Technological progress, non-price factors competitiveness and changes in trade income elasticities: empirical evidence from South Korea and Hong Kong[♣]

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Abstract

In the Balance of Payments Constrained Growth model literature, income elasticities (IE) are considered as the crucial element determining a country's long run growth rate. Although the extant literature accepts that technology matters for the IE magnitude, explanations linking technology and the IE magnitude are limited. In this paper, we make use of the National Innovation System (NIS) concept from the Evolutionary School to explain the channels through which the size of a country's IE is influenced by the level of development of its NIS, which in turn, is a channel through which the non-price competitiveness factors work. Additionally, we empirically test the hypothesis that the catch-up allowed by NIS developments achieved in South Korea and Hong Kong improved their IE over the 1980-95 period. Our empirical results suggest a link between the level of NIS development and the size of the IE.

Keywords: National Innovation System, Income Elasticities, Imports, Exports

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1. Introduction

In the seminal work of Thirlwall (1979), the differences in income elasticities (IE) of demand for imports and exports between countries are key to the deviations in their long-run growth rates. According with Thirlwall's work, it is demand that drives the economic system and the dominant demand constraint is the balance-of-payments. McCombie and Thirlwall (1994, pp. 233-34) argue that

"If a country gets into balance-of-payments difficulties as it expands demand before the short-term capacity growth rate is reached, then demand must be curtailed; supply is never fully utilized; investment is discouraged; technological progress is slowed down and a country's good compared with foreign goods become less desirable so worsening the balance of payments still further, and so on … it is only through the expansion of exports that the growth rate can be raised without the balance-of-payments deteriorating at the same time. Believers in export-led growth are really postulating a balance-of-payments constraint theory of why growth rates differ … the same rate of export growth in different countries will not necessarily permit the same rate of growth of output because the import requirements associated with growth will differ between countries, and thus some countries will have to constraint demand sooner than others for balance-of-payments equilibrium. The relation between a country's growth rate and its rate of growth of imports is the income of elasticity of demand for imports."

More recently, the literature on the Balance of Payments Constrained Growth Model (hereafter, BPCG) has developed substantially: Capital flows were introduced into the BPCG by Thirlwall and Hussein (1982), Moreno-Brid (1998, 2003) and Barbosa Filho (2001). Fagerberg (1988), focusing on the supply side, concludes that technological progress matters for IE magnitudes. Porcile *et al.* (2007), Araujo and Lima (2007), Cimoli *et al.* (2010), Gouvea and Lima (2013) also argue that supply-side effects emerge from the pattern of specialization of the industrial structure insofar as the latter affects the IE.

Common to these studies is the notion that technology is related to the relative magnitudes of the IE. Nonetheless, explanations relating the channels that link technology and the size of the IE appear limited, and this is coupled with a dearth of empirical supporting evidence.

We posit, following from the Evolutionary Schools stance, that technology is key for growth in the long-run (see Nelson and Winter, 1982; Freeman, 1995; Fagerberg, 1994). The concept of National Innovation System (NIS) is embedded in the Evolutionary argument and, therefore, can be used to investigate the BPCG. To this end, an aim of this current study is to empirically investigate whether linkages between technology and the magnitude of IE exist. More specifically, we argue that the catch-up achieved by countries' technological progress change their IE and increase their balance-of-payments equilibrium growth rate since technological progress is a channel through which the non-price competitiveness factors work. Against this background, the aims of this article are twofold. First, we contribute to the literature on BPCG by employing the Evolutionary concept of NIS and highlighting the role of NIS for the non-price competitiveness aspect and, therefore, for the IE differentials between countries. Second, using data for South Korea and Hong Kong, we test the hypothesis that the catch-up achieved by technological progress in these countries in the 1980s, led to a rise in their export demand IE and to a fall in their import demand IE. In order to achieve these aims, we first estimate export and import functions for these countries and subsequently test the hypothesis of structural breaks in the IE in both functions. Using quarterly data obtained from the International Monetary Fund (IMF) ranging from 1963*q*1 to 2017*q*1 for South Korean exports, 1970*q*1 to 2017*q*1 for Korea imports, and from 1971*q*1 to 2016*q*4 for Hong Kong exports, and 1980*q*4 to 2016*q*4 for Hong Kong imports, we apply the methods proposed by Bai (1997) and Bai and Perron (1998, 2003). These theoretical and computational methods allow us to test for multiple unknown breakpoints in the data. Our results for South Korea and Hong Kong do not reject our hypothesis of structural breaks and rises (falls) in the export (import) IE.[1]

[1] Though this is a preliminary finding, it is a significant one, in that, it is empirical evidence of a direct and significant link between a country's level of NIS development and the IE it is likely to experience.

The remainder of the paper is structured as follows: Section 2 provides a brief background and discusses the concept of NIS developed in the Evolutionary literature. Section 3 describes the channels through which the sizes of IE are influenced by the relative development of NIS. The empirical examination is carried out and reported in Section 4. Section 5 summarizes and concludes.

2. National Innovation System (NIS) and countries as separate technological systems

The concept of NIS is well-established in the Evolutionary literature, which is why a Schumpeterian/Evolutionary theoretical framework and a detailed description and analysis of the concept of NIS is not explicitly included here.[2]

In short, the NIS is a country's institutional framework that summarizes the agents involved in innovation and technical change. Firms, universities, research institutions, factor endowments, financial systems, government policies, public organizations, and cultural traditions are all considered to be part of a country's NIS (see Nelson, 1993; Freeman, 1995) and, in the literature, the networks of relationships between these agents are seen as crucial to technological progress.

Innovations and technical change have systemic and tacit aspects. In fact, Freeman (1995) emphasizes that technological change is analyzed as the joint outcome of innovation and learning activities within organizations (especially firms) and interactions between these and their environments. Firms are the main *locus* of technological accumulation and are characterized by different combinations of intrinsic capabilities, including technological know-how (Fagerberg, 1994). Moreover, firms' environment are seen as crucial for technological progress and its diffusion.[3]

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[2] A detailed review of this literature can be found in Lundvall (1992), Freeman (1995, 2002), Nelson (1993) and Fagerberg (1994).

[3] In particular, government policies and institutions are required to induce technological progress. As Mazzucato (2013)

To an extent, technologies are embedded in organizations and are not easily transferable to other settings and technological spillovers, to a large extent, are geographically localized (Fagerberg, 1994). In the literature, the cumulative – or path dependent – character of technological progress is often stressed. Dosi (1988, p.123) states that "Technology, far from being a free good, involves a fundamental learning aspect, characterized by varying degrees of *cumulativeness, opportunity and appropriability*". The specific trajectory followed by distinct NISs will differ across country groups and is characterized by different levels of development. Notably, other studies, including Lundvall (1992), Nelson (1993), Freeman (1995), go further and perceive countries as separate technological systems, each one with its own specific NIS and own specific dynamics.

History, culture, institutions and government policies together are seen as key determinants of the characteristics and dynamics of each country's NIS.[4] Therefore, country-specific factors are assumed to influence the process of technical change. Consequently, the literature from this school of thought highlights the impossibility of replacing the NIS by importation of technology, given that technology has tacit path-dependence, systemic and local features (Nelson, 2005; Freeman, 1995; Fagerberg and Godinho, 2005; Dosi *et al.*, 1994).

The literature also emphasizes that innovations and technical change depend on NIS (i.e. technology is not a free good), and each country possesses its own specific NIS with its own

stressed, when investment is capital and technological intensive, private investments depend on the high-risk investments made by an entrepreneurial state, where risks are non-private, while rewards are privatized.

[4] For instance, according to Etzkowitz (1993), a Triple Helix linking university, industry and government was formed since the late nineteenth century in the USA and fostered a series of science-based firms, contributing for local, regional and national economic development. The role of government was to provide funds to support research done in universities and develop administrative policies and organizational mechanisms to regulate and foster the formation of firms originated from universities and its applied research. On the other hand, industries that have benefited from improved access to academic research assumed the burden of their financial support and gave business advice to scientists and engineers, while universities has focused on applied research instead of basic research and on the education of trained persons for employment by industrial firms. That was the origin of the public venture capital firm, whose purpose was to bring holders of capital and business expertise together with academic scientists and engineers. This would allow inventions to be introduced into industrial production.

specific dynamics. Therefore, technology is not accessible by countries that do not have a developed NIS. In short, technologies are not easily transferable from a country to another. Moreover, technological progress and its diffusion in a country depends on the level of development of that country's NIS, which in turn, affects the level of technological sophistication of the country's production.[5] The development of a NIS can be viewed as a non-price competitiveness factor, as it leads to changes in taste, quality and variety of exports, thereby changing the countries' export market shares and its trade elasticities, as we shall see in the next section.

3. The linkages between NIS and the income elasticities

In the extant literature, the links between the level of technological sophistication of products and the magnitudes of its IE of demand for export and import are explicitly or implicitly assumed (see Fagerberg, 1988; Porcile *et al.*, 2007; Araujo and Lima, 2007; Cimoli *et al*., 2010; Gouvea and Lima, 2013). This issue is explained in the BPCG literature on the basis of the nature of the products and according to McCombie and Thirlwall (1994, pp. 390-91) "…the supply characteristics of goods (such as their sophistication, quality, etc.) determine relative income elasticities."

Notably, though, there is limited discussion on the channels that link technology and the size of countries' IE in the international trade context. We posit that the nature of a country exports and imports is not the only determinant of the size of its IE, insofar as the diversification in the

[5] These ideas and arguments from the Evolutionary literature are similar to those from the Economic Complexity literature. According to the latter, social accumulation of productive knowledge is central to economic development and has a collective feature. In modern societies, individuals' knowledge differ , but "to put knowledge into productive use, societies need to reassemble these distributed bits [of productive knowledge] through teams, organizations and markets" (Hausmann *et al*., 2014, p. 7). Productive knowledge is difficult to transfer and acquire insofar as accumulating productive knowledge depends on human networks, organizations, institutions, etc., and it is tacit and has path dependencies. Thus, technologoical progress is associated with social accumulation of productive knowledge, which, in turn, is not a free good and is not transferable from a country to another. For more on the Economic Complexity literature, see Hausmann *et al*. (2014) and Hausmann and Hidalgo (2011).

country's industrial structure and the access of the goods world markets with distinct features (as the degree of competition), which in turn depend on the country's NIS development, also matter.

In this study, we begin with an exploration of the relationship between a country's NIS and the size of its IE of demand for export. According to Hausman and Klinger (2007) and Hausmann *et al*. (2014), countries develop a comparative advantage preferentially in nearby goods and, in doing so, their export mix moves towards related goods. Furthermore, they establish that the pattern of relatedness across products is partly determined by the levels of technological sophistication amongst other factors (Lall, 2000). Hausman and Klinger (2007, p. 3) provide robust evidence that the evolution of comparative advantage in a country is significantly affected by these patterns of relatedness and Dosi (1988, pp. 127-28) reports a similar finding. Benkovskis and Wörz (2014), investigating what drives countries' export market shares, argued that non-price competitiveness aspects such as shifts in taste and quality as well as in variety (i.e. changes in the set of competitors), along with price-factors, affect their competitiveness. Based on 188 countries spanning 1996-2011, their empirical analysis reveals that non-price factors contribute most strongly to cumulative changes in export market shares, while the contribution of price factors is lower in all the countries under consideration. On the other hand, aspects of non-price competitiveness such as changes in taste, quality and variety are related with technological progress.

First, concerning the diversification of the country's industrial structure, the more developed its NIS, the greater is the possibility of reaching the technological frontier in various areas of production, and improving the diversification of the country's industrial structure. Thus, the more developed a country's NIS, the greater is the possibility of changes in taste, quality and variety (a fall in the set of competitors) of exports. Following Hausman and Klinger (2007), Hausmann *et al*. (2014) and Dosi (1988), the greater the degree of diversification in the industrial structure, the greater the range of both its export goods and the competitiveness gains along the intensive and extensive margin – market shares gains along the intensive margin represent expansion in conquered markets and those along the extensive margin represent exploration of new markets or changes in the set of products/destinations (Benkovskis and Wörz, 2014, p.7). Consequently, countries with better developed NIS expand their share of world markets through non-price competitiveness factors (changes in taste, quality and variety of exports) by expanding the range of goods that they export as the world economy grows, thereby boosting their IE of demand for export.

Second, concerning the relationship between the characteristics of the goods world markets (degree of competition) and a country's IE of demand for export, technologically sophisticated products show high levels of IE of demand for export (Fagerberg, 1988; Porcile *et al.*, 2007; Araujo and Lima, 2007) and, at the same time, few countries possess a NIS that is developed enough to enable them manufacture such products. Technological sophisticated production cannot just simply be transferred from a country to another in the absence of a developed NIS. Therefore, it follows that, the IE of demand for exports of countries with a developed NIS become larger due to the characteristics of the world markets for high technological products, as we discuss next.

There are few countries able to produce technologically sophisticated products, so a rise in world income leads to a faster increase in the global import demand for such products. Moreover, the import of such products from various countries around the world remains fairly concentrated within the exports of a few countries, i.e. the ones with a developed NIS. This, therefore, results in fast-growing (or dynamic) export markets for the few countries with developed NIS, due to a non-price competitiveness aspect that results from the development of NIS.[6] As Benkovskis and Wörz (2014, p. 2) stressed, "obviously, price factors play less important role in markets where suppliers

[6] According to Ocampo and Vos (2008, p. 61), "... dynamic export markets are generally markets for products and services whose demand grows faster than the increase of income in importing markets."

hold a high degree of monopolistic power". Second, we note that dynamism is a characteristic of the markets of high technological products that fosters a high IE of demand for a country's exports and another consequence from markets with few producers is the absence of heavy competition in such markets. Thus, tacit or explicit agreements concerning price-fixing in the world markets of technological sophisticated products are likely to be in place, resulting in a rise in the country's share of world markets. We also note that oligopoly structure is a characteristic of high technology products markets and supports an increase in the IE of demand for export, through a non-price competitiveness aspect, in the few countries able to export sophisticated products, i.e., the ones with a developed NIS.

Since there are few countries able to produce technologically sophisticated products, a third consequence from world markets supplied by few producing countries (characterized by oligopoly structure) is the low level of protectionism in such markets. A product made by a low level of technology can be produced by many countries, even if the production costs are higher than the world average; and domestic production is made feasible by erecting barriers to import of such products. However, if the required technological content of the product is high, it cannot immediately be produced even if barriers are in place, since the country's NIS is not developed enough to make production feasible. In such cases, domestic demand for the product can only be satisfied by imports and this would entail a low level of protectionism (in the domestic markets of a wide range of countries) and a high level of the IE of demand for exports for the countries able to produce high technology products. Low protectionism is a characteristic of technologically sophisticated product markets that foster a high IE of demand for such exports in the few countries able to export such products, due to a non-price competitiveness aspect, i.e. the development of the country's NIS.

The discussion above, on the four factors identified, i.e. diversification of the industrial structure, market dynamism, degree of oligopoly and protectionism, suggests that the more the developed a country’s NIS, the greater its IE of demand for exports. Moreover, the channels that link the development of NIS and shifts in the IE are non-price competitiveness factors, as changes in variety (set of competitors), taste and quality of exports.

The relationship between a country’s NIS development and its IE of demand for imports is also related with these four factors. The following considerations are noteworthy: Countries with low levels of NIS development are not capable of producing goods with high technology content and need to import such goods from highly priced markets, where oligopoly is likely to be a factor. Moreover, the more dynamic (fast-growing) a market for a particular good is, the greater will be the demand, thus favoring an increase in prices and making its import more expensive. Also, the lower the import barriers, the greater the value of the imports. Finally, the lower the development of the country's NIS, the less diversified its industrial structure is likely to be. Therefore, the more diversified its range of imports, the greater the proportion of domestic demand that will be satisfied by means of imports. All these factors are likely to lead to growth in the IE of demand for imports.

As a result, in countries where their NIS is less developed, the IE of demand for exports tends to be lower than the IE of demand for imports. We note that, other determinants of the magnitudes of IE are postulated in the literature. For example, McCombie and Thirlwall (1994, 389) argue that, “countries' income elasticities are largely determined by natural resource endowments and the characteristics of goods produced, which are the product of history”. Nonetheless, the level of development of the country's NIS also seems to be a relevant determinant of the size of a country’s IE and therefore of a country’s Balance-of-Payments equilibrium growth rate.

4- Empirical evidence

Since the 1960's, some Asian countries have shown impressive improvements in economic and social indicators and countries such as South Korea, Hong Kong, Taiwan and Singapore were referred to as the *Asian Tigers* and, in the literature, their NIS development and technological progress are often highlighted (Amsden, 1989; Freeman, 1995, 2002; Lee, 2000).

Table 1 reports the *Asian Tigers*' income per capita (IPC) together with the Lower IPC from the G7 countries i.e. Canada, France, Germany, Italy, Japan, United Kingdom and United States. Singapore and Hong Kong's IPC approached the level of the G7 group's average in the 1980s, whereas Taiwan and Korea surpassed that of the G7 countries over the period 1985-1995.

TABLE 1 HERE

The Evolutionary literature highlights that a developing country's IPC catches up with that of a developed country because of its NIS development and technological progress. Based on Table 1, and previous evidence from Freeman (1995, 2002), Dosi *et al.* (1994), Amsden (1989), Lee (2000), we hypothesize that the catch up allowed by technological progress made by the *Asian Tigers* changed their IE in the 1980s for Hong Kong and Singapore and over 1985-1995, for Korea and Taiwan. This argument is theoretically supported in Section 3 above.[7]

Based on the theoretical background, export and import demand functions for these countries can be defined and tested for structural breaks in its parameters allowing us to analyze the size and direction of the changes on the IE. It is expected that the export demand IE is likely to increase and the import demand IE to reduce for Singapore and Hong Kong in the 1980s and for Korea and Taiwan in the 1985-1995 period. A noteworthy point is that the test for parameter instability and structural change for the export and import functions is not able to determine the cause(s) of the break of the parameters, hence more evidence for the relationship between the

[7] Since the catch up of the Asian Tigers's NIS in relation to the NIS of developed countries is broadly highlighted and studied in the literature already referred, we do not, as part of our empirical analysis, measure these countries' NIS.

development of the Asian Tigers' NIS and changes in their IE is instructive. Therefore, the economic histories of these countries can be useful. Kim and Heo (2017) and Noland (2011) present South Korea as the premier development success story of the last half century, so for completeness, we present a summary of the South Korea situation.

The Case of South Korea

Aiming to spur economic growth, South Korea invested heavily and strategically in the improvement of social and economic infrastructure, which was critical for economic development (Kim and Heo, 2017; Amsden, 1989). The average growth rate in their GDP per capita from 1960 to 2010 was 9.52%. The country experienced an outstanding increase in exports, rising from 7.4% of GDP in 1967 to 36.7% in 1987 (Kim and Heo, 2017). However, "Korean economy has faced numerous structural breaks including the Asian financial crisis or major changes in policy regime." (Harvie and Pahlavani, 2006, p. 14). Figure 1 shows the evolution of exports, imports and GDP as well as of the real exchange rate in Korea.

FIGURE 1 HERE

A remarkable change in the economic policy regime took place in 1980, when the country experienced negative economic growth as a result of several factors including the oil price crisis, a bad agricultural harvest, a domestic political crisis with the assassination of President Park in 1979 and the excess of HCI (steel, heavy machinery, automobiles, industrial electronics, shipbuilding, non-ferrous metals and petrochemicals) investment in earlier periods that led to an over-capacity problem (Harvie and Pahlavani, 2006). Their new economic policy regime was based on stabilization, trade and financial liberalization, greater opening to foreign investment and stimulus to more technology based industries. These measures were adopted in the 1980s with a context of a benign external environment and were successful in reaching the goals of lower inflation and higher economic growth.

The country's trade and financial liberalization policy was strengthened in the 1990s. Although there were positive effects from the adopted economic policy regime, there was growing weakness in the financial sector due to the unprecedented accumulation of short-term debt: moral hazard, poor accounting standards, supervision and regulation and lack of transparency contributed to the financial crisis of 1997-98. Moreover, in the 1990s, the government maintained high interest rates aiming to attract domestic savings. This policy stimulated the banking sector to profit from the spread in interest rates, which then became one of the main causes of the 1997 financial crisis in Korea (Heo and Kim, 2000).

Following on from the 1997 financial crisis, the country's economic recovery was fostered by reform in areas of weakness exposed by the crisis, thereby improving corporate governance, strengthening the information and communications technology sector, continuing the process of improving human capital and opening up to international trade and foreign direct investment, expanding the existing social safety net, reforming labor practices, in the context of an outstanding growth of exports, in particular to China (Harvie and Pahlavani, 2006; Noland, 2011).

Fast forwarding to the more recent past, and following the collapse of Lehman Brothers in September 2008 the country experienced a sudden stop in capital flows. The country experienced a 43% depreciation of the domestic currency, the won, against the US dollar in the context of high levels of financial leverage and consequently, experienced a negative economic growth in 2008 (Noland, 2011).

Despite the earlier turbulent international macroeconomic environment, the economy recorded positive growth since 2009 due to a number of factors: the depreciation of the country's exchange rate, the reduction in the Bank of Korea's interest rate, a fiscal stimulus introduced by the government through spending on goods and services and construction investment, and government measures implemented to stabilize the financial system (OECD, 2017).

Harvie and Pahlavani (2006) conducted tests for structural breaks for the real exports and imports of Korea covering the period 1980*q*1 to 2005*q*3. Their results show breaks in real exports and real imports series in 1989*q*1 and 1997*q*4, respectively. According to the authors, the breaks in the exports and imports coincided with the period of trade liberalization in Korea and the Asian Financial Crisis, respectively.

Our overview of South Korea's economic history suggests potential structural breaks for her export and import functions parameters in 1973-74 (first oil price crisis), 1979-80 (second oil price crisis; domestic political crisis; new economic policy regime), 1989-90 (trade liberalization), 1997-98 (Asian Financial Crisis) and 2008-09 (Global Financial Crisis). We posit that development of South Korea's NIS led to structural breaks in the country's IE of demand for import and for export over 1985-95 (see Table 2).

TABLE 2 HERE

We proceed to test the hypothesis of an increase in the export demand IE and a fall in the import demand IE for South Korea over 1985-95, and for Hong Kong in the 1980s.[8] Figure 2 shows the evolution of exports, imports and GDP as well as of the real exchange rate in Hong Kong.

FIGURE 2 HERE

4.1. Structural break tests

The specification of a country's import and export equations, which have been employed in the empirical literature (see Senhadji and Montenegro, 1999; Senhadji, 1998; Aabu-Lila, 2014; Ketenci, 2014), considers prices and income as the determinants of exports and imports. Based on this framework, the export and import demand models can be defined as[9]:

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[8] Due to lack of adequate data, we are unable to test our hypothesis for Taiwan and Singapore.

[9] In the theorical and empirical literature of international trade, it is suggested that the cyclical (short-run) and secular (long-term) movements in real income should be treated separately (Goldstein and Khan, 1985, p. 1057). However, the cyclical component of income is not always used as one of the determinants in the import and export functions, in

$$\mathbf{log}X = \alpha_0 + \alpha_1 \mathbf{log}\left(\frac{P_1 E}{P_2}\right) + \alpha_2 \mathbf{log}Y^* + \alpha_3 \mathbf{log}U \qquad \textbf{(1)}$$

$$\mathbf{log}M = \beta_0 + \beta_1 \mathbf{log}\left(\frac{P_3 E}{P_4}\right) + \beta_2 \mathbf{log}Y \qquad \textbf{(2)}$$

where, log is the natural logarithm, X and M are the exports and imports in real terms, respectively, P_1 is the foreign currency price of competing goods, E is the nominal exchange rate, P_2 is the domestic price of exports, Y* is world real income, P_3 is the foreign currency price of imported goods, P_4 is the price of the substitutes on the domestic market, Y is domestic real income and U is the capacity utilization rate. The parameters α_1, α_2, and α_3 are the price, the income and the income cyclical component elasticities, respectively. The parameters β_1 and β_2 are the price and the income elasticities, respectively. According to the literature, it is expected that $\beta_1 < 0$, $\beta_2 > 0$, $\alpha_1 > 0$, $\alpha_2 > 0$, the sign of α_3 is an empirical matter.

Estimation of the above trade models is likely to bias the whole analysis, since it does not consider the non-price factors among the determinants of trade. As we argued in Section 3 of this paper, the development of NIS is a non-price competitiveness factor, as it leads to changes in taste, quality and variety of exports and imports, thereby shifting the countries' IE. However, if we consider structural changes in the IE, it captures the effects of non-price competitiveness factors on trade, as we argued in Section 3, therefore preventing the bias. In other words, the relationship between non-price competitiveness factors and the IE may be captured implicitly, inasmuch as we assume in the perspective presented in Section 3 that changes in IE predominantly depend on the role of development of a country's NIS.

In this paper, the models are estimated using quarterly time series data, covering the period

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the empirical literature.

1963q1-2017q1 for South Korea's exports, and 1970q1-2017q1 for the country's imports. For Hong Kong, we use 1971q1-2016q4 for exports and 1980q4-2016q4 for the import functions, as these are periods for which the data are available for those countries. The data are sourced from the International Monetary Fund's International Financial Statistics (IFS) and Economic Statistics System/Bank of Korea.

Testing for parameter instability and structural change in regression models have been a fundamental part of applied econometric work dating back to Chow (1960), who tested for regime change at *a priori* known dates using an *F*-statistic. To relax the requirement that the candidate break date be known, Quandt (1960) modified the Chow framework to consider the *F*-statistic with the largest value over all possible break dates. Andrews (1993) and Andrews and Ploberger (1994) deducted the limiting distribution of the Quandt and related test statistics.

Based on those previous methodologies, Bai (1997) and Bai and Perron (1998, 2003a, 2003b) determine theoretical and computational results that further extend the Quandt-Andrews framework by allowing to test for *multiple* unknown breakpoints. We will consider the case of a pure structural change regression model with T periods and m potential breaks (resulting $m+1$ regimes), for observations $T_j, T_j+1, \ldots, T_{j+1}-1$ for the regimes $j = 0, \ldots, m$ given by:

$$y_t = Z_t^{'}\delta_j + \varepsilon_t \qquad (3)$$

The Z variables have coefficients that are regime specific.[10] In such case the computation of the estimates of (3) can be done by applying OLS segment by segment without constraints among them. Bai and Perron (1998) depict global optimization procedures for distinguishing the m multiple breaks which minimize the sums-of-square residuals of the regression model equation

[10] Bai and Perron (2003a) structural version of the model where variables which do not vary across regimes can also be considered.

(3).

The multiple breakpoint tests may be broadly separated into three categories: tests that use global maximizers for the breakpoints, tests that employ sequentially defined breakpoints, and hybrid tests which combine the two approaches. On this research we apply the global maximizer approach based on recommendation from Bai and Perron (2003a) “The problem is that, in the presence of multiple breaks, certain configurations of changes are such that it is difficult to reject the null hypothesis of 0 versus 1 break but it is not difficult to reject the null hypothesis of 0 versus a higher number of breaks.” In such cases the sequential procedure breaks down.

Briefly for a specific set of *m* breakpoints, such as $\{T\}_m = (T_1, \ldots, T_m),$ we may minimize

$$S(\beta, \delta \mid \{T\}) = \sum_{j=0}^{m} \{ \sum_{t=T_j}^{T_{j+1}-1} y_t - X_t^{'}\beta - Z_t^{'}\delta_j \} \qquad (4)$$

Using standard least squares regression to find estimates of $(\hat{\beta}, \hat{\delta})$ in the case of a partial structural model or $(\hat{\delta})$ for a pure structural change model. Bai and Perron highlighted that the number of comparison models increases rapidly in both *m* and *T* and derived practical algorithms for computing the global optimizers for multiple breakpoint models. These global break point estimates are then utilized as the benchmark for several breakpoint tests.

Bai and Perron (1998, 2003a) present a generalization of the Quandt-Andrews test (Andrews, 1993) in which we test for equality of the across multiple regimes. For a test of the null of no breaks against an alternative of breaks, an *F*-statistic is applied to assess the null hypothesis that $\delta_0 = \delta_1 = \ldots = \delta_{l+1}$ as below:

$$F(\hat{\delta}) = \frac{1}{T}\left(\frac{T-(l+1)q-p}{kq}\right)(R\hat{\delta})'(R\hat{V}(\hat{\delta})R')^{-1}R\hat{\delta} \qquad (5)$$

From (5) $\hat{\delta}$ is the optimal *l-break* estimate of δ, $(R\delta)' = (\delta_0' - \delta_1', \ldots, \delta_l' - \delta_{l+1}')$, and $\hat{V}(\hat{\delta})$ is an estimate of the variance covariance matrix of δ which may not suffer from serial correlation and heteroscedasticity depending on assumptions regarding the distribution of the data and the errors across segments.

A singular test of no breaks versus an alternative of *l* breaks assumes that the alternative number of breakpoints *l* is pre-determined. Not to pre-specify a particular number of breaks to make an inference, Bai and Perron (BP) introduced two tests of the null hypothesis of no structural break against an unknown number of breaks given some upper bound, say *M*. These are called the *double maximum tests.* The first test is an equally-weighted version of the test, termed $UD\max$ that chooses the alternative that maximizes the statistic across the number of breakpoints. The second test employs weights to the individuals' tests such that the marginal *p-values* are equal across values of *M* and is called $WD\max$. Critical values for *M=5* and a 5%, 10% and 15% sample trimming are generated by BP [11] who suggested that 5 breaks should be sufficient for most empirical applications as the critical values appear to vary little when the upper bound *M* is greater than 5.

In this article, we apply the test to South Korea and Hong Kong, defining functions for both the quantity of exports and imports demand. The test allows heterogeneous error distributions across breaks[12] and trimming of 20% is applied instead of the usual 10 or 15% default in order to mitigate a potential reduction in the number of observations in the break regressions. Increasing the trimming would limit the number of breaks to a maximum of three. The results of the test are analyzed at 5% significance level.

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[11] Bai and Perron (2003a) provide additional critical values for 20% (M=3) and 25% (M=2).
[12] Selecting this option will provide robustness of the test to error distribution variation at the cost of power if the error distribution are the same across regimes.

Before applying the test we apply the Augmented Dickey and Fuller test (ADF) to check for the presence of unit root in the variables for both South Korea and Hong Kong. The test is conducted considering an intercept and trend and the results are summarized in Table 3.

TABLE 3 HERE

The ADF tests suggest that at 1% significance level, all the variables are integrated of order one with the exception of the capacity utilization rate (U), which is stationary. We applied the test again using the first difference for both export and import models consequently inducing stationarity to all series.

The Johansen test for cointegration is also applied to the non-stationary series for both South Korea's and Hong Kong's export and import data, and as the U variable is integrated to the order zero it is not included in the test. In order to define the number of lags in the cointegration test a lag order selection criteria test was applied to a vector autoregressive model (VAR) and based on the Schwarz Information Criterion (SIC) at 5% significance level a maximum of five lags in the VAR is suggested. Table 4 summarizes the result for both the trace and rank values:[13]

TABLE 4 HERE

As the ADF test assumes an intercept and a trend, we based our cointegration analysis using the same criterion under a linear assumption. The results suggest no cointegration for South Korean exports on both trace and maximum eigenvalue criteria, and a maximum of two cointegration vectors for the imports using the trace criterion. For Hong Kong's exports, a maximum of one cointegrating relationship is suggested by the maximum eigenvalue (trace) criterion, and a maximum of two for imports according to the trace criterion.

Instead of transforming the variables containing unit root we opted for applying the Bai and

[13] The complete results of the Johansen tests are available from authors upon request.

Perron procedure using the original equations as Perron (1989) argues that structural change and unit roots are closely related. The results for the Bai and Perron (2003a) multiple break points are summarized in Tables 5 and 6.

TABLE 5 HERE

Table 5 reports the F-statistic, along with the F-statistic scaled by the number of varying regressors (in our case all explanatory variables including the constant). The sequential result is generated by running tests from 1 to the maximum number of breaks until we cannot reject the null hypothesis of no break. The significant results pick up the largest statistically significant breakpoint. In both cases (exports and imports) the test suggests that there are 3 breaks for South Korea. The *UDmax* and *WDmax* outputs show the number of breakpoints as defined by application of the unweighted and weighted maximized statistics suggesting both the existence of a maximum 3 breaks for the *UDmax* and 2 breaks for the *WDmax* for South Korean exports and imports respectively.

TABLE 6 HERE

As reported in Table 6, for Hong Kong, the F-statistics suggest 3 breaks and the maximized *UDmax* and *WDmax*, 2 and 3 breaks respectively for the export demand, and for the import demand the *UDmax* and *WDmax* suggest 1 break.

Following the test results, we estimate the export and import demand functions for the intervals attached to the estimated break dates summarized from Tables 5 and 6. Here, we apply Bai (1997) and Bai and Perron (1998) to estimate a generalized least square procedure with breakpoints in line with Bai and Perron (2003a) multiple breakpoint test methodology.

The equation for the exports demand is:

$$XIQD_t = \alpha_0 + \alpha_1 XIP_t + \alpha_2 Y^*_t + \alpha_3 U_t + e_t \qquad (6)$$

where:

XIQD = Natural log of the total exports of goods and services in real terms[14];

XIP = Natural log of the country exports price in foreign currency divided by the trade partners export price in foreign currency;

*Y** = Natural log of the world real income;

U = Natural log of the degree of the current operational capacity;

e = Random error term.

The equation for the imports demand is:

$$MIQD_t = \beta_0 + \beta_1 RER_t + \beta_2 Y_t + e_t \qquad (7)$$

where:

MIQD = Natural log of the total imports of goods and services in real terms[15];

RER = Natural log of the nominal exchange rate multiplied by imports price in foreign currency divided by the price of domestic goods;

Y = Natural log of the country real income;

e = Random error term.

We present, in Tables 7 and 8, the results for South Korea's export and import demand. Our hypothesis of a structural break and an increase in the export demand IE for South Korea between 1985-1995 (Table 2) is not rejected at 1% statistical significance (Table 7). South Korea's export

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[14] Nominal value of total exports deflated by the goods deflator-unit value exports sourced from the Economic Statistics System/Bank of Korea.

[15] Nominal value of total imports deflated by the goods deflator-unit value imports sourced from the International Monetary Fund's International Financial Statistics (IFS).

demand IE rose from 1.55 in 1995Q1 to 1.73 in 1995Q2. Another increase in the South Korea's export demand IE in 2006Q3 is suggested by the test results. Moreover, a fall in South Korea's export demand IE in 1975Q2 (from 3.15 to 1.55, at 1% significance level) is also suggested by the test results and is in line with what was expected due to the oil price shock in the end of 1973 (Table 2).

With respect to the South Korea's import demand, the results show a structural break and a fall in the country's import demand IE from 1.35 in 1997Q3 to 0.85 in 1997Q4 with 1% of statistical significance, a point in time that is close to the period we expected a fall in this parameter (1985-95). However, the break coincides with the Asian financial crisis in 1997 (Table 2). The test results also show a rise in the country's import demand IE in 1981Q3 and a fall in 2007Q4, both with 1% of statistical significance (Table 8). The increase in the Korea's import demand IE in 1981Q3 coincides with the policy of trade liberalization period, which took place in Korea after 1980. The structural break in the country's IE in 2007Q4 coincides with the Global Financial Crises period (Table2).

The direction of the changes in South Korea's IE of demand for export and import either for the 1985-95 period, or for the other periods, are as expected *a priori*, although there was no change in the import demand IE over the 1985-95 period, as it was supposed. In line with the extant literature, the estimated signs for the import and export demand IEs are also as *a priori* expected.

TABLE 7 HERE

TABLE 8 HERE

Tables 9 and 10 report the results for Hong Kong's export and import demands. Our hypothesis of a break in the export demand IE for Hong Kong in the 1980s is not rejected (see Table 9). The test results show an increase in this parameter from 1.71 to 2.31 at 1% level of significance level in 1981Q4. The export demand IE for Hong Kong changed twice after 1990, i.e.

a fall in 1993Q1, and a rise in 2003Q2. In line with the extant literature, the estimated sign for the export demand IE is as *a priori* expected.

With respect to the import demand IE for Hong Kong, the results reported in Table 10 suggest a fall in this parameter in the 1980s as it was expected. The import demand IE changed from 1.70 in 1987Q4 to 1.04 in 1988Q1, at 1% level of significance. A rise in this parameter in 1995Q2 and a fall in 2002Q3 are also suggested by the test results. As before, in line with the literature the estimated sign for the import demand IE is as *a priori* expected. Moreover, the direction of both of the changes on Hong Kong's IE of demand for export and import for the 1980s are as *a priori* expected.

TABLE 9 HERE

TABLE 10 HERE

We posited in Section 3 of this paper, that the relative development of a country's NIS leads to changes in its export and import demand IE and that, the latter should decrease whereas the former should increase. The test results summarized in Tables 7 to 10 shows that, with the exception of South Korea's IE demand for imports, the other parameters changed in the periods and in the direction supported by the arguments presented in Section 3.

5- Conclusions

In the BPCG literature, the IE is deemed crucial for a country's growth rate in the long run. However, the literature is fairly muted on, and does not appear to explicitly explain the channels that link technology and the size of the IE. Against this background, the Evolutionary literature argues that technology is the key factor that explains economic growth in the long run. The concept of the National Innovation System (NIS) is embedded in this school of thought and, to our knowledge, none of the previous studies in the related literature that use the Evolutionary concept show why there are differences in IE among countries.

In this paper, the concepts created by the Evolutionary School were used to show the non-price competitiveness channels through which the magnitude of IEs are changed with the development of a country's NIS. In other words, we propose an explanation to show the linkages between a country's NIS development and its IEs magnitudes.

In filling the gap, we first built theoretical causal links between the development of a NIS and changes in a country's IEs. In addition, we proposed and empirically tested the hypothesis that the catch up allowed by the NIS development made by Korea and Hong Kong changed their IE. Our assumption was that export demand IE rose in the 1980s and over the 1985-95 period for Hong Kong and South Korea respectively, and that import demand IE fell in the 1980s and over the 1985-95 period for Hong Kong and South Korea, respectively.

In our quest, we test for parameter instability and structural change in these two countries, defining a function for the quantity of export and import demand. Our empirical results, and the evidence we present, do not suggest rejection of the hypothesis that there were changes in the IEs (in both countries) in the periods investigated and in the direction suggested by our arguments, with exception of Korea's IE demand for import.

Although the empirical results suggest that the hypothesis concerning the link between South Korea and Hong Kong's NIS development and changes in their IE cannot be rejected, we are cautious enough to also note that it does not provide unquestionable evidence supporting this hypothesis, because the tests for parameter instability and structural change are not able to point out the cause(s) of the break of the parameters.

However, in our analyses, and in order to provide additional evidence to support the interpretation that South Korea's IE change was caused by its NIS development, we presented an overview of the country's economic. We find no other reason for the change in South Korea's IE of demand for export in 1995q2 other than development in its NIS, as evidenced by her income per capita data (Table 1) and from the literature (Freeman, 1995, 2002; Dosi *et al.*, 1994; Lee, 2000; to cite a few) which suggest that South Korea's technological and NIS catch-up took place in the 1985-95 period. This evidence supports the hypothesis that structural breaks in the IE over the period are related with the country's NIS development.

The findings of this paper are important initial steps in establishing the links between a country's NIS and the size of the all-important IE of demand, which is instrumental in economic growth; tracing the links between the BPCG literature and the Evolutionary approach to the NIS literature. These findings are relevant in the BPCG framework, as they underscore the role of the NIS and non-price competitiveness factors in increasing the Balance-of-Payments equilibrium growth rate. Extensions to this study will be aimed at investigating grounds for more conclusive evidence for the hypothesis tested in this paper.

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Table 1. GDP Per Capita (PPP-Current International dollar) and GDP Per Capita (Current US$), 1970-2014

GDP Per Capita, PPP-Current International US$	1970	1975	1980	1985	1990	1995	2000	2005	2010	2014
Hong Kong SAR, China	...	...	6649.29	10418.11	16941.81	22633.13	26179.55	35207.12	46127.97	55084.2
Korea, Rep.	...	...	2302.29	4272.95	7829.17	12287.91	16502.58	22783.23	30041.60	34355.7
Singapore	...	...	6757.62	11248.73	17393.59	25284.96	32262.25	43975.70	56708.21	82763.4
Taiwan, China	...	...	3570.61	5809.66	9858.46	15074.68	20289.51	26657.33	35595.16	..
The Lower GDP Per cappita From G7	...	...	8380.79	11952.76	16305.65	19704.08	24669.35	28078.94	29840.63	34757.8
GDP Per Capita, Current US$										
Hong Kong SAR, China	960	2252	5700	6543	13486	23497	25757	26650	32550	40170
Korea, Rep.	292	646	1778	2542	6642	12404	11948	18658	22151	27970
Singapore	925	2559	5004	6782	12766	24937	23793	29870	46570	56287
Taiwan, China	..	..	..	..	..	..	..	..	..	..
The Lower GDP Per cappita From G7	2004	4095	8432	7967	19095	20509	20059	31974	35878	34960

Source: World Economic Outlook Data- IMF and World Development Indicators - World Bank

Table 2. Potential Structural Breaks for the South Korea's Exports and imports Functions

Time of Potential Structural Breaks	Corresponding Events
1973-74	First Oil Price Crisis
1979-80	Second Oil Price Crisis; Domestic Political Crisis; New Economic Policy Regime
1989-90	Trade Liberalization
1985-1995	Korea's Technological and Economic Catch-up
1997-98	Asian Financial Crisis
2007-08	Global Financial Crisis

Source: Authors' elaboration.

Table 3. ADF Unit Root Test Summary:

Korea Export ADF Test (Constant and Trend)				Korea Import ADF Test (Constant and Trend)			
LXIQD	-2,8524	(0.1805)	Non-stationary	LMIQD	-3.8233**	(0.0174)	Stationary at 5%
LY*	-1,697341	(0.7942)	Non-stationary	LY	-0,158897	(0.9935)	Non-stationary
LPXIP	-3.3093*	(0.0675)	Stationary at 10%	RER	-4.0118***	(0.009)	Stationary at 1%
LU	-6.4824***	(0.0000)	Stationary at 1%				
*** 1%level	** 5%level	* 10% level			Numbers in brackets p-values		
Hong Kong Export ADF Test (Constant and Trend)				Hong Kong Import ADF Test (Constant and Trend)			
LXIQD	-1,840528	(0.6806)	Non-stationary	LMIQD	-0,9347	(0.9481)	Non-stationary
LY*	-0,805175	(0.9623)	Non-stationary	LY	-2,0966	(0.5427)	Non-stationary
LPXIP	-2,845649	(0.1832)	Non-stationary	RER	-1.5145	(0.8202)	Non-stationary
LU	-4.2842***	(0.0042)	Stationary at 1%				
*** 1%level	** 5%level	* 10% level			Numbers in brackets p-values		
First Differences							
Korea Export ADF Test (Constant and Trend)				Korea Import ADF Test (Constant and Trend)			
DLXIQD	-5.1629***	(0.0001)	Stationary	DLMIQD	-8.1843***	(0.0000)	Stationary
DLY*	-5.0172***	(0.0003)	Stationary	DLY	-5.2908***	(0.0001)	Stationary
DLPXIP	-11.4133***	(0.0000)	Stationary	DRER	-11.1656***	(0.0000)	Stationary
DLU	-8.6269***	(0.0000)	Stationary				
*** 1%level	** 5%level	* 10% level			Numbers in brackets p-values		
Hong Kong Export ADF Test (Constant and Trend)				Hong Kong Import ADF Test (Constant and Trend)			
DLXIQD	-9.4796***	(0.0000)	Stationary	DLMIQD	-4.3481***	(0.0036)	Stationary
DLY*	-6.6052***	(0.0000)	Stationary	DLY	-7.0992***	(0.0000)	Stationary
DLPXIP	-9.7169***	(0.0000)	Stationary	DRER	-4.1460***	(0.0069)	Stationary
DLU	-9.7958***	(0.0000)	Stationary				
*** 1%level	** 5%level	* 10% level			Numbers in brackets p-values		

Table 4. Johansen Test Summary Results:

			South Korea Export		
Data Trend:	None	None	Linear	Linear	Quadratic
Test Type	No Intercep No Trend	Intercept No Trend	Intercept No Trend	Intercept Trend	Intercept Trend
Trace	1	1	1	0	0
Max-Eig	1	1	1	0	0
			South Korea Import		
Data Trend:	None	None	Linear	Linear	Quadratic
Test Type	No Intercep No Trend	Intercept No Trend	Intercept No Trend	Intercept Trend	Intercept Trend
Trace	1	2	3	2	0
Max-Eig	1	2	3	1	0
			Hong Kong Export		
Data Trend:	None	None	Linear	Linear	Quadratic
Test Type	No Intercep No Trend	Intercept No Trend	Intercept No Trend	Intercept Trend	Intercept Trend
Trace	2	2	3	1	1
Max-Eig	2	2	1	1	1
			Hong Kong Import		
Data Trend:	None	None	Linear	Linear	Quadratic
Test Type	No Intercep No Trend	Intercept No Trend	Intercept No Trend	Intercept Trend	Intercept Trend
Trace	3	2	1	2	0
Max-Eig	1	0	0	0	0

Table 5. BP Multiple Break Point Test for South Korea

South Korea Quantum of Exports Demand					
Sequential F-statistic determined breaks:				3	
Significant F-statistic largest breaks:				3	
UDmax determined breaks:				3	
WDmax determined breaks:				3	
		Scaled	Weighted	Critical	
Breaks	F-statistic	F-statistic	F-statistic	Value	
1 *	94,18125	376,725	376,725	15,67	
2 *	86,54079	346,1632	419,1945	12,94	
3 *	105,3593	421,4372	612,6087	10,78	
UDMax statistic*		421,4372	UDMax critical value**		15,79
WDMax statistic*		612,6087	WDMax critical value**		17,04
Estimated break dates:					
1: 1975Q2					
2: 1975Q2, 2006Q3					
3: 1975Q2, 1995Q2, 2006Q3					

South Korea Quantum of Imports Demand					
Sequential F-statistic determined breaks:				3	
Significant F-statistic largest breaks:				3	
UDmax determined breaks:				2	
WDmax determined breaks:				3	
		Scaled	Weighted	Critical	
Breaks	F-statistic	F-statistic	F-statistic	Value	
1 *	32,28439	96,85317	96,85317	13,47	
2 *	58,21998	174,6599	212,1433	11,09	
3 *	49,08358	147,2507	217,4855	9,12	
UDMax statistic*		174,6599	UDMax critical value**		13,66
WDMax statistic*		217,4885	WDMax critical value*		14,73
Estimated break dates:					
1: 1987Q1					
2: 1981Q3, 1997Q4					
3: 1981Q3, 1997Q4, 2007Q4					

* Significant at the 0.05 level.
** Bai-Perron (Econometric Journal, 2003) critical values.

Table 6. BP Multiple Break Point Test for Hong Kong

Hong Kong Quantum Exports Demand					
Sequential F-statistic determined breaks:				3	
Significant F-statistic largest breaks:				3	
UDmax determined breaks:				2	
WDmax determined breaks:				3	
		Scaled	Weighted	Critical	
Breaks	F-statistic	F-statistic	F-statistic	Value	
1 *	269,4617	1077,847	1077,847	15,67	
2 *	270,7652	1083,061	1311,558	12,94	
3 *	226,0637	904,2549	1314,441	10,78	
UDMax statistic*		1083,061	UDMax critical value**		15,79
WDMax statistic*		1314,441	WDMax critical value**		17,04
Estimated break dates:					
1: 1991Q4					
2: 1981Q4, 1992Q2					
3: 1981Q4, 1993Q1, 2003Q2					

Hong Kong Quantum Imports Demand					
Sequential F-statistic determined breaks:				3	
Significant F-statistic largest breaks:				3	
UDmax determined breaks:				1	
WDmax determined breaks:				1	
		Scaled	Weighted	Critical	
Breaks	F-statistic	F-statistic	F-statistic	Value	
1 *	96,91337	290,7401	290,7401	13,47	
2 *	66,54698	199,6409	242,4854	11,09	
3 *	60,44774	181,3432	267,8392	9,12	
UDMax statistic*		290,7401	UDMax critical value**		13,66
WDMax statistic*		290,7401	WDMax critical value*		14,73
Estimated break dates:					
1: 2003Q2					
2: 1995Q1, 2002Q2					
3: 1988Q1, 1995Q2, 2002Q3					

* Significant at the 0.05 level.
** Bai-Perron (Econometric Journal, 2003) critical values.

Table 7. South Korea Export Demand Breaks Regression

Break type: Bai-Perron tests of 1 to M globally determined breaks									
Breaks: 1975Q2, 1995Q2, 2006Q3					Breaks: 1975Q2, 1995Q2, 2006Q3				
Variable	Coefficient	Std. Error	t-Statistic	Prob.	Variable	Coefficier	Std. Error	t-Statistic	Prob.
1963Q1 - 1975Q1 -- 49 obs					1975Q2 - 1995Q1 -- 80 obs				
C	-10.80388	0.282739	-38.21144	0.00000	C	-6.71043	0.268071	-25.0323	0.00000
XIP	0.20838	0.107681	1.935151	0.05440	XIP	0.951473	0.086553	10.99294	0.00000
Y*	3.150713	0.126515	24.90388	0.00000	Y*	1.545305	0.05425	28.48495	0.00000
U	0.149637	0.160938	0.929785	0.35360	U	0.511302	0.107456	4.758258	0.00000
1995Q2 - 2006Q2 -- 45 obs					2006Q3 - 2017Q1 -- 43 obs				
C	-4.693742	0.541837	-8.662643	0.00000	C	-11.3767	7.90439	-1.43929	0.15160
XIP	0.394675	0.064438	6.124889	0.00000	XIP	0.618082	0.509196	1.213838	0.22620
Y*	1.733303	0.058478	29.64033	0.00000	Y*	2.681612	1.000668	2.679822	0.00800
U	0.266513	0.145295	1.834285	0.06810	U	-2.12254	0.845805	-2.5095	0.01290
Whole Sample: 1963Q1 2017Q1									
C	-10.57593	0.413181	-25.59637	0.000000	Break type: Bai-Perron tests of 1 to M globally determined breaks				
XIP	1.026925	0.086233	11.90869	0.000000	Break selection: Sequential evaluation, Trimming 0.20, Max. breaks 3, Sig.				
Y*	2.245579	0.042303	53.08285	0.000000	level 0.05				
U	0.373425	0.209438	1.782981	0.076000					

Table 8. South Korea Import Demand Breaks Regression

Break type: Bai-Perron tests of 1 to M globally determined breaks									
Breaks: 1981Q3, 1998Q1, 2007Q4					Breaks: 1981Q3, 1998Q1, 2007Q4				
Variable	Coefficient	Std. Error	t-Statistic	Prob.	Variable	Coefficier	Std. Error	t-Statistic	Prob.
1970Q1 - 1981Q2 -- 46 obs					1981Q3 - 1997Q3 -- 65 obs				
C	1.959511	1.09741	1.785577	0.0759	C	1.601643	0.776028	2.063899	0.0405
RER	-0.256399	0.260225	-0.9853	0.3258	RER	-0.81199	0.154971	-5.23961	0.0000
Y	0.822438	0.106065	7.75407	0.0000	Y	1.346478	0.039937	33.7149	0.0000
1997Q4 - 2007Q3 -- 40 obs					2007Q4 - 2017Q1 -- 38 obs				
C	8.997083	2.761951	3.25751	0.0013	C	10.99922	1.766768	6.225617	0.0000
RER	-1.809368	0.295549	-6.12205	0.0000	RER	-1.42229	0.330775	-4.29988	0.0000
Y	0.854512	0.223967	3.815344	0.0002	Y	0.330277	0.11843	2.788791	0.0059
Whole Sample: 1970Q1 2017Q1									
C	5.135985	0.923172	5.563411	0.0000	Break selection: Sequential evaluation, Trimming 0.20, Max. breaks 3, Sig.				
RER	-1.070974	0.195725	-5.47184	0.0000	level 0.05				
Y	0.938704	0.025019	37.52029	0.0000					

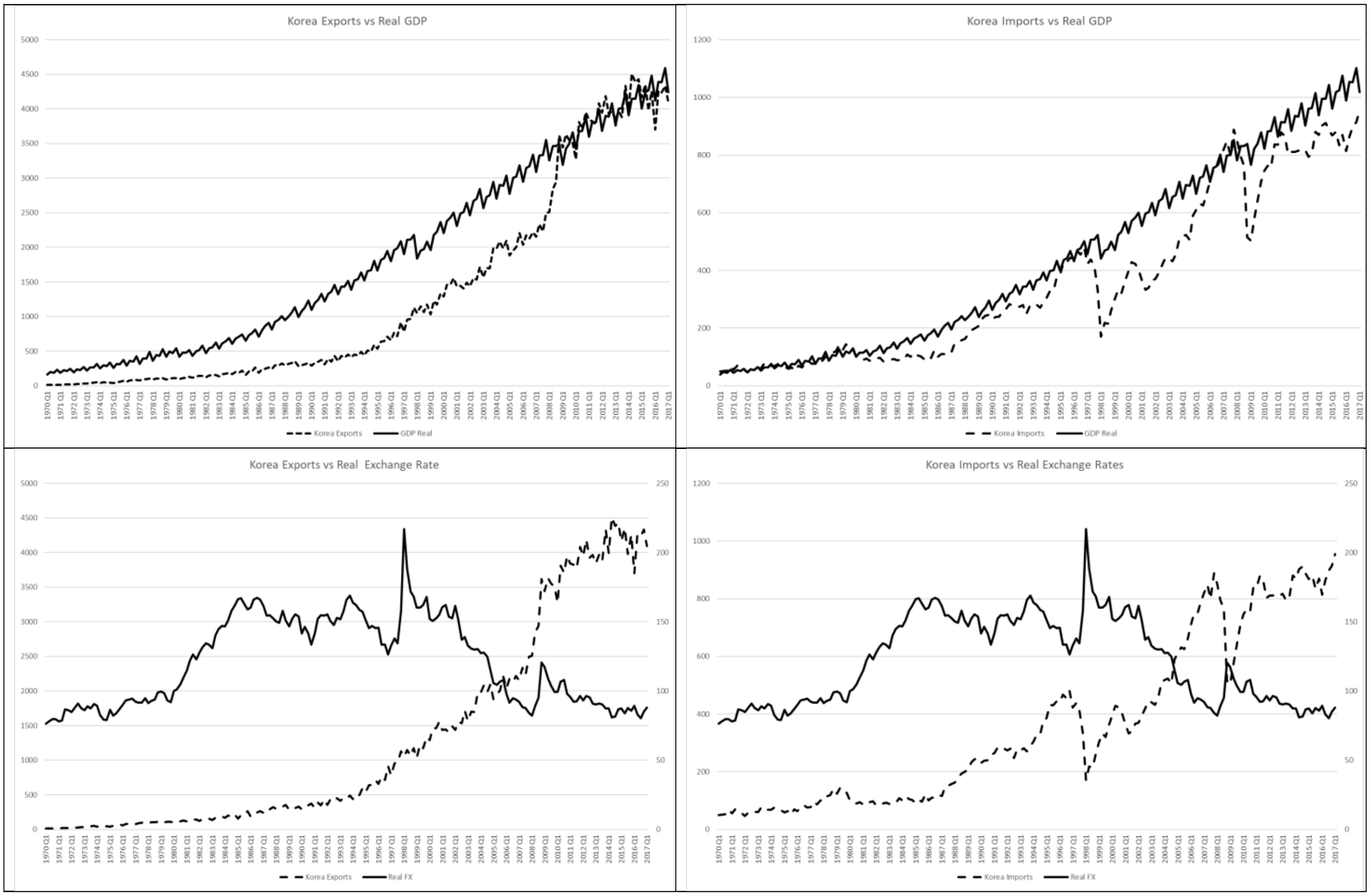
Table 9. Hong Kong Export Demand Breaks Regression

Break type: Bai-Perron tests of 1 to M globally determined breaks									
Breaks: 1981Q4, 1993Q1, 2003Q2					Breaks: 1981Q4, 1993Q1, 2003Q2				
Variable	Coefficier	Std. Error	t-Statistic	Prob.	Variable	Coefficier	Std. Error	t-Statistic	Prob.
1973Q1 - 1981Q3 -- 35 obs					1981Q4 - 1992Q4 -- 45 obs				
C	0.704687	0.996321	0.707288	0.4804	C	-7.35904	0.653179	-11.2665	0.0000
XIP	-1.02386	0.084795	-12.0745	0.0000	XIP	0.460413	0.15324	3.004513	0.0031
Y*	1.707898	0.229232	7.450513	0.0000	Y*	2.308079	0.061855	37.31414	0.0000
U	2.29645	0.587031	3.911975	0.0001	U	1.346292	0.119448	11.2709	0.0000
1993Q1 - 2003Q1 -- 41 obs					2003Q2 - 2016Q4 -- 55 obs				
C	5.237058	0.631888	8.287951	0.0000	C	-0.66596	0.523138	-1.27301	0.2049
XIP	-0.83542	0.14896	-5.60831	0.0000	XIP	0.194781	0.080299	2.425696	0.0164
Y*	0.719333	0.031288	22.99054	0.0000	Y*	0.994549	0.045805	21.71277	0.0000
U	1.391775	0.089364	15.57419	0.0000	U	0.742577	0.091687	8.099066	0.0000
Whole Sample: 1973Q1 2016Q4									
C	-6.04634	1.614797	-3.74433	0.0002	Break type: Bai-Perron tests of 1 to M globally determined breaks				
XIP	0.586147	0.432883	1.354053	0.1775	Break selection: Sequential evaluation, Trimming 0.20, Max. breaks 3, Sig.				
Y*	1.740198	0.083358	20.87626	0.0000	level 0.05				
U	0.482202	0.777608	0.62011	0.5360					

Table 10. Hong Kong Import Demand Breaks Regression

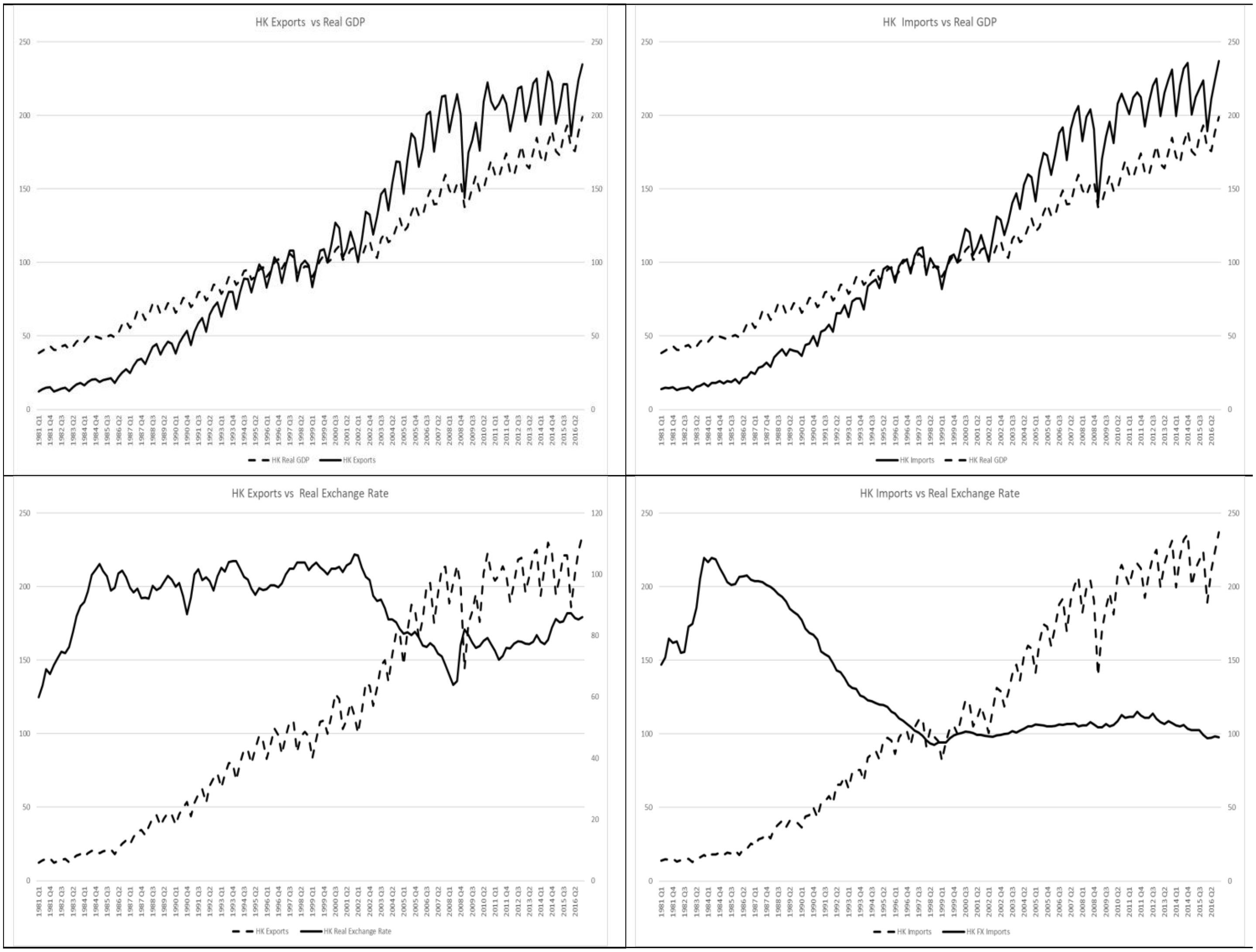
Break type: Bai-Perron tests of 1 to M globally determined breaks									
Breaks: 1988Q1, 1995Q2, 2002Q3					Breaks: 1988Q1, 1995Q2, 2003Q2				
Variable	Coefficier	Std. Error	t-Statistic	Prob.	Variable	Coefficier	Std. Error	t-Statistic	Prob.
1980Q4 - 1987Q4 -- 29 obs					1988Q1 - 1995Q1 -- 29 obs				
C	-2.3269	0.544106	-4.27655	0.0000	C	5.112241	0.947263	5.396852	0.0000
RER	-0.26325	0.103289	-2.54864	0.0120	RER	-1.12394	0.092698	-12.1248	0.0000
Y	1.704988	0.051152	33.33153	0.0000	Y	1.044294	0.12023	8.685832	0.0000
1995Q2 - 2002Q2 -- 29 obs					2002Q3 - 2016Q4 -- 58 obs				
C	-2.75847	1.012134	-2.7254	0.0073	C	-3.45467	0.729482	-4.73578	0.0000
RER	0.103913	0.111774	0.929674	0.3542	RER	0.823725	0.150977	5.455979	0.0000
Y	1.500259	0.14072	10.66131	0.0000	Y	0.966635	0.031349	30.83425	0.0000
Whole Sample: 1980Q4 2016Q4									
C	0.361546	0.789753	0.457797	0.6478	Break type: Bai-Perron tests of 1 to M globally determined breaks				
RER	-0.70118	0.08861	-7.91313	0	Break selection: Sequential evaluation, Trimming 0.20, Max. breaks 3, Sig.				
Y	1.625643	0.084413	19.25828	0	level 0.05				

Figure 1. South Korea Exports and Imports vs Real GDP and Exchange Rate: 1970.1-2017.1



Source: International Monetary Fund’s International Financial Statistics

Figure 2. Hong-Kong Exports and Imports vs Real GDP and Exchange Rate: 1981.1-2016.4



Source: International Monetary Fund's International Financial Statistics