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Exchange rate volatility, corruption, and economic growth

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ABSTRACT

This study assesses the impact of exchange rate volatility on economic growth using a panel of 194 countries for the period 1995–2019. We resort to dynamic panel data models considering the exchange rate volatility estimated based on GARCH models as an explanatory variable, along with some control variables such as the level of economic openness and financial development, investment, government spending, and the expected level of education. Countries are grouped according to the level of corruption of the governments. The estimates from both Difference and System Generalized Method of Moments are obtained. The results consistently show a significant negative effect of exchange rate volatility on economic growth, which diminishes as the financial system develops. An important finding is that the effect of volatility is lower in high-corruption countries, which could be because they are used to dealing with the economic instability associated with low levels of governance and incorporate it as part of their costs.

1. Introduction

Traditionally, the exchange rate has not played a key role in economic growth theories, probably because this was not a variable of interest for the time and countries where the main theoretical approaches originated. In an open economy, however, economic growth can rely on exports, so that the exchange rate becomes a key factor. For example, a low and stable exchange rate could promote exports and even shape the production system if it is used to move the axis of economic activity from the primary sector to others with higher added value, such as the manufacturing sector. According to Ros (2015), a competitive exchange rate favors the efficient allocation of investment resources. The fact that the proper manipulation of the exchange rate gave positive results in countries such as Japan, South Korea, India, Taiwan, China, Chile, among others, gave this variable a strategic character in the design of economic growth policies. But the thesis of manipulating the exchange rate to promote exports to favor economic growth has generated controversy and has been at the center of a long dispute. In addition to tensions among countries, maintaining this policy for long periods can be detrimental to the health of the economy by compromising international reserves. Therefore, setting a competitive exchange rate should be considered a short-term policy at most, and should be accompanied by the design of strategies for its progressive dismantling and insuring its stability.

A more recent approach suggests that economic growth is so unstable that it cannot be attributed to any one factor. Instead, it is better to analyze the turning points in the pattern of economic growth and try to understand their behavior (Pritchett, 2000). In addition, there are doubts about whether the exchange rate does indeed affect economic growth and the true direction of this relationship, as well as whether it is the result of inadequate tools of analysis, or insufficiency or inadequacy of the variables included in the study.

On the other hand, Glüzmann et al. (2012) point out that taking advantage of economic growth opportunities can be compromised by institutional weaknesses –corruption and market failures - credit market weaknesses, among others. The excess of regulations and institutional controls under non-transparent conditions may confer on some groups a certain level of monopoly on a given good, service, or activity that they regulate and a captive market for it. For example, controlling the foreign exchange market may grant some pro-government favored groups access to cheap foreign currency to sell in the black market with exorbitant profitability. Thus, corruption could affect economic growth through restrictions on access to, for example, credits and foreign currency with the negative externalities this generates, in addition to discouraging investment, diversion of resources, tax evasion, among others (Tanzi, 1998).

There is no clarity as to the effect of corruption on economic growth. Some authors consider corruption as an escape route in countries with

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legal and institutional rigidities (Méon and Weill, 2010), offering lower prices and flexible environmental laws (Yapatake-Kosole and Ngaba, 2020; Li and Rengifo, 2018), while others perceive it as an inhibitor of economic growth by discouraging investments (Nguyen et al., 2014) and reducing productivity (Zakharov, 2019). An intermediate position suggests it has a differentiated effect according to the levels of both corruption and growth (Ahmad et al., 2012; Lucic, 2016).

But the exchange rate is not *per se* the only variable of interest as a tool to promote economic growth. There is also a growing concern about its volatility as a possible disruptor/promoter of growth, although the relationship between exchange rate volatility and gross domestic product (GDP) is even less clear and may depend, in part, on the level of development of the financial system, which can be facilitated in free exchange regimes (Hohensee and Kyungjik, 2004). Thus, the exchange rate variable has begun to be related to economic growth, accompanied by the qualifier "stable" or preceded by the term "unstable".

Once again, there are doubts about the direction of the possible effect of this volatility on output. On one hand, the economy faces the cost of unpredictable fluctuations in the value of the currency. On the other hand, volatility allows the economy to absorb external shocks by favoring a greater capacity to adapt to these fluctuations and forces the monetary authorities to have greater discipline, which results in its credibility. This positive aspect of exchange rate volatility has already been highlighted by Friedman (1956), when he stated that it was the result of inadequate policies rather than speculative factors, a reason used to justify the removal of exchange controls and the abandonment of the Bretton Woods system. Based on the above, it is worth asking how economic growth is affected by the volatility of the exchange rate, and whether this effect varies in the presence of different levels of corruption. We find a strong correlation between the real per capita GDP and the level of government integrity (0.82), the former growing much faster in low-corruption countries, and being up to six times the average GDP of corrupt countries. The exchange rate volatility negatively correlates with government integrity (−0.46) and has been decreasing over time, usually being lower in low-corruption countries (2.9% versus 6.6% in high-corruption countries). Also, a significant negative effect of exchange rate volatility on economic growth (−0.50 correlation) diminishes as the financial system develops. Incorporating the role of corruption in the analysis of the relationship between exchange rate instability and economic grow is probably the main contribution of this study; the most critical finding is that the effect of volatility is lower in high-corruption countries.

The paper is organized as follows. The current section describes the phenomenon under study. Section two describes the mechanisms of transmission and revises the empirical literature, highlighting the main variables and techniques used to approach the problem. Section three describes the structure and source of the data set in use, as well as the methodology used to analyze it. Finally, the paper presents the results and conclusions.

2. Background knowledge

2.1. Mechanisms of transmission

The concern about the effect of the exchange rate on the economic growth has been giving way to a growing interest in the role of the volatility of this rate given the uncertainty it represents, with the aggravating factor that there is no clarity about how volatility can affect the economic performance. On the other hand, increasingly, citizens in developing countries are aware of their governments' mismanagement of public resources and feel that corruption prevents them from achieving economic development that allows them to get out of their characteristic circles of poverty and inequality. Once again, there is clarity as how corruption affects the countries 'economic performance, neither how corruption can interfere with the behavior of the exchange rate. Analyzing the role of exchange rate volatility in economic growth is the main purpose of this study, also seeking to identify whether this relationship varies according to the level of government's integrity.

There are different mechanisms through which the exchange rate can clearly impact economic growth. The most obvious one is its influence on trade flows by affecting relative prices. A real overvaluation makes domestic tradable products relatively more expensive, reducing exports and increasing imports. Therefore, investment, production, and employment in the tradable sector may shrink, with a reallocation of resources towards the raw materials and non-tradable goods sector, generally with lower returns. On the other hand, the lower the price of imported products, the higher the quantity demanded, which transforms local consumption patterns, generating employment and production in the country of origin of these products. According to Kandil (2015), developing countries can take advantage of overvaluation by importing capital goods and intermediate inputs at a lower price, which can even offset the negative effect and boost output. The exchange rate can also affect economic growth through its impact on the interest rate if the principle of equality of expected returns from similar assets in different denominations holds. This adjustment can affect the opportunity cost of investments and consumption decisions (Krugman et al., 2012).

On the other hand, there is limited theoretical literature that serves as a guide to understanding the mechanisms through which exchange rate volatility and economic growth interact (Aghion et al., 2009). This lack of information has been replaced by an abundance of empirical studies, often with unclear results. Volatility is known to negatively affect investment decisions, both due to the uncertainty it introduces about returns and the increased cost of debt via higher interest rates. On the consumer side, volatility promotes savings for precautionary reasons, frequently in foreign currency, if allowed, which does not translate into investments, but rather puts pressure on the exchange market and reduces the demand for durable goods (Aghion et al., 2009). Both factors depress employment and production (Bloom, 2014). Likewise, exchange rate volatility introduces noise into exchange prices and discourages both imports and exports. However, a developed financial system allows savers and investors, importers, and exporters to hedge against this fluctuation by facilitating a higher reaction capacity through more advanced financial instruments and reliable regulatory frameworks, thus reducing its negative impact on economic growth. The contradictions observed can be attributed to differences in groups of countries and periods, which make the results not comparable, and how homogeneous these groups should be; differences in methodological approach, as well as uncertainty about which factors should be considered that may vary from one country to the other; differences in the methods used to estimate exchange rate volatility, along with the debate about whether to use the nominal or real exchange rate, its misalignment, or its volatility, which would facilitate the design and implementation of policies in this regard, as described by Eichengreen (2008).

2.2. Literature review

Many studies find evidence linking economic growth to the behavior of the exchange rate. Hausmann et al. (2004) conclude that the acceleration of growth is positively correlated with the depreciation of the real exchange rate, among other factors. Rodrik (2008) suggests that undervaluation favors economic growth, especially in developing countries, and that such growth eventually appreciates the exchange rate. Jakob (2016) finds evidence that a fixed exchange rate generates economic stability and stimulates economic growth. Obstfeld et al. (2017) conclude that the greater the rigidity of the exchange rate, the greater the vulnerability of the economies to financial shocks due to their limited capacity to react and greater sensitivity to capital flows. The consequences of these rigidities maintained for long periods are analyzed by Sáez et al. (2018) in the case of Venezuela. On the contrary, Petreski (2009) finds evidence that the exchange rate regime does not affect economic growth.

Ferreira et al. (2016) reinforce the idea that the exchange rate can affect the country's productive structure since depreciation favors the production of tradeable goods with an increasing technological component. On the contrary, an appreciation caused by, say, a massive inflow of capital could shift investments towards non-tradable goods or low-added-value sectors, resulting in economic stagnation (Benigno et al., 2015). Schnabl (2007) identifies international trade and capital flows as important transmission mechanisms of exchange rate fluctuations towards the output.

Arcuyo (2016) shows how the undervaluation favored the economic growth of Nicaragua during the period 2001–2010, although its effect is temporary since prices react to bring the exchange rate to overvalued levels. In the case of Liberia, Presley and Boqiang (2018) conclude that currency depreciation reduces GDP while appreciation has no significant effects. On the contrary, in Bangladesh depreciation proved to contract the product in the short term while favoring economic growth in the long term (Khondker et al., 2012). In Mexico, Loria (2016) supports the idea that a competitive exchange rate promotes economic growth and opportunities to generate productive value chains, reducing imports. However, the higher the volumes traded in the financial market, the lower the ability of monetary authorities to respond to exchange rate volatility.

The volatility of the economy in general, and of the exchange rate in particular, has been of special interest in Latin America and the Caribbean (LAC) due to the low and unstable rates of economic growth exhibited by the region during the last two decades of the 20th century, along with the high levels of inflation. The macroeconomic policies adopted in the region generally included interventions in the foreign exchange market by monetary authorities, both to control the real and nominal volatility of the economy, and to promote growth via exports, so that the anchoring of exchange rates was of common use. The duration of this measure beyond required limits forced important devaluations which came with more inflation. By the end of the 1990s, most countries had managed to achieve stability in prices and growth, mostly due to the adoption of more flexible exchange regimes (Pineda-Salazar and Cárcamo-Díaz, 2013). Ocampo (2011) points out that the effect of a stable competitive real exchange rate on the economy is comparable to the effect of technological progress, creating a virtuous circle that strengthens investment and exports.

The levels of international reserves improved as the region moved towards more flexible exchange regimes and managed to control inflation, which resulted in the ability to react to business cycles. However, some countries have moved in the opposite direction. In 2003, Venezuela left a flexible exchange rate regime for one that is completely controlled by the government, a situation that has persisted to date, which has exacerbated the levels of exchange rate volatility (Castillo and Ramoni-Perazzi, 2017) and prices, to the detriment of economic growth.

Aghion et al. (2009) used a GMM dynamic panel data model to analyze the effect of different measures of volatility and financial development on productivity, using a sample of 83 countries between 1960 and 2000. More than the volatility of the exchange rate, they conclude that it is important to consider its interaction with the development of the financial system since high volatility in the presence of a weak financial system can prevent economic growth. Barguellil et al. (2018) used a sample of 45 developing countries during the period 1985–2015 to analyze the effect of the volatility of the real and nominal exchange rates, as measured based on GARCH (1,1) models, on the logarithm of *per capita* GDP. Their GMM panel data dynamic models include covariates such as population growth rate, an indicator of economic openness, and government expenditure as a percentage of GDP. The analysis is carried out globally, or by exchange rate regime. Their results show a negative effect of volatility on economic growth only in countries with a flexible exchange rate, an effect that increases with the degree of financial openness.

Using the same methodology, but applied to the cases of Nigeria (Sabinaa et al., 2017) and Kenya (Pokhariyal et al., 2012), the authors find evidence of a significant negative effect of exchange rate volatility on economic growth in those countries. Also, they find that, unlike government expenditure and international reserves, foreign direct investment discourages product growth, warning about the need for policies geared towards investment in sectors that favor economic expansion. Caglayan and Torres (2011) for example, find that the exchange rate volatility mainly affects export-oriented sectors and investment in the sector of nondurable goods in Mexico. Alagidede and Ibrahim (2016) found evidence of a positive effect of exchange rate volatility on the economic growth of Ghana, attributable to the fact that higher volatility promotes innovation and a more efficient allocation of resources.

The concern about identifying the best way to estimate the volatility of the exchange rate led Holland et al. (2016) to test different models in the GARCH family for each of the 82 countries in their study. In the construction of the dynamic panel data model, the authors included a measure of the educational level, public spending, and economic openness. Furthermore, to control for the effect of economic cycles, the authors divided the 1970–2009 period into eight sub-periods. Once again, higher exchange rate volatility appears to negatively impact economic growth.

According to Ghosh and Ghosh (2002), countries with low governance are more likely to face currency exchange crises. Corruption promotes an environment of excessive risk-taking by all economic actors; poor institutions and rules of law make it difficult to undertake effective surveillance of factors triggering these crises and implement mechanisms to alleviate them. High fiscal deficits and public debt are frequent among countries with high levels of corruption which is a proximate trigger of currency crises. Haj et al. (2018) find that governance influences the determination of exchange rate policies that, in turn, impact economic growth. For example, the long-lasting rigid exchange rate regime imposed in Venezuela since 2003 opened the door to a black market for dollars and a highly corrupted exchange rate system that explains the remarkable volatility of the currency exchange rate in that country (Castillo and Ramoni-Perazzi, 2017; Kulesza, 2017). Cevik et al. (2017) find that macroeconomic strength and better institutional quality are crucial for exchange rate stability. However, low integrity governments may manage both fiscal and monetary policies in a discretional way and resort to devaluations to cover fiscal deficits. According to Hefeker (2010) in countries where corruption is a prevalent phenomenon, monetary policy is used to finance the public budget, facilitated by the lack of independence of central banks (Acemoglu et al., 2008). McKinnon and Pill (1999) and Wei and Wu (2002) associate corruption with over-borrowing behaviors which may affect the countries' structural composition of capital inflows and lead to currency instability. Hussain et al. (2017) and Spyromitros (2020) find that corruption may influence borrowing costs, affecting the exchange rate. Yet, corruption is not generally considered in empirical studies that attempt to analyze the relationship between the exchange rate and economic growth. The macroeconomic instability generally associated with corruption, and the financial and currency exchange rate crises they might generate can feedback the regulatory framework, the central bank operating procedures, and portfolio quality in the financial system to ensure the effectiveness of adjustment policies (Sundararajan and Balifio, 1991). Developing countries, most of which exhibit low levels of governance, may have learned to deal with this frequent instability and smooth its impact in many cases with the guidance and support of international institutions.

3. Methodology

3.1. Data

The final unbalanced database includes 194 countries annually observed during the period 1995–2019. The period was defined based on the most recent information available at the time the study began,

allowing time series long enough as to analyze the exchange rate volatility, but without including the politically and economically more convulsive decades. The selection of countries was subject to the availability of information provided by the World Bank's Economic Development Indicators. The definition of groups of countries according to their level of corruption was based on the government integrity indicator (*intg*) of the Index of Economic Freedom that the Heritage Foundation has been measuring since 1995. Citizens' trust in politicians, irregular payments and bribes, transparency in the design of government policies, the absence of corruption, citizens' perceptions of corruption, and the level of transparency in civil and government services are all factors included in this indicator. We opt for the government integrity indicator instead of, for example, the Corruption Perception Index by International Transparency (IT), as the former covers more aspects and shows a higher correlation with real per capita GDP. Based on the distribution of *intg* suggested by IT, two groups were defined to emphasize the differences in the effects of some covariates: countries with a low level of integrity in the exercise of government, hereinafter referred to as high-corruption countries ($intg \leq 50$), and countries with high levels of government integrity or low-corruption countries ($intg > 50$).

3.2. Exchange rate volatility

In this study, the exchange rate volatility is given by the coefficient of variation calculated based on the conditional variance estimated by generalized autoregressive conditional heteroskedasticity models (GARCH) proposed by Bollerslev (1986), applied to monthly nominal exchange rate series. We decided to use the nominal rate since the real exchange rate can introduce noise from other price fluctuations. In any case, several studies agree that the high correlation between both rates means that there are no significant differences in the results obtained from them. Barguellil et al. (2018) summarize a set of studies on the topic of exchange rate volatility and its impact on other variables, most of which use GARCH models.

For each country, we assumed that the conditional variance depends on the squared errors lagged q periods and on the conditional variance lagged p periods as shown in Eq. (1)

$$h_t = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \ldots + \alpha_q \varepsilon_{t-q}^2 + \beta_1 h_{t-1} + \ldots + \beta_p h_{t-p} \quad (1)$$

where h_t is the conditional variance and ε_t represents the error term of an ARIMA model given by Eq. (2)

$$\Delta^d er_t = \beta_0 + \sum_{i=1}^{p} \beta_i \Delta^d er_{t-i} + \sum_{i=1}^{q} \theta_i \varepsilon_{t-i} + \varepsilon_t \quad (2)$$

with er_t the logarithm of the nominal exchange rate.

For the United States, formally dollarized countries, and those whose currency is anchored to the U.S. dollar, the estimated exchange rate volatility was based on the dollar index (USDX). Unfortunately, in the process of estimating this volatility, it was necessary to exclude from the sample those countries whose exchange market situation was so volatile that it was impossible to estimate it from GARCH models. During the period under study, several countries suffered changes in their monetary units: the introduction of the euro, the dollarization of some economies, the emergence of new countries resulting from the separation from others with the adoption of new currencies. This is the reason why the final series of exchange rate volatility (*vol*) was given by the coefficient of variation calculated from the estimated conditional variance and, subsequently, averaged to adjust to the annual structure of the remaining variables in the study.

3.3. Objective function

To estimate the effect of exchange volatility on economic growth we consider the model given by

$$lgdp_{it} = \alpha + \beta\, lgdp_{it-1} + \delta\, vol_{it} + \varphi' x_{it} + \mu_i + \lambda_t + \nu_{it}, \quad (3)$$

with $i = \{1,\ldots,N\}$ and $t = \{1,\ldots,T\}$, where $lgdp_{it}$ represents the logarithm of real per capita GDP for country i in period t; $lgdp_{it-1}$ accounts for the persistence of economic growth; vol_{it} is the exchange rate volatility of estimated as explained in the previous section; x_{it} is a set control variables; μ_i and λ_t represent the country-specific and time-specific effect, while ν_{it} is the idiosyncratic error term. According to the World Bank, sustained economic growth is strongly linked to poverty reduction, which makes per capita GDP a suitable indicator of economic growth.

As control variables, we included those that are common in most studies, that is the logarithm of gross fixed capital formation as a percent of GDP (*gfcf*), whose impact is expected to be positive; the logarithm of the economic openness index (*eoi*) which reflects the weight of international trade and that is assumed to favor growth through specialization and access to technology and capital inputs; the logarithm of government expenditure as a percent of GDP (*gexp*), the effect of which can be either negative (crowding out) or positive (improving infrastructure or boosting private investment), and a measure of the stock of human capital based on the average years of schooling a child can expect to reach given enrollment rates by age and life expectancy (*edu*), which is expected to be positively related to economic growth. The financial development index (*fdi*) is expected to allow the economy to take advantage of market fluctuations and protect itself from the uncertainty it implies, which is why it is evaluated with and without interaction with volatility. The Global Competitiveness Index includes a measure of financial development. Aghion et al. (2009) consider several proxies of this development, such as private domestic credit to GDP, bank deposits to GDP, and liquid liabilities to GDP.

As for the interaction between exchange rate volatility and financial development, the latter is categorized into three groups: highly developed financial systems with values in the third tercile of the distribution (*high fdi*), values in the second tercile of the distribution (*mid fdi*), while financial systems poorly developed have values in the first tercile (*low fdi*). As stated before, corruption may affect the way some variables impact economic growth, so we estimate Eq. (3) separately by groups of countries classified based on the government integrity indicator (*intg*). The expected signs of these relationships are based on empirical results from previous studies cited previously.

We estimate GMM dynamic panel data models following the general literature. The study shows both the results from the original GMM estimator developed by Arellano and Bond (1991) that uses lags and differences in explanatory variables as instrumental variables and the results from the System GMM developed by Blundell and Bond (1998a,b) which is more efficient and corrects some weaknesses of the first. To prove the consistency of the estimators, the results of the first and second-order autocorrelation tests of the residuals are included, as well as the Hansen test of over-identification of restrictions. The estimates are obtained through the *xtabond2* routine developed in Stata by Roodman (2009). For the sake of robustness, we compare the results of different settings of the objective function (3) for the two groups of countries (high and low level of corruption), to prove that the results obtained do not obey specification problems. Likewise, the results are shown for the entire 1995–2019 period, for the decade 2000–2009 and for the decade 2010–2019.

4. Results

4.1. Descriptive analysis

As shown in Figure 1, the average exchange rate volatility has decreased over time, along with a remarkable increase in the average real per capita GDP.

Using values averaged over time, a strong positive correlation is observed between the real per capita GDP and the integrity index (0.82),

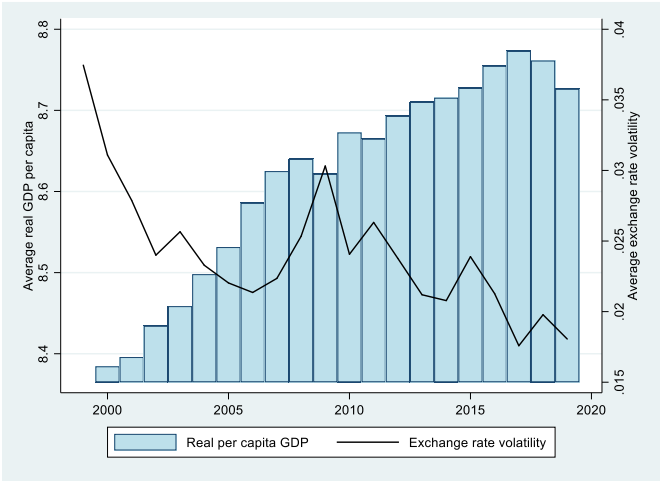

Figure 1. Evolution of the real per capita GDP and exchange rate volatility.

and significant negative correlations between real per capita GDP and exchange rate volatility (−0.50) and this last one and the integrity index (−0.46), associations illustrated in the graphs shown in Figure A1 in Appendix A.

The analysis by groups of countries based on the level of corruption indicates that real per capita GDP has been growing in both, slowly among countries with highly corrupted governments and exponentially in countries with upright governments, with marked differences in the level of this variable. On the other hand, the exchange rate volatility has been decreasing, narrowing the differences between groups. By 1995, the highest average level of volatility was observed in countries with high levels of corruption. However, the progressive decline in this volatility, either as the result of interventions in the foreign exchange markets, the dollarization adopted by some economies, or the anchoring of the local currency to the dollar, may explain the convergence of this variable in both groups (see Table 1).

According to the government integrity indicator (*intg*) of the Index of Economic Freedom by the Heritage Foundation, the five countries that repeatedly exhibit the highest levels of integrity in their governance are Finland, New Zealand, Singapore, Denmark, and Sweden, which also always rank first in the human development index (*hdi*). On the other side, it is difficult to limit the list of the most corrupt governments to just a few since many display the same values. However, some names tend to top the list when *intg* and the Corruption Perception Index by Transparency International are considered simultaneously: Indonesia, Yemen, Chad, Afghanistan, Sudan, Libya, Syria, Iraq, the Democratic Republic of the Congo, are some of them. Once again, their *hdi* usually ranks among the lowest values. As for Latin America, Chile, Uruguay, and Costa Rica are frequently listed among the first countries with the highest government integrity, while Nicaragua, Bolivia, Guatemala, Paraguay, and Ecuador are usually listed among those with the highest levels of corruption (see Appendix B for a more detailed comparison of the two groups).

Table 1. Average exchange rate volatility and real *per capita* GDP by groups.

Year	Real *per capita* GDP ($)		Exchange rate volatility (%)	
	High corruption	Low corruption	High corruption	Low corruption
1995	4,460	16,010*	9.74	3.77*
2000	4,127	25,763*	4.39	2.90**
2005	4,518	26,531*	1.89	2.56
2010	4,830	32,907*	2.10	2.87
2015	5,643	33,677*	2.90	1.56**
2019	6,684	33,920*	1.55	2.26**

Note: Test of differences in means between groups of high and low corruption based on the t-test. Statistically significant at 1% (*) and 5% (**).

4.2. Estimated results

As said before, dynamic panel data models are fitted considering robust GMM estimators, following the general literature. The results of System and Difference GMM are compared. The results for the entire period (1995–2019) are summarized in Table 2, while the results for the decades 2000–2009 and 2010–2019 are shown in Tables C1 and B2 of Appendix C. Regardless of the model specification, group, and type of estimator obtained, the coefficients associated with the lagged dependent variable are statistically significant, which corroborates the persistence and justifies the decision to fit a dynamic model.

The variable of interest, exchange rate volatility, always showed a statistically significant negative effect on economic growth, especially in the group of low-corruption countries. However, according to Aghion et al. (2009) the higher the level of financial development, the more economies can protect themselves against possible exchange market fluctuations, thus reducing the negative impact of volatility. To test this hypothesis the model included the variable *vol* in interaction with a categorized level of financial development classified from high to low (comparison group). The evidence indicates that, even though *fdi* by itself is not always statistically significant, the impact of exchange rate volatility diminishes or become less significant with highly developed financial systems, especially in low-corruption countries (see models (1.3), (1.4), (2.3), and (2.4) in Table 2).

As for the control variables, as expected, investments proved to have a positive and significant effect on economic growth, regardless of the group considered, while the impact of education seems to grow with the degree of government integrity. Regarding public spending, the crowding-out effect seems to prevail, especially in less corrupt economies, as indicated by the coefficient of *lgexp*. Economic openness has shown to have a marginally significant effect in high-corruption countries, without conclusive results for the other group. In all models, the p-values of the autocorrelation test allow us to conclude that the residuals do not present second-order autocorrelation and the Hansen over-identification test suggests that it is not possible to reject the null hypothesis of validity of the instruments used. Similar results are observed for the 2000s and 2010s separately (see Tables C1 and C2 in Appendix C, respectively).

The results are robust since they are observed in both types of estimators, under different specifications of the model and persist if the information is analyzed by periods. Likewise, they are consistent with theoretical expectations since volatility translates into uncertainty that can be better managed with a more developed financial system, for which clear rules are required. This is possible with more transparent governments. In fact, there is a marked difference in the levels of *fdi* in both groups of countries, much higher at higher values of *intg* (see Table B1 in Appendix B).

The fact that exchange rate volatility has a significant negative effect on economic growth was expected, since the literature shows many examples of similar results, despite some contradictory results. Volatility implies uncertainty, which can be attractive for speculative financial investments and can even accentuate such instability if the countries lack mechanisms to control capital flows. However, volatility translates into risk that introduces noise in the commercial exchange and discourages productive investment.

That the observed adverse effect of volatility on economic growth weakens in the presence of a solid financial system was also to be expected, as indicated by some of the studies previously cited. A developed financial system provides mechanisms for the economies to protect themselves from such instability by facilitating access to advanced financial instruments and professional advice. Also, a developed financial system could be a signal of greater transparency in the management of resources, which could facilitate the control of public funds.

Table 2. Results of the dynamic panel data models (1995–2019).

Variables	High level of corruption (1)				Low level of corruption (2)			
	(1.1)	(1.2)	(1.3)	(1.4)	(2.1)	(2.2)	(2.3)	(2.4)
lgdp(-1)								
System GMM	0.980*	0.955*	0.967*	0.847*	0.977*	0.982*	0.983*	0.763*
Difference GMM	0.814*	0.834*	0.813*	0.539*	0.913*	0.894*	0.924*	0.571**
vol								
System GMM	-0.043*	-0.038*	-0.038*	-0.088**	-0.219*	-0.239*	-0.914*	-0.773*
Difference GMM	-0.024***	-0.024**	-0.023*	-0.010*	-0.616**	-0.642*	-0.999*	-0.372**
fdi		0.342*	0.225	0.006		0.022	0.036**	0.113**
System GMM		0.179**	0.109*	0.024		0.011	0.020**	0.102
Difference GMM								
vol* mid fdi			-0.012**	-0.195**			-0.419*	-0.602***
System GMM			-0.007*	-0.258**			-0.538*	-0.165**
Difference GMM								
vol * high fdi			-1.734**	-0.090***			-0.011	-0.167
System GMM			-1.354	-1.860			-0.854***	-0.808
Difference GMM								
lgfcf				0.045*				0.058*
System GMM				0.088*				0.063*
Difference GMM								
leoi				0.025***				0.018**
System GMM				0.028***				0.001
Difference GMM								
lgexp				-0.020				-0.047**
System GMM				-0.004**				-0.029**
Difference GMM								
edu				0.177*				0.341*
System GMM				0.360*				0.613*
Difference GMM								
AR(1) p-value	0.012	0.024	0.024	0.001	0.000	0.027	0.000	0.003
System GMM	0.014	0.027	0.028	0.005	0.000	0.000	0.000	0.054
Difference GMM								
AR(2) p-value	0.364	0.769	0.753	0.587	0.076	0.797	0.714	0.182
System GMM	0.402	0.779	0.786	0.966	0.060	0.110	0.301	0.466
Difference GMM								
Hansen p-value	0.633	1.000	0.987	1.000 0.745	0.622	0.874	1.000	0.926
System GMM	1.000	1.000	1.000		1.000	1.000	1.000	1.000
Difference GMM								
Countries	121	118	118	112	73	71	71	63

Note: Logarithm of real *per capita* GDP as the dependent variable. Estimates were obtained using the command *xtabond2* for Stata (Roodman, 2009). The coefficients and robust standard errors were estimated using two-step GMM, including dichotomous variables for years. The variables *fdi*, *gfcf*, *eoi*, *gexp, edu* indicate financial development index, gross fixed capital formation, economic opening index, government expenditure, and average expected years of education, respectively. High *fdi* indicates values in the last tercile of the distribution; mid *fdi* indicates values in the second tercile of the distribution, leaving the first tercile (low *fdi*) as the comparison group. In all cases, we reject the null hypothesis that all panels contain unit roots, according to a Fisher-type unit root test based on the ADF.
Statistically significant at 1% (*), 5 % (**), and 10% (***).
P-values for first and second-order correlation test for the residuals; p-value for Hansen over-identification test.

However, that the adverse effect of exchange rate volatility is greater in countries with lower levels of corruption is probably our most important finding, for which we attempt to provide a reasonable explanation. As previously stated, most studies show that low government integrity is associated with greater macroeconomic instability that results from discretionary funds management, over-indebtedness, and the prevalence of fiscal over monetary policy. This can lead to exchange rate instability that can be induced by the government itself if it resorts to currency exchange rate manipulation to finance public spending, promote international trade, or even control the foreign exchange market for illicit purposes. The decade of the 1980s in Latin America was an example of how fiscal indiscipline forced, among others, the anchoring of the exchange rate. Therefore, we can assume that exchange rate instability is not a new or isolated phenomenon in countries with high-corruption governments who have learned from past experiences to the point that they usually cover themselves in advance through the financial system. In fact, the cost of protective measures against exchange market reversals is often incorporated into the production costs and in the accounting for investment projects, making it less profitable. Therefore, corruption can be considered as an undeclared tax. This might not be the case of more stable, low-corruption economies, in which these events may rather be rare, making them less prepared to face eventual episodes of volatility in their exchange rate markets.

5. Conclusions and discussion

This study analyzes the impact of exchange rate volatility on economic growth based on a sample of 194 countries annually observed during the period 1995–2019. Our most important contribution to the literature is that, unlike most documents in which government's integrity is not usually considered when analyzing the relationship between these two variables, we explore the possibility that the way volatility affects economic growth varies with the level of corruption. To do so, countries are divided into two groups of high and low levels of corruption based on the Government Integrity Indicator by the Heritage Foundation. In this way, we not only manage to emphasize the differences in the effects of the covariates of interest, but also avoid some endogeneity issues that

may arise from the possible relationship between them and the levels of corruption. The estimation of volatility as a coefficient of variation of monthly nominal exchange rates relies on GARCH models; to estimate the objective function dynamic panel data models are used. For the sake of robustness, the results obtained from System and Difference GMM estimators are compared, considering different model specifications and periods.

Exchange rate volatility has shown to be substantially higher (42% on average) in countries with higher levels of corruption in their governments but decreasing over time, probably due to the adoption of more controlled exchange rate regimes, at least in some periods of greater instability. Also, the levels of real per capita GDP dramatically differ between the two groups, being on average eight times higher in the low-corruption group ($ 28,800 versus $ 3,271) in the 2010s, with relatively faster growth and greater homogeneity. The results consistently support the thesis that exchange rate volatility negatively affects economic growth. We also find interesting evidence that the level of development of the financial system helps countries to cope with the uncertainty represented by the exchange rate instability, as indicated by Aghion et al. (2009), especially in low-corruption countries.

Our data show significant differences in financial development between both groups. Thus, while the median *fdi* in high-corruption countries barely increased from 0.16 to 0.19 between the decades of 2000 and 2010, in low-corruption countries it went from 0.35 to 0.50 and even reduced its dispersion. Even though some authors conclude that there is no relationship between corruption and financial development (Ekşï and Doğan-Başar, 2020), other studies find that further development of the financial system is a key factor in controlling corruption (Chandan and Paramati, 2020), which in turn depends on government transparency (Zhang et al., 2021). This occurs mainly because the higher the financial development, the greater the competition in this market, with the participation of private and foreign entities, and even the emergence of new ones. This greater participation not only reduces the costs of loans and facilitates access to them, but also allows corruption to be controlled (Sharma and Mitra, 2015).

However, the most important finding of this study is that the impact of exchange rate volatility on economic growth is higher in economies with low-corruption governments. This unexpected result deserves looking for possible answers, the corroboration of which opens an interesting field for further research. It is known that countries with high levels of corruption increasingly face macroeconomic instability typical of discretionary fiscal policy, in a scenario of lack of independence of the monetary authority, which has been associate with greater exchange rate instability and generates uncertainty (Ghosh and Ghosh, 2002; Hefeker, 2010; Fraj et al., 2018). This situation, rather than sporadic, seems natural in this group pf countries up to the point that such instability might by expected and incorporated into government and business plans, probably at the cost of overpricing and a less efficient allocation of resources, but feeding the regulatory framework and procedures of the financial system. Thus, it could be expected that these economies have learned to anticipate and react to this volatility, protecting themselves against it in advance and, therefore, reducing its impact with the guidance and support of international institutions (Sundararajan and Balifio, 1991).

Another result to highlight is the negative effect of government expenditure on economic growth, which can be interpreted as a predominance of the investment displacement effect. This result is consistent with those obtained by Barguellil et al. (2018) and Holland et al. (2016), but they contradict those authors who highlight the positive effect of public spending on output (Ahuja and Pandit, 2020). The effect of this variable is greater the lower the level of corruption, probably due to the diversion of resources that corruption represents, which weakens the positive or negative impact of this variable on the economy.

Consistent with the general literature, the effect of education remains positive and statistically significant. Education promotes economic growth through different mechanisms, such as improving the capacity to create, apply and adapt technology and thus increasing productivity and the efficient use of resources. Also, education improves living standards and, therefore, encourages the production and demand of more complex goods and services, with higher added value (Hanushek and Wößmann, 2010). The fact that this effect is relatively higher in low-corruption countries talks about the efficiency of the education system in these countries. As for economic openness, despite being relatively less dynamic in high-corruption countries, it seems to contribute more to economic growth in this group of economies, probably because it favors their participation in larger markets with greater purchasing power. Investment has a positive significant effect on economic growth, regardless of the level of corruption. However, its effect has been decreasing over time, with a greater effect on high-corruption countries in the last decade of the study.

Even though the classification of countries based on the integrity index was made on a natural interpretation suggested by IT based on its distribution, a further study should analyze whether the effects of the exchange rate volatility on economic growth change at the different quantiles of the index distribution.

As for a policy recommendation, it is necessary to promote exchange rate stability to help the economy to attract investments and promote economic growth. In this process, the financial system plays a significant role. Also, it is necessary to promote transparency in the administration of public resources which must be done both from the inside, by the citizens themselves, and from the outside, as a requirement among commercial partners and as a recipient of foreign investment. The financial system also plays an important role in this regard, as it can facilitate the process of auditing the proper management of financial resources.

Declarations

Author contribution statement

Josefa Ramoni-Perazzi, Ph.D.: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Héctor Romero, Doctor: Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data.

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Data availability statement

Data will be made available on request.

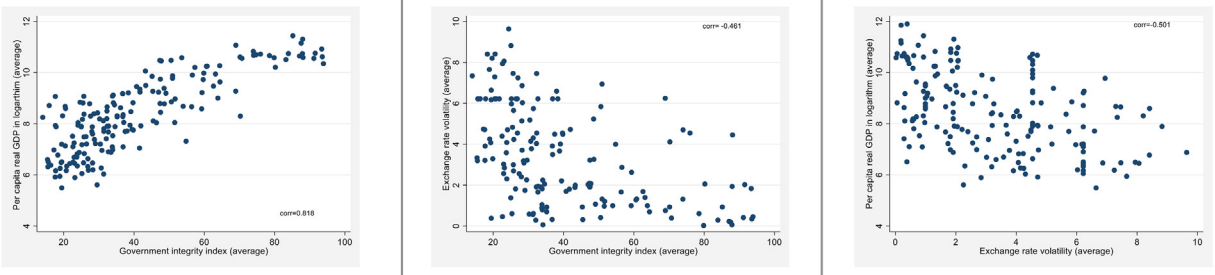
Declaration of interest's statement

The authors declare no competing interests.

Additional information

No additional information is available for this paper.

Appendix A



Note: A high government integrity index indicates low the level of corruption. All variables are averaged over time for each country.

Figure A1. Associations among real per capita GDP, exchange rate volatility and integrity index.

Appendix B

When characterizing the two groups of countries based on their level of corruption and their evolution over time, it is possible to extract some stylized facts. Table B1 depicts this behavior through the median values of the variables considered in the study, and their dispersion around the mean based on the coefficient of variation to facilitate comparison. Beyond the evident difference in the median levels of real GDP per capita (*gdp*), which in countries with low levels of corruption is eight times higher, it is important to highlight its relatively faster growth and decreasing variability in this group. There are also remarkable differences in the average expected years of study (*edu*), three years higher in countries with more upright governments. Thus, it seems that there is an increasingly homogeneous group of countries in terms of education and production, with high government integrity and high standards of living, coexisting with a heterogeneous group of countries in terms of these same variables, with low standards of living and high rates of corruption.

As expected, the greater human capital and product in countries with upright governments come with high levels of trade openness (*eoi*) and financial development (*fdi*). Gross fixed capital formation (*gfcf*) does not seem to vary significantly between groups and periods. There are also no noticeable differences in terms of the median values of exchange rate volatility, although its variability is greater in the second group. As might be expected, public spending (*gexp*) is substantially higher in less corrupt countries.

Table B1. Basic statistics by groups of countries and period

Variable	Definition	High level of corruption		Low level of corruption	
		2000–2009	2010–2019	2000–2009	2010–2019
gdp	Real gross domestic product *per capita* (PPP, $)	2,566 (1.31)	3,271 (1.34)	21,666 (1.00)	28,800 (0.85)
edu	Average expected years of education	11.40 (0.26)	12.2 (0.21)	13.50 (0.24)	15.4 (0.18)
fdi	Financial development index	0.16 (0.69)	0.19 (0.64)	0.35 (0.65)	0.50 (0.48)
eoi	Economic openness index	71.00 (0.48)	77.00 (0.48)	89.00 (0.72)	100.00 (0.68)
gfcf	Gross fixed capital formation (%)	22.39 (0.34)	23.76 (0.35)	22.93 (0.32)	22.71 (0.33)
gexp	Government expenditure (%)	20.16 (0.50)	19.67 (0.47)	26.11 (0.41)	26.53 (0.44)
debt	Public debt as a percent of GDP (%)	61.05 (56.70)	46.61 (33.08)	62.29 (40.69)	46.46 (31.44)
vol	Exchange rate volatility	0.02 (2.06)	0.01 (2.96)	0.01 (3.82)	0.014 (4.13)

Note: Median by groups of countries and period; coefficient of variation in parenthesis. Real per capita GDP based on purchasing power parity (PPP).

Appendix C

Table C1. Results of the dynamic panel data models (2000–2009)

Variables	High level of corruption (1)				Low level of corruption (2)			
	1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4
lgdp(-1)	1.021*	1.023*	1.025*	0.995*	0.971*	0.978*	0.973*	0.962*
System GMM	0.896*	0.890*	0.892*	0.880*	0.953*	0.979*	0.972*	0.904*
Difference GMM								

(*continued on next column*)

Table C1 (*continued*)

Variables	High level of corruption (1)				Low level of corruption (2)			
	1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4
vol	-0.123*	-0.081*	-0.085*	-0.105*	-0.348*	-0.227*	-0.970**	-0.397**
System GMM	-0.144**	-0.119*	-0.118*	-0.124*	-0.675*	-0.566*	-1.123*	-0.552**
Difference GMM								
fdi		0.047	0.029	0.016		0.004	0.004	0.013
System GMM		0.254*	0.159*	0.162***		0.029	0.036	0.019
Difference GMM								
vol* mid fdi			-0.439**	-0.026**			-0.748***	-0.677
System GMM			-0.164*	-0.081			-1.173**	-1.061**
Difference GMM								
vol * high fdi			-5.999	-0.089			-0.822	-0.016
System GMM			-0.829***	-0.097			-1.651*	-1.409
Difference GMM								
Log(gfdf)				0.079*				0.067**
System GMM				0.053*				0.081*
Difference GMM								
Log(eoi)				0.008				0.039***
System GMM				0.004				0.019
Difference GMM								
Log(gexp)				-0.023*				-0.078**
System GMM				-0.012***				-0.055***
Difference GMM								
edu				0.005*				0.002
System GMM				0.017*				0.004*
Difference GMM								
AR(1) p-value	0.002	0.000	0.000	0.002	0.008	0.076	0.005	0.004
System GMM	0.003	0.000	0.000	0.001	0.078	0.009	0.002	0.005
Difference GMM								
AR(2) p-value	0.556	0.506	0.465	0.370	0.388	0.392	0.371	0.488
System GMM	0.646	0.346	0.478	0.453	0.593	0.564	0.302	0.482
Difference GMM								
Hansen p-value	0.589	0.691	0.570	0.715	0.310	0.998	0.460	0.999
System GMM	0.995	1.000	1.000	1.000	0.997	0.999	1.000	1.000
Difference GMM								
Countries	125	120	120	114	74	73	73	67

Note: Logarithm of real *per capita* GDP as the dependent variable. Estimates were obtained using the command *xtabond2* for Stata (Roodman, 2009). The coefficients and robust standard errors were estimated using two-step GMM, including dichotomous variables for years. The variables *fdi*, *gfcf*, *eoi*, *gexp, edu* indicate financial development index, gross fixed capital formation, economic opening index, government expenditure, and average expected years of education, respectively. High *fdi* indicates values in the last tercile of the distribution; mid *fdi* indicates values in the second tercile of the distribution, leaving the first tercile (low *fdi*) as the comparison group. In all cases, we reject the null hypothesis that all panels contain unit roots, according to a Fisher-type unit root test based on the ADF.
Statistically significant at 1% (*), 5 % (**), and 10% (***).
P-values for first and second-order correlation test for the residuals; p-value for Hansen over-identification test.

Table C2. Estimates of the dynamic panel data models (2010–2019)

Variables	High level of corruption (1)				Low level of corruption (2)			
	1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4
lgdp(-1)	0.961*	0.943*	0.947*	0.977*	0.966*	0.968*	0.982*	1.082*
System GMM	0.609*	0.650*	0.657*	0.883*	0.864*	0.848*	0.843*	0.815*
Difference GMM								
vol	-0.001***	-0.067*	-0.067*	-0.045**	-0.155*	-0.042**	-0.075*	-0.531*
System GMM	-0.111*	-0.071*	-0.068*	-0.065*	-2.330*	-0.318*	-0.859*	-2.006**
Difference GMM								
fdi		0.198*	0.184*	0.095*		0.012**	0.010**	0.171*
System GMM		0.109*	0.067*	0.046		0.006	0.008**	0.019
Difference GMM								
vol* mid fdi			-0.034***	-0.059***			-0.065*	-1.926*
System GMM			-0.198*	-0.200**			-0.887*	-0.001
Difference GMM								
vol * high fdi			-1.005*	-0.246			-0.397	-1.056
System GMM			-0.653*	-0.019			-1.497*	-0.271
Difference GMM								
Log(gfcf)				0.070*				0.029*
System GMM				0.072*				0.054*
Difference GMM								

(*continued on next column*)

Table C2 (*continued*)

Variables	High level of corruption (1)				Low level of corruption (2)			
	1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4
Log(eoi)				0.011*				0.010
System GMM				0.0254**				0.024*
Difference GMM								
Log(gexp)				-0.038*				-0.090**
System GMM				-0.031*				-0.070*
Difference GMM								
edu				0.003*				0.002***
System GMM				0.009*				0.005**
Difference GMM								
AR(1) p-value	0.022	0.024	0.023	0.016	0.026	0.040	0.036	0.009
System GMM	0.025	0.027	0.025	0.034	0.047	0.050	0.042	0.011
Difference GMM								
AR(2) p-value	0.875	0.656	0.657	0.104	0.424	0.519	0.573	0.154
System GMM	0.792	0.592	0.597	0.171	0.958	0.329	0.755	0.152
Difference GMM								
Hansen p-value	0.909	1.000	1.000	0.916	0.941	1.000	0.996	1.000
System GMM	0.994	0.974	0.440	1.000	0.936	0.986	1.000	1.000
Difference GMM								
Countries	125	120	120	114	74	73	73	67

Note: Logarithm of real *per capita* GDP as the dependent variable. Estimates were obtained using the command *xtabond2* for Stata (Roodman, 2009). The coefficients and robust standard errors were estimated using two-step GMM, including dichotomous variables for years. The variables *fdi*, *gfcf*, *eoi*, *gexp*, *edu* indicate financial development index, gross fixed capital formation, economic opening index, government expenditure, and average expected years of education, respectively. High *fdi* indicates values in the last tercile of the distribution; mid *fdi* indicates values in the second tercile of the distribution, leaving the first tercile (low *fdi*) as the comparison group. In all cases, we reject the null hypothesis that all panels contain unit roots, according to a Fisher-type unit root test based on the ADF.
Statistically significant at 1% (*), 5 % (**), and 10% (***).
P-values for first and second-order correlation test for the residuals; p-value for Hansen over-identification test.

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