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The Long-Run Effect of International Reserves on Economic Growth in Developing Economies

Muhammed Benli[1]
Aykut Ekinci[2]
Bilal Orhan[3]

Uluslararası Rezervlerin Gelişme Yolundaki Ekonomilerde Ekonomik Büyüme Üzerindeki Uzun Dönem Etkisi	**The Long-Run Effect of International Reserves on Economic Growth in Developing Economies**
Öz	**Abstract**
Bu çalışma, 1970-2019 döneminde 41 gelişmekte olan ülkede uzun dönemde uluslararası rezervlerdeki büyümenin ekonomik büyüme üzerindeki etkisini ampirik olarak incelemeye çalışmaktadır. Bu amaçla, panellerdeki olası heterojenliği ve yatay kesit bağımlılığını hesaba katmak için CS-ARDL ve CS-DL tahmin edicileri ile geleneksel panel veri tahmincileri olan DFE ve MG tahmincileri kullanılmıştır. Ampirik bulgular, seçilen ülke örnekleminde, enflasyonun iktisadi büyüme üzerindeki negatif etkisini ve uluslararası rezervlerin uzun dönem ekonomik büyüme üzerindeki pozitif etkisini doğrulamaktadır.	This paper attempts to empirically investigate the effect of international reserves growth on economic growth in the long-run in 41 developing countries over the period 1970-2019. For this purpose, we employ the CS-ARDL and CS-DL estimators to take into account heterogeneity and cross-sectional dependence that may present in our panels, as well as the DFE and MG estimators which are the traditional panel data estimators. The empirical evidence confirms the deteriorating impact of inflation and the significant positive effect of international reserves on the long-run economic growth in the selected sample of countries.
Anahtar Kelimeler: Uluslararası Rezervler, Panel Veri Modelleri, Yatay Kesit Bağımlılığı	**Keywords:** International Reserves, Panel Data Models, Cross-Sectional Dependency
JEL Kodları: C33, F21, F30	**JEL Codes:** C33, F21, F30

Araştırma ve Yayın Etiği Beyanı	Bu çalışma bilimsel araştırma ve yayın etiği kurallarına uygun olarak hazırlanmıştır.
Yazarların Makaleye Olan Katkıları	Yazar 1'in makaleye katkısı %45, Yazar 2'nin makaleye katkısı %30, Yazar 3'ün makaleye katkısı %25'tir.
Çıkar Beyanı	Yazarlar açısından ya da üçüncü taraflar açısından çalışmadan kaynaklı çıkar çatışması bulunmamaktadır.

[1] Assoc. Prof., Bilecik Seyh Edebali University, Department of Economics, muhammed.benli@bilecik.edu.tr
[2] Prof., Bilecik Seyh Edebali University, Department of Economics, aykut.ekinci@bilecik.edu.tr
[3] Res. Asst., Bilecik Seyh Edebali University, Department of Economics, bilal.orhan@bilecik.edu.tr

1. Introduction

International reserves, sometimes referred to as foreign reserves, foreign exchange reserves, and external reserves, are capital deposits controlled by central banks or monetary authorities with the intention of accumulating a set of reserve currencies. Since international reserves are used to measure a country's capacity to meet its foreign currency obligations, they function as an economic indicator.

There are different explanations in the literature regarding what international reserves are and how they should be defined. Grubel (1984) defines international reserves as assets that nations are ready to accept from other nations to pay off their debts. Lehto (1994), on the other hand, defines international reserves as the foreign component of money supply and as a buffer used to eliminate the imbalances between foreign exchange supply and demand. According to Bird and Rajan (2003), international reserves are stocks held against future uncertainty of the balance of payments.

Most commonly, international reserves are defined as official public sector assets controlled by monetary authorities to directly finance payment imbalances and regulate the magnitude of these imbalances through affecting the exchange rate and/or for other related purposes (such as maintaining confidence in the economy and currency, and providing a basis for foreign borrowing) (IMF 2001).

The purpose of holding international reserves varies depending on the interests of each country. However, it can be argued that the main motive for accumulating reserves is to help stabilize the economy in terms of purchasing power. Therefore, international reserves serve as a mechanism responsible for compensating the balance of payments by the difference between capital inflows and outflows. Hence, international reserves function to compensate for either internal or external macroeconomic and financial imbalances. On the other hand, international reserves, especially for developing countries, are required to mitigate the negative internal and external shocks by supporting foreign debt payments and increasing the country's credibility in international financial markets. In this respect, external reserves become a critical variable in times of increased financial volatility and macroeconomic uncertainty.

The high level of international reserves does not typically indicate a strong economic performance as the low level of reserves does not necessarily signify a poor economic performance either. As a matter of fact, the theoretical literature does not provide a definitive answer on the net effect of reserves on economic growth as the impact may work indirectly, both in negative and positive directions. For instance, countries such as China, Japan, Switzerland, and Russia, which have the highest level of reserves in the world, hold a high level of reserves as a policy instrument against their international obligations. However, China, one of the largest reserve holders, has had higher growth rates during the last couple of decades, while Japan, which is another large reserve holder, has had the slowest growth rate among the developed economies during the same period (Sula and Oguzoglu 2021). On the other hand, since the international reserves are composed of strong currencies such as the US dollar, euro, yen, and sterling, countries supplying these currencies do not need to keep high-level reserves. Hence, international reserves cannot be regarded as the only indicator of a country's financial strength.

International reserves are also used to balance excess demand and supply in the foreign exchange market, helping to mitigate currency volatility and reduce exchange rate over time

(Nowak et al., 2004; Sula and Oguzoglu, 2021). This role is particularly important during a currency crisis, as reserves can be sold to other countries in order to avoid sharp drops in the value of the domestic currency and thus isolate the price level and domestic income from the crisis. (Ben-Bassat and Gottlied, 1992; Lee and Aizenman, 2005; Sula and Oguzoglu, 2021). Also, a higher reserve level signals a higher ability of central banks to ensure the stability of exchange rate, and therefore, may reduce the likelihood of a destabilizing condition in the currency (Aizenman and Sun, 2012; Sula and Oguzoglu, 2021). In addition, a sufficient level of reserve stock can take a supporting role in financing imports and paying off debts when foreign borrowing is not possible. Therefore, it can be argued that, through these channels, a high level of reserves accumulation may help countries to maintain macroeconomic stability and stimulate economic growth (Sula and Oguzoglu, 2021). International reserves may also promote exports by affecting the exchange rates (through undervaluation) (Dooley et al. 2003; de Beaufort and Sondergaard, 2007; Lee and Aizenman, 2005; Laser and Weidner, 2020). As Krušković and Maričić (2015) argued, an increase in investment and thus output is closely linked to the growth of exports and production in the tradable sector, which is in turn associated with the accumulation of external reserves. The reserves accumulation, if the tradable sector is capital intensive, not only promotes investment but also leads to a high return on investment and high capital productivity by promoting economic growth and increasing the exports/GDP ratio (Krušković and Maričić, 2015). Furthermore, undervaluation may increase foreign direct investment by lowering foreign currency prices of real domestic assets, which in turn may enhance economic growth (Polterovich and Popov, 2003).

As a monetary policy tool, external reserves may also play an important role during a financial crisis. As a matter of fact, reserves function as a liquidity buffer in case of a collapse of the international financial market, as a means of reducing exposure to external factors and increasing confidence and stability in financial markets during financial crisis periods (Nwosa 2017). In this context, Dominquez et al. (2012) empirically show that high pre-crisis reserve accumulations are associated with high post-crisis GDP growth. Benigno and Fornaro (2012) also find that the ability of using reserves to provide liquidity in times of crisis increases the positive effect of reserve accumulation on growth.

On the other hand, there is a cost associated with securing and holding reserves. The opportunity cost of external reserves arises from the choices made by countries regarding reserves. Countries may prefer to keep their reserves in assets with high liquidity and low returns against the risks that may arise from the balance of payments, or they can also use their reserves in productive areas that will enable growth. The difference in yield between the two options reflects the opportunity cost of reserves. The return on foreign exchange reserves is often lower than the one on domestic assets for developing economies. For example, the return on foreign exchange reserves in many developing countries is less than 1%. This is partly due to the fact that foreign reserves of central banks must be highly liquid to be qualified as reserves. This liquidity assessment basically means that foreign reserves should be invested in US treasury bills and government assets in euros or Japanese yen. In all these cases, the rate of return on reserves is really low, and the difference between the domestic assets' return and the low return on foreign assets makes a substantial loss of income for central banks (Nwosa, 2017). A rapid accumulation of foreign reserves also complicates money management for the central bank. When the reserves accumulation is faster than anticipated in the monetary program, both broad and reserve money tend to exceed the target rate. This causes tensions

in money management and potentially suppresses the inflationary target of the government and central bank. Finally, if the central bank attempts to sterilize excess liquidity by issuing central bank bonds or treasury bills, it will result in substantial financial costs and low central bank profits (Nwosa, 2017). In sum, reserves held in liquid foreign assets often yield low returns but are financed either by high-yielding foreign capital outflows or, current account surpluses in the absence of reserve purchases. Therefore, high levels of reserves may create a social cost by preventing the exploitation of potential investment opportunities (with higher returns), and this, in turn, can undermine or even offset the potential positive effect of reserves accumulation on long-run economic growth (Rodrik 2006; Elhiraika and Ndikumana, 2007; Sula and Oguzoglu, 2021).

In sum, both the theoretical and empirical literature examining the relationship between international reserves and economic growth is ambiguous, predicting a positive and negative effect under certain conditions. The main idea of those who criticize holding large amounts of reserves is that these resources can be used in more efficient investments that will ensure economic development. On the other hand, the view of those who support holding excess reserves is that the opportunity cost of holding reserves is much lower compared to the economic consequences of a rapid currency devaluation (Romero, 2005).

In light of these discussions, it can be argued that what international reserves mean for achieving stable macroeconomic growth rates is still an open question. However, efforts in this direction are of great importance as they have important policy ramifications as the effect of reserves on growth may go either direction. Despite this fact, there are few studies examining the relationship between international reserves and economic growth. Therefore, in this study, we aim to contribute to the literature by focusing on the effect of international reserves on economic growth.

2. Literature Review

Although there is a clear relationship between external reserve holdings and economic growth from the theoretical standpoint, the empirical literature on the interrelationship between the two is limited. It can also be argued that there is no consensus in the literature regarding the direction of the effect of external reserves on economic growth. Furthermore, empirical evidence on the direction of the causality between the two is also mostly inconclusive due to the mixed findings. This section presents the findings of some of the influential studies in the literature, whereas empirical evidence provided by the rest of the studies in the literature is summarized in Table 1.

Fukuda and Kon (2012), using an unbalanced panel of 135 developing countries, examine the effect of foreign exchange reserves accumulation on macroeconomic variables. The results of the study indicate that foreign exchange reserves shorten debt maturity and increase external debt outstanding. Foreign exchange reserves are also expected to negatively impact consumption while enhancing investment and economic growth when the tradeable sector is capital intensive. Similarly, Cruz and Kriesler (2010) analyze the potential impact of excess international reserves on economic growth using data on some selected developing countries for the period 1996-2005 and argue that this excess of resources represents a potential source to promote economic growth, which may boost aggregate demand and thus increase domestic economic activities in these countries. Furthermore, Krušković and Maričić (2015) investigate the effect of foreign exchange reserves accumulation on economic growth in emerging economies. They find that a percentage increase in reserves leads to a 0.06% increase in GDP.

The results from the Granger causality imply a unidirectional causality from foreign exchange reserves to economic growth.

In the context of time-series analyses, Akinboyo et al. (2016) investigate the long-run and causal relationship between external reserves and economic growth in Nigeria for the period 2000Q1-2013Q2 employing the Toda and Yamamoto (1995), modified Wald statistic, and the Gregory and Hansen cointegration test. The empirical findings indicate the presence of a cointegrating relationship between the two with a structural break in 2009Q4, and specifically, a percent rise in reserves leads to a 0.15% increase in economic growth. The results also suggest a unidirectional causality from external reserves to economic growth. In a similar context, Kashif et al. (2017) investigate the effect of economic growth on holdings of international reserves in Brazil for the period 1980-2014 in the context of Error Correction Mechanism (ERM). Their findings reveal both the short- and long-run association between the variables. The results also indicate that economic growth has a positive impact on foreign exchange reserves, and specifically, a percent increase in economic growth leads to a 0.16 percent rise in international holdings in Brazil. Moreover, Kashif et al. (2020), employing data on India for the period 1985Q1-2014Q4, examine both the linear and nonlinear causal relationship between accumulation of international reserves and economic growth. The empirical findings suggest bidirectional linear and nonlinear causality between the two. However, Ojiako (2020) examines the two-way relationship between foreign exchange reserves accumulation and economic performance in Nigeria for the period 1981-2018. The empirical evidence suggests a cointegrating relationship between the variables, and the Granger causality test results imply a unidirectional causality running from GDP to international reserves. One of the recent studies, Kaphle (2021), analyzes the effect of foreign exchange reserves on economic growth in Nepal for the period 1975-2018. The findings of the study indicate the presence of a cointegrating relationship between the variables and imply that foreign exchange reserves have contributed to Nepal's economic growth during the study period.

Sula and Oguzoglu (2021) examine the international reserves – economic growth nexus for 120 developing and developed economies over the period 1981-2010. Employing dynamic panel data models, they find that reserves have a significant positive effect on economic growth. However, this effect is conditional on the interest rate differential between the related country and the US. Specifically, their findings indicate that when the interest rate differential is equal to its sample average, a 1% rise in the reserves/GDP ratio raises the annual growth rate by 0.007%.

Table 1: Literature Summary

Author	Country	Period	Estimation Method	Major Findings
Karfakis (1997)	Greece	1976-1992	Johansen-Juselius ML Tests	Systematic long-run relationship between real income, real reserves, the average propensity to import, and the interest rate on the Eurodollar.
Blanchard et al. (2010)	27 Emerging Economies	2007-2009	OLS	No significant role of reserves in explaining output collapse during the 2008-2009 global financial crisis.
Llaudes et al. (2010)	57 Developing Countries	2008-2009	OLS	Pre-crisis reserve holdings helped countries to alleviate the impact of the 2008-09 global financial crisis.
Dominguez et al. (2012)	187 Countries	2000-2011	OLS	Higher GDP growth rates post-2008-2009 global financial crisis is associated with pre-crisis reserve holdings.
Bussiere et al. (2015)	112 Emerging Economies	2008-2009	OLS and 2SLS	The high level of reserves helped countries with relatively short-term debt to alleviate the impact of the 2008-09 global financial crisis.
Nwafor (2018)	Nigeria	2004-2015	OLS	International reserves do not have a significant impact on economic growth.
Awoderu et al. (2017)	Nigeria	1980-2014	Johansen Cointegration Test and OLS	There is a long-run relationship between reserves and economic growth. International reserves promote economic growth.
Nwosa (2017)	Nigeria	1981-2014	OLS	International reserves have a significant positive effect on economic growth.
Kashif and Sridharan (2015)	India	1993-2013	Johansen Cointegration Test and VECM	There is a cointegrating relationship between reserves and economic growth. Economic growth has a significant positive effect on reserves.
Kashif (2016)	Algeria	1985-2014	Granger Causality Test and BDS Test	There is bidirectional linear causality between economic growth and reserves. There is a nonlinear causality running from economic growth to reserves.
Bentum-Ennin (2014)	5 West African Countries	1984-2009	Panel Data Models and Locally Weighted Scatterplot Smoothing (LOWESS)	Panel data analysis indicates the promoting effect of international reserves accumulation on economic growth. LOWESS analysis, on the other hand implies a U-shaped relationship between international reserves and economic growth.
Lin (2011)	20 Largest Reserve Holder Countries	1980-2008	Granger Causality Test	Foreign reserves Granger cause economic growth in emerging economies, whereas there is no Granger causal relationship between the two in advanced economies.

3. Empirical Methodology

The financial linkages of developing countries with the international capital markets have risen significantly in recent decades, which creates a spillover effect on countries in terms of economic and financial shocks. Therefore, the underlying model of the panel data must be specified properly by taking into account the economic and financial ties of countries; otherwise, such dependencies may cause biased estimates and spurious inference (Pesaran and Smith, 1995). Furthermore, as we discussed earlier, the effect of external reserves on economic growth differs across countries on account of country-specific factors and institutional differences across countries. In such a case, the estimates of the long-run effects might not be consistent, given that market conditions vary across countries (Maddala et al., 1997). Hence, neglecting potential cross-sectional dependence across panel units and an assumption of parameter homogeneity may lead to misleading empirical results. Fortunately, in contrast to the traditional panel data estimators, alternative procedures which are based on heterogeneous panel data with large T and N explicitly enable one to treat a potential cross-sectional dependence and heterogeneity across cross-sections. Therefore, this study adopts cross-section augmented autoregressive distributed lag (CS-ARDL) and cross-section augmented distributed lag (CS-DL) dynamic approaches proposed by Chudik and Pesaran (2015) and advanced by Chudik et al. (2013 and 2016) to estimate the effect of reserves on economic growth.

The traditional ARDL model is founded on the assumptions of cross-sectional independence of the error terms and homogeneity among the cross-sections. The general representation of the model with no time trend and other fixed regressors can be specified as

$$y_{i,t} = \mu_i + \sum_{j=1}^{p_y} \lambda_{ij} y_{i,t-j} + \sum_{j=0}^{p_x} \beta'_{i,j} x_{i,t-j} + u_{i,t}, \quad (1)$$

where $t = 1, \dots, T$ and $i = 1, \dots, N$ denote the time period and groups (cross-sections), respectively. μ_i represents the group fixed effects capturing time-invariant heterogeneity across groups. x_{it} is a k x 1 vector of regressors and β_{it} is a $kx1$ vector of coefficients to be estimated. The error correction form is then specified by:

$$\Delta y_{i,t} = \mu_i + \phi_i (y_{i,t-1} - \theta'_i X_{it}) + \sum_{j=0}^{p_y - 1} \lambda^*_{ij} \Delta y_{i,t-1} + \sum_{j=0}^{p_x - 1} \beta'^*_{ij} \Delta x_{i,t-j} + u_{i,t}, \quad (2)$$

where $\phi_i = -(1 - \sum_{j=1}^{p_y} \lambda_{ij})$, $\theta_i = \frac{\sum_{j=0}^{p_x} \beta_{ij}}{1 - \sum_k \lambda_{ik}}$, $\lambda^*_{ij} = -\sum_{m=j+1}^{p_y} \lambda_{im}$ where $j = 1,2, \dots, p_y - 1$, and $\beta^*_{ij} = -\sum_{m=j+1}^{p_x} \beta_{im}$ for $j = 1,2, \dots, p_x - 1$.

ϕ_i is expected to be significantly negative and represents the error-correcting speed of adjustment toward the long-run equilibrium. The vector θ'_i, then, captures the long-run relationships.

One way to estimate Eq. (2) is to use a mean group (MG) estimator. Although this estimator is consistent, it is unlikely to be a good estimator when either T or N is small (Pesaran et al., 1999). Eq. (2) can also be estimated using a dynamic fixed effects (DFE) estimation procedure in which the time series data for each group are pooled and only the intercepts freely differ across cross-sections is allowed. Nevertheless, the DFE approach yields inconsistent estimations unless the slope coefficients are identical. Another alternative estimation technique to estimate Eq. (2) is the pooled mean group (PMG) estimator in which individual regression coefficients are pooling and averaged. Even though the PMG estimator allows error

variances to vary across cross-sections, it constrains the long-run coefficients to be the same, and leads to inefficient and inconsistent estimates if otherwise (Pesaran et al., 1999).

The problem with the FE, MG, and PMG estimators is that they are based on the assumption of cross-sectional independence across panel members. However, this assumption may not hold due to the omission of unobserved local or global factors which may be correlated with the explanatory variables. This, in turn, leads to inefficient or even inconsistent estimates. Therefore, the traditional ARDL model must be modified to capture the cross-sectional correlation in the error terms by augmenting the model in Eq. (1) with the cross-sectional averages (Chudik and Pesaran, 2015):

$$y_{i,t} = \mu_i + \sum_{j=1}^{p_y} \lambda_{ij} y_{i,t-j} + \sum_{j=0}^{p_x} \beta'_{i,j} x_{i,t-j} + \sum_{j=0}^{p} \bar{v}_{t-j} + u_{i,t} \text{ with } \bar{v}_{t-j} = (\bar{y}_{t-j}, \bar{x}_{t-j}) \quad (3)$$

The long-run coefficients then can be calculated as: $\hat{\theta}_{CS-ARDL,i} = \frac{\sum_{j=0}^{p_x} \hat{\beta}_{j,i}}{1-\sum_{j=1}^{p_y} \hat{\lambda}_{j,i}}$

The main merit of the CS-ARDL methodology is that it provides both the short- and long-run coefficients. However, since the approach first estimates the short-run coefficients, if the time dimension is not sufficiently large and the rate of convergence towards the long-run relation is rather slow, the sampling uncertainty could be large Furthermore, the CS-ARDL model requires the correct specification of the underlying ARDL model (the lag order) is correctly specified because of the fact that the short-run coefficient is subject to small sample bias, and the sampling uncertainty may be of a large dimension (Chudik et al., 2016). The misspecification of the lags may lead estimates to have poor small sample properties.

On the other hand, the CS-DL approach, which is based on a DL representation, enables estimating the long-run coefficients without estimating the short-run coefficients and allows for weak cross-sectional dependence and residual factor error structure (Chudik and Pesaran, 2015). The CS-DL model also derives from the ARDL approach. Specifically, under the assumption that $|\lambda_i| < 1$, rewriting Eq. (1) yields:

$$y_{i,t} = \theta_{0,i} + \theta_{1,i} x_{i,t} + \delta_i(L)\Delta x_{i,t} + \tilde{u}_{i,t}, \quad (4)$$

where $\delta_i(L) = -\sum_{j=0}^{\infty}[\lambda_i^{j+1}(1-\lambda_i)^{-1}\beta_{1,i}]L^j$, $\theta_{0,i} = (1-\lambda_i L)^{-1}\alpha_i$, $\tilde{u}_{i,t} = (1-\lambda_i L)^{-1}u_{i,t}$ and L is the lag operator. The regression in Eq. (4) is then augmented by the cross sectional averages, differences and lags of the regressors and the estimators are obtained using:

$$y_{i,t} = \theta_{0,i} + \theta_{1,i} x_{i,t} + \sum_{j=0}^{p_x-1} \delta_{ij} \Delta x_{i,t-j} + \sum_{j=0}^{p_{\bar{y}}} \gamma_{y,ij} \bar{y}_{i,t-j} + \sum_{j=0}^{p_{\bar{x}}} \gamma_{x,ij} \bar{x}_{i,t-j} + e_{i,t} \quad (5)$$

where $\bar{x}_t = N^{-1}\sum_{i=1}^{N} x_{it}$, $\bar{y}_t = N^{-1}\sum_{i=1}^{N} y_{it}$, $p = p_{\bar{x}}$ is chosen as a nondecreasing function of the sample size T (set equal to the integer part of $\sqrt[3]{T}$) and $p_{\bar{y}} = 0$. Once the individual estimates $\hat{\theta}_i$ are obtained, the consistent estimate of the average long-run effects is calculated as $\hat{\bar{\theta}} = N^{-1}\sum_i^N \hat{\theta}_i$.

The main merit of this approach is its superior small sample performance compared to CS-ARDL specification when the time dimension is not very long (30 < T < 100). However, the CS-DL estimator could suffer from simultaneity bias (Chudik et al. 2016). However, Chudik et al. (2016) argue that CS-DL approach can still outperform the CS-ARDL approach in terms of RMSE when T is not very large. Furthermore, the CS-DL approach is robust to serial correlation in residuals and possible breaks in the error processes. Nevertheless, it should be noted that the CS-ARDL and the CS-DL are not substitutes but complementary models as they have their own merits and limitations.

4. Data and Empirical Evidence

This study empirically investigates the impact of international reserves on long-run economic growth by employing a sample of 41 developing economies listed in Table 2 for the period 1970-2019. The countries and the time period have been selected based on data availability, and only countries with at least 30 years of consecutive annual observations on the variables are included in the study to obtain consistent estimates of country-specific coefficients.

Table 2: Selected Countries

Algeria	Bahamas	Bolivia	Burundi	Colombia	Costa Rica
Dominican Rep.	Ecuador	Egypt	El Salvador	Fiji	Gabon
The Gambia	Ghana	Guatemala	Honduras	India	Indonesia
Jamaica	Kenya	Madagascar	Malaysia	Mexico	Myanmar
Morocco	Nepal	Nigeria	Pakistan	Panama	Paraguay
Peru	Philippines	Saudi Arabia	Singapore	South Africa	South Korea
Sri Lanka	Thailand	Trinidad and Tobago	Turkey	Uruguay	

For the purpose of the study, we use annual data on GDP (constant at 2010 US$), total reserves minus gold (% of GDP), and consumer price index (CPI) (2010=100). The data are extracted from the primary World Bank collection of development indicators, and all the variables are transformed into their natural logarithmic form to be able attain growth variables when first differenced.

In this section, we begin with the standard panel ARDL approach, of which the error correction form is as follows:

$$\Delta y_{i,t} = c_i + \sum_{l=1}^{p} \varphi_{i,l} \Delta y_{i,t-l} + \sum_{l=0}^{p} \beta'_{i,l} x_{i,t-l} + u_{i,t} \quad (6)$$

where $y_{i,t}$ is the log of real GDP, $x_{i,t} = (res_{i,t}, inf_{i,t})'$, $res_{i,t}$ is the log of reserves to GDP ratio, and $inf_{i,t}$ is the log of CPI. Following Chudik et al. (2016), we consider the same values of p ranging from 1 to 3 for all variables/countries. Table 3, assuming slope homogeneity, presents the FE estimates which will be inconsistent in the presence of slope heterogeneity even if the time dimension is sufficiently large (Pesaran and Smith, 1995). MG estimates, on the other hand, are summarized in Table 4 (allowing for slope heterogeneity). So long as the errors are cross-sectionally independent, the MG estimates are consistent under fairly general conditions (Chudik et al. 2013). In the tables, the average estimates of the long-run effects of reserves/GDP and inflation on economic growth are represented by θ_{res} and θ_{inf}, respectively and the mean estimate of the coefficients of the error term is denoted by λ.

Table 3: FE Estimates of the Long-Run Effects Based on the ARDL Approach, 1970-2019

	ARDL (1 lag)			**ARDL (2 lag)**			**ARDL (3 lag)**		
	(a)	**(b)**	**(c)**	**(a)**	**(b)**	**(c)**	**(a)**	**(b)**	**(c)**
θ_{res}	0.022*		0.022*	0.036*		0.035*	0.046*		0.045*
	(0.006)		(0.006)	(0.008)		(0.007)	(0.010)		(0.010)
θ_{inf}		-0.026*	-0.028*		-0.028*	-0.029*		-0.026*	-0.027*
		(0.004)	(0.004)		(0.006)	(0.006)		(0.005)	(0.006)
λ	-0.704*	-0.718*	-0.714*	-0.660*	-0.674*	-0.669*	-0.682*	-0.689*	-0.689*
	(0.036)	(0.037)	(0.036)	(0.035)	(0.039)	(0.037)	(0.047)	(0.053)	(0.049)
CD	15.71*	18.05*	16.05*	15.71*	17.99*	16.29*	14.70*	17.16*	15.33*
N*T	1968	1968	1968	1927	1927	1927	1886	1886	1886

Notes: Standard errors are reported in parenthesis. * denotes significance at the 1% level.

The results indicate a direct relationship between international reserves and economic growth. Specifically, both estimation methods yield highly significantly positive coefficients with similar magnitudes across various lag orders. However, only the FE estimations provide significant evidence on the deteriorating effect of inflation on economic growth. Furthermore, across both estimation methods, the speed of adjustment to long-run equilibrium is somewhat quick.

Table 4: MG Estimates of the Long-Run Effects Based on the ARDL Approach, 1970-2019

	ARDL (1 lag)			ARDL (2 lag)			ARDL (3 lag)		
	(a)	(b)	(c)	(a)	(b)	(c)	(a)	(b)	(c)
θ_{res}	0.029*		0.028*	0.041*		0.042*	0.053*		0.059*
	(0.008)		(0.008)	(0.010)		(0.010)	(0.014)		(0.014)
θ_{inf}		-0.041	-0.047		-0.023	-0.027		-0.011	0.013
		(0.030)	(0.032)		(0.030)	(0.032)		(0.031)	(0.043)
λ	-0.685*	-0.723*	-0.708*	-0.684*	-0.705*	-0.677*	-0.672*	-0.666*	-0.650*
	(0.042)	(0.043)	(0.042)	(0.041)	(0.047)	(0.043)	(0.039)	(0.047)	(0.043)
CD	15.83*	19.20*	17.02*	16.82*	18.82*	17.29*	16.22*	18.73*	17.25*
N*T	1968	1968	1968	1927	1927	1927	1886	1886	1886

Notes: Standard errors are reported in parenthesis. * denotes significance at the 1% level.

However, as we noted earlier, the potential cross-sectional error dependencies may lead to biased estimates. As a matter of fact, the statistics of the CD test of Pesaran (2004, 2015) reported in Tables 3-4 are highly significant, indicating the presence of the cross-sectional dependence, and the estimates based on traditional ARDL model might be misleading. We employ the CS-ARDL approach in order to overcome this issue and obtain the MG estimates for different truncation lag orders. The CS-ARDL regressions which augments the ARDL regressions are given by

$$\Delta y_{i,t} = c_i + \sum_{l=1}^{p} \varphi_{i,l} \Delta y_{i,t-l} + \sum_{l=0}^{p} \beta_{i,l}' x_{i,t-l} + \sum_{l=0}^{3} \psi_i' \bar{z}_{t-m} + e_{i,t} \quad (7)$$

where $\bar{z}_t = (\bar{y}_t, \bar{x}_t')'$, and all the other variables are as defined in Equation 6.

Table 5 reports the estimation results of the CS-ARDL framework, which presents similar results to those based on the traditional ARDL approach for the effect of reserves on economic growth. The CS-ARDL estimates also yield significantly negative coefficients of inflation. Furthermore, the CD test statics are noticeably lower than those in Tables 3-4 and confirm a gradual decline when considering the CS-ARDL model. Finally, the speed of convergence to equilibrium is very quick in all cases and faster than the ones in the ARDL model. However, these values should be regarded as indicative on account of the small sample bias in the short-run estimates (Chudik et al., 2013).

Table 5: MG Estimates of the Long-Run Effects Based on the CS-ARDL Approach, 1970-2019

	ARDL (1 lag)			ARDL (2 lag)			ARDL (3 lag)		
	(a)	(b)	(c)	(a)	(b)	(c)	(a)	(b)	(c)
θ_{res}	0.019*		0.012	0.040*		0.030*	0.058*		0.031*
	(0.010)		(0.008)	(0.014)		(0.011)	(0.022)		(0.015)
θ_{inf}		-0.094*	-0.104‡		-0.136†	-0.176*		-0.130	-0.201*
		(0.035)	(0.058)		(0.061)	(0.068)		(0.090)	(0.077)
λ	-0.703*	-0.781*	-0.800*	-0.710*	-0.769*	-0.815*	-0.711*	-0.756*	-0.834*
	(0.043)	(0.040)	(0.042)	(0.049)	(0.047)	(0.052)	(0.048)	(0.045)	(0.052)
CD	-2.35†	-2.47†	-2.34†	-2.14†	-2.80‡	-1.71‡	-1.93*	-2.79*	-0.58
N*T	1886	1886	1886	1886	1886	1886	1886	1886	1886

Notes: Standard errors are reported in parenthesis. *, † and ‡ denote significance at the 1%, 5% and 10% levels, respectively.

Due to our previous discussions, we also estimate the CS-DL specification of the previous models by running the following regression:

$$\Delta y_{i,t} = c_i + \theta_i' x_{i,t} + \sum_{l=1}^{p-1} \delta_{i,l}' \Delta x_{i,t-l} + \omega_{i,y} \overline{\Delta y}_t + \sum_{l=0}^{3} \omega_{i,xl}' \bar{x}_{t-l} + e_{i,t} \quad (8)$$

where the regressors are defined as in Equation 6. Table 6 summarizes the related MG estimates, in which the results are somewhat similar to those based on ARDL (FE estimates) and CS-ARDL, but with smaller magnitudes. Specifically, as is in the case of CS-ARDL, the long-run effect of international reserves on economic growth is significantly positive, and inflation has a significant negative effect on growth in the long run. Moreover, the CD test statics are again considerably lower than the ones in Tables 3-4.

Table 6: MG Estimates of the Long-Run Effects Based on the CS-DL Approach, 1970-2019

	ARDL (1 lag)			ARDL (2 lag)			ARDL (3 lag)		
	(a)	(b)	(c)	(a)	(b)	(c)	(a)	(b)	(c)
θ_{res}	0.004		0.005	0.020†		0.018‡	0.032*		0.029†
	(0.007)		(0.007)	(0.008)		(0.010)	(0.011)		(0.012)
θ_{inf}		-0.058†	-0.066‡		-0.067†	-0.103†		-0.059†	-0.122*
		(0.026)	(0.039)		(0.029)	(0.044)		(0.028)	(0.047)
CD	-3.59*	-3.13*	-3.11*	-3.39*	-2.80*	-2.22†	-3.16*	-2.50†	-0.86
N*T	1886	1886	1886	1886	1886	1886	1886	1886	1886

Notes: Standard errors are reported in parenthesis. *, † and ‡ denote significance at the 1%, 5% and 10% levels, respectively.

Overall, all the estimation methods which we considered agree on the positive effect of international reserves on economic growth in the long-run for the selected sample of countries for the study period. Also, the results from most of the models suggest a significant negative effect of inflation on economic growth. Since the CD test statistics are statistically insignificant for the case of 3 lags in both the CS-ARDL and CS-DL models, the true magnitude of the effect of international reserves on economic growth is may expected to be somewhere between 0.029-0.031, whereas the effect of inflation ranges from -0.122 to -0.201 (Chudik et al., 2013).

5. Conclusion

From the theoretical standpoint, international reserves might be considered to be an important contributor to the long-run sustainable economic growth. However, in the literature, few studies have been devoted to empirically examine the effect of reserves on economic growth. Moreover, not only most of these studies have been limited to a few number of individual countries but also empirical evidence on the interaction between the two is equivocal. Therefore, in this study, we attempt to establish the long-run effect of international reserves on economic growth using a panel data on sample of 41 developing economies over the period 1970-2019. For this purpose, we employ both the traditional panel data estimators and the recently developed and advanced estimation techniques designed for large heterogeneous panel data with cross-sectionally correlated errors. The empirical findings reveal a significant positive effect of international reserves and deteriorating impact of inflation on the long-run economic growth in the selected sample of countries for the study period.

The literature confirms that, after the financial liberalization period in 1990s, emerging economies have become more inclined to both banking and currency crisis. The literature has also shown that countries with high international reserves are less affected by such crises. As a matter of fact, there has been a continuous increase in the reserves of emerging economies since then. However, after a certain point, an unmethodical increase in reserves possibly become a burden instead of an advantage due to potential opportunity costs. Although this study confirms the positive effect of international reserves on economic growth in the long-run, this should just be indicative due to the fact that it is an important task to determine the optimal level of reserves holdings, which may naturally vary according to the respective economic and financial dynamics of each nation.

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