How Sustainable Are Trade Balances in China, Japan, and Korea?

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Previous studies of trade flows have been based on bivariate analysis and residual-based panel cointegration techniques. This paper studies the long-run relationship between exports and imports in China, Japan, and Korea by applying the likelihood-based panel cointegration technique and multivariate analysis. The results indicate that there exists a long-run steady-state relationship between exports and imports. The policy implications of our findings are that trade flows do not lead to the violation of international budget constraints and, more importantly, there is no productivity gap between the domestic economy and the rest of the world. This implies a lack of permanent technological shocks to the domestic economy. The existence of cointegration between imports and exports in the sample countries also suggests that their macroeconomic policies are effective in bringing exports and imports into balance.

Keywords: Imports; Exports; Cointegration; China, Japan, Korea

JEL Classification: F30, F31

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I. Introduction

The sustainability of external imbalances is a matter of serious concern for governments and it is related to the issue of long-run solvency of a nation. All theories of the trade balance assert that sustained deficits or surpluses might signal underlying policy problems. The elasticity approach suggests the real exchange rate and its effect on the demand and supply of traded goods as the key factor, while the absorption approach suggests that total expenditure is the most critical factor for understanding and correcting external account imbalances. The dynamics of the external accounts are explained by agents' responses to transitory and permanent shocks, in particular shocks in productivity. In the case of favorable productivity or technological shocks, investment booms tend to boost output growth but worsen the external accounts (Glick and Rogoff 1995).

Empirical studies attempt to identify the sources of external imbalances by relating the external accounts to key macroeconomic variables. These are government spending, private consumption, income, the net financial balance of the household sector, non-financial and financial corporations, etc. (Sachs 1981; Ahmed 1987; Razin 1995; Elliott and Fatas 1996; Chen *et al.* 2013; Allen 2019). To reduce the size of external imbalances, fiscal, monetary, and commercial policies (tariff, subsidy, and exchange-rate policies) have been used in several countries (*e.g.*, Artis and Bayoumi 1989; Ariza and Bahmani-Oskooee 2018). Fiscal and monetary policies are used to alleviate domestic problems such as recession or inflation rather than external accounts problems while commercial policies such as currency devaluations or depreciations are used to deal with external problems or trade deficits.

Tu and Zhang (2019) investigate the US trade balance from 1948 to 2017. They report three findings as follows: (a) the deficit is closely related to the international monetary system started from 1973. Particularly, the persistent deficit since 1976 is a result of the US dollar as international money and reserve currency; (b) the size of the US trade deficit increases with the world trade and global economy; and (c) countries with large economy and rapid economic growth are the dominant source of the US deficit, like Japan in the 1980s-1990s and China in the new century.

It is difficult to evaluate the effectiveness of one policy in solving a problem over other policies. One way to examine the effectiveness of all policies together is to determine whether or not a country's exports and imports cointegrate in the long run (Husted 1992). If they do, then we can state that the combined effects of all macro policies are effective. Other studies suggest that there is evidence of external imbalance being the result of 'bad policy' (Summers 1988; Husted 1992; Irandoust and Sjöö 2000; Irandoust and Ericsson 2004). They conclude that outflows and inflows in the current account cointegrate unless there are policy distortions or permanent productivity shocks to the domestic economy.

Thus, in a well-functioning economy, external accounts deficits can be regarded as temporary phenomena that will be balanced by future surpluses. In a country with distorted markets there is no tendency towards the balance of payments equilibrium and thus sustained external imbalances reflect 'bad policy'. Examples of studies that have found evidence of cointegration between exports and imports include Bahmani-Oskooee (1994), who tested the hypothesis for Australia, Bahmani-Oskooee and Rhee (1997), for Korea, Arize and Bahmani Oskooee (2018), for 100 countries that supported nonlinear cointegration in most cases of bilateral trade, and, finally, Irandoust and Ericsson (2004), for industrial countries.

In this context, an empirical assessment of whether external imbalances present sustainability issues are crucial for policymakers. Previous studies suffer mainly from the fact that they are based on bivariate analysis and residual-based panel cointegration techniques. Research on the properties of panel cointegration tests indicates that the likelihood-based panel cointegration has the best size and power properties compared to other panel cointegration tests statistics (*e.g.*, Orsal, 2007). Thus, the purpose of this paper is to examine the behavior of trade flows in three East Asian countries (China, Japan, and Korea) over the period 1970-2020 by using the likelihood-based panel cointegration and multivariate analysis. The departures from earlier studies are in the asymptotic theory of likelihood-based panel cointegration allowing for multiple cointegrating vectors. Panel data series modeling addresses the likely dependence across data observations within the same group. In fact, the main difference between panel data models and time series models, is that panel data models allow for heterogeneity across groups and introduce individual-specific effects.

The main contribution of this study stems from its used methodology under assumptions of cross-sectional dependence and slope homogeneity restrictions. This is an extension of the Johansen (1995) multivariate maximum likelihood developed by Larsson and Lyhagen (1999) and Larsson *et al.* (2001). They have suggested a likelihood-based panel test of the cointegrating rank and a general likelihood-based framework for inference in panel-VAR models with cointegration restriction, allowing for multiple cointegrating vectors. By using this method, the assumption of a unique cointegrating vector and the problem of normalization is relaxed. This is not the case with the usual residual-based tests of cointegration (*e.g.*, Kao 1999; Pedroni 1999). To the best of the author's knowledge, this study is the first attempt to test the cointegration between exports and imports using panel cointegration techniques based on likelihood inference of cointegrating vectors and multivariate analysis.

Our results indicate that trade flows are cointegrated for all countries in the sample. The cointegration between exports and imports reveals that these countries are not in violation of their international budget constraint. Furthermore, macroeconomic policies have been effective in converging imports and exports into equilibrium in the long run. More importantly, there is no productivity gap between the domestic economy and the rest of the world, implying the lack of permanent technological shocks to the domestic economy.

The paper is organized as follows. Section 2 overviews some background discussions on trade balance in the sample countries, Section 3 outlines analytical framework, Section 4 discusses the data and methodology used. In section 5, we present and interpret the results from the cointegration tests. In section 6, we discuss some policy implications and present conclusions.

II. Some Stylized Facts about Trade Balance in China, Japan, and Korea

A. Korea.

Korea's level of involvement in international trade and investment has strengthened significantly over the last five decades.[1] Korea's rapid growth in trade stems directly from the government-sponsored export-

[1] The data for Korea comes from the national atlas of Korea 2019.

oriented economic development strategies that were carried out a series of five-year plans that began in 1962. For example, trading volumes have increased significantly from around USD 100 million in 1964 to USD 1.14 trillion (export: USD 605.5 billion, import: USD 535.0 billion) in 2018. This implies that Korea is now ranked 9th in the world by trading volume. Along with the significant growth of trade, the Korean economy is more and more dependent on international trade. A rapid increase in trade dependence starts from the early 2000s, accounting for 62.5% in 2004, 89.8% in 2011, and 70.4% in 2018.

Since the early 2000s, there has also been significant growth in exports. For example, exports have increased from USD 150.4 billion in 2001 to USD 605.5 billion in 2018. This makes the trade balance grow from USD 9.3 billion in 2001 to USD 70.5 billion in 2018. The main goods exported by Korea between 2008 and 2018 were semiconductors, automobiles, oil products, flat-screen displays, and sensors. Korea has also experienced remarkable growth in trade despite a downturn during the world economic crisis in 2008 and declining oil prices in 2009. Rebounding oil prices and the importation of equipment have resulted in rising imports once again. Crude petroleum is the most significant imported good, accounting for over 30% of total imports.

The main export partners for Korea are China, the US, Japan, Singapore, Vietnam, and the European Union (EU). Exports to China have increased from USD 3.8 billion (6.1% of total exports) in 1989 to USD 208.1 billion (34.3% of total exports) in 2018. Since the late 1990s, exports to Vietnam have also increased rapidly because of the rapid growth of Korean foreign direct investments in Vietnam. Exports to advanced economies such as the US, Japan, Singapore, and the EU have decreased. Along with this pattern of exports, imports have shown a similar trend. Korea's major import partners are China, Japan, the United States, and Saudi Arabia, with China being the top importer of Korean goods since 2007.

In the 1980s, the trade balance indicated deficits that continued until the mid-1990s. Beginning in the late 1990s, Korea experienced rapid increases in trade surplus, with the largest surplus of USD 95 billion in 2017, and the lowest deficit of USD 20.6 billion in 1996. Since the mid-1990s, Korea has shown mostly surpluses in large part due to the dramatic growth in exports. For example, exports had increased significantly from USD 132 billion in 1998 to USD 605 billion in 2018. Since 2003, the largest surpluses stem from trading with China. For example, a record surplus USD 99.6 billion was due to trading with China in 2018, accounting for 142.3% of total trade surplus, whereas the trade deficit with Japan increased from USD 2.8 billion in 1980 to USD 36.1 billion in 2010. Since 2011, after diversifying import sources, the trade deficit with Japan has decreased.

B. Japan.

Export trends have been an important factor during Japan's present economic adjustment period, and the structures of Japanese exports, together with the imports, have been changing substantially in recent years.[2] The changes in the country's export and import structures during the 1990s can be characterized by the following three key features: (1) the weight of IT-related goods has been rising in both real exports and imports; (2) real imports of consumer goods from East Asia have been increasing; and (3) the US remains Japan's largest trading partner as a single country.

Between 1980 and 2010 Japan had been recording trade surpluses every year due to rising exports. However, the trade balance turned to a deficit in 2011, as the Fukushima nuclear disaster caused the country to increase its purchases of fossil fuels and gas in the wake of a weaker yen. The surplus was back in 2016 and 2017, but in 2018 and 2019 Japan's trade balance turned to deficit amid persistent trade tensions between the US, and China, and sluggish global growth. In 2019, Japan reported the biggest trade surpluses with the US, Hong Kong, South Korea, Taiwan, Singapore, and the Netherlands. The biggest trade deficits were recorded with China, Australia, Saudi Arabia, the UAE, and Qatar.

Japan reported a trade deficit of JPY 668.26 billion in February 2022, compared with market consensus of a gap of JPY 112.6 billion and a surplus of JPY 175.93 billion in the same month a year earlier. The latest figure marked the seventh straight month of trade shortfall, as export grew by 19.1% year over the year to JPY 7,190.1 billion while imports jumped 34.0% to JPY 7,858.3 billion. Considering the first two month of the year, Japan recorded a trade deficit of JPY 2,861.8 billion, increasing from a shortfall of JPY 151.2 in the corresponding period of 2021. In 2021, the trade gap was at JPY 1,472.16 billion as exports rose

[2] The data obtains from the Ministry of Finance in Japan (2022)

21.5 percent and imports increased at a faster 24.3 percent compared with a surplus of JPY 388.29 billion in 2020.

C. China.

China is the largest nation in the international trade of goods since 2009 and the most important country in the world economy (Jin *et al.* 2016). China is also the second-largest source and destination of FDI (Jin *et al.* 2016). The top three world trading countries are China, the US, and Germany. The EU was the largest exporter of manufactured goods in 2017 (Yüksel *et al.* 2019). However, now China is the largest exporter in the world, based on 2020 data (Bekkers *et al.* 2021). In 2015, China began a program entitled "Made in China 2025", which includes a ten-year plan to strengthen the Chinese position in the manufacturing of high-value-added products (Bencivelli and Tonelli 2020). This program struggles to integrate new technologies that are the result of the fourth industrial revolution into the Chinese economy. China is, nowadays, a major trade partner for many countries.

The European Union (EU) is one of the important trade partners of China. In 2013, the Chinese government started its Belt and Road Initiative (BRI), and, thus, the trading volume between China and European countries rose by 15.2% in 2017 (Bekkers et al. 2021). China is one of the three most important economic centers of the world, together with the EU and the US. China is now the world's second-largest economy and has experienced uninterrupted trade surpluses since 1993. It has become the world's biggest trading nation since 2013. China's external position is very stable, and it has a positive trading balance. Its current account has displayed a surplus in every year since 1994 (The World Bank, 2021).

Due to its enormous trade surplus over the past few years, China has become the world's largest exporter and ranks second among the world's largest importers. Despite its strict policies, the country is fairly open to foreign trade, which represented around 32% of its GDP in 2020 (The World Bank, 2021). China's main exports are electrical and electronic equipment, machinery, nuclear reactors, boilers, furniture, lighting signs, prefabricated buildings, plastics, optical, photo, technical, medical apparatus, vehicles other than railway, tramway, other made textile articles, sets, worn clothing. On the other hand, the country mainly imports electrical and electronic equipment, Mineral fuels, oils, distillation products, machinery, nuclear reactors, boilers, iron ores slag and ash, optical, photo, technical, medical apparatus, vehicles other than railway, tramway. The International Monetary Fund (IMF, 2021) is forecasting a rebound of 5.7% in the volume of exports of goods and services of this country in 2022, after an increase of 4% in 2020; and an increase of only 3.2% in its imports in 2022 after a jump of 10.9% in 2021 and 0% in 2020 (IMF Country Report, 2021).

The country's main partners are the US, Japan, South Korea, Vietnam, Australia, and Germany. Tensions in the US-China relationship have created business uncertainties in 2020 and 2021, given that the US is the country's main trade partner (China's 2020 trade surplus with the US was USD 255.5 billion after an all-time record of 323.3 billion in 2018)[3]. Similar tensions were at play with Australia although with fewer consequences for China. However, the Chinese government is adopting more relaxed economic policies to relieve mounting risks to future growth. On the 15th of November 2020, China has signed the Regional Comprehensive Economic Partnership (RCEP) with 14 other Indo-Pacific countries. This free trade agreement is the largest trade deal in history, covering 30 percent of the global economy.

Trade has become an increasingly important part of China's overall economy, and it has been a significant tool used for economic modernization. As reported by WTO in 2021, exports of goods in 2020 were USD 2,590.2 billion and imports USD 2,057.2 billion, while exports and imports of services in 2020 reached USD 278 billion and USD 377.5 billion respectively. China reported an overall 5% increase in exports and an 8% decrease in imports for 2020. According to the World Bank data (2021), China's trade surplus for goods was USD 535.37 billion in 2020, an increase from USD 425.2 billion in 2019. The overall trade balance (including services) was USD 369.67 billion in 2020, from 131.84 billion the previous year.

III. Theoretical Framework

An external imbalance is seen as sustainable when it does not violate the nation's solvency constraint; and a nation is solvent if the present-value budget constraint, i.e., its intertemporal budget constraint holds.

[3] According to IMF (2021), WTO (2021), and Comtrade (2021).

One way to analyze external imbalances applies the intertemporal approach to the current account (Sachs 1981; Obstfeld and Rogoff 1995; Razin 1995; Iandoust and Sjöö 2000; Raybaudi *et al.* 2004; Chen 2011, 2014; Afonso *et al.* 2020). According to this approach, the current account equals the difference between savings and investment, and, because savings and investment decisions are subject to intertemporal factors (such as life-cycle features, the expected returns of investment projects, etc) this implies that the current account is necessarily an intertemporal phenomenon. Thus, a trade balance or current account balance would be sustainable if the series for exports and imports are found to be cointegrated (Trehan and Walsh 1991; Hakkio and Rush 1991; Wickens and Uctum 1993; Wu *et al.*,1996; Bahmani-Oskooee and Rhee 1997; Apergis *et al.* 2000; Irandoust and Sjöö 2000; Holmes 2006; Afonso *et al.* 2020).

Hence, to assess the sustainability of external imbalances, we use the present value borrowing constraint following Trehan and Walsh (1991) and Hakkio and Rush (1991). The budget constraint in t is given by:

$$C_t + I_t + G_t = Y_t + (1 + r_t)F_{t-1}\,, \tag{1}$$

where C, I G, Y, r, and F are private consumption, private investment, government spending, GDP, interest rate, and net foreign assets, respectively. Furthermore, GDP in an open economy is:

$$Y_t = C_t + I_t + G_t + EXP_t - IMP_t\,, \tag{2}$$

where EXP and IMP are exports of goods and services and imports of goods and services, respectively. Defining net exports as $NEXP_t = EXP_t - IMP_t$, from (1) and (2) we obtain:

$$F_t = (1 + r_t)F_{t-1} + Y_t - C_t - I_t - G_t\,, \tag{3}$$

$$F_t = (1 + r_t)F_{t-1} + NEXP_t\,, \tag{4}$$

Solving (4) recursively for subsequent periods, assuming that the interest rate is stationary, with mean r, we can get the present value borrowing constraint:

$$F_{t-1} = -\sum_{s=0}^{\infty} \frac{1}{(1+r)^{s+1}} (NEXP)_{t+s} + \lim_{s\to\infty} \frac{F_{t+s}}{(1+r)^{s+1}}\,, \tag{5}$$

A sustainable external position should make sure that the present value of the stock of net foreign assets goes to zero in infinity. Thus, the economy will have to attain future net exports whose present value adds up to the current value of net foreign assets. Recalling equation (5), we present two complementary definitions of sustainability for empirical testing:

a) Current net foreign assets must equal the sum of future net exports:

$$F_{t-1} = -\sum_{s=0}^{\infty} \frac{1}{(1+r)^{s+1}} (EXP_{t+s} - IMP_{t+s}), \tag{6}$$

b) Present value of current net foreign assets is zero in infinity:

$$\lim_{s\to\infty} \frac{F_{t+s}}{(1+r)^{s+1}} = 0, \tag{7}$$

With no Ponzi game condition, it is possible to test for sustainability through cointegration tests. The implicit hypothesis about the real interest rate, with mean r, is also stationarity. When assessing current account sustainability through cointegration tests, the intertemporal constraint by taking first differences is:

$$IMP_t - EXP_t = \sum_{s=0}^{\infty} \frac{1}{(1+r)^{s-1}} (\Delta EXP_{t+s} - \Delta IMP_{t+s}) + \lim_{s\to\infty} \frac{F_{t+s}}{(1+r)^{s+1}}, \tag{8}$$

and EMP_t and EXP_t must be cointegrated variables of order one for their first differences to be stationary. Therefore, we can test the cointegration regression: $EMP_t = a + bIMP_t + e_t$. This is the international budget constraint for analyzing the dynamics of exports and imports. We include trade openness since it is beneficial in various ways: (i) better utilization of countries' resources due to better production conditions thus achieving a comparative advantage, (ii) exploiting the economies of scale that will raise the level of incomes and efficiency of resource allocation, and (iii) the improvement of the total factor productivity through learning by doing and the accumulation of human capital (WTO, 2003).

$$EXP_t = a + bIMP_t + \gamma TOP_t + e_t, \tag{9}$$

Here *TOPt* shows trade openness as a control variable. The null hypothesis states that the economy satisfies its international budget constraint. Thus, it is expected that $b = 1$, and e_t is a stationary process that includes all short-term dynamics. In other words, if EXP_t and IMP_t are nonstationary and trending, then under the null hypothesis they are co-trending (cointegrating) with cointegrating vector $b = (1, -1)$. Furthermore, if *EXP* and *IMP* are non-stationary variables in levels, the condition $0 < b < 1$ is a sufficient condition for the intertemporal constraint to be satisfied. That is, any positive but smaller than one value of the coefficient b assures that trade balance worsens, but remains bounded as a ratio to GDP and thus remains sustainable and if b exceeds 1, the trade balance improves and ultimately turns into a surplus. This could be regarded as sustainable from the view of the panel of countries, even if potentially imposing a risk of unsustainable trade position for the rest of the world.

An important question here concerns the policy implications of cointegration or lack of cointegration and convergence between imports and exports. The theory suggests that cointegration is to be expected under the maintained hypothesis that the economy is working properly and that breaking international budget constraints leads to a lack of cointegration.

An important reason why the time series paths of imports and exports might not converge, and cointegrate, is technological shocks or the productivity gap hypothesis. Thus, finding cointegration for the variables rejects the assumption of a permanent technological or productivity gap between the economy and the rest of the world (Irandoust and Sjöö 2000; Irandoust and Erisson 2004). In other words, if trade flows are not cointegrating, this could be regarded as the outcome of permanent technological shocks to the domestic economy.

IV. Data and Methodology

The data used in this study are exports and imports of goods and services as a percentage of GDP, and trade openness (the sum of exports and imports of goods and services measured as a share of GDP). The sample consists of three major East Asian countries (China, Japan, and Korea) and covers the period 1970-2020. These countries represent the export-oriented policies in East Asia. The choice of the time period and sample countries are dictated by data availability. The variables are extracted from the World Bank database. Figures A1-A3, Appendix A, illustrate the variables. Descriptive statistics for the variables under analysis is also reported in Table A1, Appendix A.

The process is estimated by implementing a likelihood-based panel framework suggested by Larsson and Lyhagen (1999) and Larsson et al. (2001). By using this method, the assumption of a unique cointegrating vector and the problem of normalization is relaxed which is not the case with the usual residual-based tests of the cointegration approach. Let *LR* denote the cross-section-specific likelihood-ratio (trace) statistic of the hypothesis that there are at most *r* cointegrating vectors in the system. The standardized *LR*-bar statistic is given by:

$$Y_{\overline{LR}} = \frac{\sqrt{N(\overline{LR} - \mu)}}{\sqrt{V}}, \tag{10}$$

where $\overline{LR}$ is the average of the *N* cross-section *LR* statistics, μ is the mean, and v is the variance of the asymptotic trace statistic. Asymptotic values of μ and v (with and without constant and trend) can be obtained from stochastic simulations as described in Johansen (1995).[4]

There are two steps that should be followed before using any cointegration tests: testing the panel for cross-sectional dependence and testing for cross-country heterogeneity. The first issue implies the transmission of shocks from one variable to another. A significant body of the panel-data literature concludes that panel-data models are likely to show substantial cross-sectional dependence in the errors, which may due to the presence of common shocks and unobserved components that ultimately become part of the error term, spatial dependence, and idiosyncratic pairwise dependence in the disturbances with no particular pattern of common components or spatial dependence. One reason for this may be that during the last few decades we have witnessed an ever-increasing economic and financial integration of our sample countries and their financial entities, which implies strong interdependencies between cross-sectional units. In other words, all countries in the sample are influenced by globalization and have common economic characteristics.

The second issue shows that a significant economic connection in one

[4] This methodology is also used in Irandoust and Ericsson (2005).

country is not necessarily replicated by the others. A set of three tests is constructed to check the cross-sectional dependence assumption: the Breusch and Pagan (1980) cross-sectional dependence (CD_{BP}) test, the Pesaran (2004) cross-sectional dependence (CD_P) test, and the Pesaran et al. (2008) bias-adjusted LM test (LM_{adj}). Regarding the country-specific heterogeneity assumption, the slope homogeneity tests ($\bar{\Delta}$ and $\bar{\Delta}_{adj}$) of Pesaran and Yamagata (2008) are used (Appendix B provides more information about these tests).

The traditional panel unit root tests do not take into account the cross-sectional dependence of the contemporaneous error terms. Failing to take into account cross-sectional dependence may lead to misleading results. Thus, to eliminate this problem, we use the cross-sectionally augmented panel unit root test (CIPS) which allows for parameter heterogeneity and serial correlation between the cross-sections (Pesaran, 2007).[5] Finally, we check diagnostic tests, i.e., if the residuals are normally distributed and there is no autocorrelation. The normality test stems from a multivariate extension of the Bowman-Shenton test developed by Doornik and Hansen (1994) and the test for autocorrelation is the Ljung-Box test statistics.

V. Estimation Results

Before testing for the cointegration analysis, we first examine cross-sectional dependence and slope homogeneity assumptions. Table 1 indicates the results of cross-sectional dependence tests (CD_{BP}, CD_p, and LM_{adj}) and slope homogeneity tests ($\bar{\Delta}$ and $\bar{\Delta}_{adj}$). The first set of tests, for cross-sectional dependence, clearly shows that the null hypothesis of no cross-sectional dependence is rejected for all significance levels. This implies that there is a cross-sectional dependence in the case of our sample countries. Any shock in one country is transmitted to others. The second part of the Table shows that the null hypothesis of slope homogeneity is rejected for both tests and all significance levels. This means that the economic relationship in one country is not replicated by the others. As there are both cross-

[5] The CIPS panel unit root test is based on the Im, Pesaran, and Shin (2001) test (IPS), which controls for cross-sectional heterogeneity in the estimated coefficients. The CIPS is the average of the individual country's cross-sectionally augmented ADF (CADF) statistics.

TABLE 1
CROSS-SECTIONAL DEPENDENCE AND SLOPE HOMOGENEITY TESTS

Method	Test statistic
Cross-sectional dependence test	
CD_{BP}	275.389*** (0.000)
CD_{P}	45.261*** (0.000)
LM_{adj}	52.053*** (0.000)
Slope homogeneity test	
$\bar{\Delta}$ test	18.470*** (0.000)
$\bar{\Delta}_{adj}$ test	14.563*** (0.000)

Notes:
1. *** indicate significance for 0.01 levels. The numbers within parentheses show *p*-values.
2. CD_{BP} test, CD_{P} test, and LM_{adj} test show the cross-sectional dependence tests of Breusch and Pagan (1980), Pesaran (2004), and Pesaran et al. (2008), respectively.
3. $\bar{\Delta}$ and $\bar{\Delta}_{adj}$ tests show the slope homogeneity tests proposed by Pesaran and Yamagata (2008).

TABLE 2
PANEL UNIT ROOT TEST

Variable	CIPS statistic
EXP	-1.983
IMP	-1.879
TOP	-1.752

Note: Critical values for the CIPS test are -2.14 (1%), -2.06 (5%), and -2.01 (10%), Pesaran (2007).

sectional dependence and slope heterogeneity, the cointegration tests can be applied.

Test for panel non-stationarity among the variables should be done before applying the cointegration test. The results of the cross-sectionally augmented IPS test are reported in Table 2. After inspection of the data, we only include a constant term (mainly due to measurement errors). When applying the Schwartz criterion to decide the optimal lag length, the common lag length was set to four. The table shows that all variables support the null hypothesis of panel non-

TABLE 3
TEST FOR THE COINTEGRATING RANK

H_o	ACV^a	BCV^b	$-2logQ_T$
$R = 0$	376.17	537.36	505.17
$R \leq 1$	203.08	395.46	302.93
$R \leq 2$	93.82	221.22	110.49

Notes: a. The asymptotic critical values at 5% significance level.
b. Bartlett corrected critical values at 5% significance level.

stationarity. Furthermore, note that our approach does not exclude the possibility of including stationary variables.[6]

The likelihood ratio tests are reported in Table 3. The Bartlett corrected critical values are obtained by using the estimated model as data generating process when calculating the sample mean. Using the Bartlett corrected critical values, the test rejects the null of 0 cointegrating ranks but accepts the null of 1 cointegrating vector. Since the panel cointegration tests show that the common cointegrating rank is one, thus, it is interesting to estimate the cointegrated vectors. The estimated cointegrating vectors, normalized for *IMP,* are presented in Table 4.

Table 4 shows that *EXP* is positively associated with *IMP* and *TOP* for all countries in the sample. This implies that there is a long-run relationship between imports and exports in these countries. However, the magnitude of parameters varies from country to country. In Table 5, the results from the diagnostic tests are given. It seems that there is no

TABLE 4
COINTEGRATING VECTORS NORMALIZED ON *IMP*

	China	Japan	Korea
IMP	-1.000	-1.000	-1.000
EXP	0.903	0.956	0.838
TOP	0.567	0.429	0.605

Notes: a. The asymptotic critical values at 5% significance level.
b. Bartlett corrected critical values at 5% significance level.

[6] The effect of one stationary variable in the system is that the rank order increases with one.

Table 5

Diagnostic tests[a]

Normality[b]	Autocorrelation[c]
0.077	0.653

Notes:

a. The table reports the p-values.

b. The test is a multivariate extension of the Bowman–Shenton test developed by Doornik and Hansen (1994).

c. This is the Ljung–Box test statistics for autocorrelation.

problem with autocorrelation since the p-value is very high but the null hypothesis of normality is rejected and this problem could not be solved by using more lags.

VI. Conclusions and Policy Implications

The sustainability of external imbalances is a matter of concern for policymakers and it is related to the issue of the long-run solvency of a nation. This paper aimed to examine the long-run convergence of exports and imports in three East Asian countries (China, Japan, and Korea) over the period 1970-2020. Economic theory suggests that non-stationary trade flows in the trade balance will cointegrate in the long run. This is not in line with the theory that there are policy distortions or permanent technological shocks to the domestic economy. Thus, a natural tendency towards cointegration and convergence between exports and imports are expected in a well-functioning economy where there are neither permanent productivity shocks nor policy distortions.

In this context, an empirical assessment of whether external imbalances present sustainability issues are crucial for governments. Previous studies of trade flows have been subject to bivariate analysis and residual-based panel cointegration techniques. Several simulation studies indicate that the likelihood-based panel cointegration has the best size and power properties among other panel cointegration test statistics. Thus, based on the likelihood-based panel cointegration technique and multivariate analysis, we found cointegration and convergence between exports and imports for all countries in the sample. Our findings support the view that there is a stable underlying trend towards convergence between exports and imports in China, Japan, and Korea.

All theories of the trade balance claim that sustained deficits or surpluses might signal underlying policy problems. The elasticity approach indicates the real exchange rate and its effect on the demand and supply of traded goods as the key factor, while the absorption approach shows that total expenditure is the most critical factor for understanding and correcting external account imbalances. The dynamics of the external accounts are explained by agents' responses to transitory and permanent productivity shocks.[7] In the case of favorable productivity shocks, investment booms tend to boost output growth but worsen the external accounts (Glick and Rogoff 1995). What does cointegration or lack of cointegration between imports and exports in the trade balance tell us about the state of the economy? The theory claims that cointegration is to be expected under the maintained hypothesis that the economy is working properly and that breaking international budget constraints leads to a lack of cointegration (*e.g.*, Trehan and Walsh 1991; Hakkio and Rush 1991; Husted 1992; Bahmani-Oskooee 1997; Irandoust and Sjöö 2000; Herzer and Nowak-Lehman 2006; Ariza and Bahmani-Oskooee 2018; Afonso *et al.* 2020). This implies that sustained external imbalances are the outcome of distorted markets or 'bad policy'. For understanding the cointegration results based on the international budget constraints, the conclusion is that lack of cointegration reveals fundamental policy problems unless there exist permanent productivity shocks that create a non-stationary import-export relationship. In a well-functioning economy without permanent one-sided productivity shocks, cointegration is to be expected. What are the policy implications of our findings? First, our findings of cointegration indicate that China, Korea, and Japan, are not in violation of their international budget constraint. Second, macroeconomic policies (such as fiscal, monetary, and commercial policies) have been effective in bringing imports and exports to converge toward equilibrium in the long run.

This study has a few limitations. These stem from the fact that we used a linear without considering structural breaks since the likelihood panel cointegration model does not allow for structural shifts. Future studies should consider nonlinear methodology with structural breaks.

[7] The dynamic analysis of trade balance has also been studies by Kim (2011) and Kim (2012).

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Appendix A

Table A1
Descriptive statistics of the variables, 1970-2020, n = 51 for each individual country

Country	Mean	S.D.	Skewness	Kurtosis
Korea				
EXP	32.1040	9.8006	0.3776	2.7766
IMP	32.0625	7.2986	1.0474	3.6972
TOP	64.1666	16.5696	0.7427	3.2775
China				
EXP	16.4614	9.2786	0.2531	2.2360
IMP	14.7901	7.5514	0.0045	2.0505
TOP	31.2516	16.7379	0.1355	2.1285
Japan				
EXP	12.6519	2.8116	0.4573	1.9566
IMP	11.7502	3.5783	0.5103	2.1443
TOP	24.4091	6.2989	0.4775	2.0022

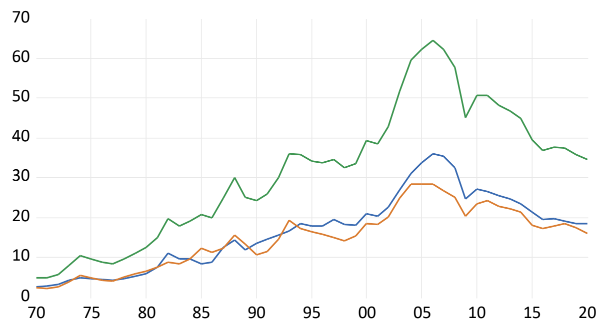

Fig. 1: Exports, imports, and trade openness in China (1970-2020).

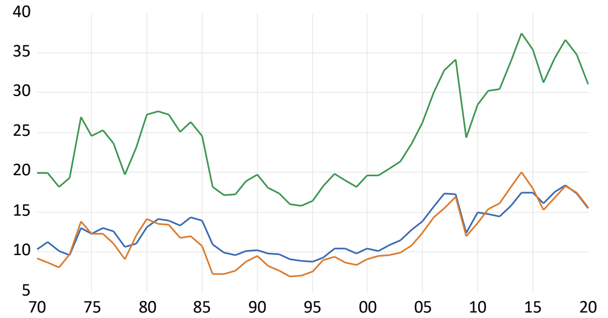

Fig. 2: Exports, imports, and trade openness in Japan (1970-2020).

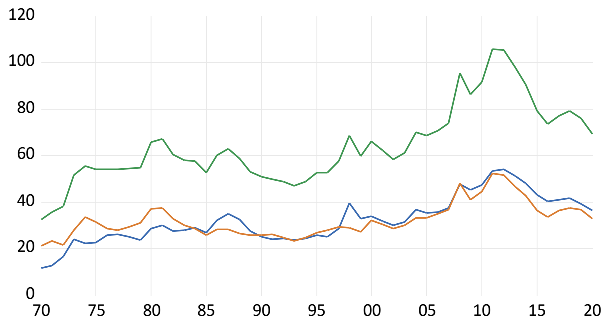

Fig. 3: Exports, imports, and trade openness in Korea (1970-2020).

Figures A1-A3: Exports, imports, and trade openness in the sample countries (1970-2020)

Appendix B:

Cross-sectional dependence tests

Breusch and Pagan's (1980) LM test has been used in many empirical studies to test cross-sectional dependency. LM statistics can be calculated using the following panel model:

$$y_{it} = \alpha_i + \beta_{it}^0 x_{it} + \mu_{it}, \qquad (i = 1, 2, \cdots, N, \quad t = 1, 2, \cdots, T) \tag{1A}$$

where i is the cross-section dimension, t is the time dimension, x_{it} is $k \times 1$ vector of explanatory variables while α_i and β_i are the individual intercepts and slope coefficients, respectively, that are allowed to differ across states. In the LM test, the null hypothesis of no cross-sectional dependence $H0 : Cov(\mu_{it}, \mu_{jt}) = 0$ for all t and $i \neq j$ is tested against the alternative hypothesis of cross-sectional dependence $H1 : Cov(\mu_{it}, \mu_{jt}) \neq 0$ for at least one pair of $i \neq j$. For testing the null hypothesis, Breusch and Pagan (1980) developed the following test:

$$CD_{BP} = T \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \hat{\rho}_{ij}^2, \tag{2A}$$

where $\hat{\rho}_{ij}^2$ is the estimated correlation coefficient among the residuals obtained from individual OLS estimation of Eq. (1A). Under the null hypothesis, the LM statistic has an asymptotic chi-square distribution with $N(N-1)/2$ degrees of freedom. Pesaran (2004) proposes that the LM test is only valid when N is relatively small and T is sufficiently large. To overcoming this problem, Pesaran (2004) introduces the following LM statistic for the cross-section dependency test:

$$CD_p = \sqrt{\frac{1}{N(N-1)}} \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \left(T \hat{\rho}_{ij}^2 - 1 \right). \tag{3A}$$

However, Pesaran et al. (2008) state that while the population average pair-wise correlations are zero, the CD test will have less power. Therefore, they proposed a bias-adjusted test that is a modified version of the LM test by using the exact mean and variance of the LM statistic. The bias-adjusted LM statistic is calculated as follows:

$$LM_{adj} = \sqrt{\frac{2T}{N(N-1)}} \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \hat{\rho}_{ij}^2 \frac{(T-k)\hat{\rho}_{ij}^2 - u_{Tij}}{\sqrt{v_{Tij}^2}}, \tag{4A}$$

where u_{Tij} and v_{Tij}^2 are the exact mean and variance of $(T-k)\hat{\rho}_{ij}^2$, which are provided in Pesaran *et al.* (2008). Under the null hypothesis of no cross-sectional dependence with $T \rightarrow \infty$ first followed by $N \rightarrow \infty$, the results of this test follow an asymptotic standard normal distribution.

Slope homogeneity tests

In order to relax the assumption of homoscedasticity in the F-test, Swamy (1970) developed the slope homogeneity test that examines the dispersion of individual slope estimates from a suitable pooled estimator. Pesaran and Yamagata (2008) state that both the F-test and Swamy's test require panel data models where N is relatively small compared to T. To overcome this problem, they proposed a standardized version of Swamy's test (the so-called $\Delta^{\tilde{}}$ test) for testing slope homogeneity in large panels. The $\Delta^{\tilde{}}$ test is valid when $(N, T) \rightarrow \infty$ without any restrictions on the relative expansion rates of N and T when the error terms are normally distributed. Pesaran and Yamagata (2008) then develop the following standardized dispersion statistic:

$$\bar{\Delta} = \sqrt{N}\left(\frac{N^{-1}S^{\approx} - k}{\sqrt{2k}}\right), \tag{5A}$$

where $S^{\approx}$ is Swamy's statistic. Under the null hypothesis with the condition of $(N, T) \rightarrow \infty$ and when the error terms are normally distributed, the $\Delta^{\tilde{}}$ test has an asymptotic standard normal distribution. The small sample properties of the $\Delta^{\tilde{}}$ test can be improved when there are normally distributed errors by using the following mean and variance bias adjusted version:

$$\bar{\Delta}_{adj} = \sqrt{N}\left(\frac{N^{-1}S^{\approx} - E(z_{it}^{\approx})}{\sqrt{\mathrm{var}(z_{it}^{\approx})}}\right), \tag{6A}$$

where $E(z_{it}^{\approx}) = k,\ \mathrm{var}(z_{it}^{\approx}) = 2k\,\frac{(T-k-1)}{(T+1)}$.

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