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Does trading with China improve diversification and economic complexity? The case of South Africa and Pakistan

Bachelor's thesis

Author: Huilin Song
Study program: Economics and Finance
Supervisor: Ing., M.A., PhD. Vilém Semerák
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Prague, May 1, 2023

Huilin Song

Abstract

This thesis discusses and analyses the effect of trade with China on its economic complexity, export diversification and export concentration. The thesis analyses the sample of thirty countries observed over 10 years (2010-2020) with a special focus on the experience of South Africa and Pakistan. General results of the tests based on linear regression models show that the increase in the proportion of trade between the country and China is negatively correlated with the growth of the country's economic complexity index and positively with the growth of export concentration; therefore, it can be related with the deterioration of economic diversification.

The results for South Africa and Pakistan have a similar structure. Similar to the results for the other countries, an increase in the share of trade with China in the case of Pakistan is related to an increase in export concentration and is also negatively correlated with its economic complexity index. Similarly, the increase in the share of South African trade with China has a positive relationship with the growth of the South African economy's export concentration (and thus a negative relationship with diversification), and the connection with economic complexity is also negative here.

Keywords Economics complexity, economic diversification, export concentration, trade value, China, Pakistan, South Africa.

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Abstrakt

Tato diplomová práce diskutuje a analyzuje dopady obchodu s Čínou na ekonomickou komplexitu, diverzifikaci a exportní koncentraci. V práce jsou analyzována data za 30 zemí během deseti let (2010-2020) s důrazem na vývoj v Jihoafrické republice a Pakistánu. Obecné výsledky testů založených na lineárním regresním modelu ukazují, že nárůst podílu Číny na obchodu je negativně zkorelován s růstem indexu ekonomické komplexity a pozitivně s růstem koncentrace exportu, tj. může být spjat se zhoršováním ekonomické diverzifikace.

Výsledky pro JAR a Pakistán mají podobnou strukturu. Podobně jako ve výsledcích pro ostatní země, nárůst podílu obchodu s Čínou souvisí v případě Pakistánu s nárůstem exportní koncentrace a současně je negativně zkorelován s jeho indexem ekonomické komplexity. Podobně nárůst podílu jihoafrického obchodu s Čínou má pozitivní vztah s růstem exportní koncentrace ekonomiky JAR (a tedy negativní s diverzifikací), a souvislost s ekonomickou komplexitou je i zde negativní.

Klíčová slova: Ekonomická komplexita, diverzifikace exportu, koncentrace exportu, Čína, Pakistán, JAR

Název: Má obchodování s ČLR pozitivní dopady na diverzifikaci a ekonomickou. komplexitu? Případ JAR a Pakistánu

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Acronyms

AFG Afghanistan
CHN China
EST Estonia
ETH Ethiopia
IND India
IDN Indonesia
PAK Pakistan
SRB Serbia
SGP Singapore
ZAF South Africa
AUS Australia
AUT Austria
BRA Brazil
CAN Canada
CZE Czechia
FRA France
DEU Germany
HUN Hungary
JPN Japan
JOR Jordan
KWT Kuwait
MYS Malaysia
NLD Netherlands
SVN Slovenia
SWE Sweden
CHE Switzerland
THA Thailand
GBR United Kingdom
USA United States

Chapter 1 Introduction

In this era of rapid development, trade between countries has become more intensive. There have been many studies on economic complexity, export diversification and export concentration at this stage. Most of the literature began to study the development of trade diversity and complexity and analyse its determinants after 2000. A brief explanation for these three words---The Economic Complexity Index is an overall measure of the productive capacity of an extensive economic system (usually a country, region, or city). It can also explain the cumulative total expressed in a population through the economic activity of a city, country, or region; Export diversification index measures, for each country, the degree of concentration of goods exported (it does not include services). It tells us if a large share of a country's exports is accounted for by a small number of commodities or, on the contrary, if its exports are well distributed among many products. Export concentration index measures, for each product, the degree of export market concentration by country of origin. It tells us if a few countries account for a large share of commodity exports or, on the contrary, if exports are well distributed among many nations.

China is one of the more prominent contributors to world economic growth. From 2013 to 2018, China's average contribution to world economic growth exceeded 28.1%. (State Council Information Office of the People's Republic of China. 2019). According to a report by the McKinsey Global Institute, from 2000 to 2017, the world's comprehensive dependence index on the Chinese economy gradually increased from 0.4 to 1.2. (McKinsey Global Institute. 2019). In the future, the role of stabiliser and power source of China's economy will become more prominent. The McKinsey Global Institute research report believes that by 2040, the integration of China and the rest of the world is expected to create an economic value of 22 trillion to 37 trillion US dollars, equivalent to 15% to 26% of the global economy. Strengthening cooperation with China will create enormous economic value (McKinsey Global Institute. 2019).

At this stage, most current literature analyses economic complexity and diversification, China-Africa trade relations, and China-Pakistan trade relations. However, few works of literature combine these elements for analysis.

Through Allen Dennis and Ben Shepherd's research (2011), we know that trade facilitation can help to develop poorer countries' diversification. In the same year, Ferdous examined the patterns of export diversification in East Asian countries. The paper by Vishal Sarin, Sushanta Kumar and Naveen Sood (2020) shows that the diversification of exports positively impacts economic growth.

The Atlas of Economic Complexity studies the meaning of the Economic Complexity Index and analyses the interaction of the Economic Complexity Index between countries through a map-like structure. Cesar. A. Hidalgo and Ricardo Hausmann (2009)

conclude that diversified countries tend to export less common products, and diversification measurescorrelate with increasing complexity income and production structures. Alexander J. G.use economic complexity as an analytical tool to understand the dynamics of economic development. Research by Talha Yalta (2021) claims that human capital is positively related to economic complexity, and natural resources are negatively associated with economic complexity.Myriam Mariem, Alexandra, Khaled and Rym obtained the same result as Talha in the 2022 research. That is, natural resources are inversely related to economic complexity.

Among the existing literature analysing China's economic impact on South Africa, Logan and Jan Abraham examined the effect of trade with China on South Africa's trade and inflation in 2011. They found that in a short period of time, trade with China can increase economic activity in South Africa, and the effect is minimal in terms of inflation. Yoon Jung Park and Chris Alden (2013) analysed China's investment and immigration to South Africa to find China's social, cultural and economic influence on. South Africa. Ultimately, their findings are similar to those of Logan and Jan. From the perspective of short-term investment, China’s trade and investment in South Africa are positive. But in terms of long-term prospects, it may not look promising. Lingfang Wu and Jinping Dai (2019) examine the correlation between Chinese aid to Africa, direct investment and Africa's upgrading in global value chains. This is also an essential reference in this thesis. Finally, they found that China's Outward Foreign Direct Investment to Africa has a positive effect on increasing the total export volume of Africa and upgrading Africa's global value chain.

In the literature on trade between Pakistan and China, Chinese investment in Pakistan benefits Pakistan; the trade also provides access to new markets for Chinese goods (Sumita Kumar, 2007). Musleh, Ejaz and Usman (2009) concluded that the bilateral trade between China and Pakistan has the potential to expand, and the bilateral trade between the two countries is inclined toward China. Saima and Jehanzeb (2015) discuss the significance and challenges of establishing the China-Pakistan Economic Corridor and conclude that this geostrategic corridor benefits Pakistan-China relations and regional development, which will eventually benefit all neighbouring countries.

Inspired by all this literature, I started to observe the trade data on China's exports to South Africa and Pakistan. I found that the data provided by the OEC shows that in 2020, South Africa and Pakistan had the same share of China's export value. The trend of trading with China for Pakistan constantly increased from 2010 to 2018, then slightly decreased to $14.8B in 2020. The trend of trading with China for South Africa gradually rose from 2010 to 2015, and then it declined to the bottom. From 2016 to 2019, it climbed up. Then it started to go down to $14.8B in 2020. There were three interactions in 2015, 2018 and 2020. The trade values for China with Pakistan and South Africa (2010 to 2020) show the following:

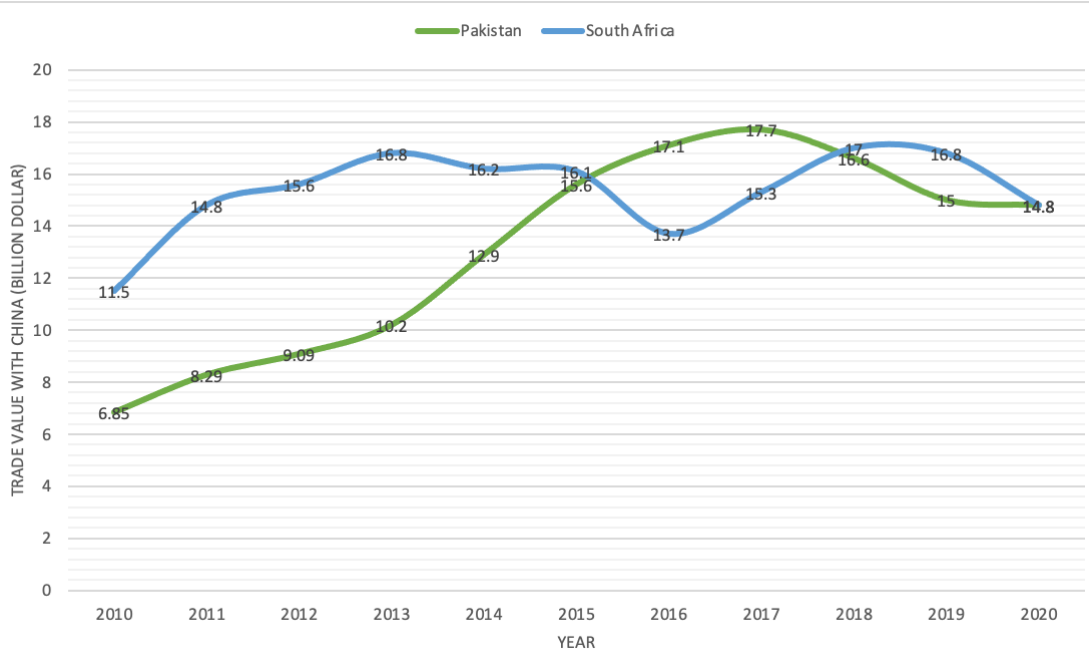

Figure 1.0 Trade value (imports) for Pakistan and South Africa with China

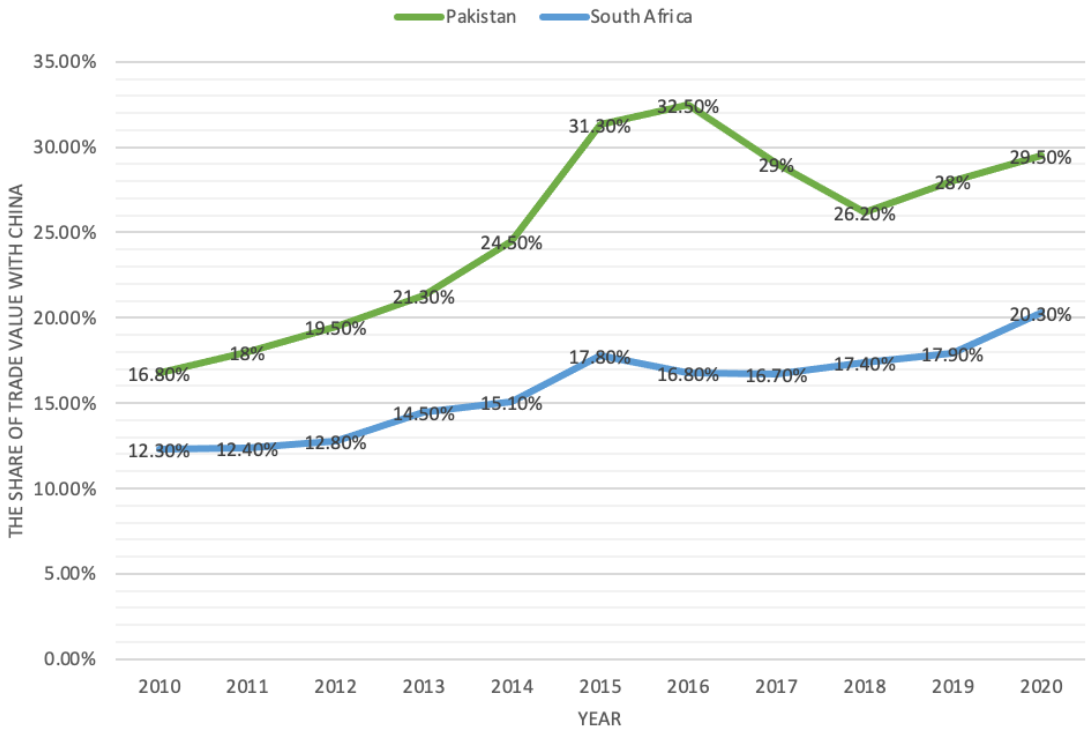

Figure 1.1 The share of trade value (imports) for Pakistan and South Africa with China

The share of trade value with China for the two countries was increasing. However, there was a gradual decline in Pakistan from 2016 to 2018. The whole trend was growing.

Here in the following shows the trends of the economic complexity index (the Atlas) in South Africa and Pakistan (from 2010 to 2020).

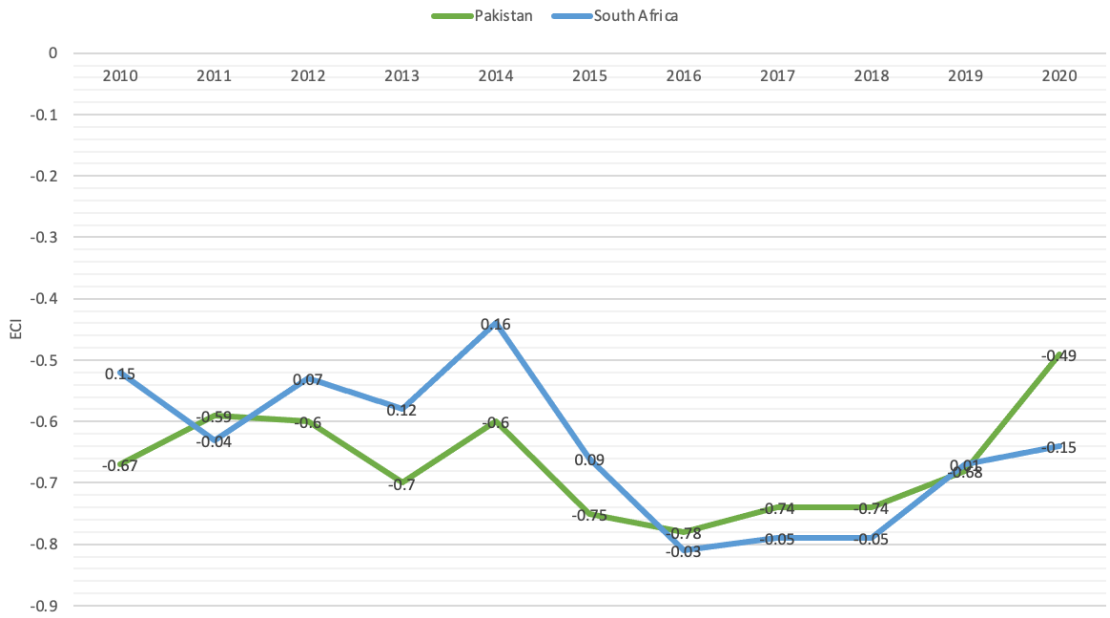

Figure 1.2 The trends of the economic complexity index for Pakistan and South Africa

From the trends of the economic complexity above of South Africa and Pakistan (2010-2020), the trends of the two countries are very similar. From 2010 to 2012, the trend in South Africa's economic complexity declined slightly and then increased gradually, while the trend in Pakistan was a gradual increase and then a slight decline. From 2012 to 2014, the two countries have the same direction. They decreased slightly, then climbed up. From 2014 until 2016, there was a sharp decline in South Africa to its bottom. There was also a decline but not significantly as in South Africa in Pakistan. Between 2016 and 2018, the trends in South Africa and Pakistan were both fluctuating. During 2018-2020, the two countries have seen an uptick. Overall, before 2016, South Africa's economic complexity was above Pakistan's. After 2016, Pakistan started to have a higher economic complexity index than South Africa.

China is the main trading partner of South Africa and Pakistan (China's exports account for 20.7% of South Africa's total trade value, and China's exports account for 29% of Pakistan's total trade value). China is somehow exporting similar goods to both countries and exporting very similar exported trade values. In contrast, the economic complexity of South Africa and Pakistan are moving in opposite directions. These observations led to the final focus of my thesis. I found that the atlas relied on international trade data and selected rich and detailed cross-country information to link products between countries, but it also had limitations. The Atlas only includes goods rather than services, such as access to education. My thesis added relevant data, such as access to education, to the analysis. Therefore, this thesis drew on the analytical

approach used by Lingfang Wu and Jinping Dai in their study of Africa's changes in global value chains to analyse what China's contribution is to the changes in economic sophistication in South Africa and Pakistan, respectively. In addition, South Africa and Pakistan import roughly the same products and capital from China.

This thesis aims to analyse the impact of a country's trade with China on its economic complexity, export diversification and export concentration. This thesis also focuses on two countries: South Africa and Pakistan. This thesis hypothesises that trading with China will increase a country with its economic complexity and diversification, respectively. After analysis and testing, the first hypothesis was rejected. I found that the country's trade with China will negatively correlate with its economic complexity. The second hypothesis was accepted. Trading with China will significantly positively influence a country's economic diversification and negatively correlate with export concentration. This thesis also analyses the same result in Talha's (2021) research: natural resources are negatively correlated to economic complexity. Population growth can increase their export concentration, but this negatively affects their own economic complexity and economic diversification. Infrastructures such as electricity can increase economic complexity, but at the same time, it has a negative effect on export concentration.

In the case of South Africa and Pakistan, their results are very similar. Trading with China does not seem to affect the increase of South Africa's economic complexity index. It can positively affect South Africa's export concentration but counterproductively affect its economic diversification. Same for Pakistan, trading with China has a significant negative impact on the rise in Pakistan's Economic Complexity Index. And it positively affects Pakistan's export concentration but negatively affects Pakistan's economic diversification.

The limitations exist in this thesis: the data of sample countries which need to be included but not (for example, the lack of data on the variable railway and air transport); The thesis did not consider specifying all sample countries into subsets for more accurate tests (for example, neighbouring countries, well-developed countries, developing countries and less-developed countries).

The chapters are structured in the following order: The literature review is in Chapter 2. Chapter 3 covers data and variables. The econometric tests are covered in Chapter 4. The analysis of results is in Chapter 5. And the conclusion in Chapter 6.

Chapter 2 Literature Review

2.1 Relevant Literature

2.1.1 Diversification of Trade and Export Concentration

There have been many studies in the literature related to trade export diversification and determinants. Lennart Petersson (2005) analysed the structural dynamics of South African exports from 1990-2003. He found structural changes in the direction of export diversification by analysing the specialisation of import-competing products and the increase in trade. He finds that emerging non-traditional export products [1] are distributed mainly in industrial clusters of different factor intensities, steadily increasing their shares in total exports and markets.

Manuel Heredia Cabral and Paula Veiga (2010) examine the political and economic factors that underpin export diversification and complexity in sub-Saharan Africa. They show that corruption is the essential factor limiting diversification and export sophistication, and transparency and accountability promote it. They also illustrate the positive correlation between human capital for export development.

Allen Dennis and Ben Shepherd's research (2011) shows that trade facilitation can help to develop and poorer countries diversify their exports. They selected 118 developing countries as research samples. The variables are international shipping costs, domestic export costs, and customs costs. They also find that trade facilitation substantially affects diversification in poorer countries.

Ferdous (2011) examines the patterns of export diversification in East Asian countries (Indonesia, Japan, Malaysia, Philippines, Korea, Singapore and Thailand). Export diversification is important, especially for developing countries. It shows that long-term economic growth is related to expanding the product range of goods. The more diversified an economy's exports are, the less volatile export earnings will be.

The paper by Vishal Sarin, Sushanta Kumar and Naveen Sood (2020) examines the link between export diversification and economic growth. They show that the diversification of exports positively impacts economic growth.

Manuel, Roberto and Claudio (2021, The World Economy) analyse the main determinants of export diversification and concentration. They use three export

[1] Non-traditional export products are agricultural, processed and semi-processed, and handicraft products. For example: horticultural products, seafood, prepared food and beverages.

indicators to find that trade openness leads to higher specialisation. They also show that human capital contributes positively to export diversification (highly educated countries can increase export diversification).

2.1.2 Economic Complexity

In the existing research on economic complexity, the definition of economic complexity has mainly been broad-based, covering multiple regions or countries and how to measure it. In his work, Adam Smith developed the idea of the division of labour, which suggests that the amount of knowledge in a society does not depend primarily on how much knowledge each individual possesses but rather on the diversity of each individual's ability. The greater the length, the greater the specialisation of the participants and the deeper the division of labour that can be achieved. Combined with what The Atlas mentioned, to utilise the diversity of knowledge in society, labours are gathered together to form a team or organisation and interconnected with the market. The types of companies that exist in society and the job requirements of the companies can reflect the amount of productive knowledge used by society. Economic complexity is similar to this complexity (a measure of how much product knowledge a society has). Economic complexity measures the complexity of this interaction and, thus, how much product knowledge a society mobilises (the Atlas).

C.S. Holling (2001) discussed the complexities of economic, ecological, and social systems. He constitutes a “Panarchy” by analysing hierarchies and adaptive loops, which are the foundation of ecological and social-ecological systems across scales. “Panarchy” describes how a healthy system can invent and experiment, benefiting from inventions that create opportunity while avoiding those that, by their nature or by excessive prosperity, lead to instability. He concluded that each level could run at its own pace, protected by slower, more significant levels above but energised from below by faster, smaller innovation cycles.

Ricardo Hausmann, Jason Hwang and Dani Rodrik (2005) concluded in their research that the commodity mix produced by a country might substantially impact economic growth. They focus on the spillover effects of cost information and are interested in the impact on economic growth. They built an index of "the level of country's export earnings" (this index is positively correlated with GDP per capita, human capital and labour force size.) and showed that it could predict economic growth.

In a study on economic complexity, Cesar.A. Hidalgo and Ricardo Hausmann (2009) refer to the number of countries able to manufacture a product as the universality of a country's development and the economic diversity of different products it can produce. They construct a measure of a country's available capabilities by treating each country's production capability as a Lego block. After this analogy, the problem of economic complexity is equivalent to inferring attributes such as the diversity of Lego blocks of the same kind of children in the group by looking at a model of a group of children.

Cesar. A. Hidalgo and Ricardo Hausmann conclude that diversified countries tend to export less common products and that diversification measures correlate with increasing complexity income and production structures. Complex economies can weave together large amounts of relevant knowledge and have large human networks that result in a diverse portfolio of knowledge-intensive products. In contrast, simpler economies have narrower productive knowledge bases, so they can produce fewer, more specific products and require relatively more minor interaction networks. Increased economic complexity is necessary for a society to hold and use more product knowledge (the Atlas).

In The Atlas of Economic Complexity (2011), an attempt is made to measure each country's practical ability by constructing an atlas of economic complexity. This Atlas can be understood simply as a map (product space) used to map out a product network by capturing the requirements of similar products. It uses export data for each country or region to determine where each country's or region's production is located on the map (product space), indicates their current production capacity, and identifies nearby products. The atlas' measure of productive ability can explain the income gap between countries worldwide and predict each country's growth rate.

Alexander J. G. and Cesar A. Hidalgo (2011) studied the observation of economic complexity as an analytical tool to understand the dynamics of economic development. They developed the Observatory of Economic Complexity, a tool that helps users understand the evolution of a country's production structure and trading partners. They bridge the gap between harnessing raw computing power through thousands of data items and the analytical, decision-making quality of the human mind through information visualisation "apps."

Talha Yalta (2021) studies the determinants of economic complexity in countries in the Middle East and North Africa. It shows that human capital is positively related to economic complexity, and natural resources are negatively associated with economic complexity.

Myriam Mariem, Alexandra, Khaled and Rym (2022, Journal of Research in International Bussiness and Finance) have highlighted the analysis of economic complexity in their research; spatial discontinuity can affect economic complexity, GDP per capita affects the economy of different countries. Complexity and the potential of natural resources are inversely related to economic complexity.

2.2 South Africa – China Relevant Trading Studies

In 2011, Logan and Jan Abraham studied China's impact on South African trade and inflation. They use data from the IMF's Trade Statistics Catalog. They choose variables such as South Africa's total exports (imports) to China, South Africa's total global

exports (imports), China's global exports (imports) and consumer price inflation rate. They obtained the results by estimating regression equations (vector autoregression model). The results suggest that strengthening trade relations between South Africa and China leads to short-run costs. In terms of inflation, the impact of Chinese inflation on South African inflation is likely to be very limited (as indicated by the low correlation coefficients throughout the sample period).

Yoon Jung Park and Chris Alden (2013) discussed the “upstairs” and “downstairs” dimensions of China and Chinese in South Africa. They first analysed wholesale distribution activities and investments (including small retail trade and free state manufacturing) of Chinese immigrants in South Africa. They then attempted to list China's social, cultural and economic influence on South Africa. They mentioned that South Africa's major trade and investment deals with China have positively impacted South Africa, contributing to macroeconomic stability. But in terms of long-term prospects, it may not look promising. Trade imbalances, limited employment opportunities, lack of technology and skills transfer, and long-term impact on manufacturing.

Simbarashe Mhaka and Leward Jeke (2018) assess and review South African trade relations with China (1995-2014). They applied the trade gravity model in their research and mainly studied the impact of the real exchange rate, market size and economic size on South Africa's trade with China. For the data selection, they used time series data for 1995-2014 and a linear regression model (least squares method - OLS) in the evaluation process. Explanatory variables are economy size (South African GDP multiplied by Chinese GDP), market size (South African population multiplied by Chinese population), and the exchange rate between South Africa and China. Finally, their results show that economic size and market size have a strong positive effect on trade between South Africa and China, and real exchange rates have a negative effect on trade between South Africa and China.

Lingfang Wu and Jinping Dai (2019) examine the correlation between Chinese aid to Africa, direct investment and Africa's upgrading in global value chains. Their estimates range from technological upgrading of export products (enterprises improve production processes, production efficiency through technological advancement and management optimisation), product upgrading (enterprises improve overall strength through technological advancement and produce higher-quality products.) and functional upgrading (Enterprises are upgrading to more value-added stages in the value chain. Product technical complexity reflects the result of product function upgrading to a certain extent.) Three dimensions measure export upgrading in the global value chain. They use the price method to measure the upgrading of export commodities (the higher the unit price of export products, the better the quality of export commodities). Their data selection is for 14 sub-Saharan African countries. Afterwards, with each country's GDP as the weight, the three-dimensional export upgrade status of the 14 African countries in the global value chain is obtained. Through analysis, they found that both

China's aid to Africa and OFDI (Outward Foreign Direct Investment) is conducive to increasing the total export volume of Africa. At the same time, OFDI is conducive to upgrading Africa's global value chain operations, products and functions.

Linda Calabrese and Tang Xiaoyang (2020) study the role of Chinese investment in Africa's economic transformation. By analysing the evidence and local policies, they concluded that acquiring Chinese enterprises in Africa had created many jobs for African workers, and the localisation rate was very high. At the macro level, Chinese investment often contributes to economic growth (especially by investing in productive industries), which can help unblock economic growth bottlenecks.

2.3 Pakistan-China Relevant Trading Studies

In a related study on the Pakistan-China trading relationship, Sumita Kumar (2007) researched the China-Pakistan strategic relationship (on trade, investment, energy and infrastructure). He finds that China-Pakistan trade goals[2] may need to be revised (or require a more significant restructuring of the Pakistani economy, which will take time). While Chinese investment in Pakistan benefits Pakistan, the trade also provides access to new markets for Chinese goods. Energy cooperation is good for China because China gets energy supply through Gwadar Port (Gwadar Port is another shipping route to Malacca Strait) and helps the development of the western region. Pakistan can also benefit from Gwadar's massive infrastructure development.

Musleh, Ejaz and Usman (2009) discuss the prospects for bilateral trade between Pakistan and China (following the signing of a free trade agreement between the two countries). By using the gravity model, they selected the value of bilateral trade between Pakistan and China (import), the value of bilateral trade between Pakistan and China (export), the proportion of the top 10 categories of China’s exports to Pakistan and the share of the top 10 categories of Pakistan’s exports to China. Ratio (mainly from statistics collected by the International Monetary Fund in the direction of trade). The results show that the bilateral trade between China and Pakistan has the potential to expand, and the bilateral trade between the two countries is inclined toward China.

Saima and Jehanzeb (2015) discuss the significance and challenges of establishing the China-Pakistan Economic Corridor (CPEC, also known as the GKEC: Gwadar-Kashgar Economic Corridor) for China and Pakistan. They first elaborated on the strategic geographic importance of CPEC. This geostrategic corridor is beneficial not only to Pakistan-China relations but also to regional development, which will eventually

[2] There are five goals in China-Pakistan Free Trade Agreement: (1) To deepen mutual friendship between the Contracting Parties: (2) To encourage the expansion and diversification of trade between the Contracting Parties; (3) To remove barriers to trade in goods between the Contracting Parties and facilitate the cross-border movement of goods between the Contracting Parties; (4) To provide fair competitive conditions for trade between the Contracting Parties;(5) Establish mechanisms for further bilateral economic cooperation to expand and enhance the benefits of this Agreement.

benefit all neighbouring countries. The benefits of CPEC include the development of infrastructure, the installation of industrial production units, the reduction of communication costs due to the shortened distance of transport routes, the shortened delivery time of goods and the decrease in inventory costs. They expected that this Economic Corridor (CPEC) would have the ability to achieve economic recovery in Pakistan and prosperity in western China, improve the quality of life in Pakistan, maximise benefits and strengthen strategic partnerships.

In 2020, Siegfried O. Wolf discussed China's 'One Belt, One Road' and economic corridors. The study provides new insights into the China-Pakistan Economic Corridor (CPEC) and analyses the expected financial and geopolitical implications for Pakistan. It highlights the benefits, expectations and policy paths behind implementing the CPEC. The study shows that since Pakistan, and indeed South Asia as a whole, still largely lacks connectivity at the national and transnational levels (South Asia is one of the least economically integrated regions in the world), to address this issue, CPEC can essentially be used as a means to overcome national and regional connectivity gaps, promote economic growth in Pakistan, and foster regional cooperation and integration. The strength of this study is that it not only brings a comprehensive deep day analysis of CPEC but also fills in the gap regarding the 'One Belt, One Road' initiative.

As seen above, many studies deal with analysing the economic complexity of countries and analysing the economic and trade development of South Africa and Pakistan, respectively, with China. However, only a few articles have so far discussed the changes in the economic complexity of South Africa and Pakistan through their trade with China in combination with their economies. My thesis combined the two by analysing China's trade with South Africa and Pakistan, respectively, and by combining the chart of economic complexity.

Chapter 3 Data & Variable

3.1 Data

Most of the data in this thesis come from the World Bank, the OEC, the Atlas and the BACI[3].

The World Bank provides data on air transport, railway, electricity, education, population growth, gross capital formation, natural resources and total trade values. The OEC offers the trade value (per year) of China's exports to various countries. The Atlas provides the Economic Complexity Index. The BACI provides data (HS6 digit) on a detailed calculation of export diversification and concentration.

The period of the data sets is from 2010 to 2020. Thirty countries[4] were selected as reference samples in the data sets. These thirty countries include developed countries, developing countries and relatively less developed countries. Some are above China's economic complexity curve, some are at a similar level, and some are below China's economic complexity curve. Among the thirty countries, South Africa and Pakistan will be the primary analysis objects of this thesis.

There are two data sets in this thesis which contain very similar data. The first data set[5] is to estimate the effect of export diversification and concentration on imports of Chinese goods and trade with China. The second data set is to estimate the impact of Economics Complexity on imports of Chinese goods and trade with China.

3.2 Main Variables

Variables	definations	sources
ECI	Economic complexity index	Atlas

[3] The BACI (CEPII), which is lastly updated on February 1st,2023. Gaulier, G. and Zignago, S. (2010) BACI: International Trade Database at the Product-Level. The 1994-2007 Version. CEPII Working Paper, N°2010-23. BibTex

[4] Thirty countries include Afghanistan; Australia; Austria; Brazil; Canada; China; Czechia; Estonia; Ethiopia; Germany; France; Hungary; India; Indonesia; Japan; Jordan; Kuwait; Malaysia; Netherlands; Pakistan; Serbia; Singapore; Slovenia; South Africa; Sweden; Switzerland; Thailand; United kingdom; United States; Vietnam.

[5] This data set lacks data on France, the United States, Vietnam and Switzerland.

Trade Value_PAK	the export value ($) of a country to Pakistan	OEC
Trade Value_ZAF	the export value ($) of a country to South Africa	OEC
Trade Value_CHN	the export value of ($) a country to China	OEC
Education	The percentage of the population ages 25 and over that attained or completed upper secondary education	World Bank
Gross Capital Formation	The gross capital formation consists of the economy's new expenditure on fixed assets plus the net change in inventories. Fixed assets include land improvements (fences, canals, drains, etc.); purchases of plant, machinery, and equipment; construction of roads, railways, schools, offices, hospitals, private homes, and commercial and industrial buildings. Net receipts of valuables are also considered capital formation.	World Bank
Population growth	Population growth rate (year-over-year percentage). The population growth rate is the index of the mid-year population growth rate from year t-1 to year t, expressed as a percentage. The population is based on the definition of population, counting all residents regardless of their legal status or citizenship.	World Bank
Natural resources	Total natural resource rents (% of GDP). Total natural resource rents are the sum of oil rents, natural gas rents, coal (hard and soft coal) rents, mineral rents, and forest rents.	World Bank
Air Transport	Registered carrier departures worldwide are domestic takeoffs and takeoffs abroad of air carriers registered in the country.	World Bank
Electricity	Access to electricity is the percentage of the population with access to electricity. Electrification data are collected from industry, national surveys and international sources.	World Bank
Railway	Goods transported by railway are the volume of goods transported by railway, measured in metric tons times kilometres travelled.	World Bank
HHI_partners	Hirschman-Herfindahl indices (calculated from the BACI data, the range is [0,1]) based on the shares of different countries in trade.	World Bank
HHI_products	Hirschman-Herfindahl indices based on the commodity structure of the trade. The index number positively correlates with the export concentration on a limited number of products.	World Bank
Share_CHN	Each country's trade value with China as a share of its total trade value.	

Chapter 4 Methodology

4.1 The determinants of export diversification and concentration

To analyse the relationship between the diversity and concentration of sample countries' trade and China's trade proportion, we collect detailed data and specify a linear regression model to evaluate the impact of these factors. The dataset (df4) contains twenty-six countries (N = 26 countries) and ten years (2010-2020).

We will add appropriate dummy variables, such as country and year, to the linear regression model. We observed that not all sample countries have relevant data for each category. For example, South Africa has no relevant data on railways. So, in some cases, in order to make an estimation model to contain more available data. We will reduce some variables according to the situation for the comprehensiveness of the analysis.

The structure of the estimations is as follows:

Equation 1:

$$HHI_{Partners(i)} \sim natural\ resources(i) + population\ growth(i) + capital\ formation(i) + education(i) + air\ transport(i) + electricity(i) + railway(i) + Trade\ Value_{CHN(i)} + share_{CHN(i)} + year + country$$

Equation 2:

$$HHI_{Products(i)} \sim natural\ resources(i) + population\ growth(i) + capital\ formation(i) + education(i) + air\ transport(i) + electricity(i) + railway(i) + Trade\ Value_{CHN(i)} + share_{CHN(i)} + year + country$$

i -- 25 sample countries in this thesis. dummy variables -- year; country

4.2 The test of economic complexity

We collected detailed data to analyse the relationship between changes in the economic complexity of the sample countries and China’s trade share with them. We designed a linear regression model to assess the impact of these factors. The data frame is a relatively short but balanced solid panel with thirty countries (N = 30 countries) and time for ten years (2010-2020).

Similar to all steps in how we use the data frame from the upper part, we will also include some correlation matrices for supplements.

The structure of the estimation is as follows:

Equation 3:

$$ECI(i) \sim natural\ resources(i) + population\ growth(i) + capital\ formation(i) + education(i) + air\ transport(i) + electricity(i) + railway(i) + Trade\ Value_{CHN(i)} + share_{CHN(i)} + year + country$$

i -- 30 sample countries in this thesis. dummy variables -- year; country

4.3 The test in the case of Pakistan and South Africa

For the specialisation in the case of Pakistan and South Africa, the author added two new dummy variables (named d_PAK and d_ZAF) to the data frames. d_PAK is measured as Pakistan is "1" and all the other sample countries are "0". d_ZAF has the same measurement as South Africa is "1". The author applied these two variables to all the estimations above. The author would like to test how South Africa and Pakistan affect differently from the tests of all sample countries.

The structure of estimations is as follows:

Equation 4.1:

$$HHI_{Partners(i)} \sim natural\ resources(i) + population\ growth(i) + capital\ formation(i) + education(i) + air\ transport(i) + electricity(i) + railway(i) + Trade\ Value_{CHN(i)} + share_{CHN(i)} + d_{PAK} * share_{CHN(i)} + year + country$$

Equation 4.2:

$$HHI_{Partners(i)} \sim natural\ resources(i) + population\ growth(i) + capital\ formation(i) + education(i) + air\ transport(i) + electricity(i) + railway(i) + Trade\ Value_{CHN(i)} + share_{CHN(i)} + d_{ZAF} * share_{CHN(i)} + year + country$$

i -- 30 sample countries in this thesis. dummy variables -- year; country

Equation 5.1:

$$HHI_{Products(i)} \sim natural\ resources(i) + population\ growth(i) + capital\ formation(i) + education(i) + air\ transport(i) + electricity(i) + railway(i) + Trade\ Value_{CHN(i)} + share_{CHN(i)} + d_{PAK} * share_{CHN(i)} + year + country$$

Equation 5.2:

$$HHI_{Products(i)} \sim natural\ resources(i) + population\ growth(i) + capital\ formation(i) + education(i) + air\ transport(i) + electricity(i) + railway(i) + Trade\ Value_{CHN(i)} + share_{CHN(i)} + d_{ZAF} * share_{CHN(i)} + year + country$$

i -- 30 sample countries in this thesis. dummy variables -- year; country

Equation 6.1:

$$ECI(i) \sim natural\ resources(i) + population\ growth(i) + capital\ formation(i) + education(i) + air\ transport(i) + electricity(i) + railway(i) + Trade\ Value_{CHN(i)} + share_{CHN(i)} + d_{PAK} * share_{CHN(i)} + year + country$$

Equation 6.2:

$$ECI(i) \sim natural\ resources(i) + population\ growth(i) + capital\ formation(i) + education(i) + air\ transport(i) + electricity(i) + railway(i) + Trade\ Value_{CHN(i)} + share_{CHN(i)} + d_{ZAF} * share_{CHN(i)} + year + country$$

i -- 30 sample countries in this thesis. dummy variables -- year; country

4.4 The correlations of all variables

For a supplement, the author applied the correlation matrix to find the relationship between the variables in the data set.

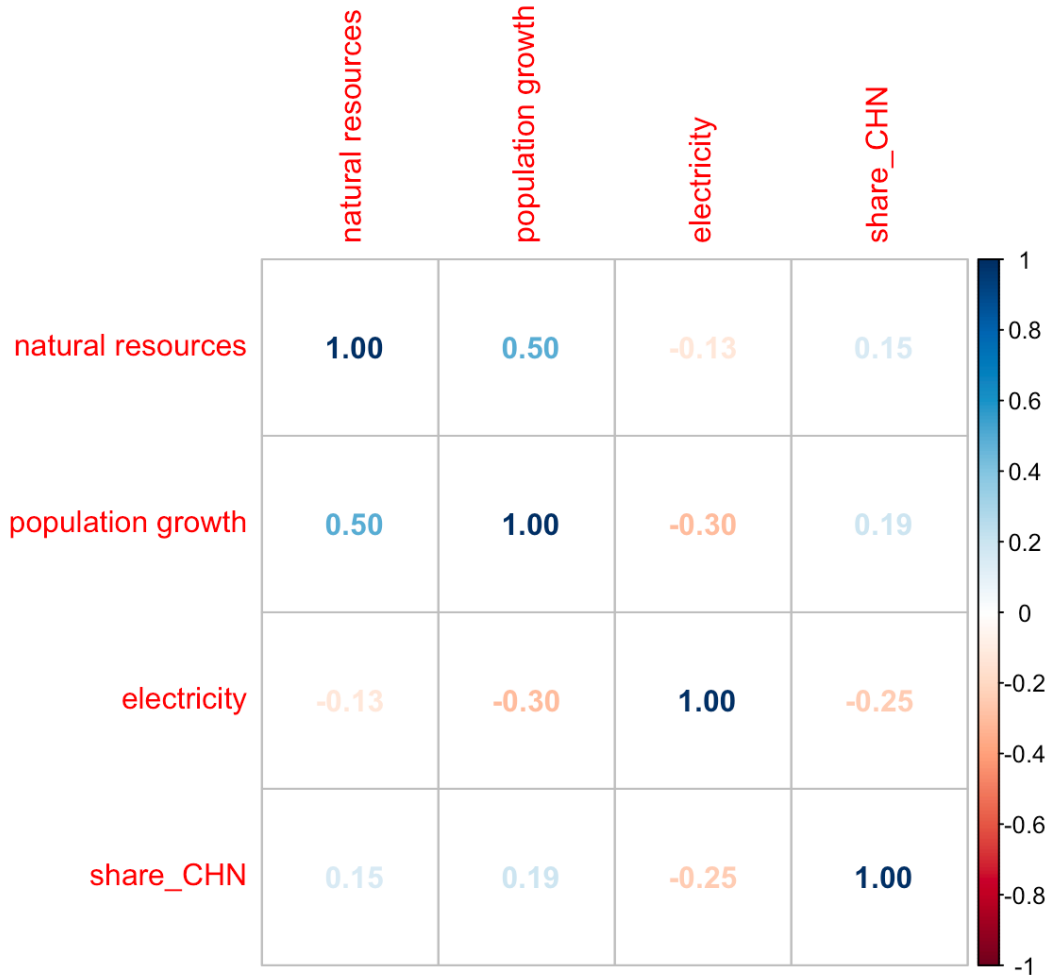

Figure 4.0 The correlation matrix among variables in the estimation of economic complexity

From the results of this correlation matrix, we can see that there is almost no relationship between these variables in the data set. They are all independent of each other. The only slight relation to notice is population growth and natural resources.

Chapter 5 Analysis and Results

5.1 Results for export diversification and concentration

This panel data set comprises 286 observations of 22 variables and ten years from 2010 to 2020, which is a balanced panel. The author then used the linear regression model to test the relations. In terms of measuring the relationship between the trade value of the sample countries with China and their trade diversity, the author chooses the original Hirschman-Herfindahl index (named HHI_partners) as the explained variable. The author takes the trade value between the sample countries with China (Trade Value_CHN) and the share of China's trade value with the sample countries (share_CHN) as independent variables on the right-hand side of the regression equation. To improve the regression results, the author includes natural resources, education level, population growth, capital formation, and general infrastructures[6] also as independent variables. The author added country[7] and year as dummy variables in the linear regression equation. Then the author estimated specification 1[8].

In terms of measuring the relationship between the trade value of the sample countries with China and their export concentration. Almost the same as the previous estimation, the author chooses the Hirschman-Herfindahl index (named HHI_products) as the measured explained variable. Then the author estimated specification 2.

Results are shown in the subsequent table. We can see that there are four significant results in the estimation of diversification, they are population growth, capital formation, education and the share of China’s trade value with the sample countries. To illustrate firstly, the increase in HHI means a decrease in diversification. Capital formation is negatively correlated (statistically significant) with developing sample countries’ economic diversification. Population growth is more influential than capital formation, which also negatively affects economic diversification. Education has a negative correlation with diversification. Although this effect is weak, it is strongly significant. The share of China’s trade value has the highest coefficient among all the estimated variables. The share of China's trade value is significant and has a negative relation to diversification. The larger the share of trade value with China, the lower the economic diversity of a country. Natural resources and electricity are insignificant, which means that their changes have an almost negligible impact on the country's

[6] Infrastructures are explained by three variables in this thesis, which are air transportation, electricity and railway. The author chose these three variables instead because the majority goals for Pakistan and South Africa to develop their infrastructures are these three variables.

[7] The countries' names are abbreviated as three letters in the data frame. Please refer to Acronyms in this thesis for the three-letter abbreviation for each sample country.

[8] In the equation, the author did not add the variable ‘railway’ because there is a lack of data on South Africa’s railway.

economic diversification.

	Dependent variable:	
	HHI_partners	HHI_products
	(1)	(2)
`natural resources`	0.0004	0.003***
	(0.001)	(0.001)
`population growth`	0.014**	0.003**
	(0.007)	(0.002)
`capital formation`	0.002*	0.0001
	(0.001)	(0.0003)
education	0.002***	0.0002
	(0.0003)	(0.0002)
electricity	-0.0001	-0.001*
	(0.001)	(0.0003)
share_CHN	0.219**	0.100***
	(0.092)	(0.036)
Time dummy	yes	yes
Country dummy	yes	yes
Observations	154	163
R2	0.339	0.995
Adjusted R2	0.251	0.994
Residual Std. Error	0.052 (df = 135)	0.007 (df = 122)
F Statistic	3.846*** (df = 18; 135)	657.438*** (df = 40; 122)
Note:		*p<0.1; **p<0.05; ***p<0.01

Figure 5.1 estimations results of equation 1 and 2

Regarding export concentration. The results of this data set show that natural resources

and population growth positively impact (statistically significant) the country's export concentration, and their influences are the same (0.003). Compared with the estimation of diversification, natural resources play a more important role in concentration. Unlike the results in estimating diversification, capital formation and education do not significantly affect the sample country's export concentration. Electricity has a very slight negative correlation with export concentration. The share of China's trade value is strongly significant and positively impacts the country's export concentration. Its coefficient is still the highest among all estimated variables.

From all results above, we can observe that the increase in the share of China's trade value will increase the sample countries' export concentration and decrease their diversification.

5.2 Results for the test of economic complexity

This panel data set comprises 330 observations of 18 variables and ten years from 2010 to 2020, which is a balanced panel. Very similar to the estimation methods from the previous part, the author then used the linear regression model as a measure. In terms of measuring the relationship between the share of the trade value of the sample countries with China and their economic complexity index. In this case, the author chooses the economic complexity index (named ECI) as the measured explained variable. The author takes the same variables as the upper part on the right-hand side of the formula. Then, the author applied specification 3 and got the following data.

To briefly explain the data set shown below. (1) is estimation with all variables included. Since the author observed that the variables air transport and railway are not significant and in order to have more observations, the author applied the estimation (2) without the variable railway and the estimation (3), which omit both of the two variables.

By observing the data, we may wonder why the results of other coefficients change after removing the variables air transport and railway. The author found that the reason may be the lack of data and selectivity. Most of the sample countries (those without these two variables) are concentrated in Central and South Asia, such as Afghanistan, Ethiopia, Indonesia, etc.

	Dependent variable:		
	ECI		
	(1)	(2)	(3)
`natural resources`	0.020	-0.019**	-0.019***
	(0.014)	(0.007)	(0.007)
`population growth`	0.036	-0.052***	-0.053***
	(0.026)	(0.019)	(0.019)
`capital formation`	-0.005	0.007*	0.007*
	(0.005)	(0.004)	(0.004)
education	0.003	0.002	0.002
	(0.003)	(0.003)	(0.002)
`air transport`	0.00000	0.00000	
	(0.00000)	(0.00000)	
electricity	0.011***	0.009**	0.010**
	(0.004)	(0.004)	(0.004)
railway	-0.00000		
	(0.00000)		
share_CHN	0.030	-0.894**	-0.867**
	(0.434)	(0.448)	(0.434)
Time dummy	yes	yes	yes
Country dummy	yes	yes	yes
Observations	129	172	181
R2	0.996	0.994	0.994
Adjusted R2	0.994	0.992	0.992
Residual Std. Error	0.067 (df = 88)	0.084 (df = 127)	0.082 (df = 137)
F Statistic	545.317*** (df = 40; 88)	482.732*** (df = 44; 127)	537.160*** (df = 43; 137)
Note:			*p<0.1; **p<0.05; ***p<0.01

Figure 5.2 The estimation of the economic complexity index

From the data results, we can observe that natural resources have a relatively significant negative impact on the economic complexity index of the sample countries. Population growth also negatively affects the Economic Complexity Index, which is more influential than natural resources. Capital formation is also positively correlated with economic complexity but not strongly. The coefficient of education is positive from the data. Since it is insignificant, we can consider that its impact on the economic complexity index is negligible here. The development of electric power positively affects the economic complexity index of the sample countries, and its influence is the

same as capital formation. The share of trade with China has a significant negative correlation with the country's economic complexity index, which shows that the greater the share of trade value with China, the lower the country's economic complexity.

5.3 Results for the case of Pakistan and South Africa

In this sub-section, the author will focus on South Africa and Pakistan from the above estimations (diversification, concentration and economic complexity). The author created two dummy variables which are for Pakistan and South Africa, respectively. Then the author added the product of these new variables and the share of China's trade value, respectively, and applied them to all estimations.

In the estimation of economic diversification, the author applied equations 4.1 and 4.2. The results are the following (the whole estimation is in the Appendix):

Interaction dummy	Estimate	Std. Error	Pr(>|t|)
China and Pakistan	-0.1713	0.07386	0.022235 *
China and South Africa	0.3682	0.1471	0.013749 *

Figure 5.3 The interaction dummy result of the economic diversification

From the results above, we can observe that the effects of the share of China's trade value on those two countries' diversification are opposite. The coefficient for the share of China's trade value for all sample countries in equation 4.1 (d_PAK) is 0.1763. The coefficient for the share of China's trade value for all sample countries in equation 4.2 (d_ZAF) is 0.04618. Then, we can summarise that the coefficient for the share of China's trade value with Pakistan is 0.005. The coefficient for the share of China's trade value with South Africa is 0.41438 Hence, the share of China's trade value has a significant negative relation (reject the thesis hypothesis) to Pakistan and South Africa on economic diversification. The increase in the share of China's trade value with Pakistan will decrease Pakistan's and South Africa's economic diversification.

In the estimation of export concentration, the author applied equations 5.1 and 5.2. The results are the following (the whole estimation is in the Appendix):

Interaction dummy	Estimate	Std. Error	Pr(>|t|)
China and Pakistan	-0.1650	0.06098	0.007887 **
China and South Africa	0.3467	0.1215	0.005155 **

Figure 5.4 The interaction dummy result of the export concentration

The results are very similar to the estimation in diversification. The coefficient for the share of China's trade value for all sample countries in equation 4.1 (d_PAK) is 0.2172. The coefficient for the share of China's trade value for all sample countries in equation 4.2 (d_ZAF) is 0.09206. Then, we can calculate that the coefficient for the share of China's trade value with Pakistan is 0.0522. The coefficient for the share of China's trade value with South Africa is 0.43876. The share of China's trade value is significantly positively correlated to Pakistan's and South Africa's export concentration. The results show that the greater the trading with China for Pakistan and South Africa, the greater the export concentration to Pakistan.

In the estimation of economic complexity, the author applied equations 6.1 and 6.2. The results are the following:

Interaction dummy	Estimate	Std.Error	Pr(>|t|)
China and Pakistan	-1.709	0.7305	0.020854*
China and South Africa	-2.020	1.489	0.177369

Figure 5.5 The interaction dummy result of the economic complexity

The coefficient for the share of China's trade value for all sample countries in equation 4.1 (d_PAK) is 0.286. The coefficient for the share of China's trade value for all sample countries in equation 4.2 (d_ZAF) is -0.8338. So, the coefficient for the share of China's trade value with Pakistan is -1.423. The coefficient for the share of China's trade value with South Africa is -2.8538. It is clear that the share of China's trade value is significantly negatively correlated to Pakistan's economic complexity. The share of China's trade value seems also negatively influences South Africa's economic complexity, but it is not significant enough. The results show that the greater the trading with China for Pakistan, the lower the economic complexity index for Pakistan.

Chapter 6 Conclusion and Discussion

The main objectives of this thesis are to analyse the economic complexity, diversification and concentration in the trading of thirty sample countries with China from 2010 to 2020 using the estimation of simple regression models with dummy variables. The thesis then focuses on the case of South Africa and Pakistan. In the thesis, chosen data are from reliable sources. They could explain the main idea of this thesis well—economic complexity index (ECI) and Herfindahl–Hirschman Index (HHI) as the explained variables. The simple regression models are applied to find out the correlation. Thirty sample countries are chosen for more observations in a worldwide capacity, from well-developed countries to less-developed countries.

Through the analysis of the previous part, this thesis can sum up some main results. The greater the share of trade value between a country and China, the less conducive to the development of the country's economic complexity. The growth of economic complexity is negatively affected by the development of natural resources. The more natural resources a country has, the lower its economic complexity index will likely be. Population growth is also correlated to economic complexity. Therefore, if a country wants to improve its own economic complexity, it might want to control the excessive growth of the population. This thesis observes that if a country wants to strengthen its economic complexity index, it can do so through capital formation and infrastructure development, such as vigorously developing an electricity network.

The share of trade value with China can increase the development of the country's export concentration and negatively affect economic diversification. Some other factors which are negatively influential on economic diversification are population growth, education and capital formation. At the same time, population growth is positively correlated with the development of export concentration. Natural resources have a very slight and not significant role in economic diversification but positively influence export concentration. Electricity is the only variable that negatively correlates to export concentration but has an insignificant positive relation to economic diversification.

Hence, when the sample countries develop their own natural resources and population growth, they can increase their export concentration, but this negatively affects their own economic complexity and economic diversification. The development of electricity can increase economic complexity, but at the same time, it has a negative effect on export concentration. The larger the share of sample countries' trade with China. However, it is not conducive to the improvement of their own economic complexity and export concentration. It can help the improvement of their own economic diversification.

In the case of South Africa and Pakistan, from the analysis, we can conclude that

different from the results obtained by the sample countries, the share of trade with China cannot affect the development of South Africa's economic complexity index (negative effect but not significant). Very similar to the results obtained for the sample countries, the share of trade value with China has a significant negative impact on the development of Pakistan's Economic Complexity Index. Among the effects of economic complexity, we can confirm that China's (negative) influence on Pakistan is more significant. In the analysis of export concentration and economic diversification, the results obtained by South Africa and Pakistan are very similar. The share of trade value with China positively affects Pakistan's and South Africa's export concentration. Much like the estimations for other countries in the sample, the increase in the share of trade value with China can help South Africa and Pakistan increase their own export concentration but counterproductively affect their own economic diversification.

This thesis still has some limitations in the following aspects: Although many countries (developed countries, developing countries and less-developed countries) have been covered in this thesis, the selection of these sample countries is only based on the graph of the trends of the economic complexity index. In the selection of sample countries, this thesis does not focus on classification and covers some countries with which are relatively frequent trade with China. For example, this thesis selects some countries with meagre trade value with China, such as Afghanistan. Secondly, this thesis does not try to classify the attributes of sample countries in the selection of sample countries. For example, some countries mainly rely on the development of natural resources; some countries mainly rely on the development of education through the import and export of high-tech or high-level talents. Third, the analysis and estimation of this thesis did not include the direct distance between China and the sample countries, and the distance may also have an impact on the data results. And this might be the reason that after applying the estimations, we lost some considerable quantity of statistically significant information from the results (for example, education, air transportation and railway).

Suppose it is possible to continue future research. In that case, future researchers may strive to increase the sample size and coverage of length of time in subsequent studies to enhance the models. We can also make the analysis object more specific. For example, whether trade with China can affect neighbouring developing countries (There are fourteen countries which border with China. In this thesis, we have nine of these countries included.) or whether trade with China can affect countries that have developed relatively well. If the countries in the discussion group are analysed and estimated by classification and batches, the data results will probably not be the same as the current ones.

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Appendix

	Dependent variable:			
	HHI_partners		HHI_products	
	(1)	(2)	(3)	(4)
`natural resources`	0.0005	0.0002	0.004***	0.004***
	(0.001)	(0.001)	(0.001)	(0.001)
`population growth`	0.0001	-0.0002	0.003*	0.003
	(0.002)	(0.002)	(0.002)	(0.002)
`capital formation`	-0.001*	-0.001***	0.0004	0.0001
	(0.0004)	(0.0004)	(0.0003)	(0.0003)
education	0.0001	0.0002	0.0001	0.0002
	(0.0003)	(0.0003)	(0.0002)	(0.0002)
`air transport`	-0.000	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)
electricity	-0.0004	-0.001	-0.0004	-0.001
	(0.0004)	(0.0004)	(0.0003)	(0.0003)
share_CHN	0.176**	0.046	0.217***	0.092**
	(0.069)	(0.045)	(0.057)	(0.037)
year)2011	0.001	-0.0001	0.002	0.001
	(0.003)	(0.003)	(0.003)	(0.003)
year)2012	0.001	0.0003	0.004	0.003
	(0.003)	(0.003)	(0.003)	(0.003)
year)2013	0.004	0.003	0.003	0.002
	(0.003)	(0.003)	(0.003)	(0.003)
year)2014	0.002	0.0002	0.003	0.001
	(0.003)	(0.003)	(0.003)	(0.003)
year)2015	0.001	0.001	-0.002	-0.002
	(0.004)	(0.004)	(0.003)	(0.003)

year)2016	-0.001	-0.001	-0.002	-0.002
	(0.003)	(0.003)	(0.003)	(0.003)
year)2017	0.0003	-0.001	0.002	0.001
	(0.004)	(0.004)	(0.003)	(0.003)
year)2018	0.002	0.001	0.002	0.001
	(0.004)	(0.004)	(0.003)	(0.003)
year)2019	-0.001	-0.001	-0.001	-0.001
	(0.004)	(0.004)	(0.004)	(0.004)
year)2020	0.001	0.004	-0.004	-0.001
	(0.006)	(0.006)	(0.005)	(0.005)
iso_3digit_alpha)AUT	-0.020	-0.032***	-0.027***	-0.040***
	(0.012)	(0.011)	(0.010)	(0.009)
iso_3digit_alpha)BRA	-0.080***	-0.083***	-0.032***	-0.035***
	(0.012)	(0.012)	(0.010)	(0.010)
iso_3digit_alpha)CAN	0.403***	0.385***	-0.014	-0.032***
	(0.013)	(0.011)	(0.011)	(0.009)
iso_3digit_alpha)CZE	-0.018	-0.023**	-0.042***	-0.046***
	(0.011)	(0.011)	(0.009)	(0.009)
iso_3digit_alpha)DEU	-0.089***	-0.121***	-0.028*	-0.058***
	(0.020)	(0.016)	(0.017)	(0.013)
iso_3digit_alpha)EST	-0.065***	-0.068***	-0.034***	-0.037***
	(0.013)	(0.013)	(0.011)	(0.010)
iso_3digit_alpha)ETH	-0.110***	-0.109***	-0.002	0.0001
	(0.035)	(0.035)	(0.029)	(0.029)
iso_3digit_alpha)GBR	-0.085***	-0.109***	-0.027**	-0.050***
	(0.015)	(0.011)	(0.012)	(0.009)
iso_3digit_alpha)HUN	-0.045***	-0.054***	-0.025**	-0.033***
	(0.012)	(0.011)	(0.010)	(0.009)
iso_3digit_alpha)IDN	-0.087***	-0.076***	-0.072***	-0.062***
	(0.014)	(0.013)	(0.012)	(0.011)

iso_3digit_alpha)IND	-0.088***	-0.100***	-0.035**	-0.047***
	(0.017)	(0.017)	(0.014)	(0.014)
iso_3digit_alpha)JOR	-0.071***	-0.063***	-0.046***	-0.039***
	(0.014)	(0.014)	(0.012)	(0.012)
iso_3digit_alpha)JPN	-0.072***	-0.096***	-0.051**	-0.074***
	(0.025)	(0.023)	(0.020)	(0.019)
iso_3digit_alpha)KWT	-0.066**	-0.049	0.254***	0.271***
	(0.032)	(0.030)	(0.027)	(0.025)
iso_3digit_alpha)MYS	-0.094***	-0.085***	-0.066***	-0.057***
	(0.009)	(0.008)	(0.008)	(0.007)
iso_3digit_alpha)NLD	-0.059***	-0.073***	-0.034***	-0.047***
	(0.011)	(0.009)	(0.009)	(0.007)
iso_3digit_alpha)PAK		-0.118***		-0.067***
		(0.022)		(0.018)
iso_3digit_alpha)SGP	-0.071***	-0.078***	0.010	0.002
	(0.008)	(0.007)	(0.007)	(0.006)
iso_3digit_alpha)SRB	-0.074***	-0.083***	-0.028**	-0.037***
	(0.013)	(0.013)	(0.011)	(0.010)
iso_3digit_alpha)SVN	-0.063***	-0.070***	-0.027**	-0.034***
	(0.013)	(0.012)	(0.011)	(0.010)
iso_3digit_alpha)SWE	-0.075***	-0.087***	-0.025**	-0.037***
	(0.014)	(0.013)	(0.012)	(0.011)
iso_3digit_alpha)THA	-0.094***	-0.092***	-0.055***	-0.053***
	(0.013)	(0.013)	(0.011)	(0.011)
iso_3digit_alpha)ZAF	-0.111***		-0.055***	
	(0.011)		(0.009)	
d_PAK	-0.171**		-0.165***	
	(0.074)		(0.061)	
d_ZAF		0.368**		0.347***

		(0.147)		(0.121)
Constant	0.170***	0.206***	0.040	0.075*
	(0.053)	(0.052)	(0.044)	(0.043)
Observations	154	154	154	154
R2	0.986	0.986	0.996	0.996
Adjusted R2	0.981	0.981	0.994	0.994
Residual Std. Error (df = 111)	0.008	0.008	0.007	0.007
F Statistic (df = 42; 111)	191.290***	192.775***	606.463***	610.696***
Note:				*p<0.1; **p<0.05; ***p<0.01

Figure i. The complete specification of diversification and concentration in the case of South Africa and Pakistan

The figure above shows the complete estimations of specifications 4.1(1), 4.2 (2), 5.1(3) and 5.2 (4).

	Dependent variable:	
	ECI	
	(1)	(2)
`natural resources`	-0.013*	-0.021***
	(0.008)	(0.007)
`population growth`	-0.057***	-0.048**
	(0.019)	(0.020)
`capital formation`	0.010**	0.006*
	(0.004)	(0.004)
education	0.001	0.003
	(0.003)	(0.003)
`air transport`	-0.000	0.00000
	(0.00000)	(0.00000)
electricity	0.011***	0.009**
	(0.004)	(0.004)

share_CHN	0.286	-0.834*
	(0.669)	(0.449)
year)2011	-0.011	-0.013
	(0.029)	(0.029)
year)2012	-0.065**	-0.075**
	(0.030)	(0.030)
year)2013	-0.030	-0.034
	(0.030)	(0.030)
year)2014	-0.020	-0.029
	(0.031)	(0.031)
year)2015	0.014	0.020
	(0.033)	(0.034)
year)2016	0.038	0.034
	(0.032)	(0.033)
year)2017	-0.052	-0.051
	(0.034)	(0.035)
year)2018	-0.042	-0.047
	(0.038)	(0.038)
year)2019	-0.003	0.010
	(0.039)	(0.040)
year)2020	-0.124**	-0.098*
	(0.058)	(0.057)
country)Austria	2.217***	2.069***
	(0.121)	(0.106)
country)Brazil	0.831***	0.833***
	(0.111)	(0.113)
country)Canada	1.020***	0.841***
	(0.133)	(0.110)
country)Czechia	2.159***	2.078***
	(0.107)	(0.105)

country)Estonia	1.316***	1.253***
	(0.120)	(0.120)
country)Ethiopia	0.536	0.656*
	(0.343)	(0.347)
country)France	1.897***	1.727***
	(0.115)	(0.089)
country)Germany	2.610***	2.331***
	(0.197)	(0.156)
country)Hungary	2.060***	1.962***
	(0.112)	(0.106)
country)India	1.032***	0.990***
	(0.162)	(0.163)
country)Indonesia	0.460***	0.614***
	(0.138)	(0.127)
country)Japan	2.869***	2.673***
	(0.240)	(0.226)
country)Jordan	0.777***	0.828***
	(0.141)	(0.141)
country)Kuwait	0.548*	0.912***
	(0.318)	(0.300)
country)Malaysia	1.571***	1.673***
	(0.091)	(0.082)
country)Netherlands	1.552***	1.424***
	(0.104)	(0.089)
country)Pakistan		0.365*
		(0.219)
country)Serbia	1.059***	0.966***
	(0.128)	(0.123)
country)Singapore	2.341***	2.254***

	(0.081)	(0.074)
country)Slovenia	2.010***	1.903***
	(0.122)	(0.117)
country)South Africa	0.805***	
	(0.104)	
country)Sweden	2.159***	2.011***
	(0.138)	(0.127)
country)Switzerland	2.582***	2.421***
	(0.120)	(0.103)
country)Thailand	1.594***	1.656***
	(0.129)	(0.129)
country)United Kingdom	2.127***	1.902***
	(0.146)	(0.111)
country)Vietnam	0.453**	0.654***
	(0.192)	(0.177)
d_PAK	-1.709**	
	(0.730)	
d_ZAF		-2.020
		(1.489)
Constant	-1.800***	-1.506***
	(0.523)	(0.513)
Observations	172	172
R2	0.994	0.994
Adjusted R2	0.992	0.992
Residual Std. Error (df = 126)	0.082	0.083
F Statistic (df = 45; 126)	488.761***	475.168***
Note:	*p<0.1; **p<0.05; ***p<0.01	

Figure ii. The complete specification of economic complexity in the case of South Africa and Pakistan

The figure above shows the complete estimations of specifications 6.1(1), 6.2 (2).