European Journal of Economics and Economic Policies: Intervention, Vol. 18 No. 1, 2021, pp. 29–54
First published online: September 2020; doi: 10.4337/ejeep.2020.0071

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

Marco Flávio Cunha Resende**
Economics Department, Federal University of Minas Gerais, Belo Horizonte, Brazil

Vitor Leone***
Leicester Castle Business School, De Montfort University, Leicester, UK

Daniela Almeida Raposo Torres****
Economics Department, Federal University of São João-Del-Rei, Brazil

Simeon Coleman*****
School of Business and Economics, Loughborough University, UK

In the balance-of-payments-constrained growth model literature, income elasticities (IEs) are considered as the crucial element determining a country's long-run growth rate. Although the extant literature accepts that technology matters for IEs magnitude, explanations linking technology and IEs 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 IEs 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 IEs over the 1980–1995 period. Our empirical results suggest a link between the level of NIS development and the size of the IEs.

Keywords: *National Innovation System, income elasticities, imports, exports*

JEL codes: *E12, F43, O44*

1 INTRODUCTION

In the seminal work of Thirlwall (1979), the differences in income elasticities (IEs) of demand for imports and exports between countries are key to the deviations in their

* *Funding:* This work was supported by the CNPq (the Brazilian federal research funding agency).
** Email: resende@cedeplar.ufmg.br.
*** Email: vitor.leone@dmu.ac.uk.
**** Email: daniraposo@ufsj.edu.br.
***** Email: S.Coleman@lboro.ac.uk.

Received 23 October 2018, accepted 30 April 2019

Journal compilation © 2021 Edward Elgar Publishing Ltd
The Lypiatts, 15 Lansdown Road, Cheltenham, Glos GL50 2JA, UK
and The William Pratt House, 9 Dewey Court, Northampton MA 01060-3815, USA

long-run growth rates. According to Thirlwall's work, it is demand that drives the economic system, and the dominant demand constraint is the balance of payments. McCombie/Thirlwall (1994: 233–234) argue that

> [i]f 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 goods 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 constrain 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/Hussain (1982), Barbosa Filho (2001), and Moreno-Brid (2003). Fagerberg (1988), focusing on the supply side, concludes that technological progress matters for IEs magnitudes. Araujo/Lima (2007), Porcile et al. (2007), Cimoli et al. (2010), and Gouvea/Lima (2013) also argue that supply-side effects emerge from the pattern of specialization of the industrial structure insofar as the latter affects IEs.

Common to these studies is the notion that technology is related to the relative magnitudes of IEs. Nonetheless, explanations relating the channels that link technology and the size of IEs 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/Winter 1982; Fagerberg 1994; Freeman 1995). The concept of the 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 IEs exist. More specifically, we argue that the catch-up achieved by countries' technological progress changes their IEs and increases their balance-of-payments equilibrium growth rate since technological progress is a channel through which non-price competitiveness factors work. Against this background, the aims of this article are twofold. First, we contribute to the literature on the BPCG by employing the Evolutionary concept of the NIS and highlighting the role of the NIS for the non-price competitiveness aspect and, therefore, for the IEs 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 IEs and to a fall in their import-demand IEs. 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 IEs in both functions. Using quarterly data obtained from the International Monetary Fund (IMF) ranging from 1963Q1 to 2017Q1 for South Korean exports, 1970Q1 to 2017Q1 for South Korean imports, and from 1971Q1 to 2016Q4 for Hong Kong exports, and 1980Q4 to 2016Q4 for Hong Kong imports, we apply the methods proposed by Bai (1997) and Bai/Perron (1998; 2003a; 2003b). 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) IEs.[1]

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

2 THE NATIONAL INNOVATION SYSTEM (NIS) AND COUNTRIES AS SEPARATE TECHNOLOGICAL SYSTEMS

The concept of the 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 the 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 analysed 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' environments are seen as crucial for technological progress and its diffusion.[3]

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: 123) states that '[t]echnology, far from being a free good, involves a fundamental learning aspect, characterized by varying degrees of *cumulativeness, opportunity and appropriability*' (emphasis in original). 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), and Freeman (1995), go further and perceive countries as separate technological systems, each one with its own specific NIS and its own specific dynamics.

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 IEs it is likely to experience.
2. A detailed review of this literature can be found in Lundvall (1992), Nelson (1993), Fagerberg (1994), and Freeman (1995; 2002).
3. In particular, government policies and institutions are required to induce technological progress. As Mazzucato (2013) stressed, when investment is capital- and technology-intensive, private investments depend on the high-risk investments made by an entrepreneurial state, where risks are non-private, while rewards are privatized.

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 the importation of technology, given that technology has tacit path-dependence, and systemic and local features (Dosi et al. 1994; Freeman 1995; Fagerberg/Godinho 2005; Nelson 2005).

The literature also emphasizes that innovations and technical change depend on the NIS (that is, technology is not a free good), and each country possesses its own specific NIS with its own specific dynamics. Therefore, technology is not accessible by countries that do not have a developed NIS. In short, technologies are not easily transferable from one 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 an 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 their trade elasticities, as we shall see in the next section.

3 THE LINKAGES BETWEEN THE NIS AND INCOME ELASTICITIES

In the extant literature, the links between the level of technological sophistication of products and the magnitudes of its IEs of demand for export and import are explicitly or implicitly assumed (see Fagerberg 1988; Araujo/Lima 2007; Porcile et al. 2007; Cimoli et al. 2010; Gouvea/Lima 2013). This issue is explained in the BPCG literature on the basis of the nature of the products, and, according to McCombie/Thirlwall (1994: 390–391), 'the supply characteristics of goods (such as their sophistication, quality, etc.) determine relative income elasticities.'

4. For instance, according to Etzkowitz (1993), a triple helix linking university, industry, and government was formed in the late nineteenth century in the USA and fostered a series of science-based firms, contributing to local, regional, and national economic development. The role of government was to provide funds to support research carried out 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 have assumed the burden of their financial support and have given business advice to scientists and engineers, while universities have 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 allows inventions to be introduced into industrial production.

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 differs, 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: 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, technological progress is associated with social accumulation of productive knowledge, which, in turn, is not a free good and is not transferable from one country to another. For more on the Economic Complexity literature, see Hausmann/Hidalgo (2011) and Hausmann et al. (2014).

Notably, though, there is limited discussion on the channels that link technology and the size of countries' IEs in the international trade context. We posit that the nature of a country's exports and imports is not the only determinant of the size of its IEs, insofar as the diversification of the country's industrial structure and the access of the world goods markets with distinct features (such 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 income elasticity (IE) of demand for export. According to Hausman/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/Klinger (2007: 3) provide robust evidence that the evolution of comparative advantage in a country is significantly affected by these patterns of relatedness, and Dosi (1988: 127–128) reports a similar finding. Benkovskis/Wörz (2014), investigating what drives countries' export market shares, argues that non-price competitiveness aspects such as shifts in taste and quality as well as in variety (that is, 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 to technological progress.

First, concerning the diversification of the country's industrial structure, the more developed its NIS, the greater 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 the possibility of changes in taste, quality, and variety (a fall in the set of competitors) of exports. Following Dosi (1988), Hausman/Klinger (2007), and Hausmann et al. (2014), 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/Wörz 2014: 7). Consequently, countries with better-developed NISs 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 IEs of demand for export.

Second, concerning the relationship between the characteristics of the world goods markets (degree of competition) and a country's IE of demand for export, technologically sophisticated products show high levels of IEs of demand for export (Fagerberg 1988; Araujo/Lima 2007; Porcile et al. 2007) and, at the same time, few countries possess an NIS that is developed enough to enable them to manufacture such products. Technologically sophisticated production cannot simply be transferred from one country to another in the absence of a developed NIS. Therefore, it follows that the IEs 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, that is, the ones with a developed NIS. This, therefore, results in fast-growing (or dynamic) export markets for the few countries with developed NISs, due to a non-price competitiveness aspect that results from the development of NISs.[6] As Benkovskis/Wörz (2014: 2) stress, 'obviously, price factors play [a] less important role in markets where suppliers 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 technologically 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 IEs of demand for export, through a non-price competitiveness aspect, in the few countries able to export sophisticated products, that is, 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 the 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 IEs of demand for exports for the countries able to produce high-technology products. Low protectionism is a characteristic of technologically sophisticated product markets that fosters a high IEs of demand for such exports in the few countries able to export such products, due to a non-price competitiveness aspect, that is, the development of the country's NIS.

The discussion above, on the four factors identified, that is, diversification of the industrial structure, market dynamism, degree of oligopoly and protectionism, suggests that the more developed a country's NIS, the greater its IE of demand for exports. Moreover, the channels that link the development of the NIS and shifts in IEs 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 to 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 whose NISs are less developed, the IEs of demand for exports tends to be lower than the IEs of demand for imports. We note that, other determinants of the magnitudes of IEs are postulated in the literature. For example, McCombie/Thirlwall (1994: 389) argue that 'countries' income elasticities are largely determined by natural

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

resource endowments and the characteristics of goods produced, which are the product of history.' Nonetheless, the level of development of a country's NIS also seems to be a relevant determinant of the size of a country's IEs and therefore of a country's balance-of-payments equilibrium growth rate.

4 EMPIRICAL EVIDENCE

Since the 1960s, some Asian countries have shown impressive improvements in economic and social indicators and countries such as South Korea, Hong Kong, Taiwan, and Singapore have been 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, that is, Canada, France, Germany, Italy, Japan, the United Kingdom, and the United States. Singapore and Hong Kong's IPC approached the level of the G7 group's average in the 1980s, whereas Taiwan and South Korea surpassed that of the G7 countries over the period 1985–1995.

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 Amsden (1989), Dosi et al. (1994), Freeman (1995; 2002), and Lee (2000), we hypothesize that the catch-up allowed by technological progress made by the Asian Tigers changed their IEs in the 1980s for Hong Kong and Singapore and during 1985–1995 for South 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 analyse the size and direction of the changes in IEs. It is expected that the export demand IEs is likely to increase and the import demand IEs to reduce for Singapore and Hong Kong in the 1980s and for South Korea and Taiwan during 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 development of the Asian Tigers' NISs and changes in their IEs is instructive. Therefore, the economic histories of these countries can be useful. Noland (2011) and Kim/Heo (2017) 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.

4.1 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 its economic development (Amsden 1989; Kim/Heo 2017). The average growth rate in their GDP per capita from 1960 to 2010 was 9.52 percent. The country experienced an outstanding increase in exports, rising from 7.4 percent of GDP in 1967 to 36.7 percent in 1987 (Kim/Heo 2017). However, the 'Korean economy has faced numerous structural breaks

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

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	–	–	6 649.29	10 418.11	16 941.81	22 633.13	26 179.55	35 207.12	46 127.97	55 084.2
South Korea, Rep.	–	–	2 302.29	4 272.95	7 829.17	12 287.91	16 502.58	22 783.23	30 041.60	34 355.7
Singapore	–	–	6 757.62	11 248.73	17 393.59	25 284.96	32 262.25	4 3975.70	56 708.21	82 763.4
Taiwan, China	–	–	3 570.61	5 809.66	9 858.46	15 074.68	20 289.51	26 657.33	35 595.16	–
The lower GDP per capita from G7	–	–	8 380.79	11 952.76	16 305.65	19 704.08	24 669.35	28 078.94	29 840.63	34 757.8
GDP per capita, current US$										
Hong Kong SAR, China	960	2 252	5 700	6 543	13 486	23 497	25 757	26 650	32 550	40 170
South Korea, Rep.	292	646	1 778	2 542	6 642	12 404	11 948	18 658	22 151	27 970
Singapore	925	2 559	5 004	6 782	12 766	24 937	23 793	29 870	46 570	56 287
Taiwan, China	–	–	–	–	–	–	–	–	–	–
The lower GDP per capita from G7	2 004	4 095	8 432	7 967	19 095	20 509	20 059	31 974	35 878	34 960

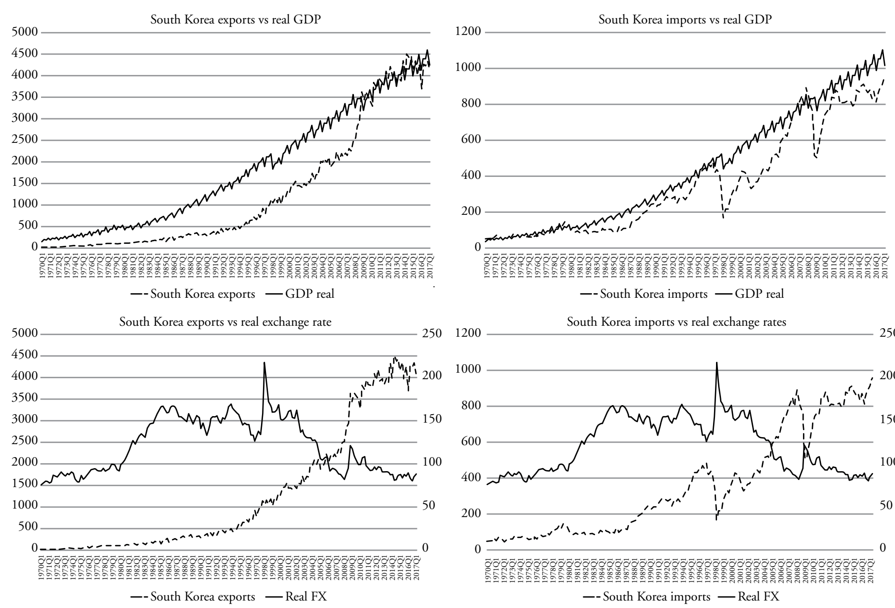
Source: World Economic Outlook Data - IMF and World Development Indicators - World Bank.

including the Asian financial crisis or major changes in policy regime' (Harvie/Pahlavani 2006: 14). Figure 1 shows the evolution of exports, imports, and GDP as well as of the real exchange rate in South Korea.

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 (Heavy and Chemical Industries: steel, heavy machinery, automobiles, industrial electronics, shipbuilding, non-ferrous metals, and petrochemicals) investment in earlier periods that led to an over-capacity problem (Harvie/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 within the 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 1997–1998. 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 South Korea (Heo/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



Source: IMF's International Financial Statistics.

Figure 1 South Korea exports and imports vs real GDP and exchange rate, 1970Q1–2017Q1 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, and reforming labor practices, in the context of an outstanding growth of exports, in particular to China (Harvie/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 percent depreciation of the domestic currency, the won, against the US dollar in the context of high levels of financial leverage, and consequently experienced negative economic growth in 2008 (Noland 2011).

Despite the earlier turbulent international macroeconomic environment, the economy recorded positive growth after 2009 due to a number of factors: the depreciation of the country's exchange rate, the reduction of 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/Pahlavani (2006) conducted tests for structural breaks for the real exports and imports of South Korea covering the period 1980Q1 to 2005Q3. Their results show breaks in the real exports and real imports series in 1989Q1 and 1997Q4, respectively. According to the authors, the breaks in the exports and imports coincided with the period of trade liberalization in South Korea and the Asian financial crisis, respectively.

Our overview of South Korea's economic history suggests potential structural breaks for its export and import functions parameters in 1973–1974 (first oil-price crisis), 1979–1980 (second oil-price crisis; domestic political crisis; new economic policy regime), 1989–1990 (trade liberalization), 1997–1998 (Asian financial crisis), and 2008–2009 (global financial crisis). We posit that the development of South Korea's NIS led to structural breaks in the country's IEs of demand for import and for export during 1985–1995 (see Table 2).

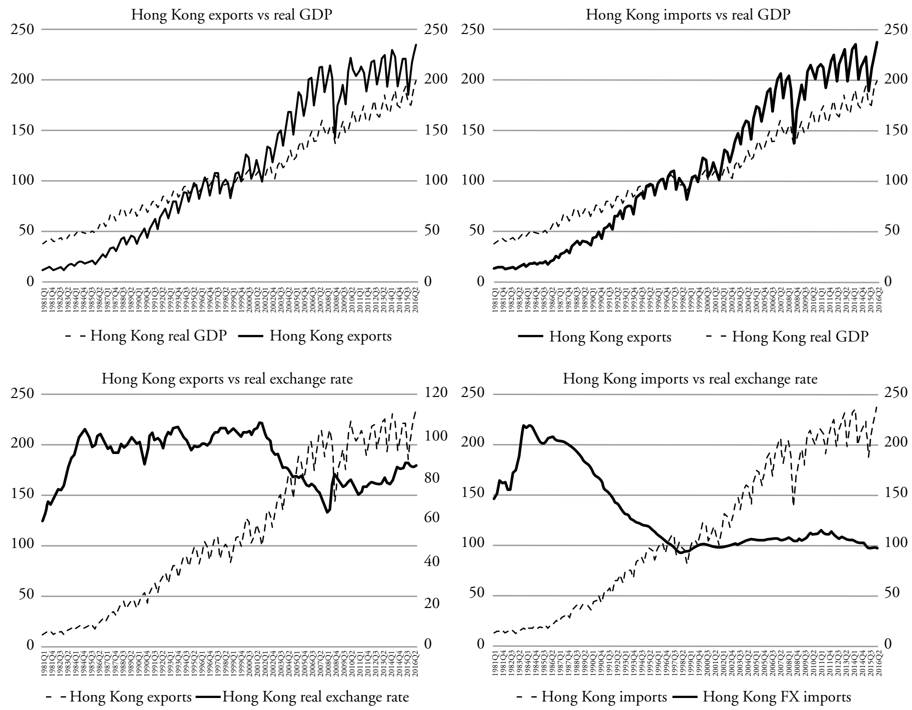
We proceed to test the hypothesis of an increase in the export demand IEs and a fall in the import demand IEs for South Korea during 1985–1995, and for Hong Kong in the 1980s.[8] Figure 2 shows the evolution of exports, imports, and GDP as well as of the real exchange rate in Hong Kong.

Table 2 Potential structural breaks for South Korea's exports and imports functions

Time of potential structural breaks	Corresponding events
1973–1974	First oil-price crisis
1979–1980	Second oil-price crisis; domestic political crisis; new economic policy regime
1989–1990	Trade liberalization
1985–1995	South Korea's technological and economic catch-up
1997–1998	Asian financial crisis
2007–2008	Global financial crisis

Source: Author's elaboration.

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



Source: IMF's International Financial Statistics.

Figure 2 Hong Kong exports and imports vs real GDP and exchange rate, 1981Q1–2016Q2

4.1.1 Structural break tests

The specification of a country's import and export equations, which have been employed in the empirical literature (see Senhadji 1998; Senhadji/Montenegro 1999; Abu-Lila 2014; Ketenci 2014), consider 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]

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

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

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

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

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 the 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' IEs. However, if we consider structural changes in IEs, 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 IEs may be captured implicitly, inasmuch as we assume from the perspective presented in Section 3 that changes in IEs 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 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 the periods for which data are available for those countries. The data are sourced from the IMF's International Financial Statistics (IFS) and Economic Statistics System/Bank of Korea.

Testing for parameter instability and structural change in regression models has 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/Ploberger (1994) deducted the limiting distribution of the Quandt and related test statistics.

Based on those previous methodologies, Bai (1997) and Bai/Perron (1998; 2003a; 2003b) determine theoretical and computational results that further extend the Quandt–Andrews framework by allowing us 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 $T_j, T_j + 1, \dots, T_{j+1} - 1$ for the regimes $j = 0, \dots, m$ given by:

$$y_t = Z_t' \delta_j + \varepsilon_t. \tag{3}$$

The Z variables have coefficients that are regime-specific.[10] In such cases the computation of the estimates of (3) can be made by applying ordinary least squares (OLS) segment-by-segment without constraints among them. Bai/Perron (1998) depict global optimization procedures for distinguishing the m multiple breaks which minimize the sums-of-square residuals of the regression model equation (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 the recommendation of Bai/Perron (2003a: 15–16): 'The problem

10. See Bai/Perron's (2003a) structural version of the model, where variables which do not vary across regimes can also be considered.

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

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

Using a 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/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 breakpoint estimates are then utilized as the benchmark for several breakpoint tests.

Bai/Perron (1998; 2003a) present a generalization of the Quandt–Andrews test (Andrews 1993) in which we test for equality 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 $\delta_0 = \delta_0 = \ldots = \delta_{l+1}$ as shown below:

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

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 heteroskedasticity 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 predetermined. Not to prespecify a particular number of breaks to make an inference, Bai/Perron introduced two tests of the null hypothesis of no structural breaks 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 UDmax, 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 this is called WDmax. Critical values for $M = 5$ and a 5 percent, 10 percent, and 15 percent sample trimming are generated by Bai/Perron[11] who suggested that five 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 the quantity of imports demand. The test allows heterogeneous error distributions across breaks[12] and trimming of 20 percent is applied instead of the usual 10 or 15 percent default in order to mitigate a potential reduction in the number of observations in the break regressions. Increasing the trimming would limit the

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

number of breaks to a maximum of three. The results of the test are analysed at 5 percent significance level.

Before applying the test, we apply the augmented Dickey–Fuller (ADF) test 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.

The ADF tests suggest that at the 1 percent 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 (VAR) model and based on the Schwarz information criterion (SIC) at 5 percent 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]

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

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 three breaks for South Korea. The *UD*max and *WD*max outputs show the number of breakpoints as defined by application of the unweighted and weighted maximized statistics suggesting both the existence of a maximum three breaks for the *UD*max and two breaks for the *WD*max for South Korean exports and imports respectively.

As reported in Table 6, for Hong Kong, the *F*-statistics suggest three breaks and the maximized *UD*max and *WD*max, two and three breaks respectively for the export demand, and for the import demand the *UD*max and *WD*max suggest one 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/Perron (1998) to estimate a generalized least square procedure with breakpoints in line with Bai/Perron's (2003a) multiple breakpoint test methodology.

The equation for the exports demand is:

$$XIQD_t = \alpha_0 + \alpha_1 XIP_t + \alpha_2 {Y^*}_t + \alpha_3 U_t + e_t, \quad (6)$$

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

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 intercept 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 intercept 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 intercept 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 intercept 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						South Korea quantum of imports demand					
Sequential *F*-statistic determined breaks:				3		Sequential *F*-statistic determined breaks:				3	
Significant *F*-statistic largest breaks:				3		Significant *F*-statistic largest breaks:				3	
*UD*max determined breaks:				3		*UD*max determined breaks:				2	
*WD*max determined breaks:				3		*WD*max determined breaks:				3	
Breaks	*F*-statistic	Scaled *F*-statistic	Weighted *F*-statistic	Critical value		Breaks	*F*-statistic	Scaled *F*-statistic	Weighted *F*-statistic	Critical value	
1*	94.18125	376.725	376.725	15.67		1*	32.28439	96.85317	96.85317	13.47	
2*	86.54079	346.1632	419.1945	12.94		2*	58.21998	174.6599	212.1433	11.09	
3*	105.3593	421.4372	612.6087	10.78		3*	49.08358	147.2507	217.4855	9.12	
*UD*max statistic*		421.4372	*UD*max critical value**		15.79	*UD*max statistic*		174.6599	*UD*max critical value**		13.66
*WD*max statistic*		612.6087	*WD*max critical value**		17.04	*WD*max statistic*		217.4885	WDMax critical value*		14.73
Estimated break dates:						Estimated break dates:					
1: 1975Q2						1: 1987Q1					
2: 1975Q2, 2006Q3						2: 1981Q3, 1997Q4					
3: 1975Q2, 1995Q2, 2006Q3						3: 1981Q3, 1997Q4, 2007Q4					

Notes: * Significant at the 0.05 level. ** Bai–Perron (2003b) critical values.

Table 6 BP multiple break point test for Hong Kong

Hong Kong quantum exports demand					Hong Kong quantum imports demand				
Sequential *F*-statistic determined breaks:				3	Sequential *F*-statistic determined breaks:				3
Significant *F*-statistic largest breaks:				3	Significant *F*-statistic largest breaks:				3
*UD*max determined breaks:				2	*UD*max determined breaks:				1
*WD*max determined breaks:				3	*WD*max determined breaks:				1
Breaks	*F*-statistic	Scaled *F*-statistic	Weighted *F*-statistic	Critical value	Breaks	*F*-statistic	Scaled *F*-statistic	Weighted *F*-statistic	Critical value
1*	269.4617	1077.847	1077.847	15.67	1 *	96.91337	290.7401	290.7401	13.47
2*	270.7652	1083.061	1311.558	12.94	2 *	66.54698	199.6409	242.4854	11.09
3*	226.0637	904.2549	1314.441	10.78	3 *	60.44774	181.3432	267.8392	9.12
*UD*max statistic*	1083.061	*UD*max critical value**		15.79	*UD*max statistic*	290.7401	*UD*max critical value**		13.66
*WD*max statistic*	1314.441	*WD*max critical value**		17.04	*WD*max statistic*	290.7401	*WD*max critical value*		14.73
Estimated break dates: 1: 1991Q4 2: 1981Q4, 1992Q2 3: 1981Q4, 1993Q1, 2003Q2					Estimated break dates: 1: 2003Q2 2: 1995Q1, 2002Q2 3: 1988Q1, 1995Q2, 2002Q3				

Notes: *Significant at the 0.05 level. **Bai–Perron (2003b) critical values.

where $XIQD =$ the natural log of the total exports of goods and services in real terms;[14] $XIP =$ the natural log of the country exports price in foreign currency divided by the trade partners export price in foreign currency; $Y^* =$ the natural log of the world real income; $U =$ the natural log of the degree of the current operational capacity; and $e =$ the 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 $MIQD =$ the natural log of the total imports of goods and services in real terms;[15] $RER =$ the natural log of the nominal exchange rate multiplied by imports price in foreign currency divided by the price of domestic goods; $Y =$ the natural log of the country real income; and $e =$ the 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 IEs for South Korea between 1985 and 1995 (Table 2) is not rejected at 1 percent statistical significance (Table 7). South Korea's export demand IEs rose from 1.55 in 1995Q1 to 1.73 in 1995Q2. Another increase in South Korea's export demand IEs in 2006Q3 is suggested by the test results. Moreover, a fall in South Korea's export demand IEs in 1975Q2 (from 3.15 to 1.55, at 1 percent significance level) is also suggested by the test results and is in line with what was expected due to the oil-price shock at the end of 1973 (Table 2).

With respect to South Korea's import demand, the results show a structural break and a fall in the country's import demand IEs from 1.35 in 1997Q3 to 0.85 in 1997Q4 with 1 percent of statistical significance, a point in time that is close to the period we expected a fall in this parameter (1985–1995). 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 IEs in 1981Q3 and a fall in 2007Q4, both with 1 percent of statistical significance (Table 8). The increase in South Korea's import demand IEs in 1981Q3 coincides with the policy of trade liberalization period, which took place in South Korea after 1980. The structural break in the country's IEs in 2007Q4 coincides with the global financial crisis period (Table 2).

The direction of the changes in South Korea's IEs of demand for export and import either for the 1985–1995 period or for the other periods are as expected *a priori*, although there was no change in the import demand IEs over the 1985–1995 period, as was supposed. In line with the extant literature, the estimated signs for the import and export demand IEs are also as *a priori* expected.

Tables 9 and 10 report the results for Hong Kong's export and import demands. Our hypothesis of a break in the export demand IEs 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 percent level of significance in 1981Q4. The export demand IEs for Hong Kong changed twice after 1990, that is, a fall in 1993Q1 and a rise in 2003Q2. In line with the extant literature, the estimated sign for the export demand IEs is as *a priori* expected.

With respect to the import demand IEs for Hong Kong, the results reported in Table 10 suggest a fall in this parameter in the 1980s, as was expected. The import demand IEs changed from 1.70 in 1987Q4 to 1.04 in 1988Q1, at the 1 percent level of significance. A rise in this parameter in 1995Q2 and a fall in 2002Q3 are also suggested by the test

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 IMF's International Financial Statistics (IFS).

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	Coefficient	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. level 0.05				
*Y**	2.245579	0.042303	53.08285	0.000000					
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	Coefficient	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. level 0.05				
RER	−1.070974	0.195725	−5.47184	0.0000					
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	Coefficient	Std. error	*t*-statistic	Prob.	Variable	Coefficient	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. level 0.05				
*Y**	1.740198	0.083358	20.87626	0.0000					
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	Coefficient	Std. error	*t*-statistic	Prob.	Variable	Coefficient	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. level 0.05				
Y	1.625643	0.084413	19.25828	0					

results. As before, in line with the literature, the estimated sign for the import demand IEs is as *a priori* expected. Moreover, the direction of both of the changes on Hong Kong's IEs of demand for export and import for the 1980s are as *a priori* expected.

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 IEs, and that the latter should decrease whereas the former should increase. The test results summarized in Tables 7 to 10 show that, with the exception of South Korea's IEs demand for imports, the other parameters changed in the periods and in the direction supported by the arguments presented in Section 3.

5 SUMMARY AND CONCLUSIONS

In the BPCG literature, IEs 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 IEs. 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 shows why there are differences in IEs between 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 an 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 South Korea and Hong Kong changed their IEs. Our assumption was that export demand IEs rose in the 1980s and over the 1985–1995 period for Hong Kong and South Korea respectively, and that import demand IEs fell in the 1980s and over the 1985–1995 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 the exception of South Korea's IEs 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 IEs cannot be rejected, we are cautious enough to note that they do 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 IEs change was caused by its NIS development, we presented an overview of the country's economics. We find no other reason for the change in South Korea's IEs of demand for export in 1995Q2 other than development in its NIS, as evidenced by its income per capita data (Table 1) and from the literature (Dosi et al. 1994; Freeman 1995; 2002; Lee 2000; to cite a few), which suggests that South Korea's technological and NIS catch-up took place in the 1985–1995 period. This evidence supports the hypothesis that structural breaks in IEs over the period are related to 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 IEs 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.

REFERENCES

Abu-Lila, Z.M. (2014): Price and income elasticities of international trade: case of Jordan, in: *International Journal of Economics and Finance*, 6(10), 250–258.

Amsden, A.H. (1989): *Asia's Next Giant: South Korea and Late Industrialization*, Oxford: Oxford University Press.

Andrews, D.W.K. (1993): Tests for parameter instability and structural change with unknown change point, in: *Econometrica*, 61(4), 821–856.

Andrews, D.W.K., Ploberger, W. (1994): Optimal tests when a nuisance parameter is present only under the alternative, in: *Econometrica*, 62(6), 1383–1414.

Araujo, R.A., Lima, G.T. (2007): A structural economic dynamics approach to balance-of-payments-constrained growth, in: *Cambridge Journal of Economics*, (31), 755–774.

Bai, J. (1997): Estimating multiple breaks one at a time, in: *Econometric Theory*, 13(3), 315–352.

Bai, J., Perron, P. (1998): Estimating and testing linear models with multiple structural changes, in: *Econometrica*, 66(1), 47–78.

Bai, J., Perron, P. (2003a): Computation and analysis of multiple structural change models, in: *Journal of Applied Econometrics*, 18(1), 1–22.

Bai, J., Perron, P. (2003b): Critical values for multiple structural change tests, in: *Econometrics Journal*, 6(1), 72–78.

Barbosa Filho, N.H. (2001): The balance-of-payments constraint: from balanced trade to sustainable debt, in: *Banca Nazionale Del Lavoro Quarterly Review*, 54(219), 381–399.

Benkovskis, K., Wörz, J. (2014): What drives the market share changes? Price versus non-price factors, European Central Bank, Working Paper Series, No 1640, February.

Chow, G.C. (1960): Tests of equality between sets of coefficients in two linear regressions, in: *Econometrica*, 28(3) 591–605.

Cimoli, M., Porcile, G., Rovira, S. (2010): Structural change and the BOP-constraint: why did Latin America fail to converge?, in: *Cambridge Journal of Economics*, 34(2), 389–411.

Dosi, F. (1988): Institutions and markets in a dynamic world, in: *The Manchester School*, LVI(2), 119–146.

Dosi, G., Fabiani, S., Freeman, C. (1994): The process of economic development: introducing some stylized facts and theories on technologies, firms and institutions, in: *Industrial and Corporate Change*, 3(1), 1–45.

Etzkowitz, H. (1993): Enterprises from science: the origins of science-based regional economic development, in: *Minerva*, 31(3), 326–360.

Fagerberg, J. (1988): International competitiveness, in: *Economic Journal*, 98(391), 355–374.

Fagerberg, J. (1994): Technology and international differences in growth rates, in: *Journal of Economic Literature*, 32(3), 1147–1175.

Fagerberg, J., Godinho, M.M. (2005): Innovation and catching up, in: Fagerberg, J., Mowery, D., Nelson, R. (eds), *The Oxford Handbook of Innovation*, Oxford: Oxford University Press, 514–543.

Freeman, C. (1995): The National System of Innovation in historical perspective, in: *Cambridge Journal of Economics*, (19), 5–24.

Freeman, C. (2002): Continental, national and sub-national innovation systems: complementarity and economic growth, in: *Research Policy*, 31(2), 191–111.

Goldstein, M., Khan, M. (1985): Income and price effects in foreign trade, in: *Handbook of International Economics*, 2, 1041–1105.

Gouvea, R.R., Lima, G.T. (2013): Balance of payments constrained growth in a multisectoral framework: a panel data investigation, in: *Journal of Economic Studies*, 40(2), 240–254.
Harvie, C., Pahlavani, M. (2006): Sources of economic growth in South Korea: an application of the ARDL analysis in the presence of structural breaks – 1980–2005, Seoul, Korea: V Conference Korea University, 7–8 July.
Hausmann, R., Hidalgo, C.A. (2011): The network structure of economic output, in: *Journal of Economic Growth*, 16(4), 309–342.
Hausmann, R., Klinger, B. (2007): The structure of the product space and the evolution of comparative advantages, CID Working Paper No 146.
Hausmann, R., Hidalgo, C.A., Bustos, S., Coscia, M., Chung, S., Jimenez, J., Simoes, A., Yildirim, M.A. (2014): *The Atlas of Economic Complexity: Mapping Path to Prosperity*, Cambridge, MA: MIT Press.
Heo, U., Kim, S. (2000): Financial crisis in South Korea: failure of the government-led development paradigm, in: *Asian Survey*, 40(3), 492–507.
Ketenci, N. (2014): The effect of global financial crisis on trade elasticities: evidence from BRICS countries and Turkey, in: *Journal of International and Global Economic Studies*, 7(1), 1–19.
Kim, H., Heo, U. (2017): Comparative analysis of economic development in South Korea and Taiwan: lessons for other developing countries, in: *Asian Perspective*, (41), 14–41.
Lall, S. (2000): The technological structure and performance of developing country manufactured exports, 1985–1998, Queen Elizabeth House Working Paper No 44, University of Oxford.
Lee, K.R. (2000): Technological learning and entries of user firms for capital goods in Korea, in: Kim, L., Nelson, R. (eds), *Technology, Learning and Innovation: Experiences of Newly Industrializing Economies*, New York: Cambridge University Press, 170–192.
Lundvall, B.A. (ed.) (1992): *National System of Innovation*, London: Pinter.
Mazzucato, M. (2013): *The Entrepreneurial State: Debunking Public vs Private Sector Myths*, London: Anthem Press.
McCombie, J.S.L., Thirlwall, A.P. (1994): *Economic Growth and the Balance-of-Payments Constraints*, New York: St. Martin's Press.
Moreno-Brid, J.C. (2003): Capital flows, interest payments and the balance-of-payments constrained growth model: a theoretical and empirical analysis, in: *Metroeconomica*, 54(2–3), 346–365.
Nelson, R. (1993): *National Innovation Systems: A Comparative Analysis*, New York: Oxford University Press.
Nelson, R. (2005): Economic development from the perspective of evolutionary economic theory, URL: http://www.globelics-beijing.cn/paper/Richard%20R%20Nelson.pdf.
Nelson, R., Winter, S. (1982): *An Evolutionary Theory of Economic Change*, Cambridge, MA: Harvard University Press.
Noland, M. (2011): Korea's growth performance: past and future, East-West Center Working Papers, Economics Series, No 123, November.
Ocampo, J.A., Vos, R. (2008): *Uneven Economic Development*, New York: United Nations.
OECD (2017): *OECD Observer*, November, URL: http://oecdobserver.org/news/archivestory.php/aid/2956/Korea_s_economy.html.
Perron, P. (1989): The great crash, the oil price shock, and the unit root hypothesis, in: *Econometrica*, 57(6), 1361–1401.
Porcile, G., Dutra, M., Meirelles, A.J. (2007): Technology gap, real wages and learning in a BoP-constrained growth model, in: *Journal of Post Keynesian Economics*, 29(3), 473–500.
Quandt, R.E. (1960): Tests of the hypothesis that a linear regression system obeys two separate regimes, in: *Journal of the American Statistical Association*, 55(290), 324–330.
Senhadji, A.S. (1998): Time series estimation of structural import demand equations: a cross-country analysis, in: *IMF Staff Papers*, 4, 236–268.
Senhadji, A.S., Montenegro, C.E. (1999): Time series analysis of export demand equations: a cross-country analysis, in: *IMF Staff Papers*, 46, 259–273.
Thirlwall, A.P. (1979): The balance of payments constraint as an explanation of international growth rate differences, in: *Banca Nazionale del Lavoro Quarterly Review*, 32(128), 45–53.
Thirlwall, A., Hussain, M. (1982): The balance of payments constraint, capital flows and growth rates differences between developing countries, in: *Oxford Economic Papers*, 10, 498–509.