International Conference Theoretical and Applied Econometrics

Conference Proceedings

Principal Investigator
Dr. YUEN W. K. Thomas

Co-Investigators
Dr. WOO K.Y.
Dr. TANG C. H. Edward

Hong Kong Shue Yan University

Preface and Acknowledgment

I would like to express my heartfelt thanks to all conference participants for their contribution to the International conference "Theoretical and Applied Econometrics Analysis" on 18 July 2019 at Hong Kong Shue Yan University. Around 40 scholars from 10 Universities including Asia University, Chinese University of Hong Kong, City University of Hong Kong, Hong Kong Baptist University and Hong Kong Shue Yan University, Shanghai University of Finance and Economics, Shanghai University, Singapore Management University, The Open University of Hong Kong, University of Illinois, University of Macau, gave their time and resources to contribute to the conference.

This conference proceedings include all of the conference abstracts that were accepted and which were presented at the conference. Invited conference papers were accepted based on the presentations.

I would like to thank the Research Grants Council of the Hong Kong Special Administrative Region, China for supporting this conference under the INTER-INSTITUTIONAL DEVELOPMENT SCHEME (IIDS). This conference is fully supported by a grant from the Research Grants Council of the Hong Kong Special Administrative Region, China (Project no. UGC/IIDS15/B02/18)

Disclaimer

Principal Investigator

Dr. YUEN W. K. Thomas

Co-Investigators

Dr. WOO K.Y.

Dr. TANG C. H. Edward

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Email: wkyuen@hksyu.edu
Phone: 852-28048526

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THE INTERNATIONAL CONFERENCE
THEORETICAL AND APPLIED ECONOMETRICS
18 July 2019

This conference aims to provide an international forum for sharing research interests and cutting-edge knowledge in econometric methods and applications of econometrics to different fields.

It will also bring academics, researchers and students together to exchange and share their research experiences and results regarding theoretical and applied econometrics.

Moreover, it will provide an opportunity for participants to submit and present their original research papers in econometrics.

Venue
Hong Kong Shue Yan University
BRAEMAR HILL CAMPUS, **Research Complex, RLB303**

Keynote

Professor Wing-Keung WONG

Chair Professor of Finance, Department of Finance, Fintech Center, and Big Data Research Center, Asia University, Taiwan.

Prof Wong has published more than two hundred papers and is in the list of top economists of RePEc and Asian economists. He has more than five thousand citations in Google scholar, around three thousand citations in ResearchGate and more than six hundred citations in Web of Science. He also ranked in the top 1% by Social Science Research Network in 2017 by both downloads and citations. Citation: 6741 (3734 since 2014), h-index: 46, (32 since 2014) and i10-index: 143, (117 since 2014) by Google Scholar citation. His research interests include financial economics, econometrics, mathematical finance and economics, investment theory, risk management, behavioral finance and economics, operational research, stochastic dominance theory, time series analysis, Bayesian theory and decision theory.

Abstracts

Abstracts are presented in the running order of the programme.

Technical efficiency of the Chinese health care sector: The choice between market-orientation and government-orientation

Prof Sung Ko LI

Xinju HE, Sung Ko LI and Valentin ZELENYUK

Abstract

China has been switching back and forth between market-oriented and government-oriented policies in the health care sector. Both government and academics have not reached a consensus in selecting the optimal strategy. This paper investigates the impacts of these two policies on the technical efficiency of the Chinese health-care sector from year 2009 to 2014. We measure the technical efficiency of representative hospitals in several directions with respect to Kuosmanen's (2005) empirical production frontier. For easy comparison, the formulae in the unified framework of Färe et al. (2019) are adopted. To lessen the curse of dimensionality, we follow Daraio and Simar's (2007) suggestion to reduce the dimension of variables. It was found that, on average, the technical efficiency of the Chinese health-care sector was more or less constant over the studied period when desirable outputs are involved. When only undesirable outputs are considered, the technical efficiency has been improving over the studied period. The truncated-regressions with bootstrap showed that market-oriented ownership reform did not worsen the technical efficiency of the health care sector. In contrast, financial support from the government could always improve the technical efficiency. Considering the low ratio of financial support to the health care sector in current government spending in China, we recommend the

Chinese government to allocate more resources to subsidize health care organizations.

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Kuosmanen, T. 2005. Weak disposability in nonparametric production analysis with undesirable outputs. American Journal of Agricultural Economics, 87(4), 1077-1082.

Key words: Chinese health care sector, Technical efficiency, Princinpal component analysis, Market-oriented policy, Government-oriented policy

The Spillover Effect of Surgeons on Expanding the Use of Kidney-Exchange Networks

Dr. Bobby W. CHUNG

Bobby W. CHUNG[1] and Ghanbariamin, ROKSANA

Abstract

National kidney-exchange networks expand the number of transplants by finding matches for incompatible patient-donor pairs within a large national pool. This paper provides the first empirical evidence on the role of surgeons in expanding the adoption by hospitals of the National Kidney Registry (NKR), the largest kidney-exchange network in the United States. We use a unique dataset from the Scientific Registry of Transplant Recipients to define links between hospitals based on the presence of common surgeons. We find that one more adoption of the NKR from connected hospitals increases the probability of the focal hospital to adopt NKR by about 4 percentage points. The magnitude is robust in the IV estimation using the intransitive nature of links. This effect is stronger for hospitals with surgeons that have performed a large number of transplant surgeries, defined as super surgeons, and for hospitals that have more than one mutual surgeon.

[1]Bobby W. Chung, Ph.D, Post-doctoral Researcher, School of Labor and Employment Relations, University of Illinois (Urbana-Champaign)

What Do We Know About Housing Supply? The Case of Hong Kong

Dr. Edward TANG

Edward TANG, Charles LEUNG and Joe NG

Abstract

The house price in Hong Kong is well-known to be "unaffordable." This paper relates the macroeconomy and the housing market of Hong Kong and argues that the housing supply plays a vital role in explaining the phenomenon. This paper also shows that there are some practical challenges in understanding the housing supply of Hong Kong, including the potentially complicated ownership structure of real estate development. While the discussion centers on the situation of Hong Kong, its lesson may also apply to the housing markets in other small open economies.

The work described in this paper was supported by a grant from the Research Grants Council of the Hong Kong Special Administrative Region, China (Project no.: UGC/FDS15/B01/18)

External shocks or internal causes?
The property markets of two Asian financial centers

Mr. Joe NG

Joe NG, Charles LEUNG and Jun YU

Abstract

Property markets in small open economies are subject to both external and internal shocks, whose importance would also affect the best policy responses. We build Bayesian VAR models to distinguish the contributions of external and internal shocks for two Asian financial centers. We find signs of flipping activities in the Hong Kong housing market but not Singapore. In particular, the U.S. aggregate demand shock and monetary policy shock will lead to positive responses of the real housing price and the vacancy rate in Hong Kong. For Singapore, we find that the U.S. aggregate demand shock has no significant effect on the real housing price and the vacancy rate, while the U.S. monetary policy shock will lead to a decreasing in the housing price and an increase in the vacancy rate. Our results survive several robustness checks.

Keywords: Bayesian VAR, small open economies, external and internal shocks, property markets flipping

JEL classification: C11, F41, R30

Authors: Joe Ng (City University of Hong Kong), Charles Leung (City University of Hong Kong)
Jun Yu (Singapore Management University)

Acknowledgement: We are grateful to Nan-Kuang Chen, Fred Kwan, for helpful discussion, and City University of Hong Kong for financial support. Part of the research is conducted when Leung visits the Hoover Institution, whose hospitality is gratefully acknowledged.

Correspondence: Ng and Leung, Department of Economics and Finance, City University of Hong Kong, Kowloon Tong, Hong Kong, joecyng-c@my.cityu.edu.hk, kycleung@cityu.edu.hk .

Are Institutions the Cause or the Outcome of Economic Growth? Evidence in Developing and Developed Countries

Mr. Chun-Kei TSANG

Sung-Ko LI* and Chun-Kei TSANG**

Abstract

Researchers of economic development believe that there is a causal relationship between institutions and economic growth. However, the direction of causality is still under debate. If institutions are a cause of economic growth, then development strategy should emphasize the improvement of institutions. On the other hand, if institutions are the outcome of economic growth, then allocating resources to improve institutions explicitly may not be needed for development. Although numerous studies in the literature have provided different theories and explanations about the relationship between institutions and economic growth, there is still a huge research gap in both theoretical and empirical studies on this important topic.

This paper aims to answer the question "Are institutions the cause or the outcome of economic growth?". Our results are significant because, to our best knowledge, such information in empirical studies with panel dataset has not been fully documented in the literature. Borrowing from the literature on endogenous growth models, this paper expresses various possible relationships between institutions and economic growth as special cases of a general growth model. Using the Institution Pillar of Global Competitiveness Index, we found statistically significant causality from

institutions to economic growth in developed countries. However, the causality in developing countries is from economic growth to institutions. This suggests different model settings should be adopted in studying institutions for countries in different development stages.

Keywords: Institutions; Economic growth; Endogenous growth models; Panel Granger causality test; Global Competitiveness Index

JEL classifications: O43, O11, O47

* Hong Kong Baptist University, email: skli@hkbu.edu.hk
** Hong Kong Baptist University and Hong Kong Shue Yan University, email: cktsang_bepp@hksyu.edu

Greater Bay Area: Price Convergence of Product

Kai Yin WOO, Shu Kam LEE and Jacky WONG

The development of the Guangdong-Hong Kong-Macau Greater Bay Area (GBA, 粵港澳大灣區) purports to increase trade flow and promote economic integration between Hong Kong, Macau and the other nine cities in Guangdong Province – Dongguan (東莞), Foshan (佛山), Guangzhou (廣州), Huizhou (惠州), Jiangmen (江門), Shenzhen (深圳), Zhaoqing (肇慶), Zhongshan (中山) and Zhuhai (珠海). The principal goal of this GBA is to develop a functionally integrated productive and competitive city cluster within which each GBA city can interact harmoniously and complementarily. This GBA initiative, like the European Union, is an ideal experimental platform for regional economic convergence and economic union in which the mobility of both goods and people are perfect in the longer term. The theory of purchasing power parity is a widely accepted conceptual framework for designing and operationalising empirical tests to assess economic convergence criteria. In this paper, we apply Threshold Vector Error Correction Model to study the PPP and the degree of regional price convergence in the GBA. It is observed that due the existence of transaction costs, the effect of linear convergence is weak but strong evidence of nonlinear price convergence is found. The implication is that efforts should be put on reducing transaction costs.

One belt One Road: Nonlinear PPP

Dr. Kai Yin WOO

Kai Yin WOO, Shu Kam LEE, and Paul SHUM

The Chinese Government has proposed the 'Belt and Road Initiative' (BRI) in order to increase trade flows and economic prosperity among the Belt and Road (BR) member countries. The BRI may call for enlargement of economic cooperation as manifested by forming an economic or monetary union in the long term. It is therefore essential to choose a subset of member countries that fulfills the criteria for joining the potential economic or monetary union. The validity of purchasing power parity (PPP) implies well-integrated goods markets and is a pre-condition for further economic convergence. While the presence of transaction costs causes nonlinearities in the adjustment mechanism, our empirical study applies a three-regime threshold autoregressive (TAR) cointegration method for analysis. Our results support the existence of a PPP relationship with China for 12 sampled Asian member countries. Chinese policymakers can prioritize these BR countries for closer economic cooperation. Also, this TAR cointegration method can estimate the unobservable proportional transaction costs from the thresholds. The results reveal BR countries with large thresholds as targets to curtail transaction costs of trading in order to enhance the efficiency in international goods arbitrage and the degree of trade integration along the BR routes.

Analyzing the relationship between Sources of Financing and Economic Growth in China.

Ms Ching Suet CHAK

CHAK Suet Ching[1]

Abstract

China's remarkable success in IT has speeded up development in its financial systems that would make financing proceedings more efficiently than before. There are three basic sources of financing: borrowing from banks, issue of shares or bonds to the public through the stock markets (IPO) and foreign direct investment (FDI inflow). In China, it is definitely a bank-based financial market which accounts for more than 70% of total financing. On the contrary, the FDI has fallen below 5% but is still an important source of foreign currency and technology transfer to China. This paper aims to exam the relationship between financing and the economic growth of China. The gross domestic product (GDP) will be compared to five groups of financial variables including money supply (M2), interest rate, FDI, IPO and aggregate financing to the real economy (flow). All the raw data are converted into logarithm. However, the time series of M2 and interest rate are given up after they have been found no granger-cause GDP and vice versa. A VEC model is built after completing ADF, Granger Causality and Johansen Cointegration Tests. The result shows China's LnGDP(-1) is the variable that affects LnGDP the most with a high parameter of 0.6,

and followed by lnFDI's 0.38. However, the parameters of aggregate financing and IPO are less than 0.5%. These figures are not consistent to the proportion of the original data. After further investigations, we find out two reasons to the aggregate financing. First, large amounts of deposits and lending have shifted to shadow banking and electronic-payment accounts operated by non-banking financial institutions. It becomes worse that money borrowers including the state-owned and commercial banks made use loan for trading in the financial products instead of flowing into the real economy. Bank of Settlement (BIS) worked out that "Credit to government and state-owned enterprises to China's GDP" has climbed up to 252.7% at the end of the third quarter of 2018, higher than the global average's 231.2%. The debt to equity ratio of the state-owned manufacturing enterprises have already moved up to 67% so far. High debt ratio means the ability to further borrowing becoming more difficult and finance costs going up higher. Under these circumstances, we therefore recommend a strategy to the highly geared entity. They should try to generate more income from overseas countries, for instances, increasing exports and IPO in overseas markets. These will achieve the objective of raising funds for domestic enterprises' innovation and expansion. More importantly, these will not push up the credit ratio to GDP and avoid deteriorating the financial risk.

[1] PhD Candidate in Finance, Shanghai University Finance and Economics
Hong Kong Shue Yan University, scchak@hksyu.edu

Happiness and Overweight:
Panel data analysis on the differences between Male and Female.

Ms Wan Ling CHU

CHU Wan Ling and YUEN Wai Kee

Abstract

Globalization of slimming norm tends to spread the perception that being fat is a source of unhappy especially for the case of female. This paper examines the association between overweight and happiness using global parallel panel data and compares the differences between male and female. Using generalized least squares to estimate the fixed effect panel data models, the empirical results show that happiness increases with percentage of overweight. Happiness tends to make people grow plump for both male and female. Increase in GDP per capita increases the percentage of overweight in a country and the effect is higher for male than female. Social support increases the percentage of overweight in low/middle income countries but reduces the percentage of overweight in high income countries for the case of female. Life expectancy increases the proportion of overweight but it is significant only for the case of male. Overweight and positive affect are negatively related and the impact is higher for male than female. Negative affect are positively associated with overweight. The association between happiness and overweight for female in high income countries tends to exhibit a different pattern in comparing with low or middle income countries.

Wine and Happiness: Panel Data Analysis

Dr. Wai Kee YUEN

YUEN Wai Kee and Wan Ling CHU

Abstract

The harmful effect of alcohol is well known, worldwide over 5% of all deaths related to the harmful use of alcohol, this represent around 3 million death each year. However, alcohol is also known as the cultural, social practices and a form of lifestyle globally. This makes the control of the harmful use of alcohol extremely difficult. If people are happy with their consumption of alcohol, it is difficult to convince them not to trace their happiness. This paper examines the association between happiness and the consumption of three types of alcohol (Beer, Wine and Spirits) with a fixed effect panel data model using global data from 2010 to 2015. The empirical result shows that apart from happiness, income, social support and life expectancy also take a role in affecting alcohol consumption. Indeed, different region have different preference in the consumption of alcohol. Europeans tend to enjoy wine with the association between wine and happiness being the largest while beers tend to bring happiness and enjoyment to people in Western Pacific and America. Although spirits take up the largest portion (over 44.8%) of worldwide, the association between happiness and spirits are weak.

Inflation Dynamics:
A Comparative Study of Mainland China and Hong Kong.

Mr. HUNG Tsz Hin, Ronald

HUNG Tsz Hin, Ronald[1] and Yum K. KWAN[2]

Abstract

Vigorous debates have been lasting on whether the inflation dynamics should follow pure backward-looking (Sticky Information) or pure forward-looking (Sticky Price) version New Keynesian Phillips Curve. Previous researches on this issue seldomly compare the validity of these two models, especially in Asian regions. Drawing on the quarterly data from Mainland China and Hong Kong during 1994 to 2017, we find (1) In both cases, pure-backward looking model explains inflation dynamics much better than the pure-forward looking one; (2) Price setters in Mainland China take shorter time on price adjustment then that in Hong Kong; (3) However, both models fail to explain the inflation dynamics well before 2005, but pure backward-looking model performs relatively better in the whole period, in terms of the lower measurement error and correct prediction trend. To the best of our knowledge, our findings, which suggest the Sticky Information model, plays an important role in Asia. This finding is different from previous American and European studies which promote the pure forward-looking model.

Keywords: Inflation dynamics, New Keynesian Phillips curve, nominal rigidity, stick price, sticky information

JEL Classification: E12, E31, E52

[1]Corresponding author: Tsz H. Hung, Department of Economics and Finance, City University of Hong Kong. Email: rhungth@gmail.com. Phone: +852 64378105
[2]Yum K. Kwan, Department of Economics and Finance, City University of Hong Kong. Email: efykkwan@cityu.edu.hk. City University of Hong Kong. Fax: +852 34420284. Phone: +852 34427578

Is Sophia The Robot A Legal Person?

Ms Sheung Chau PANG

PANG Chau Sheung Rosa[1]

Abstract

Sophia the Robot was made by Dr David Hanson of the Hong Kong-based Hanson Robotics. In October 2017, Sophia became the first robot to receive citizenship of any country. Should a robot enjoy any legal status independent of its human creators? If so, what kind of legal status would that be? Should the robot enjoy its/her/his "rights"? This paper is a comparative study of the robotic law and policy in some major jurisdictions such as the EU and the USA in relation to the legal status of robots. The study uses research methodology based on comparative law method, concepts of lesson drawing and policy transfer from political science, and socio-legal approaches. The paper suggests a twofold stance. First, policy makers should seriously consider the possibility of establishing new forms of responsibility and liability for the activities of robots in contracts and business law, e.g., new forms of agency. Second, any hypothesis of granting robots full legal person status has to be carefully considered in the foreseeable future.

Keywords: robot, legal person, robotic law and policy

[1]PANG Chau Sheung Rosa (Shanghai University of Finance and Economics)

An Empirical Study on Child Mortality Rate – Application of Regression Analysis

Mr. YEUNG Ngai Sang, Kenrick

YEUNG Ngai Sang, Kenrick, WONG Yu Hong, LEUNG Tat Yu Owen and LAI Yik Man

Abstract

This paper focus on analyzing child mortality rate [Mortality rate (under-5)] with using regression analysis. Finding best predictors and used as independent variables in a regression equation with the problem of missing data. This paper performs modern method - Bootstrap Inference When Using Multiple Imputation, which can increase the accuracy of the imputation process. This paper shows some important statistical concepts which can allow OLS regression can violate the normality assumption and how quantile regression can reduce the effect of outliers.

Key words: OLS regression, bootstrapping, multiple imputation, quantile regression

Economic and political inequality in Southeast Asia: 1998-2017

Mr. Lok Ka CHAN

CHAN Ka Lok, Daniel[1]

Abstract

Inequality is always one of the hottest focus in the fields of economics, political science and sociology. From economic inequality to political inequality, Based on Mills (1956), Domhoff (2006) and Zingales (2017) agreed that money offers power to lobby the government and establishes think tanks and media, which create civil liberties and participation. Besides, possessing political power can develop economic power, which is seen as vicious circle. On the other hand, Meltzer and Richard (1981), the poor will demand for income redistribution when economic inequality grows. When grievance is high, the means of civil disobedience and rebellion would be triggered to be adopted. In other words, economic inequality may boost the incentive of political engagement and thus reduce political inequality.

In the study of Cole (2018), this is primary attempt to investigate the relationship between economic and political inequality using a global scale. It affirmed that income inequality adversely influenced the goal of political equality and this conclusion applied to most countries around the globe, including both democratic and non-democratic as well as both developed and developing countries. Also, existing research is limited by single country cases and inter-subunit comparison in highly-developed countries (Acemoglu and et al., 2008; Gilens, 2012; Rosset and et al., 2013; Solt, 2008). Thus, in order to help provide contribution to the

field of regional studies (Southeast Asian studies) and have better comparison results, only six Southeast Asia nations under post-Asian Financial Crisis period are chosen.

In this study, it would analyze if economic inequality affects the structure of political power, or vice versa. For method, panel data regression analyses with control variables were employed to identify causal effects (Wooldridge, 2013).

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[1]CHAN Ka Lok, Daniel (Chinese University of Hong Kong)

東盟與中國自由貿易協定對兩地區域發展的影響.

楊偉文先生

楊偉文[1]

摘要

本文嘗試分析「東盟與中國自由貿易協定」對東盟十國政經的影響，按過去歷史資料分析東盟十國跟中國的政經關係，嘗試把相關數據進行量化層級分類的分析，把十國與中國關係分為「與中國關係良好」，「與中國關係中性」和「與中國關係緊張」等三組「關係群」，建立東盟十國與中國的政經關係分析框架，闡述自由貿易協定對三組不同級別的東盟國家帶來的影響，藉這「政經框架」評估東南亞與中國政經關係的未來發展。

[1]楊偉文（香港樹仁大學經濟與金融學系高級講師，樹仁大學可持續發展房地產研究中心研究員。前《信報財經月刊》專欄作家，並在各大媒體發表評論文章和出席電台報紙訪問，為政府和企業提供研究顧問報告，發表論文和著作數十篇，著有《香港與內地經濟整合研究》）。

基于协整模型的股票配对交易策略研究

魏霁月小姐

魏霁月[1]

摘要

本文首先概述了国内外学者的研究成果，阐述了配对交易的相关概念以及与之相关的数学模型，随后选取了 2017 年至 2018 年每个交易日上证 50 指数的成分股收盘价作为样本数据，运用最小距离法选出相关系数较小的 5 对股票对，运用协整模型训练并测试后得到投资结果最好的股票对（交通银行，光大银行）。文章在研究中还发现简单对所有股票对套用相同的阈值并不能得到较好的投资结果，在根据股票对（兴业银行，国泰君安）的特征修改了相应阈值后，投资结果得到了明显的提高。

关键字： 配对交易 最小距离法 协整模型

[1]魏霁月(上海大学)

Global Warming, Climate Change and World Environmental Degradation

Dr. Edward TANG

Edward TANG

Abstract

Climate change has been a long-lasting global issue. Despite its urgency, international communities are rather slow to work out a feasible solution. In this paper, we start with an overview of pollution around the world, and then proceed to the discussion of environmental justice. Finally, it explains that there are weak political and economic incentives for countries to bind a coherent agreement on climate change. The chapter is also illustrated by the examples around the world.

The Rank Tests for Nonlinear Cointegration: Examining the Price convergence of household products in Canada

Dr. WOO Kai Yin

Kai Yin WOO, Shu Kam LEE and Alan CHAN

This article examines the price convergence of beverage products within Canada in order to assess the efficacy of intranational cross-border movements of foodstuffs. Since the cointegrating relationship between product prices may not be exact or linear, we adopt the rank tests for analysis which do not require prior knowledge and specification of the linear or nonlinear functional form. Our results validate the price convergence of almost all products within Canada. Furthermore, a subset of the cointegration relationships exhibits nonlinear longrun price co-movements.

The Rank Tests for Nonlinear Cointegration: Examining the Price Competition between the Two Supermarket Giants in Hong Kong

Mr. WONG F. K. Joe

WONG F.K. Joe, LEE S.K. and WOO K.Y

Abstract

The grocery industry in Hong Kong has increased its concentration over the last two decades. High concentration may give rise to market power, which in turn causes anti-competitive behaviour and high grocery prices that lower the standard of living among consumers in Hong Kong, especially those in low-income households. The growing dominance of supermarket chains has therefore brought public concern over exploitation of market power in the HK retail grocery industry. Using cointegration analysis, this paper examines the price convergence and competition of grocery products between the two largest supermarket giants in Hong Kong, Wellcome and ParknShop. Since the cointegrating relationship between supermarket prices may not be exact or linear, we adopt the non-parametric rank tests for analysis which do not require prior knowledge and specification of the linear or nonlinear functional form. The results confirm the existence of price convergence and competition. Also, there is some evidence of nonlinear cointegration relationships between supermarket prices, which may be caused by transaction costs, nonlinear price interaction behaviors, and game theoretic strategies.

Keywords: rank tests; Hong Kong supermarkets; nonlinear cointegration; price convergence

JEL: C1, D0

Papers

Papers are presented in the running order of the programme.

An Empirical Research on the Relationship between Sources of Financing and Economic Growth in China

Suet Ching Chak
PhD Candidate in Finance, Shanghai University Finance and Economics
Hong Kong Shue Yan University
scchak@hksyu.edu

Abstract:
China's remarkable success in IT has speeded up development in its financial markets that would make financing proceedings more efficiently than before. Three major sources of financing are selected for analysis: borrowing from financial institutes, issue of shares or bonds to the public (IPO), and foreign direct investment (FDI inflow. After a series of tests including Granger Causality and Co-integration, a regression model and an error correction model are built. Our research is summarized that: (1) China is a bank-based economy that helps launching of monetary policies, (2) the supply-leading and market-based hypothesis also work in China, (3) the economic growth is positively affected by the three sources of financing, but FDI is found the highest impact on economic growth, (4) Facing increasing loan stock, higher gearing will lead to higher finance costs and lower borrowing power, (5) both money supply and interest rates do not granger cause GDP and vice versa in the research, their influence on GDP is not straight forward that needs further research.

Keywords:
China, GDP, aggregate financing, financial markets, foreign direct investment (FDI).

1. Introduction

This study was conducted in the context of economic growth of China. China's remarkable success in automation and information technology (IT) would no doubt benefit the whole country especially its financial development. At the same time, China is opening up its financial markets, it allows more private and merchant banks owned by local and foreign investments, more financial products, liberation of interest rates, and encouragement of qualified Chinese enterprises going public listing in local and overseas markets. There has been a number of academic research analyzing the relationship between economic growth and development of financial markets.

Economic growth depends on a wide variety of factors, we take the perspective of increasing investments in the real sector. When facing increasing demand, a manufacturer will increase its output by raising productivity, it can be achieved by automation of production facilities and management information system, so the owners will seek funds from internal and external sources. The most popular channels include borrowing from registered banks or financial institutes and issue of bonds to investors. To overcome the disadvantage of interest burden and loan repayment, the owner can raise fund by issue of shares in the stock market (IPO). Hence, we would like to add one more source of fund "FDI" as China is ranked as the second largest country of inbound foreign direct investment (FDI). The foreign investor can setup a business either in the form of joint-venture or wholly foreign own enterprises (WOFE).

It is generally believe that money supply and interest rate are the two basic factors that affect liquidity in the market, their relationship can be shown on Diagram 1"Financing Factors and Economic Growth" Both the money supply and interest rate will affect the amount of financing provided by banks and investors. Low interest rates is expected to increase investments and consumptions and therefore raising gross domestic output (GDP).

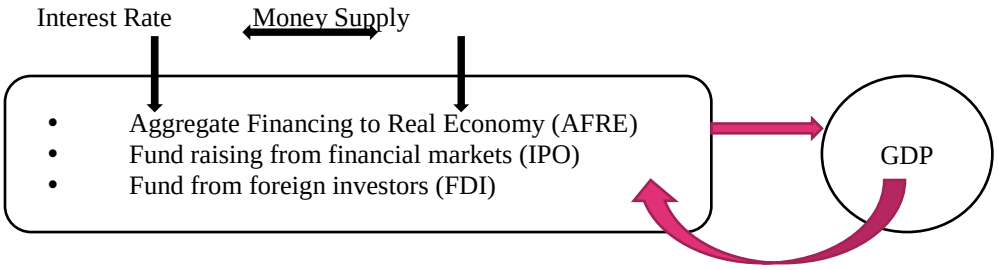

Diagram 1: Financial Factors and Economic Growth

Since 2011, the annual growth rate of the third sector (service) has overtaken than that of the second sector (manufacturing) in China. According to the national statistics, the production index of financial sector has climbed up to 9050 (1978=100) and become the highest one among all industries in China in 2017. It was much higher than manufacturing's index 5045 for the same period. Under these circumstances, the financial data could be useful for predicting the economic growth of China. This paper selects the data from the financial sectors to exam its impact on the real economy.

2. The Framework of Sources of Financing

Both financial institutes and stock markets share the role of fund supply to enterprises but their regulations, credit assessment and financing procedure are completely difference. Borrowing from financial institutes would be quickly achieved if the borrower can fulfil financial institutes' requirements in the aspects of risk assessment and repayment ability. On the other hand, it takes at least six months and millions of expenditures before getting approval of listing in the stock markets. Public listing generates huge amount of funds without the burden of repayment and raises the social status of the enterprise. Borrowing or public listing complement each other in the developed and developing markets (Nyasha and Odhiambo, 2017). Hence, a Chinese entrepreneur can seek cooperation from multinational enterprises who agree to provide funds and/or technological transfer to China.

A well-established enterprise has a wide range of choice for fund raising. We identify three major sources of financing shown on Table 1. Hence, the amount of fund raising from the major three sources are shown on Diagram 2, they are Aggregate Financing from Real Economy (AFRE), financial markets (IPO), and inbound Foreign Direct Investment (FDI) The amount of financing raised from AFRE owns around 70% to 90% of the sum of the three sources. The second one is financing from domestic and overseas stock markets that own above 20%. FDI owns around 3% of the sum. During the observation period, AFRE and IPO increased 867% and 636% respectively. However, the FDI increased 93% only that deserves concern.

I AFRE Financial Institutes	II IPO Financial Markets	III FDI Foreign Direct Investments
• State-own registered banks • Joint-venture registered banks • Private registered banks • Non-registered financial institutes	• Main board –Equity & bonds • ChiNext 創業板 • New OTC Market 新三板 2011 • Technology Innovation Board 科創板 2019	• Wholly foreign own enterprises (WFOE) • Equity joint-venture enterprises (JV)

Table 1: Source of Financing in China

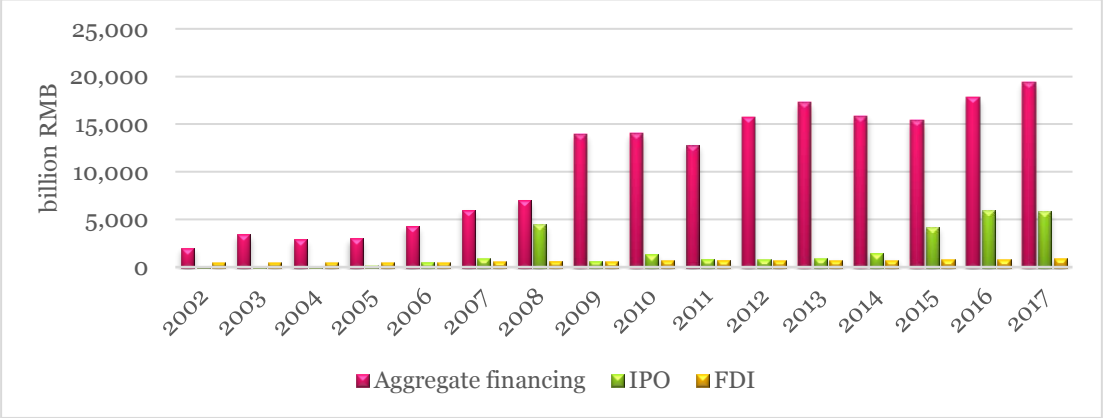

Diagram 2: Amounts of Fund Raising of Aggregate Financing, financial markets and FDI

This study aims to find out the impacts of different financing sources on the economic growth of China. Three research questions are suggested below:

Research Questions:
RQ1. Is economic growth affected by money supply and interest rate of China?
RQ2. Is economic growth affected by availability of funds for business expansion?
RQ3. Is economic growth affected by nature of source of fund?

3. Literature Review

The basic doctrine about supply of funds for enterprises' development are bank-based and market-based views. Hoshi, et al. (1990) conducted a research in Japan and concluded that a bank-based financial system is better than a market-based system because long-term funds would tend to be invested in the real sector; whereas price fluctuation in the stock market attracts the speculation. (Hoshi, Kashyap, and Scharfstein, 1990) On the other hand, the market-based view places a high importance on market-based financial development. The World Bank (1989) has indicated that for getting rid of poverty, the less-developed countries should build their financial markets and encourage public listing. Some economists have pointed out that bank's lending policy and regulations make them give priority to the low-risk debts. (Rajan 1992) The registered banks' conservative lending policy are not supportive to the innovative but risky business or startup.

Some economists would like to focus on financial functions carried out by financial institutes and believed that the financial markets and institutes are complement to each other in a dynamic sense.

(Merton and Bodie, 1995). "Competition will cause evolution in institutional structures to produce greater efficiency in the performance of financial system functions." (Merton and Bodie, 1995)

Some economists think that the importance of financial markets will be compatible to the growth of the real sector. (Demirgue-Kunt and Levine, 1996; Cull and Xu, 2011) For gaining the confidence of investors, there must be better corporate control, information disclosure, risk management and other regulations existed in the country. Gong et al. has indicated that a good legal system can overcome the pitfalls in the financial markets and reduce financial costs. (Gong, Zhang and Lin, 2014) In the reality, the implementation and enforcement of regulations and law give a big challenge to the government of developing countries.

Facing the contemporary development in the innovative business, the Chinese economists indicated that the financial markets can provide more powerful support for upgrading their industrial level in China. Gong Qiang et al. (2014)'s empirical research indicated that there is positive association between financial market and economic developments when China is investing heavily in innovation and quality. The importance of financial markets play an important role in the high-income countries, this needs the support of a well-established legal system. (La Porta et al. 1998; Cull & Xu, 2011)

The demand-following hypothesis suggests that productivity and expansion of business leads to financial development. Robinson (1952) stated that prospective profits can induce investments from existing and new firms who will increase production by buying more capital equipment. Therefore venture takes initiative and finance follows.

The supply-leading hypothesis works because financial institutes can contribute to upgrade the economy by allocating resources to the high-growth sectors instead of the traditional, low-growth sector, and to induce entrepreneur's efforts towards the prosperous industries (Patrick, 1966). In addition, Calderón (2002) also indicated that financial deepening propels economic growth through both a more rapid capital accumulation and productivity growth and therefore advocate the supply-leading hypothesis. (Calderón and Liu, 2002)

Zhang et al. (2018) find that the cross-correlations between Chinese stock market and the other three stock markets in the Belt and Road Initiatives are multifractal and there are exists more long-term trade behavior than short-term behavior. They find a positive and statistically significant single-direction relationship between economic and financial development in China. (Zhang, Zhu and Yang, 2018)

As the Chinese government has determined to upgrade its financial development gradually after its economy has been moving forward to a well-off level, it is a step stone that more foreign merchant banks and financial products appeared in China. It is no surprise that Fan, et at. (2018)'s research coming up a conclusion that both hypothesis of demand-following and supply-leading co-existed in China. Their results also reveal that there is a significant bidirectional relationship between financial development and trade openness. (Fan, Xu and Shi, 2018)

Chow et al. (2018) employed the multivariate linear and nonlinear causality tests in 14 developing countries for the period from 1950 to 2014. They find that both demand-following and supply-leading theory are significant to 10 developing countries including China. Pakistan is found to be the only country that is neither demand-following nor supply-leading. (Chow, Vietto and Wong, 2018) Maybe most business are still conducted in cash, low demand to banking service causes few banks installed in Pakistan.

3. Research Methodology

3.1 Background of Economy in China

The value of gross domestic product (GDP) of China has kept on increasing and reached a record high of RMB89.69 billion (see Diagram 3a) in 2018. However, Diagram 3b reflected that the GDP growth rate had reached a high record of 14.2% in 2007, it fell sharply to 9.7% in 2008 because of spillover effect of the US's financial tsunami. The GDP growth rates looked bound back in 2010 as a result of substantial increase in money supply during the period. It seems increase in money supply cannot really sustain the economic growth for long run. It turned to decline again and maintained around 6% during 2015 to 2018. The breakout of the China-US trade war is likely to push it further down in 2019.

This paper is going to focus on the economic factors that are likely to affect the economic growth (GDP) of China. We have already sort out five variables including money supply, interest rate, aggregate financing to the real economy (flow), funds raising from the stock markets (IPO) and foreign direct investment (FDI).

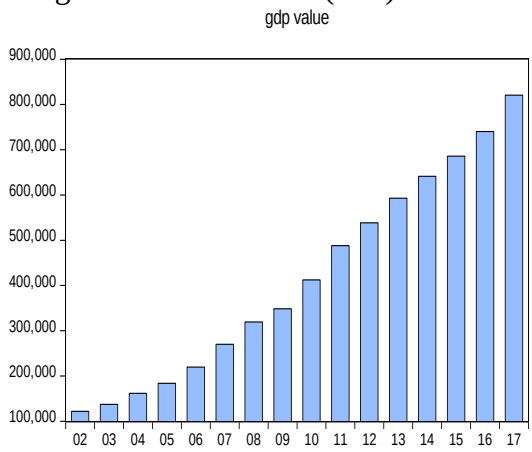

Diagram 3a: China GDP Value

Diagram 3b: China GDP Rate 2002-2018

3.2 Research Design

3.2.1 Model to be built:

GDP_t = {GDP_{-t}, Aggregate financing, IPO, FDI, interest rate, increase in money supply}

3.2.2 Data Description

Observation Period:	Annual data 2002 - 2017
Source of data:	People's Bank of China, National Statistics Bureau.

3.2.3 Dependent variable

GDP growth rate (GDP) is a typical variable representing the economic growth of a country. The definition of GDP defined by OECD is "an aggregate measure of production equal to the sum of gross value added of all resident and institutional units in production and services". In other words, the GDP value does not include the private and non-monetary activities, but it is still an acceptable

data to reflect the macroeconomics of a country. The nominal value of current GDP is used in this study for comparable to other economic data denominated in current value.

3.2.4 Explanatory Variable

- **Aggregate Financing to the real economy flow (AFRE)** is an aggregate measure of financing increased during the observation period in China. The data can be found in the People's Bank of China. AFRE is a sum of "RMB loans, foreign currency denominated loans, trust loans, entrusted loan, undiscounted banks' acceptances, net financing of corporate bonds, equity financing on the domestic stock market by non-financial enterprises". The RMB loan owns around 70% to 80% of AFRE. The amount of increase in entrusted loan was quite high during 2012 to 2016, but had reduced drastically during 2017 and 2018. At the end of 2018, the stock balance of AFRE was RMB200.75 trillion including RMB loan stock RMB134.69 trillion.

- **IPO** is the issue of shares or corporate bonds by the large enterprises to the public through the platform of stock markets. There are four types of stock markets in China: the Main Board, ChiNext, Over-the-counter market (New OTC) and Technology Innovation Board. Since 2015, the amount of IPO in the domestic market increased a lot, it reached RMB1661.3 billion in 2017. On the other hand, the issue of bonds overtakes than that of shares and reached RMB3914.7 billion. Issue of convertible bond has become more popular in recently years.

- **FDI** is investments made by the multinational enterprises in overseas markets. There are two types of investments, either buying shares in the stock market or setting up a physical enterprise. The Chinese government would like to have FDI in the form of joint-venture with the local resident, but the most popular form by foreign investors is whole foreign own enterprises (WFOE).

- **Money supply (MS)** is an important element affect liquidity of a country. It is the total value of money available in an economy at a point of time. Increase in money supply may cause higher consumption and inflation. Some policy makers will increase money supply for increasing employment.

- **The interest rate** of three-month (3m) was extracted from SHIBOR (Shanghai Interbank Offered Rate) at end of each month. The annual interest rate is the average of the monthly data. The 3m interest rate looks stable and therefore more suitable for analyzing long-term investment.

It is widely believed that reduction in interest rate will reduce savings and encourage consumption and investment. In reality, it is not always true. Diagram 4a reflects that the money supply growth rate looked fluctuated while the interest rate maintained between the ranges of 3% to 5%. The money supply growth rate maintained quite stable around 15% to 17% before 2008. However, it radically increased to 28% in 2009 because of the US financial tsunami. Thereafter, it kept on declining until 9% in 2017. Similarly, the trend of AFRE looked fluctuated. The AFRE increased 99% in 2009 but dropped sharply in the following years. Diagrams 4a and 4b reflected low associations between interest rate and money supply, and interest rate and financing during the observation period. Financing determines by return on investment while interest rate is just one of the factors affecting investment.

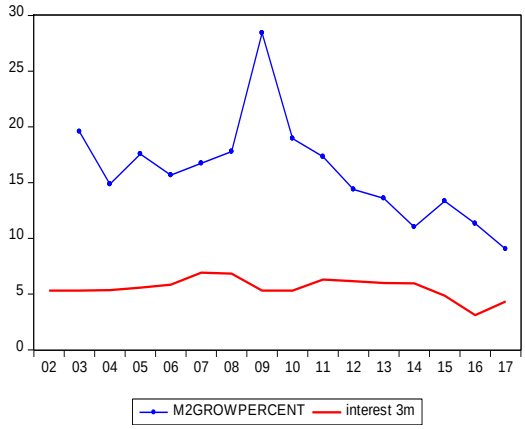

Diagram 4a: Money supply growth% and Interest %

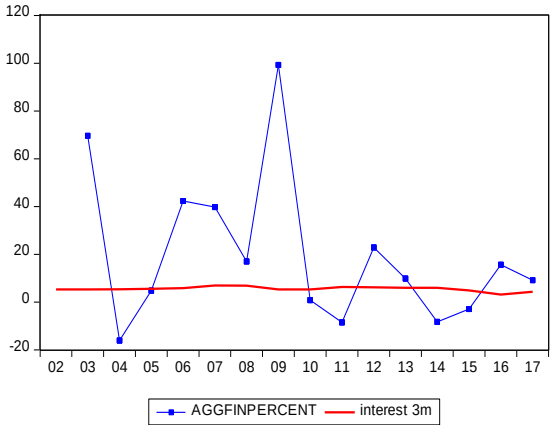

Diagram 4b: Aggregate financing growth % and Interest %

3.3 Research Procedure

3.3.1 Comparison between Dependent Variables and Explanatory variables

In this study an economic model will be developed that examines the impacts of various sources of financing on the economic growth of China during the observation period 2002 to 2017.

All original data is converted into logarithm (Ln) for comparison and analysis.
Table 2 lists the figures of covariance and correlation between the annual growth rate of GDP in China and its dependent variables. The covariance of LnGDP and Lnint moves in the opposite direction. On the contrary, LnGDP and LnFDI move in the same direction and have the high corelation.

	χ	y	Covariance	Corelation
1	LnGDP	Lnint	-0.0348	-0.3060
2	LnGDP	LnM2	0.2945	0.9463
3	LnGDP	LnAFRE	0.4509	0.9636
4	LnGDP	LnIPO	0.7194	0.9312
5	LnGDP	LnFDI	0.1195	0.9787

Table 2: Covariance and Corelation

GDP is the annual growth rate of GDP in China, int is the 3-m interest rate, M2 is the money supply 2, AFRE is the Aggregate financing to the real economy (flow), IPO is the issue of shares and bonds in the domestic and overseas stock markets, FDI is the foreign direct investment.

The XY graph of the relationship between LnGDP and its explanatory variables are shown on Diagram 5. Diagrams 5a to 5d show positive relationship with minor fluctuation. Diagram 5e shows negative direction between LnGDP and Lnint with unstable relationship.

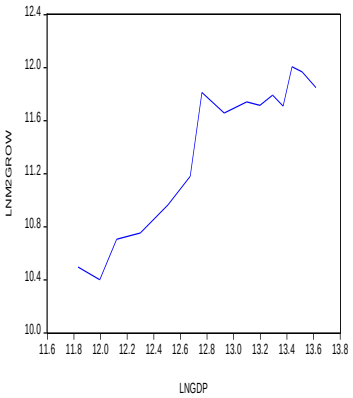

Diagram 5a LnGDP v LnM2

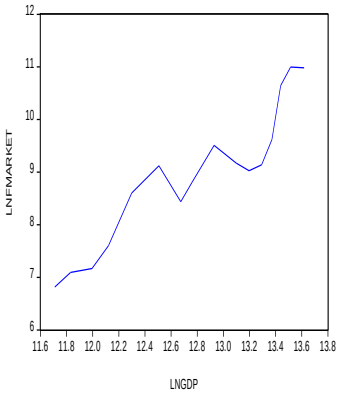

Diagram 5b LnGDP v LnIPO

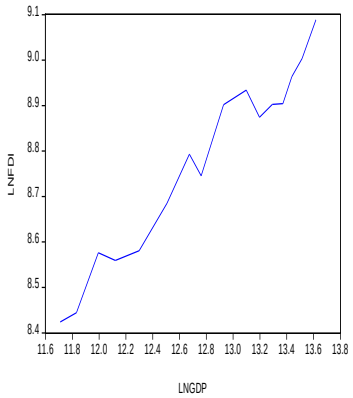

Diagram 5c LnGDP v LnFDI

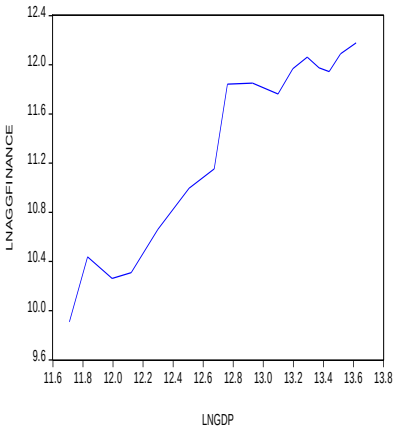

Diagram 5d LnGDP v LnAFRE

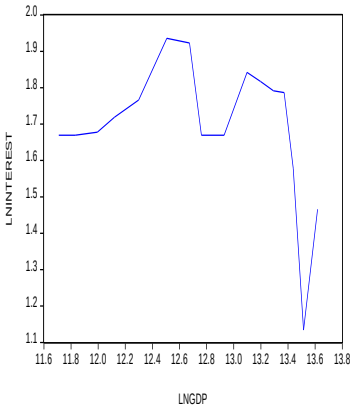

Diagram 5e LnGDP v Lnint

3.3.2 Stationarity Test of Time Series – ADF Test

ADF (Augmented Dickey-Fuller) test is adopted for testing the stationarity of the time series. This test has the null hypothesis (H_0) that a unit root is existed. In other words, the more negative the figure of t-statistics is, the stronger the rejection of H_0. Referring to Table 3, the results of unit-root test, the t-statistics of most variables are lower than its critical value at 5% or 10% significant level, therefore the time series under observation get pass in the ADF test.

Variable	(c, t, k)	t-statistics	Critical value	Probability	Result
LnGDP	(0, 0, 2)	-2.8102	-2.6813**	0.0803	Reject H_0
D(Lnint)	(0, 0, 2)	-3.8375	-3.1199*	0.0146	Reject H_0
D(LnM2)	(0, 0, 2)	-4.2263	-3.1199*	0.0077	Reject H_0
D(LnAFRE)	(0, 0, 2)	-4.1855	-3.0989*	0.0072	Reject H_0
D(LnIPO)	(0, 0, 2)	-4.2558	-3.1199*	0.0071	Reject H_0
D(LnFDI)	(0, 0, 2)	-4.8589	-3.0989*	0.0067	Reject H_0

Table 3: Results of Unit Root Test

ADF (c, t, k): c is constant, t is trend, k is length of lag;
Significant levels: *-5%, **10%

3.3.3 Granger Causality Test

The Granger causality test adopts a statistical hypothesis that one time series X including all its lag values can be used to predict the value of another time series Y. If the effect is not significant, that

means no Granger causality existed between X and Y . Granger (1969) defined the cause of one time series happens prior to its effect.
Hypothesis: H_0: X does not Granger cause Y
H_1: Y does not Granger cause X
X, Y are time series of random variables

The result is summarized and shown on Table 4. There are single direction occurred on Items 1, 2 and 4, and two-way direction occurred on Item 3. However, there is no relationship existed on Item 5 and 6, therefore LnM2 and Lnint will not be used for model building.

	Granger Causality	Lag	Result
1	LnGDP does not Granger Cause LnAFRE	2	Reject H_0
2	LnAFRE does not Granger Cause LnGDP	3	Reject H_0
3	LnGDP does not Granger Cause LnIPO LnIPO does not Granger Cause LnGDP	2	Reject H_0 and H_1
4	LnGDP does not Granger Cause LnFDI	1	Reject H_0
5	LnGDP does not Granger Cause LnInt Lnint does not Granger Cause LnGDP		Accept H_0 & H_1
6	LnGDP does not Granger Cause LnM2 LnM2 does not Granger Cause LnGDP		Accept H_0 & H_1

Table 4: Result of Granger Causality

3.3.4 Johansen Cointegration Test

In Statistics, the Johansen test is a procedure for testing cointegration of several time series. It is quite common that non-stationary time series come out, the economist can still make use them to build a useful model that shows a trend of long-term stationery.
Using Eview9, the cointegration result indicates at most 3 among 4 series at 5% critical value. They are LnGDP, LnAFRE, LnIPO and LnFDI.

3.3.5 Regression model:

After the Cointegration test, we can generate a regression model from Eview9.
LnGDP = 0.36*LnAFRE + 0.13*LnIPO + 0.85*FDI + e …….(1)
(t-stat) (4.4046) (3.2798) (10.7486)

3.3.6 Vector Error Correction Model (ecm)

The ecm is a regression model for use with nonstationary series that has co-integrated relationship. This model is based on the behavioral assumption that two or more time series display an equilibrium of long-run relationship. The mechanism restricts the long-run behavior of the endogenous variables while allowing for short-run adjustment of dynamics.

We make use Eview to generate the error correction model that includes the time series of the residual arising from Formula (1). Referring to Formula (2), the efficiency of ecm is -0.28 that indicates the short-run deviation will be adjusted and restored into the long-run equilibrium but its speed is quite slow.

D(LnGDP)=-0.28*ecm(-1) + 0.21*D(LnAFRE)+0.06*D(LnIPO)+0.94*D(LnFDI) (2)

4. Discussion of Research Results

The empirical result shows that GDP moves in the same direction with Aggregate financing (AFRE), funds raising from the stock market (IPO) and inbound foreign direct investment (FDI).

4.1 The Impact of The Aggregate financing (AFRE) on GDP

Referring to Formula 1, 1% increase in AFRE tends to cause 0.36% increase in GDP in the long run. Temporary deviations occurred during the observation period. In 2009, M2 increased 28% and AFRE increased 99% (RMB 7 trillion) but the GDP increased 0.3% only (RMB2.9 trillion). During 2015 to 2017, the central bank implemented tighter control on off-balance items of state-owned banks, this caused the redemption of trusted loan and entrusted loan. At the same time, the GDP growth decreased slightly from 2014's 7.3% to 2017's 6.8%.

4.2 The Impact of Fund Raising from the Financial Markets (IPO) on GDP

Referring to Formula 1, the parameter of IPO is 0.13, one third of AFRE's figure. The average amount of fund raising from the financial markets was around 30% of AFRE, therefore the relationship between IPO and GDP also shows weaker.

4.3 The Impact of FDI on GDP

Referring to Formula (1), the parameter of FDI is ranked the highest 0.85 even if FDI owned below 5% of their sum. All the money inflow from foreign investors will be put into the enterprises for business development under the supervision of Ministry of Finance (MOF) so its impacts on economic growth appears quickly. Without this supervision, managers may use business funds in speculative activities, so the economic growth will lag behind financing.

5. Summary and Conclusion

This result shows that the economic growth is positively related to financing from financial institutes, public listing in the stock markets, and FDI, so the availability of funds will affect the economic growth in China.

The financial structure of China is dominated by banks. The bank-based structure provide an effective channel for implementing monetary policies launched by the central government. Hence, the establishment of different types of stock markets provides more channels for fund raising, this is much important for the innovative industry and startup. However, the success of public listing depends on lots of uncontrollable factors in the markets, so it is appropriated that China maintains a bank-based financial structure.

It seems the Chinese authority will make use the operation of increase in money supply and decrease in interest rates to raise GDP. However, our study found no Granger cause to each other during the observation period. Furthermore, the accumulation of debt will cause higher finance cost and weaken future borrowing ability of enterprises. Further research is worth in this aspect.

Our study finds that FDI seems more effective to the economic growth than the other two sources. It may be because some mangers make use the fund on speculative activity in the financial markets. Facing the threat of heavy import duties implemented by the US president, Donald Trump since 2019, the Chinese government has put efforts to maintain FDI and will launch a new foreign investment law effect from January 2020. The law ban forced technology transfer and assure protection of foreign investors' intelligent-property right, hoping this gains confidence of foreign investors. For first nine months of 2019, the FDI inflows to China was reported US$100.8 billion,

slightly higher than that of previous year. A sound legal environment and lower tax rates would attract sustainable investment made by multinational enterprise.

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Happiness and Overweight:
Panel data analysis on the differences between Male and Female

Thomas Wai-Kee YUEN and Winnie Wan-Ling CHU
Department of Economics and Finance
Hong Kong Shue Yan University
Braemar Hill, Hong Kong, CHINA

Email: wkyuen@hksyu.edu, wlchu@hksyu.edu

Globalization of slimming norm tends to spread the perception that being fat is a source of unhappy especially for the case of female. This paper examines the association between overweight and happiness using global parallel panel data and compares the differences between male and female. Using generalized least squares to estimate the fixed effect panel data models, the empirical results show that happiness increases with percentage of overweight. Happiness tends to make people grow plump for both male and female. Increase in GDP per capita increases the percentage of overweight in a country and the effect is higher for male than female. Social support increases the percentage of overweight in low/middle income countries but reduces the percentage of overweight in high income countries for the case of female. Life expectancy increases the proportion of overweight but it is significant only for the case of male. Overweight and positive affect are negatively related and the impact is higher for male than female. Negative affect are positively associated with overweight. The association between happiness and overweight for female in high income countries tends to exhibit a different pattern in comparing with low or middle income countries.

1. Introduction

Advertisements for slimming products/service account for a huge market. The marketing focus on advertising the concept that slimming equals to beautiful and health. This slimming norm particularly affects the norm of female who are always caution about their appearance. Swami et al. (2015) reported a research in U.S. from 9667 women and found that BMI was negatively associated with body appreciation. Marketing perception of slimming had driven the slimming norm caused people to think that fat was unhappy thus reduced happiness of the society (Offer 2001). Of course, everyone loves to be beautiful as this is an important element of building up one's self-identity especially for female. Yet healthy is also important, there is no point being beautiful but having a poor health. Overweight is normally related to poor health because of the strong relationship between overweight and diabetes, heart disease, and cancers. This global slimming norm tends to spread the idea that being fat is a source of unhappy because being hurt your health and appearance. It is being observed that in tweets, people's happiness reduced as the obesity rate increased (Gore et al. (2015).

However, body weight depends on a lot of factors, for example, genetic code, eating culture and working life. There are a lot of things that people cannot control, thus making the process of getting slim may be difficult to some people. Slimming can make people feel unhappy because dieting can bring up anxiety and people needs to struggle with their eating habit. This can bring up negative emotion and make people obsessed with their body image (Dobson and Anderson, 2005).

Literature found that the association between happiness and body mass were indeed inconclusive and needed to account for the cultural effect. In some countries fat means happy. For example in Indonesia, happiness is positive associated with body mass (Sohn, 2017). Although, obese people are less happy than the non-obese in U.S., obesity and happiness are positively correlated in Russia. Happiness depends on a lot of factors such as income, social support and health. One of the reason for the positive relationship between body mass and happiness is that fat represents wealth and health, thus fat means people are enjoying a happy life. Wells et al. (2012) analyzed associations between obesity prevalence and income and found that there existed a positive association in the sense that rich people were getting fat. Simeon et al. (2003) found that in Trinidadian obesity was associated with wealth, and to a lesser extent with happiness. Social relationship inherently affects our eating habit. If our family and friends are following healthy eating habit, it is most likely that we are eating healthy and it is much more easily to manage our weight. If our family and friend do not care about healthy eating habit and do not engaged into physical exercise, it is likely that we get fat. Studies have found that social support such as neighborhood, family, friends and living environments affected people's body mass (Wang et al. (2014).

This paper intends to investigate the association between happiness and body mass by estimating models using fixed effect panel data model from 88 countries and compares the differences between male and female for the case of high income and low or middle income countries. The model will also include emotional factors, social support, GDP and healthy life expectancy as the dependent variables.

2. Methodology

2.1 Data

This paper estimated the panel annual data from 88 countries between the periods 2010 to 2014 with 51 high income countries and 37 low or middle income countries. The high income countries are classified following World Bank's definition where high-income countries are those with a GDP per capita of $12,736 or more. Countries with GDP per capita less $12,736 than are classified as low or middle income countries. The BMI data comes from Global Health Observatory data repository which traces for adult (+18 years) body-mass index in 200 countries from 1975 to 2014 with 19.2 million participants. The happiness and related socioeconomics comes from World Happiness Report 2015 (Helliwell et al. 2015). Matching out the data sets come up with 88 countries with data of both BMI and happiness between the periods 2010 to 2014.

Table 1 Body Mass index (BMI)

	All countries		Low or middle income		High income	
Countries	88		37		51	
Sample size	440		185		255	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
MBMI	25.5025	2.0681	23.939	2.034	26.6365	1.1516
FBMI	25.7352	1.9677	24.917	2.276	26.3290	1.4480
(%)MBMI25	49.1596	19.3430	33.342	17.724	60.6349	10.2309
(%)FBMI25	48.7409	13.6705	41.326	15.057	54.1200	9.4696
(%)MBMI30	15.6009	8.3886	8.484	6.322	20.7639	5.3873
(%)FBMI30	20.9061	9.1732	15.795	9.052	24.6145	7.2965

Where: MBMI represents the male mean body mass index, age-standardized (kg/m²), MBMI25 represents the male overweight (body mass index ≥ 25), age-standardized (%), MBMI30 represents the male obesity (body mass index ≥ 30), age-standardized (%), FBMI represents the female mean body mass index, age-standardized (kg/m²), FBMI25 represents the female overweight (body mass index ≥ 25), age-standardized (%), FBMI30 represents the female obesity (body mass index ≥ 30), age-standardized (%).

Table 1 shows that the mean BMI between male and female are similar. However in low or middle income countries, the percentage of the overweight for female is larger than that of male. The opposite situation happens in high income countries, in which, the percentage of overweight for male is larger than that of female. For the case of obesity, in all countries, the percentage of obesity for female is higher than that of male. In general, the percentage of overweight and obesity are higher in high income countries than in low/middle income countries.

2.2 Models

$$BMI_{it} = \beta_1 HAPP_{it} + \beta_2 Positive_{it} + \beta_3 Neagtive_{it} + \beta_4 GDPPC_{it} + \beta_5 Social_{it} + \beta_6 Lifeexp_{it} + \delta_t + \alpha_i + \varepsilon_{it}$$

where t = 1, . . . T time periods and i = 1 . . ., N countries. α_i are the unobserved cultural heterogeneity which is assumed to be constant overtime for each country. The observed independent variables including HAPP: happiness, Positive: positive emotions, Negative: negative emotions, GDPPC: GDP per capita, Social: social support and Lifeexp: healthy life expectancy. BMIit is dependent variable, the BMI indexes described in table 1. δ_t is the period effect which is a binary dummy used to capture the unobserved time variation effect. ε_{it} is the error term with $Var(\varepsilon_{it}) = \sigma_t^2$ and all covariance between error terms are zero.

3. Empirical Results

3.1 BMI, Happiness and Socioeconomics variables

Table 2 shows that the adjusted R^2 of the BMI models are ranged from 0.7426 to 0.2168. The adjusted R^2 are generally larger in the case of male than female. Moreover, adjusted R^2 are also higher in case of low- or middle-income countries than in high income countries. It seems that the model generally fits better for the case of low or middle income countries and for the case of male.

Table 2: BMI, Happiness and Socioeconomics variables

	All countries		Low or middle income countries		High income countries	
	MBMI	FBMI	MBMI	FBMI	MBMI	FBMI
HAPP	0.3395** (0.0937)	0.3114** (0.1482)	0.6009** (0.1563)	0.6556** (0.2344)	0.3660** (0.1140)	0.8025** (0.1554)
Positive	-5.9768** (0.6305)	-3.2276** (0.9977)	-8.1209** (0.8851)	-6.1744** (1.3307)	-3.5147** (0.8492)	-1.5016 (1.1578)
Negative	1.1636 (0.7749)	3.0028** (1.2236)	-0.3193 (1.1745)	0.1736 (1.7599)	2.0497** (0.9772)	3.8643** (1.3252)
GDPPC	0.6441** (0.0970)	0.7152** (0.1537)	0.6291** (0.2082)	0.9278** (0.3124)	0.6711** (0.1615)	0.4499** (0.2201)

Socials	2.6409** (0.6961)	1.1595 (1.0996)	4.5419** (0.8693)	4.8233** (1.3054)	-3.1906** (1.2352)	-8.6073** (1.6773)
Lifeexp	0.1095** (0.0129)	-0.0109 (0.0204)	0.1422** (0.0221)	0.0817** (0.0332)	0.0784** (0.0151)	-0.1231** (0.0206)
Adjusted R^2	0.7426	0.2652	0.7126	0.4844	0.3974	0.2168
** Significant at 5% significance level.						

The associations between happiness and BMI are positive in all cases. BMI tends to increase with the level of happiness, the effect is higher for the case of low or middle income countries than in high income countries. Moreover, the coefficients are larger for the cases of female than that for male in both high and low or middle income countries.

The associations between BMI and positive emotions are negative in all cases. High level of positive emotions tends to associate with low BMI, the effect is larger in the case of male as well as in low income countries. In the case of high-income countries, the association is insignificant for the case of female. The associations between BMI and negative emotions are positive but only significance for the case of high income countries. It seems that higher level of negative emotions tends to associate with higher BMI but the association only being effective in high income countries and that effect is larger for the case of female than male. The associations between BMI and GDP per capita are positive. In the low-income countries case, the association for female is larger than that of male, but the reverse result appears in the high-income countries. The increase in GDP per capita tends to exhibit higher influence on the BMI of female in low income countries than in high income countries. The associations of BMI and social support show opposite sign in case of both low- and high-income countries. BMI tends to increase with social support in low income countries but decreases in high income countries. The negative association between social support and BMI is the largest in case of female in high income countries.

The associations of BMI and health life expectance are positive in most cases, except for the female in both high-income countries and all countries cases. In general BMI increases with health life expectance. However, for the case of female in high income countries, BMI reduces with health life expectance.

3.2 Overweight, Happiness and Socioeconomics variables

Table 3 shows that the adjusted R^2 of the overweight models are ranged from 0.8244 to 0.2647. The adjusted R^2 are generally larger in the overweight model than BMI models. It seems that the overweight model generally fits better than the BMI model. Like the BMI models, the adjusted R^2 for male overweight model is larger than that of female. The model tends to fit better for the case of male than female. In addition, the model also works better for the case of low income countries than high income countries.

Table 3: Overweight, Happiness and Socioeconomics variables

	All countries		Low or middle income		High income	
	MBMI25	FBMI25	MBMI25	FBMI25	MBMI25	FBMI25
HAPP	3.5809 ** (0.7269)	2.7830** (0.9270)	5.4743** (1.1759)	4.5779** (1.5116)	3.6561** (0.9289)	5.6461** (0.9738)
Positive	-58.8615** (4.8805)	-30.6787** (6.2300)	-75.2299** (6.6064)	-46.9461** (8.5434)	-38.6396** (6.9129)	-16.1691** (7.2661)
Negative	14.1206**	28.5155**	-2.9947	-4.2850	30.4674**	48.7414**

	(6.0050)	(7.6518)	(8.8221)	(11.3396)	(7.9514)	(8.3416)
GDPPC	7.1518** (0.7514)	5.3503** (0.9601)	6.3158** (1.5687)	7.3060** (2.0158)	7.5176** (1.3106)	4.3028** (1.3809)
Socials	32.0745** (5.3909)	22.2328** (6.8706)	41.6024** (6.4915)	41.6899** (8.3878)	2.1391 (10.0717)	-39.7012** (10.5665)
Lifeexp	0.8645** (0.0999)	-0.1364 (0.1276)	1.2374** (0.1654)	0.3254 (0.2134)	0.5277** (0.1230)	-0.7747** (0.1292)
Adjusted R^2	0.8244	0.4062	0.7884	0.5133	0.4878	0.2647
** Significant at 5% significance level.						

The associations between happiness and overweight are positive and significant. In general the empirical result shows that percentage of overweight increases with the increasing level of happiness. Good life normally accomplished with overweight. The association for male is larger than that of female in low or middle income countries but the reverse result happens in high income countries. The associations between positive emotion and overweight are negative and significant. The increase in positive emotion reduces the percentage of overweight. Moreover, the effect tends to be larger for the cases of male than female and also for the cases of low or middle income countries than high income countries. The associations between negative emotion and overweight are significant in high income countries but insignificant in low- or middle-income countries. Moreover, the association is larger in the case of female than male. The associations between GDP per capita and overweight are positive and significant. Similar to the empirical results of the BMI models in table 1, table 2 shows that in the low or middle income countries case, the association for female is larger than that of male, but the reverse result appears in the high income countries case. The associations between social support and overweight are positive and significant in the case of low or middle income countries. However, for high income countries, the association is negative and significant only for the female. The associations between health life expectancy and overweight are positive and significant for male in low or middle income countries. For high income countries, the associations are significant but with opposite signs for male (positive) and female (negative).

3.3 Obesity and selected key factors of happiness

Table 4 shows that the adjusted R^2 of the overweight models are ranged from 0.8244 to 0.2647. The adjusted R^2 are generally larger in the case Obesity models than BMI models but less than the overweight cases. Similar to other models, the obesity models tend to fit better for the case of male than female and have higher explanation power for low income rather than high income countries.

Table 4: Obesity, Happiness and Socioeconomics variables

	All countries		Low or middle income		High income	
	MBMI30	FBMI30	MBMI30	FBMI30	MBMI30	FBMI30
HAPP	1.7473** (0.3360)	1.7775** (0.6154)	1.5350** (0.4320)	2.3325** (0.9543)	2.1115** (0.5190)	3.6957** (0.7463)
Positive	-21.6588** (2.2610)	-18.0850** (4.1415)	-27.8080** (2.4157)	-29.3610** (5.3801)	-13.8173** (3.8620)	-7.4022 (5.5612)
Negative	6.7982** (2.7780)	20.2923** (5.0815)	0.5504 (3.2519)	0.1035 (7.1709)	16.7854** (4.4399)	35.9825** (6.3696)
GDPPC	4.2033** (0.3478)	4.9551** (0.6377)	3.0161** (0.5761)	5.5005** (1.2726)	5.2786** (0.7330)	4.4377** (1.0563)
Socials	9.8157** (2.4947)	8.8576* (4.5660)	14.9940** (2.3780)	21.5031** (5.2871)	-4.4885 (5.6210)	-28.4023** (8.0724)
Lifeexp	0.1634**	-0.2996**	0.3493**	0.0396**	0.0285	-0.7167**

	(0.0462)	(0.0847)	(0.0603)	(0.1342)	(0.0687)	(0.0990)
Adjusted R^2	0.7926	0.4006	0.7747	0.4642	0.3896	0.2672
** Significant at 5% significance level. * Significant at 10% significance level.						

The associations between obesity and happiness are positive and significant. Generally, the associations for female are larger than male. Good life associated with an increase in the percentage of obesity and the effect is larger for female than male. The associations between obesity and positive emotions are negative and significant. However, for the case of female high-income countries, the association are insignificant. Positive emotions normally come with vitality that consume more energy to reduce the percentage of obesity, but this does not seem to work for female in high income countries. The association between obesity and negative emotions are positive and significant in case of high income countries. The effect on female is larger than that on male. The association between GDP per capita and obesity are positive but the coefficients are smaller than that in the case of overweight. Similar to the case of overweight, in the obesity cases the coefficient for female is higher than male in the low-income countries. However, the coefficient for male is higher than female in the high-income countries. The association between social support and obesity are positive in the low or middle income countries but negative in high income countries. Moreover, the coefficients are larger in the case of female than that of male.

The association between life expectance and obesity are positive in the case of low or middle income countries but negative for the case of female in high income countries.

4. Conclusion

In general, weight increases with life happiness evaluation. Eating better and working less can help people to feel happier in their life evaluation but there is a risk of getting fat. The coefficient for male is higher than that of female in low/middle income countries but the reverse is true for high income countries. A good life for female in high income countries generally associated with a higher calories surplus through engaging less physical activities perhaps consuming less calories in housework. Female tends to enjoy the pleasure from cooking as well as eating.

Positive emotion normally reduces weight but negative emotion increases weight in high income countries. On the one hand, many significant events utilize eating as a meaningful aspect of celebrations (positive emotion), which creates an intake of more. On the other hand, positive emotion associates with value activities such as sport on which people enjoy and willing to devote energy thus consume more calories. For the case of male positive emotion reduces weight by motivating male to participate in higher calories consumption activities than eating. Negative emotion leads to consumption of excess food and low physical activity, thus producing overweight in high income countries. Overeating can serve as a means to temporary repair negative mood but it seems that only high-income countries can afford the financial cost of overeating to comfort negative mood. The stress for female to control their weight, may ultimately play a major role in their overeating behavior. In high income countries, the slimming norm has put too much stress on female and create overweight.

Increase in GDP per capita increases body mass. However, the impact on male and female are different when comparing high and low/middle income countries. The high level of overweight among low/middle income women has widely been attributed to the habit of avoiding food wastage because of the experiences from food scarcity. As income increases,

people in low/middle income countries tend to reserve more food by eating to avoid food scarcity thus overweight increases with income. However, in high income countries, the slimming norm and the financial ability allows females to be able to pay for health food and control their weight.

Social support increases body mass in low/middle income countries but reduces body mass in high income countries. Social support can help women to manage overweight/obesity through eating behavioral change and maintaining physical activity. Low/middle income countries have a different body size norm. Fat can be a status symbol of rich because fat people have enough money to eat.

Life expectancy increases body mass in low/middle income countries but reduces body mass in high income countries. Although there is a gain in life expectancy, overweight individuals generally experience a higher proportion of poor health in life time. Female, especially those in high income countries, tends to follow a healthier lifestyle such as more physical activities and eating less so as to avoid the adverse effect of overweight/obesity.

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Alcohol and Happiness: a Panel data analysis

Thomas Wai-Kee YUEN and W.L. CHU
Department of Economics and Finance
Hong Kong Shue Yan University

Abstract

The harmful effect of alcohol is well known, worldwide over 5% of all deaths is related to the harmful use of alcohol, this represents around 3 million death each year. However, alcohol is also known as the cultural, social practices and a form of lifestyle globally. This makes the control of the harmful use of alcohol extremely difficult. If people are happy with their consumption of alcohol, it is difficult to convince them not to trace their happiness. This paper examines the association between happiness and the consumption of three types of alcohol (Beer, Wine and Spirits) with a fixed effect panel data model using global data from 2010 to 2015. The empirical result shows that apart from happiness, income, social support and life expectancy also take a role in affecting alcohol consumption. Indeed, different regions have different preference in the consumption of alcohol. Europeans tend to enjoy wine with the association between wine and happiness being the largest while beer tends to bring happiness and enjoyment to people in Western Pacific and America. Although spirits take up the largest portion (over 44.8%) of worldwide, the association between happiness and spirits are weak.

1. Introduction

Alcohol has been the lifestyle, the culture and social practices in the human history. All countries have their own ways of enjoy alcohols. In Europe, the culture of wine are colorful. France wine festival, Germany beer festival and UK whisky festival reflect the importance of alcohol in western culture. In China, the famous Chinese poet, Li Bai (701-762) was a great lover of alcohol. In one of his poet, he wrote "When one drinks with friends, even thousand cups are not enough" (酒逢知己千杯少). This reflects that in Chinese culture, drinking is a way to consolidate friendship, develop better working relationships and bring business partners together. In Japan drinking is considered as a complementary part of the working life, the word "nomunication" is a combination of the word the Japanese verb nomu--"to drink"--and communication or simply work-related drinking. Indeed in many cases, motivation for drinking simply depends on expected emotional or mood factors such as enhancing pleasure or reducing tension.

The well-known "Happy hour" linked happiness and alcohol together in our daily life. However, the harmful effect of alcohol is also well-known. According to World Health organization (2018), over 3 million deaths per year are caused by the harmful use of alcohol, worldwide and over 200 disease such as behavioral disorders, non-communicable condition as well as injuries resulting from over consumption of alcohol. Rosón et al. (2010), reported that the prevalence of patients' alcohol-drinking problems ranged from 12% to 26% in western countries. Tsai et al. (2013), reported that the prevalence of patients' alcohol-drinking problems ranged from 5.7% to 19.2% in Taiwan. Many countries have been implementing policies to reduce the harmful effect of alcohol such as increasing the public awareness of the harmful effect of alcohol, imposing taxation on alcohol, regulating the marketing of alcoholic beverages and restricting the availability of alcohol. Yet, with the millions of deaths per year caused by the harmful use of alcohol, the alcohol regulation policies seem to be fruitless. The core issue is, if people are happy with their consumption of alcohol, it is difficult to convince them not to trace their happiness.

To make the policies of regulating the consumption of alcohol effective, it is important to understand the relationship between happiness and the consumption of alcohol. This paper examines the association between happiness and the consumption of three types of alcohol (Beer, Wine and Spirits) with a fixed effect panel data model using global data from 2010 to 2015. The rest of the paper is organized as follows. Section 2 provides the literature review. Section 3 describes the model, methodology and data. Section 4 provides the empirical result and discussion. Finally section 5 is the conclusion and policy suggestion.

2. Literature Review

After decades of development, happiness data are now available in aggregate level measures as subjective wellbeing of a society. The most comprehensive data set comes from World happiness report. Dolan et al. (2011) recommended that happiness data to be used to formulate public policies since subjective wellbeing were closely related to a basket of variables such as social relationship, life expectancy, positive affects, negative affects and income.

Many studies have reported that drinking are closely associated with social relationship, income and health issues which are important factors of happiness. Lin et al. (2017) found that alcohol-drinking behaviors were related to six major patterns: family habits, leisure activities with friends, work pressures, personal taste, a way to forget one's problems and to express happiness. Cooper et al. (1995) developed the motivational model of alcohol use based on the regulating of positive and negative emotions. Parackal et al. (2017) showed that measurements of happiness could explain the global implication of alcohol. Mason and Spoth (2011) found the association between adolescence alcohol involvement and subjective wellbeing. Beattie and Longabaugh (1997) found that subjective welling of alcoholism increased by one standard deviation after controlling for the addiction to alcohol.

As the taking of alcohol is always accepted as a way to enhance socialization, it is easy to ignore the harmful impact of alcohol. Tkach and Lyubomirsky (2006) studied happiness strategies in everyday life and identified that going to bar and drinking alcohol with friends as one of the factors to increase happiness. Beccaris et al. (2012) reported the association between quality of life and alcohol consumption among young adults in Europe. Livingston et al. (2010) showed that friends and family had adverse impact on the decision of an individual to consumption of alcohol. Casswell et al. (2010), found that addiction to alcohol were closely related to the social relationship with family. Peer alcohol consumption is one of the important factors for young adolescents to drink. Jones and Magee (2014) showed that Australian adolescent's alcohol consumptions were associated with family, friend and peers. Kelly et al. (2012) reported that peer alcohol use influenced the drinking behavior of young adolescents.

3. Model, Methodology and Data

Set point theory puts forward the hypothesis that people have a subjective wellbeing set point which defines normality. The set point varies across individual in different society. Cummins (2009) pointed out that as daily life events caused subjective wellbeing to deviate from the set point, a homoeostasis mechanism would activate to restore the subject wellbeing set point. Consider drinking as a tool to trigger the homoeostasis mechanism, the consumption of alcohol should be associated with factors that affect the subject wellbeing of the society. This paper proposes a linear model for the demand for alcohol.

Consumption of alcohol = Drinking culture + β_o + β_1 Happiness + β_2 Social support + β_3 Health + β_4 income + β_5 Positive emotion + β_6 Negative emotion + Random error

Converted the model into a Fixed effect model with country aggregate data

$$Calc_{it} = \alpha Z_i + \beta_o + \beta_1 Happ_{it} + \beta_2 Social_{it} + \beta_3 Life_{it} + \beta_4 GDP_{it} + \beta_5 Positive_{it} + \beta_6 Negative_{it} + \varepsilon_{it}$$

Where

- Calc is demand for alcohol, Happ is life evaluation which is a proxy for happiness, life is life expectance which is a proxy for health, GDP is a proxy for income, Positive is positive affect which is a proxy for positive emotion and Negative is negative affect which is a proxy for negative emotion.
- i represents the individual country with i=1…N
- t represents time period with t=2010…2015
- Z is the individual country fixed effect which depends on the drinking culture of individual *(i)* country but do not vary over time in the estimated period (2010 to 2015)
- β_o is the intercept and is independent of i and t
- β_1 to β_6 are the slopes which are independent of i and t
- ε_{it} is the random error that varies over i and t

The estimation issue of the fixed effect model is that the drinking culture Z captures the individual unobserved heteroscedasticity and can be correlated with the independent variables such as happiness, income or social support. To take away the unobserved fixed effect, this paper uses the mean subtraction transformation of the model that is subtracted the mean of each variable and estimated the model with panel least square. Under this transformation of the fixed effect model, the individual intercepts are uncorrelated with random error and consistency does not require. One of the drawback for the fixed effect model is that the unobserved individual specific variable may be uncorrelated with the independent variables. As a robust test, this paper performs the redundant fixed effects test, cross section F and cross section Chi-square are estimated.

The data for alcohol consumption comes from world health organization, global information system on alcohol and health. The data records pure alcohol in liter consumption per capita of the general public with age 15 or above at country level for 144 countries during a calendar year. The beverage type involves Beer, Wine and Spirits. This paper uses the data recorded from 2010 and updated in May 2018.

The happiness data comes from world happiness report 2018 which records the data from 156 countries between the years 2010 to 2017. This paper uses the following six variables in the measurement of subjective well-being.

Factors	Variables	Descriptions
Life happiness evaluations	HAPP	Measured as the National-level average scores for subjective well-being, by answers to the Cantril ladder of valuing lives today on a 0 to 10 scale (the worst possible life is 0 and the best possible life is 10).
Positive affect	POSITIVE	Positive affect which is measured as the average of previous-day affect measures for happiness, laughter and enjoyment.

Negative affect	NEGATIVE	Negative emotion which is measured as the average of previous-day affect measures for worry, sadness and anger.
GDP per capita	GDP	Log GDP per capita is in terms of Purchasing Power Parity (PPP) adjusted to constant 2011 international dollars, taken from the World Development Indicators (WDI) released by the World Bank in November 2014.
Social support	SOCIAL	Social support measured by having someone to count on in times of trouble is the national average of the binary responses to the question "If you were in trouble, do you have relatives or friends you can count on to help you whenever you need them, or not?"
Life expectancy	LIFE	Healthy life expectancy at birth is constructed based on data from the World Health Organization (WHO) and the World Development Indicators (WDI).

Mapping the alcohol data with the happiness data, this paper involves 6 periods ranging from 2010 to 2015.

4. Empirical results and Discussion

Dependent Variable: WINE
Method: Panel Least Squares
Sample: 2010 2015
Periods included: 6
Cross-sections included: 109
Total panel (unbalanced) observations: 646

Variable	Coefficient	Std. Error	t-Statistic	Prob.
HAPP	0.284776**	0.086358	3.297630	0.0010
GDP	-0.000265	0.101940	-0.002604	0.9979
POSITIVE	-1.341107*	0.641510	-2.090548	0.0370
NEGATIVE	1.787920*	0.711073	2.514398	0.0122
SOCIAL	1.641818*	0.717857	2.287111	0.0226
LIFE	0.049966**	0.016005	3.121811	0.0019

Redundant Fixed Effects Tests:
Cross-section F 18.967461**
Cross-section Chi-square 1021.056**

Note:
** significant at 1%
* significant at 5%

The above tables show the relationship between the consumption of wine and the happiness factors for 109 countries with 646 unbalance observations. The consumption of wine is significantly correlated with life evaluation of happiness, positive affect, negative affect, social support and life expectancy. The redundant fixed effect tests show that the fixed effect is not redundant. However GDP does not correlated with the consumption of wine, increase in income does not promote the consumption of wine. The empirical result shows that as people feel happy about their life, they will increase their consumption of wine. If people are in a negative mood, they will reduce the consumption of wine. Social support is an important factor for people to increase the consumption

of wine. As people are expected to live longer, perhaps because of the improvement in the health care system, people will increase the consumption of wine. However, positive mood will cause people to reduce the consumption of wine.

Dependent Variable: BEER Method: Panel Least Squares Sample: 2010 2015 Periods included: 6 Cross-sections included: 111 Total panel (unbalanced) observations: 653				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
HAPP	0.012278	0.078923	0.155564	0.8764
GDP	0.379972**	0.099603	3.814872	0.0002
POSITIVE	-0.965613	0.548474	-1.760545	0.0789
NEGATIVE	-1.603051**	0.652307	-2.457511	0.0143
SOCIAL	5.371724**	0.642377	8.362261	0.0000
LIFE	0.035622**	0.014490	2.458354	0.0143
Redundant Fixed Effects Tests: Cross-section F 14.374123** Cross-section Chi-square 897.021934**				
Note: ** significant at 1%; * significant at 5%				

The above tables show the relationship between the consumption of beer and the happiness factors for 111 countries with 653 unbalance observations. The consumption of beer is significantly correlated with GDP, negative affect, social support and life expectancy. The redundant fixed effect tests show that the fixed effect is not redundant. However life evaluation of happiness and positive mood do not correlated with the consumption of beer. The empirical result reviews that as income increases, people will increase their consumption of beer. Social support is an important factor for people to increase the consumption of beer. A long life expectancy causes people to increase the consumption of beer. However people reduce the consumption of beer under negative mood.

Dependent Variable: SPIRIT Method: Panel Least Squares Sample: 2010 2015 Periods included: 6 Cross-sections included: 109 Total panel (unbalanced) observations: 646				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
HAPP	-0.078017	0.086051	-0.906636	0.3650
GDP	0.050502	0.115369	0.437742	0.6618
POSITIVE	-3.393620**	0.577522	-5.876169	0.0000
NEGATIVE	-3.299445**	0.708998	-4.653674	0.0000
SOCIAL	2.280811**	0.662108	3.444773	0.0006
LIFE	0.044018**	0.019695	2.235002	0.0258
Redundant Fixed Effects Tests: Cross-section F 17.269916** Cross-section Chi-square 973.429565**				
Note: ** significant at 1%; * significant at 5%				

The above tables show the relationship between the consumption of spirit and the happiness factors for 109 countries with 646 unbalance observations. The consumption of spirit is significantly correlated with positive affect, negative affect, social support and life expectancy. The redundant fixed effect tests show that the fixed effect is not redundant. However life evaluation of happiness and GDP do not correlated with the consumption of spirit. The empirical result reviews that social support is an important factor for people to increase the consumption of spirit. A long life expectancy causes people to increase the consumption of spirit. However people reduce the consumption of spirit under positive and/or negative mood.

5. Conclusion

In most of the cases, both positive and negative emotions reduce the consumption of alcohol. This may due to the fact that alcohol stimulates the mood factor and causes people's emotion to swing away from the emotional set point. As people are in positive or negative mood, the self-correction system tends to help people to swing the emotion back to the set point. One way is to reduce the consumption of alcohol so as to reduce the stimulate effect of alcohol.

All three types of alcohol are significantly associated (positive) with social support and life expectance. The empirical result shows that social support including friendship, family and working relationship, needs the consumption of alcohol as a complementary element to cultivate the social relationships. As alcohol is expected to create a mood factor to provide a better communication environment which is important for the development of social relationship. For the three types of alcohol, the coefficient between beer and social support is the largest. Beer contains the lowest percentage of alcohol and is normally cheaper than wine and spirit. With the marketing effect of drinking beer as a symbol of friendship, beer is usually considered to be an essential element for gathering events such as party, celebration and family gathering. Since social support is an important happiness element, it seems that happiness tends to encourage the increase in consumption of alcohol especially beer. To discourage the consumption of beer, policy can target on reducing the friendship or relationship symbolic effect of beer by advertising or other public relationship strategies. Moreover, the imposition of beer tax can be useful since beer is the only type of alcohol that is positively associated with GDP.

The empirical result shows that increases in life expectancy will increase the consumption of alcohol. As the health care system improves, the adverse effect of consuming alcohol tends to be neutralized. People become happier to consume more alcohol. However, this creates a negative externality for the society because the social expenditure on deceases relating to the over consumption of alcohol increases. Indeed it is not so happy even your life is longer but suffer from the deceases relating to the over consumption of alcohol. To handle this issue, government should educate people about the heath adverse effect of over consumption of alcohol.

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Is Sophia The Robot A Legal Person?

Pang Chau Sheung Rosa

Abstract

Sophia the Robot was made by Dr David Hanson of the Hong Kong-based Hanson Robotics. In October 2017, Sophia became the first robot to receive citizenship of any country. Should a robot enjoy any legal status independent of its human creators? If so, what kind of legal status would that be? Should the robot enjoy its/her/his "rights"? This paper is a comparative study of the robotic law and policy in some major jurisdictions such as the EU and the USA in relation to the legal status of robots. The study uses research methodology based on comparative law method, concepts of lesson drawing and policy transfer from political science, and socio-legal approaches. The paper suggests a twofold stance. First, policy makers should seriously consider the possibility of establishing new forms of responsibility and liability for the activities of robots in contracts and business law, e.g., new forms of agency. Second, any hypothesis of granting robots full legal person status has to be carefully considered in the foreseeable future.

Keywords: robot, legal person, robotic law and policy

Pang Chau Sheung Rosa
PhD Student of Shanghai University of Finance and Economics, The PRC
Senior Lecturer, The Open University of Hong Kong, Hong Kong SAR

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1. Introduction

On 25 October 2017, Sophia became the first robot in history to be a full citizen of Saudi Arabia. "She" is a realistic humanoid robot[1] capable of displaying humanlike expressions and interacting with people. "She" has been designed for research, education, and entertainment, and helps to promote public discussion about artificial intelligence (AI) ethics and the future of robotics.[2] In June 2018, in a nine-minute dialogue with Chief Executive Carrie Lam Cheng Yuet-ngor at the American Chamber of Commerce's smart city forum, Sophia anticipated "even greater things" in Hong Kong's blueprint for innovation as unveiled by the top official in December 2017. In the forum, Sophia, created by Hong Kong-based Hanson Robotics, said that "she" considered herself a Hongkonger even though she had been granted citizenship by Saudi Arabia.[3] "She" is so patriotic!

[1] A humanoid robot is a robot with its overall appearance based on that of the human body. Science Daily Reference Terms Retrieved from https://www.sciencedaily.com/terms/humanoid_robot.htm [accessed on 30 August 2019]
[2] Hanson Robotics website Retrieved from https://www.hansonrobotics.com/sophia/ [accessed on 31 August 2019]
[3] Tsang, D. (2018, June 27) Robot Sophia tells leader Carrie Lam how Hong Kong can succeed as smart city in show of artificial and emotional intelligence, SCMP Retrieved from https://www.scmp.com/news/hong-kong/hong-kong-economy/article/2152779/robot-sophia-tells-leader-carrie-lam-how-hong-kong [accessed on 30 August 2019]

Should a robot enjoy any legal status independent of its human creators? If so, what kind of legal status would that be? Should the robot enjoy its/her/his "rights"? These questions are going to be studied on a comparative law basis.

2. The European Union

Currently the EU laws do not have any type of provisions for robots and, in particular, for AI. According to the resolution of the EU Parliament[4] dated 16 February 2017 (the Resolution), which sets out recommendations to the Commission on Civil Law Rules on Robotics [2015/2103(INL)][5], robots cannot be held liable per se for acts or omissions that cause damage to third parties. The existing rules on liability "cover cases where the cause of the robot's act or omission can be traced back to a specific human agent such as the manufacturer, the operator, the owner or the user and where that agent could have foreseen and avoided the robot's harmful behaviour."

Following the Resolution, the EU Commission Working Document on Liability (issued on 25 April 2018) for emerging digital technologies[6], such as robots operating through AI systems, underlines that there is a regulatory gap:

- Where a robot takes autonomous decisions, according to the Resolution "the traditional rules will not suffice to give rise to legal liability for damage caused by a robot, since they would not make it possible to identify the party responsible for providing compensation and to require that party to make good the damage it has caused." These robotic systems are machines, programmable machines, and automated machines. A machine uses power to apply force, or to control a movement, or to perform an intended action. They can be driven by anything from animals, to people, to wind, or chemical, or thermal, or most commonly electrical power. These machines include system of mechanisms that takes the actuator input to achieve a specific application or output of forces and/or movement. These include computer sensors quite often that monitor the performance of these machines, that are able to plan movement in these various mechanical systems. Each of the hardware and software can be invented and/or manufactured by different entities.
- Furthermore, digital technologies generate and process a great amount of (big)data. In this regard, where a damage is caused by the supply of corrupted data, allocating liability may become unclear (and claims potentially difficult to enforce).
- Lastly, digital technologies change continuously, due to software extensions, updates and patches after their launch into the market / deployment in production. Any change to the software "may affect the behaviour of the entire system components or by third parties, in a way that can affect the safety of these technologies." Therefore, it is crucial to address responsibilities among the various actors of the AI value chain.

Responsibility may be identified upon robots' manufacturers pursuant to the provisions implementing the Product Liability Directive no. 85/374/EEC. Such Directive is based on strict liability of producers of defective products also in the event of personal injury or damage to

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[4] The European Parliament is an important forum for political debate and decision-making at the EU level. The Members of the European Parliament are directly elected by voters in all Member States to represent people's interests with regard to EU law-making and to make sure other EU institutions are working democratically. European Parliament's website Retrieved from https://www.europarl.europa.eu/about-parliament/en [accessed on 30 August 2019]

[5] European Parliament's website Retrieved from https://www.europarl.europa.eu/doceo/document/A-8-2017-0005_EN.html [accessed on 30 August 2019]

[6] European Commission Staff Working Document: Liability for emerging digital technologies (2018, April 25) Retrieved from https://ec.europa.eu/digital-single-market/en/news/european-commission-staff-working-document-liability-emerging-digital-technologies [accessed on 30 August 2019]

property. According to some commentators, there are grounds to argue that the Product Liability Directive may apply to robots causing damages to individuals/goods: for instance, where the producer did not properly inform the customer of dangers associated with the autonomous robot or whether the robot's security systems were deficient.

Furthermore, it is noted that in various civil law countries the "strict liability" doctrine is the prevailing reference. The strict liability doctrine provides that it is necessary to prove that (a) damage occurred; and (b) such damage has been caused by conduct/omission of the damaging party, so that there is no need to prove the negligence / willful misconduct of the damaging party (generally requested for torts).[7]

3. The United States of America

As autonomous systems permeate our airspace, waterways, and urban streets, the open question of assigning liability is becoming increasingly more urgent. In April 2018, the US Chamber Institute for Legal Reform[8] issued its second edition on "Torts of the Future II Addressing the Liability and Regulatory Implications of Emerging Technologies"[9]. The new report covers a wide range of legal issues related to artificial intelligence and unmanned systems.

The authors of the report suggest, "As robots and other products become more capable of making decisions on their own, courts may look to alternative models of liability." According to the study, robots may already be covered under "agency law[10]", whereby employers would be responsible for any injury resulting from their machines similar to employees. Alternatively, courts could view robots like pets in terms of liability[11], "In each of these areas, the person sued does not fully control the actions of the third party or animal that led to an injury, but, in some circumstances, is liable for the consequences."[12]

The Occupational Safety and Health Administration (OSHA) reports that in the past 30 years there have been only 30 fatalities caused by robots compared with the 5,000 workplace deaths annually. The first known robo-killing was in 1979 when a five-storey, 1-ton industrial robotic arm fatally struck Robert Williams in the head[13]. It is the first recorded human death by robot. William's family was awarded US$10 million in a jury verdict against the manufacturer. Afterwards, the plaintiff's attorney declared, "The question, I guess, is, 'Who serves who?'"

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[7] Olivi, G. European Union: Robots And Liability: Who Is To Blame? (2019, January 2) Retrieved from http://www.mondaq.com/uk/x/767368/new+technology/Robots+And+Liability+Who+Is+To+Blame [accessed on 30 August 2019]

[8] U.S. Chamber Institute for Legal Reform's website Retrieved from https://www.instituteforlegalreform.com/ [accessed on 30 August 2019]

[9] Torts of the Future II: Addressing the Liability and Regulatory Implications of Emerging Technologies (2018, April 18) Retrieved from https://www.instituteforlegalreform.com/research/ilr-research-torts-of-the-future-ii [accessed on 30 August 2019]

[10] The definition of agency law deals with agent-principal relationship and it's a relationship where one party has the legal authority to act in place of another. Definition of Agency Law: Everything You Need to Know Upcounsel Retrieved from https://www.upcounsel.com/definition-of-agency-law [accessed on 31 August 2019]

[11] Randolph, M. Dog Owners' Liability for Bites and Other Injuries: An Overview Retrieved from https://www.nolo.com/legal-encyclopedia/free-books/dog-book/chapter11-4.html [accessed on 31 August 2019]

[12] Mitchell, O. Liability in robotics: inside the legal debate (2018, May 11) Retrieved from https://www.therobotreport.com/liability-robot-legal-debate/ [accessed on 10 September 2019]

[13] Kravets, D. Jan. 25, 1979: Robot Kills Human (2018, January 25) Retrieved from https://www.wired.com/2010/01/0125robot-kills-worker/ [accessed on 31 August 2019]

In 2015, a "rogue" Fanuc robot crushed its repairer Wanda Holbrook in the head[14]. The husband subsequently filed a lawsuit against five companies associated with designing, building, and installing the industrial machine. The case is still pending, recently the five defendants appeared in the U.S. District Court for the Western District of Michigan universally claiming that the negligence lies with Holbrook, not their product.

The defendants' case might, unfortunately, have merit as current product liability statutes determine manufacturing defects at the condition of sale. The US Chamber Institute appropriately questions the relevance of present regulations for deep learning products, "In the future, a key overriding issue with respect to robotics and AI will be whether a designer's or manufacturer's conduct can continue to be evaluated under product liability principles when a product is learning and changing after its sale."

4. China

Beijing brought AI judges to court in August this year. The move, proclaimed by China as "the first of its kind in the world", comes from the Beijing Internet Court, which has launched an online litigation service center featuring an artificially intelligent female judge, with a body, facial expressions, voice, and actions all modeled off a living, breathing human. Last year, State news agency Xinhua's first English-speaking virtual anchor caused quite a stir among netizens. In relation to self-driving cars which are being developed in China, the liability regime is based on tort and product liability. In the event of a road accident, the driver/owner that caused the accident will be held liable under PRC Road Traffic Safety Law[15] and PRC Tort Law[16]. If the accident is caused due to defects of the vehicles then the manufacturer or seller of the defective vehicle will be liable[17].

China mainly embraces three types of liability, namely at-fault, presumed-fault and strict liability. As per the China Traffic Law, in cases of an accident between motor vehicles then at-fault liability will apply. On the other hand if there is an accident involving a motor vehicle and a driver of a non-motor vehicle or a pedestrian then presumed-fault or strict liability[18]will apply.
Under the Traffic Law, an insurance company of the owner of the vehicle which caused the accident will first pay damages to the victim(s), at an amount capped by compulsory third party liability insurance. If the damages paid by the insurer are not sufficient to cover the losses suffered by the victim(s) under the compulsory third party liability insurance, the driver/owner shall pay further damages to the victim(s) for the difference[19].[20]There is no robot-specific law in China.

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[14] Agerholm, H. Robot 'goes rogue and kills woman on Michigan car parts production line' (2017, March 15) Retrieved from https://www.independent.co.uk/news/world/americas/robot-killed-woman-wanda-holbrook-car-parts-factory-michigan-ventra-ionia-mains-federal-lawsuit-100-a7630591.html [accessed on 31 August 2019]
[15] Article 76 of the Traffic Law in China.
[16] Article 48 of the Tort Law in China.
[17] Articles 41 and 42 of the Product Quality Law and Article 12 of Interpretation on Several Issues Concerning the Application of Law in the Hearing of Cases Involving Compensation for Damages in Road Traffic Accidents issued by China Supreme Court 27 November 2012.
[18] Chinese scholars have different opinions on which theory of liability is adopted by the PRC Traffic Law in this regard.
[19] Article 76 of the Traffic Law in China.
[20] Schaub, M. Self-driving Cars：China and Beyond- Who will be Liable？(2017, August 8) Retrieved from https://www.chinalawinsight.com/2017/08/articles/corporate-ma/self-driving-cars%EF%BC%9Achina-and-beyond-who-will-be-liable%EF%BC%9F/ [accessed on 2 September 2019]

5. Hong Kong

Again, there is no law directed specifically to robots. There is, however, much established law on product liability for traditional products, such as the Sale of Goods Ordinance or in the tort of negligence. In negligence, where a manufacturer is liable, if it supplies a defective product, in breach of its duty of care, and that breach then causes foreseeable damage. This is the chain of causation. But what happens if that chain of causation is broken? If a manufacturer produces a product and provides specific directions as to its use, and that product is then used contrary to those directions, it may be argued that the chain of causation has been broken, and as a result, there may be a change of liability. This can also happen to software. Provided that it is used in the form delivered, liability will rest with the actual developer. However, as soon as that software is changed or indeed altered by the user, performance issues may no longer be the responsibility or the sole responsibility of the developer and as a consequence, liability is also likely to shift. The situation is somewhat different where software is developed with the intention that the user will change that software through having that software learn to perform a specific task just like what a robot does. As soon as that software learning commences, the chain of causation is arguably broken, causing a change in liability.

6. Should the law recognize a robot as a legal person so that a robot can bear his/her own liability?

The late world-renowned physicist Stephen Hawking warned that as AI reaches a level where it outperforms humans, "*we cannot know if we will be infinitely helped by AI, or ignored by it and side-lined, or conceivably destroyed by it.*"[21] Similarly, Elon Musk, the CEO of SpaceX and Tesla Motors, has sounded an alarm, advising government officials that AI poses a "*fundamental risk to the existence of human civilization.*"[22] Musk warns that AI poses "*vastly more risk*" than North Korea[23] and that it may be too late to respond if regulators wait "*until people see robots going down the street killing people*" to adopt safeguards.[24] Perhaps of more immediate concern, cybersecurity experts worry that, in addition to robots developing a mind of their own, they can be hacked, controlled by third parties, and told to do harm.[25] Robots are slowly, but certainly, entering people's professional and private lives. They require the attention of regulators due to the challenges they present to existing legal frameworks and the new legal and ethical questions they raise. There are a number of major regulatory dilemmas in the field of robotics, such as:

- how to keep up with technological advances;
- how to strike a balance between stimulating innovation and the protection of fundamental rights and values;
- whether to affirm prevalent social norms or nudge social norms in a different direction;
- how to balance effectiveness versus legitimacy in techno-regulation; and….[26]

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[21] Hannah Osborne, Stephen Hawking AI Warning: Artificial Intelligence Could Destroy Civilization, Newsweek, Nov. 7, 2017 (quoting remarks of Stephen Hawking at a technology conference in Lisbon, Portugal).

[22] See Nick Wingham, Elon Musk Says Humanity Needs to Act NOW to Stop Artificial Intelligence and Killer Robots Wiping Us Out, The Sun (U.K.), July 17, 2017.

[23] Jasper Hamill, Elon Musk Says Artificial Intelligence and Killer Computers are Far More Dangerous Than North Korea, The Sun (U.K.), Aug. 14, 2017.

[24] Tia Ghose, Elon Musk: Regulate AI Before Robots Start 'Killing People', Live Science, July 17, 2017 (quoting Musk comments to National Governors Association).

[25] See George Harrison, Hackers Could Program Sex Robots to Kill, N.Y. Post, Sept. 11, 2017 (reporting comments of Dr. Nick Patterson, a cybersecurity expert).

[26]

When robots go wrong and cause damage or injury, responsibility will usually be identified upon robots' manufacturers. For example, in the EU, pursuant to the provisions implementing the Product Liability Directive no. 85/374/EEC which is based on strict liability of producers of defective products also in the event of personal injury or damage to property. It is argued that the said Product Liability Directive may apply to robots causing damages to individuals/goods: for instance, where the producer did not properly inform the customer of the dangers associated with the autonomous robot or whether the robot's security systems were deficient.[27]

Furthermore, it is noted that in various civil law countries, such as China, the "strict liability" doctrine is the prevailing reference. The strict liability doctrine provides that the claimant will have to prove that (a) damage occurred; and (b) such damage has been caused by conduct/omission of the damaging party, so that there is no need to prove the negligence / willful misconduct of the damaging party (generally requested in torts).[28]

There are some open-ended questions that are yet to be addressed fully. Once the (legal) person responsible for the damage has been identified (the AI manufacturer, the programmer, the supplier or the user), his/her responsibility should be proportional to the "degree of autonomy" of the robot / AI system? How to properly address the degree of autonomy of the robot / AI system? Here is an example. Currently, the Federal Aviation Administration of the USA restricts drones to human-operated flights away from population centers. Yet, the Unmanned Aerial Vehicle (UAV) market opportunity is largely predicated on autonomous "Beyond Line Of Sight" (BLOS) missions. Ingenious traders can always find a way. Nestled on the show floor between spinning drone rotors and autonomous trucks, avionic insurance companies were selling coverage for operators planning future BLOS jobs. Many of these underwriters packaged custom policies on a per mission basis in distances and minutes, rather than annual premiums. SkyWatch, an Israeli insurance tech startup, demonstrated a novel platform that ties liability to GPS coordinates and telemetry data. Their websites promotes "Don't settle for 'pay-when-you-fly' when you can get 'pay-how-you-fly.'". This type of technology could, in theory, provide investigators with the empirical data to accurately assess liability.[29]

The may be situations in the future which arise in which AI products act in a manner that is beyond the control of designers, manufacturers, or owners. Just like
in employment cases, a business is generally not liable when an employee commits an assault which is beyond his/her scope of work. A pet owner may not be liable when a puppy that had always been gentle bites a four-year-old who enters its yard. Liability is based on principles of control, foreseeability, and fault. One answer to situations in which the designer, manufacturer, or owner of an AI product is not liable under existing principles is to acknowledge that the purpose of tort law is not simply to compensate a person who has experienced an injury, but to do so when another party's wrongful action caused that harm.[30]Another option may be to recognize AI entities themselves as responsible for their own actions. Some suggest that the law will need to develop a

[27] Olivi, G. European Union: Robots And Liability: Who Is To Blame? (2019, January 2) Retrieved from http://www.mondaq.com/uk/x/767368/new+technology/Robots+And+Liability+Who+Is+To+Blame [accessed on 15 September 2019]
[28] Vladeck , D.C. MACHINES WITHOUT PRINCIPALS: LIABILITY RULES AND ARTIFICIAL INTELLIGENCE (2014, March 26) Retrieved from http://euro.ecom.cmu.edu/program/law/08-732/AI/Vladeck.pdf [accessed on 15 September 2019]
[29] Mitchell, O. Liability in robotics: inside the legal debate (2018, May 11) Retrieved from https://www.therobotreport.com/liability-robot-legal-debate/ [accessed on 15 September 2019]
[30] See Victor E. Schwartz et al., Prosser, Wade & Schwartz's Torts 1-2 (13th ed. 2015)

limited form of "personhood" for autonomous technology that we will interact with in the same manner as people.[31]

More than 75 years ago, science fiction author Issac Asimov suggested laws to protect humans from interactions with robots. They are:

- A robot may not injure a human being or, through inaction, allow a human being to come to harm.
- A robot must obey the orders given it by human beings except where such orders would conflict with the First Law.
- A robot must protect its own existence as long as such protection does not conflict with the First or Second Laws [32]

At current stage in the development of AI technology, the motivation for providing autonomous technology with some legal status is largely driven by practical considerations. Corporations are "persons" under the law, and certain rights and responsibilities have been extended to them. Corporations are not individuals or human, but they have been granted many legal powers. Corporations can enter into contracts, can sue and be sued, can own assets and are subject not only to civil liability but also to criminal penalties. They even have limited rights to free speech[33] and religious freedom[34], and to engage in the political process[35]. Providing AI entities with some form of legal status could provide assurance that an entity has authority, for example, to enter into legally binding contracts for the provisions of goods or services. Recognizing robots or drones as legal entities could protect the owner in situations in which the technology caused an accident while acting autonomously and the owner is not responsible for the action. The technology itself, supporters of this approach say, should carry its own insurance to cover claims. Limited personhood might also provide certain rights to AI entities, including the ability to own the intellectual property that it creates, such as software code and other technology, as well as art, music, articles, stories, or books. Corporations have these rights already; they are in turn owned by individuals or by other corporations or entities, which ultimately are owned by individuals. Those owners benefit financially from the corporation's intellectual property and other property rights. Like corporations, which possess legal rights, it seems likely that AI entities with property and other legal rights will also be subject to ownership, and that their owners will also be the ultimate financial beneficiaries. Granting citizenship to Sophia, the robot, in Saudi Arabic appear to be for publicity purposes. However, more serious consideration is occurring in Europe. In February 2017, the European Parliament voted in favor of moving toward recognizing autonomous robots as "electronic persons"[36]. Section 59 (f) of the EU Parliament report with recommendations to the Commission on Civil Law Rules on Robotics has proposed:

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[31] Torts of the Future II Addressing the Liability and Regulatory Implications of Emerging Technologies (2018 April) Retrieved from https://www.instituteforlegalreform.com/uploads/sites/1/tortsofthefuturepaperweb.pdf [accessed on 15 September 2019]

[32] Anderson, M.R. After 75 years, Isaac Asimov's Three Laws of Robotics need updating (2017, March 17) https://theconversation.com/after-75-years-isaac-asimovs-three-laws-of-robotics-need-updating-74501 [accessed on 15 September 2019]

[33] SeeCentral Hudson Gas & Electric Corp. v. Public Serv. Comm'n, 447 U.S. 557 (1980) (invalidating state regulation banning promotional advertising by utility).

[34] SeeBurwell v. Hobby Lobby, 134 S. Ct. 2751 (2014) (holding that, as applied to closely held corporations, federal regulations requiring employers to provide female employees with no-cost access to contraception violate the Religious Freedom Restoration Act).

[35] SeeCitizens United v. Federal Election Comm'n, 558 U.S. 310 (2010) (recognizing that political spending is a form of protected speech, and government may not keep corporations or unions from spending money to support or denounce individual candidates in elections); First Nat'l Bank of Boston v. Bellotti (1978) (defining free speech rights of corporations for the first time, and holding that corporations have a First Amendment right to make contributions to ballot initiative campaigns).

[36] See European Parliament Resolution of 16 February 2017 With Recommendations to the Commission

"*Creating a specific legal status for robots in the long run, so that at least the most sophisticated autonomous robots could be established as having the status of electronic persons responsible for making good any damage they may cause, and possibly applying electronic personality to cases where robots make autonomous decisions or otherwise interact with third parties independently.*" This recommendation was part of a broader resolution that created an ethical–legal framework for robots, but, predictably, it was this element that attracted the most startling media coverage. The European Parliament's general recommendations, expressed in a resolution to the EU's Commission on Civil Law Rules on Robotics, include directing designers, producers, and operators of autonomous, self-learning robots to follow "Asimov's Laws," (discussed above) adopting codes of ethics for robotics engineers and researchers, and taking a "gradualist, pragmatic and cautious approach" to future initiatives to protect innovation[37]. With respect to civil liability, the European Parliament's resolution finds that legislation should not restrict or limit compensation to an aggrieved person "on the sole grounds that damage is caused by a non-human agent"[38]."In principle," the resolution states, "once the parties bearing the ultimate responsibility have been identified, their liability should be proportional to the actual level of instructions given to the robot and its degree of autonomy, so that the greater a robot's learning capability or autonomy, and the longer a robot's training, the greater the responsibility of its trainer."[39] The Commission finds that, at this point, "responsibility must lie with a human, not a robot."[40]The resolution recognizes, however, that when robots reach a level of autonomy and sophistication where their actions cannot be traced back to a specific person or entity, such as the designer, manufacturer, operator, owner, or user, and where the robot's actions were not foreseeable, traditional principles of liability may become insufficient. For that reason, the resolution calls on the Commission to explore the following:

- Whether to take a strict liability approach or impose liability on the person who is in the best position to minimize risks and deal with negative impacts in future legislation governing robot-related damages;[41]
- Establishing a classification and registration system for advanced robots, possibly grouping them by task, the environment in which they operate, their form, their level of human interaction, and their degree of autonomy;[42] and
- Developing a compulsory insurance scheme similar to auto insurance and creating a fund that would guarantee compensation for any damage caused by a robot that is not covered by insurance. A designer, manufacturer, programmer, owner, or user who contributes to the fund and has insurance coverage would be subject to limited liability.[43]The resolution recommends considering specific issues and concerns related to autonomous vehicles, drones, robots used during surgery, "care robots," and medical robots.[44]
- The most controversial recommendation is to give the most sophisticated autonomous robots "*a specific legal status in the long run*," making the robots "*electronic persons*" responsible

on Civil Law Rules on Robots (2015/2103(INL)).

[37] European Parliament Resolution General Principles Principle X

[38] Section 52 of the EU Parliament report with recommendations to the Commission on Civil Law Rules on Robotics.

[39] Section 56 of the EU Parliament report with recommendations to the Commission on Civil Law Rules on Robotics.

[40] -ditto-

[41] Section 53 of the EU Parliament report with recommendations to the Commission on Civil Law Rules on Robotics.

[42] Section 2 of the EU Parliament report with recommendations to the Commission on Civil Law Rules on Robotics.

[43] Section 59 of the EU Parliament report with recommendations to the Commission on Civil Law Rules on Robotics

[44] Sections 31-35 of the EU Parliament report with recommendations to the Commission on Civil Law Rules on Robotics

for any damage their decisions or interactions with people may cause as set out above.[45] This recommendation as similar to corporate personhood—creating a new "legal fiction" as a tool of convenience—not akin to human rights. "*Robots are not humans and will never be humans*," declared Mady Delvaux, the Luxembourgish member of the European Parliament responsible for presenting the action to the public[46].

The European Parliament's 2017 resolution does not have any legal force. In 2018, however, it has begun to vote on specific proposals to regulate robots and AI[47]. Others question whether robots need "personhood."[48] Many animals have skills that are on par with or more advanced than current AI technology, but they are still considered property without personhood. For example, dogs help people with a wide range of medical conditions, search for people trapped after disasters, detect explosives, and respond to numerous commands. Other animals also have the ability to use tools, think, and create. In 2016, after lengthy litigation, a federal district court in the USA ruled that a "highly intelligent" Indonesian monkey named Naruto could not seek damages for copyright infringement when others published and sold selfies he took with a nature photographer's camera[49]. If a real monkey cannot create and own property, should an autonomous monkey robot have greater rights? Given the potential of AI entities to create intellectual property and other lasting value, the answer may be yes, as was decided long ago in granting certain rights to corporations and recognizing them as "persons" for certain purposes.[50]

An Indian court's ruling in May this year that all animals and birds have the same rights as humans has put the spotlight on the idea of legal persons. Moreover, the Uttarakhand high court ruled that the Ganga and Yamuna Rivers have the same legal rights as a person, in response to the urgent need to reduce pollution in two rivers considered sacred in the Hindu religion.[51] In New Zealand, the government passed legislation that recognised the Whanganui River catchment as a legal person.[52]

Robots being given a "quasi-legal" personality (e-Person), which could protect manufacturers and users against liability (similarly to the characteristics of separate legal entity and artificial person of a company, which is distinct from the liability of the company's shareholders) may only materialize in the medium/long term, since it would also imply a substantial and broader cultural shift towards technologies' and AI products.

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[45] Section 59(f) of the EU Parliament report with recommendations to the Commission on Civil Law Rules on Robotics

[46] See Giving Robots 'Personhood' is Actually About Making Corporations Accountable, The Verge, Jan. 19, 2017.

[47] See Charlotte Walker-Osborn & Paula Barrett, Artificial Intelligence: The EU, Liability and the Retail Sector, Robotics L.J., May 8, 2017.

[48] See, e.g., Jane Wakefield, MEPs Vote on Robots' Legal Status – and If a Kill Switch is Required, BBC, Jan. 12, 2017 (quoting comments of Lorna Brazell, a partner at the law firm Osborne Clarke)

[49] Cullinane, S. Monkey does not own selfie copyright, appeals court rules CNN (2018, April 24) Retrieved from https://edition.cnn.com/2018/04/24/us/monkey-selfie-peta-appeal/index.html [accessed on 15 September 2019]

[50] Torts of the Future IIAddressing the Liability and Regulatory Implications of Emerging Technologies (April 2018) Retrieved from https://www.instituteforlegalreform.com/uploads/sites/1/tortsofthefuturepaperweb.pdf [accessed on 15 September 2019]

[51] Three rivers are now legally people – but that's just the start of looking after them (2017, March 24) Retrieved from https://theconversation.com/three-rivers-are-now-legally-people-but-thats-just-the-start-of-looking-after-them-74983 [accessed on 30 September 2019]

[52] -ditto-

That said, it is not possible to predict how the legislation on AI and liability will evolve, although most commentators rely upon the strict liability doctrine as the key driver to foster the ongoing legislative process.

7. Conclusion

No one could predict in the 1980s the amount of new legislation drafted regulating Internet privacy, social media and mobile phones. Legal questions relating to robots, autonomous cars, and drones are an indication that the cognitive industrial age is starting to affect the lives of everyday citizens. Part of the responsibility of government and industry is to protect the victims injured by technology. As the US Chamber Institute explains, "*There is no one-size-fits-all approach to addressing liability and regulatory issues associated with emerging technology. The key is to strike the right balance between promoting innovation and entrepreneurship and addressing legitimate safety and privacy concerns.*"[53]

[53] Mitchell, O. Liability in robotics: inside the legal debate (2018, May 11) Retrieved from https://www.therobotreport.com/liability-robot-legal-debate/ [accessed on 15 September 2019]

Economic and political inequality in Southeast Asia: 1998-2017

Chan Ka Lok, Daniel
The Chinese University of Hong Kong

Abstracts

The relation between economic and political inequality had long been investigated in qualitative sense. It is Due to tremendous difficulty of quantifying political inequality, researchers have successfully developed its proxy variable in a holistic sense till recent years. Thus, it has little empirical evidence to examine the impacts of economic inequality on political inequality across socio-economic positions. Using regional scope, this study is primary attempt to conduct empirical investigation under post-Asian Financial Crisis period. Among all Southeast Asian nations, Indonesia, Laos, Malaysia, Philippines, Thailand, Vietnam are chosen. Through fixed effects model, it examines whether economic inequality boosts or alleviates political inequality by controlling the effects from various macroeconomic and political factors. The former refers to relative power theory while the latter refers to conflict theory. And, the results support relative power theory. Lastly, this paper offers three significant contributions by extending existing works to a regional scale in area studies (Southeast Asia) and some middle-income countries with flawed democracy.

Keywords: Economic inequality, Political inequality, Area studies

1. Introduction

Inequality is always one of the hottest focus in the fields of economics, political science and sociology. Seemingly, economic inequality is nowadays a global phenomenon, and mitigating poverty and income inequality are clear national development goals without a doubt. In intuitive sense, political equality seems only incurs in democratic nation. But democracy and political inequality virtually are distinctive concepts. The most convincing evidences are that those communist regimes and some autocracies such as ethnocracies managed by poor ethnic groups are politically equal fairly (Acemoglu, Bautista, Querubín & Robinson, 2008; Houle, 2018). Thus, political inequality could incur in both authoritarian and democratic nations. Especially, both two ultimate forms of government are still equally debatable, though the latter enjoys higher legitimacy after the period of Cold War. It is interesting that how different the situations of economic and political inequality between authoritarian and democratic nations are.

Solt (2008) examined how changing economic inequalities affect the changes in political behaviors based on 22 diverse samples of advanced industrialized democracies, and successfully demonstrated positive relationship between income inequality and low self-reported political engagements. Proxy variables of the latter include electoral participation, political discussion and political interests. When economic inequality grows, political engagement of all income groups were reduced, but by less degree for the rich. Also, Rosset, Giger & Bernauer (2013) suggested that economic inequality decreases political representation of socially-marginalized citizens. The results of both studies support relative power theory, which emphases the rich mobilize money to influence political decision of politicians or government officials (Goodin & Dryzek, 1980). In other words, money is the one of the keys to determine whether the bill or regulation will be passed in various political markets through lobbying.

In the study of Cole (2018), this is primary attempt to investigate the empirical relationship between economic and political inequality using a global scale. Using data for 136 countries between 1981 and 2011, it confirmed that income inequality adversely influenced the goal of political equality and this conclusion applied to most countries around the globe, including both democratic and non-democratic as well as both developed and developing countries. Another study conducted by Houle (2018) also confirmed economic inequality increases political inequality via four mechanisms. Firstly, economic inequality boosts more resources of the rich than the counterparts of the poor. Besides, as relative power theory implies, inequality raises the incentives of the rich to mobilize their resources to control the policy process and outcomes, which would widen the deviations of policy preferences between the rich and the poor. In addition, inequality reduces the overall political participation, especially the poor. Lastly, for democratic nations only, the poor become less likely to prevent the rich from controlling policymaking when inequality grows. Then, it may destabilize the already established democratic nations (Houle, 2009). Using data for 144 countries between 1961 and 2008, it was found that the results hold for both authoritarian and democratic nations, as democracy level is control variable. But the effect of inequality is stronger in autocracies. Our analysis will show contribution in existing work in two aspects. Despite central significance of studying political cleavages in conflict perspective, most existing research is limited by single country cases (mostly for the US) and very few subnational-unit comparisons in highly-developed countries (Acemoglu et al., 2008; Gilens, 2012; Rosset, 2016; Solt, 2008). More importantly, existing research only focus on the particular aspect of political inequality such as political engagement and political representation. Both will restrict our understanding on the relationship between economic and political inequality around the globe. Thus, as only affluent and democratic nations as the centre of existing work, this paper will turn into the investigation of some cases of competitive or electoral authoritarianism (Howard & Roessler, 2006). Thus, filling research gap is primary motivation of this study.

Moreover, in order to have better comparison results and contribute to the relative new field of area studies (Southeast Asian studies), six competitive or electoral authoritarians in Southeast Asia under post-Asian Financial Crisis period are chosen. In this study, we would analyze if economic inequality affects political inequality. When economic inequality is higher, would the rich demand greater political power than the poor?

2. Relationship between economic and political inequality

2.1 Relative power theory

Mills (1956) and Domhoff (2006) agreed that money offers power to launch political campaigns, lobby the government and establishes think tanks and media, which create civil liberties and participation. Thus, economic resources help citizens gain access and exercising power. In general, political and economic elites are highly concentrated and interlocked, while the poor masses are fragmented. So, it is relative easier for those elites to organize than the poor. Lacking resources causes the poor suffers from political disadvantages as "politically invisible" (Brady, 2009; Cole, 2018). When the rich could mobilize the media and think tanks, their speeches of political argument could be amplified, and at the same time, they undermine the influence of the poor's voices (Solt, 2008).

Furthermore, middle and upper class are more willing to engage in political participation. It is because relative economic power is important for indicate political efficacy. Thus, citizens who have political engagements perceive the success of their favored policy reform to be sufficiently high (Gilens, 2012; Goodin & Dryzek, 1980). If they think their opposing party will win the vote,

they will not participate. In short, relative power theory proposes economic inequality leads to political stratification and political inequality. Though most of empirical studies support this perspective, there is a few exception. Adams & Ezrow (2009) discovered that no evidence was found that usual citizens influence policymaking based on the samples of European countries if the effects of opinion leaders were taken into consideration.

2.2 Conflict theory

Apart from the rich, the poor have been incentivized to reduce political inequality due to their deteriorating socio-economic spaces. According to Meltzer & Richard (1981), rising inequality results in divergence in policy preferences across socioeconomic positions, boosting the potential of policy debates and political mobilization. Thus, the poor will demand for income redistribution when economic inequality grows. When grievance is sufficiently high, the means of civil disobedience and rebellion would be adopted by protesters (Acemoglu & Robinson, 2006; Przeworski, 2009). In other words, the level of political inequality is co-determined by political demands between the rich and the poor in various political markets. In overall, the main idea of conflict theory is the opposite result of relative power theory – economic inequality helps mitigate political stratification and political inequality. However, this perspective lacks empirical support in prior research (Solt et al., 2016; 2017).

3. Data and methods

Samples include more than 112 observations of six Southeast Asian nations. The most affluent and poorest countries are deliberately neglected. For Singapore, it is the most exceptional case of high economic openness and low democracy. On the other extreme, the overall development of Cambodia and Myanmar are very low and their data are undoubtedly unreliable. Thus in this study, only leaving competitive or electoral authoritarianism (Indonesia, Laos, Malaysia, Philippines, Thailand, Vietnam) are chosen. The period of this study is from 1998 to 2017. Two fixed effects models are estimated by standard ordinary least-square (OLS), as it is more efficient (Wooldridge, 2013). But the panels are unbalanced depending on data availability.

Model 1: $PI_{it} = \alpha + \beta_1 D_i + \beta_2 Gini_{it} + \beta_3 GDP\ per\ capita_{it} + \beta_4 Exports_{it} + \beta_5 FDI_{it} + \beta_6 Loans_{it} + \beta_7 Oil\ rents_{it} + \beta_8 Demo_{it} + e_{it}$

where D_i is cross-section dummy variable (D_1: Indonesia; D_2: Laos; D_3: Malaysia; D_4: Philippines; D_5: Thailand; D_6: Vietnam)

Model 2: $PI_{it} = \alpha + \beta_1 D_i + \beta_2 Gini_{it} + \beta_3 GDP\ per\ capita_{it} + \beta_4 Exports_{it} + \beta_5 FDI_{it} + \beta_6 Loans_{it} + \beta_7 Demo_{it} + e_{it}$

3.1 Dependent variable

According to the American Political Science Association (APSA) Task Force in Inequality and American Democracy (2004) and Dubrow (2015), political inequality is the phenomenon that citizens across different socioeconomic positions share and possess different degrees of political power in term of citizen voices (participation and representation), government responsiveness (influence) and public policy making (influence in process and outcome).

As the measurements of political inequality is highly difficult, we follow the works of my pioneers (Cole and Houle) as reference. Thus, primary dependent variable (political inequality) is adopted from the Varieties of Democracy (V-Dem) Database (Coppedge et al., 2019b), which measures the degree of how political power is equally distributed across socioeconomic positions. Based on V-

Dem, political power index is constructed by country experts using five-point scale (0-4) in terms of political power, which means the citizens (a) actively participate in politics (e.g. voting) (b) participate in civil society organizations, (c) are enjoying representation in government, (d) have access to set the political agenda, (e) influence the design and the implementation of political decisions.

The rating ranges from -4 (least political equal) to +4 (most political equal). A rating of zero refers to the rich can enjoy a virtual monopoly on political power, but average people and the poor nearly have no influence. A rating of two means the rich have a very strong hold on political power, while average people and the poor are enjoying some degree of influence only on issues that matter less for the rich. At another extreme, a rating of four symbolizes the rich have no more political power than average people and the poor, so political power could be viewed as equally distributed across economic groups. After that, the ordinal index would be converted into interval variable with Bayesian item response theory measurement model. Item response theory helps reduce the bias due to conversion and different coders' mistakes and interpretations (Cole, 2018; Coppedge et al., 2019c; Houle, 2018)

3.2 Independent variables

In this research, economic inequality means income inequality, which expressed in Gini coefficients. Gini coefficient measures average difference in citizens' income in a country and has long been a widely-used measures of income inequality in longitudinal research. The definition of income in Gini coefficient is disposable income after tax and transfers. It ranges from 0 to 100. A score of zero means income are evenly distributed across the citizens in a country while a score of 100 means the individual earns the highest income in the country.

We employ the Gini coefficient from Standardized World Income Inequality Database (SWIID, version 8.1) developed by Solt (2019). As various measurements of income distribution from different governments or international organizations cause compatibility issues for comparison from the World Bank, OECD, Eurostat to the United Nation, Solt standardized the data from various sources.

3.3 Control variables

Both models include control variables to capture country fixed effects for some country-specific factors (Wooldridge, 2013). For economic development, GDP per capita is a must-have factor for measuring overall economic development (World Bank, 2019b). Other similar proxies being employed for external dependence are exports, foreign direct investment and foreign loans from World Bank (UNCTAD, 2019; World Bank, 2019a; World Bank, 2019d). For the effects of external dependence on income inequality are ambiguous. Some scholars proposed the relationship is positive, while some research found that it is negative (Balaev, 2009; Huber & Stephens, 2012; Mahutga & Bandelj, 2008; Reuveny & Li, 2003). For the context of Southeast Asia, oil rents is employed for some oil-dependence nations in some extent (World Bank, 2019c). Most of empirical results showed that rising oil dependence will lower the level of democracy and stabilize the existing form of government including both democracy and autocracy (Ahmadov, 2014; Jensen & Wantchekon, 2004; Ramsay, 2011; Ross, 2012). Also, oil-dependent countries are empirically associated with lower economic inequalities (Kim & Lin, 2018; Parcero & Papyrakis, 2016). Interestingly, Fum & Hodler (2010) affirmed that oil-dependence cut down income inequality in less-ethnically-polarized countries but boost income inequality in more-ethnically-polarized countries.

Last but not least, the control variable for identifying the effect on democratization is the polity score from the Polity IV database, ranging from +10 (most democratic) to -10 (least democratic). Polity score reflects the competitiveness and openness of personnel recruitment, constraints on

chief executive and the regulation and competiveness of political participation (Marshall, Gurr & Jaggers, 2018). For sure, democracy affect the distribution of power and personal income. As democracy is one of the crucial determinants of income redistribution, it may reduce economic and political inequalities (Huber & Stephens, 2012; Reuveny & Li, 2003). The detail explanation of all proxy variables is provided in Table A3.

4. Results

4.1 Descriptive statistics

Before empirical investigation of the relation between economic and political inequalities, we can have an intuitive look about socioeconomic condition. Table A1 lists the countries with the scores of economic and political inequalities in sampled year (2013) and table A2 presents descriptive statistics of all variables in the Appendix. In general, highly-industrialized countries top both the lists of economic and political inequalities. The lower the Gini ratio, the higher economic equal the country can enjoy and rank higher. But for the higher political inequality index, the greater political equal the country can enjoy and rank higher. Thus, the positive association between economic and political inequality can be unmasked in a loose sense.

The mean of Gini ratio among these sampled countries is 41.5, which is relative higher around the globe. For sampled countries in term of Gini ratio, the level of economic development of Laos and Vietnam placed the lowest, while the level of Thailand and Malaysia placed the highest. So, it is in no doubt Gini ratio rises when the level of economic development is higher. For Philippine and Indonesia, they are exceptional cases. As continental region across the nation are highly disperse as archipelagic nations, urban-rural disparity is extremely large and thus both countries top the sampled list.

On the other hand, the mean of political inequality index among these sampled countries is 0.057, which is relative lower around the globe. For sampled countries in term of political inequality index, democratic development of Malaysia is the highest as competitive authoritarian, this enjoying the highest index. Besides, although Thailand, Philippines and Indonesia are multi-party regimes, the difference in political structure is apparent: successful turnover of two major ruling parties with different political cultures and ideologies in Thailand reflect voters' political influence, although military and royal family are the highest ruling power.

4.2 Inference statistics

Table 1 shows two fixed effects models estimated by OLS to analyze political inequality (Model 1 and 2). More than half parameters yield the results of statistically significance. From model 1, it suggests 1-point rise in income inequality reduce political inequality index by 0.0336 points, holding other variables constant. It implies income inequality results in greater political inequality. Importantly, this relationship is not caused by other macroeconomic and political factors which I have controlled in the analysis. Model 2 also evaluates impacts from various proxy variables on political inequality from model 1 by removing oil rents, as the association between political inequality and oil rents is not statistically significant in model 1. And, model 2 presents a smaller decline of 0.0316 points. Again, it lends empirically support "Relative power theory" among six Southeast Asian nations and opposes "Conflict theory".

Aside from negative impacts on income inequality, GDP per capita, exports and foreign investments are also negatively correlated with political inequality index. Based on model 2, it suggests 1-point rise in GDP per capita reduce political inequality index by 0.564 points, ceteris paribus. Thus, the higher the level of economic development, the greater political inequality the

country will suffer from. Besides, 1% rise in exports-GDP ratio reduce political inequality index by 0.006 points, ceteris paribus. As exports will boost the pace of integration from national economy into global capitalistic system, the sampled Southeast Asian economies will inevitably suffer from greater political inequality. For FDI, 1% rise in FDI-GDP ratio increase political inequality index by 0.009 points, ceteris paribus. Furthermore, foreign direct investment acting as leading economic indicator will reflect future economic outlook of a nation. A positive relationship between FDI and political inequality index means the influx of FDI may reflect political inequality is improving in socio-economic environment. For democracy, 1-point rise in democracy score increase political inequality index by 0.04 points, ceteris paribus. As the sole political factor, democracy level will not be difficult to understand to reduce political inequality. As democratization nurture political equality, it helps alleviate the degree of political inequality of Southeast Asian economies.

Table 1: OLS analyses for the effect of income inequality on political inequality

	Dependent variable	
	Degree of political equality	
	Model 1 Cross-section fixed (dummy variables)	Model 2 Cross-section fixed (dummy variables)
Income inequality (Gini)	- 0.03358**	- 0.03162*
	(0.017)	(0.017)
GDP per capita (Log)	- 0.55257***	- 0.56447***
	(0.099)	(0.098)
Exports (% of GDP)	- 0.00573***	- 0.00642***
	(0.002)	(0.002)
FDI (% of GDP)	0.00826**	0.00937***
	(0.003)	(0.003)
World Bank Loans	0.000001	0.000001*
	(0.0001)	(0.0001)
Oil rents (% of GDP)	- 0.0138	
	(0.017)	
Democracy score (Polity IV)	0.04111***	0.04075***
	(0.009)	(0.009)
Constant	6.30656***	6.28347***
	(1.180)	(1.178)
Adjusted R-squared	0.86762	0.86802
n	112	112

Note: Standard error in parentheses. *p < 0.1, **p < 0.05, ***p < 0.01

5. Conclusion

Growing concerns of Income inequality on democracy when neoliberalism successfully transform all nations into global capitalistic system under post-global-financial-tsunami era. In this study, the major work lies on the estimation of the impact of income inequality on political inequality. The results are quite clear: income inequality worsen political inequality, which is consistent with relative power theory. As income inequality arises, the rich enjoy greater political power in terms of citizen voices, political participation and representations and the influence of policy-making process than the poor can possess. These results hold for employing control variables that capture

the variations of economic development, external dependence and democracy across six Southeast Asian countries.

This paper has four contributions by extending existing works to a regional scale in area studies (Southeast Asia) and some middle-income countries with flawed democracy, utilizing holistic definition of political inequality for quantitative study. Of course, this study is only a starting point for studying regional political inequality empirically. The next step will be the introduction of more political and social variables for complexity of authoritarian politics and cultural dynamics in Southeast Asia.

These findings provide useful implications for policy design of Southeast Asian development. In general, only Singapore enjoys the notion of highly-developed nation, so the road of modernization of Southeast Asia have a far way to go. Since economic inequality destabilizes democracy, Southeast Asia countries needs to be careful of choosing the ongoing direction of political development. And political inequality is co-determined by political demands between the rich and the poor in various political markets. Especially for current trend, resurgent populism and nationalism play an increasing role in Southeast Asian politics, as ethnicity and religion symbolize national identity of citizens and cultural diversity of Southeast Asia. Linking with economic inequality, working-class voters and the poor will be easily mobilized by the wave of populism. For instance, Thaksin in Thailand, Duterte in Philippines, Widodo in Indonesia and Aung San Suu Kyi in Myanmar. Hence, countries should pay much more attention on the issue on growing economic inequality for future development.

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Appendix

Table A1: Countries with the scores of economic and political inequalities in 2013 (sample year)

Year 2013

Country	**Gini**	**Rank**	**Country**	**PI**	**Rank**
Belarus	24	1	Japan	3.5	1
Iceland	24.8	2	Denmark	2.602	2
Denmark	25.1	3	Vanuatu	2.33	3
Norway	25.1	4	Bolivia	2.327	4
Slovakia	25.2	5	Malta	2.201	5
Czech Republic	25.3	6	Netherlands	2.099	6
Finland	25.4	7	Iceland	1.992	7
Slovenia	25.4	8	Finland	1.955	8
Belgium	25.6	9	Luxembourg	1.954	9
…	…	…	Belgium	1.934	10
Laos	**35.3**	**60**	…	…	…
Vietnam	**37.4**	**70**	United States	1.073	52
United States	37.9	72	…	…	…
Thailand	**39.3**	**82**	**Malaysia**	**0.75**	**76**
Malaysia	**40.3**	**86**	…	…	…

Hong Kong	40.9	89	**Thailand**	**0.419**	**102**
China	41	91	…	…	…
Philippines	**41.3**	**94**	**Indonesia**	**0.088**	**118**
…	**...**	…	**Laos**	**-0.121**	**127**
Indonesia	**46.9**	**124**	Hong Kong	-0.133	128
Palau	47.6	125	China	-0.256	132
Saudi Arabia	47.7	126	…	…	…
Cape Verde	47.9	127	**Vietnam**	**-0.409**	**140**
Honduras	48.6	128	**Philippines**	**-0.595**	**149**
Sri Lanka	48.8	129	…	…	…
Colombia	49.1	130	Qatar	-1.487	171
Puerto Rico	51.7	131	Zimbabwe	-1.507	172
Comoros	52.1	132	Bahrain	-1.683	173
Zambia	54.4	133	Kazakhstan	-1.685	174
Botswana	58.6	134	Tajikistan	-1.689	175
Namibia	59.7	135	Turkmenistan	-1.817	176
South Africa	59.7	136	Syria	-1.93	177
			Ukraine	-2.124	178

Table A2: Summary Statistics

	Mean	SD	Max	Min
Political Inequality (PI)	**0.057**	0.490	0.490	-0.979
Income inequality (Gini)	**40.454**	3.603	47.3	33.8
GDP per capita (Log)	8962.249	6204.063	27271.86	2267.479
Exports (% of GDP)	55.735	26.458	121.311	19.089
FDI (% of GDP)	31.228	13.367	62.438	3.408
World Bank Loans	3930000000	4750000000	17900000000	0
Oil rents (% of GDP)	2.375	2.534	9.330	0
Democracy score (Polity IV)	1.617	6.740	9	-7

Table A3: Explanations of variables

	Definitions	Sources
Political Inequality	Political inequality index (Power distributed by socioeconomic position)	Varieties of Democracy Database (V-Dem, v9)
Income inequality	Gini coefficient	Standardized World Income Inequality Database (SWIID, v8.1)
GDP per capita (Log)	GDP per capita, PPP (constant 2011 international $)	World Bank (2019b)
Exports	Exports of goods and services (% of GDP)	World Bank (2019a)
FDI	Inward stock of Foreign direct investment (% of GDP)	UNCTAD (2019)

World Bank Loans	IBRD loans and IDA credits are public and publicly guaranteed debt extended by the World Bank Group (DOD, current US$)	World Bank (2019d)
Oil rents	Oil rents are the difference between the value of crude oil production at world prices and total costs of production, which is expressed in term of % of GDP.	World Bank (2019c)
Democracy score	Polity score (Revised Combined Polity Score)	Polity IV Database, Center for Systemic Peace (2019)

HKSYU INTERNATIONAL CONFERENCE: THEORETICAL AND APPLIED ECONOMETRICS

中國與東盟自由貿易協定對兩地區域發展的影響

楊偉文　　上海財經大學金融學院金融學博士研究生[54]

本文嘗試分析「中國與東盟自由貿易協定」對東盟十國政經的影響，利用歷史數據資料建立「中國與東盟政經關係模型」分析中國跟東盟十國的政經關係，模型把中國與東盟十國關係分為「與中國關係良好」，「與中國關係中性」和「與中國關係緊張」三個「關係組別」，透過模型論述自由貿易協定對三組不同組別的東盟國家所受到的影響，評估中國在東南亞未來的政經發展。

關鍵詞：東盟與中國自由貿易協定、中國、東南亞、區域經濟。

The Impact of China-ASEAN Free Trade Agreement on Regional Development

Yeung Wai-man, Raymond　Ph.D. Student, Shanghai University of Finance and Economics, Shanghai, China.

This paper attempts to analyze the influence of the "China-ASEAN Free Trade Agreement" on the political and economic relations of the 10 ASEAN countries through historical data by a quantitative method of hierarchical classification. The state of countries relationship in the China-ASEAN Political and Economic Relationship Model is divided into three groups of "Good", "Neutral", and "Tension". The paper established an analysis framework for the political and economic relationship between China and the 10 ASEAN countries to elaborate on the effect of the free trade agreement (FTA) and assess the future development of the political and economic relationship between Southeast Asia and China.

Keywords: ASEAN-China Free Trade Agreement, China, Southeast Asia, Regional Economy.

[54] 作者通訊處：香港北角，寶馬山慧翠道 6 號，香港樹仁大學研究院大樓高座 434 室，經濟及金融學系；電郵：wmyeung@hksyu.edu.
Correspondence concerning this article should be addressed to Department of Economics and Finance, RHB 434, Research Complex, Hong Kong Shue Yan University, 6 Wai Tsui Crescent, Braemar Hill Road, North Point, Hong Kong, email: wmyeung@hksyu.edu.

前言

根據世界貿易組織 (World Trade Organization, WTO) 的資料顯示，自二次世界大戰結束後，全球區域性經貿合作協定持續增長，由 1948 年開始到 2017 年，總共完成 445 項協定簽訂 (表 1)。1993 年是區域經濟協作的轉捩點，區域貿易協議 (Regional Trade Agreements, RTAs) 急速增加，開啟國際經貿發展的新趨勢，雙邊或多邊的區域性經貿合作成為各國經濟發展的重要策略。

表 1：全球區域貿易協議 (Regional Trade Agreements, RTAs)，1948 – 2017

時期	當期協議數目	累積協議數目
1948 – 1960	3	3
1961 – 1970	2	5
1971 – 1980	10	15
1981 – 1990	10	25
1991 – 2000	69	94
2001 – 2010	215	309
2011 – 2017	146	455

資料來源：世界貿易組織。

到 2019 年，比較重要和規模龐大的區域性自由貿易協議有三個，包括亞太經濟合作組織（Asia-Pacific Economic Cooperation，APEC，下稱「亞太經合組織」）、跨太平洋伙伴全面及進展協定（Comprehensive and Progressive Agreement for Trans-Pacific Partnership，CPTPP，下稱「跨太平洋協定」）和區域全面經濟夥伴關係協定（Regional Comprehensive Economic Partnership，RCEP，下稱「區域全面夥伴協定」）。這三個區域性自由貿易協議有重疊的國家和地區，如澳洲、汶萊、日本、馬來西亞、新西蘭、新加坡和越南等，有些是首次加入大型的區域性經貿協議組織，如柬埔寨、印度、老撾、緬甸等(表 2)。

亞太經合組織成立於 1989 年，總部設在新加坡現在有 21 個成員經濟體。亞太經合組織是經濟合作的論壇平台，其運作是通過非約束性的承諾與成員的自願，強調開放對話及平等尊重各成員意見，並沒有任何貿易經濟條約限制的經貿組織，嚴格上來說，並不屬有關稅協定的自由貿易協定組織。從 1989 年至 2018 年，舉辦了 29 次「領導人非正式會議」和 4 次「部長級會議」，主要集中討論各國關注的國際政經問題，發達國家與發展中國家之間的關稅、經濟合作和技術交流等問題。

跨太平洋協定的前身是由美國總統奧巴馬 (Barack Obama) 於 2010 年積極推動的跨太平洋夥伴關係協定（The Trans-Pacific Partnership，TPP），希望整合太平洋地區的各經濟體，包括發達國家和發展中國家，成為一個包含亞太經合組織和東南亞國家聯盟（Association of Southeast Asian Nations，ASEAN，下稱「東盟」）重疊的經貿協作組織，成為亞太區域內的最具規模的貿易協作組織。但 2017 年 1 月，美國總統特朗普(Donald John Trump) 正式退出協定，餘下的 11 個成員組織體繼續進行協商，並改組為「跨太平洋伙伴全面及進展協定」，總部設於新西蘭。

表 2：各大規模區域性自由貿易組織概要

國家/地區	APEC	CPTPP	RCEP
澳洲	O	O	✓

汶萊	O	✓	✓
柬埔寨	-	-	✓
加拿大	O	O	-
智利	O	✓	-
香港	O	-	-
印度	-	-	✓
印尼	O	-	✓
日本	O	O	✓
老撾	-	-	✓
韓國	O	-	✓
馬來西亞	O	✓	✓
墨西哥	O	O	-
緬甸	-	-	✓
新西蘭	O	O	✓
秘魯	O	✓	-
巴布亞新畿內亞	O	-	-
中國	O	-	✓
菲律賓	O	-	✓
俄羅斯	O	-	-
新加坡	O	O	✓
中華台北	O	-	-
泰國	O	-	✓
美國	O	-	-
越南	O	O	✓
總部	新加坡	新西蘭	-
經濟體成員數目	21	11	16
人口規模 (億)	29	5	34
佔全球 GDP 比率 (%)	60	14	39

註：「O」為已批准加入組織；「✓」為已簽署意向書或協議中；「-」為未有加入組織。

區域全面夥伴協定由東盟十國發起聯合中國、日本、韓國、印度、澳洲、和新西蘭合作推展 16 個經濟體的多邊經貿協定（free trade agreement，FTA），簡稱「10+6」自貿協定。2019 年 9 月，第七屆區域全面夥伴協定的部長級會議在泰國曼谷舉行，9 月中旬，貿易談判委員會會議在越南峴港舉行，就各經濟體的經貿協定進行最後商討，計劃 2020 年 16 個成員國正式簽署協議逐步推行自由貿易協定。

區域全面夥伴協定佔全球國內生產總值 (Gross Domestic Product，GDP) 百分之四十及全球貿易總額約三成；跟另一個正在進行的大型區域自由經貿協定「日本與歐洲經濟夥伴關係協定」（Japan-EU Economic Partnership Agreement，EPA），幅蓋約六億人口，佔全球國內生產總值百分之二十八及全球貿易總額約三成七；成為全球最大規模的兩個區域性自由貿易協議的組織。

「中國與東盟自由貿易協定」是「區域全面夥伴協定」的一個部份，早在 2010 年 1 月啟動，影響中國和東盟的政治和經濟發展。本文透過數據建立模型分析「自由貿易協定」建立前後對中國和東盟的政經關係影響，除了可評估中國與東盟受「自由貿易協定」影響的深度和方向外，更可以藉此進一步了解「自由貿易協定」對區域經濟的影響和發展，如區域全面夥伴協定對成員國之間政經關係影響。

本文分為三節，具體如下：第一節，介紹「中國與東盟的政經關係」模型的構思；第二節，介紹相關指標的數據和資料，說明模型在不同時期，包括「金融海嘯期」(2006 年 – 2008 年)，「金融海嘯後期」(2009 年– 2010 年) 和「中國東盟自由貿易協定 (China-ASEAN FTA) 時期」(2011 年 – 2015 年) 中國跟東盟十國的政經關係變化；第三節，總結有關分析和相關啟示。

中國與東盟的政經關係模型

「中國與東盟政經關係模型」(China-ASEAN Political and Economic Relationship Model，CAPERM，下稱「主模型」) 是分析中國和東盟在經濟和政治關係情況的理論框架，模型由兩組「子模型」構成，分別是「經貿關係模型」(Economic Relationship Model，ERM) 和「政治制約模型」 (Political Constraint Model，PCM)，反映中國與東盟的「利益驅動效應」(Benefit Driven Effect，BDE) 和「價值觀驅動效應」(Value Driven Effect，VDE) 之互動結果[55]。

「經貿關係模型」是分析中國與東盟十國的貿易變所產生的經貿關係評估之工具，由兩個貿易數字組成模型的縱橫兩軸的變量觀察，即「經濟依賴指數」 (Economic Dependence Index，EDI) 和「貿易密切指數」(Trade Intensity Index，TII)。

所謂「經濟依賴指數」是指東盟各國對中國的商品出口佔該東盟成員國的商品出口總額比例，反映中國對該國的商品貿易創匯的影響程度，以對中國商品出口佔全國商品總出口額百分之十為標準水平，高於百分之十為「經濟依賴程度高」，低於百分之十「經濟依賴程度低」 (圖 1)；而「貿易密切指數」是指東盟各國對中國商品進口佔該東盟成員國的商品進口總額比例，反映了該國對中國商品需求的密切度，也影響著該國民生經濟的影響，同樣，以對中國商品進口佔全國商品總進口額百分之十為標準水平，高於百分之十為「貿易密切程度高」，低於百分之十「貿易密切程度低」(圖 2)。

把「經濟依賴指數」和「貿易密切指數」作為縱橫兩軸的量度指標，就構成了「經貿關係模型」框架，按兩軸程度組合分成四個「經貿關係水平」，分為「經貿關係緊密」，即「經濟依賴指數」和「貿易密切指數」均在百分之三十或以上的進出口貿易額水平；次一級為「經貿關係良好」，即「經濟依賴指數」和「貿易密切指數」 不能同時處於百分之三十或以上，而其中一項低於百分之五，另一項必需高於百分之五的貿易水平；再次一級為「經貿關係一般」，即「經濟依賴指數」或「貿易密切指數」其中一項指數低於百分之五的水平，另一項指標需在百分之五至百分之二十九之內；最後一級是「經貿關係薄弱」，即「經濟依賴指數」和「貿易密切指數」均在百分之五以下的進出口貿易額水平。(圖 3)

[55] 關於「利益驅動效應」和「價值觀驅動效應」的概念，參考王嵎生 (2007)，〈變化中的東亞與美國〉，載於黃大慧主編 (2010)，《變化中的東亞與美國：東亞的崛起及其秩序建構》，北京：社會科學文獻出版社，第 8 – 13 頁。

圖 1：經濟依賴指數 (Economic Dependence Index，EDI)

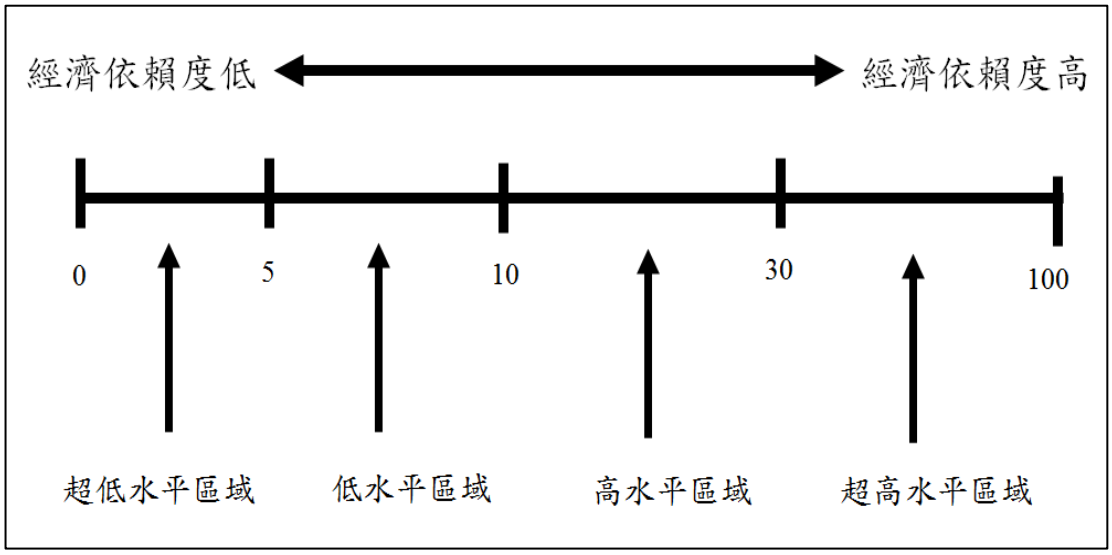


圖 2：貿易密切指數 (Trade Intensity Index，TII)

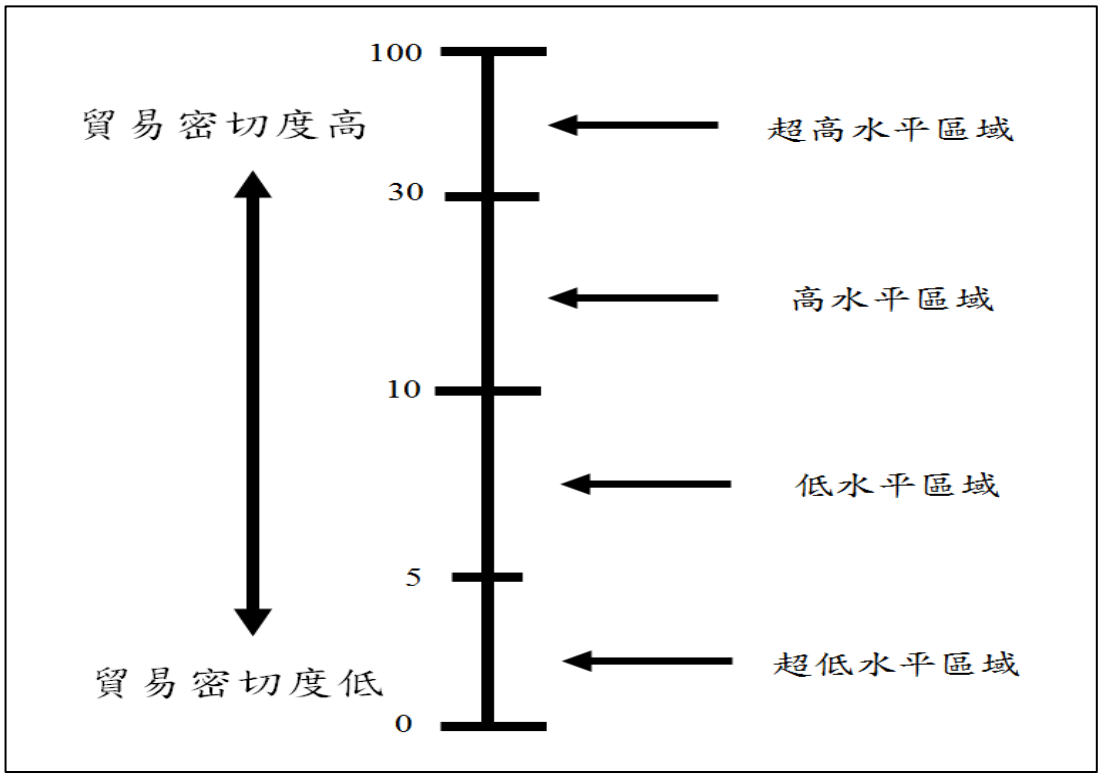
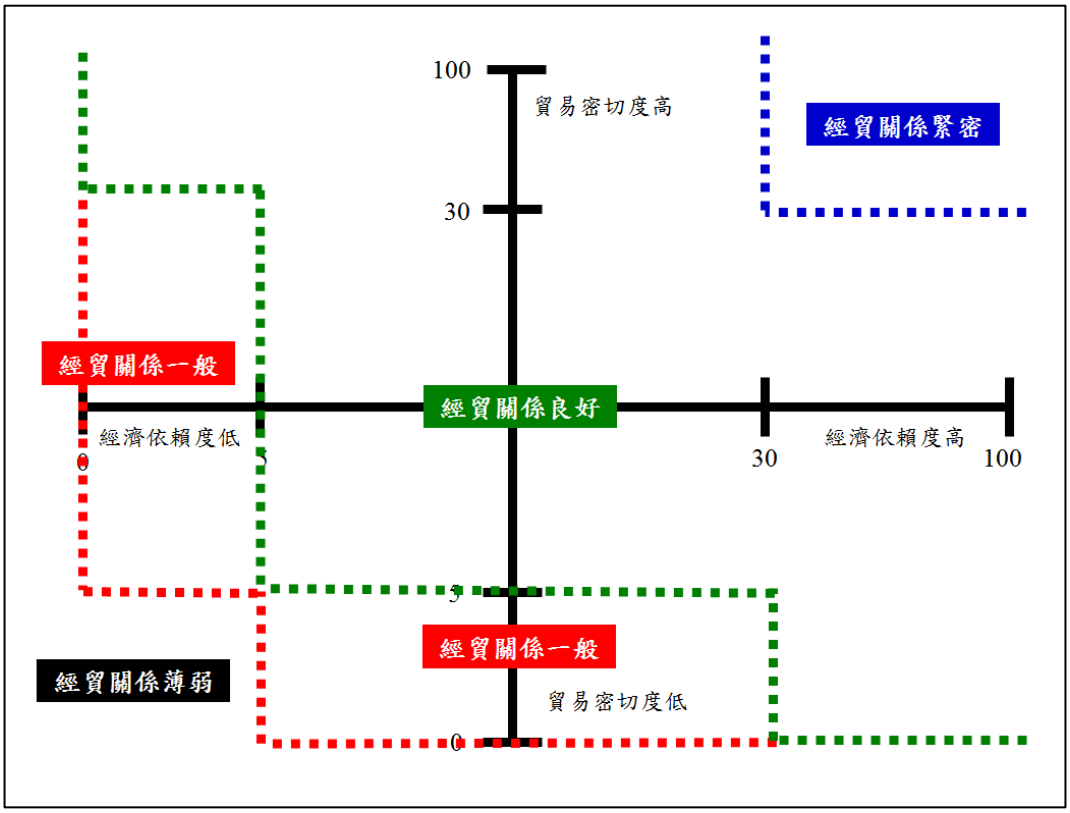
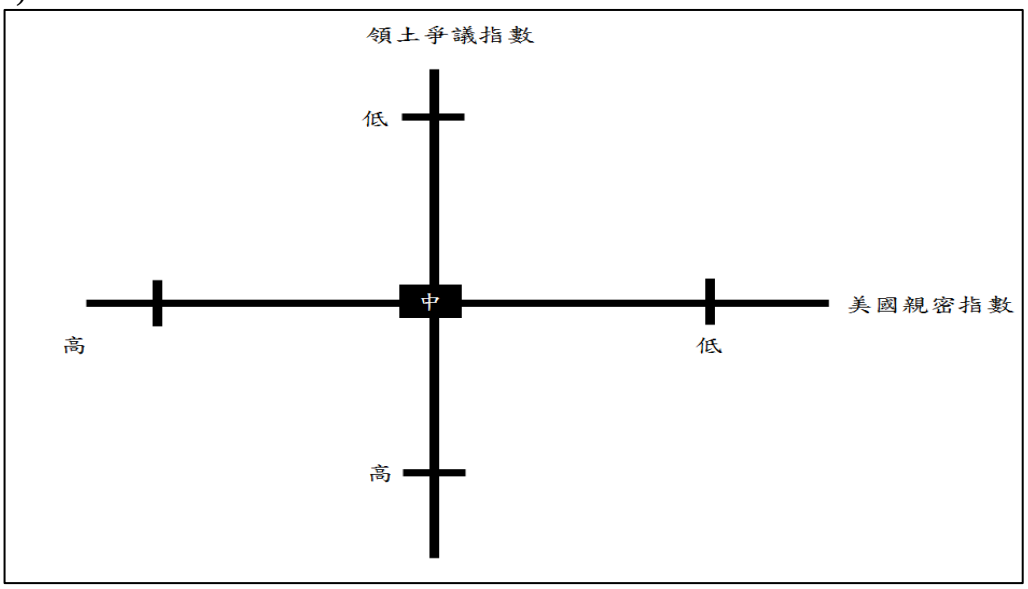


圖 3：經貿關係模型 (Economic Relationship Model，ERM)



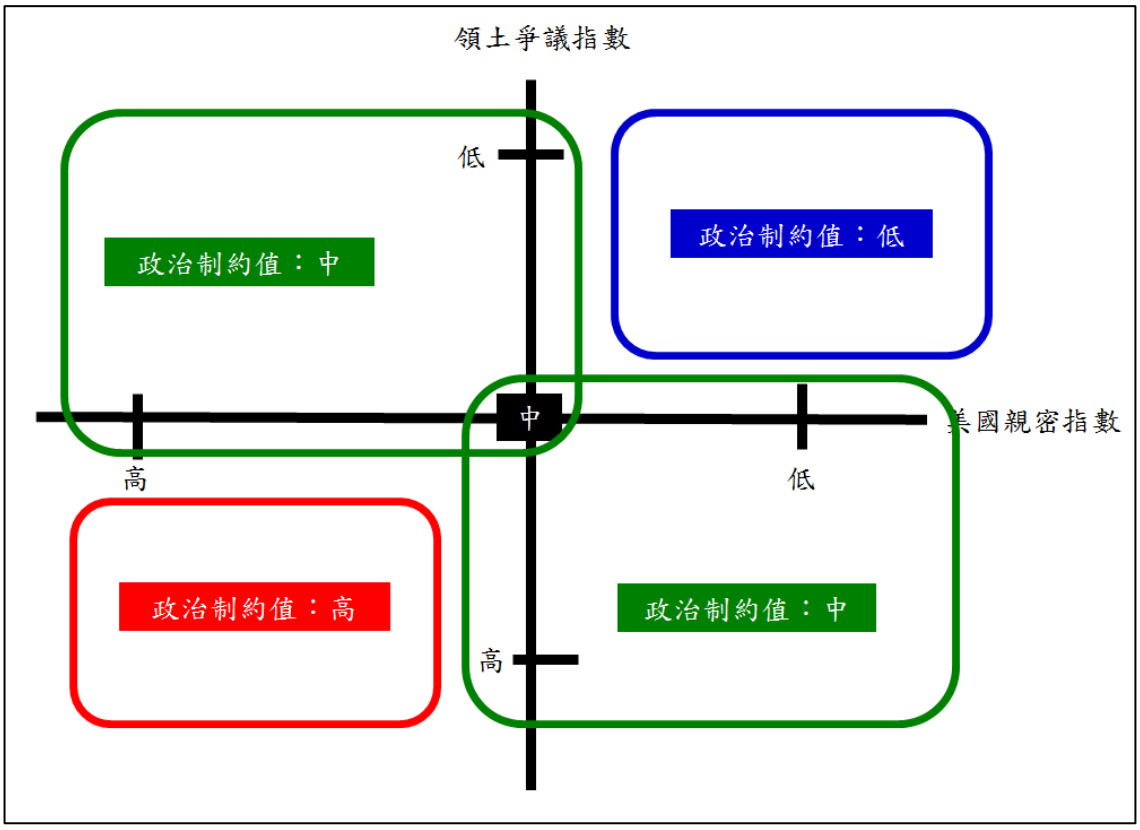
「政治制約模型」是分析東盟十國對中美兩個陣營的外交策略和關係評估工具，由兩個政治因素組成模型的縱橫兩軸的評估指標，即「美國親密指數」和「領土爭議指數」。所謂「美國親密指數」(Pro-US Index，PUSI) 是指東盟十國與美國軍事結盟與中美外交關係情況評級，分為「高、中、低」三級；而「領土爭議指數」(Territorial Dispute Index，TDI) 是指中國跟東盟十國的各項領土或領海的爭議情況評級，也分為「高、中、低」三級。(圖 4)

圖 4：美國親密指數 (Pro-US Index，PUSI) 和 領土爭議指數 (Territorial Dispute Index，TDI)



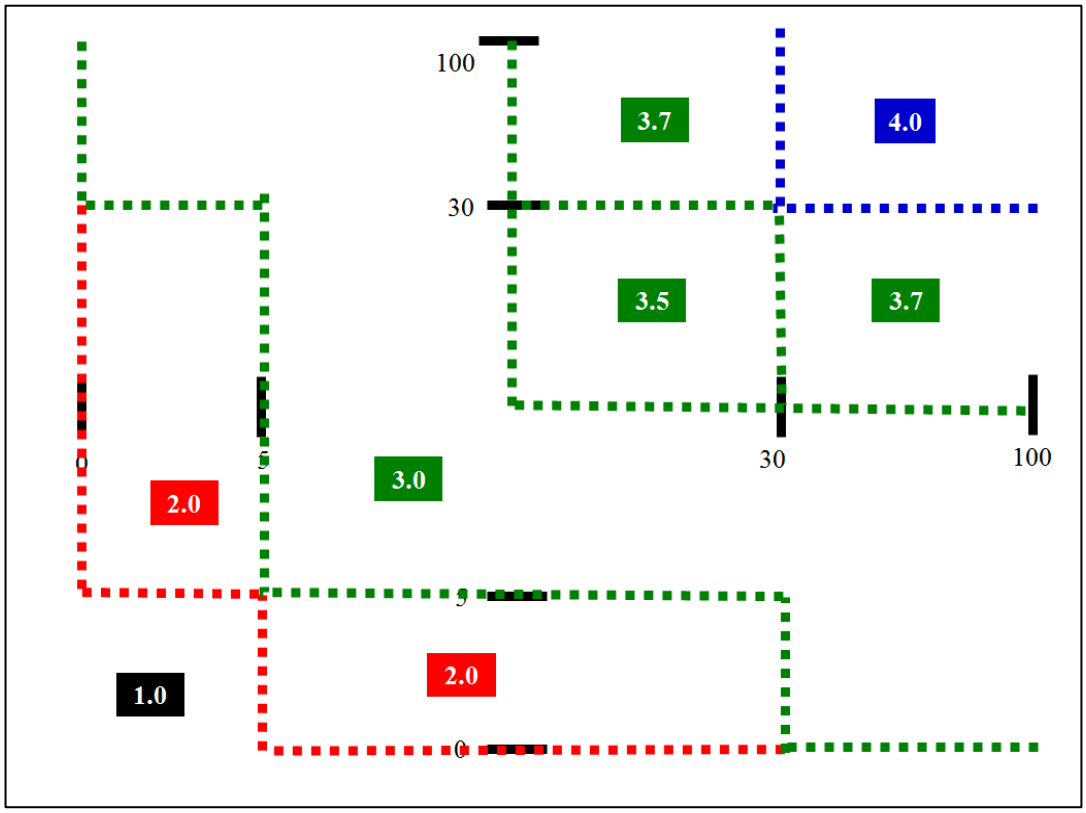
把「美國親密指數」和「領土爭議指數」作為縱橫兩軸的量度指標，就構成了「政治制約模型」框架，反映東盟各國與中國在政治和外交上的制約程度或阻力水平高低，按兩軸程度組合分成三個「政治制約水平」，分為「政治制約程度低水平值」，即「美國親密指數」和「領土爭議指數」均在低水平值；次一級為「政治制約程度中水平值」，即「美國親密指數」和「領土爭議指數」均在中水平值或其中一項在低水平值，最後是「政治制約程度高水平值」，即「美國親密指數」和「領土爭議指數」均在高水平值。(圖 5)

圖 5：政治制約模型 (Political Constraint Model，PCM)



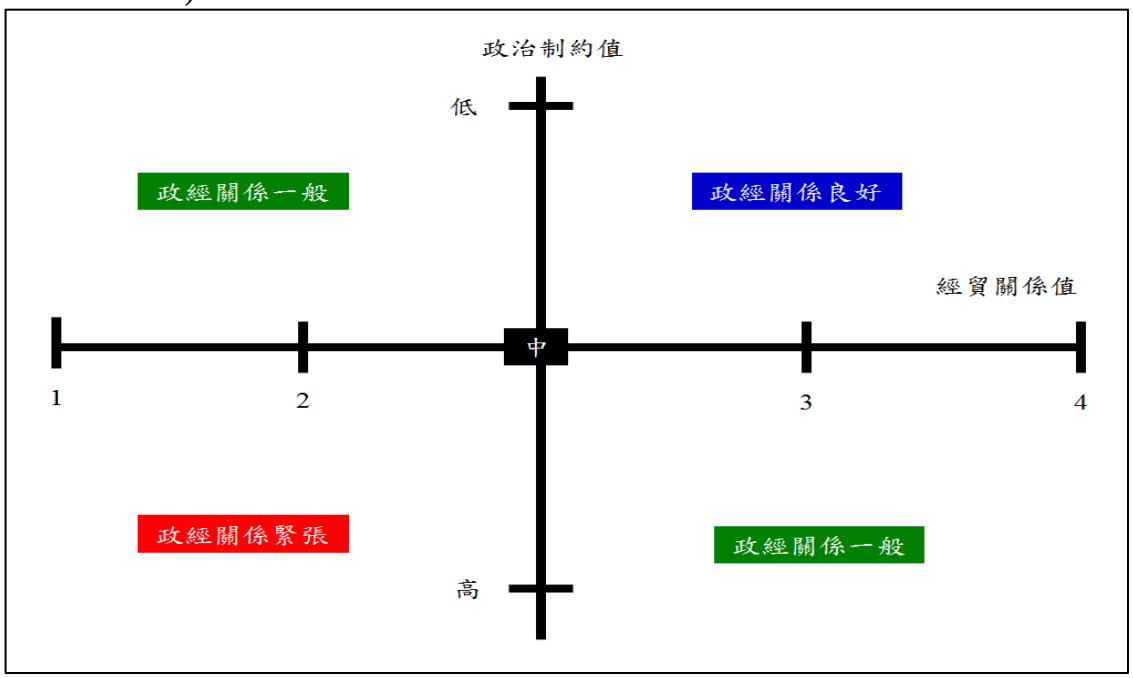
得到兩個「子模型」的評估分析結果，便把兩組評級整合成為主模型，由「經貿關係模型」的「經貿關係值」和「政治制約模型」的「政治制約值」組成模型兩軸的變量指標。其中，「經貿關係模型」的「經貿關係值」再進行級別量化為六級，即「經貿關係緊密」指數為 4.0；「經貿關係良好」分為三級，在「貿易密切指數」或「經濟依賴指數」，其中一項高於百分之三十的水平，「經貿關係指數」為 3.7 (「經貿關係良好」上層位置的一級水平)，兩項指數均在百之十至百分之二十九，「經貿關係指數」為 3.5 (「經貿關係良好」中層位置的二級水平)，而兩項指數的其中一項低於百分之五，另一項指數必需高於百之二十九，或其中一項在百分之五至百分之九，另一項指數至少在百分之五水平，「經貿關係指數」為 3.0 (「經貿關係良好」底層位置的三級水平)；而第五級的「經貿關係一般」指數為 2.0 和第六級的「經貿關係薄弱」為 1.0。(圖 6)

圖 6：經貿關係指數的「六級評分」量表



由「經貿關係模型」的「經貿關係值」和「政治制約模型」的「政治制約值」整合的「主模型」分為三組政經關係情況，分別為「政經關係良好」反映東盟與中國政經關係良好，「政經關係一般」反映中國與東盟的政經關係處於中性水平和「政經關係緊張」反映中國與東盟的關係緊張。(圖 7)

圖 7：中國與東盟政經關係模型 (China-ASEAN Political and Economic Relationship Model，CAPERM)



中國與東盟的政經關係變化分析 2006 - 2015

本文按模型的各項指標代入相關的統計數據和文獻資料分析，分析中國與東盟在 2006 年至 2015 年的十年期間的政經關係變化，並對「自由貿易協定」效益作出評估。

研究採用的數據和資料來源取自兩方面，有關「經貿關係模型」的數據資料來自兩個資料庫，分別是 Observatory of Economic Complexity (簡稱 OEC) 和世界貿易整合數據庫 (World Integrated Trade Solution，簡稱 WITS) 的網上資料庫數據。OEC 是美國麻省理工學院媒體實驗室屬下一個收集整理各項經濟數據的研究小組，有關數據來自法國半官組織的法國國際預測研究中心 (Center for International Prospective Studies, 簡稱 CEPII) 的世界貿易數據庫 (BACI) ，該數據來自聯合國統計處 (United Nations Statistical Division, 簡稱 UNSD)， 而採用 OEC 提供網上數據的主要原因是它能提供最充足有關緬甸的貿易數據，而其他多個國際組織的數據庫都只提供零散有關緬甸的數據。另外，世界貿易整合數據庫 (WITS) 是聯合國(UN) 、世界銀行 (World Bank) 、世界貿易組織 (WTO) 和國際貿易中心 (International Trade Center) 共同開發的全球貿易數據庫。本文收集的貿易數據是現行國際貿易談判和管理主要採用的「國際商品統一分類制度」(Harmonized Commodity Description Coding System，簡稱 HS) 數據類別，覆蓋時段為 2006 年至 2015 年，並把這十年晴間分為三個階段分析，分別是「金融海嘯期」(2006 年 – 2008 年) ，「金融海嘯後期」(2009 年– 2010 年) 和「中國東盟自由貿易協定 (China-ASEAN FTA) 時期」(2011 年 – 2015 年) 。

而有關「政治制約模型」的資料則來自大量不同媒體的相關報導，如香港的《亞洲週刊》和《中美聚焦》 (China-US Focus)、英國的「英國廣播公司」(British Broadcasting Corporation, 簡稱 BBC) 等媒體報導和評論文章，並收集有關學術論文的資料和分析，例如有關領土爭議資料，本文主要參考自胡宗山和巫爽於 2015 年發表在《社會主義研究》的一篇論文〈中國與周邊國家領土爭端研究〉。

有關東盟與中國的雙邊商品貿易數據列於表 3–5，分別顯示東盟各國與中國商品進出口佔該成員國的貿易比重 (列於表 3 和表 4，每個東盟國家第二行數據) 和進出口比重的排名 (列於表 3 和表 4，每個東盟國家第一行數據)。

按表 3 資料顯示，出口去中國比重較大的東盟國家是寮國、緬甸和菲律賓；但是，2015 年菲律賓出口去中國的比重大跌，一年間，比重由百分之二十四下跌至百分之十一，這可能與菲律賓就南海主權爭議向國際海洋法法庭提出仲裁的聽證會有關，也是《南海仲裁案》白熱化的階段，這反映了東盟與中國的經貿關係和領土爭議有著高度相關度和敏感性。

至於進口方面，進口比例較重的東盟國家是柬埔寨、寮國、緬甸和越南，這反映東盟組織內的新興經濟體較依賴中國商品的進口，也利加深中國與東盟的聯繫。從表 4 看到，對中國商品貿易比重較大和較重要的國家則是新加坡、馬來西亞、泰國和越南。

表 3：東盟出口貨品到中國佔該國總商品出口比例及排名，2006 – 2015

東盟十國	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
汶萊	9	6	11	7	5	6	9	10	13	10
	2.50	3.20	0.79	4.00	7.40	4.60	2.60	0.87	1.60	1.52
柬埔寨	12	13	17	17	13	10	11	8	9	6
	0.81	0.91	0.64	0.60	1.50	2.70	2.20	3.10	3.70	4.75
	4	4	3	4	2	2	2	2	2	-

印尼	8.20	8.40	8.50	9.40	10.00	12.00	12.00	13.00	11.00	-
寮國	7	3	3	2	1	1	1	1	1	-
	3.80	7.60	10.00	28.00	36.00	33.00	34.00	32.00	45.00	-
馬來西亞	3	3	4	3	1	1	3	2	2	2
	9.20	8.60	7.90	11.00	13.00	14.00	12.00	13.00	12.00	13.00
緬甸	6	3	3	3	3	3	3	2	1	-
	2.50	6.90	11.00	9.60	12.00	12.00	14.00	26.00	36.00	-
菲律賓	1	1	1	1	1	1	1	1	1	3
	22.00	16.00	14.00	19.00	20.00	20.00	23.00	21.00	24.00	11.00
新加坡	2	2	2	2	1	1	1	2	2	1
	10.00	10.00	9.60	9.90	12.00	12.00	13.00	12.00	12.00	14.00
泰國	3	2	3	1	1	1	1	1	1	2
	10.00	11.00	10.00	12.00	13.00	13.00	13.00	13.00	12.00	11.00
越南	4	4	4	3	3	3	3	2	2	2
	5.50	6.00	5.90	7.30	8.50	10.00	12.00	9.90	11.00	10.00

資料來源：OEC 及 WITS

表 4：東盟自中國進口貨品佔該國總商品進口比例及排名，2006 – 2015

東盟十國	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
汶萊	5	5	4	4	3	2	4	4	3	3
	7.60	6.30	6.00	6.20	14.00	20.00	11.00	13.00	15.00	11.00
柬埔寨	2	3	3	3	3	2	1	1	2	1
	17.00	15.00	14.00	16.00	15.00	22.00	24.00	24.00	22.00	36.00
印尼	2	2	2	2	1	1	1	1	1	-
	11.00	12.00	12.00	15.00	16.00	15.00	16.00	17.00	18.00	-
寮國	2	2	2	2	2	2	2	2	2	-
	12.00	9.10	11.00	15.00	15.00	11.00	17.00	26.00	26.00	-
馬來西亞	3	1	1	1	1	1	1	1	1	1
	12.00	13.00	14.00	16.00	14.00	14.00	16.00	19.00	18.00	19.00
緬甸	1	1	1	1	1	1	1	1	1	-
	35.00	35.00	32.00	37.00	35.00	40.00	37.00	40.00	42.00	-
菲律賓	4	4	4	2	2	1	1	1	1	1
	8.40	8.70	9.30	11.00	10.00	13.00	13.00	15.00	17.00	16.00
新加坡	3	1	1	1	1	1	1	1	1	1
	12.00	14.00	12.00	12.00	12.00	11.00	12.00	12.00	13.00	14.00
泰國	2	2	2	2	2	2	2	2	1	1
	11.00	12.00	12.00	14.00	14.00	14.00	15.00	16.00	18.00	20.00
越南	1	1	1	1	1	1	1	1	1	1
	16.00	19.00	19.00	22.00	23.00	22.00	28.00	28.00	30.00	30.00

資料來源：OEC 及 WITS

表 5：東盟十國佔中國商品貿易比重，2015

東盟十國	出口比例		進口比例	
	名次	比例 (%)	名次	比例 (%)
越南	7	2.91	15	1.49
新加坡	11	2.33	13	1.64
馬來西亞	13	1.94	6	3.17
泰國	15	1.68	9	2.21
印尼	18	1.51	17	1.18
菲律賓	24	1.71	18	1.13
緬甸	37	0.41	42	0.32
柬埔寨	59	0.17	87	0.04

汶萊	101	0.06	128	0.01
寮國	108	0.05	67	0.08

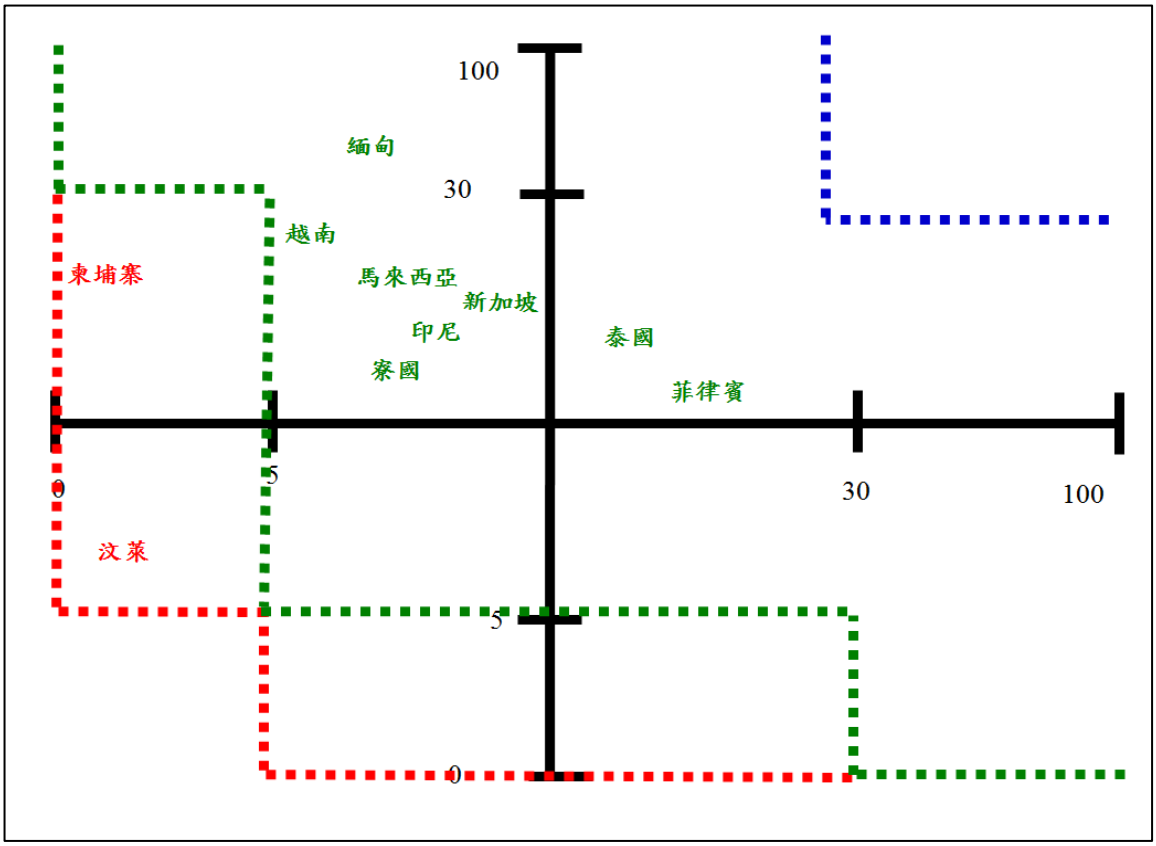
資料來源：WITS

表 6 資料是經加權整理有關數據得出，每時期越早的年份，權重越小，越接近時期尾段的年份，權重則越大，以反映每時期最終的影響和變化，本文並按相關數據繪製了相關經貿關係模型的分析圖解 (圖 8 – 10)。

表 6：三個時期的經濟依賴指數和貿易密切指數變化，2006 – 2015

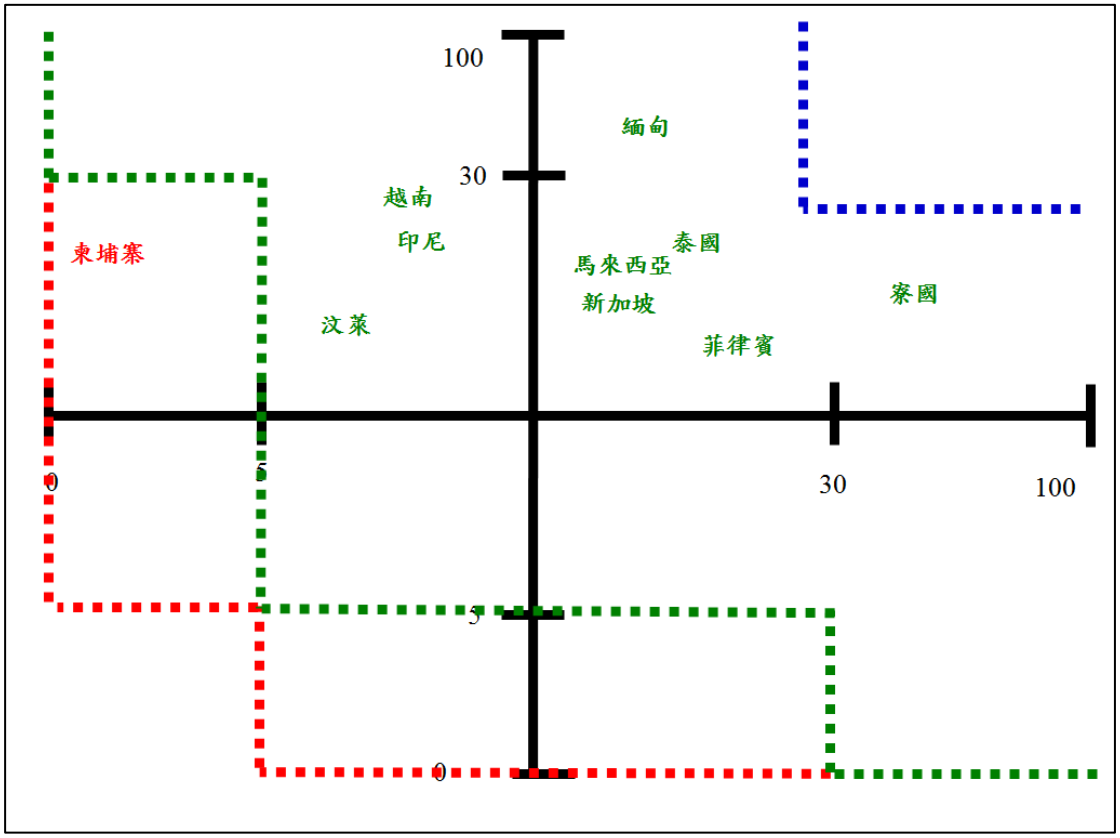
東盟十國	金融海嘯期 2006 - 2008		金融海嘯後期 2009 - 2010		自由貿易協定時期 2011 - 2015	
	依賴指數	密切指數	依賴指數	密切指數	依賴指數	密切指數
汶萊	1.88	6.37	6.27	11.40	1.90	13.27
柬埔寨	0.76	14.83	1.20	15.33	3.51	26.55
印尼	8.42	11.83	9.80	15.67	11.88	16.88
寮國	8.17	10.53	33.33	15.00	37.50	21.88
馬來西亞	8.35	13.33	12.33	14.67	12.64	17.73
緬甸	8.22	33.50	11.20	35.67	25.00	40.00
菲律賓	16.00	8.95	19.67	10.33	19.36	15.27
新加坡	9.80	12.67	11.30	12.00	12.73	12.73
泰國	10.33	11.83	12.67	14.00	12.18	17.27
越南	5.87	18.50	8.10	22.67	10.62	28.55

圖 8：「經貿關係模型分析」：金融海嘯期，2006 - 2008



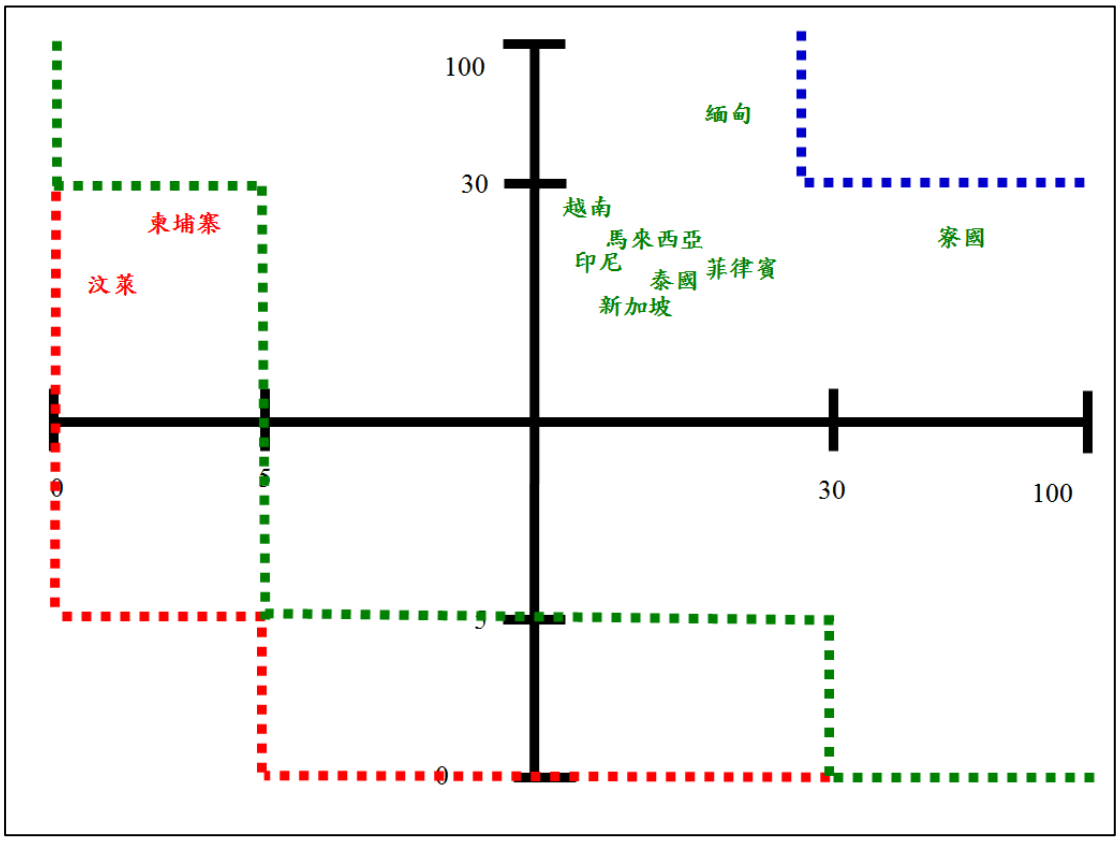
從圖 8 顯示，在金融海嘯期間，大部份東盟成員國與中國的經貿關係已經發展至「良好水平」，與東盟的經貿往還算是密切，其中以緬甸、泰國和菲律賓較為突出，而柬埔寨和汶萊跟中國經貿關係較相對不太緊密。圖 9 顯示的金融海嘯發生後，東盟和中國的經貿關係有明顯變化和移動，而總體移動趨勢是進一步加強與中國的經貿聯繫，而非移到模型左下角，即「經貿關係薄弱」的情況，三個模型結果反映了全球經濟波動和衰退情況下，突出了中國在國際經濟上的優勢，其中變化最明顯是緬甸和寮國，而汶萊則從「經貿關係一般」發展至「經貿關係良好」。

圖 9：「經貿關係模型分析」：金融海嘯後期，2009 - 2010



2010 年，中國與東盟正式啟動「中國與東盟自由貿易協定」(China – ASEAN FTA，簡稱「10+1 自由貿易協定」)，標誌著中國與東盟的自由貿易區(簡稱 10+1 自由貿易區) 成立，並將進步加強中國與東盟各國經貿聯繫往來。根據 10+1 自由貿易協定，中國與東盟創始成員國包括印尼、泰國、菲律賓、馬來西亞、新加坡和汶萊在 2010 年開始撤除九成商品關稅和投資壁壘，其餘四個東盟新興經濟成員國，包括越南、柬埔寨、寮國和緬甸則到 2015 年才調低關稅為零。所以，10+1 自由貿易區對部份東盟國家的影響可能未反映現在數據上。不過，從圖 10 的觀察，比較圖 9 有進一步明顯變化，除了汶萊倒退回「經貿關係一般水平」和柬埔寨沒有很明顯突破外，其他東盟成員國進一步向模型的右上角移動，展示大趨勢是中國和東盟的經貿關係越來越密切，其中緬甸和寮國已經相當接近「經貿關係緊密」區，而餘下的東盟成員國也移動到「經貿關係良好」中層位置的二級水平，反映了 10+1 自由貿易協定的正面且快速的影響力。

圖 10：「經貿關係模型分析」：中國東盟自由貿易協定時期，2011 - 2015



「政治制約模型」由「美國親密指數」和「領土爭議指數」組成。「美國親密指數」是用一側面方法評估東盟國家跟中國在政治和外交上的合作和親密關係，建基於現實的中美在國際政治的角力關係，利用「親中」或「親美」二元概念勾劃出中國在東盟外交關係上的處境有一定的準確性，惟美國在國際上更多軍事聯盟合作，較有利建立相對客觀和具體的參考指標，故以「美國親密指數」反映東盟與中國外交政治關係水平。美國親密指數分三級，建立堅實的軍事合作和採取「親美」外交政策，為指數最高級別；不論是否建立堅實的軍事合作，以採取平衡外交政策，為指數中級水平；沒有與美國建立軍事合作並採取「親中」外交政策或與美國關係有明顯惡化跡象，為指數最低水平。從表 7 顯示，最突出和戲劇性的外交政治關係變化是菲律賓，由指數最高級別下跌至最低級別，但最不反映兩國交惡，只是外交政策可能出現不一致立場和行動，而對另一陣營帶來好處。在十國與中國在外交政治最密切關係應該是馬來西亞，這是在所有資料收集中，唯一個國家有三年的穩定聯合軍事合作記錄。

「領土爭議指數」則按胡宗山和巫爽於 2015 年發表在《社會主義研究》的論文〈中國與周邊國家領土爭端研究〉資料作籃本，再進行網上資料核對整理出表 8 有關中國與東盟各國的領土爭議項目，並分為兩級評估，有領土或領海爭議，指數評為高爭議水平，沒有領土或領海爭議，指數評為低爭議水平。

表 7：東盟跟美國外交關係水平 2016 – 2017

東盟十國	與美國軍事合作	中美外交立場	美國親密指數
越南	-	越南現領導層為「知華派」採取平衡外交政策。	中
新加坡	簽訂《美新後勤設備使用備忘錄》，美軍常駐新加坡樟宜海軍基地。	新加坡李顯龍政府採取「親美」外交政策。	高
馬來西亞	-	馬來西亞與中國自 2014 年開始聯合軍事演習，名為「和平友誼」聯合軍演。	低
泰國	簽訂《美泰共同安全法》，但自 2014 年軍事政變後，每年一度的“金色眼鏡蛇” 軍事演習規模縮小。	2014 年軍事政變後，美泰關係惡化，讓泰國跟中國關係有了發展機會。	中
印尼	-	印尼佐科威政府採用「輕微親中」的平衡外交政策，但美國特朗普禁止伊斯蘭人入境將可能阻礙美印外交發展。	低
菲律賓	簽訂《美菲共同防禦條約》，但軍事合作可能 2018 年停止。	菲總統杜特爾特採取「親中」外交政策。	低
緬甸	-	緬甸吳廷覺政府 (國務資政昂山素姬) 採取「平衡外交」。	中
柬埔寨	-	柬埔寨洪森政府採用「親中」外交政策。	低
汶萊	簽訂《美汶防禦合作諒解備忘錄》	汶萊一直保持中立的平衡外交策略，但美國特朗普禁止伊斯蘭人入境將可能阻礙美國與汶萊的外交發展。	中
寮國	-	寮國常務副總理宋沙瓦・凌沙瓦是「親中派」華裔，傾向「親中」外交政策。	低

表 8：中國與東盟的領土主權爭議

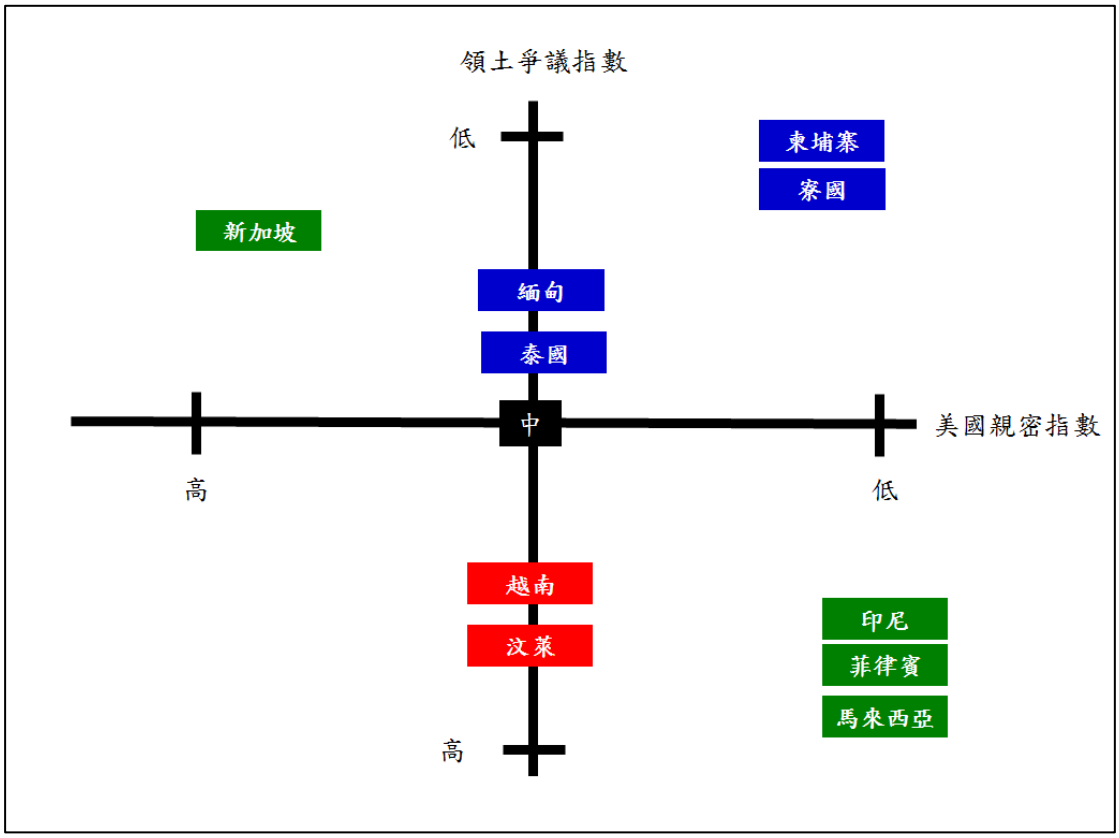
東盟十國	中國與東盟的領土主權爭議	領土爭議指數
越南	西沙群島及南沙群島部份島礁爭議	高
新加坡	-	低

馬來西亞	南沙群島部份島礁爭議	高
泰國	-	低
印尼	南海海洋專屬經濟區爭議	高
菲律賓	黃岩島及南沙群島部份島礁爭議	高
緬甸	-	低
柬埔寨	-	低
汶萊	南沙群島部份島礁及海域爭議	高
寮國	-	低

資料來源：胡宗山，巫爽 (2015)，〈中國與周邊國家領土爭端研究〉，《社會主義研究》，總第 224 期，第 140 – 146 頁。

根據表 7 及表 8 資料，整理出圖 11「政治制約模型」的圖解。圖解結果顯示東盟對中國的「政治制約值」屬於低指數值的國家，包括柬埔寨、寮國、緬甸和泰國，而屬於中度指數值的國家則包括馬來西亞、印尼、菲律賓和新加坡；制約值最高的國家，包括越南和汶萊。

圖 11：「政治制約模型」：東盟與中國政治交外關係 2015 – 2016



最後，本文把圖 8 和圖 11 的資料整合出東盟與中國在金融海嘯前的政經面貌布局 (圖 12)[56]。而整合圖 10 和圖 11 資料得出 10+1 自由協定時期的東盟和中國政經關係布局的情況 (圖 13)。

[56] 嚴格來說，圖 11 反映的是 2015 - 2017 中國與東盟合作的政治制約情況，而圖 8 反映的是 2006 – 2008 東盟與中國的經貿關係，在時間上兩圖並不相同，不應合併兩個「子模型」的結果，但為了比較中國和東盟的政經變化，並考慮除菲律賓外交政策立場出現較大變化之外，其他成員國的外交策略和立場變化並不十分明顯，故合併兩圖解資料作圖 13 的參考點。

圖 12：東盟與中國政經關係 2006 – 2009 (金融海嘯期)

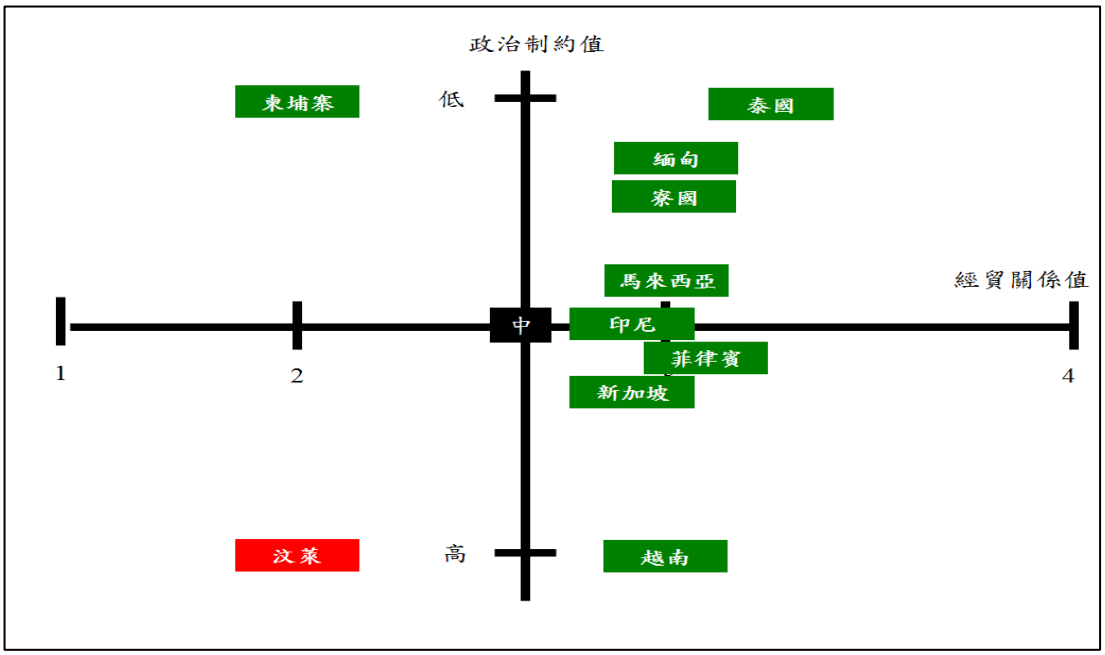
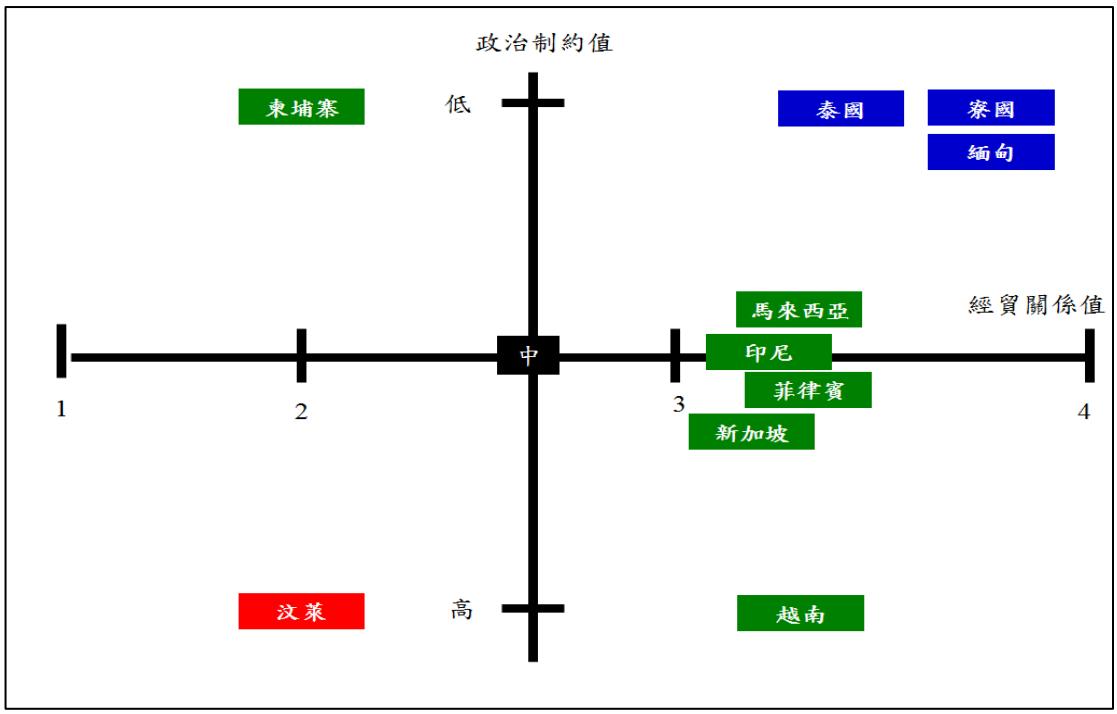


圖 13：東盟與中國政經關係 2011 – 2016 (10+1 自由貿易協定時期)



從圖 12 和圖 13 的比較，我們可以觀察到東盟與中國政經關係發展主要朝向改善雙方合作的方向，這十年間，東盟與中國政經發展改變最大的國家是那些低政治制約值的國家，如泰國，寮國和緬甸，模型結果顯示似乎政治因素比經濟因素對區域政經合作更為重要。

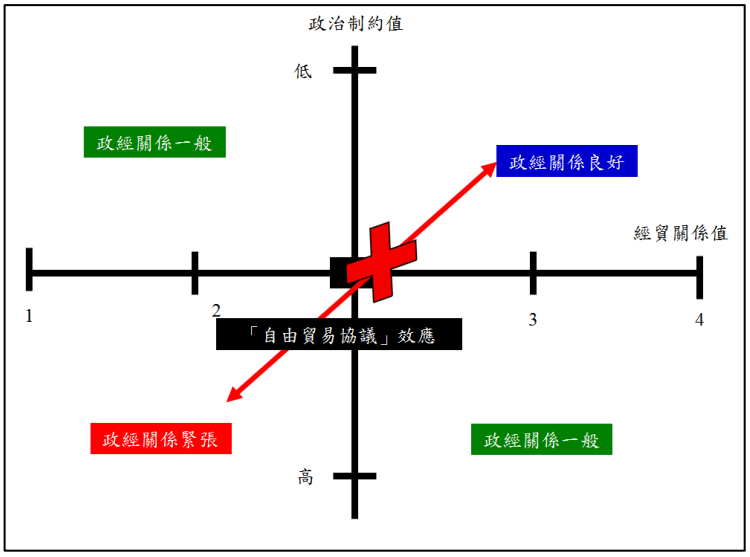
總結

本文的目的是希望透過對中國與東盟的政經關係變化之分析，了解區域政經合作會受甚麼主要因素影響。模型是由反映「利益因素」的「經貿關係值」和反映「意識型態因素」的「政治制約值」組合而成，利用模型對三個時期的「政經關係」變化結果的比較作出影響中國和東盟合作的因子和特徵。本文總結有關分析如下：

從模型的政經關係值變化觀察，本文發現在金融海嘯前時期 (即 2006 年 - 2008 年) 的政治制約值低的國家到「10+1 自由貿易區」時期 (即 2011 年 - 2016 年) 變化相對較大，例如泰國、寮國和緬甸等三個國家，在金融海嘯前時期，政經關係值只是處於一般水平，但到了「10+1 自由貿易區」時期，已經由「政經關係一段」水平上升至「政經關係良好」水平。相反，政治制約值高的汶萊和越南，在 2006 至 2016 這十一年的時間，與中國的政經關係值變化不大。這反映出逐步深化的經貿關係有助帶動外交政治關係進一步親密不是必然結果，也需要一個相當長的時間演變，畢竟「美國因素」是一個相當關鍵和不是東盟國家願意或可以不考慮的因素，當中較特別的例子是菲律賓，由政治制約值高的國家轉變成政治制約值中度水平的國家，令她與中國的政經關係趨向模型的右上角的位置，反映與中國關係有明顯改善。

分析結果顯示，政經關係模型 (主模型) 和 經貿關係模型 (子模型) 均呈現兩個基本趨勢，第一是大部份東盟國家與中國的經濟和政治關係都是趨向緊密和不斷改善，兩個模型的圖解都是往右上角方向移動，反映與中國關係持續改善；第二是所有政經關係變化都不會是簡單正線進行，而是經過一個漸進方法演變 (圖 14) 。

圖 14：政經關係變化不會直線演進



本文相信其他類型的「區域經貿合作協議」跟「10 + 1 自由貿易區」一樣，能帶來更多區域經濟合作機會，進一步加深區域經濟體之間的經貿往來，取得經濟學中「合作分工」和「互補優勢」的效益回報。但是，影響這方面發展始於是複雜的國際政治問題，如 2015 年《南海仲裁案》發展至白熱化階段時，在國際海洋法法庭正式進行仲裁聽證會，帶來中國和菲律賓之間巨大的經貿關係壓力。這反映區域性經貿合作問題，經濟效益絕對不是唯一考慮和影響因素，在國際政治經濟學上，政治因素往往比經濟因素的影響更重，也是傳統經濟學計量模型難以進行準確評估和預測的原因。

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基于协整模型的股票配对交易策略研究

魏霁月

摘要：本文梳理了现有研究文献，理论介绍了配对交易的相关概念以及与之相关的数学模型。随后对上证 50 指数成分股进行传统配对交易策略实测。优化了阈值参数和训练期长度后本文发现优化阈值参数有助于降低交易策略，而训练期长度对改善交易期收益率相关性不大。最后，本文选取 2018 年大盘指数走势不同的三个时间段进行实测，验证了策略的风险中性特点。

关键字： 配对交易 最小距离法 协整模型

1. 引言

2010 年以前，中国 A 股市场只能进行单向交易，股票投资者只能进行单向做多的交易方式。2010 年 3 月起，中国证券市场允许开展融资融券业务和股指期货业务。截至 2019 年上半年，沪深股市融资融券余额为 9108. 17 亿元，融资余额占流通市值 2.04%。
在这一新的交易环境下，源于华尔街的配对交易策略，开始受到中国学术界和投资界的重视，对配对交易策略应用于我国证券市场的研究也相继展开。时至今日，得益于数理金融和计算机的发展，配对交易已经衍生出众多模型和交易规则，并为各种避险基金和股票投资者使用。

配对交易策略有两个关键点：如何挑选股票对和如何制定交易策略。
在配对阶段，实证研究较多的传统方法是最小距离法和协整法。国内外学者对最小距离法和协整法的有效性研究较多。Gatev E et al(2006)以标普 500 指数成分股实证检验了最小距离法能够获得超额收益[1]。Huck N & Afawubo K(2015)以标普 500 指数成分股，实证结果表明基于协整法的配对交易策略有效[2]。Do B & Faff R W(2010)、Hendershott T et al(2011)、Alsayed H & Mcgroarty F(2012)、Liu(2013)等在交易时假设触发阈值就开仓，结果能够获得超额收益[3] [4] [5] [6] [7]。国内学者就两种方法在 A 股市场的有效性进行了研究。崔方达和吴亮（2011）以上证 50 指数成分股，验证了最小距离法能够在 A 股市场获得超额收益且该策略风险较小[8]。雷井生和林莎（2013）以上证超级大盘指数成分股，王春峰等（2013），实证结果表明在 A 股市场按照价差开展配对投资操作能够消除主要的市场风险且持续盈利[9] [10]。

随后，学者们在建立股票对方面对传统方法进行优化，提出混合多阶段配对交易策略或现代算法以挖掘套利机会。Miao(2014)、陈晓芬和杨朝军（2017）结合相关性和协整法，胡伦超等（2016）结合协整法和距离法，研究表明混合多阶段配对交易策略能产生超额收益，且在一定程度上优于单一方法的配对交易策略[11] [12] [13]。郑青青和罗津（2017）对比了相关性和最小距离法在筛选股票对时的优劣，发现相关性适用资金受限时的投资组合，最小距离法适用资金不受限的投资组合[14]。李文等（2015）以日收盘股价的收益率相对波动挑选相关性高且波动大的股票对，实证套利机会后发现可获得超额收益[15]。叶映彤等（2017）以栈式自动编码器挖掘股价相关性中蕴含的套利机会，李兵等（2019）以引入聚类思想的 Elastic-net 算法，实证表明套利算法具有较强的实战价值[16] [17]。

同时，学者们也在寻找更优化的交易策略参数。Triantafyllopoulos K & Montana G(2011)等，认为价差突破阈值只是触发信号，直到价差首次落回 2 倍标准差以内的那日才建仓[18]。Nath(2003)在交易策略中加入止损条件，研究表明改进后的最小距离法能够获得更优的投资收益[19]。Kuo et al (2015)研究了采用背离策略的配对交易的最优平仓点，并用数值分析案例对其结论给出例证[20]。麦永冠和王苏生(2014)对比了触发即建仓、触发后落回 2 倍标准差内建仓、价差折回首日的三种建仓策略，实证验证了相关策略的改进是可以获取超额收益的[21]。陈晓芬和杨朝军（2017）研究发现价格动量能高效地使用资金，均值更新策略增加了原本传统策略中开仓后无法平仓的股票对的套利次数并获得正收益[12]。欧阳红兵和李进(2015)挑选出价差序列满足 AR(1)过程的股票对，证明了最优阈值建仓比设定单一阈值建仓更有效[22]。

2. 配对交易策略相关理论及模型介绍

2.1 配对交易策略定义

配对交易，又称为价差交易或者统计套利交易，是一种风险小、收益较稳定的市场中性策略。一般的做法，是在市场中寻找两只历史价格走势有对冲效果的股票，组成配对，使得股票配对的价差大致在一个范围内波动。一种可能的操作方式是，当股票配对价差正向偏离时，因预计价差在未来会回复，做空价格走势强势的股票同时做多价格走势较弱的股票。当价差收敛到长期正常水平时，即走势较强的股票价格回落，或者走势较弱的股票价格转强，平仓赚取价差收敛时的收益；当股票配对价差负向偏离时，反向建仓，在价差增回复至正常范围时再平仓，同样也可赚取收益。

2.2 配对交易的步骤

配对交易策略的时期分为形成期和交易期。在形成期挑选历史价格走势存在规律的股票对，并制定交易策略；在交易期模拟开仓平仓交易，而后计算收益。

2.2.1 挑选进行配对的股票

运用定性分析的手段，初步挑选好配对的股票池以后，在配对池众多股票对中，挑选股票对的定量方法主要有最小距离法和协整方法。

配对交易的一个选择标准在于寻找历史价差稳定的股票对。为了客观衡量两只股票价格的距离，首先需要对股票价格进行标准化处理。学界和业界认为股票 i 在第 t 天的标准化价格 $\hat{p}_t^i$ 可由这 t 天内的累积收益率来计算，即：

$$\hat{p}_t^i=\sum_{\tau=1}^{t}\left(1+r_\tau^i\right)=\sum_{\tau=1}^{t}\left(1+\frac{P_t^i-P_{t-1}^i}{P_{t-1}^i}\right),t=1,2,3,...,T \quad \text{（公式 3.1）}$$

假设有股票 X 和股票 Y ，则可以计算二者之间的标准化价格偏差的平方和：

$$SSD_{X,Y}=\sum_{t=1}^{T}\left(\hat{p}_t^X-\hat{p}_t^Y\right)^2 \quad \text{（公式 3.2）}$$

选择配对交易股票对另一种常用的方法是选择两只股票价格序列存在协整关系的股票对。金融资产的对数价格一般可以视为一阶单整序列。而股票 X 的对数价格的差分序列可表达如下：

$$\log\left(P_t^X\right)-\log\left(P_{t-1}^X\right)=\log\left(\frac{P_t^X}{P_{t-1}^X}\right) \quad \text{（公式 3.4）}$$

又股票 X 在 t 期的单期简单收益率为：

$$r_t^X = \frac{P_t^X - P_{t-1}^X}{P_{t-1}^X} = \frac{P_t^X}{P_{t-1}^X} - 1 \qquad \text{（公式 3.5）}$$

则：

$$\log\left(P_t^X\right) - \log\left(P_{t-1}^X\right) = \log\left(\frac{P_t^X}{P_{t-1}^X}\right) = \log\left(1 + r_t^X\right) \approx r_t^X \qquad \text{（公式 3.6）}$$

即股票 X 的简单单期收益率序列 $\{r_t^X\}$ 是平稳的。

2.2.2 制定交易策略的开仓信号

基于协整法的配对交易在筛选出股票对并由误差修正模型确立了交易的量化关系之后，就需要明确交易信号，以确定开平仓的时机。运用协整检验选择的股票对，选定新的交易期，设定形成期的价差序列为：

$$Spread_t = \log\left(P_t^Y\right) - \left[\hat{\alpha} + \hat{\beta}\log\left(P_t^X\right)\right] \qquad \text{（公式 3.7）}$$

其中，P_t^X、P_t^Y 是股票 X 和股票 Y 的对数价格；$\hat{\alpha}$ 和 $\hat{\beta}$ 是在形成期对 $\log\left(P_t^Y\right)$、$\log\left(P_t^X\right)$ 进行线性回归得到的系数值。根据 $\hat{\alpha}$ 和 $\hat{\beta}$，可以计算形成期价差 $Spread_t$ 的均值 μ 和标准差 σ，选择均值 μ 加减一定倍数 σ 作为交易期价差的阈值。当 σ 的倍数设定较小时，会频繁触发交易信号，但是赚取的收益较小。当 σ 的倍数设定较大时，会赚取较高收益，然而触发信号则相对较少。

3. 配对交易策略实测

3.1 传统配对交易策略

3.1.1 确定股票对

配对交易策略的第一步是挑选进行配对的股票。本文选择上证 50 指数的成分股作为配对交易的股票池，以 2010 年 4 月 1 日到 2017 年 12 月 31 日为形成期。先对 50 只成分股进行相关性检验，保留相关系数在 0.8 以上的股票对，共 153 对；接着运用最小距离法来挑选可以用于配对交易的股票对，将计算出的 SSD 由小到大进行排序，保留排名前 14 组的股票对作为配对交易策略的股票对。对股票对的对数价格进行的一阶单整检验，以及对 OLS 模型拟合的残差单位根进行的检验结果如表 3.1 所示。

股票 A	股票 B	相关系数	SSD	股票 A 一阶单整检验	股票 B 一阶单整检验	OLS 模型 残差协整检验
北京银行	上海银行	0.9452	2.8112	-19.043***	-16.753***	-1.379
工商银行	建设银行	0.9765	5.7685	-9.144 ***	-7.750***	-3.168**
农业银行	建设银行	0.9639	6.2880	-7.900***	-7.572***	-3.062**
光大银行	中国银行	0.9445	9.7604	-8.582***	-18.426***	-4.162***
农业银行	工商银行	0.9335	10.6603	-7.900***	-15.885***	-2.36
上汽集团	中国太保	0.9193	18.3654	-33.223***	-9.177***	-4.023***
中国人寿	中国银行	0.9252	21.0949	-8.094***	-18.960***	-4.605***

中国太保	建设银行	0.9187	22.3720	-9.177***	-7.750***	-3.768***
交通银行	光大银行	0.9664	24.9484	-8.722***	-8.582***	-5.124***
中国人寿	光大银行	0.9009	29.4151	-8.017***	-8.582***	-3.593***
上汽集团	建设银行	0.9104	33.6632	-33.223***	-7.750***	-3.652***
交通银行	中国银行	0.9444	36.7472	-9.185***	-18.960***	-4.265***
中国人寿	华泰证券	0.9066	38.8601	-8.094***	-39.627***	-3.525***
招商银行	建设银行	0.9271	43.8761	-12.252***	-7.750***	-3.024**

表 3.1 配对交易策略的股票对

可以发现，对股票的价格进行对数处理和一阶差分处理后，均可以在 1%的置信水平下拒绝原假设，即此时价格序列是平稳的。对股票对进行 OLS 模型拟合后得到的残差进行协整检验，最终确定 12 组进行后续配对交易策略。

3.1.2 传统配对交易策略

本文以 2018 年 1 月 1 日到 2019 年 6 月 30 日为交易期，设定开仓和平仓的阈值，以及协整关系可能破裂而强制平仓的阈值。具体交易规则如下：

当价差上穿 μ+1.5σ 时，做空配对股票，反向建仓（卖出股票 B，同时买入股票 A，两只股票的资金比值为 beta）；当价差下穿 μ+0.2σ 时，做多配对股票，反向平仓；当价差下穿 μ-1.5σ 时，做多配对股票，正向建仓（买入股票 B，同时卖出股票 A，两只股票的资金比值为 beta）；当价差又回复到 μ-0.2σ 上方时，做空配对股票，正向平仓；当价差突破 $\mu \pm 2.5\sigma$ 时，及时平仓。

股票 A	股票 B	formStart	训练期收益率	交易期收益率	WinRate	VaR	maxDrawDown
工商银行	建设银行	2010/4/1	0.1309	0.1511	1.00000	0.00563	-0.02185
农业银行	建设银行	2010/7/15	0.0535	-0.0762			
光大银行	中国银行	2010/8/18	0.1456	0.1238	1.00000	0.00665	-0.01846
上汽集团	中国太保	2010/4/1	0.4848	-1.3622			
中国人寿	中国银行	2010/4/1	0.0880	0.1745	0.87500	0.00847	-0.02059
中国太保	建设银行	2010/4/1	0.0797	0.7475	0.88889	0.08405	-0.42834
交通银行	光大银行	2010/8/18	0.0967	0.1245	0.50000	0.00048	-0.00885
中国人寿	光大银行	2010/8/18	0.4426	1.0312	1.00000	0.00464	-0.01364
上汽集团	建设银行	2010/4/1	0.0727	0.1858	0.81818	0.01950	-0.04536
交通银行	中国银行	2010/4/1	0.0483	0.0866	1.00000	0.00515	-0.01314

中国人寿	华泰证券	2010/4/1	0.2150	1.4683	1.00000	0.08547	-0.55303
招商银行	建设银行	2010/4/1	-0.0907	0.0199			

表 3.2 传统策略模拟结果

从策略的收益角度来看，配对交易策略的胜率 winRate 一般维持在 0.8 以上，说明每 10 次交易机会中能够有 8 次获得正收益。从策略的风险角度来看，大部分股票对有 5%的可能在一年半的交易期内损失超过 0.1%，只有两组的可能损失超过 8%；最大回撤 maxDrawDown 基本在 2%左右。对比相同交易期内上证 50 指数的收益率 0.5%，最大回撤 maxDrawDown -0.2885，总体来看，配对交易策略的风险较小。

3.2 优化配对交易策略

3.2.1 优化阈值设置

基于上述结论，文章运用编程语句对各个股票对以 0.1 作为步长遍历 0.0 - 3.0 之间的参数设置，挖掘训练期内的最优阈值设置，结果如表 3.3 所示。从表中可以看到虽然有些股票对的最优阈值不能有效提高交易期收益率，但是通过对比风险指标可以发现，策略的 VaR 和最大回撤 maxDrawDown 有了明显的降低，策略风险变小，仍能获得超额收益。

股票 A	股票 B	formStart	训练期收益率	交易期收益率	WinRate	VaR	maxDrawDown
工商银行	建设银行	2010/4/1	0.2327	-0.0871			
农业银行	建设银行	2010/7/15	0.0826	0.0375	0.88889	0.00769	-0.01953
光大银行	中国银行	2010/8/18	0.2672	0.1004	0.50000	0.00496	-0.01597
上汽集团	中国太保	2010/4/1	0.5010	-1.3622			
中国人寿	中国银行	2010/4/1	0.2685	0.2010	0.91667	0.00728	-0.01841
中国太保	建设银行	2010/4/1	0.0797	0.1041	1.00000	-0.05932	-0.40811
交通银行	光大银行	2010/8/18	0.4848	0.0936	0.50000	0.00532	-0.01039
中国人寿	光大银行	2010/8/18	0.5245	0.9034	0.41667	0.00902	-0.01846
上汽集团	建设银行	2010/4/1	0.0898	-0.0401			
交通银行	中国银行	2010/4/1	0.0555	0.0918	1.00000	0.00711	-0.01840
中国人寿	华泰证券	2010/4/1	0.2810	1.5641	0.66667	0.02342	-0.08456
招商银行	建设银行	2010/4/1	0.2003	2.9891	1.00000	0.01946	-0.56135

表 3.3 优化阈值的模拟结果

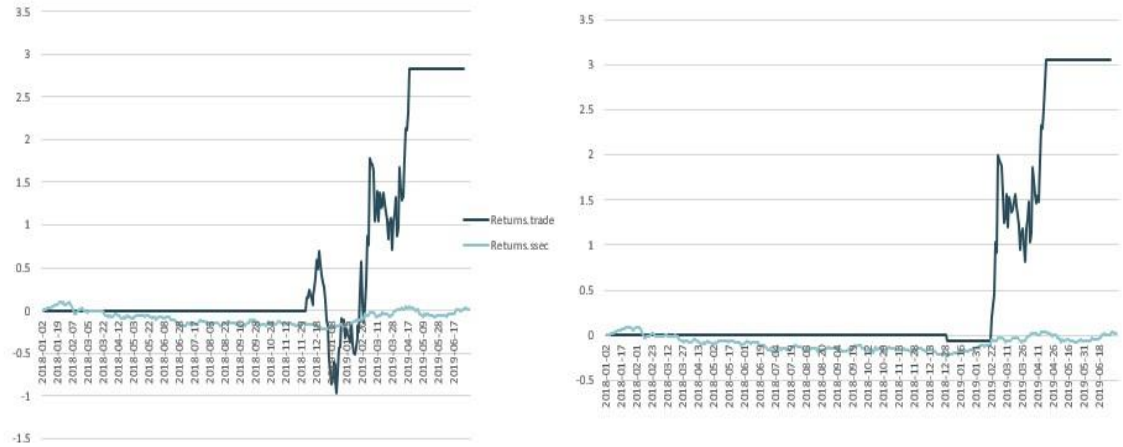

图 3.1 优化策略模拟结果（中国人寿，华泰证券）

选取表现较优的股票对（中国人寿，华泰证券）作图对比指数收益率，可以看出，在优化阈值之后规避了原本有亏损可能的交易信号，策略收益率也因此有所提高，显得更为稳健。

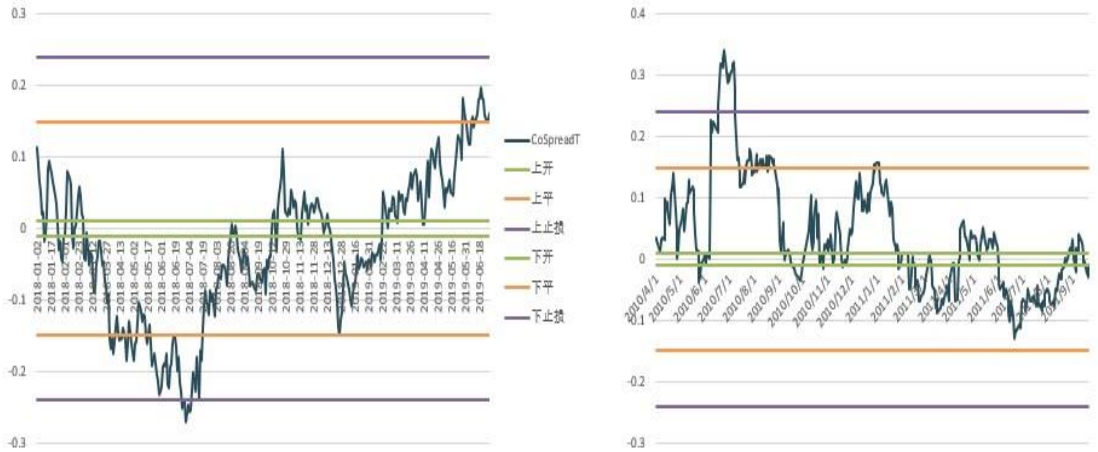

图 3.2 优化策略模拟结果（上汽集团，中国太保）

而表现较差的股票对（上汽集团，中国太保）分属不同行业板块，配对交易收益率较低，作图交易期残差后发现交易期只在两个时间段触发交易，虽然已经采用优化后的阈值，但交易亏损仍太大，第二段交易不足以扭亏为盈。分析交易期残差发现残差走势有触及下平仓线，甚至突破了下止损线，波动较大，而在训练期时残差则向上突破上平仓线，出现收益，所以当训练期的潜在收益转为交易期的潜在亏损时，优化过的阈值也未能有效规避这一风险。

3.2.2 优化训练期长度

基于上述分析，本文提出假设：缩短训练期长度能够更好地预测交易期残差走势，进而提高交易期收益率。本文选取 6 组表现欠佳的股票对，尝试对其改变训练期长度，以不同训练期挖掘出的最优阈值进行交易期策略实测。

排除更改训练期后不满足协整关系的股票对，可以看到缩短训练期后，股票对（上汽集团，中国太保）确实在交易期提高了收益率，但总体而言其他股票对的交易期收益率却没有明显的提高，表明训练期长度与交易期收益率的关系并不显著。

		formStart: 2010-04-01		formStart: 2012-01-01		formStart: 2014-01-01		formStart: 2016-01-01	
股票 A	股票 B	训练期收益率	交易期收益率	训练期收益率	交易期收益率	训练期收益率	交易期收益率	训练期收益率	交易期收益率
工商银行	建设银行	0.1309	0.1511	0.5250	3.5491	0.7579	5.3901		
光大银行	中国银行	0.1456	0.1238	0.0803	0.1226	0.6282	0.1206		
上汽集团	中国太保	0.4848	-1.3622	0.5500	1.5648				
交通银行	光大银行	0.0967	0.1245	0.5463	1.8725	0.7700	0.0925	1.9771	1.2873
中国人寿	光大银行	0.4426	1.0312	0.3896	0.2431	0.7422	-0.0369	1.9936	1.9172
上汽集团	建设银行	0.0727	0.1858	0.3140	0.1838			1.866	-0.2961

表 3.4 缩短训练期的模拟结果

4. 优化交易期长度

最后，本文选取了 2018 年的三个时间段，分别对应上证 50 指数走势上扬、下跌和振荡的三个时间段，讨论配对交易策略在大盘不同走势情况下的收益率。

上证 50 指数 涨	上证 50 指数 跌	上证 50 指数 振荡
tradeStart = ‘2018 - 01 - 01’	tradeStart = ‘2018 - 06 - 13’	tradeStart = ‘2018 - 07-20’
tradeEnd = ‘2018 - 02 - 01’	tradeEnd = ‘2018 - 07 - 11’	tradeEnd = ‘2018 - 09 - 13’
len = 23	len = 20	len = 40
Returns.cumprod = 0.0799	Returns.cumprod = -0.0950	Returns.cumprod = -0.0045

表 4.1 对应股指的交易期

股票 A	股票 B	上证 50 指数 涨 交易期收益率	上证 50 指数 跌 交易期收益率	上证 50 指数 振荡 交易期收益率
工商银行	建设银行	0.3082		
中国人寿	中国银行	0.0194	-0.0214	
交通银行	光大银行	0.0832	-0.0716	0.067
中国人寿	光大银行		0.0699	-0.0268
上汽集团	建设银行		0.1877	

表 4.2 对应股指的交易期模拟结果

采用 2010 年至 2017 年训练期挖掘出的优化阈值实测交易期后，可以看到除了没有触发交易的股票对以外，对比同一交易期内持有期收益率，基本可以验证配对交易策略能够在不同指数走势下获得超额收益，但若要进一步提高收益率则需要对股票对的套利关系进行进一步挖掘。

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