BRICs and PIGS in the presence of Uncle Sam and big brothers: Who drive who? Evidence based on asymmetric causality tests.

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Abstract

We investigate the asymmetric causal interaction between the group of presently depressed markets of Portugal, Italy, Greece and Spain (PIGS), on one hand, and the booming markets of Brazil, Russia, India and China (BRIC), on the other hand, taking into account Germany and France (Big Brothers) and the United States (Uncle Sam), based on the asymmetric causality test methodology developed by Hatemi-J (2012). We found that in both up and down market conditions, the BRICs influence the PIGS, pulling the latter up during up market conditions and dragging them down during down market times. The PIGS also affect the BRICs but only during down market situations when the former pulls down the latter. Thus, the BRICs seem to be more influential on the PIGS than the PIGS on the BRICs.

Keywords: BRIC, PIGS, asymmetric causality test, stock markets

JEL Classification: G15, C32
Introduction

The PIGS (Portugal, Ireland, Greece and Spain) are presently experiencing economic difficulties while the BRICs (Brazil, Russia, India and China) are still relatively booming. Recently, the BRICs have been asked to help rescue the PIGS as Big Brothers (Germany and France) and Uncle Sam (the US) are dilly dallying. It may not be well known but there has been a very strong economic and financial interaction between the PIGS and the BRICs over the years. We therefore suspect that there has been a significant linkage between the stock markets of these two groups of countries and it would be therefore interesting to know as to who drive who. This paper investigates the interdependence between the BRICs and the PIGS based on the newly developed Hatemi-J (2012) asymmetric causality test. The test is very appropriate as the situation of the two groups is asymmetric – the BRICs are emitting good news while the BRICs, bad news. In order to avoid misspecification, we include the Big Brothers and Uncle Sam as both the PIGS and the BRICs are highly linked to these two.

There is now a voluminous literature on the issue of financial market integration. However, there is no general agreement yet as to whether stock markets are integrated or segmented. The findings of this literature are mixed depending on the set of countries, time period and methodology being used. There is therefore still a need for further studies on this issue. Our paper seeks to address this knowledge gap. To the authors’ best knowledge, this is the first study that examines the stock market linkage between the BRICs and the PIGS. As mentioned, it applies the asymmetric causality test of Hatemi-J (2012). This newly developed causality test differs from other tests which allow for asymmetric effects in that it explicitly separates the positive shocks from negative shocks while the others utilize threshold, indicator variables or Markov regimes.

Knowledge about the linkage between these two groups of important markets is one that is very useful to investors and portfolio managers. This can assist them in developing profitable trading strategies and in their quest for diversification of their portfolios. For example, would it be a profitable strategy to short the PIGS and then be long on the PIGS? The results of this study could also be of assistance to
policymakers and regulators in terms of formulating policies that can contain contagion risks. For instance, how can the BRICs ensure that the downturn in the PIGS does not spill over to them? If it is found that there is a high linkage between the PIGS and the BRICs, could this be a ground to convince the BRICs to assist the PIGS in their recovery?

**Literature on Financial Market Integration: An Overview**

A huge number of studies have now investigated the issue of integration among stock, bond, and money markets (e.g. Panopolou and Pantelidis, 2009; Chi, et al., 2006; Click and Plummer, 2005; Roca, 1999). The ones pertaining to stock markets have examined the following issues: (a) the extent to integration; (b) stability of linkages; (c) groupings among markets in terms of linkages; and (d) the manner of interaction among markets—which markets are influential, how one market affects another market, and the speed of interaction among markets.

The results of stock market integration studies covering different countries, regions, time periods and methods, however, have been mixed. For example, some find stock markets to be integrated (e.g. Agmon, 1972; Ripley, 1973; Hillard, 1979; Ibbotson et al., 1982; Jaffe and Westerfield, 1985; Schollhammer and Sand, 1987; Wheatley, 1988; Hamao, et al., 1990; Espitia and Santamaria, 1994, among others) while others find them to be segmented (e.g. Grubel, 1968; Makridakis and Wheelwright, 1974; Adler and Dumas, 1983; Jorion and Schwartz, 1986; Levy and Lerman, 1988; Dwyer and Hafer, 1988; Jorion, 1989; Smith, et al., 1995). Similarly, some studies find equity market linkages to be stable (e.g. Panton, et al., 1976; Philippatos, et al., 1983; Goodhart, 1988) while others claim such linkages are unstable (e.g. Maldonado and Saunders, 1981; Roll, 1989a and 1989b).

With regards to the structure of interaction among equity markets in terms of the influence of one market on another, the manner of response of markets to influences coming from other markets, and the speed by which shocks or volatility from one market is transmitted to other markets, there is some evidence that the US might be the world’s most influential stock market (e.g. Khoury, et al., 1987; Schollhammer and Sand, 1987; Fischer and Palasvirta, 1990; Espitia and Santamaria, 1994). However, the US market in turn might also be affected by other markets. For
instance, in a study of the interaction among national equity markets, Huyghebaert and Wang (2010) find that Singapore and Hong Kong Granger-cause the US market. Further, some studies find no lead–lag relationships between markets (e.g. Granger and Morgenstern, 1970; Hillard, 1979). With respect to transmission of shocks between markets, the results have also been mixed with some studies reporting that the transmission process is efficient, i.e., occurring within a period of one to two days (e.g. Schollhammer and Sand, 1987; Khoury, et al., 1987) while other studies (e.g. Ng, et al., 1991) report the process to be inefficient.

Several studies point to the existence of linkages among certain groups of equity markets based on some unifying or common factor, such as regional, economic, and geographical relationships. To, et al. (1994) found the following clusters: Japan and Asian emerging markets, and the UK and African emerging markets. Hillard (1979) discovered a close association among intra–continental markets during the oil crisis of 1973 while Jorion (1989) reported a high degree of linkage among European continental markets. An Anglo–Saxon cluster was also reported by Jorion (1989).

In light of the foregoing inconclusive evidence regarding integration and linkages—that markets might or might not be integrated; that linkages might or might not be stable; and that while the US stock market might be the most influential in the world, it may itself be influenced by other markets—this study makes a significant contribution to the literature by investigating, for the first time, the stock market linkages between two very important blocs of markets – the BRICs and PIGS, which are currently in the limelight and whose present conditions have provided lessons for policymakers around the world. This is also the first stock market integration study which applies the Hatemi-J (2012) asymmetric causality test.

The BRICs and PIGS and their Economic Interaction: A Brief Backgrounder

The acronym BRICs was coined by a Goldman Sachs investment banker, Jim O’Neill in 2001 in a paper titled "Building Better Global Economic BRICs". It refers to a

1 see http://en.wikipedia.org/wiki/BRIC#cite_note-0#cite_note-0; http://www.globaldashboard.org/2010/12/06/from-brics-to-pigs-whats-in-a-name/
country group that includes the four most promising emerging economies around the world. These are Brazil, Russia, India, and China. As projected by O’Neill (2003), the combined economies (in GDP terms) of Brazil, Russia, India and China would be larger than those of G7 in 40 years, suggesting the significance of the BRICs as a whole to the global economy. As a matter of fact, the weight of the BRICs economies is already 15% of the world economy in 2007, higher than the projection of 10% in Goldman Sachs’s 2001 paper (O’Neill, 2007). At present, China and Russia have accumulated trillions of dollars in foreign exchange reserves, and are now the main creditors of western sovereigns. In the 1980s, emerging markets depended on the west for capital inflows. Now, the situation is reversed, and the US and EU depend on China to buy their sovereign debt. The BRICs possess a combined 4.3 trillion dollars in hard cash reserves, with China holding three-quarters of the kitty, much of it in Euros.

Given the global slowdown and the current eurozone debt crisis, a considerable attention has been given to the BRICs with views that they can drive forward the global economy. In fact, there has been proposals for the BRICs to come to the rescue of a block of countries which are currently in dire economic situation. This group is the so-called PIGS which refer to the countries of Portugal, Italy, Greece and Spain. These countries have been victims of the recent Global Financial Crisis. Before the crisis, these countries had high growth rates fuelled by massive spending by both the government and private sectors with money flowing into speculative sectors of their economies such as the real estate sector. When the GFC occurred and liquidity vanished, their economies were hardest hit starting with their real estate and banking sectors which then spread across other sectors including their governments. These countries had to be bailed out with funds coming from the EU and the IMF which happened only after so much dilly-dallying.

As mentioned, there have been calls for the BRICs to come to the rescue of the PIGS. It is claimed that it is in the BRICs self-interest to undertake this, since although it is

\[ \text{G7 includes Germany, France, Italy, Japan, U.K., U.S., and Canada.} \]

\[ \text{http://www.globaldashboard.org/2010/12/06/from-brics-to-pigs-whats-in-a-name/} \]

\[ \text{http://www.cigionline.org/articles/2011/09/emerging-markets-hit-economic-stage-tonne-brics} \]
not well known, there is actually significant economic linkage between these two blocs of economies. There has been substantial trade between these two groups over the years, with the BRICS enjoying surpluses consistently, as shown in Figure 1.

**Figure 1. BRICs Exports to and Imports from PIGS**

![Graph showing BRICs Exports to and Imports from PIGS](source: World Trade Organisation)

Given this substantial trade interaction between the BRICs and the PIGS, we expect that there would also be significant linkage between the stock markets of these two blocs of countries, with the BRICs granger-causing the PIGS. We therefore test this expectation in this paper.

**Methodology**

We test the interaction between the BRICs and the PIGS controlling for the effect of Uncle Sam (US) and Big Brothers (Germany and France). We collect weekly stock market data for each of the PIGS, BRICs and Big Brothers, and also for Uncle Sam during the said period. We take an average of the stock price of the BRICs to proxy for the BRICs and we do the same for the PIGS. The empirical investigation in this paper is based on the asymmetric causality test as suggested by Hatemi-J (2012). This test separates the potential causal impact of positive shocks from the negative ones. This is an important issue to take into account because people usually tend to react to
the negative news more than the good ones. This new methodology separates explicitly the impact of permanent positive shocks from the negative ones unlike other methods which allow for potential asymmetric impacts by using thresholds, indicator variables or Markov-switching regimes.

In order to describe the asymmetric causality test in a simple way we concentrate on a bivariate case. Consider the following two integrated variables, denoted by $P_{1t}$ and $P_{2t}$:

$$
P_{1t} = P_{1t-1} + \varepsilon_{1t} = P_{1,0} + \sum_{i=1}^{t} \varepsilon_{1i},
$$

(1)

and

$$
P_{2t} = P_{2t-1} + \varepsilon_{2t} = P_{2,0} + \sum_{i=1}^{t} \varepsilon_{2i},
$$

(2)

where $t = 1, 2, \ldots, T$, the constants $P_{1,0}$ and $P_{2,0}$ are the initial values and $\varepsilon_{1i}$ and $\varepsilon_{2i}$ are white noise error terms. Positive and negative changes of each variable are defined as $\varepsilon_{1i}^+ = \max(\varepsilon_{1i}, 0)$, $\varepsilon_{2i}^+ = \max(\varepsilon_{2i}, 0)$, $\varepsilon_{1i}^- = \min(\varepsilon_{1i}, 0)$ and $\varepsilon_{2i}^- = \min(\varepsilon_{2i}, 0)$, respectively. This means that $\varepsilon_{1i} = \varepsilon_{1i}^+ + \varepsilon_{1i}^-$ and $\varepsilon_{2i} = \varepsilon_{2i}^+ + \varepsilon_{2i}^-$. Based on this we can conclude that

$$
P_{1t} = P_{1t-1} + \varepsilon_{1t} = P_{1,0} + \sum_{i=1}^{t} \varepsilon_{1i}^+ + \sum_{i=1}^{t} \varepsilon_{1i}^-,
$$

and likewise

$$
P_{2t} = P_{2t-1} + \varepsilon_{2t} = P_{2,0} + \sum_{i=1}^{t} \varepsilon_{2i}^+ + \sum_{i=1}^{t} \varepsilon_{2i}^-.
$$

Thus, the positive and negative shocks of each variable in a cumulative format are

$$
P_{1t}^+ = \sum_{i=1}^{t} \varepsilon_{1i}^+ , \quad P_{1t}^- = \sum_{i=1}^{t} \varepsilon_{1i}^- , \quad P_{2t}^+ = \sum_{i=1}^{t} \varepsilon_{2i}^+ \quad \text{and} \quad P_{2t}^- = \sum_{i=1}^{t} \varepsilon_{2i}^-,
$$

respectively. These cumulative components provide the possibility to implement asymmetric causality
between tests. For instance, in case the interest lies on testing for causality between the positive components then the vector that should be used is \( P_t^+ = (P_{1t}^+, P_{2t}^+) \). This vector can be used to estimate the following vector autoregressive model with the lag order \( k \), VAR (L):\(^5\)

\[
P_t^+ = \nu + A_1^+ P_{t-1}^+ + \ldots + A_L^+ P_{t-k}^+ + u_t^+ ,
\]

where \( \nu \) is the \( 2 \times 1 \) vector of intercepts, and \( u_t^+ \) is representing a \( 2 \times 1 \) vector of the errors. \( A_r \) is a \( 2 \times 2 \) matrix of parameters for lag order \( r (r = 1, \ldots, k) \) to be estimated. The optimal lag order \( k \) is selected by the minimization of the following information criterion:

\[
\text{HJC} = \ln \left( |\Omega_f| \right) + k 2T^{-1} \left( m^2 \ln T + 2m^2 \ln(\ln T) \right), \quad k = 0, \ldots, k_{\text{max}}.
\]

Here \( |\Omega_f| \) signifies the determinant of the variance-covariance matrix of the residuals in the VAR model based on lag length \( k \), \( m \) is the number of equations in the VAR model, and \( T \) is the sample size.\(^6\) After selecting the optimal lag order, the following null hypothesis can be tested:\(^7\)

\( H_0: \) the row \( j \), column \( k \) element in \( A_r \) equals zero for \( r = 1, \ldots, k \).

---

\(^5\) For conducting tests for causality between negative cumulative components, the vector \( P_t^- = (P_{1t}^-, P_{2t}^-) \) is used.

\(^6\) The HJC is recommended in Hatemi-J (2003, 2008). Via Monte Carlo simulations the author showed that this information criterion is successful in picking the correct lag order even if ARCH effects prevail. The conducted simulations also showed that this information criterion has good forecasting properties.

\(^7\) In order to account for the fact that each variable has a unit root, we have included an additional unrestricted lag following the recommendations of Toda and Yamamoto (1995).
Before defining the Wald test we introduce some denotations to make the presentation simple. Thus, we define the following:\(^8\)

\[
Y := \left( P_1^+, \ldots, P_T^+ \right) \quad (m \times T) \text{ matrix,}
\]

\[
D := \left( v, A_1, \ldots, A_k \right) \quad (m \times (1 + mk)) \text{ matrix,}
\]

\[
Z_t := \begin{bmatrix}
1 \\
P_t^+ \\
\vdots \\
P_{t-p+1}^+
\end{bmatrix} \quad ((1 + mk) \times 1) \text{ matrix, for } t = 1, \ldots, T,
\]

\[
Z := \left( Z_0, \ldots, Z_{T-1} \right) \quad ((1 + mk) \times T) \text{ matrix, and}
\]

\[
\delta := \left( u_1^+, \ldots, u_T^+ \right) \quad (m \times T) \text{ matrix.}
\]

Via these denotations, the VAR(\(k\)) model can compactly be presented as

\[
Y = DZ + \delta; \quad (6)
\]

The Wald test to be used for the testing the null hypothesis of non-Granger causality, \(H_0: R\beta = 0\), is defined as

\[
Wald = (R\beta)^T \left[ R^T (Z^T Z)^{-1} \otimes S_U \right] R^{-1} (R\beta), \quad (7)
\]

where \(\beta = \text{vec}(D)\) and \(\text{vec}\) is the column-stacking operator; \(\otimes\) is the Kronecker operator, and \(R\) is a \(k \times m(1+mk)\) indicator matrix containing ones for restricted parameters and zeros for the unrestricted parameters. The unrestricted variance-covariance matrix of the VAR model is \(S_U = \frac{\hat{\delta}_U \hat{\delta}_U^T}{T-c}\), where \(c\) is the number of parameters in each of the equations in the underlying VAR. If the assumption of

\(^8\) It should be mentioned that initial values are assumed to be available. For more information on the reason behind this assumption see Lutkepohl (2005).
normality holds, the Wald test in equation (7) is distributed as $\chi^2$ with $k$ degrees of freedom asymptotically. However, if the assumption of normality does not hold and if ARCH effects exist then the Wald test will deviate for this assumed asymptotic distribution. This is more likely to be the case when the sample size is small. A potential solution to remedy this statistical problem is using the bootstrap simulations. This procedure can be performed as follows. First run the regression model (6) with the imposed restrictions under the null hypothesis of Granger non-causality. Next, generate the bootstrap data, $Y^*_t$, via $Y^* = \hat{D}Z + \delta^*$. It should be mentioned that the bootstrapped residuals ($\delta^*$) are produced by $T$ independent random draws from the modified residuals of the regression. This bootstrap residuals are also mean-adjusted in each simulation in order to make sure that the expected value of the residuals is zero. The original residuals of the regression are also adjusted by using leverages in order to achieve constant variance. The bootstrapping is repeated 10000 times in order to estimate the Wald test each time so as to create the distribution of the test. Then, we take the ($\alpha$)th upper quantile of the distribution of bootstrapped Wald test, which is the bootstrap critical value at the $\alpha$-level of significance, denoted by $c^*_\alpha$. Finally, we compare the calculated the Wald test, which is estimated by using the original data, to the bootstrap critical value $c^*_\alpha$. The null hypothesis can be rejected if the estimated tests values is higher than the critical value. The bootstrap simulations for implementing the asymmetric causality tests are performed via a statistical software component written in GAUSS, which is available online.

RESULTS

Before testing for causality, we tested each variable for unit root. The results revealed that each variable has indeed one unit root. We also tested the residuals of the VAR model for multivariate normality and multivariate ARCH effects. The results showed

\[9\] For additional information on leverage adjustment see Davison and Hinkley (1999) for univariate analysis and Hacker and Hatemi-J (2006) for multivariate analysis.

\[10\] See Hatemi-J (2011) for the statistical software component.
that the neither the assumption of normality nor the assumption of no ARCH can be validated empirically.  

The estimation results are shown in Table 1 in which we report the results pertaining to the interaction between the BRICs and the PIGS.

### Table 1. The Results of the Non-asymmetric Causality Tests

<table>
<thead>
<tr>
<th>Null Hypothesis</th>
<th>Test Value</th>
<th>Bootstrap CV at 1%</th>
<th>Bootstrap CV at 5%</th>
<th>Bootstrap CV at 10%</th>
<th>Causal Parameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>$PIGS^+ \Rightarrow BRIC^+$</td>
<td>3.867</td>
<td>9.868</td>
<td>6.427</td>
<td>4.945</td>
<td></td>
</tr>
<tr>
<td>$PIGS^- \Rightarrow BRIC^-$</td>
<td>15.198***</td>
<td>10.886</td>
<td>5.854</td>
<td>4.543</td>
<td>0.064</td>
</tr>
<tr>
<td>$BRIC^+ \Rightarrow PIGS^+$</td>
<td>16.062***</td>
<td>9.666</td>
<td>6.127</td>
<td>4.788</td>
<td>0.111</td>
</tr>
<tr>
<td>$BRIC^- \Rightarrow PIGS^-$</td>
<td>15.381***</td>
<td>9.679</td>
<td>5.902</td>
<td>4.607</td>
<td>-0.174</td>
</tr>
</tbody>
</table>

1. The denotation $A \not\Rightarrow B$ implies that variable $A$ does not Granger cause variable $B$.

2. CV is an abbreviation for the critical value.

3. An extra unrestricted lag was included in the VAR model in order to account for the effect of a unit root.

It can be seen from the Table that a negative change in the PIGS causes positively a negative change in the BRICs. This means that a downturn in the PIGS leads to a greater downturn in the BRICs. However, a positive change in the PIGS does not affect the BRICs at all. Thus, the PIGS drag the BRICs down during a downturn but does not pull it up during a market upturn.

A negative change in the BRICs granger-causes a negative change in the PIGS. This means that the BRICs also pull down the PIGS during a market downturn. A positive

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11 The results of these diagnostic tests are not presented here in order to save space. These results are available on request.
change in the BRICs causes positively a positive change in the PIGS which means that in an upturn, the BRICs pull up the PIGS, unlike the PIGS who do not carry the BRICs up during a market upturn. Hence, it appears that the BRICs are more influential than the PIGS as they are able to affect the PIGS in both market conditions while the PIGS only influence the BRICs during a downturn.

Conclusion

In this paper, we examine the interaction between the PIGs and BRICs based on the asymmetric causality test of Hatemi-J (2012). Our results confirm the significant interaction between the two blocs of markets. We find that the BRICs granger-cause the PIGS in both up and down market conditions, driving the PIGS up when markets are up and down when markets are down. The PIGs also granger-cause the BRICs but this is only during down market conditions pulling down the BRICs when markets are down. Thus, it appears that the BRICs are more influential on the PIGS than the PIGS on the BRICs. These results reflect the economic interaction between the two groups over the last decade in which the trade balance had been overwhelmingly in favour of the BRICS. These findings also reaffirm the growing economic clout of the BRICs which is now being reflected in financial markets. It also provides support to the claim that the BRICs markets are also affected by conditions in the PIGS and hence, there may be a case for the BRICs to take an active interest in helping ensure the recovery of the PIGS for their own sake.


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