the revenue relative to GDP is continuously exceeded by expenditure as a percentage of GDP.

In order to achieve this objective, we also test whether the coefficient of GX in the GR model is significantly different from 0. The long-run coefficients are reported in Table 5. From the table, it can be said that the estimated β of GX is 0.73, which is not too far from unity. Further tests on the model reject both the null hypothesis of $\beta = 0$ and that of $\beta = 1$ at the conventional significance levels. Hence, while two non-stationary variables, GR and GX, are cointegrated in the panel of Latin American economies, they can best be judged to be sustainable only in the weak form. We argue that, on the basis of causality, a rise in GR causes a rise in GX and vice versa. However, the magnitude of changes in GR and GX differ. From our analysis, a 1% increase in GX causes GR to increase by less than 1%, which implies that although sustainable fiscal positions are feasible, governments in the region spend

more than they receive in revenue. By extension, the results imply that if governments spend at a lower rate compared to their ability to raise revenue in the long run, so that GX and GR are one-to-one, then the strong-form sustainability can be confirmed and there would be no cause for alarm about the future course of a fiscal deficit situation.

5. CONCLUDING REMARKS AND POLICY RECOMMENDATIONS

This study is a contribution to the empirical literature on fiscal sustainability. We make use of recent advances in time series econometric techniques to test whether fiscal policies executed in Latin America over the period 1990–2012 are sustainable in the long run. Tests for panel data for the Bahamas, Brazil, Guatemala, Nicaragua, Peru, and Uruguay in the form of unit roots and cointegration were applied and the results indicate that while both government expenditure (GX) and government revenue (GR) contain unit roots, they have a significant relationship in the long run. This means that fiscal policies in the region are in harmony with their intertemporal budget constraints, indicating the ability to repay financial obligations in the form of debt without explicit default. Sustainable fiscal policies can be continued without changes in policy directions, particularly when there is validity of intertemporal budget constraint in present value terms. However, this long-run sustainability is only in the weak form.

The results show that there is significant causality between expenditure and revenue in the short run as well as long-run bidirectional causality between them, suggesting that both GX and GR help push the budget towards equilibrium in the event of deviations from the long-run relationship. This finding supports the hypothesis of fiscal synchronization, demonstrating the impact fiscal and institutional reforms have had on budgetary outcomes in the region over the study period. To be able to tackle the issue of persistent fiscal deficits in the region, policymakers need to devise strategies to increase revenue and moderate government spending concurrently, as the results point to weak-form sustainability. Consistent with the common caveat in panel cointegration literature, we note that our results are not to be taken out of the regional context to suggest that individual countries within Latin America have pursued sustainable fiscal policies. The sustainability of individual countries may not be achieved if the government's past fiscal behavior remains unbalanced in the long run.

This study enjoys the advantage of the panel approach and points to the solvency of fiscal policies, providing relevant, practical insights into the dynamics of fiscal policy adjustments in the absence of a common fiscal policy in the region. We uphold that future studies should consider models consistent with independent national fiscal policies whenever the available data allow for such analysis.

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