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This empirical study aims at assessing sustainability of fiscal policies in twenty Central and Latin American countries over the period 1990-2012. We employ the second generation panel unit root test proposed by Pesaran (2007) to take into account for cross-section dependence and it is found that the fiscal variables are integrated of order one. Using the panel cointegration tests suggested by Westerlund (2007), econometric results show that there is a long-run relationship between government revenue and spending. The estimate of the panel cointegrating regression in an error correction model indicates that the budget deficit turns out to be weakly sustainable.

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1. Introduction

Since the debt crisis of the 1980s, the fiscal sustainability has been an important preoccupation of Central and Latin American countries (C.L.A.C) and international institutions Indeed, such issue has regained importance during the early 2000s decade following a series of debt restructurings or moratoria in Latin American countries (Argentina, Ecuador or Uruguay). Moreover, fiscal sustainability is constituting again a relevant issue in this region (i) to face of adverse effects[1] on public debt position, (ii) to prevent a debt crisis and (iii) because of the current high level of uncertainty in this post-crisis period of "soft landing" growth, due notably to the decline of commodity prices or to exogenous event such as the "vulture funds" on the Argentine debt.

As a result, we propose here to explore such fiscal sustainability issue by employing a panel approach on C.L.A.C. over the period 1990-2012. Indeed, a panel approach is more appropriate given the strong economic, tradable and financial links among the economies of a region. Moreover, such study offers three new contributions to the existing literature.

First, we consider a panel of Central and Latin American countries which has never been performed in the literature[2]; this latter focusing only on Central or Latin American countries but not together. Second, we take into account a recent period including the effects of the 2008 Global financial crisis impacts on fiscal sustainability issue over our panel. Third, the second generation panel unit root and cointegration tests (the Pesaran and Westerlund tests, respectively) allowing cross-sectional dependence among countries, are applied to test the fiscal sustainability.

We use the present-value methodology of the relationship between government expenditures and revenues to determine whether the government intertemporal budget constraints holds, so if the public debt is sustainable in the long run. According to the present-value methodology, we need to study panel stationarity and cointegration between these two fiscal variables.

2. Data

The sustainability of fiscal policy is assessed in a panel of twenty Central and Latin American countries[3] over the period from 1990 to 2012. We use annual data taken from ECLAC (Economic Commission for Latin America and the Caribbean)'s *CEPALSTAT* database online.

The series include the variables of budget deficit $(G - T)$ with G corresponding to public expenditure and lending minus repayments and T being equal to revenue and grants, and the public debt variable. Except for Bolivia, fiscal variables are relative to central government. Due to unavailability of central government data, general government data were used for Bolivia. Concerning specifically the public debt variable, Cuba and the Dominican Republic are excluded from the analysis because the data are unavailable in the first case and the number of observations is insufficient in the second one. All the fiscal variables are expressed as a percentage of nominal GDP.

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[1] Such as a sudden depreciation, a rise in public debt interest rates, a growth slowdown or the conversion of contingent liabilities into public debt.

[2] We can list the works of Paunovic (2005), Chortareas, Kapetanios and Uctum (2008), De Mello (2008), Daude, Melguizo and Neut (2011), Campo Robledo and Melo Velandia (2015),

[3] Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, El Salvador, Guatemala, Haiti, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru, Uruguay, Venezuela.

3. Empirical results

3.1 Panel unit-root tests

The econometric methodology employed to test whether the public deficit in our sample of C.L.A.C. consists mainly of two steps. In the first step, the stationarity properties of fiscal variables are studied by using unit-root tests for panel data. Fiscal sustainability requires that fiscal variables (public expenditure, revenue, overall fiscal balance and public debt) are integrated of order zero.

The unit root tests can be classified into two groups, depending on whether they account for cross-section dependence or not. The first generation panel unit root tests (Im *et al.*, 2003; Maddala and Wu, 1999; Choi, 2001 among others) have been criticized because they assume cross-sectional independence. This hypothesis is rather restrictive and unrealistic since macroeconomic time series exhibit significant cross-sectional correlation among the countries in the panel (Baltagi, 2008) and co-movements of economies are often observed in the majority of macroeconomic applications of unit root tests. The presence of cross-sectional correlation of errors in panel data applications in economics is likely to be the rule rather than the exception (Chudik and Pesaran, 2013). Moreover, correlation across units in panels may have significant consequences on the first generation of tests assuming cross-sectional independence. When applied to cross-sectionally dependent panels, such panel unit root tests can generate substantial size distortions (O'Connell, 1998). As a result, alternative (the second generation) panel unit root tests (Bai and Ng, 2004; Chang, 2002, 2004; Choi, 2002; Moon and Perron, 2004; Phillips and Sul, 2003; Pesaran, 2007) have been proposed to account for cross-section dependence.
The results of the Pesaran's test of cross-sectional dependence are summed up in table 1. Thus, the CD test strongly rejects the null hypothesis of cross-sectional independence. In addition, the average absolute correlation is higher than 0.5 for the ratios of revenue, public expenditure and debt, which is a very high value. Hence, there is enough evidence suggesting the presence of cross-sectional dependence in our panel of 20 Central and Latin American countries.

Table 1: Pesaran (2004) test for cross-section dependence

Variables (in % of GDP)	CD-test	P-value	Avg. (ρ_{ij})	Avg. $(\lvert\rho_{ij}\rvert)$
Revenue	35.97	0.000	0.573	0.578
Public expenditure	28.50	0.000	0.450	0.521
Overall fiscal balance	10.59	0.000	0.160	0.270
Public debt	11.60	0.000	0.213	0.510

Note: CD reports the Pesaran (2004) cross-section dependence statistic. Under the null hypothesis of cross-section independence $CD \rightsquigarrow N(0,1)$. Avg. (ρ_{ij}) and Avg. $(|\rho_{ij}|)$ denote average and average absolute cross-section correlation coefficients.

So to study the issue of fiscal sustainability, it is necessary to employ the second generation panel unit root tests allowing for this cross-country dependence.

The CIPS panel unit root test has been performed and the results are in table 2. When no lag is considered, this implies that there is no serial correlation in the variables. However, as shown by Wooldridge's test, the null hypothesis of no serial correlation is strongly rejected. We have to be careful determining the suitable lag size when eliminating serial correlation. Including too few lags will not remove serial correlation and considering too many lags will reduce the degrees of freedom and thus decrease the power of the test. So with only $T = 23$ years, for variables in level it is reasonable to include 2 lags to adjust for serial correlation. For the same reasons (a relatively short sample and a loss of power of the test when adding too many lags),

it is reasonable to consider one lag when we are testing for a unit root the variables in first difference.
As shown in table 2, the unit-root panel test of Pesaran (2007) indicates that the ratios of public expenditure, revenue, overall fiscal balance and public debt are not stationary in level at the conventional levels of significance of 1%, 5% and 10%. However, the CIPS test rejects the null hypothesis of nonstationarity at the 1% level when the variables are transformed in first difference. The fiscal variables are therefore stationary in first difference or integrated of order 1. All the previous results lead us to examine whether ratios of public expenditure and revenue are cointegrated in a panel perspective.

Table 2: Pesaran (2007) panel unit root (CIPS)

	Variables in level		**Variables in first difference**	
Variables	**Constant**	**Constant and trend**	**Constant**	**Constant and trend**
Rev	-0.716	1.980	-6.895***	-4.545***
Exp	-0.069	1.907	-6.930***	-4.983***
Ofb	-1.145	-0.915	-9.260***	-7.005***
Debt	-1.287	2.850	-5.459***	-4.876***

Note: Rev (Government revenue), Exp (Public expenditure), Ofb (Overall fiscal balance), Debt (Public debt). The null hypothesis of the Pesaran (2007) test is that all series are nonstationary. The alternative assumption is that only a fraction of the individual series in the panel is stationary. We report the standardized Z-tbar statistic, which is compared with critical values provided by Pesaran (2007). The 1%, 5% and 10% critical values for the CIPS test with constant only are -2.40, -2.21 and -2.10 respectively. The critical values for the CIPS test with constant and trend are -2.92 (1%), -2.73 (5%) and -2.63 (10%). *** Statistically significant at the 1% level.

3.2 Panel cointegration tests

In the second step, provided that government expenditure and revenue are found to be nonstationary, it is relevant to investigate whether these two fiscal variables are cointegrated. Cointegration among the fiscal variables is a necessary condition for the fiscal sustainability. Panel cointegration tests can be carried out using either residual-based tests proposed by Pedroni (1999, 2004) or error correction tests suggested by Westerlund (2007). Pedroni suggested seven test statistics for the null hypothesis of no-cointegration, with four panel cointegration statistics and three group mean cointegration statistics. We use the four panel cointegration tests of Westerlund. He demonstrates that the error correction tests have better size accuracy (good small-sample properties) and higher power relative to the residual-based tests of Pedroni (2004). This difference in power of the tests arises mainly because the residual-based tests impose a possibly invalid common factor restriction: the long-run parameters for the variables in level have to be equal to the short-run parameters for the variables in first difference. A failure to satisfy this restriction can generate a significant loss of power for the residual-based tests (Kremers *et al.*, 1992). The panel coinegration tests proposed by Westerlund avoid the problem of common factor restriction (the short- and long-run dynamics are allowed to differ) and are designed to test the null assumption of no-cointegration by inferring whether the error-correction term in a conditional error-correction model (ECM) is equal to zero. To construct the panel cointegration statistics, Westerlund (2007) considers the following ECM:

$$\Delta y_{it} = \delta_i' d_t + \alpha_i\left(y_{i,t-1} - \beta_i' x_{i,t-1}\right) + \sum_{j=1}^{P_i} \alpha_{ij} \Delta y_{i,t-j} + \sum_{j=-q_i}^{P_i} \gamma_{ij} \Delta x_{i,t-j} + u_{it} \qquad (1)$$

where d_t represents the deterministic components and the parameter α_i is the error-correction term. The values of p_i and q_i represent the number of lags and leads, respectively. The first sum corresponds to standard lagged differences to account for short-run adjustment dynamics.

By including not just the current and past changes (lags) but also the future changes (leads) of the differenced regressors in the second sum, Westerlund is able to maintain the strict exogeneity of x.

The ECM in (1) will only be stable if the variables studied are all stationary. As a result, as $y_{i,t-1} - \beta_i' x_{i,t-1}$ must be stationary, the vector β_i defines a long-run equilibrium relationship between x_{it} and y_{it}. Any deviation from this equilibrium relationship lead to a correction by a proportion α_i. If $\alpha_i < 0$, then there is error correction and y_{it} and x_{it} are cointegrated. If $\alpha_i = 0$, then the error correction will be absent (we have no long-run equilibrium equation) and there is no cointegration. In order to estimate the error correction parameter α_i by least squares, the equation (1) can be written as:

$$\Delta y_{it} = \delta_i' d_t + \alpha_i y_{i,t-1} + \lambda_i' x_{i,t-1} + \sum_{j=1}^{P_i} \alpha_{ij} \Delta y_{i,t-j} + \sum_{j=-q_i}^{P_i} \gamma_{ij} \Delta x_{i,t-j} + u_{it} \qquad (2)$$

where $\lambda_i' = -\alpha_i \beta_i'$. The four panel cointegration tests of Westerlund (2007) are based on the least squares estimate of α_i in (2) and its t-ratio. Formally, Westerlund's various tests take the following forms:

$H_O: \alpha_i = 0$ for all i (nocointegation in all countries)

versus

$H_1^G: \alpha_i < 0$ for at least one i (cointegration at least in one country)

or $H_1^P: \alpha_i < 0$ for all i (cointegration in the whole panel)

The group-mean statistics test the null hypothesis against the alternative hypothesis H_1^G. The panel statistics test the null assumption versus H_1^P. The Westerlund's tests allow for cross-section dependence. Indeed, he finds that the bootstrapped error correction tests are very effective in eliminating the effects of the cross-sectional dependence without sacrificing power. These test statistics are also suitable for unbalanced panel data. The table 3 reports the results from Westerlund's tests for panel cointegration.

Table 3: Westerlund (2007) ECM Panel cointegration tests

	Without constant and trend			**Constant**			**Constant and trend**		
Statistics	*Value*	*P-value*	*Robust P-value*	*Value*	*P-value*	*Robust P-value*	*Value*	*P-value*	*Robust P-value*
G_τ	-1.530	0.009	0.010	-1.986	0.150	0.058	-4.025	0.000	0.029
G_α	-4.832	0.156	0.007	-5.009	0.960	0.378	-6.874	1.000	0.485
P_τ	-6.931	0.000	0.007	-7.792	0.092	0.078	-10.017	0.257	0.069
P_α	-4.755	0.000	0.000	-4.767	0.295	0.097	-8.491	0.626	0.039

Note: G_τ and G_α are the group-mean statistics. P_τ and P_α are the panel statistics. The panel cointegration tests of Westerlund take no cointegration for all countries in the panel as the null hypothesis. Large negative values of the test statistics imply that the null hypothesis can be rejected. The P-values are for one-sided test based on the asymptotic normal distribution. The robust P-values are for one-sided test based on the bootstrapped distribution. We use 1000 bootstrap replications. The bootstrapped versions of the error-correction tests are robust to the presence of cross-section dependence.

When testing for cointegration in panel data, the presence of cross-sectional dependence makes inference based on the asymptotic normal distribution inadequate. So inference must be based on the robust P-values that are generated through bootstrapping to account for the cross-

section dependence. The results from the robust P-values show that except for the G_α test (in two cases: a constant only and both a constant and a trend), all the tests conclude to the reject of the null hypothesis of no-cointegration. Monte Carlo simulations carried out by Westerlund (2007) show that first, the panel tests have the highest power and second, among the group-mean statistics, G_τ has the highest power. In our study, all the panel tests reject the null of no-cointegration at the 1%, 5% and 10% significance levels. Moreover, all the group-mean test statistics G_τ reject the null of no-cointegration at the conventional levels of significance. According to the results, we can conclude that the null hypothesis of no-cointegration is rejected in our study. The findings imply that fiscal policies in our panel of 20 C.L.A.C. are sustainable in the long run.

3.3 Estimating panel cointegration vector

Because there is a cointegration relationship between public revenue and expenditure, the final step of our empirical study consists in determining the panel cointegration vector by estimating the ECM in (2). The estimation of the panel cointegrating regression (long-run parameter) and the short-run adjustment coefficients are reported in table 4.

The parameters of interest are the long-run coefficient $(\hat{\beta})$ and the error-correction term $(\hat{\alpha})$.

The mean-group (MG) estimator used here allows the long-run slope coefficients to vary across countries by running separate regressions for each cross-section and then averaging them: $\hat{\beta} = \frac{1}{N}\sum_{i=1}^{N} \hat{\beta}_i$. As a consequence, the estimates of the long-run coefficients can be viewed as the mean value of the individual cointegration vectors. $\hat{\alpha}$ provides estimates of the speed of error-correction towards the long-run equilibrium for the panel as a whole. In small datasets, as in our study $(T = 23)$, Westerlund (2007) warns that the estimation results may be sensitive to the specific choice of lag and lead lengths. Hence, we have estimated the MG error-correction model using various combinations of lags and leads. Due to an insufficient number of observations, we cannot estimate the model considering two lags and leads simultaneously. The estimates appear to be not very sensitive to the choice of the number of lags and leads. The coefficient of public expenditure $(\hat{\beta})$ is positive and highly significant at the 1% level. The magnitude of the long-run coefficients range between 0.856 and 0.948, implying that, in the long term, a one percentage point increase in the public expenditure to GDP ratio leads to an increase in the government revenue to GDP ratio of around 0.856-0.948 percentage point on average for the C.L.A.C. In addition, the coefficient measuring the speed of adjustment towards the long-run equilibrium $(\hat{\alpha})$ is negative and statistically significant at the 1% level, which underlines the existence of a stable cointegration relationship between government revenue and spending. This implies that if the fiscal receipts are lower (higher) than their equilibrium level, they will increase (decrease) for the model to approach the long-run equilibrium. Finally, following Quintos (1995), since government revenue and spending are cointegrated and $0 < \hat{\beta} < 1$, the budget deficit in our panel of 20 C.L.A.C. turns out to be weakly sustainable over the period 1990-2012.

Table 4: Results from panel ECM estimated for C.L.A.C

Dependent variable: public revenue			
Explanatory variables	**Number of lags (L) and leads (F)**		
	L=1 and F=1	L=2 and F=1	L=1 and F=2
	Long-run coefficient		
Public spending $(\hat{\beta})$	0.948***	0.856***	0.923***
	(44.77)	(8.38)	(50.43)
	Short-run coefficients		
Error-correction term $(\hat{\alpha})$	-0.386***	-0.477***	-0.495***
	(-6.35)	(-5.65)	(-6.94)
ΔRev_{t-1}	0.070	0.113	0.135**
	(1.52)	(1.56)	(2.54)
ΔRev_{t-2}		-0.018	
		(-0.30)	
ΔExp_{t+2}			0.116***
			(2.80)
ΔExp_{t+1}	0.155***	0.129*	0.216***
	(3.09)	(1.91)	(3.64)
ΔExp_t	0.353***	0.357***	0.418***
	(3.53)	(3.53)	(4.45)
ΔExp_{t-1}	-0.191***	-0.233***	-0.203***
	(-5.89)	(-4.47)	(-5.59)
ΔExp_{t-2}		-0.080	
		(-1.46)	

Note: Rev (Government revenue), Exp (Public expenditure). *** Statistically significant at the 1% level. ** Statistically significant at the 5% level. * Statistically significant at the 10% level.

4. Conclusion

In this study, we have conducted a formal test of whether fiscal policies undertaken in twenty Central and Latin American countries are sustainable in the long-run. Recent panel unit-root and cointegration tests for panel data allowing for cross-sectional dependence have been performed to examine if the governments' behaviours have been coherent with their inter-temporal budget constraints. Using the panel unit-root test of Pesaran (2007) that simultaneously takes account of cross-section dependence and residual serial correction, econometric estimations show that the ratios of public expenditure, revenue, overall fiscal balance and public debt (in percentage of GDP) are not stationary in level but are integrated of order one. The error-correction based panel cointegration tests of Westerlund (2007) provide empirical support that government revenues and expenditures are cointegrated. The economic implication of this result is that public revenues and expenditures move together in the long-run. Nevertheless, the estimated cointegration parameter is less than one, which suggests that government spending is growing at a faster rate than government revenue. Such a relationship between these two fiscal variables questions the issue of fiscal sustainability.

The past fiscal behaviour of the governments could not be continued indefinitely in the future without inducing an adverse response from lenders. In other words, if fiscal policies were to be conducted in the future as it was in the past, the governments could eventually run into difficulties in marketing their debt.

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