Real Exchange Rate and Export Diversification: How do Financial Crises shape the Causation?

THAI Long
Foreign Trade University (Hanoi, Vietnam)
University of Kent (Canterbury, UK)
l299@kent.ac.uk
longt78@gmail.com

PHI Minh Hong
Foreign Trade University (Hanoi, Vietnam)
CREAM, University of Rouen (France)
phiminhhong@gmail.com

TRAN Thi Anh-Dao
CREAM, University of Rouen (France)
thianh-dao.tran@univ-rouen.fr

Postal address:
School of Economics, Keynes College
University of Kent, Canterbury, Kent, CT2 7NP (UK)
Phone number: +44 (0) 1227 826507

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Abstract

Diversification in export has become of growing interest in the recent literature. When a correlation between the real exchange rate and export diversification is established, most studies focus on the causal link from the former to the latter. Surprisingly, the reverse causal direction is usually ignored. This paper proposes a panel Granger causality test between real exchange rate and export diversification in the middle-income countries of Asia and Latin America over the period 1995-2015. We also examine the effects of two financial crises on the causal relationship, namely the East Asian financial crisis of 1997 and the global crisis of 2008. Looking at the whole sample, our study finds a bidirectional causality between the two variables. A causal link running from real exchange rate to export diversification is consistent with the conventional literature. However, our empirical findings provide evidence of a reverse causality, which is a novel contribution to previous studies. Our results are confirmed when the data are investigated by region: the causality results are consistent with those for the full sample of middle-income countries at the optimal lag length. While most countries were unaffected by the financial crises, the link running from export diversification to real exchange rate was disturbed by the crises in almost eight individual countries.

JEL Codes: F14, F41, 011, O24, O53, 057

Key words: Export diversification, real exchange rate, emerging Asia and Latin America, panel Granger causality
1. Introduction

For many developing countries, export performance has become crucial in order to make trade and international integration an efficient instrument for development. Given that globalization implies an increasing level of imports relative to Gross Domestic Product (GDP), it follows that export performance has been the most critical factor in GDP growth and balance of payments constraints. Building domestic supply capacity and enhancing international competitiveness while managing integration with the global economy are of great concern for most of them, as such performance is likely to be the outcome of a combination of various elements which still have to be clearly identified. Among them, diversification in export has become of growing interest in the recent literature and it is generally viewed as a positive development (IMF, 2014; Newfarmer et al., 2009).

According to UNCTAD statistics, half of all developing countries depend on non-fuel commodities for more than half of their export earnings, two thirds if fuels are included. However, the secular decline and large fluctuations in real commodity prices have direct consequences for earnings and poverty levels. Moreover, exporters of primary commodities have been faced with additional difficulties arising from their weakening position in global value chains. Vertical integration of the different stages in the supply chain has strengthened the bargaining power of a few multinational corporations and large distribution networks in a number of commodity markets. This has led developing countries to target diversification of their export portfolios, especially into manufactured goods.

Among the drivers of export performance, the literature on export-led growth points to the benefits of keeping the prices of exportable products at competitive levels in order to make it attractive to shift resources into their production. The Real Exchange Rate (RER), which reflects
the underlying relative movement of prices at home and abroad, proves to have a significant
effect on export performance. Using the RER to shift resources into manufacturing can promote
exports without driving down prices as external demand is elastic, unlike the situation with
primary commodities. The early experiences of the Newly Industrializing Countries (NICs) of
East Asia have directed attention to the RER as a development-relevant policy tool. A stable and
competitive RER should be thought of as a facilitating condition for exploiting a country’s
capacity for growth and development (Eichengreen, 2008). This raises the question as how to
adopt and maintain a competitive RER level.

Two important strands of literature are combined in the present study: the first concerns
the determinants of export diversification in growth and international trade theories, and the
second the determinants of the RER in international macroeconomics. The literature in both
areas is extensive but there is no connection between them. When the RER and export
diversification are correlated, most studies focus on the RER as a determinant of export
diversification: RER undervaluation and stability promote export diversification by increasing
the profitability of the export sector. However, the early experiences of the Asian NICs and more
recently, of China, might show a reverse causation: by diversifying their trade, those countries
have succeeded in lowering their supply prices thanks to productivity gains, larger export
production capacities and enhanced tradable sectors. Hence, export diversification may
determine the RER by affecting the relative price of traded goods or the relative movement of
prices. Surprisingly, this causal direction is usually ignored in earlier studies. One important
purpose of this study is to fill this gap.

To explore the issue, we focus on the Lower- and Upper-Middle Income (respectively
LMI and UMI) countries of Asia and Latin America from a comparative perspective. On the one
hand, Asia is the only region in the entire sample of developing countries that has improved its export performance since the 1980s and the evidence suggests that it has been driven by an outstanding relative improvement in their supply capacity (Fugazza, 2004; Redding and Venables, 2003). Moreover, the evolution of export diversification indicators for different regions of the world shows that exports have tended to be more diversified for Asia over time (Amurgo-Pacheco and Pierola, 2008). While part of their success has been attributed to their participation in the more dynamic sectors of trade (i.e. goods with high world demand), one possible interpretation of their export performance is that it was a combination of exchange rate and active diversification policies which framed firms’ production environment and export products’ access to international markets (Rodrik, 2006; Stiglitz and Yusuf, 2001). On the other hand, many studies indicate that the more advanced developing countries are better able to exploit market opportunities through product diversification (Agosin et al., 2009). This comes from Imbs and Warcziag (2003), who showed a non-linear relationship between per capita income and product diversification. In other words, inter- or intra-sectoral diversification is relatively more important at the middle stage of development, which enables us to focus on the middle-income countries.

The present paper contributes to the literature in three respects. Firstly, it examines the directional causality between RER and export diversification, which has not yet been done. Secondly, as export diversification is more prevalent in the middle income countries, we explore the causality relationship in the specific sample of LMI and UMI countries of Asia and Latin America over the period 1995-2015. Thirdly, the causality is more efficiently tested in a panel context given cross-sectional dependencies and heterogeneity across countries.
The remainder of this paper will be organized as follows. Section 2 provides an overview of the literature and the conceptual framework underlying the relation between RER and export diversification. Section 3 presents the general options of our econometric approach before we report our empirical findings in Section 4. Section 5 summarizes the results and concludes.

2. RER and export diversification: a two-way causation?

2.1. On the determinants of export diversification

In traditional trade theory based on factor endowments, a country should specialize (not diversify) in the products that it produces more efficiently than others. When all countries specialize in accordance with their comparative advantage, the entire world is better off and the consequent gains from trade become an argument for trade liberalization. According to free trade theory, specialization for developing countries implied reliance on export of raw materials or primary commodities in exchange for consumer and investment goods manufactured in the North. There are two main points in the critiques of this pattern of trade (Meija, 2011). Firstly, export concentration combined with specialization in primary commodities is correlated with volatile and adverse terms of trade shocks, rendering free trade less beneficial for developing countries. Secondly, too much reliance on a small set of products results in export revenue instability, with detrimental effects on investment, import capacity, employment, and growth. These critiques are synthesized in the literature on the “natural resource curse”, i.e. a negative relationship between natural resource abundance and growth (Cadot et al., 2013).

The answer to the question of trade diversification was then seen to lie in the development of a portfolio: by diversifying, countries reduce the risk of export instability, their vulnerability to external trade shocks and the dependence on a limited number of commodities.
Similarly, if an economy exports to a large number of countries, it will be less sensitive to large fluctuations in the demand from one country or region. Geographic diversification, like product diversification, can moderate the transmission of adverse international shocks (Newfarmer et al., 2009). Additionally, those countries that diversify their exports more tend, by and large, to have higher income elasticity of global demand (Haddad et al., 2010).

The issue of export diversification as a stabilization strategy then became an important economic issue. A large number of countries undertook the usual measures to open up their economies. One of the objectives of the trade liberalization efforts was to benefit from increased diversification and reduced dependence on a few products and markets. However, the recent literature on new growth and trade models has shifted the focus on to the emergence of and trade in new or high-productivity varieties of goods. Contrary to traditional trade theory, export diversification and sophistication play an important role in promoting sustainable economic growth. Countries that produce more diversified and high-productivity goods experience faster export growth than countries with concentrated and lower productivity export baskets (Hausmann et al., 2007; Hummels and Klenow, 2005). In the same vein, the new economic geography models have demonstrated that access to foreign markets is a critical determinant of export performance (Fugazza, 2004; Redding and Venables, 2004). However, the choice of trading partners can improve the size of the export basket, the number of differentiated items, and their relative prices (Amurgo-Pacheco and Pierola, 2008; Regolo, 2013).

The above-mentioned points suggest that developing export capacity outside the resource-based sector should be in the center of focus. There are different patterns of diversification, varying from country to country and depending on the stage of development (Cadot et al., 2013; IMF, 2014). Diversification in export also has many dimensions and can occur either vertically (a shift
in exports from primary products to the manufacturing and tertiary sectors) or horizontally (an increase in the number of exported products within the existing export basket). However, much attention has been paid to its underlying determinants. There are many studies exploring the factors that affect export diversification in developing countries. They can be reduced to three kinds of factors:

• **Structural determinants**
  - GDP, which is a measure of a country’s size. Larger countries have potential for diversifying productive capacity through scale effects.
  - GDP per capita, which measures the level of development. The degree of diversification may grow with the level of development up to a threshold income level (Imbs and Warcziag, 2003).
  - Factor endowments. An abundance of natural resources and/or a high reliance on primary goods is an obstacle to export diversification. In contrast, the availability of physical and human capital favors diversification: in particular, stocks of knowledge enable countries to change their specialization patterns through the externalities of learning-by-doing and R&D tasks that support innovation.
  - The technology gap or asymmetry. When faced with a wide technological gap, a developing country can diversify its export structure only by imitating, thereby doing little to narrow the technological gap separating it from its trading partners.
  - Geographical distance to main trading partners. Increasing remoteness or higher transport costs tend to reduce export diversification (Regolo, 2013).

• **Policy and reform measures**
- Tariff rates. Trade liberalization is expected to improve access to foreign markets, which will eventually lead to export diversification. However, some studies taking a Structuralist approach have found that lower tariff rates induce specialization rather than diversification (Agosin et al., 2009; Cimoli et al., 2011).

- Market access through bilateral or multilateral trade arrangements. As countries become increasingly integrated, their trade tends to diversify more because countries can exploit economies of scale and spillover effects.

- Investment in infrastructure (highways, ports, telephone, electricity, water). Improving infrastructure and trade networks is among the main determinants of successful attempts at diversification (IMF, 2014).

- Regional integration as measured by the trade intensity index is also a key factor. Most recent studies show that country pairs with low trade costs (because of geographic proximity and involvement in trade agreements) have more diversified bilateral exports (Regolo, 2013).

- Financial development. Access to credit helps countries diversify their exports (Agosin et al., 2009).

• Macroeconomic factors

- Foreign Direct Investment (FDI), and more generally, physical capital accumulation. FDI can promote diversification and upgrading of the host country’s export basket through spillover benefits (Iwamoto and Nabeshima, 2012). But Hausmann et al. (2007) stress that, although FDI has a generally positive effect on export diversification, it has a greater impact on vertical diversification than on horizontal.
- Terms of trade shocks. Improvements in terms of trade (with an increase in the price of the main exported products) tend to concentrate exports as fewer inputs are available for new export activities. Agosin et al. (2009) suggest an interesting interaction between this variable and human capital: countries with higher levels of education take advantage of positive terms of trade variations to increase export diversification.

- The level of the RER and its volatility. Real depreciation may improve competitiveness, while removing RER misalignment can favor the extent of export diversification. By increasing uncertainty and reducing the profitability of the exportable sector, real overvaluation or exchange rate fluctuations discourage investment and the emergence of new tradable activities (IMF, 2014).

Product diversification and product quality upgrade are well documented explanations of high export performance, especially in the NICs in East Asia. The point is that all this literature takes the RER as strictly exogenous: however, what happens if causation runs the other way around? Evidence of the link is not definitive. The reverse causality issue is rarely addressed and few, if any, studies have examined the mechanisms through which export diversification may affect the RER. This leads us to investigate a second strand of literature, i.e. the determinants of the RER.

2.2. On the determinants of the real exchange rate

There is an extensive literature in which the RER is examined in terms of monetary or short-run considerations. It starts with the seminal contributions of Balassa (1964) and Samuelson (1964), who demonstrated that a rapidly growing country is more likely to experience real appreciation as differences in the relative price of tradable and non-tradable goods between
home and abroad reflect international differences in productivity in the tradable sector. The well-known Balassa-Samuelson effect equates to a “natural” rise in the RER. Another strand of the literature links a resource sector with the rest of the economy and the RER by means of the well-known concept “Dutch Disease”. Dependence on a natural resource (like oil, gas or related commodities) tends to raise the RER and undermine the competitiveness of other tradable sectors (Corden and Neary, 1982; Corden, 1984).

Export diversification will take place if factors are reallocated to exportable goods, if more resources are made available or freed up in, thereby facilitating inter-sectoral reallocations. A range of economic measures can be adopted to smooth the way for this structural change. One important variable in this regard is the RER. Results indicate that an overvalued RER is seriously detrimental to export profitability, and this is of particular importance for commodities and manufactured products that are labor-intensive. With both types of goods that are essential components of their export baskets, it is observed that weak export performers suffer more from price competitiveness.

In developing countries, the possibilities for devaluation are limited by the need to maintain macroeconomic and price stability, and frequent use of the exchange rate for macroeconomic adjustments increases uncertainty. Any policy aimed at manipulating the nominal exchange rate would lead to problems in managing the economy. In addition, the Structuralist school opposes devaluation for its many adverse consequences for the economy. Developing countries usually export goods that are highly dependent on imported raw materials and intermediate inputs, machinery and equipment. Any currency depreciation would increase the cost of imported inputs and tighten the liquidity constraint or the foreign-currency debt
servicing faced by exporters, thereby impeding the contribution of exchange rate depreciation to export growth (Taylor, 1983).

A key concern then is whether there are other ways to slow down the real appreciation or to maintain competitive RER levels. Any search for alternatives to competitive devaluations of nominal exchange rates would soon identify the factors influencing the “fundamentals” as having potential. One alternative to devaluation would be to slow down the real appreciation through trade liberalization (Mouna and Reza, 2001). The pro-market and structural adjustment policies of the 1980s focused on relative price adjustment as a mechanism for promoting trade and non-traditional exports, hence diversification. Wider private sector participation, market and trade liberalization and exchange rate and price reforms became policy priorities. An increase in trade liberalization would reduce the relative price of importable products, which in turn diverts spending toward exportable products. The associated depreciation of the RER could lead to product diversification, allowing countries to improve their export performance and face less aggressive competition than in more labor-intensive product markets. As a result, their competitiveness might be expected to be less sensitive to small movements in the RER.

In international macroeconomics, the literature examines how trade liberalization (or reductions in trade protection) would help to lower the equilibrium level of RER. The latter is defined as the level of the real effective exchange rate that is consistent with external and internal balances: it follows that misalignments (that is, any deviation of the observed exchange rate from its equilibrium values) arise from external and internal imbalances. The former are represented by the difference between the observed current account and the equilibrium level given by its fundamentals, while the latter refer to output gaps, generally measured as the difference between the observed GDP and its potential level (Gnimassoun and Mignon, 2013).
There is a strand of literature which emphasizes the Purchasing Power Parity (PPP) and equilibrium exchange rate approaches to determining the RER and its movements (Coudert and Couharde, 2008). The various macroeconomic factors are:

- per capita GDP or productivity growth as an illustration of the Balassa-Samuelson effect
- growth in the working-age population
- capital inflows and credit boom
- the ratio of debt service to exports or the country’s net foreign assets as % of GDP
- the share of fuel and primary commodities in total exports as an illustration of the Dutch Disease phenomenon
- changes in the terms of trade.

Regarding trade variables, Sorsa (1999) showed that a decrease in trade protection lowered the RER in Algeria. This helped to improve export competitiveness and increased incentives to invest in the non-oil sector. Relying on his model, Mouna and Reza (2001) tested if openness (an intended outcome of the reforms) has a significant impact on the RER in Algeria, Morocco and Tunisia. The RER is defined here as the ratio of the price of tradable goods to non-tradable goods. An increase (decrease) in the RER indicates depreciation (appreciation). The model used is derived by assuming that changes in the RER (denoted here $e$) can be decomposed into its nominal and fundamental determinants. In Equation (1), the monetary determinants are the differences between supply and demand for money (respectively $M^s$ and $M^d$), the rate of nominal devaluation ($DEV$), differences between the equilibrium RER ($e^*$) and its lagged value. In Equation (2), the fundamentals that affect $e^*$ are real government expenditures on non-tradable goods (or the share of government current expenditures in GDP, denoted $g$), changes in the terms of trade ($TOT$) and trade openness ($OP$).
\[ \Delta \log e_t = \theta (\log e_t^* - \log e_{t-1}) + \rho (\log M_{t-1}^d - \log M_t^d) + \Phi \text{DEV}_t \]  
\[ \log e_t^* = \delta_0 + \delta_1 \log TOT_t + \delta_2 \log g_t + \delta_3 \log OP_t \]

By combining the above two equations, the RER equation becomes:

\[ \log e_t = \alpha_0 + \alpha_1 \log TOT_t + \delta_2 \log g_t + \delta_3 \log OP_t + \rho (\log M_{t-1}^d - \log M_t^d) + \Phi \text{DEV}_t + \alpha_4 \log e_{t-1} + \varepsilon_t \]

A recent and still expanding strand of the literature attempts to examine the transmission mechanisms between external and internal disequilibria and RER misalignments in the context of widespread macroeconomic imbalances (Gnimassoun and Mignon, 2013). However, no study addresses export diversification as a determinant of the RER. The literature has invested more in documenting the impact of RER misalignment on export diversification than in identifying any feedback or bidirectional causality in the relationship. To the best of our knowledge, only Bodart et al. (2011) proposed an interesting study that found that the degree of export diversification, among several structural factors, affects the magnitude of the RER reaction to terms of trade shocks. Increases in the terms of trade (like commodity price shocks) are associated with a rise in the RER. The authors found that a high degree of export diversification decreases the elasticity between the RER and the price of the main exported raw commodity, which is in line with the portfolio approach.

To get a better understanding of this shortcoming, the research question to be tackled here is how export diversification affects the RER. *A priori*, it introduces changes in the relative prices of the goods produced and hence in future competitiveness. Several mechanisms through which export diversification affects the RER can be identified:

- Diversification increases domestic production capacities, either by expanding inputs into export production or by enlarging the export basket. In addition, improved production
techniques associated with export diversification raise a country’s aggregate productivity level, bringing down costs. Both higher domestic supply and lower producer prices help to consolidate export performance. Those countries that cannot increase the number of domestic varieties produced will be exposed to exchange rate shocks.

- Diversification leads to changes in product composition, implying changes in the composite price index. This product composition effect combined with dynamic economies of scale resulting from the production process belongs to the “price-driver-export diversification”, contrasting with the income-driver-export diversification suggested by the new trade theories. It also contrasts with the “fallacy of composition”, which arises when too many countries rush into the same sectors or products, thereby driving down terms of trade and export earnings (Faini et al., 1992).

- Diversification is likely to be achieved without substantial growth in domestic wages when the increased demand for labor in the new tradable sectors is absorbed by underemployment and the large number of new entrants in the labor market. In other words, export diversification may not affect factor remuneration for countries with relatively large labor forces or low wage levels\(^1\).

- Diversification in the exporting country helps to decrease the consumer price index in the importing countries, elevating the purchasing power of their expenses and their market absorptive capacity. But the lower consumer prices might help to consolidate a competitive exchange rate policy, which in turn stimulates exports in the latter countries.

\(^1\) Export diversification may however impact on relative labor costs, notably the skilled-unskilled wage differentials. When the exported goods are different varieties of a non-homogenous industry, the reward to human capital will increase.
The last point is dictated by theoretical considerations. The underlying framework is essentially a standard monopolistic competition model of international trade in the presence of product differentiation and trade costs (Redding and Venables, 2004). The demand for differentiated products is modelled using a symmetric Constant Elasticity of Substitution (CES) in the utility function as follows:

\[
U_j = \left( \sum_{i=1}^{N} n_i x_{ij}^{(\sigma-1)/\sigma} \right)^{\sigma/(\sigma-1)}, \sigma > 1
\]  

(4)

Where \( \sigma \) is the elasticity of substitution between any pair of products, \( n_i \) is the set of varieties produced in country \( i \) and \( x_{ij} \) is the consumption by country \( j \) of a single product variety from this set.

Assuming product symmetry, we can then define the price index in each country \( j \) (\( G_j \)) by using the price of individual varieties produced by country \( i \) and sold in country \( j \) (\( p_{ij} \)):

\[
G_j = \left( \sum_{i=1}^{N} n_i p_{ij}^{\sigma} \right)^{1/(1-\sigma)}
\]  

(5)

Let us denote \( E_j \) country \( j \)’s total expenditure on differentiated products. Using Shephard’s lemma on the price index, country \( j \)’s demand for each variety can be written as follows:

\[
\dot{x}_{ij} = p_{ij}^{-\sigma} E_j G_j^{\sigma-1}
\]  

(6)

Hence the trading partner’s demand and its consumer price index are influenced by the volume of goods produced in the exporting country \( i \). More generally, export diversification in country \( i \) helps to build domestic supply capacity and simultaneously to increase export competitiveness though cost reduction. However, the higher potential of market absorption capacity in the importer country \( j \) helps country \( i \) in turn to diversify its own production capacities.
Such theoretical considerations imply that the relationship between export diversification and the RER is of particular relevance. It means that regressions “explaining” export diversification in terms of the RER will be contaminated by reverse causation. Unfortunately, there is no unified theoretical framework explaining these endogenous interactions. Since export diversification affects relative prices in a rather complex way, this phenomenon calls for an empirical approach to the problem.

3. Empirical framework

3.1. Data

As there are several dimensions of diversification, the analysis can be undertaken at different levels (IMF, 2014). In our study, we focus on intensive export diversification (when it results from changes in the relative share of goods in the export basket), which is based on the most commonly used statistic for measuring export concentration, namely the Herfindhal-Hirschman product concentration Index (HHI). The index for country $i$, normalized to range from 0 to 1 (so that the information about the number of export products is lost), measures export concentration (diversification being the complement to 1 of concentration):

$$HHI_i = \left( \sum_{k=1}^{N} \frac{p_k^2}{1 - \frac{1}{N}} \right) \quad \text{with} \quad p_k = \frac{x_k}{X_i}$$

Where $p_k$ is the share of export line $k$ (with $x_k$ denoting the amount exported) in total exports of country $i$ ($X_i=\Sigma x_k$) and $N$ is the total number of export products. The share of each product in a country’s total exports is weighted, to make sure that a small export value has a minor influence on the outcome of the index. Contrary to the usual index, which ranges from 1/N to 1, the
normalized HHI is more suitable as a measure for equality of distribution. This is especially the case here if we consider export diversification in a portfolio approach: the lower the HHI, the less concentrated or more diversified exports are. The shares of each product $k$ are used in whole percentages, so that the index for country $i$ can range from 0 to 10,000. In interpreting the HHI results, we follow the rule that that states that concentration is normal if $\text{HHI} \geq 2,000$.

The RER can also be defined in various ways:

- It can be defined as the nominal exchange rate that is adjusted by the ratio of the foreign price level to the domestic level. A decline will be interpreted as a real appreciation
- It can be defined as the relative price of the tradable good in terms of the non-tradable good. Higher relative prices of the non-tradable good results in a deterioration in the country’s level of competitiveness (or a real appreciation of the domestic currency).

In our study, we choose the former definition which is the most frequent:

$$RER = \frac{EP^*}{P}$$

Where $E$ is the official nominal exchange rate (the number of local currency units per unit of foreign currency) and $P^*$ and $P$ are the foreign and domestic prices respectively.

To calculate HHI, we use country-level data from the Basis for the Analysis of International Trade (BACI) dataset which is compiled by the CEPII at the HS 6-digit product level. Original data are taken from countries’ bilateral exports in value to all regions from 1995 to 2015. The sample is limited to a set of LMIIs and UMIIs in a comparative perspective, i.e. 21 Asian countries and 23 Latin American countries.

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2 See [http://www.cepii.fr/anglaisgraph/bdd/baci.htm](http://www.cepii.fr/anglaisgraph/bdd/baci.htm) for further details.

3 According to the World Bank classification, there are 28 LMI and UMI countries in South Asia, East Asia and Pacific and 25 LMI and UMI countries in Latin America and the Caribbean. However, because data are not available for all countries, our balanced sample is reduced to 44 countries over a 21-year period. The countries in our sample are listed in the appendix.
For the RER, it is usually preferable to deflate the nominal exchange rate with producer prices or costs and weight bilateral exchange rates by the share of the main trading partners. Unfortunately, it is not possible to compute real effective exchange rates, as there are no available data on trade structure for all the LMI and UMI countries under consideration. Moreover, it was price-driver-export diversification that prompted our empirical study and it is crucial to choose a composite price index that takes account of all destination prices and their mutual dependence. Therefore, we decided to compute the RER for our sample by using the Consumer Price Indices (CPIs). The United States will be defined as foreign and the nominal exchange rates are the number of local currency units per US dollar. Annual data are extracted from the World Bank’s World Development Indicators (WDI) database with base 2010 = 100.

(Insert Table 1 and Figure 1 here)

Using the available data, summary statistics are given in Table 1. In accordance with the literature linking the evolution of export diversification with development, our statistics provide evidence that export diversification is more prevalent in the middle-income countries, although it is less pronounced in small countries. Figure 1 shows the evolution in Asia and Latin America over the period considered; the mean by region is individual HHI and RER data weighted by the share of each country in the regional GDP. The remarkable point is that mean HHI in both regions is relatively low, even if there was an increase in export concentration in Latin America over the last decade. On the other hand, the unweighted RER has a mean value of 114.5 in Asia and 110.1 in Latin America, which is quite low compared to previous decades (Table 1). In addition, standard deviation in both regions is 23.9 and 20.1 respectively, suggesting that the panel data sets are not so spread. An interesting point is that, on average, exports tended to become less diversified in Latin America while the RER was declining within the same period.
As our time period includes two financial crises, namely the East financial crisis of 1997 and the global financial crisis of 2008, we wonder if these two shocks have affected the causal relationship between the real exchange rate and export diversification. For example, one might argue that the East Asian MICs have come out of the financial crisis of 1997 with the decision to improve export performance through diversification. On the opposite, the global financial turmoil of 2008 resulted in global recession with a decline in international trade. It might play a role in the dynamics of exchange rates and the associated effects on the real economy. In order to consider this possible impact of the two financial crises on the causality between RER and HHI, we will use dummy variables in our Granger causality techniques.

3.2. Methodology

The standard causality test defined by Granger (1969) has been widely applied in the empirical literature. A time series variable \( y_t \) “Granger causes” another time series variable \( x_t \) if the past values of \( y_t \) are statistically significant and help to predict the present value of \( x_t \) in a regression on its own past values and other relevant information. The simple causal model can be described mathematically as follows:

\[
\begin{align*}
    x_t &= \sum_{j=1}^{m} a_j x_{t-j} + \sum_{j=1}^{m} b_j y_{t-j} + \epsilon_t \\
    y_t &= \sum_{j=1}^{m} c_j x_{t-j} + \sum_{j=1}^{m} d_j y_{t-j} + \nu_t
\end{align*}
\]

Where \( \epsilon_t, \nu_t \) are uncorrelated white noise series and \( m \) is the finite length of the available data. \( y_t \) (or \( x_t \)) is said to Granger cause \( x_t \) (or \( y_t \)) if some \( b_j \) (or \( c_j \)) are different from zero. In case where \( b_j \) and \( c_j \) simultaneously differ from zero, we have a bivariate causality between \( x_t \) and \( y_t \).
However, because interactions along production chains have increased with trade integration and globalization, the question of causality between export diversification and RER may exist in panels. A causality analysis using panel data then enables us to account for both cross-country dependence and heterogeneity across countries, i.e. a causal link may exist for one country but may not exist for others. Taking these considerations into account, we use the Granger non-causality test developed by Dumitrescu and Hurlin (2012). The test is based on heterogeneous panel data models with fixed coefficients and stationary variables:

\[ y_{it} = \alpha_i + \sum_{k=1}^{K} \gamma_{i,k} y_{i,t-k} + \sum_{k=1}^{K} \beta_{i,k} x_{i,t-k} + \epsilon_{it} \]

We assume the lag orders K are identical for all cross-section units of the panel (i=1,...,N) observed at time period t (t=1,...,T), while the autoregressive parameters \( \gamma_{i,k} \) and the regression slopes \( \beta_{i,k} \) differ across countries. Similarly, \( \alpha_i \) denotes the individual effects and all those coefficients are constant in time.

A variable \( x \) causes another variable \( y \) if the coefficients of its past values are statistically significant and help to explain and predict \( y \) on its own past values and other relevant information. The authors propose to test the Homogeneous Non Causality (HNC) hypothesis, which means that there is no causal relationship from \( x \) to \( y \) for all countries in the panel.

\[ H_0: \beta_i = 0 \ \forall \ i = 1,...,N \]

A rejection of the null hypothesis suggests the existence of causality from \( x \) to \( y \) for at least one individual.

Associated with the null HNC hypothesis, the authors define the average of individual Wald statistics for each unit \( i \) as:
\[ W_{N,T}^{HNC} = \frac{1}{N} \sum_{i=1}^{N} W_{i,T} \]

Where \( W_{i,T} \) denotes the individual Wald statistics for the ith-cross-section unit corresponding to the individual test \( H_0: \beta_i = 0 \). Each individual Wald statistic has a chi-squared distribution with K degrees of freedom.

For large N and T samples, the standardized statistic is defined by:

\[ Z_{N,T}^{HNC} = \sqrt{\frac{N}{2K}} (W_{N,T}^{HNC} - K) \]

For finite T samples, the approximated moment \( \tilde{Z}_{N}^{HNC} \) is used to test the null HNC hypothesis:

\[ \tilde{Z}_{N}^{HNC} = \sqrt{\frac{N}{2K}} \left( \frac{T - 2K - 5}{(T - K - 3)} \right) \left( \frac{T - 2K - 3}{(T - 2K - 1)} W_{N,T}^{HNC} - K \right) \]

For large N samples, if \( \tilde{Z}_{N}^{HNC} \) are superior to the corresponding normal critical value for a given level of risk, the HNC hypothesis is rejected.

Our empirical investigation will be conducted separately for Asia and Latin America; however, in order to analyze the robustness of our results obtained by region and to compare them, we do the same Granger causality analysis on the 44 individual countries. Our two variables are expressed in logarithms in order to include the proliferative effect of time series.

To estimate the sign of causality, for each country, we test the null hypothesis \( H_0: \sum_{k=1}^{K} \beta^{(k)} = 0 \) against the alternative \( H_1: \sum_{k=1}^{K} \beta^{(k)} < 0 \) (respectively \( H_1: \sum_{k=1}^{K} \beta^{(k)} > 0 \)). Then, by using Fisher’s method, we combined the p-values from these tests into a joint test whether the global null hypothesis can be rejected.
3.3. Preliminary tests

To determine the appropriate method, Dumitrescu and Hurlin’s causality test with panel data (Dumitrescu and Hurlin 2012) requires some preliminary tests that involve verifying cross-sectional dependence, stationarity of the variables and selection of optimal lag length.

We use Pesaran’s methodology (Pesaran 2004) to determine whether our panel data is cross-sectionally independent. Cross-sectional dependence is a rapidly growing field of study in panel data analysis. This is restrictive, as macro time series exhibit significant cross-sectional correlation among countries in the panel. Phillips and Sul (2003) argue that it is important to take this feature into account in panel analysis because cross-sectional dependence increases the variation of the pooled (panel) least-squared estimators. Their results indicate that cross-sectional dependence must be considered if we want to gain from panel estimation by pooling cross section and time series information.

Pesaran (2004) extends Breuch-Pagan methodology by testing cross-sectional independence. The proposed test is based on an average of pairwise correlation coefficients of OLS residuals from the individual regressions in the panel:

\[
CD = \sqrt{\frac{2NT}{N(N-1)} \left( \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \hat{\rho}_{ij} \right)}
\]

Under the null hypothesis of no cross-sectional dependence, \( CD \to N(0,1) \) for \( N \to \infty \) and \( T \) sufficiently large. The CD statistic has exactly mean at zero for fixed values of \( N \) and \( T \) under a wide range of panel data models, including: heterogeneous models, non-stationary models and dynamic panels.

\((Insert \ Table \ 2 \ here)\)
The statistics in Table 2 show clearly that the null hypothesis of no cross-sectional dependence is rejected in both the whole sample and sub-samples. Therefore, cross-sectional dependencies exist in our data and it confirms that the panel causality is appropriate.

In the third step, we need to take into account cross-sectional and slope heterogeneity features when we have to verify the stationarity of our panel data sets. Panel unit root tests, especially the “first generation” tests, have been criticized because they assume cross-sectional independence. The Chang (2002), Choi (2002) and Pesaran (2007) tests belong to the “second generation” of panel unit root testing methods which take into account cross-sectional dependence. To eliminate the latter, Chang (2002) proposes to use, for each cross-sectional unit, the instruments generated by an integrable nonlinear function of the lagged levels of variables. The test statistic, $S_N$, is given by an average IV t-ratio statistics for testing the unity of the AR coefficient computed from each cross-sectional unit. Choi (2002) proposes a panel unit root test for cross-sectional correlation which comes from error components. To test the null hypothesis of unit root test, the author deletes the constant term and the non-stochastic components from the observed panel data by time series and cross-sectional de-meanings. The combination test statistics proposed include: the $P_m$ test, which comes from Fisher (1932); the Z test proposed by Stouffer et al. (1949); and the $L^*$ test, which relies on George (1977). These tests have a standard normal distribution. To deal with the presence of cross-sectional dependence in an alternative way, Pesaran (2007) augments the Augmented Dicky-Fuller (ADF) regression with cross-sectional averages of lagged levels and first-differences of the individual series, and then obtains the augmented model CADF (Cross-Sectionally Augmented Dickey-Fuller). From the individual CADF statistics, Pesaran (2007) suggests the CIPS (Cross-sectionally augmented IPS) statistics and their truncated version CIPS*. 
The results of the unit root tests are reported in Table 3. Taking the country sample as a whole, the statistics indicate a rejection of the null hypothesis and suggest stationarity at the level of both variables. We also obtain the same results for the regional sub-samples.

Choosing an appropriate lag length is important in the Granger causality test because its results are sensitive to the number of lags. The omission of lags leads to a bias inference, while selecting more lags than the true lag length in the equation may cause the estimates to be inefficient. Because the results from the causality test may be sensitive to the lag structure, we test the robustness of our findings by following two alternative approaches. On the one hand, we compute the statistics for various lags without choosing a common lag order; on the other hand, we select the optimal lag length to be set before testing our Granger causality. According to Hsiao (1981), the number of lags can be chosen by Akaike information (AIC) and Bayesian information Criteria (BIC). However, these criteria information are incompatible with dynamic panel models (Moon et al., 2007). Han et al. (2012) demonstrate also the inconsistency of BIC in panel data. We use, therefore, BIC modified by Han et al. (2012) to select the optimal lag length for the Granger causality test. This modified BIC is calculated from the following simple panel AR(k) process:

\[ y_{it} = \sum_{s=1}^{k} \rho_s y_{it-s} + \epsilon_{it} \]

Where \( k \) is the lag length, \( i = 1, \ldots, N, \quad t = 1, \ldots, T \) and \( \epsilon_{it} \sim iid \ N(0, \sigma^2) \). By defining \( X_{k,ij} = (y_{it-1}, \ldots, y_{it-k})', \lambda_k = (\rho_1^*, \ldots, \rho_k^*)' \), the modified BIC is expressed as follows:

\[ IC(k) = \ln \hat{\sigma}_k^2 + k \times \frac{\ln(\sqrt{NT_k})}{\sqrt{NT_k}} \]
Where $\hat{\sigma}^2_k = \frac{1}{NT_k} \sum_{t=1}^{T} \sum_{i=1}^{N} \hat{\varepsilon}_{k,it}^2$, where $\hat{\varepsilon}_{k,it} = y_{it} - X_{k,it} \hat{\lambda}_k$

The optimal lag length selected under the Bayesian information criteria (BIC) and the modified BIC proposed by Han et al. (2017) is 3 for HHI and RER.

4. Empirical results

The preliminary analysis having been completed, we now turn to the Granger causality test. First, we define a benchmark model where the financial crises of 1997 and 2008 have not affected the causal relationship. The Granger causality test is based on the following model with fixed coefficients and stationary variables:

$$
\begin{align*}
HHI_{it} &= \alpha_{HHI,i} + \gamma_{HHI,j} HHI_{i,j-1} + \beta_{HHI,i} RER_{i,j-1} + \epsilon_{it} \\
RER_{it} &= \alpha_{RER,i} + \gamma_{RER,j} HHI_{i,j-1} + \beta_{RER,i} RER_{i,j-1} + \epsilon_{it}
\end{align*}
$$

In the model without dummy, the null hypothesis of HNC $H_0: \beta_{HHI,i} = 0$ with $\forall i = 1,2,\ldots,N$ means that the RER does not Granger cause HHI and $H_0: \gamma_{RER,i} = 0, \forall i = 1,2,\ldots,N$ means that HHI does not Granger cause the RER. The rejection of the null hypothesis implies the existence of causality in at least one country.

An alternative model consists in introducing dummy variables to point out the possibility of external shocks on the causality relationship. This assumption allows us to introduce two dummy variables (D97 and D08) which indicate the financial crisis of 1997 and 2008, respectively. Therefore, the alternative model becomes:

$$
\begin{align*}
HHI_{it} &= \alpha_{HHI,i} + \theta_{1} D_{97,i} + \theta_{2} D_{08,i} + \gamma_{HHI,j} HHI_{i,j-1} + \beta_{HHI,i} RER_{i,j-1} + \epsilon_{it} \\
RER_{it} &= \alpha_{RER,i} + \theta_{1} D_{97,i} + \theta_{2} D_{08,i} + \gamma_{RER,j} HHI_{i,j-1} + \beta_{RER,i} RER_{i,j-1} + \epsilon_{it}
\end{align*}
$$
Where D97 (respectively, D08) takes a value of one for 1997-1998 (2008–2009) and zero otherwise.

In the case of the existence of cross-sectional dependence, Dumitrescu and Hurlin (2012) suggest to use bootstrapped critical values instead of asymptotic critical values. The block bootstrap procedure is performed with 1000 replications.

*(Insert Table 4 here)*

The upper part of Table 4 provides the Granger causality results following Dumitrescu and Hurlin (2012) methodology without taking into account the financial crises. Firstly, the null hypothesis is rejected at 1% level of significance in both directions taking the whole sample. A bidirectional causality indicates that neither export diversification nor the RER can be considered exogenous here because feedback may occur. To get a deeper understanding, the same Granger causality analysis is conducted by dividing our sample by region. The results reported here provide strong evidence that the same bidirectional relationship exists for the Latin American sub-sample, which implies that there is a two-way causality between the RER and HHI in at least one country within the region. In the case of Asia, there is strong evidence that RER Granger causes HHI. But the null hypothesis that HHI does not homogeneously cause RER is not rejected with the selected optimal lag length. Because the results may be influenced by lag-order misspecification, the same causality tests were performed with various lags. These results change when we introduce the two dummy variables which capture the effects of financial crises. The lower part of Table 4 reports our empirical results, which are similar to the ones obtained previously for Latin America and the broader sample: there is at least one country where HHI “Granger causes” the RER and *vice versa* for the whole sample at all lags, including
the optimal one. While we obtain the same bidirectional causality in Asia, this not the case for the Latin American sub-panel anymore. All in all, our findings seem to reveal divergent effects of financial crises across countries in the two regions, calling for deeper investigation.

The sign of causality is estimated in the model with optimal lag. Without dummies, for the whole sample and two sub-sample, HHI Granger causes RER with negative effect. The sign of causality from RER to HHI is both positive and negative for the whole sample and the Latin America sub-sample and ambiguous for the Asia sub-sample.

The financial crisis do not affect the effect of HHI to RER in the Asian case, but for the whole sample and the case of Latin America, HHI has both positive and negative effect on RER. On the reverse causation, the effect of RER to HHI is unchanged for the whole sample and the case of Latin America whereas the sign become negative in the sub-sample of Asia.

(Insert Table 5 here)

Therefore, Granger causality tests are conducted on individual countries and the results are displayed in Table 5. Firstly, if we compare both parts of the table, we find that the two financial crises of 1997 and 2008 have not affected the causal relationship in the majority of countries. Nine countries show no causality between RER and export diversification in either direction, with or without dummies. Four MICs show a bidirectional causality in both models, namely: Bangladesh, Columbia, Jamaica, and Vietnam. Interestingly, the role of the RER as a conventional determinant of export diversification dynamics, whatever the model, is not systematic at all. Only five countries (Belize, Costa Rica, Nicaragua, Pakistan, and Thailand) show a univocal causation from RER to HHI. On the opposite, six countries (among which, China) show a univocal link running from HHI to RER, which is very appealing in terms of economic policy.
Secondly, the individual statistics on the Granger causality test show some interesting results on the impact of financial crises. While most countries were unaffected, the link running from export diversification to real exchange rate was disturbed by the financial crises in almost eight countries.

5. Conclusion

In recent years, export diversification is held to be important for developing countries because many of them are often highly dependent on relatively few primary commodities for their export earnings. Unstable prices for these commodities may subject an exporting country to serious terms of trade shocks. This has led developing countries to target diversification of the export portfolio, especially into manufactured goods, as a means of improving their economic performance and income. Benefits of diversification include higher and more stable export earnings, job creation and learning effects, and the development of new skills and infrastructure that would facilitate the development of even newer export products.

Accordingly, the purpose of our study was threefold. Firstly, by examining the causal relationship between export diversification and the RER, our study differs from previous studies that mostly focus on unidirectional causality running from the RER to export diversification. An important purpose of the study was to go further by identifying the direction of the causality. Secondly, as increasing export diversification is more prevalent in middle-income countries, we explored the causality relationship in the specific sample of LMI and UMI countries in Asia and Latin America. Lastly, the causality can be more efficiently tested in a panel context given cross-sectional dependencies and heterogeneity across countries. We investigated this issue in a
panel data set covering the sample of all middle-income countries over the period 1995-2015 and then by region.

Looking at the sample as a whole, our study found a bidirectional causality between the level of the real exchange rate and export diversification. A causal link running from the real exchange rate to export diversification is consistent with the standard literature. However, there is also evidence that diversifying exports causes the real exchange rate, which is very appealing in terms of economic policy for countries at the middle-income level. Real exchange rate undervaluation and stability promote export diversification by increasing the profitability of the export sector. However, successful diversification efforts may also lower supply prices thanks to productivity gains, larger export production capacities and enhanced tradable sectors. Hence, export diversification may determine the real exchange rate by affecting the relative price of traded goods or the relative movement of prices.

Our causality results confirm the popular view that trade liberalization and the associated exchange rate could have led to diversification of exportable products and the economy, as suggested by the conventional theories. However, we have revealed a reverse causality where export diversification might help to consolidate a competitive exchange rate policy. This causation is neglected in the existing studies. In the Asian countries, it appears that financial crises yield export diversification to cause real exchange rate at an optimal lag length. The result suggests that these countries have overcome the impact of financial crises by allowing diversification to become an alternative to devaluation in slowing down real appreciation of the exchange rate. Panel causality tests which were performed with various lags and at individual countries revealed that a bidirectional causality exists. China aptly illustrates this one-way causality between export diversification and real exchange rate policy. Most countries try to keep
a stable and low real exchange rate in order to move resources into manufactured exports. However, some others like China have resisted market pressures for currency appreciation by diversifying their export basket. The overall productive gains and exploitation of economies of scale have exerted downward pressures on prices across the economy, allowing the countries to maintain external competitiveness.

Finally, we also show that the two financial crises of 1997 and 2008 have not affected the causal relationship in the majority of countries. One limitation of our empirical investigation is that the dynamic process that seems to be at work, especially in the Asian region, remains under-investigated as it is beyond the scope of this paper. An undervalued currency has significantly boosted export diversification and development in those countries, but there may be a deliberate strategy behind successful diversification efforts that aided this process. For example, we did not take into account the possibility of a causal link between countries through trade linkages. Thus future research might extend this study by identifying the real or monetary interdependencies among the countries within or outside the same trade area.

References


Choi, I. (2002), Combination unit root tests for cross-sectionally correlated panels, Mimeo, Hong Kong University of Science and Technology.

Cimoli, M., S. Fleitas, and G. Porcile (2011), Real exchange rate and the structure of exports. MPRA paper N°37846. [http://mpra.ub.uni-muenchen.de/37846/1/MPRA_paper_37846.pdf](http://mpra.ub.uni-muenchen.de/37846/1/MPRA_paper_37846.pdf)


### Appendix: Country sample

<table>
<thead>
<tr>
<th>Region</th>
<th>Countries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asia</td>
<td></td>
</tr>
<tr>
<td>East Asia and Pacific (15)</td>
<td>China, Fiji, Indonesia, Kiribati, Lao PDR, Malaysia, Mongolia, Papua New Guinea, Philippines, Samoa, Solomon Islands, Thailand, Tonga, Viet Nam, Vanuatu</td>
</tr>
<tr>
<td>South Asia (6)</td>
<td>Bangladesh, Bhutan, India, Sri Lanka, Maldives, Pakistan</td>
</tr>
<tr>
<td>Latin America and the Caribbean (23)</td>
<td>Belize, Bolivia, Brazil, Colombia, Costa Rica, Dominica, Dominican Republic, Ecuador, El Salvador, Grenada, Guatemala, Guyana, Honduras, Jamaica, Mexico, Nicaragua, Panama, Paraguay, Peru, St. Lucia, St. Vincent and the Grenadines, Suriname, Venezuela</td>
</tr>
</tbody>
</table>
Figures and Tables

Figure 1: HHI and RER in the middle income countries of Asia and Latin America (1995-2015)

Source: Authors’ calculations.

Note: Individual HHI and RER are weighted by the share of each country in the regional GDP.
Table 1. Summary statistics of HHIs and RER indices (1995-2015)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Obs.</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>WHOLE</td>
<td>924</td>
<td>1168.139</td>
<td>1242.802</td>
<td>29.056</td>
<td>7956.216</td>
</tr>
<tr>
<td>RER</td>
<td>924</td>
<td>112.183</td>
<td>22.107</td>
<td>36.237</td>
<td>233.777</td>
</tr>
<tr>
<td>Asia</td>
<td>441</td>
<td>1152.067</td>
<td>1299.882</td>
<td>29.056</td>
<td>6782.021</td>
</tr>
<tr>
<td>HHI</td>
<td>441</td>
<td>114.462</td>
<td>23.93</td>
<td>59.222</td>
<td>233.777</td>
</tr>
<tr>
<td>RER</td>
<td>483</td>
<td>110.102</td>
<td>20.099</td>
<td>36.237</td>
<td>224.928</td>
</tr>
</tbody>
</table>

Table 2. Cross-sectional dependence test

<table>
<thead>
<tr>
<th>Null hypothesis:</th>
<th>F-statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cross-sectional independence</td>
<td>WHOLE</td>
</tr>
<tr>
<td></td>
<td>HHI</td>
</tr>
</tbody>
</table>

Note: The cross-sectional dependence test is performed following Pesaran (2004) approach. *, **, *** indicate the rejection of the null hypothesis at 10%, 5% and 1% level of significance respectively.

Table 3. Unit root test

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>CIPS</td>
<td>Pm</td>
<td>Z</td>
</tr>
<tr>
<td>RER</td>
<td>-2.374***</td>
<td>3.510***</td>
<td>-2.608***</td>
</tr>
<tr>
<td>Asia</td>
<td>-2.401***</td>
<td>4.159***</td>
<td>-4.035***</td>
</tr>
<tr>
<td>HHI</td>
<td>-2.737***</td>
<td>2.179***</td>
<td>-1.955**</td>
</tr>
<tr>
<td>RER</td>
<td>-1.979</td>
<td>9.483***</td>
<td>-6.361***</td>
</tr>
<tr>
<td>Latin America</td>
<td>-2.020</td>
<td>2.772***</td>
<td>-1.739**</td>
</tr>
</tbody>
</table>

Note: Pesaran (2007), Chang (2002) and Choi (2002) test the null hypothesis of unit root test. *, **, *** stand for significance at 10%, 5% and 1% respectively.

Table 4. Granger causality test with various lags

<table>
<thead>
<tr>
<th>Null hypothesis of HNC</th>
<th>Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>From HHI to RER</td>
</tr>
<tr>
<td>Without dummies</td>
<td>W_{HNC}</td>
</tr>
<tr>
<td>WHOLE</td>
<td>k=1</td>
</tr>
<tr>
<td></td>
<td>2.766</td>
</tr>
</tbody>
</table>

37
<table>
<thead>
<tr>
<th>k</th>
<th>3.881</th>
<th>12.477***</th>
<th>4.009***</th>
<th>5.425</th>
<th>22.717***</th>
<th>7.889***</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>5.710</td>
<td>22.104***</td>
<td>4.188***</td>
<td>8.610</td>
<td>45.540***</td>
<td>9.676***</td>
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<tr>
<td>** (negative)</td>
<td>4.009***</td>
<td>5.425</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.477***</td>
<td>7.889***</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>** (both)</td>
<td>** (ambigous)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asia</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>k=1</td>
<td>2.412</td>
<td>4.575***</td>
<td>3.363***</td>
<td>2.854</td>
<td>6.007</td>
<td>4.519***</td>
</tr>
<tr>
<td>k=2</td>
<td>3.349</td>
<td>6.184***</td>
<td>1.847*</td>
<td>3.896</td>
<td>8.687</td>
<td>2.795***</td>
</tr>
<tr>
<td>** (negative)</td>
<td>4.227***</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20.926</td>
<td>4.227***</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>** (both)</td>
<td>** (ambiguous)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Latin America</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>k=1</td>
<td>3.089</td>
<td>7.083***</td>
<td>5.372***</td>
<td>2.502</td>
<td>5.093*</td>
<td>3.766***</td>
</tr>
<tr>
<td>k=2</td>
<td>4.366</td>
<td>11.349</td>
<td>3.781***</td>
<td>6.821</td>
<td>23.120***</td>
<td>8.241***</td>
</tr>
<tr>
<td>k=3</td>
<td>6.611</td>
<td>21.211</td>
<td>4.263**</td>
<td>10.319</td>
<td>42.991***</td>
<td>9.344***</td>
</tr>
<tr>
<td>** (negative)</td>
<td>4.263**</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>10.319</td>
<td>42.991***</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>** (both)</td>
<td>** (both)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note:** The Granger causality test for panel data follows Dumitrescu and Hurlin (2012) methodology with an optimal lag order $k$ selected in bold. The null hypothesis is the homogeneous non causality (HNC) from X to Y. The bootstrapped critical values with 1000 replications are used to take into account the cross-sectional dependence. The sign of causality is reported in the model with optimal lag. *, **, *** stand for significance at 10%, 5% and 1% respectively.
Table 5. Granger causality test for panel data: Individual statistics with optimal lag length

<table>
<thead>
<tr>
<th>Country</th>
<th>Without dummies</th>
<th>With dummies</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HHI does not cause RER</td>
<td>RER does not cause HHI</td>
</tr>
<tr>
<td>Bangladesh</td>
<td>6.6396*</td>
<td>15.1728***</td>
</tr>
<tr>
<td>Belize</td>
<td>0.2556</td>
<td>20.3931***</td>
</tr>
<tr>
<td>Brazil</td>
<td>2.3398</td>
<td>0.3379</td>
</tr>
<tr>
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Note: *, **, *** indicate the rejection of the null hypothesis at 10%, 5% and 1%, respectively.