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Which Country is the Most Sustainable Trade Partner for Latin America –Korea, Japan, or China?*

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ABSTRACT

Which Country is the Most Sustainable Trade for Latin America –Korea, Japan, or China?: The goal of this study is to build an index that reflects how sustainable trade relationships between East Asia and Latin America have changed over time, to evaluate the current state of trade relations, and identify challenges to be addressed to guarantee the sustainability of trade between these regions. First, we select nine variables that correspond to key economic, social, and

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environmental pillars. Second, we convert the variables into the Trade Relations Sustainability Index (TRSI). The main findings are as follows: First, the average value of the TRSI between East Asia and Latin America follows a U-shaped pattern over time. Second, China has been the most sustainable trading partner for Latin America over the period studied. Third, the variables that most influence the TRSI are the export diversification index, share of polluting product exports, and trade costs. Lastly, Argentina has been the most sustainable partner for East Asia.

Keywords: Latin America; East Asia; Sustainability; Trade; Trade Relations Sustainability Index (TRSI), Principal Component Analysis / America Latina; Este de Asia; Sustentabilidad; Comercio; Índice de Sustentabilidad de las Relaciones Comerciales; Análisis de Componentes Principlaes

INTRODUCTION

Before the 1990s there was little trade between Asia and Latin America, as transportation connections were poor, trade barriers were high, and few cultural, diplomatic, and business ties existed between the two regions (Wignaraja 2015). However, the landscape has dramatically changed since that time. Total trade volume between the two regions grew an average of 17% per year between 2000 and 2013. As a result, Asia is now the second largest export destination for Latin America after the United States, based on 2018-2019 trade volumes. In addition, according to Berry and Inoue (2015), the Asian region is Latin America's fastest growing trading partner. China has played a particularly significant role in closing the previous gap in trade between these regions. Since the 2000s, when the importance of the Global Value Chain (GVC) emerged in the global economy, China has imported significant quantities of primary commodities from Latin America. Therefore, it should not be difficult to determine whether Asian countries are among the most important trading partners for Latin America. However, as seen in the trade conflict between the United States and China in 2019, the existence of a substantial trade dependence does not guarantee sustainability. Trade imbalances, and social and environmental issues arising from trade can present barriers to achieving sustainable trade relations between countries, and are being increasingly emphasized at this time when protectionism is reemerging in many countries. Thus, it is not easy to determine whether Asian countries are Latin America's best-trading partners in terms of sustainable trade.

Looking closely at trade relationships between countries in East Asia and Latin America shows that both regions have generally benefited, and have promoted their mutual interests. However, the analysis shows trade is limited to a small number of economic sectors and concentrated in a few goods. In addition, the importance of one region versus another differs. While East Asia is one of the most important trading partners in Latin America, the reverse is not true. East Asia's exports to Latin America show more promising signs of growth than Latin America's exports to East Asia. Previous studies expressed concerns that Latin America could become entrenched in a widening trade deficit with Asia (Berry and Inoue 2015; Hamanaka and Tafgar 2013; Kuwayama et al. 2000). Also, trade flow between the two regions remains inter-industrial. Since the structure of exports has become less diversified and exports of commodities for manufacturing goods from Latin America has intensified, there is a non-trivial risk of reverting toward re-primarization (Berry and Inoue 2015; Kahn et al. 2012). In summary, trade between East Asia and Latin America has greatly increased in absolute terms, but there are questions about whether this relationship has been moving in a sustainable direction.

In this study, we build an index, called the Trade Relations Sustainability Index (TRSI),[1] which demonstrates how a sustainable trade relationship between East Asia and Latin America has changed over time. Using this index, we evaluate current trade relations and present challenges to be addressed to support sustainable trade between these regions and in the bilateral relationships of the countries involved. The main contributions of this study are as follows. First, it derives and estimates the TRSI for East Asia and Latin America. To date, no studies have offered an index related to sustainable trade between these regions. Second, we determine which of three countries, Korea, China, and Japan, has been the best partner for Latin America from the perspective of sustainable trade. Third, we document

1 Please refer to the Data Section for a more detailed definition of TRSI.

dynamic changes in the TRSI and suggest which of the pillars that comprise the TRSI should be improved for sustainability. Lastly, we apply Principal Component Analysis (PCA) to reduce multidimensional variables into a one-dimensional problem.

The remainder of this study is organized as follows. Section II reviews previous studies related to sustainable trade. Section III identifies nine factors constituting three pillars of the TRSI and explains the reasons for selecting these variables and countries. Section IV discusses the methodology used to build the TRSI. Section V documents the empirical results, providing a comparative analysis. Finally, Section VI highlights the research results and the significance of this study, presenting the limitations of the study and areas for future research.

LITERATURE REVIEW

Interest in the term 'sustainable development' has been growing since the 1970s. According to Wu and Wu (2012), the term appeared during that period as a solution to the conflicts between development and conservation. For the first time, World Commission on Environmental and Development (1987) proposed a definition of 'sustainable development' as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" in 1987. Then, as a result of the Earth Summit in 1992, 'sustainable development' was shown to consist of the three interdependent aspects, namely economic, social, and environmental dimensions (United Nations 2007). According to World Trade Organization (2012), international trade is a fundamental component of sustainable development. Trade contributes to an efficient allocation of resources and helps countries to access goods, services, and technologies. The Economist Intelligence Unit (2018) defined 'sustainable trade' as "participating in the international trading system in a manner that supports the long-term domestic and global goals of economic growth, environmental protection, and strengthening social capital."

There is a growing discussion of sustainable development in trade, although there has been little research on the topic conducted to date. George and

Kirkpatrick (2004) developed a new methodology called sustainability impact assessment (SIA) to evaluate the likely impact of trade policy reform on sustainable development. It is meaningful that it considered three pillars of sustainable development for policy assessment. It focuses more on trade policy and its' possible impact on sustainable development than the sustainability of existing trade relationships. The Economist Intelligence Unit (2018) analyzed the sustainable trade participation of 19 Asian countries and the United States by constructing a sustainable trade index. The index consisted of three pillars, economic, societal, and environmental. This index was significant in that it measured not only economic factors but also social and environmental factors that are essential for sustainable trade. However, it only focused on whether a country is participating in international trade in a sustainable manner and did not expand to analyze the sustainability in the bilateral trade relationship. DITC, UNCTAD (2005) conducted research on the interaction between trade and human development in 110 developing and developed countries around the world. This index consisted of 11 components, including economic development, social development, and environmental sustainability, and recognized that trade, as an engine of development, must lead to steady improvements in societal and environmental conditions as well as economic growth. But, as in The Economist Intelligence Unit (2018), DITC, UNCTAD (2005) only studied the trade policies for each country without considering bilateral trade relationships.

Even though the importance of trade relations between East Asia and Latin America has been steadily increasing over time, no studies have focused on constructing a sustainable trade index between the two regions.

DATA

Structure of TRSI

This study focuses on three East Asian countries, China, Japan, and the Republic of Korea, and six Latin American countries, Argentina, Brazil, Chile, Mexico, Peru, and Colombia, representing their respective regions. Trade relationships between the two regions have been concentrated in a few countries; the above three Asian countries accounted for nearly 80% of East

Asia's total trade with Latin America in the 2010s. The six Latin American countries listed above are responsible for the majority of the region's trade with East Asia. This study covers the period from 2000 to 2016, divided into three sub-periods before, during, and after the primary commodity boom period from 2003 and 2011.

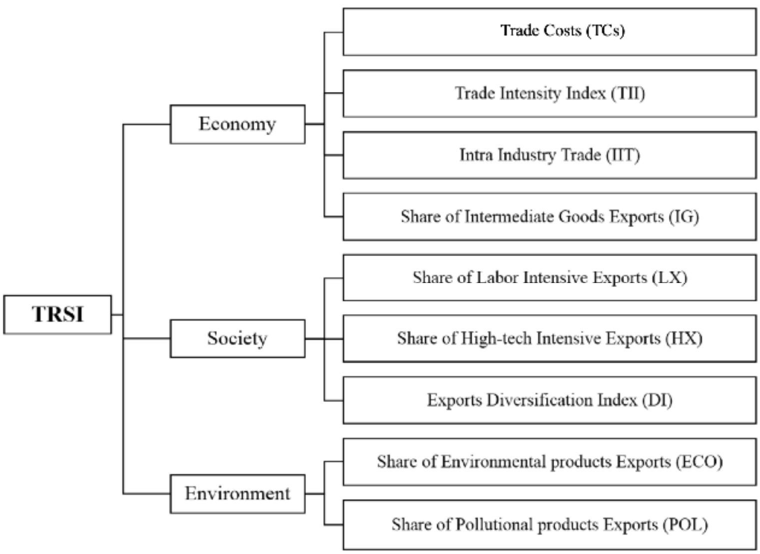


Figure 1. Structure of TRSI

The TRSI in this study largely follows the definition of sustainable trade suggested by The Economist Intelligence Unit (2018), as mentioned in Section II. However, since this study focuses on bilateral trade relations, we modified the TRSI definition to incorporate "measuring trade relations in a manner that supports economic growth, social development, and environmental protections in both partner countries." In addition, we defined TRSI from the perspective of Latin American countries rather than East Asian countries. Thus, a higher number in the TRSI indicates that trade relations between the two regions are more sustainable than relations between countries with a low TRSI from the perspective of Latin American countries. As sustainable trade is supported by various factors in the trade environment, we selected nine variables to represent the three pillars of the TRSI. Based on each definition and its role in the TRSI, four variables were included in the economic pillar, three in the social pillar, and two in environmental pillar (see Figure 1).

Economic Pillar

The economic pillar measures the extent to which bilateral trade contributes to promoting economic growth in the partner countries. The economic pillar consists of four variables, trade costs (TCs), a trade intensity index (TII), intra-industry trade (IIT), and share of intermediate goods exports (IG). Anderson and Van Wincoop (2004) defines TC as "all costs incurred in getting a good to a final user other than the marginal cost of producing the good itself: transportation costs (both freight costs and time costs), policy barriers (tariffs and non-tariff barriers), information costs, contract enforcement costs, costs associated with the use of different currencies, legal and regulatory costs, and local distribution costs (wholesale and retail)." When TCs are low, economic welfare can increase as the economic cost of doing business between countries is reduced. Lower TCs can be associated with innovation activities because firms can produce new goods by accessing foreign inputs at a lower cost (OECD/WTO 2015). So, lower TCs may contribute to sustainable trade relations between countries. The TII also indicates whether one region exports to another region more than the global average. In other words, it can be interpreted as an export share. If the TII is greater than one, it indicates an intensive trade relationship. Since it does not suffer from a size bias, the statistic can be compared over time, across regions. According to Raj and Ambrose (2014), the TII helps to identify how intensively countries are trading with each other. Also, Drysdale and Garnaut (1982) documented that the TII is a meaningful factor in the sense that it reveals resistance implied in bilateral trade. Thus, a higher TII indicates that trade relations between countries are becoming more sustainable. The IIT measure reflects monopolistic competition within industries. IIT increases the variety of goods and contributes to internal economies of scale by extending the market (Chang 2009; Krugman 1979). Since countries tend to adopt other countries' technologies more easily when imports are from the same sectors as their production and export sectors, IIT contributes to technology transfer more effectively than inter-industry trade (Hakura and Jaumotte 1999). Therefore, a higher IIT also indicates that trade relations between countries are becoming more sustainable. Finally, the IG shows the extent of the GVC between regions, which can be demonstrated as the degree of integrity between them. Ali and Dadush (2011) emphasized that IG trade has increased in importance as a source of efficiency. From the Latin American region's point of view, an increase in IG implies Latin America is a source of efficiency for East Asia's production chain and increases the opportunity to obtain a win-win trade result. That is to say, Latin America can participate in the GVC without building an entire supply chain by exporting IG. Also, Kowalski et al. (2015) documented that Latin America could have an opportunity to diversify its production and trade, thereby associating the region with rapid learning, technology transfers, and knowledge spillover. Therefore, exports of IG can contribute to the expansion of the GVC and may positively contribute to sustainable trade relations.

Social Pillar

The social pillar captures the extent to which bilateral trade contributes to social development, such as employment, in partner countries. The social pillar is composed of the share of labor-intensive exports (LX), the share of high-tech intensive exports (HX), and an exports diversification index (DI). First, labor-intensive industries have been the starting point of the industrialization of many developed countries (Khondoker and Kalirajan 2012). In addition, industrial development has the potential to raise incomes and living standards and generate many new jobs that help to maintain social stability (Hayami et al. 1998; Stober 2014). Accordingly, the greater the share of LX in bilateral trade compared to the share of exports of natural resources, the greater the sustainability of bilateral trade. Second, technology-intensive exports positively affect a country's economic output (Satrovic 2018). Also, trade exposes firms and countries to the knowledge capital its trading partner possesses, which leads to technology transfer and subsequent innovation (Grossman and Helpman 1991; Love and Ganotakis 2013). Therefore, the greater the share of HX in bilateral trade, the more sustainable that trade will be. Third, export diversification plays an important role in economic and social development for developing countries. Jansen et al. (2014) stated that export diversification contributes to employment growth and income redistribution as well as sustainable economic growth. Hartmann et al. (2017) argued that countries that export a diverse array of products tend to have less income inequality. Thus, high values of the DI indicate more sustainable trade relations between countries.

Environmental Pillar

The environmental pillar measures the degree to which bilateral trade consists of eco-friendly products. The environmental pillar consists of two variables, namely the share of environmentally friendly products exports (ECO) and the share of polluting products exports (POL). The development of goods and services that are beneficial to, or at least do not harm the environment is important in order to achieve economic growth without environmental degradation. Trade provides access to environmentally friendly goods and services for countries that do not have sufficient familiarity with such products, thereby promoting economic development while reducing environmental pollutants. Bucher et al. (2014) noted that trade in eco-friendly goods and services helps to create new business and jobs. Vossenaar (2013) argued that trade liberalization in environmentally friendly products can enable countries to achieve sustainable development goals by reducing air and water pollution, improving energy and resource efficiency, generating jobs, and transferring skills and technology. Thus, if countries increase bilateral trade in environmentally friendly products, that trade relationship will be more sustainable. Furthermore, to the extent that polluting industries move from industrialized countries to developing countries, i.e., from countries with strong pollution regulations to less regulated economies, POL will increase. According to World Bank (2012), growth at the expense of the environment, in the end, threatens the potential for future growth and the progress achieved to that point. Thus, growth based on “dirty” industries is not sustainable. That is, an increase in the POL will impede trade sustainability.

Data Construction

We construct the nine variables described above as follows. To recap, the economic pillar includes TCs, the TII, the IIT index, and the share of IG exports. The social pillar includes the share of labor-intensive exports, high-tech intensive exports, and exports DI. Finally, the environmental pillar consists of the share of environmental products exports and the share of polluting product exports. The calculation methods and data sources for each variable are provided in Table A1.

Within the Economic pillar, the TCs variable is constructed from the TC database from the ESCAP-World Bank. This database provides an all-inclusive measure of international TCs that consists of international transport costs, border-related TCs such as tariff and non-tariff barriers, and other costs associated with language barriers, currency barriers, and cumbersome import and export procedures (ESCAP-World Bank 2017). The TII is defined as the share of one country's exports to a trade partner divided by the share of world exports going to that partner. We followed the method data used in WITS World Bank, where $T_{ij} = (x_{ij}/X_{it})/(x_{wj}/X_{wt})$. Here, x_{ij} and x_{wj} represent country *i*'s exports and total world exports to country *j* and x_{ij} and X_{wt} represent country *i*'s total exports and total world exports, respectively. An index greater (less) than one indicates a bilateral trade flow that is larger (smaller) than expected, given the partner country's importance in world trade. For the intra-industry index, among the various ways of calculating such an index we chose the Marginal Intra-Industry Trade (MIIT) Index approach because the MIIT is a more dynamic measure than the traditional GL index of IIT (Brülhart 1994; Hamilton and Kniest 1991). We selected three sectors based on the standard international trade classification (SITC)-Rev. 2 group that composed the majority of the trade between the two regions: Metals, Chemicals, and Machinery, and electronics. A high value for the index means that the trade partners have a similar industry, and have a close complementary relationship. A country's share of the IG trade was calculated based using the WITS World Bank Database. After collecting the data for Latin American countries' total and intermediate good exports to East Asian economies from 2000 to 2016, we divided IG export data divided by total export value. In this way, we verified how the

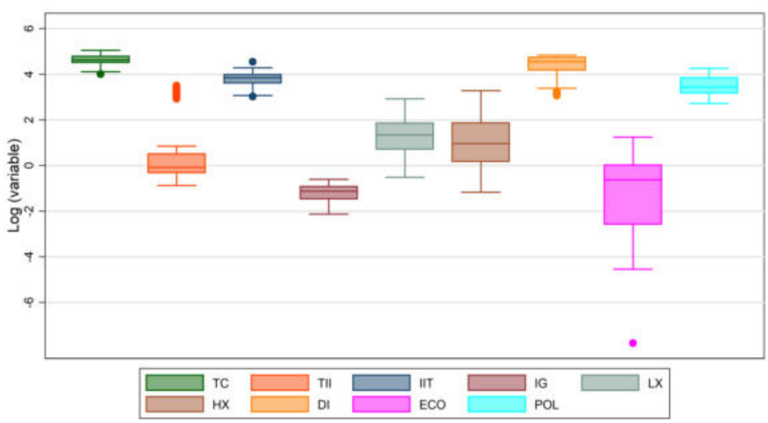
IG share between the two regions changed over time.

Within the Social pillar, to calculate the share of labor-intensive exports we selected labor-intensive sectors based on the factor intensity classification for unskilled-labor using the International Trade Center's classification (Hinloopen and Van Marrewijk 2004), plus the common denominators of three theses with the focus on labor-intensive manufacturing (Das and Kalita 2009; Lary 1968; Tregenna 2010). Data was collected using the Harmonized System's (HS) 1988/92 codes. For the share of high-tech intensive exports, sectors were selected based on the Eurostat indicators of the High-tech industry and Knowledge. This provided a list of high-tech products based on SITC Rev.3 within nine industrial sectors based on OECD definitions. These are products for which manufacturing involves a high level of R&D (Eurostat 2014). For export diversification, we use the DI from the United Nations Conference on Trade and Development (UNCTAD). According to UNCTAD, the index represents the extent to which the structure of exports or imports by product of a given economy or group of economies differs from the world pattern (UNCTADStat). Following this definition, we calculated the export DI based on HS 1988/92 codes divided into 16 product groups from WITS World Bank.

Lastly, within the Environmental pillar, to calculate the share of eco-friendly products, we select products based on the Asia-Pacific Economic Cooperation's list of 54 environmentally conscious goods using 6-digit HS codes. Environmental goods included in this list focus on renewable energy generation, environmental monitoring, analysis, and assessment equipment, environmental-protection, and environmentally preferable products (Vossenaar 2013). To calculate the share of polluting products, we selected "dirty" products based on the criteria in Wilson et al. (2002). They categorized pollution-intensive industries' 3-digit SITC codes based on Tobey (1990)'s definition of pollution-intensive industries, including five industrial sectors.

METHODOLOGY

In order to derive the TRSI, two important issues had to be considered: how to normalize the variables and how to calculate the weights to be applied when reducing multi-dimensional variables to a uni-dimensional index. First, to adjust for the difference in level among the variables, we use a max-scaling methodology that is frequently applied in this kind of study. Since this normalization method is strongly affected by the maximum value selected, it is important to choose the appropriate maximum. As a preliminary procedure before normalization, we remove outliers that could bias the normalization by using the Upper Horizontal Value (UHV) rather than the maximum value, as shown in Figure 2. The UHV is the inter-quartile range multiplied by 1.5, plus the top quartile value. For the variables where a higher value indicates a stronger connection between countries, the observed value at time *t* was divided by its UHV. For the variables in which a higher value denotes a weaker relationship between countries, one minus the value at time *t*, divided by the UHV is used.



Note: The horizontal line above the box is the UHV. The dots represent outliers.

Figure 2. Box-and-Whisker Plot

Second, we use PCA to calculate the weights for each variable. As PCA transforms a number of possibly correlated variables into a smaller number of orthogonal (uncorrelated) components, any overlapping information among variables is removed. In this study, we follow the methodology developed by Huh and Park (2018). To explain this in more in detail, suppose that data vector $x = [x_{1,} x_{2,} x_3]$. For *j=1,2,3*, each principal component is defined as $PC_j = e_j^{'}$ where $e_j = [\alpha_{1j,} \alpha_{2j,} \alpha_{3j}]$ is the eigenvector, and its eigenvalue is λ_j. Since $\alpha_{ij}\sqrt{\lambda_j}$ indicates the correlation between x_i and PC_j, $\alpha_{ij}^2 \lambda_j$ represents the proportion of the variance of x_i that is explained by PC_j. According to Huh and Park (2018), there are three constraints that must be met: (i) the principal components should have eigenvalues greater than one (the Kaiser criterion), (ii) each component should be able to explain at least 10% of the total variance, and (iii) the sum of the components explains more than 60% of the total variance. Based on these three constraints, we chose the principal components. Assuming λ_1 and λ_2 satisfy these conditions, an index using the variables is constructed as follows:

$$Index_t = \left(\frac{\alpha_{11}^2 \lambda_1}{(\lambda_1 + \lambda_2)} + \frac{\alpha_{12}^2 \lambda_2}{(\lambda_1 + \lambda_2)}\right) x_{1t} + \left(\frac{\alpha_{21}^2 \lambda_1}{(\lambda_1 + \lambda_2)} + \frac{\alpha_{22}^2 \lambda_2}{(\lambda_1 + \lambda_2)}\right) x_{2t} + \left(\frac{\alpha_{31}^2 \lambda_1}{(\lambda_1 + \lambda_2)} + \frac{\alpha_{32}^2 \lambda_2}{(\lambda_1 + \lambda_2)}\right) x_{3t}. \quad (1)$$

Table 1 summarizes the results of the PCA. With respect to ECON, the first two principal components satisfy the three constraints, accounting for 66% of the total variance. Adding the third component would increase the proportion of the variance explained by 90%, but it was not included because it did not satisfy the Kaiser criterion. In the case of SOC, two principal components explained over 90% of the total variance, the largest cumulative proportion among the three pillars. For ENV, only the first principal component was available and its explanatory power was relatively low.

Table 1. Summary of PCA Results

	ECON				SOC			ENV	
PC_j	1	2	3	4	1	2	3	1	2
λ_j	**1.61**	**1.04**	0.98	0.37	**1.82**	**1.00**	0.19	**1.24**	0.76
α_{1j}	**0.6863**	**0.1862**	-0.1901	-0.6769	**0.1209**	**0.9926**	0.0091	**0.7071**	0.7071
α_{2j}	**0.6996**	**-0.1615**	-0.0899	0.6902	**0.7015**	**-0.0919**	0.7067	**0.7071**	-0.7071
α_{3j}	**0.1978**	**-0.1676**	0.9590	-0.1148	**-0.7023**	**0.0791**	0.7075		
α_{4j}	**0.0193**	**0.9546**	0.1902	0.2286					
Proportion	**0.4026**	**0.2591**	0.2455	0.0928	**0.6081**	**0.3293**	0.0626	**0.6182**	0.3818
Cumulative	**0.4026**	**0.6617**	0.9072	1.0000	**0.6081**	**0.9374**	1.0000	**0.6182**	1.0000

Table 2. Weights for Variables and Sectors

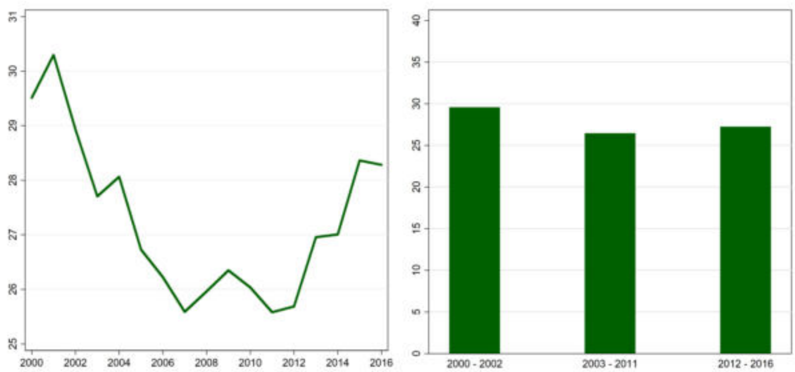
ECON	Weights	SOC	Weights	ENV	Weights	TRSI	Weights
TC	0.2998	LX	0.3588	ECO	0.5000	ECON	0.3333
TII	0.3076	HX	0.3206	POL	0.5000	SOC	0.3333
IIT	0.0348	DI	0.3205			ENV	0.3333
IG	0.3579						

Table 2 reports the weights calculated for the variables and sectors using the information from Table 1 and Equation (1). With respect to ECON, the weights were fairly evenly distributed among the variables except for IIT, which has a weight of only 0.0348. The maximum weight of 0.3579 was assigned to IG. Similarly, the weights for the SOC variables were fairly equal, and for ENV, the weights were exactly equal. Since the explanatory power for ENV was relatively low, the 50% weight for both variables seems appropriate. Finally, we impose equal weights for the three pillars in the TRSI, because the assumption that there is a specific principal component that ties the economy, society and environment together is a rather extreme assumption. Thus, we assume equal weights for the three pillars in the TRSI.

RESULTS

East Asian TRSI

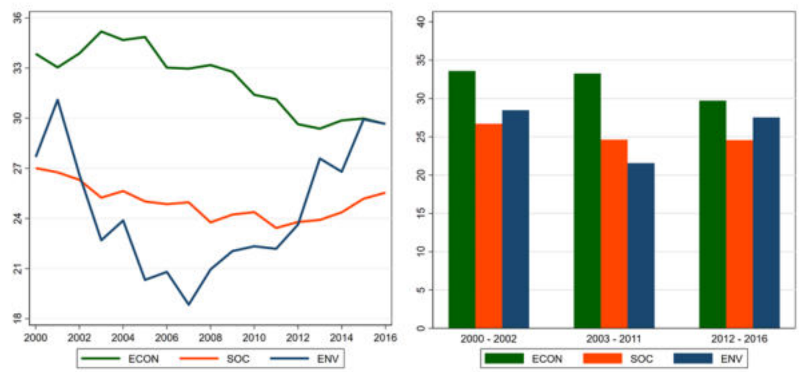
The East Asian TRSI, consisting of KOR, CHN, and JPN, relative to the six Latin American countries is reported in Figure 3. As seen in the left panel, fluctuations in the index over the sample period follow a U-shape, rising after a long decline between 2001 and 2011. In other words, sustainable trade relations between East Asia and Latin America have recovered rapidly since 2012 but have not yet reached the level seen in the early 2000s. The right panel of Figure 3 displays the average for the East Asian TRSI in the three different sub-periods, before, during, and after the primary commodity boom period from 2003 to 2011. Similar to results found in previous studies, the overall index shows that trade relations between the two regions deteriorated during the commodity boom.



Note: The left panel shows the average for the three East Asian countries' TRSIs relative to the six Latin American countries. The right panel shows the average of the three East Asian TRSIs to the six Latin American countries for the three sub-periods. For the sub-periods, the values of the TRSI are 29.58, 26.47 and 27.26, respectively.

Figure 3. East Asian TRSI

The three pillars that comprise the TRSI show substantially different variations over the same period. The Economic TRSI has the highest absolute value and the steepest downward trend over time, particularly in the second sub-period. The decline appears to have plateaued in the third sub-period, 2012-2016. The right panel of Figure 4 shows that the average of the Social TRSIs declined over time. Fluctuations in the Social TRSI over the sample period were the smallest of the three, with values that remained in the range of 24.00 to 27.00. The average of the Social TRSIs for the three sub-periods declined over time, although the change was insignificant. The Environmental TRSI most closely resembles the pattern of the overall East Asian TRSI, which was the U-shape, as seen in Figure 3. However, the environmental TRSI has recovered more rapidly since 2011, and was almost at the same level as the economic TRSI in 2016.



Note: The left panel shows the average across the three East Asian TRSIs relative to the six Latin Ameri-can countries for each pillar. The right panel shows the average of the three East Asian TRSIs to the six Latin American countries for each pillar in the three sub-periods. For the sub-periods, the Economic, Social, and Environmental pillars have values of (33.59, 33.24, 29.70), (26.69, 24.61, 24.56), and (28.46, 21.56, 27.52), respectively.

Figure 4. East Asian TRSI for Economic, Social, Environmental Pillars

Which variable had the greatest influence on the East Asian TRSI over the sample period? According to Table 3, which reports the contribution of each variable to the total TRSI, the exports DI, share of polluting product exports (POL), TC, and share of IG had substantial impacts on the East Asian TRSI, accounting for about 93% of the index.

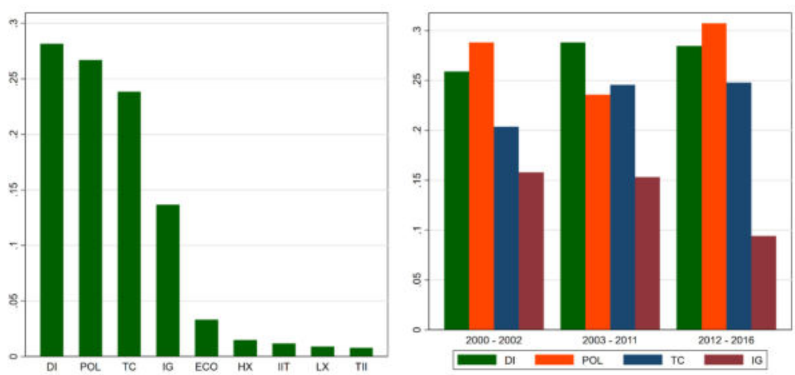
Table 3. Contribution of Each Variable to the East Asian TRSI

	DI	POL	TC	IG	ECO	HX	IIT	LX	TII
Value	0.28	0.27	0.24	0.14	0.03	0.01	0.01	0.01	0.01

Note: Each value was derived as the portion of each variable considering the weight in the East

Asian TRSI.

Interestingly, the order of the top four variables with the greatest influence on the East Asian TRSI differed over the three sub-periods. For 2000-2002, POL accounted for the largest share, with 29%, followed by DI and TC, with 26% and 20%, respectively. However, in the second sub-period, DI occupied the largest share with 29%, and TC became the second most influential variable, overtaking the share for polluting product exports. The third sub-period shows the same trend as the first sub-period, where the order was POL, DI, and TC. Separately, the importance of IG in the East Asian TRSI has declined continuously over time.

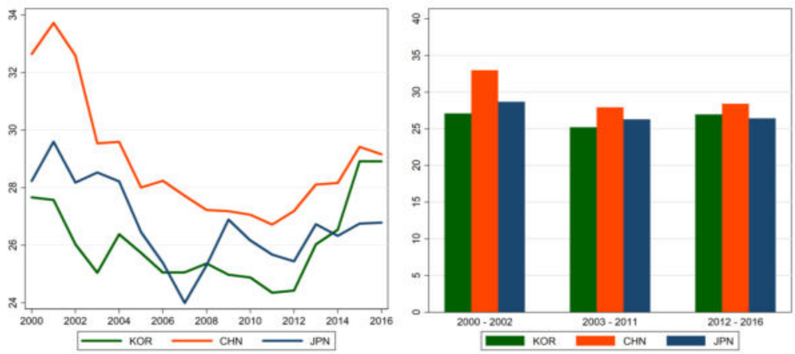


Note: The left panel shows the percentage contribution of each variable to the East Asian TRSI, ranging from 0 to 1. The right panel shows the average contributions of the top four variables in the three sub-periods. For the sub-periods, the exports diversification index (DI), share of polluting product exports (POL), trade costs (TC), and intermediate goods exports (IG) have values of (0.26, 0.29, 0.28), (0.29, 0.24, 0.31), (0.20, 0.25, 0.25), and (0.16, 0.15, 0.09), respectively.

Figure 5. Contribution of Main Variables to East Asian TRSI

TRSI for KOR, CHN, and JPN

To better capture the time-varying changes of the East Asian TRSI, we show each East Asian country's overall TRSI (Figure 6) and analyze each of them in detail in terms of the three pillars and the sub-periods as shown in Table 4 and Figure 7.



Note: The left panel shows the TRSIs for Korea, China, and Japan relative to the six Latin American countries. The right panel is the averages of each of the East Asian TRSIs to the six Latin American countries for the three sub-periods. For the sub-periods, KOR, CHN, and JPN have values of (27.09, 25.20, 26.96), (32.99, 27.92, 28.41), and (28.67, 26.29, 26.40), respectively.

Figure 6. TRSI for KOR, CHN, and JPN

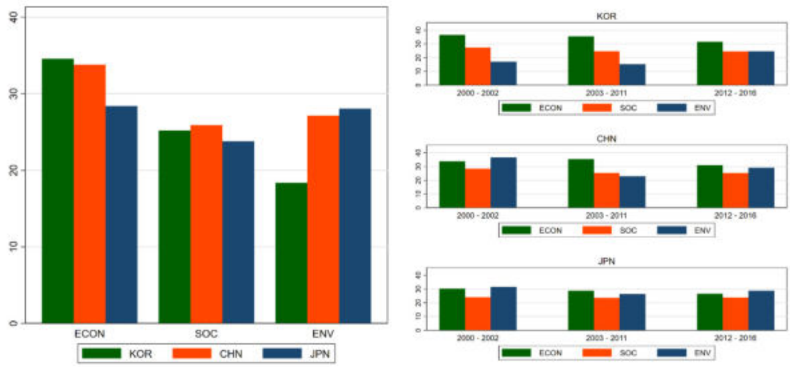
The low values for the East Asian TRSI shown in Figure 3 are mainly attributable to KOR, as the Korean TRSI was lower than the TRSI for the other two countries over most of the sample period. However, KOR made the largest contribution to the rapid recovery in the East Asian TRSI from 2012 onward. As a result, KOR became the only country whose TRSI in the third sub-period (26.96) was almost as high as its value in the first sub-period (27.09). In contrast, China's TRSI was the highest of the three for the entire sample period, even though the gap between CHN and the other two countries has decreased recently. Due primarily to a large decline from 2002 to 2003, the Chinese TRSI declined the most between the first two sub-periods. Thus, although the TRSI increased slightly between the second and third sub-periods, sustainable trade relationship with the six Latin American countries decreased substantially compared to the first sub-period. The JPN index has two notable characteristics. First, the Japanese TRSI was the lowest of the three for the period 2012-2016 (26.40), as the Korean TRSI increased dramatically during that period. The second is the JPN's sharp, V-shaped rebound from 2004 to 2009, unlike KOR and CHN where no such pattern is observed. In other words, the Japanese TRSI began to recover relatively early compared to the others, although the recovery was not been sustained after a sharp increase in 2009.

Table 4. Each Pillar's TRSI for KOR, CHN, and JPN

	KOR			CHN			JPN		
	ECON	SOC	ENV	ECON	SOC	ENV	ECON	SOC	ENV
Total	34.58	25.20	18.38	33.81	25.90	27.16	28.40	23.78	28.05
2000-2002	36.64	27.48	17.15	33.83	28.52	36.60	30.29	24.08	31.63
2003-2011	35.53	24.80	15.27	35.43	25.40	22.93	28.77	23.63	26.47
2012-2016	31.63	24.56	24.70	30.88	25.24	29.11	26.59	23.87	28.75

Note: Information about the contributions of the variables can be found in Figure B1, Table B1, and Table B2.

Table 4 summarizes information for the three pillars and the sub-periods. A common feature across the three East Asian countries is that the Economic TRSI is higher than the TRSIs for the other pillars, with KOR at 34.58, CHN at 33.81, and JPN at 28.40. The importance of the Economic TRSI for KOR was relatively high compared to CHN and JPN. Another interesting property of KOR is the fact that the Social TRSI was higher than the Environmental TRSI, whereas the opposite is true for CHN and JPN. On the other hand, for CHN and JPN the TRSIs' pillars are high in order of economic, environment, and social. Nonetheless, while China's Economic TRSI was relatively high compared to its other pillars, the Economic and Environmental scores for JPN were fairly similar. Additionally, as shown in Figure 7, the Environmental TRSIs decreased during the primary commodity boom period. The decline for CHN, where the absolute size of trade with Latin American countries was large, was larger than for KOR and JPN. We can infer from this that in-creased trade between East Asia and Latin America had a negative impact on the TRSI during that period.



Note: The left panel shows each pillar's TRSI for the East Asian countries relative to the six Latin American countries. The right panel shows the averages of each pillar for Korea, China, and Japan relative to the six Latin American countries over the three sub-periods.

Figure 7. Each Pillar's TRSI for KOR, CHN and JPN for All and Sub-periods

TRSIs for KOR, CHN, and JPN over the Three Sub-periods

In this sub-section, we report the TRSIs for East Asia and for each country-pair, and changes over the three sub-periods. Figure 8 presents the averaged TRSIs for the entire sample period. Among the Latin American countries, ARG was found to have the highest sustainability in trade with East Asia, with the highest TRSIs for both KOR and CHN. COL also had significantly sustainable trade relationships with the East Asian countries, ranking second in all of them, although due to the high score between MEX and JPN, COL followed MEX overall. Third, BRA, the largest economy in Latin America, has a low over-all TRSI. Among the three East Asian countries, BRA's TRSI with JPN (22.58) was the lowest, followed by KOR (24.05) and CHN (27.14).

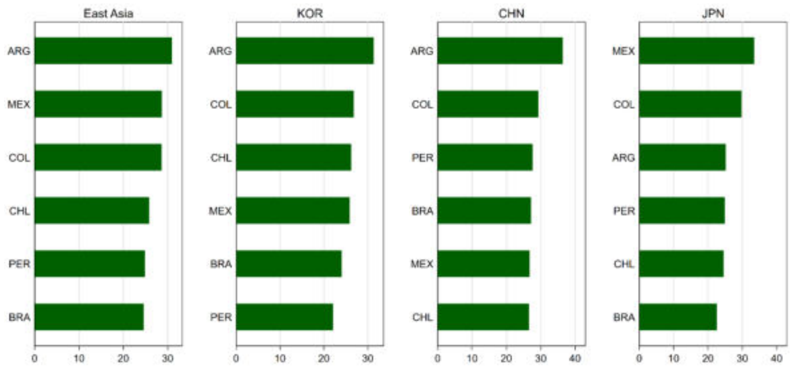
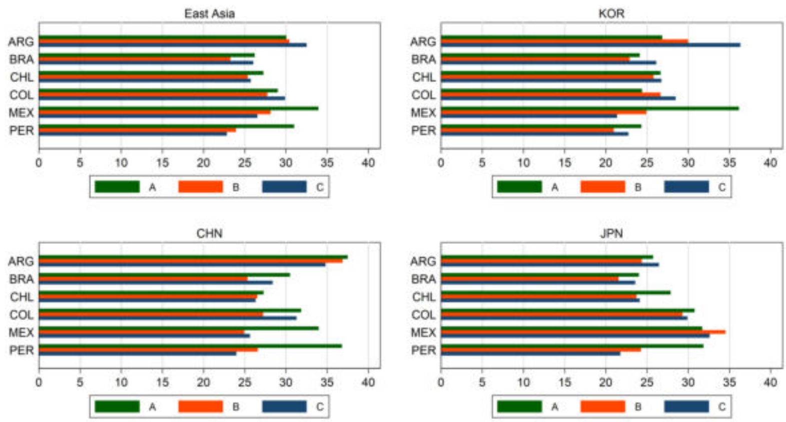


Figure 8. TRSI by Country Pairs Between 2000 and 2016

Figure 9 shows changes for both the overall East Asia TRSI, and for each country-pair's TRSI over the three sub-periods. As shown in the left upper panel, the East Asian TRSI relative to each Latin American country worsened from the first to the second sub-period, except for ARG. Most notable are the large declines in TRSI for MEX and PER, which continued into the third sub-period when the other countries reversed their down-ward trends. The upper right panel in Figure 8 shows large changes in the Korean TRSI relative to ARG and MEX over the three sub-periods. While the TRSI between KOR and ARG increased consistently (26.86, 29.99, 36.33), the TRSI with MEX declined (36.16, 24.92, 21.37). The lower left panel confirms that the sharp decline in the TRSI between East Asia and PER was mainly attributable to CHN. From the first to the third sub-period, the TRSI between CHN and PER declined substantially (36.81, 26.58, 23.99). Likewise, the TRSI between CHN and MEX also declined significantly (33.99, 24.94, 25.64). In contrast, CHN had a strong sustainable trade relationship with ARG. In addition to the high degree of TRSI in absolute terms, its decrease was insignificant over the period, and the TRSI ranked first in the third sub-period. The lower right panel shows that, like CHN, JPN contributed to the declining TRSI between East Asia and PER over time. However, contrary to the results for KOR and CHN, the TRSI between JPN and MEX was fairly stable over this period (31.72, 34.53, 32.61). The TRSI with MEX was the largest among the three East Asian countries in the third sub-period, and MEX was the only country where its TRSI with JPN increased from the first to the second sub-period.



Note: The letters A, B, and C indicate the three sub-periods: A is 2000-2002, B is 2003-2011, and C is 2012-2016. More detailed information can be found in Figure C1, Figure D1, and Table E1.

Figure 9. TRSI by Country Pairs over the Tree Sub-periods

CONCLUSIONS

This study analyzed and evaluated the sustainability of trade relations between Latin American and East Asian countries by developing a Trade Relations Sustainability Index, the TRSI. The average value of the East Asian TRSI relative to Latin American countries has U-shaped pattern; sustainable trade relations declined substantially over the period from 2001 to 2011, then rapidly recovered starting in 2012. Our results support previous researches' findings that during the primary commodity boom period, the sustainability of trade relationships between the two regions deteriorated.

Of the three East Asian countries included in this study, China is shown to be the most sustainable trade partner for Latin American countries over the entire period, although China showed a dramatic decline in its TRSI during the sub-period of the commodity boom. Korea was the worst trade partner until 2014, but showed substantial improvement in sustainable trade relations since then. As of 2016, Korea was the second most sustainable partner for Latin America. Japan generally maintained its position be-tween China and Korea, but had the lowest TRSI in the third sub-period.

In terms of the TRSI for the three pillars, the Economic TRSI has two notable characteristics compared to the other two TRSIs, namely its high absolute value and its downward trend over time. The fluctuations in the Social TRSI over the research period are the smallest, while the Environmental TRSI has a pattern that is most similar to the U-shaped pattern for the overall East Asian TRSI. Among the nine variables that comprise the index, the variable with the greatest influence on the TRSI is DI (the exports diversification index). After DI, the POL (share of polluting product exports) and TC (trade costs) variables have the greatest influence. Therefore, in order to improve TRSI between East Asia and Latin America going forward, diversification of exports, reductions in exports of polluting products, and a reduction in TCs should be areas of focus for policymakers.

Among the Latin American countries included in the study, Argentina is the most sustainable trade partner for East Asia, followed by Mexico and Colombia. In particular, trade relations between Argentina and Korea have been improving continually over the period studied. In contrast, although East Asia's trade relations with Mexico maintained a high ranking over the period, the relationship has deteriorated consistently and markedly. The overall index shows a different trend from the trade relationship that considers only economic factors. For example, Argentina is not the most sustainable trade partner for East Asian countries when considering the Economic pillar alone, but it is the best partner when all the three pillars are considered. Chile is ranked highest when focusing only the Economic sector but falls behind when all three pillars are considered. This shows that in order to build sustainable trade relations between partners, not only economic aspect but also other aspects such as social and environmental factors should be considered.

Peru and Brazil are at lower levels in terms of sustainable trade relations with East Asia. For these two countries, environmental factors have the lowest score. Therefore, it will be important to improve in terms of environmental aspects of trade for these countries to reach sustainable trade relations with

East Asia in the future.

This study is significant because it develops a comprehensive bilateral trade relations index, the TRSI. Also, it analyzes bilateral trade relations between Latin America and East Asia and compares the results among individual countries. However, the variables in the studies were limited since the variable selection was based on the data related to bilateral trade, limiting to explain the full aspect of the trade relations. Also, since TRSI was constructed from the perspective of Latin America, it will be meaningful to develop an index that indicates the sustainability of both directions. More detailed analyses about why the TRSI changed between specific countries over the period can be conducted in further studies.

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APPENDIX A

Table A1. Equations for 9 Variables

	Variable	Calculation method	Source
ECON	TC	$\left[1-\frac{TC\ index}{UHV}\right]*100$	ESCAP-World Bank
	TII	$\left[\frac{TII\ index}{UHV}\right]*100$	WITS World Bank
	IIT	$\left[\frac{(X_i+M_i)-\lvert X_i-M_i\rvert}{X_i+M_i}/UHV\right]*100;0\leq GL_i\leq 1$	WITS World Bank
	IG	$\left[\frac{\frac{\bigcap mediate\ of goods}{Total\ exports}}{UHV}\right]*100$	WITS World Bank
SOC	LX	$\left[\frac{\frac{Labor\ \int ensive\ \prod ucts\ exports}{Total\ exports}}{UHV}\right]*100$	UNCOMTRADE
	HX	$\left[\frac{\frac{High\ tech\ \prod ucts\ exports}{Total\ exports}}{UHV}\right]*100$	UNCOMTRADE
	DI	$\left[\frac{Exports\ \div ersification\ \in dex}{UHV}\right]*100$	WITS World Bank
ENVI	ECO	$\left[\frac{\frac{Environmental\ \prod ucts\ exports}{Total\ exports}}{UHV}\right]*100$	UNCOMTRADE
	POL	$\left[1-\frac{\frac{Pollutional\ \prod ucts\ exports}{Total\ exports}}{UHV}\right]*100$	UNCOMTRADE

APPENDIX B

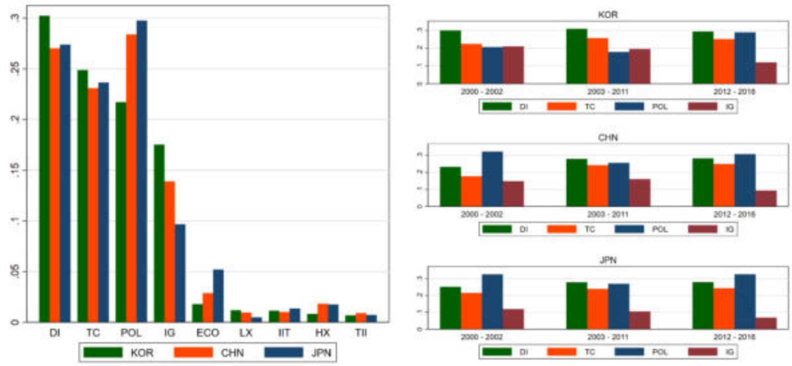


Figure B1. Contribution of Each Variable to TRSIS for KOR, CHN, and JPN

Table B1. Contribution of Each Variable to TRSIS for KOR, CHN, and JPN Between 2000 and 2016

Value	DI	POL	TC	IG	ECO	HX	IIT	LX	TII
KOR	0.30	0.22	0.25	0.18	0.02	0.01	0.01	0.01	0.01
CHN	0.27	0.28	0.23	0.14	0.03	0.02	0.01	0.01	0.01
JPN	0.27	0.30	0.24	0.10	0.05	0.02	0.01	0.00	0.01

Table B2. Contribution of Main Variables to TRSIS for KOR, CHN, and JPN over the Tree Sub-periods

	KOR			CHN			JPN		
	2000-2002	2003-2011	2012-2016	2000-2002	2003-2011	2012-2016	2000-2002	2003-2011	2012-2016
DI	0.30	0.31	0.29	0.23	0.28	0.28	0.25	0.28	0.28
TC	0.22	0.26	0.25	0.18	0.24	0.25	0.22	0.24	0.24
POL	0.21	0.18	0.29	0.32	0.26	0.31	0.33	0.27	0.33
IG	0.21	0.20	0.12	0.15	0.16	0.09	0.12	0.10	0.07

APPENDIX C

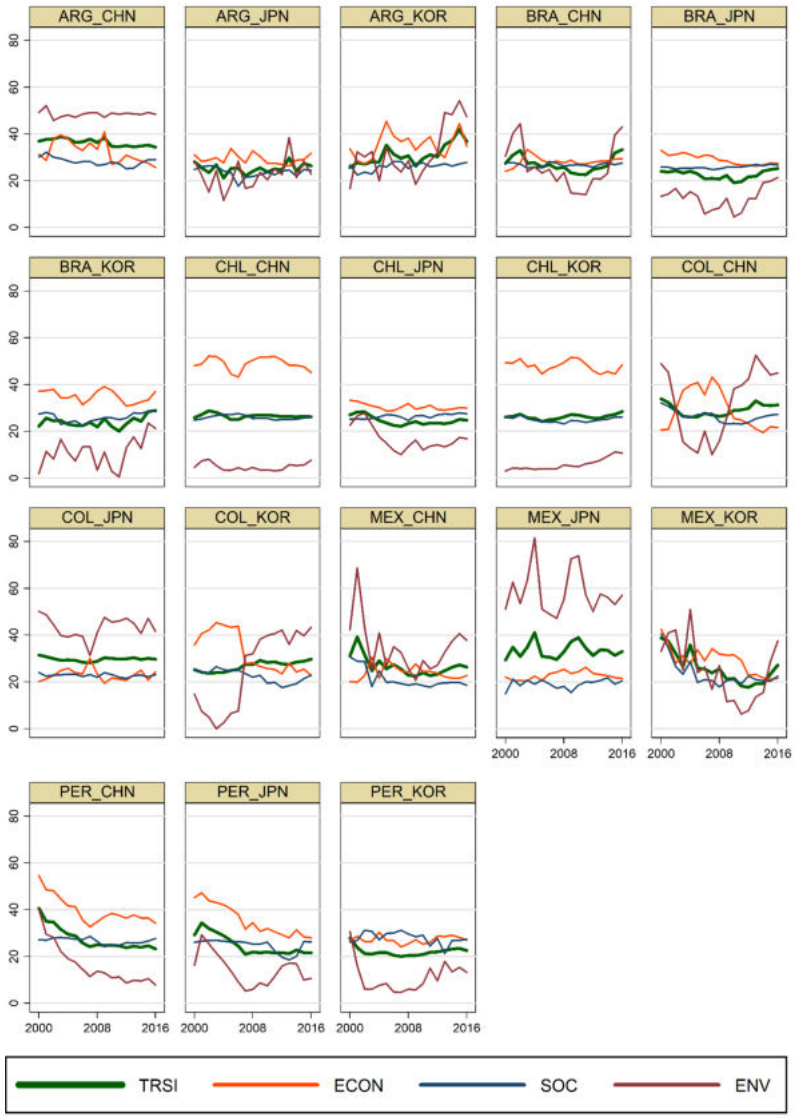
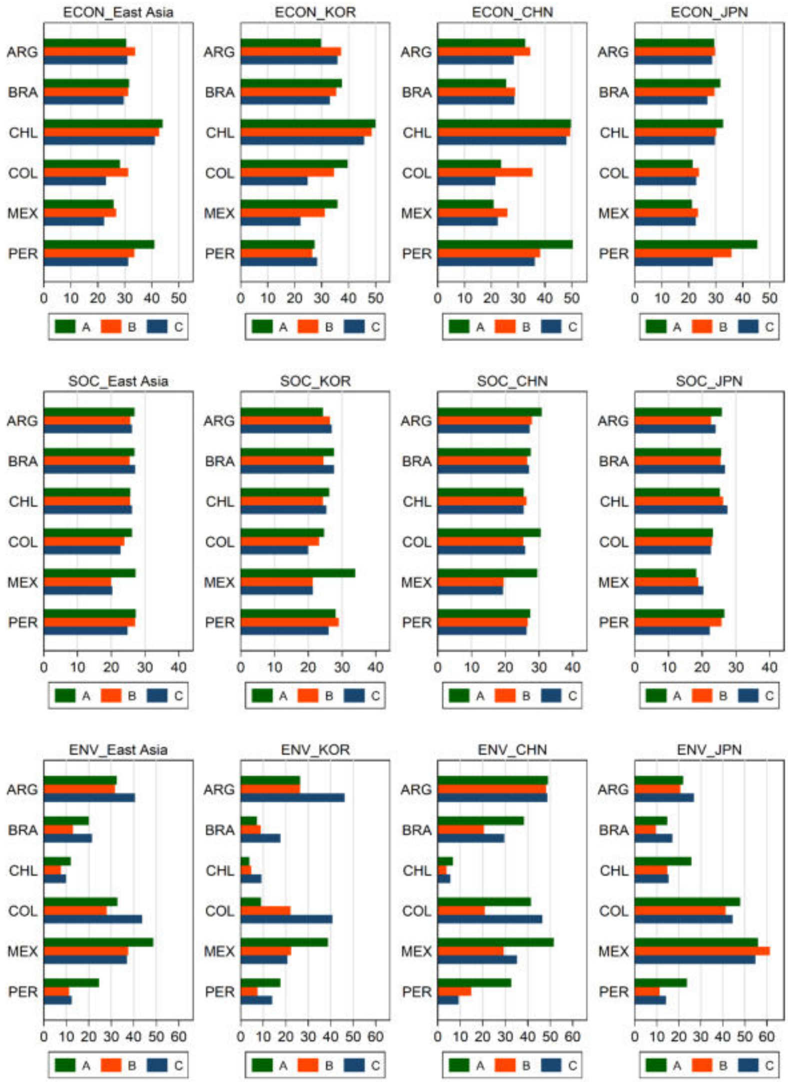


Figure C1. Change of All Indexes in All 18 Cases

APPENDIX D



Note: The letter A, B, and C indicate the three sub-periods. A is 2000-2002, B is 2003-2011, and C is 2012-2016.

Figure D1. Each Pillar Index for All 12 Cases

APPENDIX E

Table E1. Rank Between Countries over the Three Sub-periods

Rank	East Asia				KOR			
	T	A	B	C	T	A	B	C
1st.	ARG (30.97)	MEX (33.95)	ARG (30.41)	ARG (32.53)	ARG (31.30)	MEX (36.16)	ARG (29.99)	ARG (36.33)
2nd.	MEX (28.69)	PER (31.00)	MEX (28.13)	COL (29.89)	COL (26.78)	ARG (26.86)	COL (28.46)	COL (28.46)
3rd.	COL (28.59)	ARG (30.04)	COL (27.73)	MEX (26.54)	CHL (26.23)	CHL (26.65)	CHL (25.81)	CHL (26.74)
4th.	CHL (25.80)	COL (29.01)	CHL (25.36)	BRA (26.03)	MEX (25.86)	COL (24.41)	MEX (24.92)	BRA (26.11)
5th.	PER (24.86)	CHL (27.27)	PER (23.94)	CHL (25.73)	BRA (24.05)	PER (24.43)	BRA (22.89)	PER (22.75)
6th.	BRA (24.59)	BRA (26.21)	BRA (23.25)	PER (22.83)	PER (22.08)	BRA (24.13)	PER (20.96)	MEX (21.37)
Rank	CHN				JPN			
	T	A	B	C	T	A	B	C
1st.	ARG (36.38)	ARG (37.51)	ARG (36.88)	ARG (34.80)	MEX (33.47)	PER (31.87)	MEX (34.53)	MEX (32.61)
2nd.	COL (29.25)	PER (36.81)	COL (27.25)	COL (31.30)	COL (29.74)	MEX (31.72)	COL (29.30)	COL (29.91)
3rd.	PER (27.62)	MEX (33.99)	PER (26.58)	BRA (28.40)	ARG (25.22)	COL (30.78)	ARG (24.37)	ARG (26.46)
4th.	BRA (27.14)	COL (31.84)	CHL (26.54)	CHL (26.32)	PER (24.88)	CHL (27.88)	PER (24.28)	CHL (24.12)
5th.	MEX (26.74)	BRA (30.49)	BRA (25.33)	MEX (25.64)	CHL (24.57)	ARG (25.74)	CHL (23.72)	BRA (23.57)
6th.	CHL (26.61)	CHL (27.28)	MEX (24.94)	PER (23.99)	BRA (22.58)	BRA (24.02)	BRA (21.55)	PER (21.76)

Note: The letter T is the total period and the A, B, and C indicate the three sub-periods. A is 2000-2002, B is 2003-2011, and C is 2012-2016.