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Growth Effects of Trade Liberalization: An Empirical Analysis of Japan and the Republic of Korea over the period 1970 - 2020

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Abstract: English

Japan and South Korea have achieved remarkable post-war economic growth through drastic policy-changes. After their respective post-war periods, the two economies underwent significant policy changes, which primarily focused on industrialization through trade liberalization. The focus on international trade not only strengthened political ties with foreign countries, but also led to economic miracles in both countries. By focusing on export-led growth and gradually reducing trade barriers to facilitate imports, Japan and South Korea fostered economic upswing. Nowadays, both countries are among the ten largest economies in the world.

This thesis focuses on the foreign trade patterns and economic growth of both countries in the period of 1970 to 2020. The empirical analysis focuses on the question, how an increased engagement in foreign trade and investments can be linked to economic growth. Even though the economies of Japan and South Korea share many similarities, the findings of the research differ between the two countries.

The analysis shows, that Japan particularly benefits from imports, which have created a high dependency on foreign markets, but have facilitated a remarkable economic upswing. South Korea on the other hand, generates economic growth through their export-led economy. It can be seen, that the focus on international trade has created a reliance on foreign markets and political stability, but has created incredible economic growth in the past decades.

Abstract: Deutsch

Japan und Südkorea haben ihre Wirtschaft in der Nachkriegszeit drastisch umgestellt und dadurch ein bemerkenswertes Wirtschaftswachstum erzielt. Die beiden Volkswirtschaften sind bedeutende politische Veränderungen durchlaufen, die sich in erster Linie auf die Industrialisierung durch Handelsliberalisierung konzentrierten. Dies führte nicht nur zu stärkeren diplomatischen Beziehungen, sondern löste in beiden Ländern ein Wirtschaftswunder aus. Die Industrie richtete sich auf Export aus und stetig wurden Zölle und Importbeschränkungen reduziert. Durch diese Umstellung der Wirtschaft gehören Japan und Südkorea heutzutage zu den zehn größten Volkswirtschaften der Welt.

Im Mittelpunkt dieser Arbeit stehen die Handelsentwicklung und das Wirtschaftswachstum beider Länder im Zeitraum von 1970 bis 2020. Die empirische Analyse konzentriert sich auf die Frage, wie ein verstärktes Engagement in internationalem Handel und Investitionen mit Wirtschaftswachstum in Verbindung gebracht werden kann. Obwohl die Volkswirtschaften Japans und Südkoreas viele Gemeinsamkeiten aufweisen, unterscheiden sich die Ergebnisse der Untersuchung zwischen den beiden Ländern.

Die Analyse zeigt, dass Japan in hohem Maße von Importen profitiert, die zu einer starken Abhängigkeit von ausländischen Märkten geführt, aber auch einen außerordentlichen wirtschaftlichen Aufschwung ermöglicht haben. Südkorea hingegen erzielt Wirtschaftswachstum durch seine exportorientierte Wirtschaft. Es zeigt sich, dass bei beiden Ländern der Fokus auf internationalen Handel zu einer Abhängigkeit von ausländischen Märkten, sowie politischer Stabilität geführt hat, aber auch zu einem bemerkenswerten Wirtschaftswachstum in den letzten Jahrzehnten.

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1. Introduction

The advantages of trade liberalization through the reduction of trade barriers, has been subject to extensive debate among policy makers. With the on-going globalization, more and more countries have chosen to open their borders and facilitate the flow of goods and services, as well as investments in the economy, which commonly resulted in extensive economic upswing. Two recent examples of remarkable economic growth, due to drastic policy changes, could be observed in Japan and South Korea. The two east Asian economies have experienced incredible economic success in their respective post-war era. Within less than one hundred years, they have both grown from being among the poorest countries in the world, to being among the ten largest economies in the world (World Bank, 2022).

Japan experienced rapid economic growth after World War II. The U.S. started to transform the Japanese economy during their occupation. During this time, political, social, and economic reforms were established. Furthermore, a strong alliance between suppliers, manufacturers and financial institutions was established, that ensured economic stability. With the U.S. as a strong trade partner, Japan grew to become a leading industrial nation and as of today is the 4th largest economy in the world.

After the Korean war in 1953, the Republic of Korea, in the following just *Korea*, was in shambles and among the poorest economies in the world. With the establishment of diplomatic and economic relations with the West, as well as Japan, Korea gained access to international markets and could attract foreign investors. Due to economic reforms and a strict political course, Korea achieved double digit GDP growth up until the late 90s (World Bank, 2021). Today, Korea is a leading manufacturer of industrial goods and the 10th largest economy in the world.

Aim and scope

The objective of this paper is to analyze the impact of trade liberalization on post-war economic growth for Japan and Korea. More specifically, the impact of increased Import, Export and Foreign Direct Investment on the Gross Domestic Product will be analyzed. Therefore, 50 years of historical data will used to measure the dynamics of the variables, in order to gain a deeper understanding of how they influence one another.

Both economies have historically taken a protectionist economic approach, but have gone through drastic changes in the 20th century. The study could have implications for the political and economic approach of other economies and their trade policies.

Outline of thesis

In the second chapter, the literature review gives an overview on past research on free trade and trade liberalization, as well as the current scientific perception of the advantages and disadvantages of it. The third chapter introduces the variables of the analysis. Furthermore, the econometric models are presented and described, to give a better understanding of why they were chosen, as well as their purpose. The fourth chapter gives a historical overview of the two countries' post-war development, and what structural and policy changes were applied up until today. The fifth chapter is the main part of the analysis. The empirical models show the results of the conducted tests and the findings are analyzed. Additionally, the model is being tested for its statistical suitability. In the sixth and final chapter, the findings of the study are concluded. The main findings of the research are presented and the implications of the findings are discussed.

2. Theoretical Framework

Literature review

The literature review gives an overview of significant past research. It provides information on the foundation of our modern understanding of international trade theory. From its roots, up until our current understanding and theories regarding free trade. Therefore, it is divided into two parts. First, a review of historical trade theory, which generally shows the advantages of international trade. Second, economic growth theory is reviewed, which more specifically analyzes certain factors of an economy and how those lead to growth. The literature review examines the strengths and weaknesses of past research and shows the theory upon which the research of this paper is based.

International Trade Theory

International trade theory has shaped economics for hundreds of years and has analyzed and shaped the global economy's development from protectionism to a steady trade liberalization and globalized trade approach. There are many works that have had a drastic impact on the

perception of international trade and its benefits. One of the earliest works pointing out the benefits of international trade is "The Wealth of Nations" by Adam Smith. Smith emphasized the importance of specialization, which leads to increased productivity. He argued, that through the specialization of producing certain goods and lower opportunity costs, economies could gain an absolute advantage. Furthermore, he also pointed out the benefits of comparative advantage, which helps increase production and promotes economic growth (Smith, 1776). David Ricardo expanded on Smith's work in "Principles of Economy and Taxation". He showed the importance of utilizing comparative advantage in a theoretical model, where all absolute advantage is held by one economy. According to Ricardo, countries should specialize in producing certain goods for which they have a lower opportunity cost, which leads to gains and overall economic welfare (Ricardo, 1817). Eli Heckscher and Bertil Ohlin developed the Heckscher-Ohlin Model in 1933, which explored the relation between factor endowments and comparative advantages. The model highlights the import and export characteristics, regarding the factor endowments of economies. Countries will focus their production on resources they have in abundance and import scarce resources. It shows that focusing on factor based production can lead to income distribution and balance out scarce factors by creating highly specialized industries (Heckscher, et al., 1991). Frankel and Romer's 1999 paper "Does Trade cause Growth?" explores the causal relationship between trade and growth and the direction of cause (Frankel & Romer, 1999). In their model, trade only indirectly increases growth, due to the exchange of knowledge and technology; similar to the works previously mentioned. Nevertheless, the research shows a moderate positive effect of trade on income. Rodrik and Rodriguez' paper from 2000 is a critical review and examination of empirical evidence regarding the relationship of trade policy and economic growth (Rodriguez & Rodrik, 2000). The authors challenge previous research, which shows a generalized approach of liberalization to achieve economic growth. They critique the one-size-fits-all approach and emphasize the context-dependent approach to trade policy, which varies between countries, due to their unique circumstances. Rodrik and Rodriguez' skeptical guide underlines the importance of an individual approach and the consideration of a nation's characteristics when trade policies and strategies are formulated.

Economic Growth Theory

The Solow growth model is an exogenous model, that analyzes the dynamics of long-term economic growth by focusing on the impact of capital and labor inputs on production. Since it

was independently also developed by Trevor Swan, it is also referred to as the *Solow-Swan model*. The model assumes constants in population growth and returns to scale, and takes labor, capital and knowledge as the main factors for output. According to Solow's model, economies eventually reach a steady state equilibrium, where permanent growth can only be attained through technological advances (Solow, 1956). The model implies a convergence of poorer countries, which grow faster than highly developed countries. Thereby, they catch-up to the standards of other countries. A crucial weakness of the model is the assumption of exogenous fixed technology and technological change. While technological advances are important for economic growth, endogenous technological changes and innovation are not taken into account. Thereby, it limits the dynamics of economic development.

Other models built upon the Solow model, expanded the function with endogenous factors. In Romer's paper "Endogenous Technological Change", he introduced endogenous growth variables, as the main contributing factor for economic growth (Romer, 1990). Romer argues that technological change is a factor of research and development (R&D) investments, while Solow's model implies technological change as an external force. Further he emphasizes the potential of investments in human capital and knowledge, which drives growth and enhances productivity. Therefore, technological progress is a result of market- and policy-driven factors. It points out the role of government, regarding fostering innovation through targeted policies. Grossman & Helpman's model highlights the importance of knowledge accumulation and transfer for economic growth (Grossman & Helpman, 1991). The authors build a theoretical model of economies, that engage in international trade. Through investments in R&D, the production standards are raised and innovation is created. International trade leads to knowledge spillovers, that levels out the discrepancy of production standards. This development leads to an increased demand for innovation, to differentiate and regain a productivity advantage. The model highlights the value of intellectual property, as well as the advantages of engaging in international trade. Similarly it points out the importance of investment in human capital and R&D. Aghion & Howitt's model similarly emphasizes the importance of innovation and investment in R&D for economic growth (Aghion & Howitt, 1992). They recognize the challenges of "creative destruction", a term coined by the Austrian economist Joseph Schumpeter. It describes the ever-changing process of innovation and technological changes, which result in challenges for the workforce, but ultimately lead to economic progress and welfare effects. In this regard, the authors emphasize the importance of

an educated and skilled workforce, to adapt to technological changes and use it to drive innovation.

Sachs and Warner's 1995 paper "Economic Reform and the Process of Global Integration" shows evidence on income convergence caused by international trade. In order to examine the effects of trade, they divide all countries observed into open and closed economies. Whether a country is open or closed is defined by factors such as non-tariff barriers, tariff rates, black market exchange rate, socialist political system and state monopolies on major exports. The starting point of their research and the categorization of countries is 1970 and they analyze the development in the following two decades. The research shows significant income convergence among open economies, within the observed period of 1970-1989. The economic outperformance of open economies can be witnessed within "economic growth, avoidance of extreme macroeconomic crises, and structural change." (Sachs & Warner, 1995). In Ben-David's 1993 paper "Equalizing Exchange: Trade Liberalization and Income Convergence", the author investigates the economic relationship between trade liberalization on income convergence (Ben-David, 1993). He analyzes the connection between trade openness and income disparities, by examining trade policy shifts across different countries. The main findings of the paper show, that increased trade liberalization leads to higher income divergence, especially for previously less developed economies. The paper "Trade Liberalization and Growth: New Evidence" extends Sachs and Warner's 1995 study to the 1990s and finds further evidence that trade liberalization is positively related to economic growth (Wacziarg & Welch, 2008). The research investigates the period of 1950-98 and shows, that countries experience higher average annual growth rates after liberalizing trade. The research also points out the necessity of political stability, to realize the benefits of trade liberalization.

3. Data and Methodology

Research Design

The paper aims to analyze the impact of Japan and Korea's trade liberalization policies on economic growth. Therefore, a comprehensive statistical analysis of the period 1970 up until 2020 is conducted. There are four variables in the analysis. The dependent variable is Gross Domestic Product, while the independent explanatory variables are Import, Export and Foreign Direct Investment (FDI). The quantitative data used to conduct the research originates from the

World Bank (see Appendix, Table 1 & 2). The economic data is limited to the time period of 1970 until 2020. Thereby, the development of trade liberalization can be observed within the variables, which progressed in the mid to late 20th century and lasts until today. Furthermore, the recent years of 2020 until today are not included, in order to prevent the data set from being distorted by the Covid-19 pandemic.

The quantitative analysis consists of statistical models, which measure the suitability of the variables and the data, as well as the relationship between the variables. After the models are applied, the findings are being analyzed, evaluated for causality and the model is tested. All the statistical models are performed using the programming language *R*. In the following, the variables and econometric models are further described.

Variables

Gross Domestic Product

In this model economic growth is measured by the Gross Domestic Product and its annual changes. The GDP is the sum of gross value added by all goods and services produced within a country's economy in a single year. The value of the GDP is expressed in current U.S. dollars, which is converted from domestic currencies, using single year official exchange rates.

GDP is an important measurement for the development of growth, since it illustrates the combined economic output within a country's borders. This includes both domestic companies, as well as foreign companies operating and producing within a country. Observed over time, it presents an economy's trajectory regarding output growth or contraction and helps to reflect economic dynamics. According to the development of GDP, policymakers can react and mitigate economic shocks, that pose a threat to the economy.

A growing GDP is indicative for a healthy economy, with growing production. Conversely, a declining GDP indicates economic contraction and alerts policy makers to intervene in the economy, to mitigate factors such as unemployment and inflation. Since GDP can be broken down into components, such as investments, government spending, exports and others, the driving forces behind output growth can be recognized. Thereby, vulnerable parts of the economy can get recognized, in order to make policy improvements that stimulate growth and lead to stability. To gain a better understanding of the standard of living within a country, GDP per capita can be derived by dividing the GDP by the population size. This metric offers

insights into factors such as income distribution and overall economic well-being. It helps policy makers to assess inequalities and improve the quality of life for a country's citizens. Therefore, GDP is commonly utilized as the most important indicator of economic growth and well-being.

Import

Perhaps the most relevant factor for trade liberalization are the imports of goods and services, which an economy purchases from the rest of the world. Those goods and services are brought to domestic territory for consumption, distribution or further production. Imports consist of goods such as raw materials, as well as intermediate and finished goods. Services consist of insurance, transport, information, communication and many others. They do not include the compensation of employees, investment income and transfer payments. Among the advantages of imports are access to resources and raw materials, economic efficiency, specialization and cost savings for consumers and businesses. Among the disadvantages are job displacements, dependency on foreign suppliers, competitiveness for domestic industries, as well as a trade deficit and debt. The data for this research is presented in current U.S. dollars.

Export

Contrary to imports, exports are the value of combined goods and services provided to the rest of the world. Similarly, the value of exports in the used data set are presented in current U.S. dollars. Exports are a primary driver of economic growth. They create job opportunities, as well as chances for market diversification, by entering different markets with varying demand. Due to the international competitiveness, export-oriented industries must improve their efficiency, which also leads to advantages in the domestic market. It goes along with technological advancement and increased productivity. Among the disadvantages of exports is the dependency on international markets. The dependence on international trading partners can imply risks, not only through increased competition, but also diplomatic relationships. If diplomatic relationships between two countries deteriorate, a decrease in demand for the opposing countries goods and services is a common response, which puts domestic industries under pressure. Furthermore, high export orientation makes economies more vulnerable to global economic downturns. Even if the global economic conditions do not directly impact the exporting economy, the downturn in demand of foreign markets in distress leads to decreased economic activity.

Foreign Direct Investment

Foreign direct investment refers to international investments with direct ownership stake, which goes along with control/ voting rights in an enterprise. It refers to business investments in the reporting economy, with ownership investments of at least 10 percent. The data for FDI is expressed in current U.S. dollars.

Through FDI mainly capital, but along with it usually also resources, technology and knowledge, is transferred from one country to another. The acquisition of equity in a foreign enterprise can be through common equity, joint ventures, mergers, acquisitions, as well as setting up subsidiaries in a foreign country. There are many reasons for companies or individuals to directly invest in foreign economies. These can be accessing new markets, acquiring foreign competitors or technology, gaining access to natural resources, taking advantage of lower labor and material costs, upon many others.

Through trade liberalization and the reduction of barriers for international investors, FDI is not only facilitated, but also promoted. FDI commonly leads to a transfer of technology, the creation of jobs, stronger diplomatic ties, and thereby creates economic growth. In order to attract FDI, governments commonly facilitate legal and regulatory frameworks for investors, in order to grant better access to the new markets and increase legal protection. FDI creates mutual benefits for both the investing company or individual, as well as the host country.

Data preparation and Econometric Models

Before the data can be used for analysis, it is prepared by performing a log transformation. Thereby, the logarithm of each data point is taken, in this example the natural logarithm (ln). The natural log transformation is used for variables that exhibit exponential growth patterns. Taking the logarithm helps to normalize the data and puts less emphasis on higher values. Additionally, it helps to stabilize the variance of the data and thereby mitigates heteroscedasticity. As a result, outliers have a lower risk of distorting statistical models.

After performing the natural log transformation and normalizing skewed distributions and stabilizing the variance, the data can be used for further analysis.

Unit Root Test - Augmented Dickey-Fuller

A unit root test is applied in time series analysis, to assess if a variable has a unit root, which indicates non-stationarity. Non-stationary data has a stochastic trend, which implies that the mean and variance of the data are not constant over time. Such non-stationary data can produce

unreliable results. Conversely, stationary data does not have a unit root and has stable statistical characteristics. Stationary data with a constant variance and mean can be used for further analysis.

The Augmented Dickey-Fuller (ADF) test is used to determine if a time series data set has a unit root, which indicates non-stationarity. If the data in a time series does have a unit root, it can be transformed into stationary data by differencing. Differencing is achieved by computing the differences between two consecutive observations of a data set. Thereby, a new series is created, which captures the changes within a time series. Differencing usually results in data with a unit root becoming stationary. If that is not the case, the differencing process is repeated. Within an ADF test, the critical values are determined by the sample size, as well as the specific form of the test. If the test statistic is below the critical value determined by the test, the null hypothesis is rejected, which indicates that the time series is stationary. Conversely, if it exceeds the critical values, the null hypothesis cannot be rejected, and the data is accepted as non-stationary.

Cointegration Test

The cointegration test assesses long-term equilibrium relationship between two or more non-stationary variables. Cointegration relationships imply that a long-term relationship between two or more variables in a time series exists, by having an underlying common stochastic trend. This common relationship between non-stationary variables suggests that through combination the variables become stationary. Testing for cointegration helps to differentiate between true long-term relationships and spurious correlations.

A common method for testing cointegration is the Johansen Cointegration Test. It extends the Engle-Granger two-step procedure and is applicable for tests involving more than two variables. Since it allows more than one cointegration relationship, it can be generally applied. The test carries out the maximum eigenvalue and trace test, to determine the cointegration rank r. If the rank is higher than 0, but smaller than the number of variables in the system, cointegration does exist in the model.

Vector Error Correction Model

The Vector Error Correction Model (VECM) is an extension of the Vector Autoregressive model (VAR). It is used for multiple non-stationary variables, which show cointegration. The VAR model assumes stationarity of variables, which is corrected in the VECM. The VECM includes an Error Correction Term, which takes deviations from the equilibrium into account. Thereby, it gives a better understanding of short- and long-term effects of deviations. Through the error correction, the VECM more accurately shows the dynamics of short and long run changes of variables.

Granger Causality Test

The Granger Causality Test is a method, which tests if the past values of a variable can be used to predict future values of another variable. If this is the case, there may be a causal relation between two variables. A significant Granger causal relationship does not imply a direct cause-and-effect relationship of the variables, but rather a predictive causality or the variables being temporally related. Therefore, the term causality has to be taken with a grain of salt and the test is used as an addition to the VECM, not the primary indicator.

Testing the model

In order to test the model, the data sets are divided into two data sets. The training data set consists of the first 40 years of data and is used to predict the values of the next 10 years. The predicted values are based on the previous calculations for the VECM. After the values are predicted, they are compared to the test data set, which depicts the last 10 years of data. The training data set is first tested for autocorrelation. The test for autocorrelation within the time series is conducted with the Ljung-Box Test. The test is conducted for each variable. If the test statistic is above the 5% significance level, a presence of autocorrelation can be rejected.

After testing the variables for autocorrelation, we compare the Akaike Information Criterion (AIC) and Bayesian Information Criterion or Schwarz Information Criterion (BIC) of the original VECM and the VECM of the training data set. The test statistic is used to estimate the quality of a model, compared to a different model. Thereby, we can compare the fit of the testing data to the original data set. At last the predicted values from our training data set are compared to the actual values of our test data set. The Root Mean Square Error (RMSE) measures the difference between the predicted and the actual observed values. In doing so, we

can see how far the predictions deviate from the real data set, which gives an impression of the accuracy of our model and the suitability of each variable.

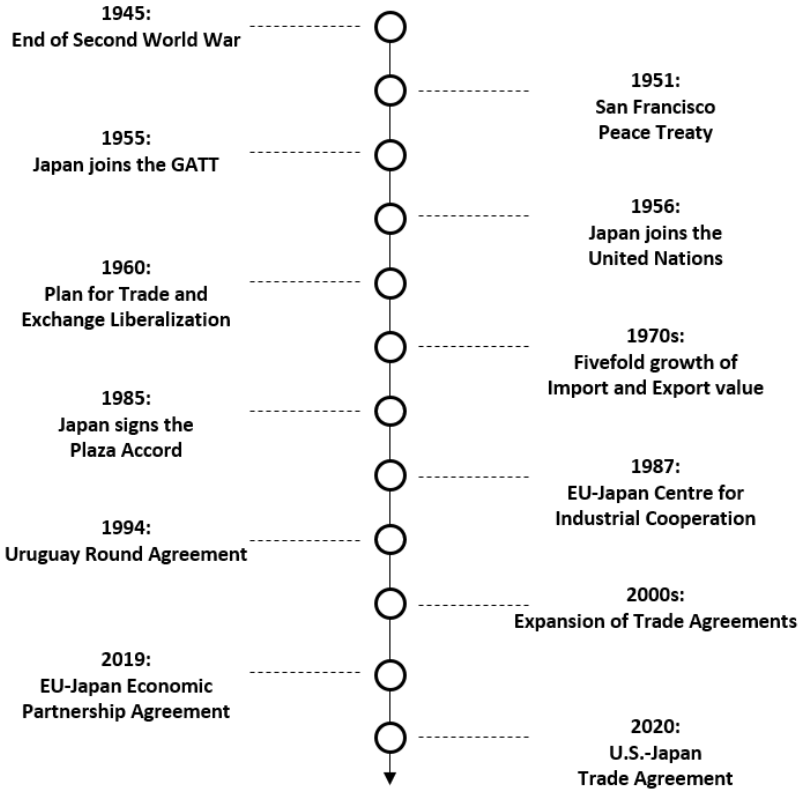
4. Historical Background

Japan after WWII: Facilitation of the Japanese economic miracle

Japan has a rich history of trade, which is centuries old and dates back to its feudal period. The country's history of international trade is in comparison relatively young. During the so called *sakoku*, which literally translates to *country in chains* or *closed country*, the country was almost completely shut off from other countries and the outside world. There were strict regulations and restrictions on travel and foreign trade, in order to secure domestic stability, as well as control and reduce the influence of other countries on the Japanese culture and economy. This period lasted from 1633 until 1853. Only in the late 19th century, Japan started to loosen its restrictions and increased foreign trade, as well as diplomatic engagement. With the motto *fukoku kyohei*, which translates to *rich country, strong army*, the Meiji government pursued policies of economic and military strength, through trade and industrialization.

After the Second World War, the Japanese economy was in shambles and was occupied by the Allied forces, following Japan's surrender on the 2nd of September 1945. The Allied forces helped to rebuild the country and quickly gave back control to the newly established government. After signing the San Francisco Peace Treaty in 1951, the Allied forces started to withdraw their troops and Japan started to rebuild its economy. What followed was the Japanese economic miracle, which primarily lasted from the 1950s to the 1980s. During this time Japan experienced incredible economic success and the country's population experienced a sharp rise in standard of living. The economic miracle, which resulted in Japan becoming the second largest economy in the world up until the 2000s, was the result of different economic and political factors.

Figure 1: Timeline of Japanese Post-War Economic Development



Administrative Guidance

The post-war government of Japan established strong cooperative ties between the public and private sector. This administrative guidance mainly consisted of three key players, which led the economic development: The ruling political administration, the business sector which is called *keiretsu* and the bureaucratic offices. This loosely organized relationship, with the goal of accelerating the industrialization, is known as the *Iron Triangle* (Katz, 1998).

The Liberal Democratic Party (LDP) was founded in 1955 and has almost exclusively been the ruling party in Japan since (Britannica, 2023). During the post-war period, the party legislated favorable policies for big corporations. In return, the business sector provided them with political funding, whereby they could maintain their position of power and remain in office.

Japan's economy is heavily focused on big businesses. These conglomerates are called *keiretsu*. They originate from the *zaibatsu*, which commonly were old family-led conglomerates. These *zaibatsu* were broken up by the Allied forces after the Second World War, in an effort to democratize the Japanese economy. Nevertheless, their influence remained and these keiretsu still dominate many sectors of the economy. Commonly these conglomerates are built around a core brand and consist of a complex network of subsidiaries and affiliated

firms. Some examples of such big business are the Toyota Group, the Mitsubishi Group and the Hitachi Group (Addicott, 2017). Within the Iron Triangle, these corporations worked closely with the government, whereby they could secure favorable bank loans, tax breaks, as well as the exemption from certain regulatory actions (Curtis, 1988).

The third component of the Iron Triangle is the government bureaucracy. Especially the bureaucrats of the Ministry of International Trade and Industry (MITI) provided private businesses with their expertise and supported them through government intervention measures. Thereby economic growth could be accelerated. In return, private businesses supported the bureaucrats in achieving favorable positions.

Strategic industrial policy

In order to strengthen the economy, especially in its export-oriented manufacturing sector, the Japanese government heavily intervened in the economy. Firms were incentivized to increase exports, by promoting research and development through government subsidies, as well as tax-incentives. Thereby, Japanese companies could broaden their potential customers beyond the domestic market and offer their goods internationally at a competitive level (Boltho & Boltho, 1985). Sectors that gained particular support by the government through industrial policy, were industries such as the steel industry, shipbuilding, as well as semiconductors. The semiconductor industry gained government support in the 1970s, due to the sharp increase in domestic and international demand. Japan managed to establish itself on the international market and quickly gained market share in the chip sector, through various government funding and projects. For example, they financed research projects between competing firms, to pool the knowledge and further develop the technology, without spilling knowledge to international competitors (Medina, 2011). Through these efforts, new innovations could be achieved and Japanese chip producers increased their international competitive advantage. By the end of the 1980s, Japanese companies accounted for over half of global semiconductor manufacturing.

Another example is the strategic development and protection of the automotive industry. The support reaches back to the 1930s, when the leading manufacturers like General Motors and Ford were forced to leave Japan. Instead, the government encouraged the *zaibatsu* to enter the automotive industry. Toyota was saved by the Bank of Japan after the companies bankruptcy in 1949 and the support continued throughout the 1950s and 60s. The major components of the strategy, which was lead by the *Iron Triangle*, were “early nurturing of the industry through protection and financing; attempts to rationalize industry production; and assistance with

exports and overseas marketing and distribution." (Magaziner, 1981). Thereby, Japan managed to become a leading manufacturer of automobiles and engines. The strategic policies declined in the 1970s, due to the success of the industry and the pressure of other global manufacturers.

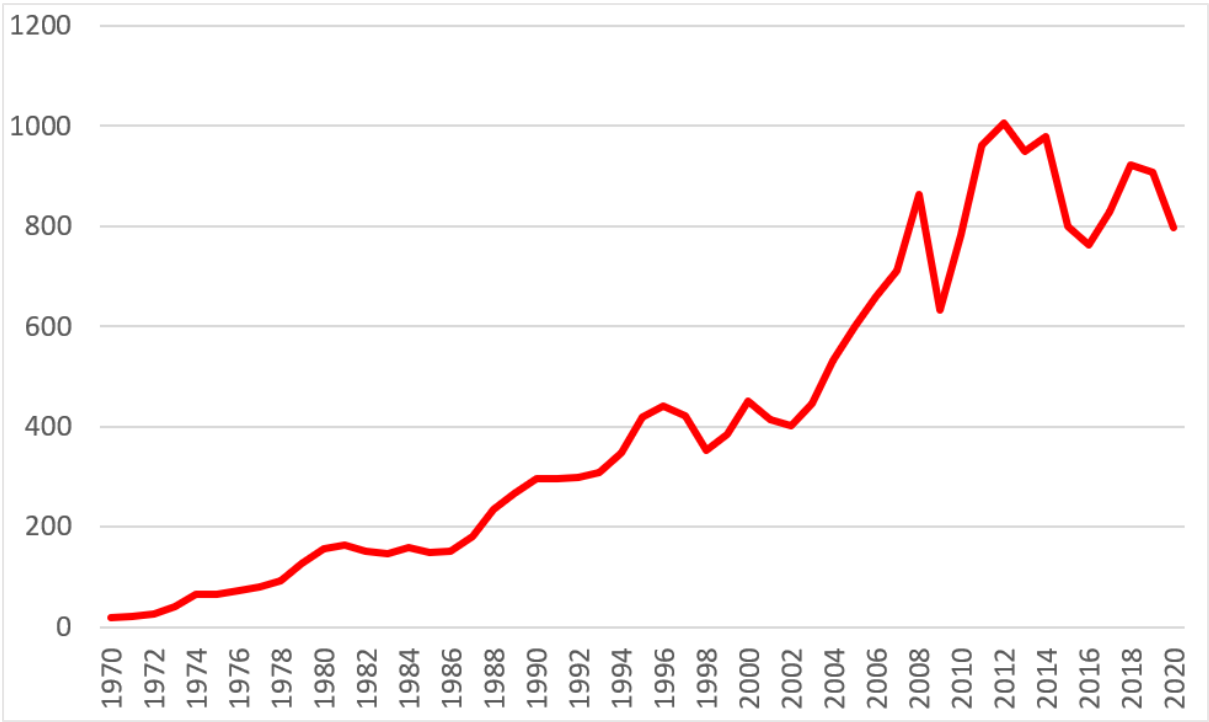
Economic reforms

Onward from the end of World War II, Japan undertook several economic reforms, in order to shift its economy towards export and liberalize trade. The first big step, that paved the way towards this development, was becoming a member of the General Agreement on Tariffs and Trade (GATT) in 1955. Thereby, Japan committed to reducing its trade barriers and tariffs. The lowered tariffs also facilitated export growth for Japanese manufacturers. Products such as automobiles and electronics gained broader access to international markets. Furthermore, by being a member of the GATT, Japan became a more attractive market for international investors. The inflow of not only foreign capital, but also foreign know-how, expanded the capabilities of the Japanese market. Market specific knowledge was transferred and improved production processes efficiency in the manufacturing sector. The increased competitiveness, which Japanese *keiretsu* faced, due to foreign competitors entering the market, resulted in innovation, as well as welfare benefits.
A year later in 1956, Japan also joined the United Nations, which further strengthened it as a member of the international community, regarding politics and trade. It was another step towards the end of Japan's post-war isolation and its return to a fully developed and independent nation. The membership of the United Nations served as a platform for diplomacy, international cooperation and peacekeeping efforts.

Due to Japan's successful economic recovery, the pressure on its economy from the IMF and other countries grew, regarding Japan's approach to international trade. As Japan's economy and industrial sectors became more competitive on the international stage, they were urged to further reduce its trade barriers and liberalize trade. In June 1960, the "Plan for Trade and Exchange Liberalization" (Boeki Kawase Jiyuka Keikaku) was approved (Takagi, 1997). This plan aimed at increasing Japan's liberalization ratio from 40 to 80%, in the span of three years. This goal was further raised to 90% in 1961. By 1962, Japan had already achieved a liberalization rate of 73% and in 1963, the ratio rose to 92%. Throughout the 1960s and 70s

the Japanese imports rose sharply. In the 1970s alone, the value of imports increased fivefold, as it can be seen in Figure 2.

Figure 2: Value of Japanese Imports in Billions of USD 1970-2020 (Macrotrends, 2023)



In 1985, Japan signed the Plaza Accord, along with the United States and several Western European economies. The objective of the accord, was to devalue the U.S. dollar, in order to reduce the United States' trade deficit with several nations, especially Japan. Due to Japan's heavily subsidized export sector, as well as intervention into its currency exchange rate, Japan had a large trade surplus with the United States, its most vital economic partner. The economic frictions, which were a result of Japan flooding the United States with highly competitive exports, the Plaza Accord was an effort to reduce the trade deficit and facilitate better conditions for American exports.

Japan and the European Union had their first ministerial meetings in the 1980s. With this, a closer cooperation between the two sides started. In 1987, the Japanese government and the European Union created the EU-Japan Centre for Industrial Cooperation (EU-Japan Centre for Industrial Cooperation, 2023). Organized as a non-profit organization, with headquarters in Tokyo and Brussels, the objective was to strengthen economic ties, as well as increase competitiveness among both industrial systems. Since 2019, Japan and EU have a free trade

agreement; the European Union-Japan Economic Partnership Agreement (EPA). Together, they build the world's largest open economic area.

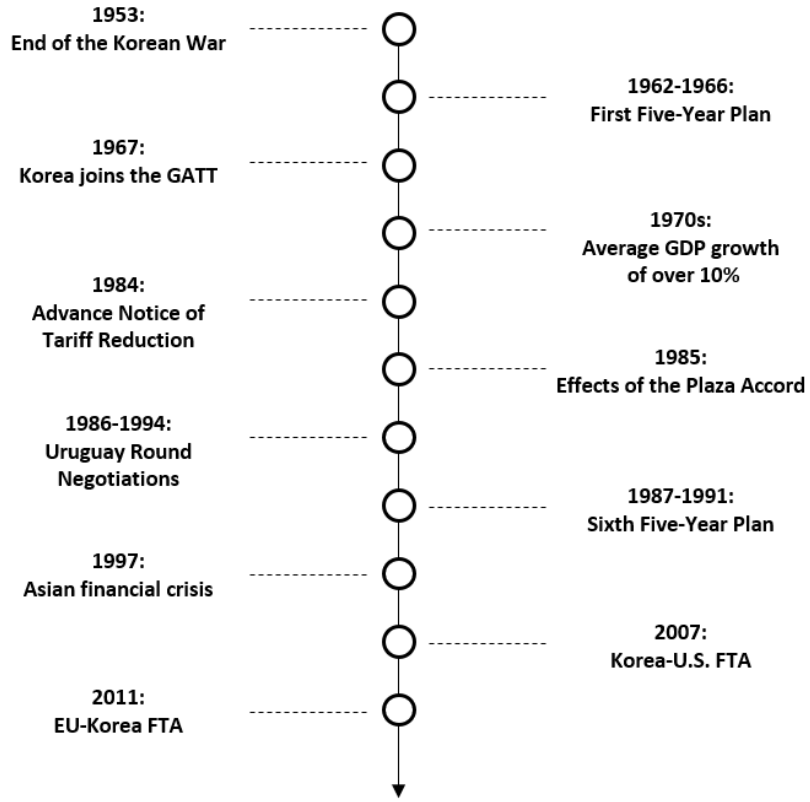
As of today, Japan has 21 active economic partnership agreements, with economies such as the EU, the U.S. and India. In the past decades, the Japanese government has constantly undertaken efforts to decrease trade barriers and incentivize foreign trade among all kinds of sectors.

Korea after the Korean War: The origin of the Miracle on the Han River

Post war economy and stabilization of the nation

The Korean War ended in 1953, which finalized the division between the North and the South of the Korean peninsula. The war had left South Korea, in the following just *Korea*, in ashes. The economy was in shambles, major infrastructure was destroyed and the people were left traumatized by the lasting conflicts. Many people had lost their lives, cities were destroyed and agricultural production had plummeted. Even though the war had ended, poverty and hunger left many people fighting for survival. Due to the severe humanitarian conditions, the first objective of the Korean post-war government was to rebuild and stabilize the nation.
In order to diminish historical disparities of land ownership, the new government took a new approach and initiated comprehensive land reforms. The government forced landlords into the sale of their farmland, which then was sold to farmers at favorable prices (Jeon & Kim, 2000). This Farmland Reform Act laid the foundation of a market based economy, as at the time the vast majority of the Korea population were farmers. These measures increased equality among the population and was one of the first steps of economic reconstruction (Haggard, 1990).

Figure 3: Timeline of Korean Post-War Economic Development



Industrialization through targeted policies

During the post-war era and the reconstruction of the country, the necessity of industrialization for economic growth was recognized. The government played a central role in the achievement of the rapid transformation of the economy, coming from mainly agricultural production, by implementing targeted policies and interventions (Amsden, 1992).

The Korean government concentrated on economic growth by focusing on heavy industries, such as steel, chemicals and ship building. These economic development plans were commonly drawn out in so called "Five-Year Plans". The Five-Year Plan, that focused on rapid industrialization through export oriented growth of heavy industries, lasted from 1967-1971 under President Park Chung-Hee. The plan aimed at export growth of manufactured goods, through government intervention and support (Chung, 1974).

Those targeted industries received financial support from the government, through subsidies, low interest loans, as well as favorable access to credit. Furthermore, the necessary infrastructure for these industries to excel were provided. Industrial parks and ports were built, as well as transportation networks to facilitate the movement of goods. Another measure that

was taken, was the investment into research and development. In cooperation with research institutions and universities, innovative technologies were fostered, which further primarily benefited the heavy industries. Thereby, the growth of these industries was nurtured. The growth and success of these heavy industries lead to Korea's export-oriented strategy of economic development (Wade, 1990).

While Korea emerged as an internationally competitive producer of heavy industry goods, and later also consumer goods, it still held onto a protectionist economic framework. The industrialization of the Korean economy facilitated the ability to partake in international trade, even though the government maintained significant trade barriers, tariffs and import restrictions. Through the adoption of import substitution industrialization policies (ISI), the reliance on foreign imports were reduced and domestic industries were favored. It also discouraged foreign competition, which gave local industries an advantage domestically, while still having the possibility to trade internationally. Tariff barriers were imposed on various goods, to protect the local economy and incentivize consumers to choose domestic products. Similarly, foreign direct investment (FDI) was tightly regulated. The inflow of foreign capital was kept to a minimum, whereby the control over key industries could be maintained.

The governmental guidance of key industries and the preferential treatment they were given, in combination with the protectionist approach to shield the domestic economy, lead to the rise of huge conglomerates within the Korean economy. Those conglomerates are called "chaebol", which can be translated to *rich business family*. Many of these companies started out as family owned businesses, of which many today are still in control by the descendants of the founding families. These conglomerates seized the opportunity of the post-war policies and grew to become gigantic corporations, covering a widely diversified range of industries and services. Chaebols take advantage of synergies, by broadly diversifying into multiple industries. Not only does the ownership of significant parts of the value chain result in cost effectiveness, but the wide range of service offerings also acts as a hedging strategy against economic fluctuations of single sectors.

An example is the chaebol Samsung, which nowadays is the largest company in Korea. The company was founded in 1938 as a small trading company. In the 1950s Samsung started to diversify its portfolio and entered the food processing, textile and retail sectors. Throughout the decades Samsung entered more and more markets. Nowadays it is best known as a leading manufacturer of smartphones and consumer electronics, but is also active in sectors such as semiconductors, healthcare, automotive and biotechnology (Britannica, 2023). Especially in

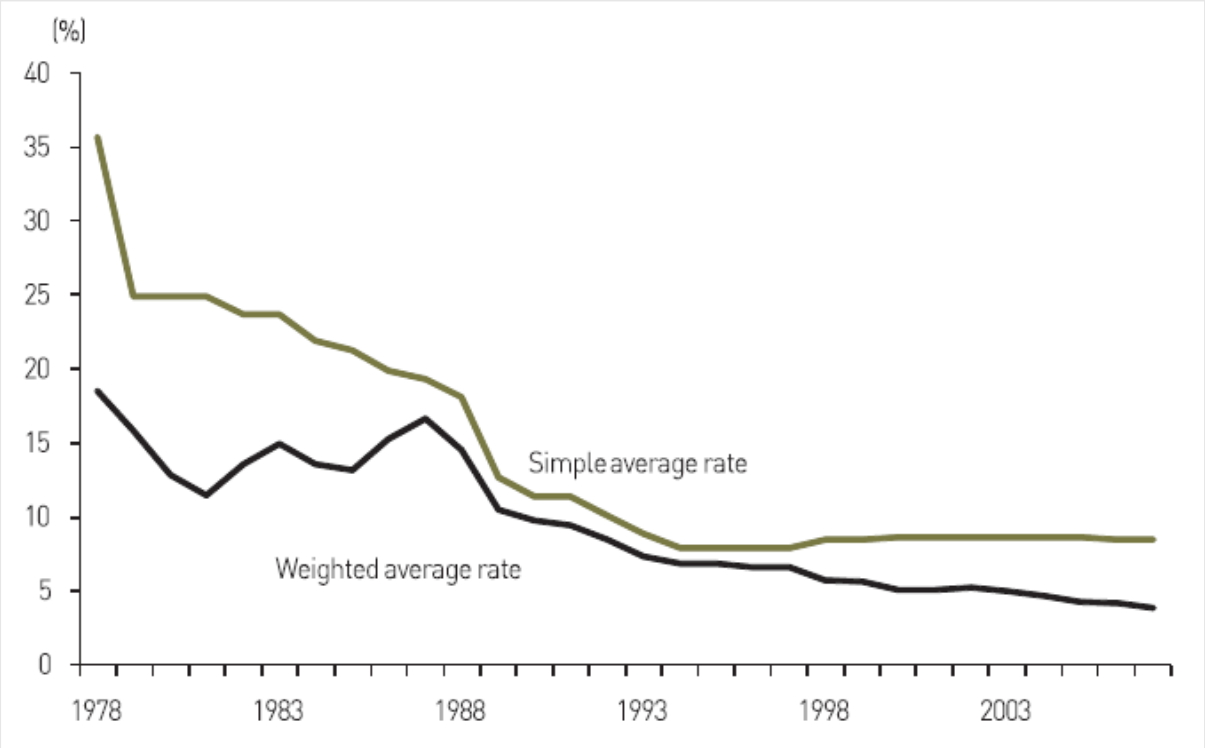
its home market, the service offerings far exceed what the brand is known for globally, and its revenue makes up a staggering 20% of the Korean GDP in 2021 (Statista, 2023).

Trade liberalization and international orientation

Exports rapidly rose in the 1960s, due to the government's efforts of export promotion. At first, the Korean government heavily promoted domestic production and exports, while simultaneously restricting imports. Programs such as the *Comprehensive Export Promotion Program* of 1964 further developed plans to improve international competitiveness. In the same year, the government devalued the Korean Won by around 50%. An effort to further strengthen export-oriented industries and boost economic growth.

A major step of Korea's trade liberalization, as well as its relevance on the international trading stage, was joining the General Agreement on Tariffs and Trade (GATT) in 1967. The GATT was created in 1947, to promote international trade and eliminate trade barriers and protectionist measures. It was originally signed by 23 nations and was in place until 1995, when it was replaced by the World Trade Organization (WTO) (WTO, 2023). Becoming a member of the GATT allowed Korea to gain increased access to global markets and further facilitated trade negotiations with other valuable member countries. In turn, Korea committed to reducing its tariffs and trade barriers, which promoted openness to investors. Overall, it made Korea a household name regarding global trade and the changes of the following years encouraged FDI.

Figure 4: Development of Korean tariffs in % from 1978-2007 (Il & Koh, 2010)



In the following years, the government reduced its approach of economic growth through export promotion in HCI (Heavy and Chemical Industry). Instead, it further shifted to a market-driven economy. In 1984, Korea introduced the Advance Notice of Tariff Reduction, whereby tariffs were gradually reduced over an 11 year period. Thereby, the Korean economy and especially the previously heavily subsidized industries, were prepared for the open-market approach and international competitors. The Uruguay Round (UR) negotiations, which lasted from 1986-1994, also heavily contributed to Korea's reduction of tariffs. Those negotiations were conducted within the framework of the GATT and involved 123 countries. As a result of the UR negotiations, Korea increased its share of tariff-free goods to 26% of total items; the average tariff rate dropped from 12.7% in 1989 to 7.9% in 1995 (Il & Koh, 2010).

The Plaza Accord of 1985 resulted in a sharp rise in value for the Japanese yen, which turned out to be beneficial for Korean exports. This increased the trade surplus of Korea with the U.S., which resulted in further tensions between the two countries. The U.S.' investigations under Section 301 of the Trade Act of 1974, caused Korea to further open its markets in the 1990s. The Sixth Five-Year Development Plan lasted from 1987-1991 and included further internationalization and liberalization measures, including easier access for FDI.

The 1997 Asian financial crisis involved many Asian economies, as well as Korea. The crisis was a result of fast growth among many Asian economies, which was largely fueled by high levels of debt. Since many of the involved financial systems were over-leveraged, they were very prone to external shocks. The Korean economy was built upon close ties between politicians and businesses, which resulted in careless management and overspending. Large business groups such as the chaebol were believed to be "too big to fail". In 1997, the Korean manufacturing sector had a debt-to-equity-ratio of 400%; twice as high as that of Japan or the U.S. (Lee, 2011). The financial crisis resulted in an economic contraction, which led to a decline in GDP, a rise of unemployment, as well as many businesses facing bankruptcy. Especially many chaebol had to undergo severe restructuring measures, in order to reduce their debt levels and maintain their solvency. Banks were forced to close or consolidate. The IMF agreed to a bailout program, which stabilized the Korean financial system. Together with the World Bank, the Asian Development Bank and other countries provided 58 billion USD to the Korean economy; at the time the largest rescue package in the history of the IMF (IMF, 2001). The funds were provided on the condition of macroeconomic measures the Korean government had to implement, such as interest rate increases and restructuring measures for the chaebol and financial sector.

Even though Korea experienced a severe economic downturn as a result of the financial crisis, with the help of the financial aid programs and restructuring measures, it managed to overcome the recession. Korea further continued its path of trade liberalization, which was boosted by the downturn. The decrease in value of Korean assets attracted international investors, and the volume of FDI further expanded. Korea began pursuing FTA policies, not only as a reaction to the aftermath of the crisis, but also to follow the example of international development. Many countries and regions started signing free trade agreements, in order to promote trade and economic cooperation. In order not to lose competitiveness and experience trade discrimination, mainly from the U.S. and the EU, Korea signed several FTAs. One of the most notable ones is the Korea-U.S. FTA (KORUS FTA) from 2007, with a total of 168 billion USD worth of goods and services traded in 2019 (USTR, 2023). Another being the EU-Republic of Korea FTA, which is in effect since 2011 and amounted to around 107 billion U.S. dollars of traded goods in 2021 (European Commission, 2023). Currently 21 FTAs with 59 countries have been concluded by the Korean government (Korea Customs Service, 2023).

5. Empirical Analysis: Models and Results for Japan and Korea

Unit Root Test

Before the data can be further analyzed, it has to be tested to stationarity. The stationarity of the data in the time series enhances the reliability and simplifies the modelling process. If the data does not appear to be stationary, it needs to be transformed accordingly. A unit root test is applied, to test the data for stationarity. In particular, the Augmented Dickey-Fuller test shows whether the data is already stationary, or if the data needs to be differenced in first order. The deterministic regressors are chosen based on the variables characteristics and if a trend can be observed. Before the unit root test can be conducted, the number of lags needs to be determined. The Akaike Information Criterion shows us the ideal number of lags for the time series.

The results of the Augmented Dickey-Fuller can be seen in Table 1 for Japan and Table 2 for Korea. The two tables below both show, that for the Japan data set two variables are non-stationary, while for the Korea data set all variables are non-stationary if they are simply logarithmized. Therefore, the first order difference is taken for all variables and the test is conducted again. After testing for the first order difference of the variables, we see that all variables are now stationary. The values are below the critical 5% level and the null-hypothesis can be rejected.

Table 1: Augmented Dickey-Fuller Unit Root Test for Japan

Variables	Test statistics	5% Critical Value	Deterministic regressors	Lags	Results
ln_GDP	-2.0784	-3.50	Constant + Trend	1	Non-stationary
ln_Imports	-3.7123	-3.50	Constant + Trend	1	Stationary
ln_Exports	-2.9603	-3.50	Constant + Trend	1	Non-stationary
ln_FDI	-3.6802	-3.50	Constant + Trend	1	Stationary
dln_GDP	-3.3648	-1.95	Constant	1	Stationary
dln_Imports	-3.8051	-1.95	Constant	1	Stationary
dln_Exports	-3.121	-1.95	Constant	1	Stationary
dln_FDI	-6.3338	-1.95	Constant	1	Stationary

After the unit root test shows the stationarity of the first order differenced variables, the data can be further analyzed.

Table 2: Augmented Dickey-Fuller Unit Root Test for Korea

Variables	Test statistics	5% Critical Value	Deterministic regressors	Lags	Results
ln_GDP	-1.6794	-3.50	Constant + Trend	1	Non-stationary
ln_Imports	-2.2213	-3.50	Constant + Trend	1	Non-stationary
ln_Exports	-2.9433	-3.50	Constant + Trend	1	Non-stationary
ln_FDI	-3.0136	-3.50	Constant + Trend	1	Non-stationary
dln_GDP	-2.6929	-1.95	Constant	1	Stationary
dln_Imports	-3.349	-1.95	Constant	1	Stationary
dln_Exports	-2.7081	-1.95	Constant	1	Stationary
dln_FDI	-6.4604	-1.95	Constant	1	Stationary

The number of lags has been previously selected using the Akaike Information Criterion (AIC) (see Appendix, Table 3 for Japan & Table 4 for Korea). Since the data is annual, a low level of lags is appropriate. The lag selection shows, that the ideal number of lags is 1, both for the Japan and Korea data set.

Cointegration Test

After having tested the variables for stationarity, they can be tested for cointegration. Thereby, the variables are tested for long-term relationships among each other and spurious correlations can be distinguished from meaningful statistical relationships. In order to test for cointegration, the Johansen cointegration test is applied to the data set. Unlike the Engle-Granger test, it permits more than one cointegration relationship. Therefore, it can be applied more generally, especially to data sets with multiple variables.

After performing the Johansen cointegration test, we see in Table 3 & 4 that there is one cointegration relationship among the variables of either data set. The data sets are tested by carrying out two tests; the maximum eigenvalue, as well as the trace test. They are used, to determine the cointegration rank of r^*. If the test statistic is below the 5% significance level at $r = 0$, it indicates no cointegration relationship. As we can see in the tables below, the test value for both data sets and both tests exceed the 5% significance level at $r = 0$. Therefore, at least one cointegration relationship exists.

Table 3: Johansen Cointegration Test for Japan

Number of cointegrating vectors	Trace Statistic	5 % Critical Value	Max-Eigen Value	5 % Critical Value
r = 0	70.92	53.12	38.97	28.14
r ≤ 1	31.95	34.91	18.09	22.00
r ≤ 2	13.86	19.96	12.19	15.67
r ≤ 3	1.67	9.24	1.67	9.24

At the cointegration rank of r ≤ 1, the test statistic in both the trace and maximum eigenvalue lies below the 5% significance level. Therefore, we can reject the null hypothesis, and conclude, that one cointegration relationship exists. This can be observed for the Japan as well as the Korea data set.

Table 4: Johansen Cointegration Test for Korea

Number of cointegrating vectors	Trace Statistic	5 % Critical Value	Max-Eigen Value	5 % Critical Value
r = 0	79.73	62.99	39.96	31.46
r ≤ 1	39.77	42.44	21.19	25.54
r ≤ 2	18.57	25.32	13.35	18.96
r ≤ 3	5.22	12.25	5.22	12.25

Due to the presence of a cointegration relationship among the variables, the VAR framework, under which the Johansen cointegration test is conducted, is transformed into a VECM.

Vector Error Correction Model

The Vector Error Correction Model is a combination of a Vector Autoregressive Model, with cointegration relationships. It allows us to examine short-term dynamics and long-term relationships among non-stationary variables. Since the variables have been previously tested as non-stationary, as well as having cointegration relationships, it is an accurate model for our data set.

The results of the VECM show a complex relationship between the dependent and independent variables, with deviating cause and effect relationships between the two countries. Differences between the directions of causal effects among the variables, show the individual characteristics of each economy.

The results of the VECM for the Japan data set in Table 5, show that the impact of the independent variables on the dependent variable is not significant at first sight. Significance can only be observed in other cause and effect relationships. This can be seen in GDP growth, which has a high impact on imports. A 1% increase in the previous period, increases Imports by 0.67%. Similarly, we see that import growth in the previous period, also results in growth in the current period. On the contrary, we see the negative impact of export growth on imports in the following year. An increase of exports by 1% in the previous period, results in a decrease of imports by 0.77%. A similar trend can observed for the impact of exports in the previous period, on current exports. Increasing exports by 1%, leads to a 0.66% decrease in exports in the following period. We can see a similar trend for increases in FDI, which decrease FDI in the following period by 0.34%. The Error Correction Term shows us that deviations from the equilibrium are quite quickly corrected, except for FDI. Since the significant values are negative, they adjust towards the equilibrium, whereby the deviations are reduced.

Table 5: Vector Error Correction Model for Japan

		Coefficient	**Standard Error**
ln_GDP	ln_GDP	0.0637	0.1472
	ln_Imports	-0.0258	0.1540
	ln_Exports	-0.1910	0.2128
	ln_FDI	0.0026	0.0091
	ECT	-0.0026***	0.0396
	Intercept	2.8354***	0.4895
ln_Imports	ln_GDP	0.6437**	0.2194
	ln_Imports	0.4768*	0.2296
	ln_Exports	-0.7697*	0.3173
	ln_FDI	0.0061	0.0136
	ECT	-0.1228*	0.0590
	Intercept	1.5547*	0.7297
ln_Exports	ln_GDP	0.2166	0.1897
	ln_Imports	0.3324	0.1985
	ln_Exports	-0.6577*	0.2744
	ln_FDI	0.0088	0.0118
	ECT	-0.1579**	0.0510
	Intercept	2.0079**	0.6310
ln_FDI	ln_GDP	-1.4517	2.4748
	ln_Imports	0.7566	2.5894
	ln_Exports	-2.3914	3.5789
	ln_FDI	-0.3413*	0.1533
	ECT	-0.1528	0.6651
	Intercept	2.2331	8.2309

The main observations of the VECM for the Japan data set, are the significant impact of GDP on imports and exports. This causal relationship can also be observed in the Granger Causality Test in Table 6. The relationship is positive with imports, meaning growth increases imports. However, with exports and adverse effect can be observed.

Table 6: Granger Causality Test for Japan

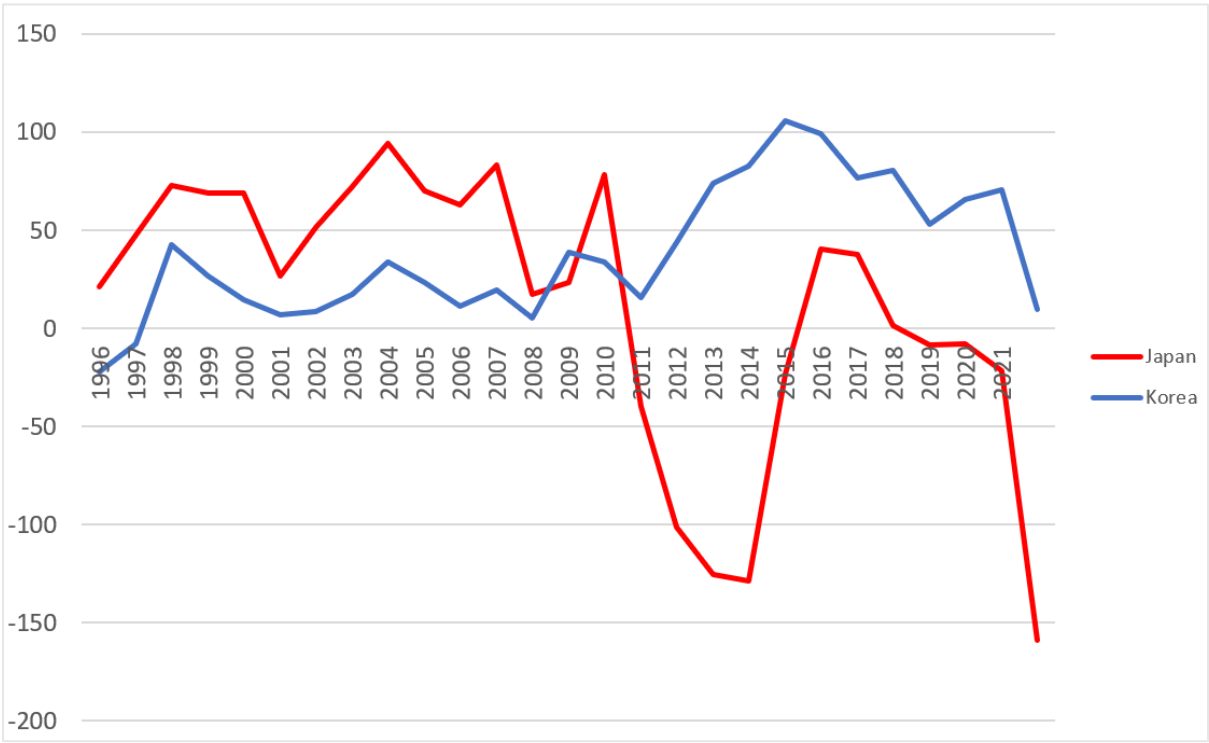
Null hypothesis, H0	P-Value	F-Test
dln_GDP does not Granger cause dln_Imports	**0.00009181**	16.775
dln_GDP does not Granger cause dln_Exports	**0.00959**	7.0059
dln_GDP does not Granger cause dln_FDI	0.1942	1.7108
dln_Imports do not Granger cause dln_GDP	0.05642	3.7353
dln_Imports do not Granger cause dln_Exports	0.9197	0.010213
dln_Imports do not Granger cause dln_FDI	0.3274	0.96961
dln_Exports do not Granger cause dln_GDP	0.6588	0.19623
dln_Exports do not Granger cause dln_Imports	0.6693	0.18367
dln_Exports do not Granger cause dln_FDI	0.1662	1.9482
dln_FDI does not Granger cause dln_GDP	0.4283	0.63306
dln_FDI does not Granger cause dln_Imports	0.7627	0.091684
dln_FDI does not Granger cause dln_Exports	0.5807	0.30736

These results for Japan can be explained by the characteristics of the Japanese economy and domestic market. Even though Japan is geographically secluded, they have a very strong domestic market. With its population of over 125 million people, it ranks fourth among the largest single country consumer markets in the world, with household final consumption expenditure of over 2.3 trillion dollars in 2022 (World Bank, 2024). Due to the size of its domestic market, Japan is less reliant on exports.

The Japanese economy shifted from mostly agricultural production after the Second World War, to mostly industrial goods nowadays. Especially highly specialized goods, such as machinery and vehicles. For other goods, Japan is heavily reliant on imports. Japan has very few natural resources, which are not sufficient to power the industrial sector, as well as provide

households with energy. Therefore, a lot of resources need to be imported by Japan, such as minerals, oil and coal (Santander, 2024). In 2020, Japan had an energy self-sufficiency ratio of only 11%. In comparison, countries like the U.S. and Australia have energy self-sufficiency of 100% (Lowy Institute, 2023). A similar dependency for Japan on imports can be observed for food. Japan's food self-sufficiency for 2022 was less than 40% (Jircas, 2024).

Figure 5: Net trade in goods and services, Japan and Korea from 1996 – 2022 in billion US$ (World Bank, 2024)



Japan's heavy reliance on imports can be observed in its net trade in goods and services. In Figure 5 we can see, that Japan mostly had a trade deficit in the past years. The trade deficit, among other factors, led to Japan accumulating a national debt of 255% in 2023 (Statista, 2024). The high dependency on foreign goods and services, as well as the considerable national debt accumulated, bear not only financial but also political risks, but have facilitated the tremendous economic uprising of the Japanese economy within the last decades. Therefore, the high volume of imports benefit the Japanese economy. They take advantage of cheap international goods and resources, and enable the industrial complex to focus on the production of goods and services of higher value.

The VECM for the Korea data set in Table 7 shows, that increases in GDP and exports lead to a significant growth of GDP in the following period. Increasing exports by 1%, increases GDP by 0.67% in the following period. Similarly, we can see the positive impact of GDP and export growth on imports and exports in the following period. The significance on export growth can also be observed in the positive Error Correction Term.

Meanwhile, the relationship with import growth is adverse. A 1% increase in imports, decreases GDP by 0.79% in the following period. Import growth also has negative impact on imports and exports in the following period.
For FDI no significant changes can be observed. Neither by the growth of either variable in a previous period, nor the impact of FDI on other variables.

Table 7: Vector Error Correction Model for Korea

		Coefficient	Standard Error
ln_GDP	ln_GDP	0.6790**	0.2334
	ln_Imports	-0.7868**	0.2276
	ln_Exports	0.6709***	0.1848
	ln_FDI	-0.0228	0.0183
	ECT	-0.0003	0.0004
	Intercept	0.0305	0.0282
ln_Imports	ln_GDP	0.8636**	0.3101
	ln_Imports	-0.8882**	0.3025
	ln_Exports	0.8494**	0.2456
	ln_FDI	-0.0280	0.0243
	ECT	-0.0002	0.0004
	Intercept	0.0109	0.0375
ln_Exports	ln_GDP	0.6378*	0.2434
	ln_Imports	-0.8740***	0.2374
	ln_Exports	0.7389***	0.1927
	ln_FDI	-0.0058	0.0191
	ECT	0.0014**	0.0004
	Intercept	0.1035**	0.0294
ln_FDI	ln_GDP	-0.3834	2.0711
	ln_Imports	1.8281	2.0201
	ln_Exports	-3.0516	1.6403
	ln_FDI	-0.1683	0.1622
	ECT	0.0002	0.0037
	Intercept	0.3746	0.2505

The Granger Causality Test for the Korea data set in Table 8, indicates a causal relationship between the GDP and Imports. Similarly we see a significant impact of Exports on Imports and vice versa. The findings show the importance of imports and exports, and the results of the VECM show the growth relationships of the variables.

Table 8: Granger Causality Test for Korea

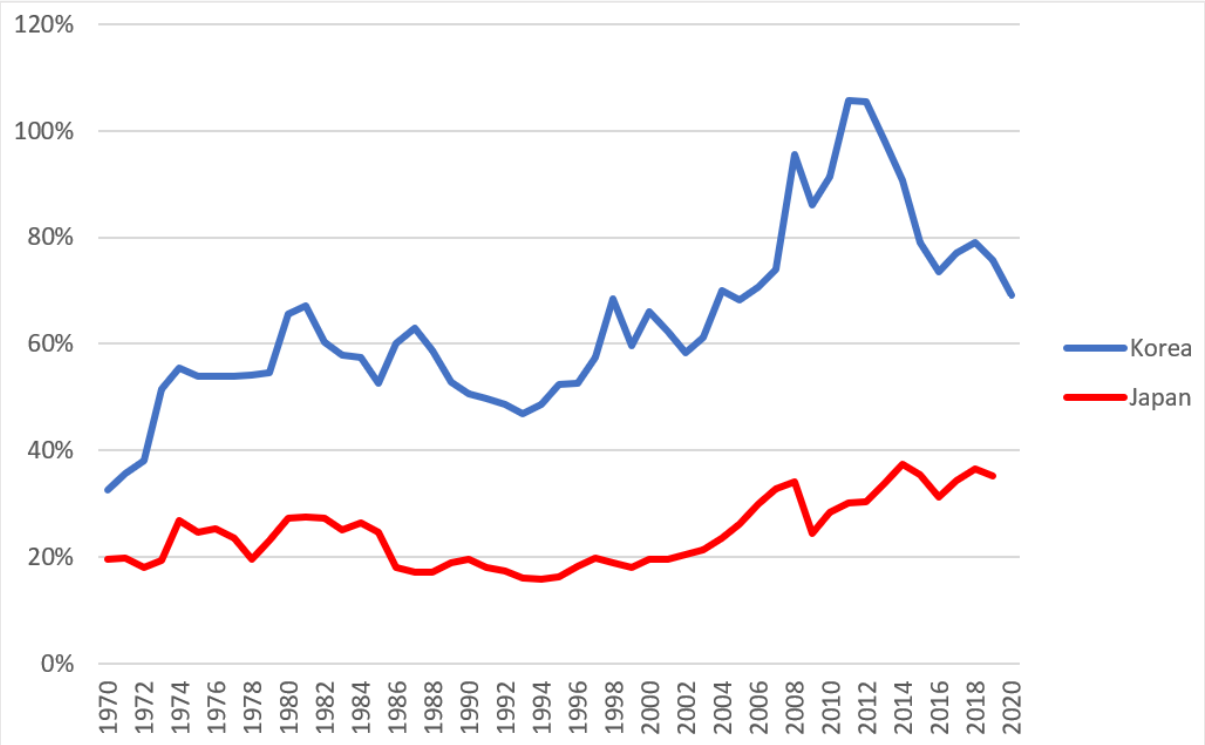
Null hypothesis, H0	P-Value	F-Test
dln_GDP does not Granger cause dln_Imports	**0.02358**	5.3042
dln_GDP does not Granger cause dln_Exports	0.8961	0.017135
dln_GDP does not Granger cause dln_FDI	0.619	0.24896
dln_Imports do not Granger cause dln_GDP	0.1406	2.2099
dln_Imports do not Granger cause dln_Exports	**0.02507**	16.954
dln_Imports do not Granger cause dln_FDI	0.579	0.31014
dln_Exports do not Granger cause dln_GDP	0.1277	2.3642
dln_Exports do not Granger cause dln_Imports	**0.002963**	9.3318
dln_Exports do not Granger cause dln_FDI	0.1114	2.5842
dln_FDI does not Granger cause dln_GDP	0.9149	0.01147
dln_FDI does not Granger cause dln_Imports	0.8782	0.023619
dln_FDI does not Granger cause dln_Exports	0.1365	2.2574

The main findings of the analysis for Korea, are the positive impact of exports on growth and the adverse relationship of imports on growth. Even though Korea is less dependent on imports than Japan, it still relies on energy imports, electronic equipment and other goods (Trading Economics, 2024). Due to their higher self-sufficiency, the imported goods proportionally constitute a bigger threat to domestic businesses. Even though the analysis shows, that the imports reduce GDP growth, the positive indirect advantages of imports cannot be disregarded. Those are access to a broader variety of goods, cost savings and consumer welfare, technological transfer, as well as others.

The positive aspects on exports on the other hand, can be more directly linked to growth. As we have previously seen, Korea's export growth has a significant positive effect on GDP growth. Looking at Korea's overall trade patterns, we can see in Figure 5, that for the past 20 years, Korea consistently experienced positive net trade in goods and services. Their primary

exports are consumer electronics, vehicles, as well as machinery (Trading Economics, 2024). Their positive trade balance and general engagement in international trade, enabled Korea to substantially grow their economy in the past decades. But the high engagement in foreign trade also bears risks. As we can see in Figure 6, Korea has a very high trade openness. Trade openness expresses the combined imports and exports, in relation to the GDP. Korea's trade openness has been rising quite steadily in the past until the 2010s, due to their increased trade liberalization efforts. Reaching trade openness of over 100% in the early 2010s, we can see the vulnerability of Korea's economy and foreign trade activity to external shocks. In comparison, we can see that Japan's trade openness is less than half of Korea's, due to its strong domestic economy and consumer market.

Figure 6: Trade Openness in %, Japan and Korea from 1970 – 2020 (World Bank, 2022)



This exposure to foreign trade has paid off for Korea, with high export-led economic growth in the past decades. But it also leaves the economy vulnerable to foreign impact, that pose a permanent threat at the current level of dependency on foreign trade for growth.

Testing the model

The results of the empirical model are tested by dividing the data set into a training data set and a test data set. The training data set consists of the values for the years 1970 – 2009 of each country. The test data set consists of the values for the years 2010 – 2019 for each country. In order to predict the values of the test data set, we use the training data set's calculations of the VECM.

Table 9: Ljung-Box Test for Japan

Variable	P-value
ln_GDP	0.4162
ln_Import	0.8889
ln_Export	0.6321
ln_FDI	0.6573

The results for the Ljung-Box Test show, that the residuals of both Japan and Korea's variables do not exhibit autocorrelation. The p-values of the tested variables for Japan in Table 9 and the results for Korea in Table 10 are all above the 5% significance level.

Table 10: Ljung-Box Test for Korea

Variable	P-value
ln_GDP	0.8791
ln_Import	0.4801
ln_Export	0.4079
ln_FDI	0.6445

When we look at the AIC and BIC for each training data set's corresponding VECM, we see that the values are higher than for the original full data set (see Appendix, Table 13 for Japan & Table 14 for Korea). The results are as expected, since the original data set is bigger and therefore a more accurate and better fit for the model.

The last step is to compare the predicted values from the training data set, to the actual data of the test data set. The calculation of the Root Mean Square Error (RMSE) shows us the square root of the average of the squared errors. Thereby, we see how far on average the predicted values deviate from the actual values. The results for Japan and Korea are quite similar.

Table 11: RMSE for Japan

Variable	Root Mean Square Error
ln_GDP	0.194168
ln_Import	0.3205162
ln_Export	0.1924559
ln_FDI	3.086363

In Table 11 for Japan and Table 12 for Korea we can see, that the predicted values for the dependent variable GDP and the independent variables Import and Export are relatively close to the actual values of the data set. Meanwhile, the predicted values for the variable FDI and the actual values are significantly deviated. These results confirm the previous findings of the VECM. For both countries, the results of the VECM for the variable FDI have been mostly insignificant.

Table 12: RMSE for Korea

Variable	Root Mean Square Error
ln_GDP	0.2472789
ln_Import	0.3473361
ln_Export	0.3141456
ln_FDI	1.908745

These results show, that the variables GDP, Import and Export are appropriate for the model. They can be used for forecasting and have shown to significantly influence each other, while not being autocorrelated. The impact of FDI in the model is not significant and the results are not meaningful for accurately explaining the other variables.

6. Conclusion

The main objective of this study, has been to analyze the economic growth effects of the post-war trade liberalization of Japan and Korea. Both economies underwent significant changes in their respective post-war era, to shift the economic focus towards industrialization and production of highly developed goods and services. Therefore, the relationship between foreign trade and investments, and economic growth has been examined, to find cause and effect

relationships, that explain the extraordinary economic growth of the two economies in the past 50 years.

Within the last 50 years, both Japan and Korea have liberalized most of their trade and are among the biggest and most important economies engaging in foreign trade. Japan's development towards free trade started after the Second World War. Japan joined the GATT and the United Nations, and progressively reduced trade barriers. Today, most of Japan's traded goods and services are liberalized and the country has over 20 active economic partnership agreements. The European Union-Japan Economic Partnership Agreement currently covers 40% of global trade.

Korea started to shift their economy towards industrialization after the Korean War in 1953, and soon started to engage in international trade. Their export-led growth transformed the economy to produce in the area of heavy industries, according to international demand. Due to their high export surplus, the pressure by foreign trade partners on Korea to reduce trade barriers and increase imports grew. Korea joined the GATT, gradually reduced its trade barriers and recorded extraordinary economic growth in the second half of the 20th century. Today, Korea has free trade agreements with over 50 countries; notable among those are the EU, as well the U.S.

The empirical model, as well as the tests of it have shown, that for the variables GDP, Import and Export significant cause and effect relationships could be observed. The impact of FDI has been mostly insignificant. The findings of the empirical analysis were quite different for the two economies. Even though Japan and Korea share similar characteristics, they benefit differently from their liberalized trade. The empirical model showed, that neither import nor export growth has a direct significant impact on GDP growth for Japan. But it showed, that GDP growth has a positive impact on imports, whereas export growth has an adverse effect on imports. The findings for the positive relationship with imports can be explained by the import patterns and reliance on imported goods of the Japanese economy. In the past years, Japan mostly had a trade deficit, as the value of goods and services imported is higher than the country's exports. Japan is heavily reliant on imports of energy, and only has an energy self-sufficiency of around 10%. Due to the strong domestic market, Japan is less reliant on exports for economic growth.

Japan's high reliance on imports and the accumulated national debt, make their economy vulnerable to import disruptions. Nevertheless, they have benefitted, and continue to do so, from cheap imports, which has been an important factor in their economic growth.

Korea on the other hand primarily benefits through their exports. Export growth can be directly linked to GDP growth, whereas import growth has an adverse effect. Even before Korea started to heavily liberalize their trade, the primary driver of economic growth was their access to international markets and the engagement in foreign trade. Exports allowed Korea to expand to new markets and boost their economic growth. Imports cannot be directly linked to economic growth, but increase product variety, cost savings, as well as technological transfer. Korea's high dependence on foreign trade can be seen in their trade openness, which has been around 75% in 2019. Even though the dependence on foreign markets for trade makes the Korean economy vulnerable to external demand, their export-led growth has been substantial in the economic upswing of the past decades.

As the findings of the empirical model have shown, even economies with similar characteristics and economic development profit differently from trade liberalization. These findings demonstrate, that the individual characteristics of economies can have a significant impact on the way they profit from foreign trade. The analysis has shown, that mitigating foreign trade risks is crucial, to be protected from external shocks. Overall, the act of trade liberalization has proven to be beneficial in the long-run. Not only in this analysis, but generally for economic growth. In conclusion, taking advantage of foreign demand and supply and realizing economic efficiencies fosters economic growth, promotes innovation, strengthens diplomatic ties, and leads to a shared prosperity for the participating nations.

Bibliography

Addicott, D. A. C., 2017. The Rise and Fall of the Zaibatsu: Japan's Industrial and. *Global Tides,* Volume 11, p. Article 5.

Aghion, P. & Howitt, P., 1992. A Model of Growth Through Creative Destruction. *Econometrica,* 60(2), pp. 323-351.

Amsden, A. H., 1992. *Asia's Next Giant: South Korea and Late Industrialization.* s.l.:s.n.

Ben-David, D., 1993. Equalizing Exchange: Trade Liberalization and Income Convergence. *The Quartely Journal of Economics,* 108(3), pp. 653-679.

Boltho, A. & Boltho, A., 1985. Was Japan's industrial policy successful?. *Cambridge Journal of Economics,* 9(2), pp. 187-201.

Britannica, 2023. *Liberal-Democratic Party of Japan.* [Online]
Available at: https://www.britannica.com/topic/Liberal-Democratic-Party-of-Japan
[Accessed October 2023].

Britannica, 2023. *Samsung as a global company.* [Online]
Available at: https://www.britannica.com/topic/Samsung-Electronics/Samsung-as-a-global-company
[Accessed October 2023].

Chung, K. H., 1974. Industrial Progress in South Korea. *Asian Survey,* 14(5), pp. 439-455.

Curtis, G. L., 1988. *The Japanese Way of Politics.* s.l.:Columbia University Press.

Dickey, D. A. & Fuller, W. A., 1979. Distribution of the Estimators for Autoregressive Time Series With a Unit Root. *Journal of the American Statistical Association,* 74(366), pp. 427-431.

Dickey, D. A. & Fuller, W. A., 1981. Likelihood Ratio Statistics for Autoregressive Time Series with a Unit Root. *Econometrica,* 49(4), pp. 1057-1072.

EU-Japan Centre for Industrial Cooperation, 2023. *EU-Japan Centre.* [Online]
Available at: https://www.eu-japan.eu/
[Accessed October 2023].

European Commision, 2022. *Negotitations and agreements.* [Online]
Available at: https://policy.trade.ec.europa.eu/eu-trade-relationships-country-and-region/negotiations-and-agreements_en

European Commission, 2022. *EU27 Trade in Goods by partner (2021, excluding intra-EU trade).* [Online]
Available at: https://trade.ec.europa.eu/doclib/docs/2006/september/tradoc_122530.pdf

European Commission, 2023. *South Korea.* [Online]
Available at: https://policy.trade.ec.europa.eu/eu-trade-relationships-country-and-region/countries-and-regions/south-korea_en
[Accessed October 2023].

European Union, 2022. *Facts and figures on life in the European Union.* [Online]
Available at: https://european-union.europa.eu/principles-countries-history/key-facts-and-figures/life-eu_en

Frankel, J. A. & Romer, D. H., 1999. Does Trade Cause Growth?. *American Economic Review,* 89(3), pp. 379-399.

Frankel, J. A. & Romer, D. H., 1999. Does Trade Cause Growth?. *American Economic Review,* 89(3), pp. 379-399.

Granger, C. W. J., 1969. Investigating Causal Relations by Econometric Models and Cross-spectral Methods. *Econometrica,* Volume 37, pp. 424-438.

Grossman, G. M. & Helpman, E., 1991. Trade, knowledge spillovers, and growth. *European Economic Review,* 35(2-3), pp. 517-526.
Haggard, S., 1990. *Pathways from the Periphery: The Politics of Growth in Newly Industrializing Countries.* s.l.:s.n.
Il, S. & Koh, Y., 2010. Expansion of economic liberalization and globalization. In: *The Korean Economy: Six Decades of Growth and Development.* s.l.:s.n., pp. 137-139.
IMF, 2001. *Korean Crisis and Recovery,* s.l.: International Monetary Fund and.
Jeon, Y.-D. & Kim, Y.-Y., 2000. Land Reform, Income Redistribution, and Agricultural Production in Korea. *Economic Development and Cultural Change,* 48(2), pp. 253-268.
Jircas, 2024. *Trends and Outlook of Food Self-Sufficiency Ratio — Toward Revision of the Basic Law on Food, Agriculture and Rural Areas.* [Online]
Available at: https://www.jircas.go.jp/en/program/proc/blog/20240131#:~:text=However%2C%20as%20of%20FY2022%2C%20Japan%27s,food%20self%2Dsufficiency%20among%20nations.
[Accessed February 2024].
Katz, R., 1998. *Japan, the System That Soured.* 1st ed. s.l.:s.n.
Korea Customs Service, 2023. *FTA Trend in Korea.* [Online]
Available at: https://www.customs.go.kr/engportal/cm/cntnts/cntntsView.do?mi=7304&cntntsId=2329#:~:text=Currently%2C%2021%20FTAs%20have%20been,59%20countries(effectuated%20and%20agreed
[Accessed October 2023].
Lee, K.-S., 2011. *The Korean Financial Crisis of 1997.* s.l.:World Bank Publications.
Lowy Institute, 2023. *Lowy Institute Asia Power Index.* [Online]
Available at: https://power.lowyinstitute.org/data/resilience/resource-security/energy-selfsufficiency/
[Accessed February 2024].
Macrotrends, 2023. *Japan Imports 1970-2023.* [Online]
Available at: https://www.macrotrends.net/countries/JPN/japan/imports
[Accessed October 2023].
Magaziner, I. C., 1981. Japanese Industrial Policy: Source of Strength for the Automobile Industry. In: R. E. Cole, ed. *The Japanese Automotive Industry.* s.l.:University of Michigan Press, p. 80.
Medina, C., 2011. The US and Japanese Semiconductor Industries, 1970-2002. *Journal for Global Business and Community,* 2(1), pp. 43-45.
Rodriguez, F. & Rodrik, D., 2000. Trade Policy and Economic Growth: A Skeptic's Guide to the Cross-National Evidence. *NBER Macroeconomics Annual 2000,* Volume 15, pp. 261-338.
Rodriguez, F. & Rodrik, D., 2000. Trade Policy and Economic Growth: A Skeptic's Guide to the Cross-National Evidence. *NBER Macroeconomics Annual,* Volume 15, pp. 261-338.
Romer, P. M., 1990. Endogenous Technological Change. *Journal of Political Economy,* 98(5), pp. 71-102.
Sachs, J. D. & Warner, A. M., 1995. In: *Economic Reform and the Process of Global Integration.* s.l.:s.n., p. 35.
Santander, 2024. *Japanese foreign trade in figures.* [Online]
Available at: https://santandertrade.com/en/portal/analyse-markets/japan/foreign-trade-in-figures#:~:text=The%20country%27s%20main%20imports%20include,%2D%20data%20Com

trade%20for%202022).
[Accessed February 2024].
Smith, A., 1776. *The wealth of nations.* s.l.:s.n.
Solow, R. M., 1956. A Contribution to the Theory of Economic Growth. *The Quartely Journal of Economics,* 70(1), pp. 65-94.
Statista, 2023. *Revenue of leading affiliates of Samsung Group as percentage of gross domestic product (GDP) in South Korea from 2017 to 2021.* [Online]
Available at: https://www.statista.com/statistics/1314374/south-korea-samsung-groups-revenue-as-a-share-of-gdp/
[Accessed October 2023].
Statista, 2024. *Japan: National debt from 2018 to 2028 in relation to gross domestic product.* [Online]
Available at: https://www.statista.com/statistics/267226/japans-national-debt-in-relation-to-gross-domestic-product-gdp/
[Accessed February 2024].
Takagi, S., 1997. *Japan's Restrictive System of Trade and Payments: Operation, Effectiveness, and Liberalization, 1950-1964,* s.l.: International Monetary Fund.
Trading Economics, 2024. *South Korea Exports By Category 2022.* [Online]
Available at: https://tradingeconomics.com/south-korea/exports-by-category
[Accessed February 2024].
Trading Economics, 2024. *South Korea Imports By Category.* [Online]
Available at: https://tradingeconomics.com/south-korea/imports-by-category
[Accessed February 2024].
USTR, 2023. *U.S. - Korea Free Trade Agreement.* [Online]
Available at: https://ustr.gov/trade-agreements/free-trade-agreements/korus-fta
[Accessed October 2023].
Wacziarg, R. & Welch, K. H., 2008. Trade Liberalization and Growth: New Evidence. *The World Bank Economic Review,* 22(2), pp. 187-231.
Wade, R., 1990. *Governing the Market: Economic Theory and the Role of Government in East Asian Industrialization.* s.l.:Princeton University Press.
World Bank, 2021. *GDP growth (annual %).* [Online]
Available at: https://data.worldbank.org/indicator/NY.GDP.MKTP.KD.ZG?locations=KR
World Bank, 2022. *Exports of goods and services (current US$) - Japan.* [Online]
Available at: https://data.worldbank.org/indicator/NE.EXP.GNFS.CD?locations=JP
World Bank, 2022. *Exports of goods and services (current US$) - Korea, Rep..* [Online]
Available at: https://data.worldbank.org/indicator/NE.EXP.GNFS.CD?locations=KR
World Bank, 2022. *Foreign direct investment, net inflows (BoP, current US$) - Japan.* [Online]
Available at: https://data.worldbank.org/indicator/BX.KLT.DINV.CD.WD?locations=JP
World Bank, 2022. *Foreign direct investment, net inflows (BoP, current US$) - Korea, Rep..* [Online]
Available at: https://data.worldbank.org/indicator/BX.KLT.DINV.CD.WD?locations=KR
World Bank, 2022. *GDP (current US$) - Japan.* [Online]
Available at: https://data.worldbank.org/indicator/NY.GDP.MKTP.CD?locations=JP
World Bank, 2022. *GDP (current US$) - Korea, Rep..* [Online]
Available at: https://data.worldbank.org/indicator/NY.GDP.MKTP.CD?locations=KR
World Bank, 2022. *Import of goods and services (current US$) - Japan.* [Online]
Available at: https://data.worldbank.org/indicator/NE.IMP.GNFS.CD?locations=JP

World Bank, 2022. *Import of goods and services (current US$) - Korea, Rep..* [Online]
Available at: https://data.worldbank.org/indicator/NE.IMP.GNFS.CD?locations=KR
World Bank, 2024. *Household and NPISHs Final consumption expenditure.* [Online]
Available at: https://data.worldbank.org/indicator/NE.CON.PRVT.CD?locations=JP-KR&year_high_desc=true
[Accessed February 2024].
World Bank, 2024. *Net trade in goods and services (BoP, current US$) - Japan, Korea, Rep..* [Online]
Available at:
https://data.worldbank.org/indicator/BN.GSR.GNFS.CD?end=2022&locations=JP-KR&start=1997
[Accessed February 2024].
WTO, 2023. *What is the World Trade Organization?.* [Online]
Available at:
https://www.wto.org/english/thewto_e/whatis_e/tif_e/fact1_e.htm#:~:text=The%20WTO%20began%20life%20on,50th%20anniversary%20of%20the%20system.)
[Accessed October 2023].

Appendix

Table 1: GDP, Import, Export and FDI data for Japan from 1970 - 2019 (World Bank, 2022)

Year	GDP	Import	Export	FDI
1970	212.609.187.919,44	19.572.635.780,56	22.026.785.841,67	94.000.000,00
1971	240.151.807.460,24	20.867.004.112,32	26.966.713.726,02	210.000.000,00
1972	318.031.297.492,35	25.436.329.221,81	32.270.972.030,77	169.000.000,00
1973	432.082.670.450,72	41.807.597.571,16	41.576.284.285,30	-42.000.000,00
1974	479.625.998.613,41	66.503.972.918,61	62.536.307.378,91	202.000.000,00
1975	521.541.905.673,25	64.302.596.002,19	63.986.133.887,04	226.000.000,00
1976	586.161.858.999,67	72.270.446.349,30	76.182.443.149,19	113.000.000,00
1977	721.411.786.536,81	79.894.824.196,49	90.568.192.249,82	21.000.000,00
1978	1.013.612.173.518,84	91.906.326.825,91	108.052.061.240,71	8.000.000,00
1979	1.055.012.119.526,33	127.175.652.404,86	116.997.148.836,36	239.000.000,00
1980	1.105.385.973.763,87	155.866.963.510,76	145.104.895.104,90	278.000.000,00
1981	1.218.988.935.129,81	164.658.527.096,28	172.134.410.830,35	189.000.000,00
1982	1.134.518.001.884,56	151.713.508.328,96	157.933.279.186,69	439.000.000,00
1983	1.243.323.592.058,83	146.249.637.386,29	165.329.539.555,32	416.000.000,00
1984	1.318.381.627.003,76	157.511.814.670,19	189.758.022.924,14	-10.000.000,00
1985	1.398.892.744.820,69	149.721.341.618,32	194.351.120.460,74	608.713.150,22
1986	2.078.953.333.673,55	150.490.328.139,48	226.865.329.771,34	242.107.761,69
1987	2.532.808.573.157,03	181.576.008.987,99	251.700.285.195,75	1.177.422.254,18
1988	3.071.683.013.178,91	233.782.306.438,39	294.106.125.786,86	-483.800.486,92
1989	3.054.914.166.263,18	267.623.386.902,71	308.916.648.062,83	-1.059.696.732,48
1990	3.132.817.652.848,04	295.830.930.469,47	320.186.473.746,91	1.806.039.007,68
1991	3.584.420.077.100,84	297.072.083.274,25	350.804.377.213,61	1.284.268.820,48
1992	3.908.809.463.463,86	298.544.112.851,59	378.894.650.114,13	2.755.603.982,60
1993	4.454.143.876.947,21	308.939.565.351,11	404.418.972.317,80	210.435.439,49
1994	4.998.797.547.740,97	348.440.138.619,56	441.885.061.609,78	888.384.470,88
1995	5.545.563.663.889,70	420.000.722.945,88	488.922.980.748,38	41.463.072,35
1996	4.923.391.533.851,63	440.058.798.059,55	458.650.604.757,72	-38.203.596,34
1997	4.492.448.605.638,94	422.282.171.634,40	466.482.189.982,88	2.486.935.040,42
1998	4.098.362.709.531,24	353.663.297.055,20	425.156.200.703,87	2.512.021.924,47
1999	4.635.982.224.063,88	385.717.972.939,28	454.583.045.085,98	14.780.510.030,71
2000	4.968.359.075.956,59	452.064.900.176,77	519.863.963.884,55	10.688.168.325,61
2001	4.374.711.694.090,87	414.845.357.770,87	440.830.946.383,95	4.926.033.619,18
2002	4.182.846.045.873,61	401.205.059.495,33	454.066.577.343,92	11.557.373.873,94
2003	4.519.561.645.253,53	445.643.407.643,18	518.203.970.379,57	8.771.535.612,32
2004	4.893.116.005.656,56	532.277.504.089,91	625.646.760.881,02	7.527.948.175,22
2005	4.831.467.035.389,80	599.781.161.368,99	667.510.447.457,86	5.459.618.342,94
2006	4.601.663.122.649,92	660.752.902.210,07	720.499.607.478,29	-2.396.909.736,31
2007	4.579.750.920.354,81	711.118.565.477,88	791.798.969.882,00	21.631.204.435,68
2008	5.106.679.115.127,30	862.718.956.651,30	880.163.893.981,69	24.624.845.329,56
2009	5.289.493.117.993,89	633.184.104.751,41	656.932.075.524,13	12.226.471.578,74
2010	5.759.071.769.013,11	782.080.174.983,16	859.167.320.527,63	7.440.979.284,16

2011	6.233.147.172.341,35	961.182.364.174,19	920.913.976.671,97	-850.717.035,07
2012	6.272.362.996.105,03	1.007.099.152.148,38	904.146.988.796,65	546.962.692,19
2013	5.212.328.181.166,18	948.362.884.511,71	822.722.049.495,08	10.648.441.636,21
2014	4.896.994.405.353,29	980.024.678.767,85	852.990.577.902,81	19.752.249.424,09
2015	4.444.930.651.964,18	799.671.850.411,58	775.051.882.733,21	5.252.218.412,39
2016	5.003.677.627.544,24	763.174.802.438,92	803.489.014.102,66	40.954.181.468,55
2017	4.930.837.369.151,42	829.947.425.329,11	867.405.253.150,19	18.802.251.208,11
2018	5.037.835.383.110,97	922.228.472.388,62	923.234.601.723,63	25.289.367.857,85
2019	5.123.318.151.510,62	908.591.904.960,75	893.782.209.080,50	39.960.544.340,01

Table 2: GDP, Import, Export and FDI data for Korea from 1970 - 2019 (World Bank, 2022)

Year	GDP	Import	Export	FDI
1970	9.005.023.183,93	1.902.047.913,45	1.030.074.703,76	66.000.000,00
1971	9.903.499.927,99	2.279.130.059,05	1.255.365.115,94	42.000.000,00
1972	10.862.327.878,03	2.329.150.652,85	1.803.049.199,52	496.000.000,00
1973	13.876.531.432,01	3.837.366.941,15	3.319.943.763,81	4.000.000,00
1974	19.544.094.741,27	6.508.270.081,84	4.344.697.999,85	2.000.000,00
1975	21.784.297.520,66	6.824.793.388,43	4.934.710.743,80	6.000.000,00
1976	29.902.479.338,84	8.477.066.115,70	7.634.504.132,23	81.000.000,00
1977	38.446.487.603,31	10.717.561.983,47	10.014.876.033,06	94.000.000,00
1978	51.972.107.438,02	15.187.190.082,64	12.990.909.090,91	89.000.000,00
1979	66.946.900.826,45	20.679.752.066,12	15.836.157.024,79	172.000.000,00
1980	65.398.646.757,65	24.257.445.302,34	18.598.850.896,40	47.100.000,00
1981	72.933.350.953,70	27.124.943.100,89	21.836.189.301,50	155.100.000,00
1982	78.358.866.334,74	25.749.575.969,80	21.445.122.284,84	120.900.000,00
1983	87.760.360.941,02	26.351.401.869,16	24.472.574.927,49	184.300.000,00
1984	97.510.235.986,00	27.755.155.214,77	28.184.322.191,62	223.300.000,00
1985	101.296.177.099,38	26.119.629.433,81	27.219.948.966,69	355.300.000,00
1986	116.836.802.995,07	32.877.077.542,69	37.350.048.216,01	682.500.000,00
1987	147.948.259.722,58	41.699.065.125,16	51.508.564.620,64	838.600.000,00
1988	199.590.823.957,24	52.321.489.603,13	64.845.584.918,04	1.293.100.000,00
1989	246.927.292.765,02	63.102.493.074,79	67.555.773.985,05	1.389.600.000,00
1990	283.367.525.714,93	72.984.062.394,03	70.825.844.919,18	1.045.600.000,00
1991	330.648.530.715,21	86.128.997.068,25	78.616.895.070,57	1.455.200.000,00
1992	355.525.267.405,37	87.768.654.326,52	85.583.424.069,69	1.001.600.000,00
1993	392.666.101.884,96	91.279.978.073,18	92.953.766.803,29	832.300.000,00
1994	463.617.399.962,66	114.027.381.915,49	111.596.614.599,54	1.136.600.000,00
1995	566.583.427.334,14	151.503.105.267,94	145.749.348.477,19	2.487.100.000,00
1996	610.169.556.840,08	169.944.434.085,40	151.334.079.184,54	2.782.600.000,00
1997	569.754.543.829,96	166.240.263.221,52	161.499.858.087,44	3.301.100.000,00
1998	383.330.931.042,36	111.015.669.596,99	151.556.327.777,14	5.989.200.000,00
1999	497.512.659.612,05	135.183.795.696,57	162.143.469.995,46	10.726.300.000,00
2000	576.178.114.168,49	185.275.783.405,25	195.550.063.662,73	11.509.400.000,00
2001	547.658.231.279,87	166.685.566.890,53	174.088.180.388,69	6.522.300.000,00
2002	627.246.081.417,00	179.268.717.678,19	186.748.435.364,36	5.475.100.000,00

2003	702.717.332.012,99	209.246.481.650,88	220.638.044.326,58	7.010.000.000,00
2004	793.175.007.858,07	263.820.940.872,42	291.526.211.015,26	13.294.400.000,00
2005	934.901.071.332,98	308.907.471.189,56	329.861.919.056,69	13.643.200.000,00
2006	1.053.216.909.887,56	368.894.013.922,43	375.223.465.252,33	9.161.900.000,00
2007	1.172.614.086.539,86	427.797.123.573,85	438.465.966.315,25	8.826.900.000,00
2008	1.047.339.010.225,25	501.407.971.186,70	498.972.049.006,64	11.187.500.000,00
2009	943.941.876.218,74	386.527.844.126,15	426.523.458.607,76	9.021.900.000,00
2010	1.144.066.965.324,49	506.774.296.512,04	538.898.293.429,15	9.497.400.000,00
2011	1.253.223.044.718,99	654.540.621.556,36	668.440.747.705,41	9.773.000.000,00
2012	1.278.427.634.342,59	656.655.103.709,75	691.553.300.804,60	9.495.900.000,00
2013	1.370.795.199.976,18	639.613.504.243,36	703.109.248.740,17	12.766.600.000,00
2014	1.484.318.219.633,63	635.036.176.085,57	709.970.494.628,10	9.273.600.000,00
2015	1.465.773.245.547,15	529.773.440.038,19	630.129.491.251,22	4.104.100.000,00
2016	1.500.111.596.236,37	502.104.730.870,38	602.034.550.194,78	12.104.300.000,00
2017	1.623.901.496.835,79	587.636.539.402,98	664.731.199.232,57	17.912.900.000,00
2018	1.724.845.615.629,26	642.946.115.402,09	719.489.868.241,71	12.182.600.000,00
2019	1.651.422.932.447,77	602.460.189.255,23	648.610.576.582,72	9.634.300.000,00

Table 3: Lag selection test results for Japan data set

```
$selection
AIC(n)  HQ(n)  SC(n) FPE(n)
     1      1      1      1

$criteria
                 1             2             3             4
AIC(n) -1.413786e+01 -1.400857e+01 -1.353355e+01 -1.356614e+01
HQ(n)  -1.383852e+01 -1.346976e+01 -1.275528e+01 -1.254840e+01
SC(n)  -1.333490e+01 -1.256324e+01 -1.144585e+01 -1.083607e+01
FPE(n)  7.271204e-07  8.426561e-07  1.418607e-06  1.502105e-06
```

Table 4: Lag selection test results for Korea data set

```
$selection
AIC(n)  HQ(n)  SC(n) FPE(n)
     1      1      1      1

$criteria
                 1             2             3             4
AIC(n) -1.533120e+01 -1.517237e+01 -1.530808e+01 -1.482757e+01
HQ(n)  -1.503187e+01 -1.463357e+01 -1.452980e+01 -1.380982e+01
SC(n)  -1.452824e+01 -1.372704e+01 -1.322038e+01 -1.209750e+01
FPE(n)  2.204672e-07  2.631572e-07  2.405449e-07  4.254712e-07
```

Table 5: Unit Root Test - Augmented Dickey-Fuller test results for Japan data set

```
> summary(ADFlnGDP)

###############################################
# Augmented Dickey-Fuller Test Unit Root Test #
###############################################

Test regression trend


Call:
lm(formula = z.diff ~ z.lag.1 + 1 + tt + z.diff.lag)

Residuals:
      Min        1Q    Median        3Q       Max
-0.187044 -0.058221 -0.003202  0.064213  0.296858

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept)  2.0305866  0.9109969   2.229   0.0310 *
z.lag.1     -0.0697828  0.0335748  -2.078   0.0435 *
tt           0.0004808  0.0022651   0.212   0.8329
z.diff.lag   0.2132680  0.1406150   1.517   0.1365
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.09842 on 44 degrees of freedom
Multiple R-squared:  0.3692,    Adjusted R-squared:  0.3262
F-statistic: 8.585 on 3 and 44 DF,  p-value: 0.000134


Value of test-statistic is: -2.0784 5.8372 6.3912

Critical values for test statistics:
      1pct  5pct 10pct
tau3 -4.15 -3.50 -3.18
phi2  7.02  5.13  4.31
phi3  9.31  6.73  5.61
> summary(ADFlnEX)

###############################################
# Augmented Dickey-Fuller Test Unit Root Test #
###############################################

Test regression trend


Call:
lm(formula = z.diff ~ z.lag.1 + 1 + tt + z.diff.lag)

Residuals:
     Min       1Q   Median       3Q      Max
-0.27714 -0.06025  0.01640  0.06730  0.18807

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  3.535417   1.128309   3.133  0.00307 **
z.lag.1     -0.134335   0.045379  -2.960  0.00494 **
tt           0.004197   0.003124   1.344  0.18595
z.diff.lag  -0.187281   0.136366  -1.373  0.17660
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.09782 on 44 degrees of freedom
Multiple R-squared:  0.3532,    Adjusted R-squared:  0.3091
F-statistic: 8.008 on 3 and 44 DF,  p-value: 0.0002283


Value of test-statistic is: -2.9603 12.9363 11.7643

Critical values for test statistics:
      1pct  5pct 10pct
tau3 -4.15 -3.50 -3.18
phi2  7.02  5.13  4.31
phi3  9.31  6.73  5.61
```

```
> summary(ADFlnIM)

###############################################
# Augmented Dickey-Fuller Test Unit Root Test #
###############################################

Test regression trend


Call:
lm(formula = z.diff ~ z.lag.1 + 1 + tt + z.diff.lag)

Residuals:
     Min       1Q   Median       3Q      Max
-0.31999 -0.07223  0.00975  0.08422  0.21527

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept)  5.612567   1.472119   3.813 0.000424 ***
z.lag.1     -0.221857   0.059762  -3.712 0.000575 ***
tt           0.011766   0.004286   2.745 0.008717 **
z.diff.lag   0.189292   0.128977   1.468 0.149314
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.1222 on 44 degrees of freedom
Multiple R-squared:  0.3627,    Adjusted R-squared:  0.3193
F-statistic: 8.349 on 3 and 44 DF,  p-value: 0.0001665


Value of test-statistic is: -3.7123 9.2097 9.8922

Critical values for test statistics:
      1pct  5pct 10pct
tau3 -4.15 -3.50 -3.18
phi2  7.02  5.13  4.31
phi3  9.31  6.73  5.61
> summary(ADFlnFDI)

###############################################
# Augmented Dickey-Fuller Test Unit Root Test #
###############################################

Test regression trend


Call:
lm(formula = z.diff ~ z.lag.1 + 1 + tt + z.diff.lag)

Residuals:
    Min      1Q  Median      3Q     Max
-3.3878 -0.2826  0.2583  0.6141  1.7847

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept) 10.758892   2.933728   3.667 0.000658 ***
z.lag.1     -0.600248   0.163102  -3.680 0.000633 ***
tt           0.076999   0.023244   3.313 0.001854 **
z.diff.lag   0.005105   0.149694   0.034 0.972949
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 1.165 on 44 degrees of freedom
Multiple R-squared:  0.3032,    Adjusted R-squared:  0.2557
F-statistic: 6.382 on 3 and 44 DF,  p-value: 0.001098


Value of test-statistic is: -3.6802 4.7931 6.8276

Critical values for test statistics:
      1pct  5pct 10pct
tau3 -4.15 -3.50 -3.18
phi2  7.02  5.13  4.31
phi3  9.31  6.73  5.61
```

```
> summary(ADFdlnGDP)

###############################################
# Augmented Dickey-Fuller Test Unit Root Test #
###############################################

Test regression none


Call:
lm(formula = z.diff ~ z.lag.1 - 1 + z.diff.lag)

Residuals:
     Min       1Q   Median       3Q      Max
-0.19262 -0.03905  0.01844  0.07272  0.36353

Coefficients:
           Estimate Std. Error t value Pr(>|t|)
z.lag.1    -0.44847    0.13328  -3.365  0.00157 **
z.diff.lag -0.05544    0.14178  -0.391  0.69760
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.1103 on 45 degrees of freedom
Multiple R-squared:  0.2637,    Adjusted R-squared:  0.231
F-statistic: 8.059 on 2 and 45 DF,  p-value: 0.00102


Value of test-statistic is: -3.3648

Critical values for test statistics:
      1pct  5pct 10pct
tau1 -2.62 -1.95 -1.61
> summary(ADFdlnEX)

###############################################
# Augmented Dickey-Fuller Test Unit Root Test #
###############################################

Test regression none


Call:
lm(formula = z.diff ~ z.lag.1 - 1 + z.diff.lag)

Residuals:
     Min       1Q   Median       3Q      Max
-0.34256 -0.01688  0.05238  0.09516  0.30206

Coefficients:
           Estimate Std. Error t value Pr(>|t|)
z.lag.1     -0.4962     0.1590  -3.121  0.00314 **
z.diff.lag  -0.2854     0.1388  -2.056  0.04564 *
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.1259 on 45 degrees of freedom
Multiple R-squared:  0.4036,    Adjusted R-squared:  0.3771
F-statistic: 15.23 on 2 and 45 DF,  p-value: 8.905e-06


Value of test-statistic is: -3.121

Critical values for test statistics:
      1pct  5pct 10pct
tau1 -2.62 -1.95 -1.61
```

```
> summary(ADFdlnIM)

###############################################
# Augmented Dickey-Fuller Test Unit Root Test #
###############################################

Test regression none


Call:
lm(formula = z.diff ~ z.lag.1 - 1 + z.diff.lag)

Residuals:
     Min       1Q   Median       3Q      Max
-0.39336 -0.03390  0.04635  0.11433  0.41033

Coefficients:
           Estimate Std. Error t value Pr(>|t|)
z.lag.1    -0.59125    0.15539  -3.805 0.000425 ***
z.diff.lag  0.04206    0.14756   0.285 0.776934
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.1519 on 45 degrees of freedom
Multiple R-squared:  0.2927,    Adjusted R-squared:  0.2613
F-statistic: 9.312 on 2 and 45 DF,  p-value: 0.0004128


Value of test-statistic is: -3.8051

Critical values for test statistics:
      1pct  5pct 10pct
tau1 -2.62 -1.95 -1.61

> summary(ADFdlnFDI)

###############################################
# Augmented Dickey-Fuller Test Unit Root Test #
###############################################

Test regression none


Call:
lm(formula = z.diff ~ z.lag.1 - 1 + z.diff.lag)

Residuals:
    Min      1Q  Median      3Q     Max
-3.0058 -0.4248  0.1715  0.7152  3.5941

Coefficients:
           Estimate Std. Error t value Pr(>|t|)
z.lag.1     -1.4953     0.2361  -6.334 9.96e-08 ***
z.diff.lag   0.1631     0.1469   1.111    0.273
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 1.309 on 45 degrees of freedom
Multiple R-squared:  0.6516,    Adjusted R-squared:  0.6361
F-statistic: 42.08 on 2 and 45 DF,  p-value: 4.969e-11


Value of test-statistic is: -6.3338

Critical values for test statistics:
      1pct  5pct 10pct
tau1 -2.62 -1.95 -1.61
```

Table 6: Unit Root Test - Augmented Dickey-Fuller test results for Korea data set

```
> summary(ADFlnGDP)

###############################################
# Augmented Dickey-Fuller Test Unit Root Test #
###############################################

Test regression trend


Call:
lm(formula = z.diff ~ z.lag.1 + 1 + tt + z.diff.lag)

Residuals:
     Min       1Q   Median       3Q      Max
-0.43326 -0.04551  0.02264  0.06796  0.23813

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept)  1.886823   1.012617   1.863   0.0691 .
z.lag.1     -0.071955   0.042846  -1.679   0.1002
tt           0.003844   0.004689   0.820   0.4168
z.diff.lag   0.142545   0.144699   0.985   0.3300
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.1162 on 44 degrees of freedom
Multiple R-squared:  0.2584,    Adjusted R-squared:  0.2079
F-statistic: 5.111 on 3 and 44 DF,  p-value: 0.00403


Value of test-statistic is: -1.6794 7.4285 5.3304

Critical values for test statistics:
      1pct  5pct 10pct
tau3 -4.15 -3.50 -3.18
phi2  7.02  5.13  4.31
phi3  9.31  6.73  5.61
> summary(ADFlnEX)

###############################################
# Augmented Dickey-Fuller Test Unit Root Test #
###############################################

Test regression trend


Call:
lm(formula = z.diff ~ z.lag.1 + 1 + tt + z.diff.lag)

Residuals:
      Min        1Q    Median        3Q       Max
-0.199092 -0.051520 -0.007255  0.082725  0.202661

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept)  2.961095   0.924875   3.202  0.00254 **
z.lag.1     -0.122774   0.041713  -2.943  0.00517 **
tt           0.009541   0.005197   1.836  0.07313 .
z.diff.lag   0.095954   0.137688   0.697  0.48954
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.1161 on 44 degrees of freedom
Multiple R-squared:  0.4335,    Adjusted R-squared:  0.3949
F-statistic: 11.22 on 3 and 44 DF,  p-value: 1.355e-05


Value of test-statistic is: -2.9433 10.8568 10.9279

Critical values for test statistics:
      1pct  5pct 10pct
tau3 -4.15 -3.50 -3.18
phi2  7.02  5.13  4.31
phi3  9.31  6.73  5.61
```

```
> summary(ADFlnIM)

###############################################
# Augmented Dickey-Fuller Test Unit Root Test #
###############################################

Test regression trend


Call:
lm(formula = z.diff ~ z.lag.1 + 1 + tt + z.diff.lag)

Residuals:
     Min       1Q   Median       3Q      Max
-0.43441 -0.06456  0.02550  0.11261  0.25160

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept)  3.300383   1.392652   2.370   0.0222 *
z.lag.1     -0.139193   0.062662  -2.221   0.0315 *
tt           0.011779   0.007386   1.595   0.1179
z.diff.lag   0.148173   0.143672   1.031   0.3080
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.1572 on 44 degrees of freedom
Multiple R-squared:  0.2337,    Adjusted R-squared:  0.1815
F-statistic: 4.474 on 3 and 44 DF,  p-value: 0.007939


Value of test-statistic is: -2.2213 6.9328 5.2991

Critical values for test statistics:
      1pct  5pct 10pct
tau3 -4.15 -3.50 -3.18
phi2  7.02  5.13  4.31
phi3  9.31  6.73  5.61
> summary(ADFlnFDI)

###############################################
# Augmented Dickey-Fuller Test Unit Root Test #
###############################################

Test regression trend


Call:
lm(formula = z.diff ~ z.lag.1 + 1 + tt + z.diff.lag)

Residuals:
    Min      1Q  Median      3Q     Max
-3.9734 -0.2020  0.0447  0.3958  2.3566

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept)  7.77145    2.51590   3.089  0.00347 **
z.lag.1     -0.44289    0.14696  -3.014  0.00427 **
tt           0.06300    0.02421   2.602  0.01258 *
z.diff.lag   0.02439    0.15359   0.159  0.87453
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.9219 on 44 degrees of freedom
Multiple R-squared:  0.2072,    Adjusted R-squared:  0.1532
F-statistic: 3.834 on 3 and 44 DF,  p-value: 0.01595


Value of test-statistic is: -3.0136 3.4236 4.6263

Critical values for test statistics:
      1pct  5pct 10pct
tau3 -4.15 -3.50 -3.18
phi2  7.02  5.13  4.31
phi3  9.31  6.73  5.61
```

```
> summary(ADFdlnGDP)

###############################################
# Augmented Dickey-Fuller Test Unit Root Test #
###############################################

Test regression none


Call:
lm(formula = z.diff ~ z.lag.1 - 1 + z.diff.lag)

Residuals:
     Min       1Q   Median       3Q      Max
-0.37379 -0.02667  0.04254  0.09658  0.46447

Coefficients:
          Estimate Std. Error t value Pr(>|t|)
z.lag.1     -0.3636     0.1350  -2.693  0.00991 **
z.diff.lag  -0.1479     0.1475  -1.003  0.32145
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.1394 on 45 degrees of freedom
Multiple R-squared:  0.231,     Adjusted R-squared:  0.1968
F-statistic: 6.759 on 2 and 45 DF,  p-value: 0.002711


Value of test-statistic is: -2.6929

Critical values for test statistics:
      1pct  5pct 10pct
tau1 -2.62 -1.95 -1.61
> summary(ADFdlnEX)

###############################################
# Augmented Dickey-Fuller Test Unit Root Test #
###############################################

Test regression none


Call:
lm(formula = z.diff ~ z.lag.1 - 1 + z.diff.lag)

Residuals:
     Min       1Q   Median       3Q      Max
-0.24922 -0.07735  0.02166  0.11547  0.38683

Coefficients:
          Estimate Std. Error t value Pr(>|t|)
z.lag.1     -0.3158     0.1166  -2.708  0.00953 **
z.diff.lag  -0.1466     0.1439  -1.019  0.31360
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.1457 on 45 degrees of freedom
Multiple R-squared:  0.2172,    Adjusted R-squared:  0.1825
F-statistic: 6.245 on 2 and 45 DF,  p-value: 0.004042


Value of test-statistic is: -2.7081

Critical values for test statistics:
      1pct  5pct 10pct
tau1 -2.62 -1.95 -1.61
```

```
> summary(ADFdlnIM)

###############################################
# Augmented Dickey-Fuller Test Unit Root Test #
###############################################

Test regression none


Call:
lm(formula = z.diff ~ z.lag.1 - 1 + z.diff.lag)

Residuals:
     Min       1Q   Median       3Q      Max
-0.39659 -0.02879  0.06155  0.14934  0.48439

Coefficients:
          Estimate Std. Error t value Pr(>|t|)
z.lag.1    -0.50916    0.15203  -3.349  0.00165 **
z.diff.lag -0.02661    0.14848  -0.179  0.85855
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.1883 on 45 degrees of freedom
Multiple R-squared:  0.2615,    Adjusted R-squared:  0.2287
F-statistic: 7.969 on 2 and 45 DF,  p-value: 0.00109


Value of test-statistic is: -3.349

Critical values for test statistics:
      1pct  5pct 10pct
tau1 -2.62 -1.95 -1.61
> summary(ADFdlnFDI)

###############################################
# Augmented Dickey-Fuller Test Unit Root Test #
###############################################

Test regression none


Call:
lm(formula = z.diff ~ z.lag.1 - 1 + z.diff.lag)

Residuals:
    Min      1Q  Median      3Q     Max
-4.4139 -0.1989  0.1937  0.5758  2.6992

Coefficients:
          Estimate Std. Error t value Pr(>|t|)
z.lag.1    -1.3675     0.2117   -6.46 6.46e-08 ***
z.diff.lag  0.1715     0.1372    1.25    0.218
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.9317 on 45 degrees of freedom
Multiple R-squared:  0.6282,    Adjusted R-squared:  0.6116
F-statistic: 38.01 on 2 and 45 DF,  p-value: 2.152e-10


Value of test-statistic is: -6.4604

Critical values for test statistics:
      1pct  5pct 10pct
tau1 -2.62 -1.95 -1.61
```

Table 7 : Johansen Cointegration Test results for Japan data set

```
######################
# Johansen-Procedure #
######################

Test type: trace statistic , without linear trend and constant in cointegration

Eigenvalues (lambda):
[1] 5.559865e-01 3.140560e-01 2.242361e-01 3.415089e-02 2.102585e-15

Values of teststatistic and critical values of test:

          test 10pct  5pct  1pct
r <= 3 |  1.67  7.52  9.24 12.97
r <= 2 | 13.86 17.85 19.96 24.60
r <= 1 | 31.95 32.00 34.91 41.07
r = 0  | 70.92 49.65 53.12 60.16

Eigenvectors, normalised to first column:
(These are the cointegration relations)

              lnGDP.l2      lnIM.l2    lnEX.l2    lnFDI.l2    constant
lnGDP.l2   1.000000000  1.000000000  1.0000000  1.00000000  1.00000000
lnIM.l2    2.302812832  2.938409964  0.9894121 -0.45168408  0.32666182
lnEX.l2   -2.813583599 -3.887329018 -2.4358491 -0.43667673 -1.50298009
lnFDI.l2  -0.004468029 -0.007922575  0.2903531  0.00874533 -0.06597502
constant -15.224432536 -2.955308555  3.6848057 -5.18991118  3.72838839

Weights W:
(This is the loading matrix)

          lnGDP.l2      lnIM.l2     lnEX.l2    lnFDI.l2      constant
lnGDP.d -0.1633141 -0.078256729  0.03684709 -0.01389187 -1.409215e-12
lnIM.d  -0.1067964 -0.004075411  0.05705436  0.07598395 -4.823928e-13
lnEX.d  -0.1546019  0.087204763  0.06659373  0.03468877 -4.781664e-14
lnFDI.d -0.5219376  0.729877840 -1.50093059  0.43619246 -2.206293e-12
######################
# Johansen-Procedure #
######################

Test type: maximal eigenvalue statistic (lambda max) , without linear trend and constant in cointegration

Eigenvalues (lambda):
[1] 5.559865e-01 3.140560e-01 2.242361e-01 3.415089e-02 2.102585e-15

Values of teststatistic and critical values of test:

          test 10pct  5pct  1pct
r <= 3 |  1.67  7.52  9.24 12.97
r <= 2 | 12.19 13.75 15.67 20.20
r <= 1 | 18.09 19.77 22.00 26.81
r = 0  | 38.97 25.56 28.14 33.24

Eigenvectors, normalised to first column:
(These are the cointegration relations)

              lnGDP.l2      lnIM.l2    lnEX.l2    lnFDI.l2    constant
lnGDP.l2   1.000000000  1.000000000  1.0000000  1.00000000  1.00000000
lnIM.l2    2.302812832  2.938409964  0.9894121 -0.45168408  0.32666182
lnEX.l2   -2.813583599 -3.887329018 -2.4358491 -0.43667673 -1.50298009
lnFDI.l2  -0.004468029 -0.007922575  0.2903531  0.00874533 -0.06597502
constant -15.224432536 -2.955308555  3.6848057 -5.18991118  3.72838839

Weights W:
(This is the loading matrix)

          lnGDP.l2      lnIM.l2     lnEX.l2    lnFDI.l2      constant
lnGDP.d -0.1633141 -0.078256729  0.03684709 -0.01389187 -1.409215e-12
lnIM.d  -0.1067964 -0.004075411  0.05705436  0.07598395 -4.823928e-13
lnEX.d  -0.1546019  0.087204763  0.06659373  0.03468877 -4.781664e-14
lnFDI.d -0.5219376  0.729877840 -1.50093059  0.43619246 -2.206293e-12
```

Table 8: Johansen Cointegration Test results for Japan data set

```
######################
# Johansen-Procedure #
######################

Test type: trace statistic , with linear trend in cointegration

Eigenvalues (lambda):
[1]  5.650671e-01  3.569645e-01  2.428524e-01  1.030527e-01 -1.164501e-17

Values of teststatistic and critical values of test:

          test 10pct  5pct  1pct
r <= 3 |  5.22 10.49 12.25 16.26
r <= 2 | 18.57 22.76 25.32 30.45
r <= 1 | 39.77 39.06 42.44 48.45
r = 0  | 79.73 59.14 62.99 70.05

Eigenvectors, normalised to first column:
(These are the cointegration relations)

            lnGDP.l2     lnIM.l2     lnEX.l2    lnFDI.l2   trend.l2
lnGDP.l2   1.0000000  1.00000000  1.00000000  1.00000000  1.0000000
lnIM.l2   14.8792423 -8.50358477  2.25588871 -1.02934092  2.4647034
lnEX.l2  -17.9586345  8.41237049 -2.32401646  0.02129900 -0.6250584
lnFDI.l2   0.8301316 -2.20300632 -0.22169835 -0.07356275  0.5614695
trend.l2   0.1563820  0.06299152 -0.02665967  0.02109871 -0.4464373

Weights W:
(This is the loading matrix)

            lnGDP.l2      lnIM.l2     lnEX.l2   lnFDI.l2      trend.l2
lnGDP.d -0.002885179  0.014712575 -0.13196931 0.04767724  4.378116e-13
lnIM.d  -0.001071754 -0.001908300 -0.15048659 0.22366076  3.624110e-13
lnEX.d   0.022718079  0.004437915 -0.08418701 0.17242802 -1.032847e-13
lnFDI.d  0.010284797  0.245882749  0.45514994 0.63278089  9.201475e-13
######################
# Johansen-Procedure #
######################

Test type: maximal eigenvalue statistic (lambda max) , with linear trend in cointegration

Eigenvalues (lambda):
[1]  5.650671e-01  3.569645e-01  2.428524e-01  1.030527e-01 -1.164501e-17

Values of teststatistic and critical values of test:

          test 10pct  5pct  1pct
r <= 3 |  5.22 10.49 12.25 16.26
r <= 2 | 13.35 16.85 18.96 23.65
r <= 1 | 21.19 23.11 25.54 30.34
r = 0  | 39.96 29.12 31.46 36.65

Eigenvectors, normalised to first column:
(These are the cointegration relations)

            lnGDP.l2     lnIM.l2     lnEX.l2    lnFDI.l2   trend.l2
lnGDP.l2   1.0000000  1.00000000  1.00000000  1.00000000  1.0000000
lnIM.l2   14.8792423 -8.50358477  2.25588871 -1.02934092  2.4647034
lnEX.l2  -17.9586345  8.41237049 -2.32401646  0.02129900 -0.6250584
lnFDI.l2   0.8301316 -2.20300632 -0.22169835 -0.07356275  0.5614695
trend.l2   0.1563820  0.06299152 -0.02665967  0.02109871 -0.4464373

Weights W:
(This is the loading matrix)

            lnGDP.l2      lnIM.l2     lnEX.l2   lnFDI.l2      trend.l2
lnGDP.d -0.002885179  0.014712575 -0.13196931 0.04767724  4.378116e-13
lnIM.d  -0.001071754 -0.001908300 -0.15048659 0.22366076  3.624110e-13
lnEX.d   0.022718079  0.004437915 -0.08418701 0.17242802 -1.032847e-13
lnFDI.d  0.010284797  0.245882749  0.45514994 0.63278089  9.201475e-13
```

Table 9 : Vector Error Correction Model test results for Japan data set

```
##############
###Model VECM
##############
Full sample size: 50    End sample size: 48
Number of variables: 4  Number of estimated slope parameters 24
AIC -681.4114   BIC -630.8889   SSR 75.58539
Cointegrating vector (estimated by ML):
   lnGDP     lnIM      lnEX       lnFDI
r1     1 2.466479 -3.065828 -0.01263332


               ECT                 Intercept          lnGDP -1            lnIM -1             lnEX -1
Equation lnGDP -0.2263(0.0396)***  2.8354(0.4895)***  0.0637(0.1472)      -0.0258(0.1540)     -0.1910(0.2128)
Equation lnIM  -0.1228(0.0590)*    1.5547(0.7297)*    0.6437(0.2194)**    0.4768(0.2296)*     -0.7697(0.3173)*
Equation lnEX  -0.1579(0.0510)**   2.0079(0.6310)**   0.2166(0.1897)      0.3324(0.1985)      -0.6577(0.2744)*
Equation lnFDI -0.1528(0.6651)     2.2331(8.2309)     -1.4517(2.4748)     0.7566(2.5894)      -2.3914(3.5789)
               lnFDI -1
Equation lnGDP 0.0026(0.0091)
Equation lnIM  0.0061(0.0136)
Equation lnEX  0.0088(0.0118)
Equation lnFDI -0.3413(0.1533)*
```

Table 10: Vector Error Correction Model test results for Korea data set

```
#############
###Model VECM
#############
Full sample size: 50    End sample size: 48
Number of variables: 4  Number of estimated slope parameters 24
AIC -687.8732   BIC -637.3508   SSR 43.55462
Cointegrating vector (estimated by ML):
   lnGDP     lnIM      lnEX    lnFDI
r1     1 273.3256 -288.8942 15.95593

               ECT                Intercept          lnGDP -1           lnIM -1            lnEX -1
Equation lnGDP -0.0003(0.0004)     0.0305(0.0282)     0.6790(0.2334)**   -0.7868(0.2276)**  0.6709(0.1848)***
Equation lnIM  -0.0002(0.0006)     0.0109(0.0375)     0.8636(0.3101)**   -0.8882(0.3025)**  0.8494(0.2456)**
Equation lnEX  0.0014(0.0004)**    0.1035(0.0294)**   0.6378(0.2434)*    -0.8740(0.2374)*** 0.7389(0.1927)***
Equation lnFDI 0.0002(0.0037)      0.3746(0.2505)     -0.3834(2.0711)    1.8281(2.0201)     -3.0516(1.6403).
               lnFDI -1
Equation lnGDP -0.0228(0.0183)
Equation lnIM  -0.0280(0.0243)
Equation lnEX  -0.0058(0.0191)
Equation lnFDI -0.1683(0.1622)
```

Table 11: Granger Causality Test results for Japan data set

```
        Granger causality H0: dlnGDP do not Granger-cause dlnIM

data:  VAR object VAR_GDP_IM
F-Test = 16.775, df1 = 1, df2 = 90, p-value = 9.181e-05


$Instant

        H0: No instantaneous causality between: dlnGDP and dlnIM

data:  VAR object VAR_GDP_IM
Chi-squared = 4.2711, df = 1, p-value = 0.03877


        Granger causality H0: dlnGDP do not Granger-cause dlnEX

data:  VAR object VAR_GDP_EX
F-Test = 7.0059, df1 = 1, df2 = 90, p-value = 0.00959


$Instant

        H0: No instantaneous causality between: dlnGDP and dlnEX

data:  VAR object VAR_GDP_EX
Chi-squared = 11.033, df = 1, p-value = 0.0008953

        Granger causality H0: dlnGDP do not Granger-cause dlnFDI

data:  VAR object VAR_GDP_FDI
F-Test = 1.7108, df1 = 1, df2 = 90, p-value = 0.1942


$Instant

        H0: No instantaneous causality between: dlnGDP and dlnFDI

data:  VAR object VAR_GDP_FDI
Chi-squared = 2.1535, df = 1, p-value = 0.1422

        Granger causality H0: dlnIM do not Granger-cause dlnEX

data:  VAR object VAR_IM_EX
F-Test = 0.010213, df1 = 1, df2 = 90, p-value = 0.9197


$Instant

        H0: No instantaneous causality between: dlnIM and dlnEX

data:  VAR object VAR_IM_EX
Chi-squared = 19.785, df = 1, p-value = 8.664e-06

        Granger causality H0: dlnIM do not Granger-cause dlnFDI

data:  VAR object VAR_IM_FDI
F-Test = 0.96961, df1 = 1, df2 = 90, p-value = 0.3274


$Instant

        H0: No instantaneous causality between: dlnIM and dlnFDI

data:  VAR object VAR_IM_FDI
Chi-squared = 0.071759, df = 1, p-value = 0.7888
```

```
        Granger causality H0: dlnIM do not Granger-cause dlnGDP

data:  VAR object VAR_GDP_IM
F-Test = 3.7353, df1 = 1, df2 = 90, p-value = 0.05642


$Instant

        H0: No instantaneous causality between: dlnIM and dlnGDP

data:  VAR object VAR_GDP_IM
Chi-squared = 4.2711, df = 1, p-value = 0.03877


        Granger causality H0: dlnEX do not Granger-cause dlnGDP

data:  VAR object VAR_GDP_EX
F-Test = 0.19623, df1 = 1, df2 = 90, p-value = 0.6588


$Instant

        H0: No instantaneous causality between: dlnEX and dlnGDP

data:  VAR object VAR_GDP_EX
Chi-squared = 11.033, df = 1, p-value = 0.0008953

        Granger causality H0: dlnFDI do not Granger-cause dlnGDP

data:  VAR object VAR_GDP_FDI
F-Test = 0.63306, df1 = 1, df2 = 90, p-value = 0.4283


$Instant

        H0: No instantaneous causality between: dlnFDI and dlnGDP

data:  VAR object VAR_GDP_FDI
Chi-squared = 2.1535, df = 1, p-value = 0.1422

        Granger causality H0: dlnEX do not Granger-cause dlnIM

data:  VAR object VAR_IM_EX
F-Test = 0.18367, df1 = 1, df2 = 90, p-value = 0.6693


$Instant

        H0: No instantaneous causality between: dlnEX and dlnIM

data:  VAR object VAR_IM_EX
Chi-squared = 19.785, df = 1, p-value = 8.664e-06

        Granger causality H0: dlnFDI do not Granger-cause dlnIM

data:  VAR object VAR_IM_FDI
F-Test = 0.091684, df1 = 1, df2 = 90, p-value = 0.7627


$Instant

        H0: No instantaneous causality between: dlnFDI and dlnIM

data:  VAR object VAR_IM_FDI
Chi-squared = 0.071759, df = 1, p-value = 0.7888
```

```
        Granger causality H0: dlnEX do not Granger-cause dlnFDI

data:  VAR object VAR_EX_FDI
F-Test = 1.9482, df1 = 1, df2 = 90, p-value = 0.1662


$Instant

        H0: No instantaneous causality between: dlnEX and dlnFDI

data:  VAR object VAR_EX_FDI
Chi-squared = 0.1463, df = 1, p-value = 0.7021
```

```
        Granger causality H0: dlnFDI do not Granger-cause dlnEX

data:  VAR object VAR_EX_FDI
F-Test = 0.30736, df1 = 1, df2 = 90, p-value = 0.5807


$Instant

        H0: No instantaneous causality between: dlnFDI and dlnEX

data:  VAR object VAR_EX_FDI
Chi-squared = 0.1463, df = 1, p-value = 0.7021
```

Table 12: Granger Causality Test results for Korea data set

```
        Granger causality H0: dlnGDP do not Granger-cause dlnIM

data:  VAR object VAR_GDP_IM
F-Test = 5.3042, df1 = 1, df2 = 90, p-value = 0.02358


$Instant

        H0: No instantaneous causality between: dlnGDP and dlnIM

data:  VAR object VAR_GDP_IM
Chi-squared = 18.714, df = 1, p-value = 1.519e-05

        Granger causality H0: dlnGDP do not Granger-cause dlnEX

data:  VAR object VAR_GDP_EX
F-Test = 0.017135, df1 = 1, df2 = 90, p-value = 0.8961


$Instant

        H0: No instantaneous causality between: dlnGDP and dlnEX

data:  VAR object VAR_GDP_EX
Chi-squared = 12.571, df = 1, p-value = 0.0003917
        Granger causality H0: dlnGDP do not Granger-cause dlnFDI

data:  VAR object VAR_GDP_FDI
F-Test = 0.24896, df1 = 1, df2 = 90, p-value = 0.619


$Instant

        H0: No instantaneous causality between: dlnGDP and dlnFDI

data:  VAR object VAR_GDP_FDI
Chi-squared = 0.06001, df = 1, p-value = 0.8065
```

```
        Granger causality H0: dlnIM do not Granger-cause dlnGDP

data:  VAR object VAR_GDP_IM
F-Test = 2.2099, df1 = 1, df2 = 90, p-value = 0.1406


$Instant

        H0: No instantaneous causality between: dlnIM and dlnGDP

data:  VAR object VAR_GDP_IM
Chi-squared = 18.714, df = 1, p-value = 1.519e-05
        Granger causality H0: dlnEX do not Granger-cause dlnGDP

data:  VAR object VAR_GDP_EX
F-Test = 2.3642, df1 = 1, df2 = 90, p-value = 0.1277


$Instant

        H0: No instantaneous causality between: dlnEX and dlnGDP

data:  VAR object VAR_GDP_EX
Chi-squared = 12.571, df = 1, p-value = 0.0003917
           Granger causality H0: dlnFDI do not Granger-cause dlnGDP

    data:  VAR object VAR_GDP_FDI
    F-Test = 0.01147, df1 = 1, df2 = 90, p-value = 0.9149


    $Instant

            H0: No instantaneous causality between: dlnFDI and dlnGDP

    data:  VAR object VAR_GDP_FDI
    Chi-squared = 0.06001, df = 1, p-value = 0.8065
```

```
        Granger causality H0: dlnIM do not Granger-cause dlnEX

data:  VAR object VAR_IM_EX
F-Test = 5.1912, df1 = 1, df2 = 90, p-value = 0.02507


$Instant

        H0: No instantaneous causality between: dlnIM and dlnEX

data:  VAR object VAR_IM_EX
Chi-squared = 16.954, df = 1, p-value = 3.83e-05
        Granger causality H0: dlnIM do not Granger-cause dlnFDI

data:  VAR object VAR_IM_FDI
F-Test = 0.31014, df1 = 1, df2 = 90, p-value = 0.579


$Instant

        H0: No instantaneous causality between: dlnIM and dlnFDI

data:  VAR object VAR_IM_FDI
Chi-squared = 1.878, df = 1, p-value = 0.1706
        Granger causality H0: dlnEX do not Granger-cause dlnFDI

data:  VAR object VAR_EX_FDI
F-Test = 2.5842, df1 = 1, df2 = 90, p-value = 0.1114


$Instant

        H0: No instantaneous causality between: dlnEX and dlnFDI

data:  VAR object VAR_EX_FDI
Chi-squared = 0.28132, df = 1, p-value = 0.5958
```

```
        Granger causality H0: dlnEX do not Granger-cause dlnIM

data:  VAR object VAR_IM_EX
F-Test = 9.3318, df1 = 1, df2 = 90, p-value = 0.002963


$Instant

        H0: No instantaneous causality between: dlnEX and dlnIM

data:  VAR object VAR_IM_EX
Chi-squared = 16.954, df = 1, p-value = 3.83e-05
        Granger causality H0: dlnFDI do not Granger-cause dlnIM

data:  VAR object VAR_IM_FDI
F-Test = 0.023619, df1 = 1, df2 = 90, p-value = 0.8782


$Instant

        H0: No instantaneous causality between: dlnFDI and dlnIM

data:  VAR object VAR_IM_FDI
Chi-squared = 1.878, df = 1, p-value = 0.1706
        Granger causality H0: dlnFDI do not Granger-cause dlnEX

data:  VAR object VAR_EX_FDI
F-Test = 2.2574, df1 = 1, df2 = 90, p-value = 0.1365


$Instant

        H0: No instantaneous causality between: dlnFDI and dlnEX

data:  VAR object VAR_EX_FDI
Chi-squared = 0.28132, df = 1, p-value = 0.5958
```

Table 13: Vector Error Correction Model test results of Japan training data set

```
#############
###Model VECM
#############
Full sample size: 40    End sample size: 38
Number of variables: 4  Number of estimated slope parameters 24
AIC -528.3663   BIC -484.1515   SSR 56.46473
Cointegrating vector (estimated by ML):
   lnGDP     lnIM      lnEX      lnFDI
r1     1 3.728298 -4.183807 -0.0419577

               ECT                Intercept          lnGDP -1          lnIM -1           lnEX -1
Equation lnGDP -0.1818(0.0381)*** 2.8381(0.5844)***  0.0028(0.1883)    0.0352(0.1832)    -0.1824(0.2605)
Equation lnIM  -0.1328(0.0534)*   2.0707(0.8197)*    0.5318(0.2642).   0.6729(0.2569)*   -0.9108(0.3654)*
Equation lnEX  -0.1343(0.0486)**  2.1133(0.7457)**   0.0480(0.2403)    0.4642(0.2337).   -0.5614(0.3324)
Equation lnFDI 0.2631(0.5986)     -3.6279(9.1840)    1.1973(2.9599)    0.7625(2.8787)    -3.8571(4.0940)
               lnFDI -1
Equation lnGDP 0.0028(0.0116)
Equation lnIM  0.0016(0.0163)
Equation lnEX  0.0056(0.0148)
Equation lnFDI -0.2501(0.1826)
```

Table 14: Vector Error Correction Model test results of Korea training data set

```
#############
###Model VECM
#############
Full sample size: 40    End sample size: 38
Number of variables: 4  Number of estimated slope parameters 24
AIC -522.3737   BIC -478.1588   SSR 39.90203
Cointegrating vector (estimated by ML):
   lnGDP     lnIM     lnEX     lnFDI
r1     1 5.586941 -7.02053 0.3970261

               ECT                Intercept          lnGDP -1           lnIM -1            lnEX -1
Equation lnGDP -0.0141(0.0181)    0.0337(0.0395)     0.7757(0.2723)**   -0.8728(0.2744)**  0.6566(0.2043)**
Equation lnIM  -0.0088(0.0219)    0.0204(0.0476)     1.0409(0.3285)**   -1.0612(0.3310)**  0.8419(0.2464)**
Equation lnEX  0.0530(0.0171)**   0.1486(0.0373)***  0.6840(0.2575)*    -0.9159(0.2595)**  0.6792(0.1932)**
Equation lnFDI -0.0257(0.1649)    0.4648(0.3589)     -0.3345(2.4768)    1.7968(2.4956)     -3.3656(1.8579).
               lnFDI -1
Equation lnGDP -0.0313(0.0212)
Equation lnIM  -0.0447(0.0256).
Equation lnEX  -0.0153(0.0201)
Equation lnFDI -0.1800(0.1929)
```

Table 15: Predicted Values based off training data set for Japan

	lnGDP	lnIM	lnEX	lnFDI
41	29.30445	27.22293	27.22227	24.86326
42	29.26245	27.21550	27.23131	25.00261
43	29.23516	27.15849	27.21993	25.39324
44	29.24852	27.12267	27.22714	25.72469
45	29.28906	27.12753	27.25742	26.02088
46	29.34142	27.16381	27.30553	26.27926
47	29.39602	27.21448	27.36187	26.50999
48	29.44989	27.26874	27.42047	26.72908
49	29.50311	27.32270	27.47912	26.94468
50	29.55631	27.37607	27.53756	27.15995

Table 16: Predicted Values based off training data set for Korea

	lnGDP	lnIM	lnEX	lnFDI
41	27.68914	26.76634	26.87145	23.57999
42	27.80688	26.88282	26.96435	23.78373
43	27.91106	26.98768	27.04816	24.11704
44	28.00154	27.07525	27.13759	24.43525
45	28.09955	27.17162	27.24168	24.70878
46	28.20653	27.28070	27.35424	24.95396
47	28.31551	27.39384	27.46875	25.19492
48	28.42344	27.50627	27.58402	25.43589
49	28.53135	27.61881	27.70093	25.67279
50	28.64022	27.73269	27.81944	25.90484

Table 17: Ljung-Box Test results for Japan training data set

```
> box_test_lnGDP

        Box-Ljung test

data:  Vecm1_residuals[, 1]
X-squared = 10.281, df = 10, p-value = 0.4162
> box_test_lnEX

        Box-Ljung test

data:  Vecm1_residuals[, 3]
X-squared = 7.9671, df = 10, p-value = 0.6321
```

```
> box_test_lnIM

        Box-Ljung test

data:  Vecm1_residuals[, 2]
X-squared = 5.0341, df = 10, p-value = 0.8889
> box_test_lnFDI

        Box-Ljung test

data:  Vecm1_residuals[, 4]
X-squared = 7.7079, df = 10, p-value = 0.6573
```

Table 18: Ljung-Box Test results for Korea training data set

```
> box_test_lnGDP

        Box-Ljung test

data:  Vecm1_residuals[, 1]
X-squared = 5.1756, df = 10, p-value = 0.8791
> box_test_lnEX

        Box-Ljung test

data:  Vecm1_residuals[, 3]
X-squared = 10.379, df = 10, p-value = 0.4079
```

```
> box_test_lnIM

        Box-Ljung test

data:  Vecm1_residuals[, 2]
X-squared = 9.5576, df = 10, p-value = 0.4801
> box_test_lnFDI

        Box-Ljung test

data:  Vecm1_residuals[, 4]
X-squared = 7.84, df = 10, p-value = 0.6445
```

Table 19: Root Mean Square Error test results of Japan predicted values and test data set

```
> RMSE_lnGDP
[1] 0.1941268
> RMSE_lnIM
[1] 0.3205162
> RMSE_lnEX
[1] 0.1924559
> RMSE_lnFDI
[1] 3.086363
```

Table 20: Root Mean Square Error test results of Korea predicted values and test data set

```
> RMSE_lnGDP
[1] 0.2472789
> RMSE_lnIM
[1] 0.3473361
> RMSE_lnEX
[1] 0.3141456
> RMSE_lnFDI
[1] 1.908745
```