Economics Bulletin

Volume 39, Issue 1

Inflation and real exchange rate and macroeconomic gaps: causality for 50 emerging and developing countries

Ricardo R. Moreira
Federal University of Espírito Santo

Abstract

This article presents and tests two opposing hypotheses regarding the causality relationships between the inflation rate (as well as the real exchange rate) and macroeconomic gaps, especially the investment-domestic savings gap. For empirical purposes, the Dumitrescu and Hurlin (2012) method for Granger causality in panel data was applied to annual series from 1995 to 2014, covering a group of 50 emerging and developing countries. Furthermore, we also applied different methods for Dynamic Panel Data, specifically Difference and System GMM regressions. The empirical findings indicated a complementarity of both theoretical perspectives to explain the aforementioned relations, although these results are more robust for the conventional hypothesis.

I am thankful to the anonymous reviewers of Economics Bulletin for his/her important comments on the initial version. I am also thankful to Helder Ferreira de Mendonça (UFF-Brazil) for his important suggestions regarding the final version. Any errors are the author's responsibility.
Citation: Ricardo R. Moreira, (2019) "Inflation and real exchange rate and macroeconomic gaps: causality for 50 emerging and developing countries", *Economics Bulletin*, Volume 39, Issue 1, pages 142-158
Contact: Ricardo R. Moreira - ricardo.moreira@ufes.br.
Submitted: June 22, 2017. **Published:** January 13, 2019.

1. Introduction

The inflation rate and real exchange rate can be regarded as adjustment mechanisms facing macroeconomic disequilibria. However, controversy surrounds the causality relationships between these adjustment mechanisms and the related macroeconomic gaps, especially the investment-domestic savings gap. Basically, there are two opposing hypotheses on this subject: on the one hand, the conventional approach, according to which both inflation and real exchange rates are endogenous to the investment-domestic savings gap, i.e. the latter causes the former over time (Clark *et al.*, 1994; Clark and Laxton, 1995; MacDonald, 1997; Laxton and Pesenti, 2003). On the other hand, there is an alternative perspective that defines an inverse relation, i.e., both inflation and real exchange rates are considered as the exogenous cause of the investment-domestic savings gap (Montiel and Serven, 2008; Oreiro *et al*. 2014). The aim of the present article was to perform an empirical analysis of these hypotheses, based on a group of 50 emerging and developing countries and with annual series from 1995 to 2014. Thus, we applied the Dumitrescu and Hurlin (2012) method for Granger causality in panel data, as well as Dynamic Panel Data models (Difference and System GMM) in order to test the robustness of our causality findings.

In the conventional view, the investment-domestic savings gap determines the behavior of both the inflation and real exchange rate. For instance, if the investment rate is higher than the domestic savings rate there will be an excessive domestic demand over the GDP, thereby stimulating higher inflation rates (Clarida *et al.*, 1999). In other words, the output level stays above the potential output, which is accompanied by an increase in the inflation rate, resembling the theoretical results of the new-Keynesian Phillps curve.

In turn, in this context of an excessive investment rate over the domestic savings rate, there will also be a real overvaluation of the domestic currency as a consequence. In the conventional view, this occurs because such an excessive investment rate is translated into deficits in the current account of the balance of payments. Thus, a country in such a situation has to import foreign savings by means of an increase in its basic interest rate, so that the latter induces an inflow of foreign currencies as well as a nominal overvaluation of the domestic currency. Therefore, the nominal overvaluation, along with the higher domestic inflation rate, implies a real overvaluation of the domestic currency, given that we can usually express the real exchange rate as $\varepsilon = E.(P/P^*)$, with ε standing for the real exchange rate, E the nominal exchange rate, P a domestic prices index and P^* a foreign prices index. This means that if a country aims to sustain a more competitive real exchange rate – a lower ε – it is necessary to increase domestic savings so that there will be the inverse process, i.e. a reduction of both inflation and domestic basic interest rates, thus inducing a real undervaluation of the domestic currency (Clark *et al.*, 1994; Clark and Laxton, 1995; MacDonald, 1997; Laxton and Pesenti, 2003). We can then formalize the conventional hypothesis as follows:

$$y_t = \alpha + \sum_{j=1}^{n} \beta_j y_{t-j} + \sum_{i,j=1}^{n} \chi_{ij} x_{it-j} + \delta_t \tag{1}$$

where y_t can represent either the inflation or real exchange rate as a dependent variable, while x_{it-j} represents the possible i-explanatory variables or causes – especially the investment-domestic savings gap for our study – fixed in j possible time lags. In turn, χ_{ij} are the associated coefficients, while δ_t stands for a stochastic residual. Moreover, we also take into account the potential inertia of the dependent variable so that its past values can influence its current ones. Thus, $\sum_{j=1}^{n} \beta_j y_{t-j}$ stands for such a potential inertia component.

In contrast, the non-conventional approach defines the inflation rate and real exchange rate as causes of the investment-domestic savings gap. For example, if a country achieved a suitable management of its nominal exchange rate, domestic wages and costs of production, it would then be possible to sustain a mix of lower domestic interest rates and a real undervaluation of the domestic currency. Such an ideal mix would thus induce surpluses in both trade and current accounts of the balance of payments, as well as higher GDP levels and, consequently, enhanced domestic savings rates. Therefore, in the non-conventional view, the behavior of investment-domestic savings depends on the previous adjustment of the inflation and real exchange rate (Montiel and Serven, 2008; McMillan *et al.* 2013; Oreiro *et al*. 2014).

In the contemporaneous discussion on inflation targeting regimes, based on the alternative approach, one could suggest an adjustment of the inflation target (an increase) in order to allow for dropping the basic interest and real exchange rates. This kind of proposal is more frequent in emerging and developing countries, where inflation rates are mostly neither low nor quiet, requiring from Central Banks higher real interest rates compared to levels observed in advanced and developed countries. In short, from the alternative perspective, economic policies should first control inflation and real exchange rates so that *ex post* (as a consequence or effect) we can obtain desired changes in investment-domestic savings gaps.

Thus, based on Equation (1), the alternative hypothesis imposes an inversion: the inflation and real exchange rates appear as explanatory variables, or into x_{it-j}, while the gap is seen as the dependent series y_t. As one has available series regarding these three macroeconomic variables, i.e. inflation, real exchange rate and investment-domestic savings gaps, as well as a suitable econometric method to test for the opposing hypotheses, the controversy between them can be then empirically assessed. Obviously, due to common restrictions surrounding time samples for emerging and developing countries, it is convenient to perform panel data studies to allow for a larger number of observations.

It is noteworthy that both theoretical hypotheses can be considered as complementary in assessing our subject, despite each usually ignoring the other. Based on the conventional perspective, although investment-domestic savings gaps are assumed to explain inflation and real exchange rate behavior, one could raise the question about which forces determine such gaps at an initial moment. At the limit, all the variables that can affect investment and domestic savings decisions are potential candidates, including even the inflation and real exchange rates if we account jointly for the alternative perspective. In this case, we allow for a type of circularity (endogeneity) commonly disregarded in works dealing with each of these hypotheses. Past values of the investment-domestic savings gap are also an explanatory variable at the current level that we should take into account, as expressed in Equation (1).

The same consideration serves for the opposite direction: in the alternative perspective, inflation and real exchange rates are seen as the causes of the investment-domestic savings gap. However, what are the initial sources for changes in inflation and real exchange rates? Here, we can also consider the possibility of a complementary role of the conventional view, as well as the potential effects of past values of inflation (inflation inertia) and real exchange rates on their current behavior. This joint analysis, and its assumption of a possible circular causality among our studied variables over an expressive number of observations, is the main contribution of the current article that distinguishes it from the reviewed literature (Clark *et al*., 1994; Clark and Laxton, 1995; MacDonald, 1997; Laxton and Pesenti, 2003; Montiel and Serven, 2008; McMillan *et al.* 2013; Oreiro *et al*. 2014), which usually addresses each hypothesis on the issue (conventional and non-conventional) separately.

The remainder of the paper is structured as follows. The second section shows the dataset and the methodological strategy for empirical purposes. Finally, the third section analyzes the findings, which are followed by concluding remarks and the references.

2. Dataset and methodological strategy

The annual time series were all collected from the International Monetary Fund *(IMF) World Economic Outlook Database* for a group of 50 emerging and developing countries from 1995 to 2014 (T=20), thus encompassing 1,000 observations. The variables are: *gap* = gap between investment and domestic savings rates, both measured as a ratio to GDP; *p* = accumulated annual inflation rate (%); *ppp* = real exchange rate, represented by the IMF's *purchasing power parity*. Although it would be better if we used quarterly or even monthly data, as it would expressively increase our number of observations, these IMF time series are available only on an annual basis. It is important to note that in terms of *ppp* a domestic currency overvaluation is expressed by an increase in the variable, and the undervaluation by its decrease. Table 1 shows the group of 50 countries used in this work, while Table 2 highlights some descriptive statistics, and Figures 1 to 3 present the graphical behavior of the three series for each country.

Table 1 – The 50 emerging and developing countries

1.Armenia	11.Croatia	21.Haiti	31.Malawi	41.Nigeria
2.Azerbaijan	12.Djibouti	22.Hungary	32.Malaysia	42.Pakistan
3.The Bahamas	13.Dominica	23.India	33.Mauritania	43.Panama
4.Bahrain	14.Dominic. Rep.	24.Jamaica	34.Mexico	44.Peru
5.Brazil	15.Ecuador	25.Kazakhstan	35.Moldova	45.Philippines
6.Cameroon	16.Egypt	26.Kenya	36.Morocco	46.Poland
7.Chile	17.El Salvador	27.Kuwait	37.Mozambiq.	47.Romania
8.China	18.Ethiopia	28.Kyrgyz Rep.	38.Namibia	48.Russia
9.Rep. of Congo	19.Ghana	29.Lesotho	39.Nepal	49.Rwanda
10.Costa Rica	20.Guatemala	30.Libya	40.Nicaragua	50.Saudi Arab.

Source: Prepared by the author.

Table 2 – Descriptive statistics for our 50 emerging and developing countries

	gap (% of GDP)	*ppp (índex)*	*p (%)*
Mean	2.39	38.23	9.03
Median	2.78	4.42	5.40
Maximum	48.04	374.47	411.76
Minimum	-51.10	0.04	-9.86
St. Dev.	10.65	72.93	19.30

Source: Prepared by the author.

Before performing the causality analysis for the panel data, it is important to assess the integration order of the time series to avoid spurious estimates. For robustness reasons, we applied four unit root tests for panel data, i.e. the tests of Levin, Lin and Chu (2002), Im, Pesaran and Shin (2003) and ADF-Fisher, which is decomposed into two methods, the Fisher Chi-square and the Choi Z. Table 3 presents the results of these tests.

Table 3 – Unit root tests for the panel data (prob.)

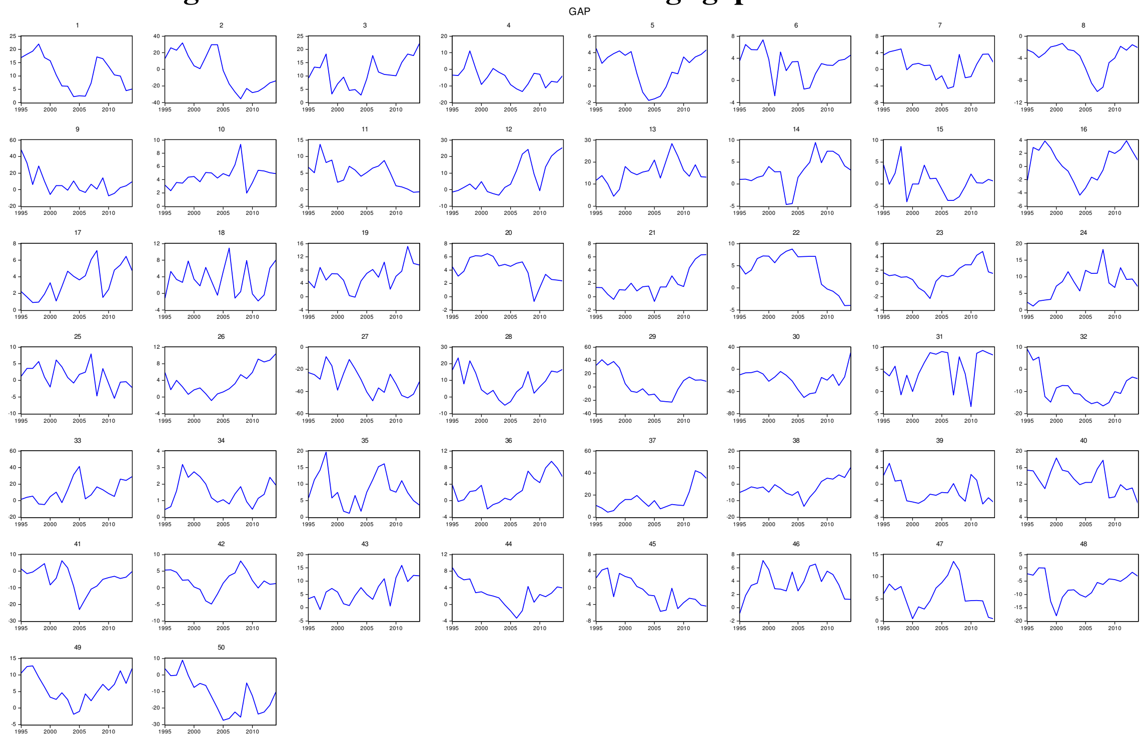
Individual intercept and trend				
	gap	**ppp**	**d(ppp)**	**p**
Levin, Lin & Chu*	0.0000	0.6395	0.0000	0.0000
Im, Pesaran & Shin*	0.0000	0.9966	0.0000	0.0000
ADF - Fisher Chi-square**	0.0000	0.2234	0.0000	0.0000
ADF - Choi Z-stat**	0.0000	0.9965	0.0000	0.0000
Individual intercept				
	gap	**ppp**	**d(ppp)**	**p**
Levin, Lin & Chu*	0.0000	1.0000	0.0000	0.0000
Im, Pesaran & Shin*	0.0000	1.0000	0.0000	0.0000
ADF - Fisher Chi-square**	0.0000	0.4582	0.0000	0.0000
ADF - Choi Z-stat**	0.0000	1.0000	0.0000	0.0000

Note: *lags* in each test were defined by the Schwarz criterion. Source: Prepared by the author.

Based on the results, only *ppp* is I(1), while *gap* and *p* are I(0). Figures 1-3 also confirm these findings. The trend in data is evident for *ppp* graphs. In this case, we did not perform the cointegration analysis proposed for panel data in Pedroni (1999), Kao (1999) and Maddala and Wu (1999). Instead, we used *ppp* in its first difference form or *d(ppp)*, and *gap* and *p* in level values. The Dumitrescu and Hurlin (2012) test for Granger causality in panel data is based on Wald statistics of mean non-causality over the cross-section units. The test recognizes the heterogeneity of the causality relationships among the cross-section units as well as the heterogeneity of the model used to test the Granger causality (Tugcu, 2014).

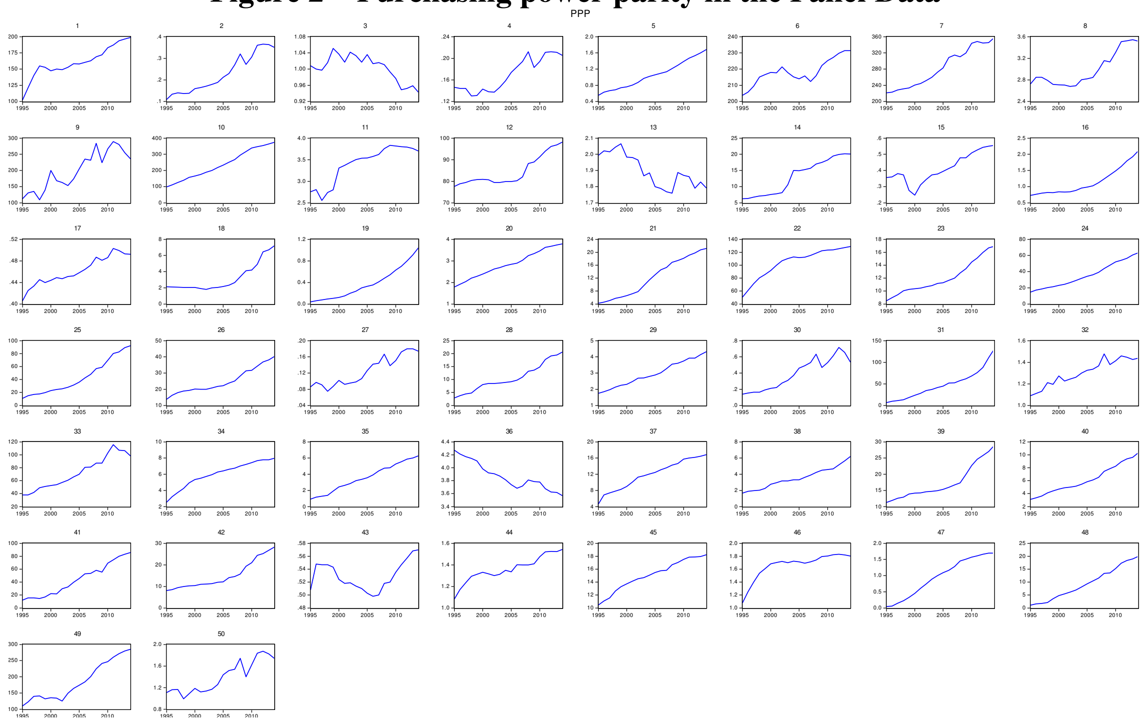
Initially, we adopted such a specific empirical method for two main reasons, an economic reason and a statistical one. Regarding the former, causality tests are suitable when an economic relationship is sensitive to theoretical controversies concerning the associated causality. Either the relation between the investment-domestic savings gap and inflation rate or the relation between this gap and the real exchange rate are exposed, as mentioned above, to different visions, especially with regard to theh causality path. Thus, the Dumitrescu and Hurlin (2012) test in panel data has a strong appeal for our research.

Figure 1 – Investment-domestic savings gap in the Panel Data



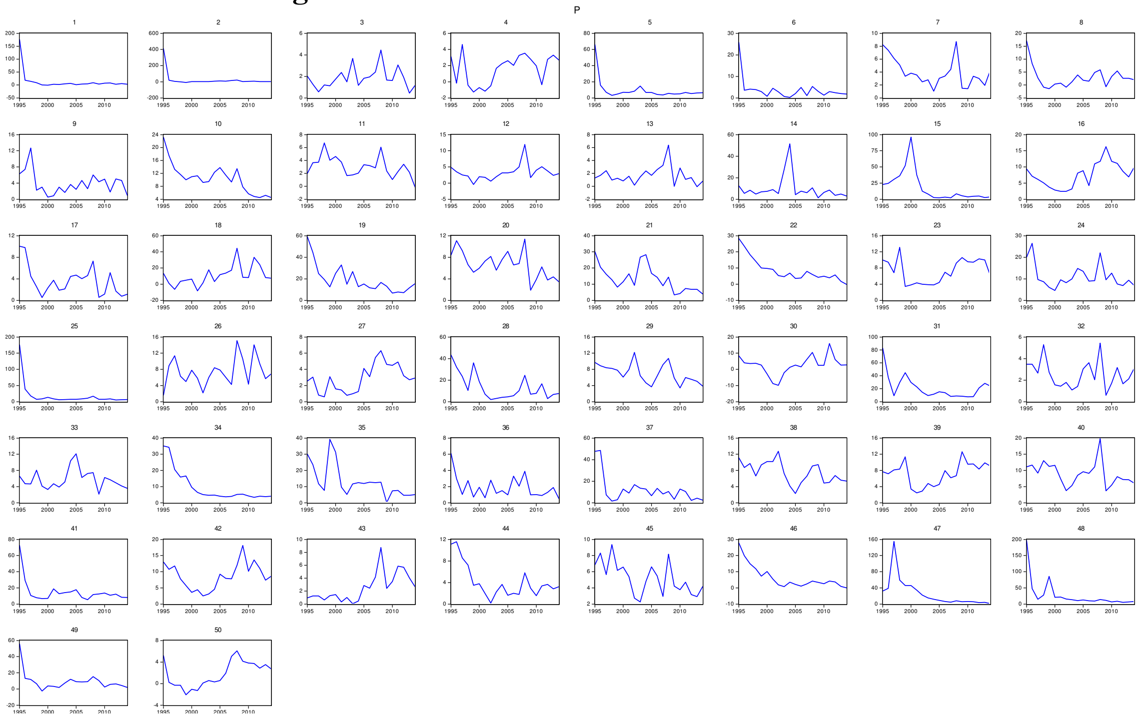
Source: Prepared by the author.

Figure 2 – Purchasing power parity in the Panel Data



Source: Prepared by the author.

Figure 3 – Annual inflation in the Panel Data



Source: Prepared by the author.

On the other hand, when it comes to the statistical reason, the main advantage of this heterogeneous panel data causality test in relation to existing frameworks, such as in Holtz-Eakin et al. (1988), is that it does not impose homogeneous coefficients on the lagged variables across countries. In other words, the Dumitrescu and Hurlin (2012) test allows for estimating Granger causality for each country individually and, in the second stage, averaging the individual Wald statistics to measure a standardized causality statistic. Furthermore, the test has very good small sample properties, even with cross-section dependence (Herzer, 2016). Therefore, this relatively new Granger-causality test for panel data is preferable, as our sample is not so large, particularly with regard to time (1995-2014) and also due to common cross-section dependence among the data. Finally, we performed the test for 1, 2 and 3 lags to allow it the potential to capture more delayed effects between the variables[1].

In turn, in order to test for the robustness of our causality results and preliminary correlation measures, we performed regressions based on the *Panel Generalized Method of Moments – GMM*, i.e. Dynamic Panel Data methods, taking into account the entire sample. The latter were applied especially as a strategy to control for potential endogeneity problems regarding regressors, as discussed earlier, and to exploit all the information contained in the sample efficiently through the instrumental variables approach (Arellano and Bond, 1991; Holtz-

[1] Some macroeconomic effects are not observed rapidly due to problems of inertia and/or rigidity in data and among variables. Therefore, specific cause and effect relations can require time lags in order to be identified. As we mention in this article, for instance, effects of the real exchange rate on trade balance, and thereby economic activity, need time to occur, such as those described by the J-Curve condition (Bahmani-Oskooee and Ratha, 2004). Thus, the motivation for testing 1, 2 and 3-year lags in the Dumitrescu and Hurlin (2012) procedure is indeed based on theoretical and empirical lags between macroeconomic causes and effects, rather than statistical robustness reasons.

Eakin, Newey and Rosen, 1988). Furthermore, when dependent variables are included as a lagged regressor, there may be a problem of dynamic bias in panel models (Wooldridge, 2002).

Arellano and Bond (1991) used a first-differenced equation and lagged levels of data as instruments to control these potential problems regarding endogeneity in regressors and bias in panel data models, as well as to remove unobserved fixed country specific effects. In addition, such a method allows consistent estimation in the presence of measurement error and also avoids spurious estimates due to omitted variables that are constant over time. Therefore, Difference GMM (D-GMM) regressions for panel data can be regarded as a superior estimation approach compared to simple cross-section regressions and other estimation methods for dynamic panel models (Bond et al. 2001).

However, the D-GMM method is prone to a serious drawback, which can occur when lagged levels of data are weak instruments for first-differences ahead, under persistent data and a low number of time series observations. To overcome such a restriction, Arellano and Bover (1995) and Blundell and Bond (1998) suggested a System GMM (S-GMM), based on the inclusion of moment conditions. S-GMM models are formed by first-differenced and level equations jointly, thus taking into account both lagged levels and first-differences as instruments.

It is important to consider that these estimators (D-GMM and S-GMM) are efficient only if we confirm the validity of the instruments adopted in the equations. We can test it based on the J-test (the test for over-identifying restrictions) and on the Arellano-Bond serial correlation test. If the instruments are valid in a Dynamic Panel Data estimation then the *differenced* residuals should exhibit serial correlation (by the AR(1) test), but it cannot be observed for the AR(2) statistics. Moreover, although S-GMM models are generally more efficient than D-GMM ones, we cannot take this for granted. One should compare empirical results and the tests for the validity of instruments as generated by both methods so that an appropriate choice between them can be made. In turn, Roodman (2009) addressed the problem regarding the adoption of an excessive number of instruments relative to the number of individuals in panel data models. This generally leads to a bias in the results.

Therefore, to avoid such a risk we highlighted specifications in which the instrument rank is lower or equal to our number of countries (N=50) in the estimation. It should be noted that D-GMM and S-GMM generate one instrument for each time period and lag available. Thus, increasing the number of time periods is a source for a proliferation of the number of instruments. As our number of units is larger than the number of time periods (N>T), both methods became suitable for our purposes.

3. Empirical results

3.1 Causality findings

In Table 4, we can observe the results from the Granger causality test for panel data proposed by Dumitrescu and Hurlin (2012). We first tested for the relation between *p* and *gap*, followed by the relation between *d(ppp)* and *gap*.

Regarding the former, the test rejects the null hypothesis of non-Granger causality from *gap* to *p* in all three specifications. Thus we can assume that, based on our Panel Data, changes in the gap between investment and domestic savings rates are followed by changes in the accumulated annual inflation rate 1, 2 and 3 years forward. The inverse causality relation was not corroborated. The null hypothesis of non-Granger causality from *p* to *gap* was accepted in all the three specifications. In short, for the 50 emerging and developing countries, we confirmed the conventional hypothesis according to which economic policies aiming to stabilize inflation dynamics should control monetary and fiscal instruments correlated to investment and domestic savings rates over time.

In turn, regarding the relationship between *d(ppp)* and *gap*, we did not reject the null of non-Granger causality in any direction for 1 and 2 lags, but for 3 lags and exclusively with respect to the causality from *d(ppp)* to *gap*. In this case, the alternative perspective was corroborated: real exchange rate changes cause the gap between investment and domestic savings 3 years forward and not the contrary.

Table 4 – Dumitrescu-Hurlin's Granger causality for panel data

Lags	Null hypothesis	W-Stat.	Zbar-Stat.	Prob.
1	p does not homogeneously cause gap	1.39433	0.98404	0.3251
	gap does not homogeneously cause p	1.99107	3.31916	0.0009
2	p does not homogeneously cause gap	2.71298	0.86958	0.3845
	gap does not homogeneously cause p	3.48889	2.80093	0.0051
3	p does not homogeneously cause gap	3.9878	0.40559	0.6850
	gap does not homogeneously cause p	5.1543	2.39519	0.0166
1	d(ppp) does not homogeneously cause gap	0.98319	-0.65551	0.5121
	gap does not homogeneously cause d(ppp)	1.21897	0.25015	0.8025
2	d(ppp) does not homogeneously cause gap	2.56125	0.3879	0.6981
	gap does not homogeneously cause d(ppp)	2.55581	0.37483	0.7078
3	d(ppp) does not homogeneously cause gap	5.60888	2.78112	0.0054
	gap does not homogeneously cause d(ppp)	4.07954	0.35309	0.7240

Source: Prepared by the author.

We tested Ordinary, Spearman and Kendall correlation measures for *gap* and *p*, as well as for *d(ppp)* and *gap* (Tables 5 and 6). We found that for both pairs there exists a positive correlation[2]. It means that when *gap* increases it Granger-causes an increase in the inflation rate 1, 2 and 3 years forward in our Panel Data. In turn, when *d(ppp)* decreases – i.e. there is a domestic currency undervaluation, it Granger-causes a reduction in *gap* only 3 years

[2] Although all the estimated coefficients have small values, it is important to regard them as a preliminary step. Indeed, our main goal in the present work was to assess causality relations between the studied variables. More robust measures of correlation require multiple regression analysis in panel data, thereby taking into account control variables affecting the behaviour of the dependent time series across countries.

forward, thereby improving the current account position of the countries in question (such a positive correlation was rejected only based on the ordinary correlation measure – Table 6).

This latter result, in our view, is consistent with the Marshall-Lerner condition and the J-Curve (Bahmani-Oskooee and Ratha, 2004), the idea of a considerable lag between an undervaluation of domestic currency and its positive effects on trade balance, which can explain our results with respect to the observed causality relationship from *d(ppp)* to the investment-domestic savings gap only after three years.

Furthermore, our results can be regarded as in line with several works that obtained empirical findings showing positive effects of the real undervaluation of domestic currencies on modern and tradable industries, thereby enhancing overall productivity and GDP growth, such as in Rodrik (2007), McMillan and Rodrik (2011) and McMillan *et al.* (2013).

Table 5 – Measures of correlation between *gap* and *p*

	Ordinary correlation	**Spearman rank-order**	**Kendall's tau**
Coef.	0.063	0.139	0.095
Stat.*	1.998	4.419	47221.000
Prob.	0.046	0.000	0.000

Notes:(*) t-stat for ordinary and Spearman correlations, and Scores for Kendall's.

Table 6 – Measures of correlation between *d(ppp)* and *gap*

	Ordinary correlation	**Spearman rank-order**	**Kendall's tau**
Coef.	0.012	0.115	0.078
Stat.*	0.374	3.569	34964.000
Prob.	0.709	0.000	0.000

Notes:(*) t-stat for ordinary and Spearman correlations, and Scores for Kendall's.

3.2 Controlling for GDP based on PPP per capita

Our Panel Data are composed by a group of countries with important particular differences that may not be captured by our specific econometric analysis. For instance, do those previous empirical results present sensitivity to differences regarding GDP per capita among our selected countries? Although our 50 countries are regarded as emerging and developing economies by the IMF, it is possible that the estimated causality relations among them vary, according to subgroups with different patterns of income per capita. Performing such a subsequent analysis can produce additional and relevant information.

To do so, we separated our initial data into two new panels, taking into account the estimated *GDP based on PPP per capita* of each country for 2017. This measurement is available in the *IMF DataMapper*[3]. We then divided the previous 50 countries into a group, in which the respective economies have less than 11,000[4] *current international dollars per capita*, and a second group, in which the respective economies have more than this amount. These two new groups are shown in Tables 7 and 9 (Tables 8 and 10 showing, respectively, their descriptive statistics). For the first group, the Panel Data analysis was composed of 520 observations (26

[3] http://www.imf.org/external/datamapper/PPPPC@WEO/OEMDC/ADVEC/WEOWORLD

[4] We adopted such a specific value because it allowed us to divide our previous Panel Data into two new groups with more balanced observations (26 and 24 countries respectively).

countries), and for the second we had 480 observations (24 countries). We maintained the same series (*gap*, *p* and *ppp*) and annual sample (1995-2014) applied in the previous section.

Table 7 – Emerging and developing economies with fewer international dollars per capita

1.Armenia	2. Cameroon	3.Rep. of Congo	4. Djibouti	5.Ecuador
6.El Salvador	7.Ethiopia	8.Ghana	9.Guatemala	10.Haiti
11.India	12.Jamaica	13.Kenya	14. Kyrgyz Rep.	15.Lesotho
16.Malawi	17.Mauritania	18.Moldova	19.Morocco	20.Mozambiq.
21.Nepal	22.Nicaragua	23.Nigeria	24.Pakistan	25.Philippines
26.Rwanda	-	-	-	-

Source: Prepared by the author.

Table 8 – Descriptive statistics for emerging and developing countries with fewer international dollars per capita

	gap (% of GDP)	*ppp (índex)*	*p (%)*
Mean	5.25	45.87	9.72
Median	3.96	13.71	6.88
Maximum	48.04	289.29	176.74
Minimum	-23.04	0.04	-8.23
St. Dev.	8.40	68.91	12.74

Source: Prepared by the author.

Table 9 – Emerging and developing economies with more international dollars per capita

1.Azerbaijan	2.The Bahamas	3.Bahrain	4.Brazil	5.Chile
6.China	7.Costa Rica	8.Croatia	9. Dominic. Rep.	10.Hungary
11.Kazakhstan	12.Kuwait	13.Malaysia	14.Mexico	15.Panama
16.Poland	17.Romania	18.Russia	19.Saudi Arab.	20.Libya
21.Peru	22.Egypt	23.Dominica	24.Namibia	-

Source: Prepared by the author.

Table 10 – Descriptive statistics for emerging and developing countries with more international dollars per capita

	gap (% of GDP)	*ppp (índex)*	*p (%)*
Mean	-0.69	29.95	8.29
Median	1.45	1.69	4.00
Maximum	31.88	374.47	411.76
Minimum	-51.10	0.04	-9.86
St. Dev.	11.90	76.26	24.49

Source: Prepared by the author.

Some highlights can be observed based on the descriptive statistics of our two groups (Tables 8 and 10). Regarding *gap*, emerging and developing countries with fewer international dollars per capita present higher mean and median values than those observed in our emerging and developing countries with more international dollars per capita, which is an expected finding given the normally lower domestic savings found in poorer countries; in relation to *ppp*, the former group also present higher mean and median levels in comparison to the latter one. It means that generally emerging and developing countries with fewer international dollars per capita perform a less competitive real exchange rate compared to the other group. In turn, with respect to *p*, we verified that the emerging and developing countries with more international dollars per capita have lower mean and median levels.

Therefore, we tested for the causality relation between *gap* and *p*, as well as between *gap* and *d(ppp)*, in two stages. Firstly, for the group of countries with lower GDP based on PPP per capita (<11,000), followed by the tests for the countries with higher GDP based on PPP per capita (>11,000). Tables 11 and 12 present the Dumitrescu and Hurlin (2012) causality analysis applied to our two groups (1, 2 and 3 lags).

Table 11 – Dumitrescu-Hurlin's Granger causality for the countries with fewer international dollars per capita

Lags	Null hypothesis	W-Stat.	Zbar-Stat.	Prob.
1	p does not homogeneously cause gap	1.55373	1.15939	0.2463
	gap does not homogeneously cause p	1.49666	0.99836	0.3181
2	p does not homogeneously cause gap	2.28424	-0.14251	0.8867
	gap does not homogeneously cause p	2.87509	0.91803	0.3586
3	p does not homogeneously cause gap	4.38037	0.77532	0.4382
	gap does not homogeneously cause p	3.85797	0.13279	0.8944
1	d(ppp) does not homogeneously cause gap	0.89881	-0.70640	0.4799
	gap does not homogeneously cause d(ppp)	1.49473	0.94420	0.3451
2	d(ppp) does not homogeneously cause gap	2.54872	0.25799	0.7964
	gap does not homogeneously cause d(ppp)	2.92450	0.90987	0.3629
3	d(ppp) does not homogeneously cause gap	5.62424	2.02307	0.0431
	gap does not homogeneously cause d(ppp)	4.14524	0.32983	0.7415

Source: Prepared by the author.

Table 12 – Dumitrescu-Hurlin's Granger causality for the countries with more international dollars per capita

Lags	Null hypothesis	W-Stat.	Zbar-Stat.	Prob.
1	p does not homogeneously cause gap	1.22165	0.21361	0.8309
	gap does not homogeneously cause p	2.52668	3.75166	0.0002
2	p does not homogeneously cause gap	3.17745	1.40346	0.1605
	gap does not homogeneously cause p	4.15383	3.08728	0.0020
3	p does not homogeneously cause gap	3.56251	-0.22156	0.8247
	gap does not homogeneously cause p	6.55867	3.31894	0.0009

1	d(ppp) does not homogeneously cause gap	1.07459	-0.21090	0.8330
	gap does not homogeneously cause d(ppp)	0.92023	-0.62169	0.5341
2	d(ppp) does not homogeneously cause gap	2.57482	0.29137	0.7708
	gap does not homogeneously cause d(ppp)	2.15640	-0.40600	0.6847
3	d(ppp) does not homogeneously cause gap	5.59224	1.90851	0.0563
	gap does not homogeneously cause d(ppp)	4.00837	0.16634	0.8679

Source: Prepared by the author.

With respect to developing countries with lower GDP per capita (Table 11), the test *accepted* the null hypothesis of non-Granger causality from *gap* to *p* in all specifications (from 1 to 3 years of lag); and at the same time it confirmed the inverse non-causality (from *p* to *gap*). However, when we tested such a null hypothesis of non-Granger causality for the second group (i.e. developing countries with higher GDP per capita, Table 12) our new results corroborated the findings obtained for the entire Panel Data. Thus, we can suggest that *gap* causes *p* 1, 2 and 3 years forward based on emerging and developing countries with higher GDP per capita. In other words, the conventional theoretical hypothesis according to which the inflation rate dynamic is an effect of investment-domestic savings gap changes was not empirically verified for developing countries with lower income per capita, but it was confirmed for our second group, composed of those countries with more international dollars per capita.

Although we do not have specific theoretical grounds to explain such a cross-country difference, a possible way to interpret it is by regarding the median investment-domestic savings gap and inflation rate of each group. While the developing countries with lower GDP per capita have a median gap at 3.96% of GDP and a median inflation rate at 6.88% per annum, the developing countries with higher GPD per capita have a median gap at 1.56% of GDP and a median inflation rate at 4.00% annually. Above a certain critical value of the gap and the inflation rate, the latter could cease to respond to changes in the former due to a process of inflationary inertia. When higher than the critical values, the inflation rate would gain an dynamic exogenous to the conditions of short-term demand-supply behavior through the indexing of prices, wages and other income to past inflation.

In turn, regarding the relation between *gap* and *d(ppp)*, the estimates confirmed the Granger causality from the latter to the former, but only when we extended lags over 3 years, thereby suggesting that this causality relation takes longer to appear. Furthermore, this result was corroborated for both groups, i.e. those with fewer and more international dollars per capita (Tables 11 and 12).

3.3 Controlling for endogeneity based on D-GMM and S-GMM

Tables 13 and 14 show the estimates from Panel GMM regressions, respectively, for *p* and *gap* as dependent variables, by means of both D-GMM and S-GMM methods. Particularly for testing impacts of *gap* on inflation rates (*p*), the D-GMM regressions confirmed our previous results based on all three models estimated. We specified the latter with 1, 2 and 3 lags in *gap*, in order to maintain consistency with the previously performed Dumitrescu-Hurlin Granger causality. The positive sign for *gap* was corroborated and we found statistical significance in all D-GMM models. Moreover, both the J-test (p-value > 0.1) and AR tests (p-value < 0.1 and for AR(1) and p-value > 0.1 for AR(2)) indicated the validity of our instrument list and thus the consistency of the D-GMM in our panel data.

In turn, the S-GMM models also showed the positive effect of *gap* on *p* and statistical significance in Model 2 and Model 3, thus stressing the robustness of the D-GMM findings. The J-test also confirmed the hypothesis of valid instruments and specifications in S-GMM equations, although the AR(2) test rejected the hypothesis of non-autocorrelation of residuals. In this case, we regarded D-GMM models as more consistent with our particular panel data. Finally, both the methods corroborated the existence of persistent inflation rates in our panel data, as *p*(-1) presents a statistically significant coefficient in all the models.

Table 13 – Dynamic Panel Data. Dependent variable: *p*

	D-GMM			S-GMM		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
p(-1)	0.529***	0.536***	0.526***	0.542***	0.541***	0.576***
	(0.009)	(0.009)	(0.007)	(0.000)	(0.001)	(0.001)
gap(-1)	0.083***	-	-	-0.002	-	-
	(0.023)	-	-	(0.002)	-	-
gap(-2)	-	0.188***	-	-	0.011***	-
	-	(0.027)	-	-	(0.002)	-
gap(-3)	-	-	0.026*	-	-	0.041***
	-	-	(0.014)	-	-	(0.004)
J-stat	32.603	39.091	33.357	47.061	46.565	46.016
(p-value)	(0.339)	(0.123)	(0.307)	(0.470)	(0.490)	(0.475)
AR(1)	-2.632	-2.696	-2.620	-14.094	-14.107	-15.915
(p-value)	(0.008)	(0.007)	(0.008)	(0.000)	(0.000)	(0.000)
AR(2)	-1.113	-1.213	-1.170	-3.662	-3.654	-2.455
(p-value)	(0.265)	(0.225)	(0.242)	(0.000)	(0.000)	(0.0143)
Inst. rank	32	32	32	49	49	48

Notes: we used lagged values of *p* (t-4 to t-5) and *gap* (t-3 to t-5) as instruments.; *, ** and *** for statistical significance at 10%, 5% and 1%, respectively; White period (AB n-step) as GMM weights for D-GMM and S-GMM regressions. D-GMM uses two-step of Arellano and Bond (1991) without time period effects; S-GMM uses two-step of Arellano and Bover (1995) without time period effects.

Especially for the effects of the real exchange rate *(ppp)* on investment-domestic savings gaps, our results are, in general, compatible with the previous ones. Based on the Arellano-Bover (1995) System GMM equations, we identified a positive correlation and statistical significance between these variables for two of the three models, meaning that when domestic currencies appreciate (or depreciate) in real terms, there exists an increase (or a decrease) of the *gap* in our panel data. The instruments list was validated by the over-identifying restrictions test (J-test) in all the models, but the AR test did not confirm the absence of serial correlation in residuals (p-value < 0.1 in the AR(2) test). In turn, the Difference GMM specifications showed a statistically significant negative association of *ppp* with *gap*, regardless of the lag number in the former. The validity of our instruments list was strengthened based on the J-test (p-value > 0.1 in all models), and the Arellano-Bond (AR) serial correlation test statistics supported the hypothesis of non-autocorrelation in residuals for Model 3. Therefore, with regard to the evidence of *ppp* effects on *gap*, as found in D-GMM and S-GMM estimates, we have to be more parsimonious.

Table 14 – Dynamic Panel Data. Dependent variable: *gap*

	D-GMM			S-GMM		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
gap(-1)	0.418***	0.462***	0.436***	0.663***	0.665***	0.655***
	(0.018)	(0.017)	(0.021)	(0.006)	(0.006)	(0.010)
ppp(-1)	-0.077*	-	-	0.010***	-	-
	(0.042)	-	-	(0.003)	-	-
ppp(-2)	-	-0.087***	-	-	0.006	-
	-	(0.020)	-	-	(0.003)	-
ppp(-3)	-	-	-0.120***	-	-	0.013**
	-	-	(0.028)	-	-	(0.006)
J-stat	34.194	32.852	31.335	38.951	37.910	36.849
(p-value)	(0.410)	(0.376)	(0.349)	(0.219)	(0.183)	(0.150)
AR(1)	-2.853	-3.519	-3.253	-0.403	-0.351	-0.407
(p-value)	(0.004)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)
AR(2)	-2.916	-2.773	-1.555	-0.144	-0.132	-0.090
(p-value)	(0.003)	(0.005)	(0.119)	(0.000)	(0.000)	(0.023)
Inst. rank	35	33	31	35	33	31

Notes: we used lagged values of *gap* (t-2 to t-3) and *ppp* (t-2 to t-4) as instruments.; *, ** and *** for statistical significance at 10%, 5% and 1% respectively; White period (AB n-step) as GMM weights for D-GMM and S-GMM regressions. D-GMM uses two-step of Arellano and Bond (1991) without time period effects; S-GMM uses two-step of Arellano and Bover (1995) without time period effects.

4. Concluding remarks

The macroeconomic relations between the investment-domestic savings gap and inflation rates, as well as between the former and real exchange rates, cannot be assessed exclusively either through the conventional perspective or the alternative one. Based on Panel Data composed of 50 emerging and developing countries, from 1995 to 2014, we found empirical results supporting both visions, although not for the same relations and not with the same statistical significance.

In the case of the investment-domestic savings gap and inflation rates, the results demonstrated that the conventional perspective is more suitable; in other words, that inflation dynamics can be explained by factors affecting differences between investment and domestic savings rates. When investment rises (or domestic savings decline) *coeteris paribus* there exists a rise in inflation rates over a term of 3 years. However, when inflation rates change *coeteris paribus*, we did not find *gap* changes as a response. Hence, monetary and fiscal counter-cyclical policies that aim to stabilize consumer prices can be efficient if their instruments are effective in controlling investments and domestic savings over time. Furthermore, we identified that this causality relation from those gaps to inflation rates was mainly based on the countries with higher GDP *per capita* in our sample. Such causality was not verified for the group made up of countries with lower GDP *per capita*. It is likely that this cross-country asymmetry is associated with the effects of median levels of the inflation rate and investment-domestic savings gap, which are relatively higher in the group of countries with lower GDP per capita.

In turn, for the case of real exchange rates and the investment-domestic savings gap, our empirical findings lend more support to the alternative perspective: when emerging and developing countries achieve more competitive real exchange rates, so that *ppp* levels are lower, we see a reduction in the investment-domestic savings gap 3 years forward, thereby improving their current account position. This type of empirical finding suggests that economic policies intended to take real exchange rates to higher levels are generally followed by improvements in current account outcomes of our 50 studied countries, although this benefit does not emerge rapidly. Furthermore, this result was confirmed for both groups of countries, i.e., those with higher and the ones with lower GDP per capita.

Finally, we extended our estimates taking into account the potential problems with regard to endogeneity in regressors. Particularly, we applied Dynamic Panel Data methods based on Difference and System GMM regressions by using instrumental variables that can influence regressors over time. First, for our results as a whole, D-GMM showed more adherence to our panel data in comparison with S-GMM, due to the general statistics found in J-test and AR tests. Especially when testing for *gap* effects on *p* over time, D-GMM estimates presented remarkable results, thereby corroborating the conventional hypothesis and validating the instruments adopted in all the models. In turn, when testing the alternative causality relation from *ppp* to *gap*, the D-GMM and S-GMM estimates obtained contradictory results. They confirmed the alternative perspective when based on S-GMM, but also rejected it when we applied the D-GMM approach. Furthermore, the specifications did not reject the existence of serial correlation in residuals as tested by the Arellano-Bond (AR) approach, although all the models demonstrated a validation of their instruments (J-stat/p-value > 0.1).

In short, our empirical article has highlighted the robustness of the conventional perspective, particularly applied to the relation from investment-domestic savings gap to inflation rates over our panel data. In turn, the alternative vision, i.e. the causality from *ppp* to *gap*, although not rejected when we took into account the Dumitrescu-Hurlin Granger causality test, should be used only with parsimony due to the aforementioned restrictions found in the Dynamic Panel Data estimates for this kind of relation, thus awaiting future new empirical findings.

5. References

Arellano, M and O. Bover (1995) "Another look at the instrumental variables estimation of error-components models" *Journal of Econometrics* **68**, 29–51.

Arellano, M and S. Bond (1991) "Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations" *Review of Economic Studies* **58**, 277 - 297.

Bahmani-Oskooee, M and A. Ratha (2004) "The J-Curve: A literature review" *Applied Economics* **36**, 1377-1398.

Blundell, R and S. Bond (1998) "Initial conditions and moments restrictions in dynamic panel data models" *Journal of Econometrics* **86**, 115–143.

Bond, S, A. Hoeffler and J. Temple. (2001) "*GMM Estimation of empirical growth models*" Economics Papers 2001-W21, Economics Group, Nuffield College, University of Oxford.

Clarida, R, J. Galí, and M. Gertler (1999) "The science of monetary policy: a new Keynesian perspective" *Journal of Economic Literature* **37**, 1661-1707.

Clark, P B and D. Laxton (1995) “Exchange rate effects of fiscal consolidation” annex to *World Economic Outlook* IMF October.

Clark, P B, L. Bartolini, T. Bayoumi, and S. Symansky (1994) “Exchange rates and economic fundamentals: a framework for analysis” Occasional Paper n.115 Washington DC IMF.

Dumitrescu, E I and C. Hurlin (2012) “Testing for Granger non-causality in heterogeneous panels” *Economic Modelling* **29**, 1450-1460.

Herzer, D. (2016) “Unions and Income Inequality: A Heterogeneous Panel Co-integration and Causality Analysis” *Labour* **30**, 318–346.

Holtz-Eakin, D, W. Newey, and H.S. Rosen (1988) “Estimating vector autoregressions with panel data” *Econometrica* **56**, 1371–1396.

Im K, H. Pesaran, and Y. Shin (2003) “Testing for Unit Roots in Heterogeneous Panels” *Journal of Econometrics* **115**, 53-74.

Kao, C. D. (1999) ‘Spurious Regression and Residual-Based Tests for Cointegration in Panel Data” *Journal of Econometrics* **90**, 1–44.

Laxton, D and P. Pesenti (2003) “Monetary rules for small, open, emerging economies” *Journal of Monetary Economics* **50**, 1109-1146.

Levin, A, C. Lin, and C. J. Chu (2002) “Unit root tests in panel data: asymptotic and finite-sample properties” *Journal of Econometrics* **108**, 1-24.

MacDonald, R. (1997) “What determines real exchange rates? The long and short for it” IMF Working Paper n.21.

Maddala, G S and S. Wu (1999) “A Comparative Study of Unit Root Tests with Panel Data and A New Simple Test” *Oxford Bulletin of Economics and Statistics* **61**, 631–52.

McMillan, M and D. Rodrik (2011) “Globalization, structural change and productivity growth” In Bacchetta M and M. Jense (Eds.), Making globalization socially sustainable (49–84). Geneva: International Labour Organization and World Trade Organization.

McMillan, M, D. Rodrik and Í. Verduzco-Gallo (2013) “Globalization, Structural Change, and Productivity Growth, with an Update on Africa” *World Development* **63**, 11-32.

Montiel, P J and L. Serven (2008) “Real exchange rates, saving and growth: is there a link?” Policy Research Working Paper n.4636 World Bank.

Oreiro, J L C, F. Basilio, and G. Souza (2014) “Effects of overvaluation and volalitity of exchange rate over investment in manufacturing industry: empirical evidences and policy proposals for the Brazilian case” *Brazilian Review of Political Economy* **34**, 347-369.

Pedroni, P. (1999) “Critical Values for Cointegration Tests in Heterogeneous Panels with Multiple Regressors” *Oxford Bulletin of Economics and Statistics* **61**, 653–70.

Rodrik, D. (2007). One economics, many recipes. Princeton, NJ: Princeton University Press.
Roodman, D. (2009) "How to do xtabond2: An introduction to difference and system GMM in Stata" *Stata Journal* **9**, 86–136.

Tugcu, C.T. (2014) "Tourism and economic growth nexus revisited: A panel causality analysisc for the case of the Mediterranean Region" *Tourism Management* **42**, 207-2012.

Wooldridge, J. M. (2002). Econometric analysis of cross-section and panel data. Cambridge, MA: The MIT Press.