The Hong Kong Polytechnic University

Institute of Textiles and Clothing

Essays in Unit Root Test and Competitiveness: Evidence from China and her Textiles Industry

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CERTIFICATE OF ORIGINALITY

I hereby declare that this is an original work based primarily on my own research and that, to the best of my knowledge and belief, it reproduces no material previously published or written, nor material that has been accepted for the award of any other degree or diploma, except where due acknowledgement has been made in the text.

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ABSTRACT

This thesis comprises four research chapters that examine the issues on economic trends, determinants contributing economic growth, and competitiveness of textile industries in China. ***Chapter 1*** provides a schematic structure of this thesis and summarizes the motives, analytic methods, and empirical findings of the subsequent chapters. The first part of ***Chapter 2*** reviews unit root test methodology in economic analyses. On these premises, I develop two new panel unit root tests, which are found to be more powerful in rejecting false I (1) time series as compared to the performance by univariate Augmented Dickey–Fuller (ADF) test and some of the conventional panel unit root tests. The finite sample performance of the two new panel unit root tests is verified using the Monte Carlo Simulation technique. The methodology purports to analyze the phenomena in China and Hong Kong textiles industry, which will further be articulated in part two of ***Chapter 2.*** The second part in this chapter uses the gravity model to estimate the trade elasticity of China's apparel cottons in the U.S. market for the period between 1989 and 2009. From the gravity model, two phenomena are observed. First, there exists a unique long-run equilibrium relationship among the import quantity demanded, the import price and the U.S. GDP per capita, and second, the import price and income elasticity are significant with expected signs, and those estimated parameters are essential for performing trade–policy analyses.

Chapter 3 comprises macroeconomic discussions, generally divided into two parts. The first part focuses on the tradable goods and financial integration between China and her main trading partners from the empirical perspectives of real interest parity, uncovered interest parity and relative purchasing power parity. Using the two

new panel unit root test I developed in ***Chapter 2***, I confirm that tradable goods and financial integration between China and other trading partners are well established. In confirmation of the integration relationship, the second part examines the growth path dynamics and growth determinants in the Chinese economy using the provincial data. I examine the empirical validity of both beta and sigma unconditional income convergence across Chinese provinces from 1952 to 2005. Using both linear and non-linear panel unit root tests, I find that interprovincial inequalities have been widening since 1978 and such an observation is in line with Pedroni and Yao's (2006) findings. In addition, I examine the determinants of conditional income convergence in China and find that low inflation, better quality of human capital, improvement in transport and telecommunication infrastructures, and trade openness stimulate economic growth in China. Interestingly, the dynamic played by human capital is non-linear in the sense that the growth becomes negative when the human capital are at low levels and becomes positive when the levels are raised to the middle ones.

Chapter 4 is composed of two interrelated studies in firm performance at the microeconomic aspect. The first study focuses on the investigation of interrelationships among firm-related characteristics, business environments and firms' performance in China using survey data obtained by the World Bank. The second one explores the key factors that determine Chinese firm competitiveness in the textile and apparel industries. In the first study, I use a panel data regression technique to identify factors that determine a firm's performance. The first observation is that being a State-Owned Enterprise has no bearing on a firm's performance; however, a firm's age and ownership status does. The second observation is that there exists a positive relationship between a firm's performance and its importation of machinery and equipment for production purposes. The third observation is linked to exporting firms. Literature shows that a firm’s performance is linked to whether or not a firm is performing exporting activities; however, in my observation, this condition does not exist. Probably, this has been so because of a different approach I have taken to categorize the Work Bank data. In the second study, I conduct a survey designed to use productivity, supply-side and demand-side determinants to measure an enterprise’s competitiveness and find that government policies and related industry infrastructures are the most important competitiveness determinants in the textile and apparel industries, followed by domestic demand.

List of Publications

1. Lau, C. K. (2010). New evidence about regional income divergence in China. *China Economic Review,* 21(2), 293-309. [SSCI]
2. Lau, C. K. (2009). A More Powerful Panel Unit Root Test with an Application to PPP. *Applied Economics Letters,* 16 (1), 75–80. [SSCI]
3. Lau, C. K., Mehmet Huseyin Bilgin, (In Press). Export Conditions of the Chinese Textile Industry: An Analysis in Comparison with Selected ASEAN Countries. *Textile Research Journal*. [SCI]
4. Lau, C. K., To, K, M, & Zhang, Z, M., J. Chen (2009). The Determinants of Competitiveness: Observations in China's Textile and Apparel Industries. *China and World Economy,* 17(2), 45–65. [SSCI]
5. Lau, C. K., To, K, M, & Zhang, Z, M. (2008). MFA Fibers and Cotton Imported to The United States from China and Hong Kong – A Structural Change Analysis. *Journal of the Textile Institute,* 99(1), 29–36. [SCI]
6. Lau, C. K., To, K, M, & Zhang, Z, M. (2010). Import Demand Response of MFA Apparel/Non-Apparel Fibers and Cottons in the U.S: A Case of China and HK. *Journal of the Textile Institute,* 101(3), 223-235. [SCI]
7. Lau, C. K. (2010). Convergence across the United States: Evidence from Panel ESTAR Unit Root Test. *International Advances in Economic Research*, 16(1), 52-64. [ECO-LIT]
8. Lau, C. K. (2008). A New Panel Unit Root Test with an Application to a Growth Theory. *Empirical Economics Letters,* 7(1), 110–119. [ECO-LIT]
9. Lau, C. K. To, K, M, & Zhang, Z, M. (2008). Forecasting Monthly Prices and Quantities: A Study of Apparel Cottons Export. *Empirical Economics Letters,* 7(10), 1023–1027. [ECO-LIT]

10. Lau, C. K. (2009). New Evidences about Convergence across States. *International Research Journal of Finance and Economics,* 16 (1), 75–80. [ECO-LIT, SSCI monitored]
11. Lau, C. K. (2010). A Quantitative Assessment of Real and Financial Integration in China – the Markov Switching Approach. *International Research Journal of Finance and Economics*. 39, 121-133. [ECO-LIT, SSCI monitored]
12. Bilgin Mehmet Huseyin, Demir, Ender, Lau, C. K., To, K, M, & Zhang, Z, M. (In Press). The Turkish Handmade Carpet Industry: An Analysis in Comparison with Selected Asian Countries. *Journal of the Textile Institute* [SCI]
13. Bilgin Mehmet Huseyin, Lau, C. K., Manuela Tvaronavičienė (2010). Is China Integrated with Her Major Trading Partners? Evidence on Financial and Real Integration. *Technological and Economic Development of Economy,* 16(2), 173-187. (SSCI)

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In October 2006, I started my part-time PhD candidacy at the Institute of Textile and Clothing, Hong Kong Polytechnic University with my academic background on international economics and time series econometrics, from the Granger School of Economics in the University of Nottingham. This thesis departs from the research interest in literature development of panel unit root tests, destining for the issues on economic growth and competitiveness, and textile trade performance of the Chinese economy. This thesis also illustrates how empirical economics analysis can be benefited from time series econometrics, with special reference to ‘panel unit root test’.

Panel unit root test caught my attention as a meaningful and essential approach to guide the process of implementing empirical analysis. The design for a more powerful unit root is a fairly new and promising research discipline, which, according to my experiences, could contribute a lot to applied economics literatures.

Following this paradigm, I wrote a series of related papers and finally complied this thesis. During the course, I believe I could not have waded through without a number of persons’ supports and encouragement. I would like to give my deepest gratitude to my Chief -supervisor, Dr. Chester To Kin-Man, Assistant Professor of Institute of Textiles and Clothing, and my Co-supervisor, Dr. Zhi-Ming Zhang, Associate Professor of Institute of Textiles and Clothing, for their guidance, unwavering help, constant encouragement, and critical comments on this research project. My deeply appreciation also goes to the dissertation committee for their valuable suggestions that greatly enhanced the quality of my research.

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Last but not least, I wish to dedicate this thesis to my dearest parents, and Galaxy Hung for their invaluable encouragement throughout the years and unlimited support for my study.

Table of Contents

List of Tables

List of Figures

Chapter 1: Introduction

This thesis comprises ***six research works in three chapters*** that examine trade issues in use of new panel unit root tests, and investigate the determinants contributing economic growth and competitiveness in China and Hong Kong; in particular it observes the factors affecting China's apparel cotton trade performance in the US market. Statistical methods applied in this thesis include panel unit root tests, panel cointegration test, factor analysis, and panel data regression.

1.1. Developing new panel unit root tests

This part concerns the development of methodology adopted to observe the captioned phenomena. The seminal work by Nelson and Plosser (1982) about the existence of unit roots in macroeconomic time series has led to a great amount of theoretical and applied research since the 1980s. In the absence of unit roots in a macroeconomic series, two situations will happen: first, mathematically speaking, the data generating process will be stationary and the mean reversion behavior will occur in the sense that the macroeconomic series will fluctuate over time around a constant long-run mean; and second, from the policy point of view, the effects of any economic shocks are only temporary and will dissipate over time.

Scholars recognize and agree on importance of unit root tests in estimating a model and hence the development of more powerful tests is still a fruitful research area because empirical studies may become spurious and meaningless without applying unit root tests to time series data. Unfortunately, it is well known that conventional unit root tests are lack of power in the sense that they incline to accept the null hypothesis of non-stationarity too often when the true data generating process is indeed stationary. The pitfalls of conventional unit root tests come from the fact that they fail to take simultaneously the issue of *contemporaneous correlations* and the features of *non-linearity* among members into account.

In light of such pitfalls of conventional unit root tests, this part sets forth to fill the gap by developing two more powerful unit root tests, taking simultaneously the issue of *contemporaneous correlations* and the features of *non-linearity* among members into account. A detailed literature review on the theoretical and empirical research significance of unit root tests are discussed in this chapter. Two new panel unit root tests are found to be more powerful in rejecting false I(1) time series as compared to the performance by univariate Augmented Dickey–Fuller (ADF) test and some of the conventional panel unit root tests. The finite sample performance of the two new panel unit root tests is verified using the Monte Carlo Simulation technique.

1.2. Export Demand Function of Chinese Textiles Industry: An Analysis in Comparison with Selected ASEAN Countries

The textile and apparel industry has been playing an important role in international business and trade. Many politicians, business practitioners and academic scholars believe in the practice of introducing industrial policies to promote the industry and to use it as the springboard for their economic development journey. The industry employs the largest share of the world's population (Dickerson, 1995) and was considered as the *engine of growth* for developed countries during the Industrial Revolution. Scholars (e.g. Goto, 1989; Cline, 1987) believe that one way to increase economic welfare for developing countries is to encourage the expansion of the textile and apparel industry in domestic and international markets. At present, the industry still contributes significantly to many economies (Abernathy et al., 2004). In 2004, the industry reached a retail value of US$2,378 billion. In 2007, the global textile and apparel industry generated US$583 billion in world exports and accounted for a 4.2 per cent share of global merchandize exports.

However, after quota elimination, there has been a mixed result on export performance for a number of countries and economies (WTO, 2006).[1] China's textile and apparel industry is among the largest and fastest growing exporters of textile and apparel worldwide. The industry accounts for one-fifth of the world's total production. According to the China National Textile and Apparel Council (CNTAC, 2004), total sales of the industries in 2004 amounted to RMB2640 billion, having grown by 22.8 percent from 2003. Relying on relatively low cost and skilled labor, the textile and apparel industry in China is particularly export-oriented. In 2005, textiles and apparel accounted for 11 percent of the total export of the economy and 21 percent of the world's total export value of textiles and garments. In 2005, these industries employed 19 million people in China, including 13.5 million from rural areas. Hence, the textile and apparel industry has become one of the pillar industries of China's economy (Zhang et al., 2004).

In view of the Multi Fiber Agreement (MFA) elimination, many scholars have focused on evaluating the bilateral and global impacts of removing MFA quotas as part of World Trade Organization (WTO) Agreement on the textile and clothing industry.

1 Chinese textile exports grew by 22.8 percent from 2004 to 2005, which accounted for more than 20 per cent of textile trade in 2005. Also, exports from developing countries in Asia (Bangladesh, India, Indonesia, Malaysia, Pakistan and Thailand) grew at between 7 and 15 per cent. Textile exports from Asia to Africa, Europe and North America increased by 14-20 per cent immediately after the quota removal. On the other hand, textile exports from East Asian economies (Hong Kong, Japan, Republic of Korea, and Taiwan) decreased by 3-4 per cent from 2004 to 2005. The EU, the largest textile exporter in the world, also suffered from export loss in both intra and inter markets, amounting to reductions of 7.2 and 3.3 per cent respectively.

Some of them concentrate on tax equivalents of the elimination of quotas restraint (Francois & Spinanger, 2001; Elbehri et al., 2003; Kathuria et al., 2001; Yang et al., 1997). These studies adopt the trade elasticity (i.e. price elasticity and income elasticity) estimated from previous studies in their empirical works. However, there is little research on the estimates of trade elasticity for each and every listed MFA item, which are essentials for evaluating international economic policy analysis. Many empirical studies on international trade require estimates of trade elasticity. For example, the estimated trade elasticity is needed to evaluate welfare effects of trade liberalization, as well as the impacts of currency appreciation on import price and external balance.

In view of this significance, I use the gravity model to estimate the trade elasticity of China's apparel cottons in the U.S. market for the period between 1989 and 2009. I provide a comprehensive, up-to-date and disaggregated set of elasticity estimates using quarterly data for apparel cottons in the U.S. market. The study is more precise than most studies reported in the literature, which adopt aggregated data and yearly data, resulting in loss of informational contents and misleading results. In my empirical examination of the MFA apparel cottons during the years 1989–2009, I apply panel cointegration techniques, error correction approaches, panel estimation methods, and the impulse response function to the U.S.'s import demand function for MFA apparel cottons from China Mainland, Hong Kong and four Association of Southeast Asian Nations (ASEAN) countries. I draw several important conclusions from this study. First, there exists a unique long-run equilibrium relationship among the import quantity demanded, the import price and the U.S. GDP per capita. Second, the import price and income elasticity are significant with expected signs, of which are significant for performing trade–policy analyses. Third, the increasing amount of Chinese MFA apparel cottons export does not threaten the survival of its neighboring countries in the U.S. market.

1.3. A Quantitative Assessment of Real and Financial Integration in China

In the era of globalization, a strong connection with main trading partners and neighboring countries is important for sustained growth and development of the Chinese economy. China became the 143rd member of the World Trade Organization (WTO) on 11 December 2001 and signed the Agreement on Trade in Goods (TIG) with ASEAN countries at the 10th Summit in Vientiane in November 2004, in the hope that closer international trade and investment would occur by removing trade and investment barriers in the global market. The ultimate goal of these policies is to enable Chinese enterprises to become competitive, and China to achieve higher income growth. However, the future performance of the Chinese economy is still uncertain and dependent on how strong the connection China has with her main trading partners and neighboring countries.

There are only several thoroughgoing quantitative analyses focusing on the empirical issues of tradable goods and financial links between separate countries. Cheung et al (2003, 2006) quantifies the degree of integration in capital, financial and goods markets by using the methodology of Augmented Dickey-Fuller (ADF) unit root test. Cheung et al., (2003) studies the real and financial integration among China, Hong Kong, and Taiwan in the period from Feb 1996 to June 2002. They find China and Hong Kong appear to have experienced significant increases in integration. Cheung et al., (2006) extends the study by including Japan and the U.S. and find evidence in favor of tradable goods and financial integration between China and Japan as well as China and the US. Unfortunately, the unit root tests applied in the study are not appropriate in the sense that they ignore the issues of contemporaneous cross-sectional dependence and non-linear dynamic in the arbitrage process and this may lead to misleading conclusions regarding degrees of tradable goods and financial links.

In light of such pitfalls of conventional unit root tests adopted, part one of ***Chapter 3*** sets forth a unit root test that takes into account the non-linearity and contemporaneous cross-sectional dependence as developed in ***Chapter 2*** to examine the degrees of real and financial links. In addition, I extend the geographical coverage to China's four main trading partners and four ASEAN countries[2] such that the study is of current interest to readers in the era of globalization. The empirical evidence suggests that real and financial integration between China and its trading partners are well established. These findings provide supporting evidence in favor of the international competitiveness of the Chinese economy from the perspective of degree of integration in the tradable goods and financial markets.

1.4. New Evidence about Regional Income Divergence in China

The analysis of growth convergence and growth determinants is based on Solow's (1956) model; this neo-classical growth model predicts that a poor economy tends to grow faster than a rich one. On this ground, there are a vast amount of studies devoted to economic growth and convergence (see Baumol, 1986; Barro, 1991; Barro and Sala-i-Martin, 1991; Mankiw, Romer and Weil, 1992; Jones, 1997; Pritchett, 1997 among others). The assumption of diminishing returns is crucial for the convergence hypothesis to hold. This is because economic agents will allocate labor and capital resources across different locations so as to maximize their wealth. As a result,

2 Four main trading partners are the United States, European Union, Japan, and United Kingdom. Four ASEAN countries include Singapore, Thailand, Malaysia, and the Philippines.

differences in returns to labor or capital among different regions will diminish over time. However, I argue in my paper that only when all economies are able to access to the same technology can it eventually leads to convergence in the long-run.

One channel for technology spillover across borders is through the inter-regional trade of manufactured goods and production specialization. Fan (2004) provides a basic analytical framework, which builds on Dixit and Stiglitz' (1977) work. The major theoretical implication of Fan's model is that economies with very different structures will converge to the same equilibrium in the long-run in a non-linear dynamic mean. The model also incorporates the role of product quality and international trade to explain the East Asian miracle and the empirical finding of conditional convergence. In the study, quality is perceived as a superior goods and the demand for it increases with income. His model suggests a conflict in the preference for the ideal quality of consumption between the rich and poor regions. A poor region may choose an "inferior" autarkic production technology so that a greater quantity of "low" quality goods can be produced, subject to a given availability of resources. By making such a trade off, the poor region forgoes the opportunity of joining the "global" markets and catching up with its neighbors through division of labor, production specialization and technology spillover. Therefore, I expect the growth path will be in a non-linear dynamic.

Another endowment for economic growth is human capital. Poor regions will grow eventually when their human capital accumulates over time. When this capital approaches the average levels of other regions, the chance of participating in "global" industrial specialization will occur. I denote a threshold level, "c", of human capital accumulation beyond which the economy will experience a "jump" in its per capita human capital and income and I expect the growth path will again be non-linear.

Thus far, there is no empirical research devoted to studying the possibility of non-linear growth dynamics with regard to the above two aspects. In my studies, I model the growth dynamics of Chinese provinces in such a way that the economy may only experience a high economic growth rate when it reaches the threshold level of human capital accumulation and starts to engage in trade with other regions. I use the ESTAR (i.e. non-linear panel unit root test) model to estimate the growth dynamics across provinces so as to capture the likelihood that the growth rate of different localities will converge provided that they reach the threshold level of human capital accumulation.

The growth path dynamics and growth determinants in the Chinese economy are examined using provincial data. I examine the empirical validity of both beta and sigma unconditional income convergence across Chinese provinces from 1952 to 2005. Using both linear and non-linear panel unit root tests, I find that interprovincial inequalities have been widening since 1978 and such an observation is in line with Pedroni and Yao's (2006) findings. In addition, I examine the determinants of conditional convergence in China and find that low inflation, the quality of human capital, improvement in transport and telecommunication infrastructures, and trade openness stimulate economic growth in China. Interestingly, the dynamic played by human capital is non-linear in pattern in that economic growth becomes negative when the human capital are at low levels and becomes positive when the levels are raised to the middle ones.

1.5. Determinants of Chinese Manufacturing Firms' Performance

Solow's (1956) model concludes that growth rate of output in the long-run depends upon the rate at which technological change occurs. Exports, imports of machinery and capital, and foreign direct investment (FDI) are channels through which technology and hence economic performance can be enhanced. A number of studies document a direct relationship between trade and economic growth using cross-country data[3]. Recently studies find evidence that exporting firms achieve higher productivity than non-exporters[4], and exporting activities Granger-cause productivity[5]. Fan and Hu (2008) examine the relationship between firms' productivity and imports through which technological progress occurred for Chinese enterprises. However, there is lack of literature on comparing the efficiency of different channels on enhancing firms' performance. The study attempts to fill this gap.

In this chapter, I illustrate the interrelationships among firm-related characteristics, business environments and firms' performance in China using survey data obtained by the World Bank. I use a panel data regression technique to identify factors that determine a firm's performance. The first observation is that being a State-Owned Enterprise has no bearing on a firm's performance; however, a firm's age and ownership status does. The second observation is that there exists a positive relationship between a firm's performance and its importation of machinery and equipment for production purposes. The third observation is linked to exporting firms. Literature shows that a firm's performance is linked to whether or not a firm is

3 The relevant empirical literature includes Sachs and Warner (1995), Edwards (1998), and Frankel and Romer (1999).

4 For example, Bernard and Jensen (1999) and Clerides, Lach, and Tybout (1998).

5 See for example, Aw et el., (2008, 2009), Alvarez and López (2005, 2008).

performing exporting activities; however, in my observation, this condition does not exist. Probably, this has been due to a different approach I have taken to categorize the Work Bank data.

1.6. Determinants of Competitiveness: Observations in China's Textile and Apparel Industries

In the era of globalization; China is the unrivalled leader of export growth during the past two decades (Dollar and Kraay, 2003). The researchers argue that openness to foreign trade is not a sufficient condition for sustained GDP growth. They further suggest that, "For China and other developing countries to perform well, *investment climates* are important complements to good macroeconomic and trade policies" (Dollar and Kraay 2003, pp.7). The above suggestions support a need for comprehensive study on the determinants of competitiveness in china's manufacturing industry.

There are uncertainties for China's textile and clothing firms in the post quota-elimination era. China not only needs to sustain her competitiveness and survive in the post-quota regime, but also needs to exploit the opportunities created by the increased competition in the industry. The elimination of quotas leads to an opportunity to increase exports for countries having high competitive power in textile and clothing industry. Competitiveness is a key determinant of a firm's survival in the global market.

Despite the fact that competitiveness has long been a popular topic of discussion in national performance research, comprehensive studies regarding the determinants of competitiveness from the point of view of entrepreneurs' are, however, insufficient. In this discussion I attempt to explore the micro foundations of enterprises' competitiveness by examining the perceived factors of competitiveness among of Chinese textile firms.

I analyze the field survey that uses productivity, supply-side and demand-side determinants to measure enterprises' competitiveness in relation to Chinese textile and apparel firms. The collected survey data is then analyzed using factor analysis to capture the related determining factors indicative of competitiveness at the enterprise level. The survey is conducted with Chinese textile firms located in two regions: the Pearl River Delta at Guangdong and Yangtze River Delta at Zhejiang and Jiangsu, where textile and apparel clusters are significant. In the majority, the enterprises are export-oriented and compete in the worldwide marketplaces. The findings demonstrate that government policies and related industry infrastructure are the most important competitiveness determinants in the textile and apparel industries, followed by domestic demand. This suggests that the improvement of industry infrastructure can foster industry performance and that more resources should be endowed to enhance the domestic business competitiveness of local enterprises. The development of domestic demand will foster the competitiveness of the textile and apparel industries on a more sustainable basis.

Chapter 2: Non-linear panel unit root test and its application，*AND* the export demand function of Chinese Textiles Industry:　An Analysis in Comparison with Selected ASEAN Countries

Part 1- Non-linear Panel Unit Root Test and Its Application

2.1. Introduction

Econometrics always plays an important role in mainstream economics research because it provides a tool for researchers to confirm or reject the refutable implication derived from the economics model. The primary revolution in modeling economic phenomena in past decades is the unit root test developed by Dickey and Fuller (1979), which has both statistical and economic implications in economic modeling, and it has, indeed, many practical uses.

A number of studies provide an introduction to the unit root literature; they include Perman (1991), Campbell and Perron (1991), Dolado et al., (2006). Theoretical papers on the unit root, at a higher technical level, include surveys conducted by Dickey et al., (1986), Elliott et al. (1996), Perron (1988), and Diebold and Nerlove (1988).

The outline of this chapter is as follows. In section 2.2, I define and illustrate the concept of the unit root test and the statistical significance of the unit root test in economic modeling. In section 2.3, an overview of empirical studies involving the use of the unit root test is provided. The related focuses include purchasing power parity, unconditional convergence hypothesis, and financial market bubbles in macroeconomic aspects, while corporate profit persistence and financial leverage mean reversion behavior are the specific areas of application in microeconomic study. All the above applications, indeed, provide us with implications about regional and international competitiveness of the economy. In section 2.4, I study the historical development of the linear panel unit root test, which can take the issue of *contemporaneous correlations* among members into account, with an application to four OECD countries. In section 2.5 I develop a more powerful non-linear panel unit root test, and examine the Purchasing Power Parity (PPP) hypothesis of China's four main trading partners. Section 2.6 discusses some important issues in selecting an appropriate panel unit root test. Section 2.7 closes this paper.

Section 2.8 go 2.13 is devoted to the study of export demand function. Section 2.8 introduces the topic. In section 2.9, the results of previous studies on the import demand function and gravity model are briefly discussed. Section 2.10 and section 2.11 provides econometrics methodology for addressing the issues of estimating trade elasticity. The main findings are presented in section 2.12 and the section 2.13 close the second part.

2.2. Statistical significance of the unit root test

The conventional econometric method employed in testing the relationship between explanatory variable and potential independent variables is ordinary least square (OLS) regression technique. In order to have valid estimates and inference statistics (i.e. mainly t-statistics), researchers need to assume constant mean and variance across the sample, which is the reason for testing autocorrelation and heteroskedacity for the residuals of the estimated model. Variables with the characteristics of time variant means and variances are called non-stationary or unit root variables. When we use the OLS estimation technique to estimate relationships involving unit root variables, we always jump to misleading inferences, and this problem is known widely as the spurious estimation problem, as advocated by Granger and Newbold (1974).

The intuitive explanation for spurious regression is that, if sample means and variances of unit root variables is time dependent, then all the computed summary statistics fail (first, second, and third moment) to converge to their true values, even asymptotically, as the sample size increases. Consequently, the conventional tests of hypothesis and the corresponding test statistics will be seriously biased towards rejecting the null hypothesis (i.e. no relationship between the dependent and independent variable), even if the null hypothesis of no relationship between unit root variables is true. Philips (1986) develops a theoretical model to show that a spurious regression usually includes indicators, for example, high t-statistics and low Durbin-Watson (D-W) statistic[6], whereas low DW statistic indicates variables in the

6 Where large t-statistics indicates high correlation between dependent and independent variables, while DW statistic measures autocorrelation in the residuals.

regression are non-stationary. To illustrate the above significant statistical implication, the author performs a Monte Carlo Simulation experiment[7], as advocated by Granger and Newbold (1974). Suppose an economist has a bivariate normal model as follows:

$$y(t) = \beta_0 + \beta_1 x(t) + \varepsilon(t) \qquad \text{t denotes time.}$$

Where

$$y(t) = y(t-1) + \upsilon(t)$$

$$x(t) = x(t-1) + \mu(t)$$

$\upsilon(t)$ and $\mu(t)$ are both identically and independently distributed.

Apparently, variable y and x has a unit root, which means that the first difference of the variable is stationary[8], and, therefore, $\upsilon(t)$ and $\mu(t)$ are white noise. The steps of experiment are explained as follows:

1).To generate the residual $\upsilon(t)$ and $\mu(t)$ randomly from a normal distribution with mean 0 and variance of 1, and the observations of the artificial time series is set to 100. 2). Run the regression using OLS. 3). Plot the series. 4). Plot the fitting line and show the t-statistic of its slope

In theory, we expect β_1=0 because $\upsilon(t)$ and $\mu(t)$ are randomly generated. However, t-statistic, the coefficient of multiple correlation R^2, and F-statistic all suggest that variable *x (t)* has significant impact on variable *y (t)*. Not surprisingly, variables are highly correlated due to the fact that they both have time trend, not because they have any intrinsic relationship.

7 Monte Carlo experiment is a class of computational algorithms that rely on repeated random sampling to compute their results.

8 "Stationarity" implies constant mean and variance of the variable over time.

2.3. Exemplary Applications of unit root test

The key element presented by the Keynesian and neoclassical macroeconomic archetype is that economic shock (i.e. aggregate demand shock) imposes only temporary fluctuation on the economy, the impulses will die out eventually through time, and the economy will, once again, reach full employment equilibrium sooner or later. If the above assumption about the dynamic of the economy is true, the real output should be stationary.

In contrast, the real business cycle theorists have argued that economic shocks have permanent effect on the output, and have proposed that those fluctuations are caused by shock to the aggregate supply. If the above assumption about the dynamic of the economy is true, then the real output should be non-stationary. In their seminal paper, Nelson and Plosser (1982) finds that most US macroeconomic time series data are, indeed, I(1)[9], and this evidence supports the real business cycle theorists. Nevertheless, the conventional unit root test (i.e. ADF test) used is well known for lacking power against the null hypothesis of having a unit root, and, therefore, there is a vast and growing body of research looking at the development of more powerful unit root tests.

In the following sections, I attempt to illustrate the significance in use of unit root tests in a number of economic phenomena, which include purchasing power parity, unconditional income convergence hypothesis, and financial market bubbles in macroeconomic aspects, while corporate profit persistence and financial leverage mean

9 I(1) data means the time series data needed to be differenced once in order to have constant mean ands variance overtime. In this sense I(1) data is nonstationary in nature.

reversion behavior are the corresponding study in microeconomics. I would further apply the methodology of unit root test for textiles trade elasticity estimation. (See section 2.8-2.13)

2.3.1. Purchasing power parity

Developed by Gustav Cassel in 1920, the idea of purchasing power parity (PPP) is based on the law of one price, in that, in an efficient market, identical goods must have only one price after taking account of nominal exchange rate, and domestic and foreign prices while assuming negligible transaction cost. PPP theory uses the long-term equilibrium exchange rate of two currencies to equalize the purchasing power of two countries. The idea of PPP rests on the competitiveness[10] of a nation because it assumes that nominal exchange rate equalizes the purchasing power of two currencies in the domestic and foreign country with a given basket of goods. It is often used to compare the standards of living between countries, and so it is a common practice, nowadays, to use PPP-adjusted GDP per capita to compare living standards across countries. If PPP holds, then the bilateral exchange rate is proportional to the difference in the inflation rates between two countries.

PPP is regarded as one of the three pillars of international trade and finance; thus, if PPP is invalidated, then previous studies on international trade may be invalid because all the theoretical models are derived under the assumption of PPP being valid.

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10 The Balassa and Samuelson (BS) hypothesis (Balassa (1964), Samuelson (1964)) postulate that countries with faster relative productivity growth in their tradable sector, as compared to that of the non-tradable sector, will exhibit real currency appreciation. Therefore the BS hypothesis implies that economic development and the real exchange rate are closely related because higher treatable sector productivity is normally linked to real GDP growth. Thus it concludes countries with slower economic growth as compared with her trading partners will experience real exchange rate depreciations with respect to her trading partners.

Despite the importance of the concept, researchers still lack consensus with regard to the validity of PPP (Rogoff, 1996; Cheung & Kon, 2000; Taylor & Taylor, 2004). As illustrated in section 2.5.1, using OECD countries, if the observed purchasing power parity differential is found to be stationary, then there is evidence in support of PPP, and vice versa.

2.3.2. Unconditional income convergence hypothesis

The analysis on conditional convergence literature is based on Solow (1956)'s model. This neo-classical growth model predicts that a poor economy tends to grow faster than a rich one. A vast amount of studies (e.g., Baumol, 1986; Barro, 1991; Barro & Sala-i-Martin, 1991; Jones, 1997; Pritchett, 1997) devoted to economic growth and convergence are based on Solow's model. The assumption of diminishing returns is crucial for the convergence hypothesis to hold. Economic agents allocate resources (i.e. labor and capital) across different locations so as to maximize their wealth. As a result, differences in returns on labor or capital among different regions will diminish over time. However, I argue in my paper that only when all economies are able to gain access to the same technology may there be, eventually, convergence in the long-run.

Following Evans and Karras (1996), the term '*income convergence*' may be defined as the convergence of long-run output difference as the forecasting horizon increases. It implies that the per capita GDP of any pair of countries will converge to the same level in the long-run. In statistical terms, the per capita income gap between any two countries must be mean-reverting or stationary, if the conditional income convergence hypothesis is hold.

2.3.3. Financial market bubbles

Explosive bubbles in the financial market rest on the asset pricing theory, which is first proposed by Blanchard and Watson (1983), assuming that investors believe that they can resell the assets, such as stocks, foreign exchange and real estate, at higher prices in the future. The assumption that all investors have rational expectations and symmetric information leads to explosive bubbles, in the sense that the observed price is higher than its corresponding fundamental value. If an explosive bubble in the stock market exists, then the residual from the regression of real stock price on real dividends will be non-stationary. Diba and Grossman (1987), and Campbell and Shiller (1987), using US annual data, test for unit root of the regression residuals and conclude that there is no evidence of speculative bubbles. Fukuta (1996) also argues that, if the first difference of real stock price is stationary, then there are no explosive or speculative bubbles in the stock market. More recently, there are also studies in this area (e.g. Cooper et al., 2001; Ritter & Welch, 2002; Ofek & Richardson, 2003).

2.3.4. Corporate profit persistence

A number of studies on profit persistency have been initiated by the seminal papers of Mueller (1977, 1986, 1990) and Geroski and Jacquemin (1988). With the presence of entry barriers and product differentiation, firms may enjoy excess profit in the short run and, eventually, reach the breakeven point in the long-run. The unit root test has played an important role in testing for profit persistence. A random walk process is confirmed if the profit series is found to be non-stationary, implying that a current return provides most of the information on a future's return, therefore providing evidence for profit persistence.

Geroski (1990) suggests that a firm's profitability growth exhibits persistence over time, while Bektas (2007) finds that profit persistence does not exist in the Turkish banking system because stationarity is found in the dataset. A detailed survey of previous studies is provided by Lipczinsky and Wilson (2001), indicating that the empirical results are mixed.

2.3.5. Financial leverage mean reversion behavior

In corporate finance, the trade-off models propose that the firm will choose the optimal debt-to-equity ratio so as to maximize its value by equalizing marginal benefits of leverage (i.e. tax savings) and marginal costs of leverage (i.e. default costs), as seen in the detailed discussions by Bradley et al., (1984), and Harris and Raviv (1991). In contrast, the pecking order theory, according to Myers and Majluf (1984), suggests that external financing for an investment project is not preferred by the firm due to asymmetric information about the correct value of external funding. Consequently, there is no optimal financial leverage and the firm will always prefer debt financing over issuing new equity, keeping other items constant because the problem of asymmetric information and also the problem of moral hazard are more severe for the later financing channel.

Using the unit root test, the researcher can examine which theory holds by examining the stationarity of the debt-equity ratio. Evidence supports the trade-off model once the debt-equity ratio is found to be stationary, because it suggests that firms will, gradually, adjust to the optimal and constant debt-equity ratio, and shocks are only temporary.

2.4. Development of a more powerful linear panel unit root test

In this section, I would employ Purchasing Power Parity as test bed to evaluate the performance of new developed panel unit root tests. There has been a surge in research into PPP in recent years. For example, Taylor (1988), using the cointegration technique, finds extremely unfavorable evidence against the long-run PPP on five major currencies. Lothian and Taylor (1996) find that the null hypothesis of a unit root cannot be rejected and hence, there is lack of evidence of long-run PPP existing within the Kareken-Wallace two-country overlapping generations (OLG) model. However, Taylor (2003, 2006) provides a comprehensive review on the recent development on long-run PPP, pointing out that the conventional unit root tests are not powerful enough to reject the null hypothesis of a unit root, thus resulting in a misleading conclusion on the long-run PPP. Taylor concludes further that developing more powerful unit root tests has become the focus of a growing body of literature, either by incorporating more information (panel unit root test) or allowing for non-linearity in the adjustment of real exchange rates. The focus of research interest is to develop a more powerful panel unit root test while taking *non-linearity* and *contemporaneous cross-sectional dependence* into account.

2.4.1. Univaraite augmented Dickey-Fuller test

I first employ the annual real exchange rate of four OCED countries as test bed: Denmark, Norway, Netherlands and Spain. All data are collected from International Financial Statistics (IFS) from 1950 to 1995. Real exchange rates are measured in logarithms, such that the series of interest for country i is, at time t,

$$y_{i,t} = e_{i,t} - c_{us,t} + c_{i,t} \qquad t = 1,\ldots,T \qquad \textbf{(2.1)}$$

where $y_{i,t}$ is the logarithm of the real exchange rate against the US dollar, $e_{i,t}$ is the logarithm of the nominal exchange rate against the US dollar, and $c_{us,t}$ and $c_{i,t}$ are, respectively, logarithms of consumer price indices in the US and country i. Let's suppose that the data generating process for real exchange rate has the form:

$$\begin{array}{lllll} y_{1,t} = \alpha_1 + \theta_1 y_{1,t-1} + \sum_{j=1}^{K_1} \delta_{1,j} \Delta y_{1,t-j} + \mu_{1,t} & & & & t = 1,\ldots,T \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ y_{i,t} = \alpha_i + \theta_i y_{i,t-1} + \sum_{j=1}^{K_i} \delta_{i,j} \Delta y_{i,t-j} + \mu_{i,t} & & & & t = 1,\ldots,T \end{array} \qquad \textbf{(2.2)}$$

where K_i is the number of augmenting terms and $\{u_{i,t}\}$ $(i = 1,2..,4)$ are white noise series independently distributed across countries, i.e. $u_{i,t} \sim id(0,\sigma_i^2)$. I rearrange equation (2.2) so that it becomes:

$$\begin{array}{lllll} \Delta y_{1,t} = \alpha_1 + \beta_1 y_{1,t-1} + \sum_{j=1}^{K_1} \delta_{1,j} \Delta y_{1,t-j} + \mu_{1,t} & & & & t = 1,\ldots,T \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ \Delta y_{i,t} = \alpha_i + \beta_i y_{i,t-1} + \sum_{j=1}^{K_i} \delta_{i,j} \Delta y_{i,t-j} + \mu_{i,t} & & & & t = 1,\ldots,T \end{array} \qquad \textbf{(2.3)}$$

where Δ is the first difference operator and $\beta = (\theta - 1)$, since there was no serial correlation detected when one lagged augmentation term was implemented. Also, an additional lag was insignificant at the 10% level, and so, the specification of (2.3) becomes:

$$\Delta y_{1,t} = \alpha_1 + \beta_1 y_{1,t-1} + \delta_1 \Delta y_{1,t-1} + \mu_{1,t} \qquad t = 1,\ldots,T$$

$$\vdots \quad \vdots \quad \vdots \quad \vdots \qquad \vdots$$

$$\Delta y_{i,t} = \alpha_i + \beta_i y_{i,t-1} + \delta_i \Delta y_{i,t-1} + \mu_{i,t} \qquad t = 1,\ldots,T \qquad \textbf{(2.4)}$$

Hence, the null hypothesis and the alternative is:

$$H_{0,ADF,i} : \beta_i = 0\,, \quad H_{1,ADF,i} : \beta_i < 0 \qquad i = 1,\ldots,N \qquad \textbf{(2.5)}$$

Table 2.1 indicates that the unit-root null hypothesis is accepted and hence, the purchasing power parity hypothesis is rejected for all countries. Next, I proceed to examine the two conventional panel unit root tests and their potential weaknesses when applying to empirical studies.

Table 2.1. Univariate Augmented Dickey-Fuller test

Country	β_i	**Test Stat. (p-value#)**
Denmark	-0.06	-1.352 (0.6038)
Norway	-0.054	-1.403 (0.5794)
Netherlands	-0.56	-1.244 (0.6539)
Spain	-0.086	-1.644 (0.4602)

#MacKinnon approximate p-value is used

2.4.2. Conventional linear panel unit root tests

The Im, Pesaran and Shin (IPS) Tests

The Im, Pesaran and Shin (1997) test is based on the mean of the individual ADF t-statistics of each member in the panel. The IPS test assumes that all series are non-stationary under the null hypothesis. In contrast to the LL test, the IPS test assumes that, under the alternative hypothesis, at least one series is stationary. That is:

$$H_{0,IPS}: \beta_i = \beta = 0 \quad (i = 1,2,...,N) \tag{2.6}$$

$$H_{1,IPS}: \beta_i = \beta < 0 \text{ for } i = 1,2,...,N_1 \text{ and } \beta_i = 0 \text{ for } i = N_1 + 1,...,N$$

However, the IPS test fails to take contemporaneous cross correlation among panel members into account, as well as fails to specify which panel members are stationary and which are not.

The Sarno and Taylor tests

Sarno and Taylor (1998) proposed a Multivariate Augmented Dickey-Fuller (MADF) test. The test applies Zellner's Seemingly Unrelated Regressions Estimation (SURE) [11] to equation (2.4) while allowing for contemporaneous cross-sectional correlations across panel members. Under the null hypothesis, all of the series under consideration are realizations of I(1), while under the alternative panel, members are allowed to have different convergent rates. That is:

$$H_{0,MADF}: \beta_i = \beta = 0,$$

$$H_{1,MADF}: \beta_i =< 0 \qquad (i = 1,2,...,N) \tag{2.7}$$

11 SURE is a technique for analyzing a system of multiple equations with cross-equation parameter restrictions and correlated error terms.

The MADF test takes into account the contemporaneous error correlations across panel members, but it provides no information on which panel members are stationary and which are not, due to the restrictive joint hypothesis of the null. Furthermore, even one stationary series inside a panel will lead to a rejection of the null hypothesis.

The Breuer, McNown and Wallance (BNW) tests

Interestingly, all old-fashioned panel data root tests tell the same story, which is when the joint null hypothesis was rejected it implies only that not all countries converge to the long-run hypothesis. Unfortunately, in what we interested is which country converge to PPP and which do not. The BNW test, developed by Breuer et al., (2001), applies the method of SURE to equation (2.4), which allows the autocorrelation coefficient and the lag structure to vary across the panel. The hypothesis is:

$$H_{0,NPUR}:\beta_i = 0, \quad H_{1,NPUR}:\beta_i =< 0 \quad (i = 1,2,\ldots,N) \tag{2.8}$$

Table 2.2 reports the BNW statistics, along with the simulated critical values. It concludes that the null hypothesis is rejected for Norway at the 10% significance level, while Netherlands and Denmark are close to I(0). This finding implies that the PPP hypothesis holds for Norway only.

Table 2.2. BNW test results with simulated critical values

Country	Test Stat.	Simulated Critical Values		
		1%	5%	10%
Denmark	-3.68	-4.78	-4.216	-3.87
Norway	-3.8*	-4.661	-4.024	-3.683
Netherlands	-3.41	-4.721	-4.111	-3.797
Spain	-2.83	-4.343	-3.755	-3.432

* denotes significance at 10% significance level

In what follows, I will provide details of the simulating procedures for critical values, power and size analysis.

2.4.3. BNW test: Critical values

The critical values adopted in Table 2.2 come from 50000 simulations constructed at 1%, 5% and 10% significance levels (one-sided test), and the lower tailed bootstrap critical values are reported in Table 2.3. Critical values must be simulated with error covariance matrix, the coefficients on the lagged difference estimated being based on a I(1) environment (null hypothesis) assuming no drift unit root process. That is:

$$\begin{array}{llll} \Delta y_{1,t} = \delta_1 \Delta y_{1,t-1} + \mu_{1,t} & & & t = 1,...,T \\ \vdots & \vdots & \vdots & \vdots \\ \Delta y_{N,t} = \delta_N \Delta y_{N,t-1} + \mu_{N,t} & & & t = 1,...,T \end{array} \tag{2.9}$$

First, equation (2.9) is estimated applying the Seemingly Unrelated Regression Estimation (SURE) technique. The estimated vector of parameters such as $\hat{\delta}^{H_0,Hist}$ and $\hat{\mu}^{H_0,Hist}$ is gathered and the null variance-covariance matrix $\hat{\sum}^{H_0,Hist}$ of

$\hat{\mu}^{H_0,Hist}$ is constructed. A vector of uncorrelated artificial error terms (NxT), $\hat{\mu}^{H_0,Ran}$ is randomly drawn, such that $\hat{\mu}^{H_0,Ran} \sim N(0,1)$. The Cholesky decomposition of the null variance-covariance matrix $\hat{\Sigma}^{H_0,Hist}$ produces the lower-triangular (square root) matrix L, such that $LL' = \hat{\Sigma}^{H_0,Hist}$. Hence the cross-correlated artificial vector of residuals can be generated as: $\hat{\mu}^{H_0,Sim}$=L$\hat{\mu}^{H_0,Ran}$ Next, y_t*, the first differenced artificial series is generated as:

$$\begin{array}{llllll}
\Delta y_{1,t}^{*} = \delta_1^{H_0,Hist} \Delta y_{1,t-1}^{*} + \mu_1^{H_0,Sim} & & t = 1,\ldots,T \\
\vdots \quad \vdots \quad \vdots \quad \vdots & & \vdots \\
\Delta y_{i,t}^{*} = \delta_i^{H_0,Hist} \Delta y_{i,t-1}^{*} + \mu_i^{H_0,Sim} & & t = 1,\ldots,T
\end{array} \qquad \textbf{(2.10)}$$

To minimize the effect of sensitivity on initial conditions, 96 observations are generated for each variable, with the first 50 observations deleted, leaving us with 46 usable observations. The initial values for each simulated series are set to zero. That is:

$$\Delta y_{N,t-j}^{*} = 0,\ \ y_{N,t-j}^{*} = 0 \ \ (\text{for } \ t - j \le 0), \text{ and } \ \Delta y_{N,1}^{*} = \mu_{N,1}^{H_0,Sim} \qquad \textbf{(2.11)}$$

Finally, I need to generate the level artificial series as:

$$\begin{array}{ll}
y_{1,t}^{*} = \Delta y_{1,t}^{*} + y_{1,t-1}^{*} & t = 1,\ldots,T \\
\vdots \quad \vdots \quad \vdots & \vdots \\
y_{i,t}^{*} = \Delta y_{i,t}^{*} + y_{i,t-1}^{*} & t = 1,\ldots,T
\end{array} \qquad \textbf{(2.12)}$$

With these 50000 bootstrap series I can obtain the bootstrap estimates, such as $\hat{\alpha}^{*}, \hat{\beta}^{*}, \hat{t}_{\beta}^{*NPUR}$, after estimating model (2.4).

2.4.4. BNW test: Power and size analysis

I examine the power and size properties of the BNW test through Monte Carlo Simulations. Power test and size test are based on 50000 replications. In the power simulation, the 'true' values of the intercept and the variance covariance matrix used are $\hat{\alpha}^{Hist}$ and $\hat{\Sigma}^{Hist}$, which are available immediately after estimating equation (2.4). A vector of uncorrelated artificial error terms (NxT), $\hat{\mu}^{Hist,Ran}$ is drawn randomly, such that $\hat{\mu}^{Hist,Ran} \sim N(0,1)$. The Cholesky decomposition of the full sample variance-covariance matrix $\hat{\Sigma}^{\mathrm{Hist}}$ produced by the lower-triangular (square root) matrix S, such that SS'=$\hat{\Sigma}^{\mathrm{Hist}}$. Hence, the cross-correlated artificial vector of residuals can be generated as:

$$\hat{\mu}^{P,Sim} = \mathrm{S}\,\hat{\mu}^{Hist,Ran}$$

Next, the I(0) level series is generated by setting the AutoRegresive coefficient to 0.95 so that:

$$\begin{array}{l} y^P_{1,t} = y^P_{1,t-1} + \hat{\alpha}^{Hist}_1 - 0.05 y^P_{1,t-1} + \sum_{j=1}^{K_1} \delta^{Hist}_{1,j} (y^p_{1,t-j} - y^p_{1,t-j-1}) + \mu^{P,Sim}_{1,t} \\ \quad \vdots \qquad\qquad \vdots \qquad\qquad \vdots \qquad\qquad \vdots \\ y^P_{N,t} = y^p_{N,t-1} + \hat{\alpha}^{Hist}_N - 0.05 y^P_{N,t-1} + \sum_{j=1}^{K_1} \delta^{Hist}_{N,j} (y^p_{N,t-j} - y^p_{N,t-j-1}) + \mu^{P,Sim}_{N,t} \qquad t = 1,...,T \end{array} \tag{2.13}$$

The initial values for each simulated series are, as before, set to zero. Finally, the first differenced series is obtained by:

$$
\begin{array}{ll}
\Delta y_{1,t}^{P} = y_{1,t}^{P} - y_{1,t-1}^{P} & t = 1,\dots,T \\
\vdots \qquad \vdots & \vdots \\
\Delta y_{N,t}^{P} = y_{N,t}^{P} - y_{N,t-1}^{P} & t = 1,\dots,T
\end{array}
\qquad \textbf{(2.14)}
$$

The size test is similar to the power test except by setting the AR (1) coefficient[12] to a unit root, that is, makes it 0 instead of -0.05 in model (2.13). As usual, 96 observations are generated for each variable, with the first 50 observations deleted to avoid sensitivity to initial conditions, which ends up with 46 usable observations. Table 2.3 reports the power and size results for the single ADF and BNW tests. Size and power of the test are determined by the rejection rate of the unit root null hypothesis using 5% critical values. A lower rejection rate leads to better size behaviour, while a higher rejection rate leads to more power gains.

Table 2.3 . Empirical Size/Power of ADF & BNW tests

Country	Size		Power	
	ADF	BNW	ADF	BNW
Denmark	0.0440	0.0526	0.1374	0.3628
Norway	0.0462	0.0550	0.1452	0.3634
Netherlands	0.0444	0.0494	0.1246	0.2914
Spain	0.0492	0.0596	0.1482	0.3186

12 This coefficient measures the degree of a time series data of current period exhibits cause and effect relationship with its one-step ahead time period data.

2.4.5 LAULIN test

In this section, I introduce an alternative method, Lau's linear panel unit root (LAULIN) test as introduced by Lau (2009). This modification makes use of the bootstrapping method, instead of simulation. Unlike equation (2.12), I generate

$$\hat{\varepsilon}_{1,t}^{H_0,Hist} = L^{-1}\hat{\mu}_{1,t}^{H_0,Hist} \quad \textbf{(2.15)}$$

where $E(\hat{\varepsilon}_{1,t}^{H_0,Hist}\hat{\varepsilon}_{1,t}^{H_0,Hist}{}') = S^{-1}\hat{\mu}_{1,t}^{H_0,Hist}\hat{\mu}_{1,t}^{H_0,Hist}{}'S^{-1}{}' = S^{-1}\hat{\Sigma}^{H_0,Hist}S^{-1}{}' = I$

I next bootstrap $\hat{\varepsilon}^{H_0,Hist}$ to get $\hat{\varepsilon}^{H_0,Hist*}$ and then obtain

$$\hat{\mu}_{1,t}^{H_0,Hist*} = S\hat{\varepsilon}_{1,t}^{H_0,Hist*} \quad \textbf{(2.16)}$$

where $E(\hat{\mu}_{1,t}^{H_0,Hist*}\hat{\mu}_{1,t}^{H_0,Hist*}{}') = SS' = \hat{\Sigma}^{H_0,Hist}$

Finally, I use $\hat{\mu}_{1,t}^{H_0,Hist*}$, instead of $\hat{\mu}_{1,t}^{H_0,Sim}$, to generate y* series. Table 2.4 reports the test statistics and critical values of this modified test. When compared with the BNW test, it is concluded that Denmark and Norway are stationary, while Netherlands and Spain are non-stationary. Furthermore, this modified test performs better than the BNW test in terms of power and size properties on average, as shown in Table 2.5.

Table 2.4. Modified test results with simulated critical values

Country	Test Stat.	Simulated Critical Values		
		1%	5%	10%
Denmark	-3.68*	-4.494	-3.705	-3.323
Norway	-3.8*	-4.643	-3.957	-3.595
Netherlands	-3.41	-4.75	-4.048	-3.672
Spain	-2.83	-4.444	-3.773	-3.416

* denotes significance at 10% significance level.

Table 2.5. Empirical Size/Power of ADF & Modified test

Country	Size		Power	
	ADF	LAULIN	ADF	LAULIN
Denmark	0.044	0	0.1374	0.999
Norway	0.0462	0	0.1452	0.999
Netherlands	0.0444	0	0.1246	0.186
Spain	0.0492	0	0.1482	0.999

In this section, I present the BNW test and the new linear panel unit root test developed by Lau (2009). It overcomes the pitfalls of old-fashioned panel unit root tests and makes it possible for researchers to test individual series for a unit root while taking contemporaneous cross-sectional dependence into account by avoiding the drawing of conclusions about only the panel as a whole.

I perform a single ADF test and several old-fashioned panel data unit root tests on the logarithms of the real exchange rates of four OECD countries. The conventional ADF test rejects the unit-root null hypothesis for all countries, implying that none of them converge to long-run PPP. Moreover, conventional panel data unit root tests are not able to differentiate which countries converge to long-run PPP and which do not. The only conclusion they reach is that all countries, as a whole, do not converge to long-run PPP. However, the BNW test reveals that Norway converges to long-run PPP. Moreover, the LAULIN test concludes that, except Spain and Netherlands, other currencies are stationary. I also demonstrate, through the Monte Carlo Simulation experiment, that Lau's test gains additional power over the single ADF test, and BNW test on average with satisfactory size behavior at negligible computational expense.

2.5. A more powerful non-linear panel unit root test

Pesaran (2007) develops a simple linear panel unit root test called cross-sectionally augmented ADF statistics (CADF), which takes into account cross-sectional dependence across panel members. It is also shown that the individual CADF statistics are asymptotically similar and do not depend on the factor loadings.

There is a growing body of literature on the study of non-linear adjustment of macroeconomic variables. The equalization dynamics of prices of goods and factors of production follow a non-linear dynamics, as shown by many researchers (e.g. Michael et al., 1997; Taylor et al., 2001; Sarno et al., 2004). These models suggest that exchange rate adjustment follows a non-linear path due to the existence of "bands of inaction" in the exchange rate adjustment process. Within the bands, arbitrage of tradable good is not profitable because transaction cost (i.e. the sum of transportation cost, cost of trade barriers, and distribution cost) is greater than the price difference (Krugman, 1993).

Fan (2004) shows that, theoretically, the growth path of a developing economy may exhibit non-linearity. In the same fashion, Lau examines empirically whether the regional growth dynamics in China (Lau, 2010a) and United States (Lau, 2010b) follow a non-linear path, and the economy may only experience a high growth rate when it reaches the threshold level of human capital accumulation and starts to engage in trade with other regions. I adopt the Exponential Smooth Transition Autoregressive (ESTAR) model to specify the nonlinear growth dynamic across regions so that it can capture the likelihood that the growth of different regions will converge only if the region reaches a threshold level of growth rate.

2.5.1 Traditional non-linear panel unit root test

Cerrato et al., (2009) developed a new non-linear panel ADF test under cross-sectional dependence, which is based on the following the ESTAR specification applied to the de-meaned series of interest. For example, let $\overline{y}_{it}$ be the real exchange rate in PPP theory, which could be the logarithm of the real exchange rate against the US dollar.

In its general form, we have:

$$\bar{y}_{it} = \xi_i \bar{y}_{i,t-1} + \xi_i^* \bar{y}_{i,t-1} Z(\theta_i; \bar{y}_{i,t-d}) + \mu_{it}, \qquad t = 1,...,T, \quad i = 1,...,N, \tag{2.17}$$

where

$$Z(\theta_i; \bar{y}_{i,t-d}) = 1 - \exp[-\theta_i (\bar{y}_{i,t-d} - c)^2] \tag{2.18}$$

where θ_i is a positive coefficient and c is the equilibrium value of the real exchange rate. The initial value $\tilde{y}_{i0}$ is given, and the error term μ_{it} has the one-factor structure:

$$\mu_{it} = \gamma_i f_t + \varepsilon_{it},$$

$$\varepsilon_{it} \sim i.i.d.(0, \sigma_i^2) \tag{2.19}$$

where f_t is the unobserved common factor, and ε_{it} is the individual-specific (idiosyncratic) error. Following the existing literature, the delay parameter d is set to be equal to one, so that equation (2.17) may be rewritten in first difference form in general as:

$$\Delta\bar{y}_{i,t} = \alpha_i + \xi_i \bar{y}_{i,t-1} + \sum_{h=1}^{h-1} \delta_{ijh} \Delta\bar{y}_{ij,t-h} + (\bar{\alpha}_i^* + \xi_i^* \bar{y}_{i,t-1} + \sum_{h=1}^{h-1} \delta_{ih}^* \Delta\bar{y}_{i,t-h}) * Z(\theta_i; \bar{y}_{i,t-d}) + \gamma_i f_t + \varepsilon_{it} \tag{2.20}$$

Notice that when $\tilde{y}_{i,t-d} = c$, $Z(\cdot) = 0$ and equation (2.20) is equivalent to a standard linear ADF model of equation (2.4). However, when the magnitude of divergence between $\tilde{y}_{i,t-d}$ and c becomes large and hence $Z(\cdot) \approx 1$ will generate a new linear ADF model with parameter $\beta_i = \xi_i + \xi_i^*$. When the differential becomes more serious, ξ_i^* plays an important role in governing the adjustment dynamic. One should take note that $\xi_i + \xi_i^* < 0$ is the necessary condition for global stability to hold. Once the condition of $\xi_i + \xi_i^* < 0$ is fulfilled it is legitimate to have $\xi_i \geq 0$. If this is occurred, then the implication is that process follows a nonstationary path (e.g. random-walk or explosive innovation within the band of inaction of c), and eventually, it converges back to its equilibrium once the magnitude of exchange rate differential is outside the band. If we assumed that y_{it} follows a unit root processes in the middle regime, then $\xi_i = 0$, meaning that equation (2.20) can be rewritten as:

$$\Delta \bar{y}_{i,t} = \xi_i^* \bar{y}_{i,t-1}[1 - \exp(-\theta_i \bar{y}_{i,t-1}^2)] + \gamma_i f_t + \varepsilon_{i,t} \qquad \textbf{(2.21)}$$

The null hypothesis of non-stationarity is $H_0 : \theta_i = 0 \forall i$, against the alternative of:

$H_1 : \theta_i > 0$ for i=1,2,…, N_1 and $\theta_i = 0$ for i= N_1+1,…,N

Because ξ_i^* in equation (2.21) is not identified under the null, it is not feasible to test the null hypothesis directly. Thus, Kapetanios et al., (2003) reparameterize equation (2.21) by using a first-order Taylor series approximation and obtain the auxiliary regression, where the cubic term $\bar{y}_{i,t-1}^3$ approximates the ESTAR non-linearity.

$$\Delta \bar{y}_{i,t} = a_i + \delta \bar{y}_{i,t-1}^3 + \gamma_i f_t + \varepsilon_{i,t} \qquad \textbf{(2.22)}$$

For a more general case where the errors are serially correlated, regression (2.22) is extended to

$$\Delta \bar{y}_{i,t} = a_i + \delta \bar{y}_{i,t-1}^3 + \sum_{h=1}^{h-1} \vartheta_{ih} \Delta y_{i,t-h} + \gamma_i f_t + \varepsilon_{i,t} \qquad \textbf{(2.23)}$$

Cerrato et al., (2009) further prove that the common factor f_t can be approximated by;

$$f_t \approx \frac{1}{\approx\atop\gamma} \Delta \overset{\approx}{y}_t - \frac{\bar{b}}{\bar{\gamma}} \overset{\approx}{y}{}^3_{t-1}, \qquad \textbf{(2.24)}$$

where $\overset{\approx}{y}_t$ is the mean of $\tilde{y}_t$ and $\bar{b} = \frac{1}{N}\sum_{i=1}^{N} b_i$

It follows, therefore, that equation (2.23) can be written as the following non-linear cross-sectionally augmented DF (NCADF) regression:

$$\Delta \bar{y}_{i,t} = a_i + b_i \bar{y}^3_{i,t-1} + c_i \Delta \overset{\approx}{y}_t + d_i \overset{\approx}{y}^3_{t-1} + \varepsilon_{i,t} \qquad \textbf{(2.25)}$$

In a univariate setup without terms of $\Delta \bar{y}_t$ and $\Delta \bar{y}^3_{t-1}$, Kapetanios et al., (2003) suggest a t-test for the unit root hypothesis against the alterative of globally stationary ESTAR, where the null is H_0:b_i=0 against the alterative: H_1: b_i<0. Given the framework above, the authors develop a unit root test in a heterogeneous panel model based on equation (2.25). Extending the idea in Kapetanios et al., (2003), the authors suggest using the model based on equation (2.25) and t-statistics on b_i, which is denoted by:

$$t_{iNL}(N,T) = \frac{\hat{b}_i}{s.e.(\hat{b}_i)} \qquad \textbf{(2.26)}$$

where $\hat{b}_i$ is the OLS estimate of b_i, and $s.e.(\hat{b}_i)$ is its associated standard error. Following Pesaran (2007), the t-statistic in equation (2.26) can be used to construct a panel unit root test by averaging the individual test statistics:

$$\bar{t}_{iNL}(N,T) = \frac{1}{N}\sum_{i-1}^{N} t_{iNL}(N,T) \qquad \textbf{(2.27)}$$

This is a non-linear cross-sectionally augmented version of the IPS test (NCIPS). Consequently, the authors calculate critical values of both individual and panel NCADF tests for varying cross section and time dimensions. In the following section, I develop a new non-linear panel unit root test, which takes contemporaneous cross sectional correlations across panel members into account, and identifying which member converges to the null hypothesis and which does not.

2.5.2 Seemingly uncorrelated regressive non-linear panel unit root test (SUR-NPURT)

Breuer et al., (2001) applies the method of Zellner's Seemingly Unrelated Regressions Estimation (SURE) to model (2.4) while allowing for contemporaneous cross-sectional correlations across panel members. Lau (2009) provides an alternative test, which is proved to be more powerful. Following Lau (2009) and Breuer et al., (2001), I am going to develop a non-linear panel unit root test (i.e. LAUNONLIN test) that takes contemporaneous cross-sectional correlations across panel members into account.

Using the data of China, European Union, Japan, UK, and US from February 1997 to August 2009, PPP differential series are constructed. Following Cerrato et al., (2009) the critical values adopted in Table 2.6 come from 50000 stochastic simulations constructed at 1%, 5%, and 10% significance levels (one-sided test) and the lower tailed bootstrap critical values are reported in Table 2.6. Critical values must be simulated with the error covariance matrix, the coefficients on the lagged difference estimated being based on a I(1) environment (null hypothesis of unit root under ESTAR model) assuming no drift unit root process and y_t is the time series under consideration. That is:

$$\begin{array}{llll} \Delta y_{1,t} = \delta_1 \Delta y_{1,t-1} + \mu_{1,t} & & t = 1,\ldots,T & \\ \vdots \quad \vdots \quad \vdots & & \vdots & \\ \Delta y_{N,t} = \delta_N \Delta y_{N,t-1} + \mu_{N,t} & & t = 1,\ldots,T & \mathbf{(2.28)} \end{array}$$

where $\Delta y_{1,t}$ is the PPP differential series for country i against the US dollar, expressed in its first difference. First, equation (2.28) is estimated by applying the SURE technique. The estimated vector of parameters such as $\hat{\delta}^{H_0,Hist}$ and $\hat{\mu}^{H_0,Hist}$ is gathered and the null variance-covariance matrix $\hat{\Sigma}^{H_0,Hist}$ of $\hat{\mu}^{H_0,Hist}$ is constructed. A vector of uncorrelated artificial error terms (NxT), $\hat{\mu}^{H_0,Ran}$ is drawn randomly, such that $\hat{\mu}^{H_0,Ran} \sim N(0,1)$. The Cholesky decomposition of the null variance-covariance matrix $\hat{\Sigma}^{H_0,Hist}$ produce the lower-triangular (square root) matrix L, such that $LL' = \hat{\Sigma}^{H_0,Hist}$. Hence, the cross-correlated artificial vector of residuals can be generated as:

$$\hat{\mu}^{H_0,Sim} = \mathrm{L}\,\hat{\mu}^{H_0,Ran}$$

next, y*, the first differenced artificial series is generated as:

$$\begin{array}{llll}
\Delta y^*_{1,t} = \delta_1^{H_0,Hist} \Delta y^*_{1,t-1} + \mu_1^{H_0,Sim} & & & t = 1,\ldots,T \\
\vdots \quad \vdots \quad \vdots & & & \vdots \\
\Delta y^*_{N,t} = \delta_N^{H_0,Hist} \Delta y^*_{N,t-1} + \mu_N^{H_0,Sim} & & & t = 1,\ldots,T
\end{array} \qquad \textbf{(2.29)}$$

To minimize sensitivity to initial conditions[13], 201 observations are generated for each variable, with the first 50 observations deleted, leaving 151 usable observations. The initial values for each simulated series are set to zero. That is:

$$\Delta y^*_{N,t-j} = 0,\ y^*_{N,t-j} = 0 \text{ (for } t - j \le 0\text{), and } \Delta y^*_{N,1} = \mu_{N,1}^{H_0,Sim} \qquad \textbf{(2.30)}$$

finally, I need to generate the level artificial series as:

$$\begin{array}{ll}
y^*_{1,t} = \Delta y^*_{1,t} + y^*_{1,t-1} & t = 1,\ldots,T \\
\vdots \quad \vdots \quad \vdots & \\
y^*_{N,t} = \Delta y^*_{N,t} + y^*_{N,t-1} & t = 1,\ldots,T
\end{array} \qquad \textbf{(2.31)}$$

13 The problem of initial condition was addressed by Harvey et al. (2009).

With these bootstrap series, I can obtain the bootstrap estimates after estimating the auxiliary regression of the following form:

$$\Delta y_{i,t} = \alpha_i + b_i y_{i,t-1}^3 + \partial_i \Delta y_{i,t-1} + \mu_t \qquad i = 1,..., N\,; t = 1,...,T \qquad \textbf{(2.32)}$$

The critical values of the newly developed non-linear panel unit root (LAUNONLIN) test are presented in Table 2.6.

Table 2.6. Non-linear panel unit root test with simulated critical values

Non-linear panel unit root test	Test Stat.	Simulated Critical Values			Conclusion
Country		**1%**	**5%**	**10%**	
European Union	-5.495	-3.994	-3.374	-3.060	I(0)***
Japan	-4.954	-3.740	-3.106	-2.796	I(0)***
United Kingdom	-3.297	-4.031	-3.396	-3.079	I(0)*
United States	-4.831	-3.720	-3.096	-2.781	I(0)***

* and *** denotes significance at 10% and 1% significance level respectively.

As shown in Table 2.6, the result concludes that PPP holds for European, Japan, United Kingdom, and the United States towards China at the 10% significance level.

The size and power experiment are based on the following panel ESTAR:

$$\Delta y_{it} = \xi_i^* y_{i,t-1}(1 - \exp\{-\theta_i (y_{i,t-1} - c)^2\}) + \mu_{it} \qquad \textbf{(2.33)}$$

I fix ζ_i^*=-1, as imposed in many empirical studies, (e.g. Taylor et al., 2001; Cerrato et al., 2009), while c, the location parameter, is set to zero. The size and power experiments are the same as that of the linear panel unit root test, except using equation (2.32) for running regression, so as to acquire more information content about the true Data Gereating Process (DGP) based on the historical estimates and historical residuals for simulation purposes. The size experiments are based on 50000 replications by setting θ_i=0 and the evidence is based on the 5% significance level. Table 2.7 shows the results for the power and size experiments, and most rejection rates under the null hypothesis are quite close to the 5% rejection level, suggesting that the tests have an acceptable size, and is correctly sized.

Table 2.7. Empirical Size/Power of non-linear panel unit toot test

Country	Size		Power[14]	
	ADF	LAUNONLIN	ADF	LAUNONLIN
European Union	0.044	0.055	0.1374	0.886
Japan	0.0462	0.056	0.1452	0.895
United Kingdom	0.0444	0.055	0.1246	0.820
United Sates	0.0492	0.055	0.1482	0.998

[14] I compare the power of the LAUNONLIN test with that of ADF test because ADF is the first unit root test adopted by the literature, see Breuer et al., (2001). For reader's information, in a similar class of nonlinear panel ADF , the power for t=100,N=10 as reported by Cerrato et al., (2009, appendix c, table 14) is 0.8942. However, as I mentioned their test cannot identify which member is converging and which does not.

2.6. Issues in selecting the appropriate panel unit root test

2.6.1. Evidence for OECD countries

In this section, I show the importance of choosing the appropriate panel unit root test in empirical research. Figure 2.1 shows the graph of four OECD countries' PPP differential series, which are very likely to obey a linear functional form.

Figure 2.1. PPP differential of four OECD countries

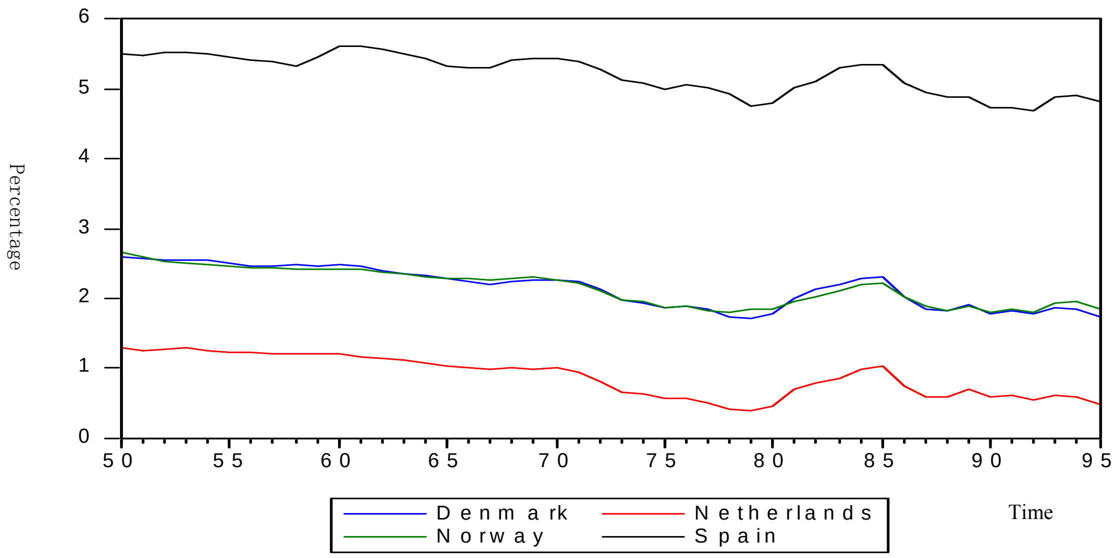


Table 2.8 provides comparison of the evidence of the presence of PPP by using both linear and non-linear unit root test, as developed in this paper. Based on 50000 replications, the critical values of both linear and non-linear panel unit root tests are presented in Table 2.8. The results indicate that the linear unit root test supports PPP for Denmark and Norway at the 10% significance level. In contrast, results from the non-linear panel unit root test suggest that all countries are non-stationary and, hence, violate PPP.

Table 2.8. Comparison of linear and non-linear panel unit root tests

Linear panel unit root test	Test Stat.	Simulated critical values			Conclusion
Country		**1%**	**5%**	**10%**	
Denmark	-3.68	-4.494	-3.705	-3.323	I(0)*
Norway	-3.8	-4.643	-3.957	-3.595	I(0)*
Netherlands	-3.41	-4.75	-4.048	-3.672	I(1)
Spain	-2.83	-4.444	-3.773	-3.416	I(1)
Non-linear panel unit root test	**Test Stat.**	**Simulated critical values**			
Country		**1%**	**5%**	**10%**	
Denmark	-3.293	-4.848	-4.144	-3.785	I(1)
Norway	-3.436	-4.744	-4.001	-3.617	I(1)
Netherlands	-2.976	-4.807	-4.098	-3.722	I(1)
Spain	-2.502	-4.601	-3.817	-3.432	I(1)

* denotes significance at 10% significance level.

Table 2.9 presents the results for power and test experiments based on 50000 replications and 5% significant reference level. We can observe that the power of the non-linear panel unit root test is extremely low, reaching an unacceptable level, which is even lower than the power of the ADF test.

Table 2.9. Empirical Size/Power of linear and non-linear test

Country	Size		Power	
	Linear panel	**Non-linear panel**	**Linear panel**	**Non-linear panel**
Denmark	0	0	0.999	0.1417
Norway	0	0	0.999	0.0632
Netherlands	0	0	0.186	0.0725
Spain	0	0	0.999	0.0437

The reason for the low power of the non-linear panel unit root test is due to model misspecification: the BDS test introduced by Brock et al., (1996) is applied to residuals after fitting the ARMA (1, 1) model, which is selected by using the Akaike Information Criteria (AIC) and Durbin-Watson (DW) statistic. The BDS test accepts the null hypothesis that the residuals of the series are dependent and, hence, provide evidence for linearity of the series. The conclusion of PPP for four OECD countries should, therefore, draw from the upper panel of Table 2.9: that Spain and Netherlands violate PPP, while Denmark and Norway show evidence of PPP towards the United States using the methodology of linear panel unit root test as developed by Lau (2009).

2.6.2 Evidence for China's four main trading partners

Figure 2.2 shows the PPP differential series of China's four main trading partners, which are very likely to follow a non-linear dynamic, which is confirmed by the BDS test.

Figure 2.2. PPP differential of China's trading partners

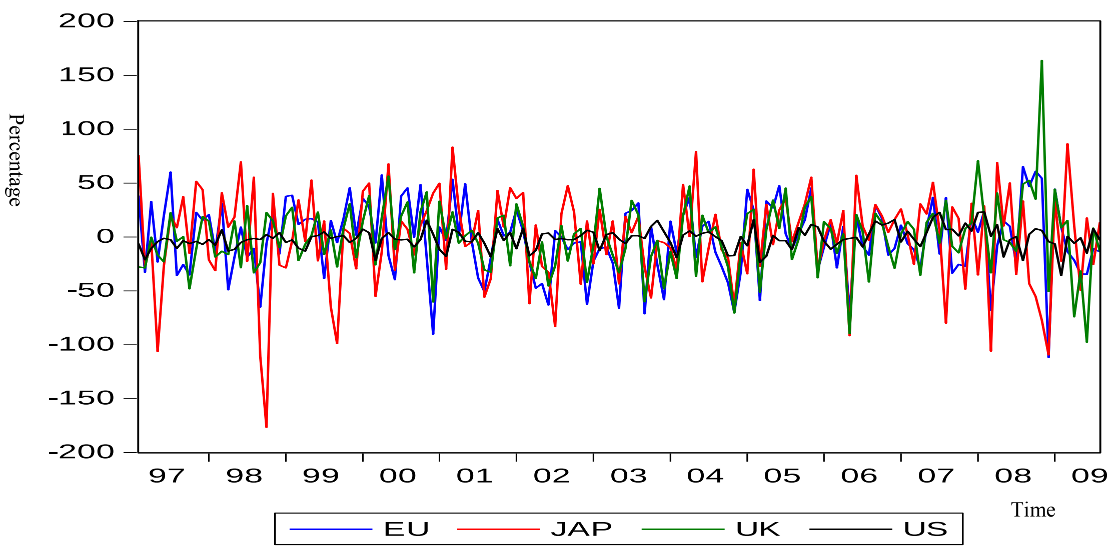


Table 2.10 provides empirical results of PPP by using both the linear and non-linear unit root tests. Again, the critical values of both linear and non-linear panel unit root tests are based on 50000 replications, which are presented in Table 2.10. The results indicate that PPP holds for all countries at the 10% significance level using both the linear and non-linear panel unit root test.

Table 2.10. Comparison of linear and non-linear panel unit root tests

Linear panel unit root test	Test Stat.	Simulated critical values			Conclusion
Country		**1%**	**5%**	**10%**	
European Union	-11.067	-3.990	-3.387	-3.058	I(0)***
Japan	-8.726	-3.711	-3.078	-2.762	I(0)***
United Kingdom	-9.810	-4.013	-3.389	-3.070	I(0)***
United States	-8.066	-3.647	-3.037	-2.726	I(0)***
Non-linear panel unit root test	**Test Stat.**	**Simulated critical values**			
Country		**1%**	**5%**	**10%**	
European Union	-5.495	-3.994	-3.374	-3.060	I(0)***
Japan	-4.954	-3.740	-3.106	-2.796	I(0)***
United Kingdom	-3.297	-4.031	-3.396	-3.079	I(0)*
United States	-4.831	-3.720	-3.096	-2.781	I(0)***

* and *** denotes significance at 10% and 1% significance level.

Table 2.11 presents the results for the power and size test experiments based on 50000 replications and the 5% significance reference point. We can observe that the power of the non-linear panel unit root test is extremely high, with a relatively reasonable size, and the BDS test rejects the null hypothesis at the 5% significance level, indicating that the residuals of the series are dependent and, hence, provide evidence for non-linearity of the series. In contrast, the power of linear panel unit root test is too low to accept (see Table 2.11). Therefore evidence of PPP for China's trading partners should, therefore, draw from the lower panel of Table 2.10: that all countries show evidence of PPP towards China.

Table 2.11. Empirical Size/Power of linear and non-linear panel unit root tests

Country	Size		Power	
	Linear panel	Non-linear panel	Linear panel	Non-linear panel
European Union	0.040	0.055	0.098	0.886
Japan	0.047	0.056	0.194	0.895
United Kingdom	0.043	0.055	0.255	0.820
United Sates	0.039	0.055	0.212	0.998

2.7 Conclusion

This part reviews various empirical applications of unit root tests, including, but not limited to, the macroeconomic study of purchasing power parity, unconditional income convergence hypothesis, and financial market bubbles. In microeconomics, corporate profit persistence and financial leverage mean reversion behavior are the main areas of the methodology. All the above applications, indeed, impose upon us implications about regional and international competitiveness of the economy.

Applying two new panel unit root tests developed in this paper, the first linear panel unit root test overcomes the pitfalls of the old-fashioned panel unit root tests and makes it possible for researchers to test individual series for a unit root while taking contemporaneous cross- sectional dependence into account. The second test takes non-linear dynamics into account. The proposed tests are, indeed, more powerful than the Univariate Augmented Dickey-Fuller (ADF) test and some conventional panel unit root tests in rejecting false I(1) time series. I applied these panel unit root tests to the long-run purchasing power parity (PPP) hypothesis of OECD countries and China's four main trading partners, and the finite sample performance of the new test is examined though Monte Carlo Simulation, which is superior when compared with that of the single ADF unit root test. By using a newly developed linear panel unit root test, I conclude that Spain and Netherlands violate PPP, while Denmark and Norway show evidence of PPP towards the United States. Moreover, evidence of PPP for China's four trading partners is examined by using the newly developed non-linear panel unit root test, and I find that the European Union, United Kingdom Japan and the United Sates show evidence of PPP towards China. In what follows in the second part of this chapter, I will use a gravity model to estimate the trade elasticity of China's apparel cottons in the US market for the period between 1989 and 2009.

Part 2-Export demand function of Chinese Textiles Industry: An Analysis in Comparison with Selected ASEAN Countries

2.8 Introduction

The Multi Fiber Agreement (MFA) was signed in 1974 to impose quota restriction on textile and apparel items exported to the U.S. from developing countries. However, at the Uruguay Round, a breakthrough was achieved by agreeing to bring the MFA-restricted items under GATT disciplines with World Trade Organization's (WTO) juridification. The liberalization process of quota restriction on textiles and apparel items was taken over a 10-year period. The *Agreement on Textile* and Clothing (ATC) called for a gradual phase out of the MFA quotas. As Gelb (2005) mentions, the ATC called for reductions of 16% (January 1, 1995), 17% (January 1, 1998), 18% (January 2002), and 49% (January 1, 2005) of the quotas were eliminated on all trade between WTO countries, as required by the ATC.

It was expected that "the gradual transition period would allow clothing and textile manufacturers enough time to prepare for the more competitive global market of the post-ATC era" (Martin, 2007). The elimination of the last set of quotas of the ATC ostensibly brought about the end of the 40 years period of quantitative restrictions on the international trade of textiles and apparel (Martin, 2007). Thus, the framework for world trade in textiles and apparel was liberalized.

A number of studies examine the impact of the elimination of quotas. For instance, Fox et al., (2007) uses the USAGE–ITC model to estimate the U.S. welfare gains and sectoral effects of removing all textile and apparel restraints in 2005. Their model estimates that the liberalization increases the U.S. welfare, while decreasing U.S. textile and apparel output. Moreover, Elbehri (2004) employs a modified version of an applied general equilibrium GTAP model and uses recent estimates of MFA trade restrictiveness in analyzing MFA removal impact. His findings support that significant trade in apparel shift in favor of Asian and South Asian suppliers that are subject to binding MFA-quotas.

On the other hand, Brambilla et al., (2007) investigates China's experience under the U.S. apparel and textile quotas. They find that China is relatively more constrained under these regimes than other countries and that, as quotas being lifted, China's exports grew disproportionately. In fact, when the ATC ended in 2005, China's exports surged while those from nearly all other regions fell. Moreover, Gelb (2005) analyzes the effects of the phase-out of the quotas on textiles and apparel that occurred January 1, 2005 - discussing the consequences and on implementation issues. The author argues that there will be benefits to the overall U.S. economy from acceleration of imports of textiles and apparel.

Nordås (2004) analyzes the global textile and clothing industry in the post-ATC regime. The author says that "there is no doubt that both China and India will gain market shares in the European Union, the United States and Canada to a significant extent, but the expected surge in market share may be less than anticipated".

Non-tariff barriers on textile and apparel imports are imposed by the U.S. government during the period of this investigation. The United States agreed to liberalize 16 percent of their textile imports on 1st January 1995, 17 percent in 1998, 18 percent in 2002, and the remaining 49 percent at the end of the transition period, on 1st January 2005. Time lag effect might take effect for consumption and production process in response to such a trade liberalization schedule. Consequently, as Fox et al., (2007) mentions that imports have increased in the U.S. market, particularly for apparel industry. From 2002 to 2005, U.S. imports of textiles and apparel increased 23.3 percent to $100.4 billion. On the other hand, from 2002 to 2005, U.S. production and employment in these sectors declined by 11 percent and 23 percent respectively.

China is the major player in global textiles and apparel trade, joining WTO in 2001. China is the big winner of the post-quota era. Fox et al., (2007) state that “China has been the largest beneficiary (by value) from global quota elimination and the resulting market share reallocation” (p.4). Within this regard, Chinese exports to the U.S. rose from $12.8 billion to $27.7 billion between 2002 and 2005, an increase of 115.5 percent. This increase gave rise to the establishment of 10 safeguards (quantitative restraints) on selected imports of Chinese textile and apparel articles in 2005.

The main purpose of this part is to investigate the behavior of export performance, particularly the role played by income, and prices in the determination of MFA fibers and cottons (apparel and non-apparel) being imported from Mainland China, Hong Kong, and four ASEAN countries[15] to the U.S. market. The U.S. continues to be the world's largest importer of textiles and apparel, and it accounted for 17 percent of world imports of these goods in 2005. In other words, as Elbehri (2004) states, the U.S.

15 These countries are Singapore, Malaysia, Thailand, and the Philippines.

has a significant influence on world textiles and apparel markets. Moreover, it is the most important export market for the Chinese textile and apparel industry.

Quarterly data from 1st quarter, 1989 to 3rd quarter, 2009 are collected from the U.S. Department of Commerce, Office of Textiles and Apparel[16]. I apply panel cointegration and error correction model to the data, examining the sign and extending that real income per capita and prices affecting import demand for apparel cottons exported to the U.S. from Mainland China, Hong Kong, and four ASEAN countries during the period of 1989-2009. I believe that the above fundamental research perspectives are important to international textile and clothing buyers and sellers as well as to the trade policy makers.

In my empirical examination of the MFA apparel cottons exported to the US from mainland China, Hong Kong and four ASEAN countries during the years 1989–2009, I apply panel cointegration techniques, error correction approaches, panel estimation methods, and the impulse response function to the US's import demand function. I draw some important conclusions from this study. First, I extract a unique long-run equilibrium relationship among import quantity demanded, imported price and US GDP per capita. This implies that the existing trade mechanism is capable of ensuring co-movement/equilibrium of imported quantity, price and income in the long-run. Second, the long-run price and income elasticity is found to be significant with expected signs, which are important for most trade–policy analyses. Third, the increasing amount of Chinese MFA apparel cottons export do not threaten the survival of its neighboring countries in the US market, because the negative impact of China's emergence is only temporary and insignificant. This part provides a comprehensive and

16 Original Data is available at http://otexa.ita.doc.gov/msrpoint.htm

disaggregated set of elasticity estimates to date. The estimates made here are at a detailed level of disaggregation and should provide researchers with opportunities for future analysis.

2.9. Previous Studies on Gravity Model

There are many empirical studies on the research topic of trade potential, trade determinants, and trade direction using gravity model. For example, Rahman (2006) examines the trade determinants in Bangladesh using panel data estimation technique and generalized gravity model, and Batra (2006) applies augmented gravity model to estimate India's trade potential. Christie (2002) investigates trade potential for Southeastern Europe.

The conventional gravity model is originated from the Newtonian physics notion[17]. The Newtonian type of gravity model is borrowed by trade economists and there is growing literature on the application of "gravity trade model" since 1940s[18]. The economics version of gravity model proposes that trade flow between two economies is positively related to the product of each economy's 'economic mass', as measured by GDP and negatively related to the distance between the country's economic centre of gravity. Most estimated gravity equations take the form[19]

$$x_{ij} = \alpha_1 y_i + \alpha_2 y_j + \sum_{m=1}^{M} \beta_m \ln(z_{ij}^m) + \varepsilon_{ij} \tag{2.34}$$

where x_{ij} is the import volume in logarithmic form imported from country i to j,

17 The theory is based on the late 17th century notion that the Universe is made up of solid objects which are attracted towards each other by a force called 'Gravity'. In sum it proposes that two bodies attract each other proportionally to the product of each body's mass (in kilograms) divided by the square of the distance between their respective centers of gravity (in meters).

18 Oguledo and Macphee (1994) provides detailed literature review on "gravity trade model.

19 I follow exactly the notation used by Anderson and van Wincoop (2004) here.

y_i and y_j are the logarithm of GDP of the exporter and importer respectively, and z_{ij}^{m} ($m=1,\ldots, M$) is a set of observed variables.

Based on equation (2.34) McCallum (1995) finds that trade between Canadian provinces is 22 times (2,200 %) more than trade between states in the U.S. and Canadian provinces, after controlling for size and geographical distance. However, Anderson and van Wincoop (2004) argues that gravity equations can be derived from various different trade theories[20], but none of them leads to conventional gravity model of equation (2.34), therefore the result of McCallum (1995) is misleading simple due to model misspecification.[21] This implies future researches using gravity equation should avoid adopting equation (2.34). Given the trade cost function, Anderson and van Wincoop (2003) derives a micro-founded gravity equation with trade cost, and the logarithmic form of the empirical gravity equation becomes

$$x_{ij} = \alpha_1 y_i + \alpha_2 y_j + \sum_{m=1}^{M} \beta_m \ln(z_{ij}^{m}) - (1-\sigma)\ln(\Pi_i) - (1-\sigma)\ln(p_j) + \varepsilon_{ij} \qquad \textbf{(2.35)}$$

where $\beta_m = (1-\sigma)/\gamma_m$, σ>1 is the elasticity of substitution across goods. Π_i and p_j are country *i*'s and country *j*'s price indices. p_j is the inward multilateral resistance index (i.e. the supply price), since the law of demand implies that the flow of good from i into j is stimulated (assuming σ>1) by high trade costs, compared with other exporting countries to market j as represented by p_j. On the other hand higher resistance of exports from i to its alternative foreign markets resulted in more trade back to market i from j, and this is represented by the outward multilateral

20 For example the partial equilibrium model of export supply and import demand as developed by Linneman (1966); the trade share expenditure system as proposed by Anderson (1979), and a microeconomic foundation model as developed by Bergstrand (1985, 1989).

21 Unfortunately, there are large number of literatures follows this type of gravity equation, among others, including Helliwell and McCallum (1995) and Shang-Jin Wei (1996).

resistance index, Π_i. To illustrate this point, I borrow an example from Novy (2008) that U.S. –China trade is not only influenced by their bilateral barriers but also by their trade barriers with other countries. Suppose U.S. trade barriers are decreased with all other countries except for China, this implies the multilateral trade barrier goes down. Therefore, part of U.S. trade will be diverted away from China towards other countries although the U.S. –China trade barrier itself remained unchanged.

One practical approach for estimating equation (2.35) is to use data for the price indices with Ordinary Least Square (OLS) estimation technique as suggested by Anderson and van Wincoop (2003). Many researchers have taken this approach[22]. The drawback of this approach is that it is difficult to measure the theoretical price indices in the data as emphasized by Baier and Berstrand (2001). Also the consumer price index, in practice includes nontradables and is affected by local taxes and subsidies as mentioned by Anderson and van Wincoop (2004). Novy (2008) argues that equation (2.35) derived by Anderson and van Wincoop (2003) have upward bias towards the extent of international trade. For the year 1993 the author report a 31 percent tariff equivalent of overall U.S.–Canadian trade costs, compared to 46 percent reported by Anderson and van Wincoop (2003). The reason for this bias is because the GDP data includes the services component and this tends to overstate the extent of international trade and thus the level of trade costs (Novy, 2008).

22 For example, Bergstrand (1985,1989,1990), Baier and Bergstrand (2001), and Head and Mayer (2000).

There are several reasons why equation (2.35) is not suitable for my research purpose. First, we must be aware that the theoretical gravity model of equation (2.35) is valid with macroeconomic assumption that general equilibrium model and trade expenditure function for the whole economy can be derived, and hence the model can only apply to the aggregate economy. For researchers who are interested in examining trade issues, which are industry/product specific, equation (2.35) is inappropriate and will provide misleading results. Secondly, if researchers are interested in the dynamics of trade flow of time series or panel data estimation, econometrics test for stationarity and cointegration are unavoidable. Therefore I will provide a modified model which aims at estimating trade elasticity, and the model will be discussed in the following sections.

2.10. Trade Elasticity

Income and price elasticity are important for international economic policy analysis. For instance, the welfare effects of trade liberalization and the impacts of currency appreciation on import quantity/price, and the external balance all depend on the estimates of trade elasticity. Thursby and Thursby (1984) is among the pioneering studies to estimate different specifications of the import demand functions. It uses five OECD countries as examples to demonstrate how to find an appropriate aggregate import demand function. They suggest that the coefficient of multiple correlations R^2, and the 'Regression Specification Error Test' (RESET)[23] are relevant statistical indicators that may define unbiased and efficient elasticity estimates. Goldstein and Khan (1985) presents a detailed review of the import demand functions. The study cites

23 They are indicators of measuring model goodness of fit. RESET is designed to detect omitted variables, incorrect functional form and nonindependences of regressors and disturbances.

some relevant contributions to summarize the model's specification, estimation, and inference decision procedures on estimating "price" and "income" elasticity in trade. The authors provide detailed decision rules on how to specify an appropriate import demand function based on the methodology of cross sectional econometrics. Both papers however, appeared before the innovation of cointegration technique. The authors use all time series data, which falls in the field of nonstationary econometrics. Therefore, the statistical indicators of RESET, R^2, and t- statistics, for example, are not relevant for choosing an appropriate import demand function. That is why the R^2 is so high in the estimated models cited by the authors.

If nonstationary econometrics techniques are not employed, the authors may incorrectly conclude that a relationship exists between the Dependent variable and regressors even though they have no relationship at all. In other words, if import quantity, price, and income variable contain stochastic time trends, the elasticity estimates will be biased and inefficient. The cointegration technique is important because of the potential existence of unit root in the related data series. The concept of the cointegration test (pioneered by Clive Granger, the 2003 Nobel Laureate in economics) and unit root test will be elaborated upon in later sections.

More recent studies have attempted to find evidence of a long-term relationship (cointegration) between levels of import volume, import price and income. However, results of these studies are mixed. Clarida (1994) use the cointegration technique to estimate the U.S. import elasticity of nondurable goods and concludes that U.S. income and price elasticities of imports were 2.20 and -0.94 respectively. Johnston and Chinn (1996) find a unique cointegrating relationship within import demand function by excluding agricultural products and fuels for the 1973-95 period in the U.S., whereas

Chinn (2004) obtains evidence of a cointegrating relationship only when computers are excluded. Konho and Fukushige (2002) estimate the bilateral U.S. - Canada long-run import demand function in aggregate level taking into account the effects of Canada - U.S. Free Trade Agreement. The results show that the free trade agreement made the U.S. customers sensitive to import prices and insensitive to its domestic income.

Moreover, Dutta and Ahmed (1999) estimates the aggregate import demand function for India using cointegration and error correction approaches and come to three conclusions. First, import quantity cointegrated with import price and real GDP. Second, the import quantity was sensitive to real GDP, and insensitive to import price changes. Third, the trade liberalization program had little effect on import volume.

In contrast, Rose and Yellen (1989), and Meade (1992) failed to find evidence of cointegration in the data for the period 1960-87 in the U.S. Furthermore, Tang (2003) reports no long-run equilibrium relationship among the Japanese aggregate imports, real income and relative price of imports. However, Abbott et al., (1996), Giovannetti (1989), Mohammed and Tang (2000), and others are critical of the aggregate model in that it suffers from aggregation bias and hence may discount the reliability of policy implications. In this study, I focus on the textile and apparel sector to minimize this bias.

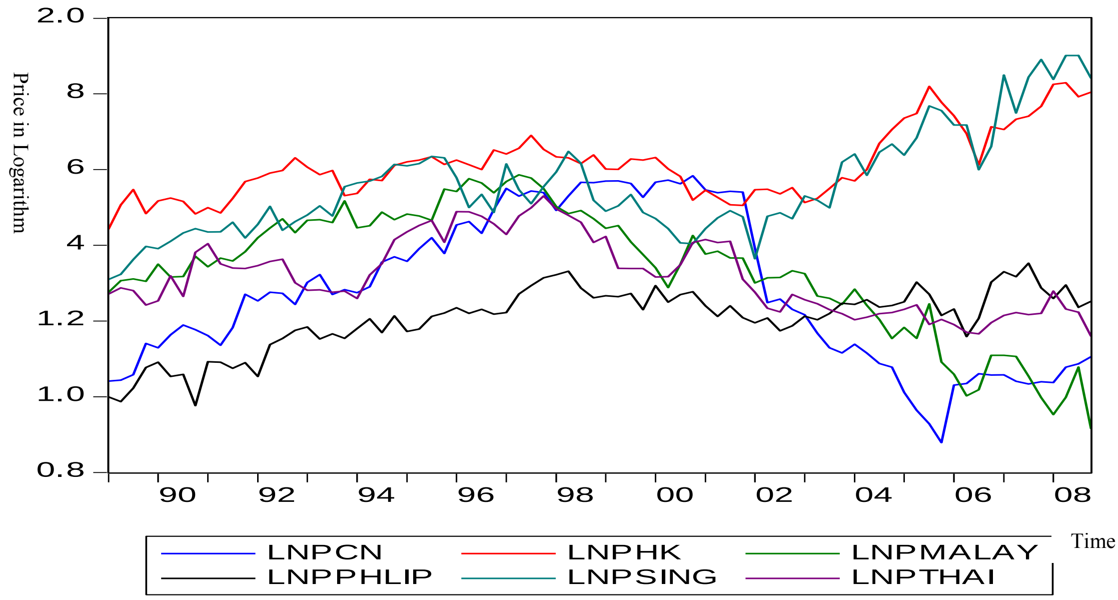
Lau et al., (2010c) documents the export performance of MFA fibers mainly in cottons exported from Mainland China and Hong Kong, to the U.S. during 1989-2005. The authors use the cointegration and error correction approach to investigate whether long-run relationships among variables exist. The empirical results suggest that a unique long-run relationship exists among import price and quantity, real income per capita, and trade liberalization. The short-run dynamics of export demand functions were estimated using an error correction model, in which the error correction term was found correctly signed. The present study extends the research interest to ASEAN countries, and in a panel data framework.

2.11. Econometrics methodology

2.11.1 Long-run Import Demand Function

The unit price (USD/m^2) and quantity (m^2) in natural logarithm are plotted in Figure 2.3 and Figure 2.4, and readers may have more information on the behavior of the apparel cottons that the U.S. imported from each importing country. Several preliminary observations were made. First, the unit prices of China and Malaysia were generally cheaper in the whole sample period. The unit price decreased substantially after 2002, while the opposite observation was found for Hong Kong and Singapore. Second, before 2002, the import quantity was roughly the same for Hong Kong and Mainland China; however, from 2002 onwards Mainland China increased its exports substantially and the gap has since further widened. In addition, Singapore's exports decreased substantially after 2002.

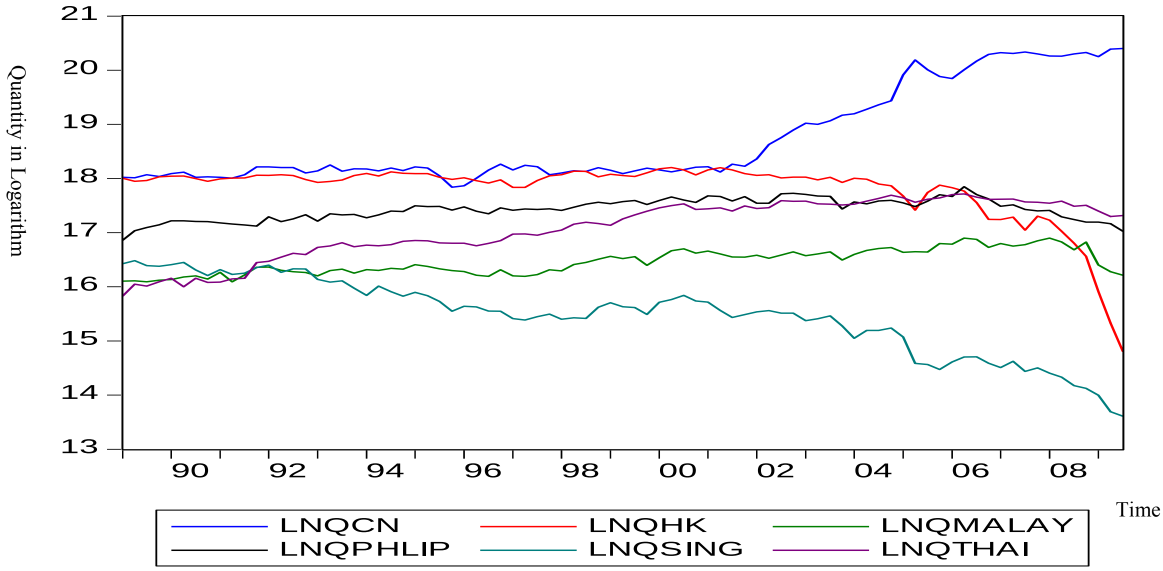
Figure 2.3. Prices of imports (on a logarithmic scale).



Note:

- Y-axis denotes import price in logarithm while X-axis denotes time.
- LNPCN denotes import price in logarithm for *China*
  LNPHK denotes import price in logarithm for *Hong Kong*
  LNPMALAY denotes import price in logarithm for *Malaysia*
  LNPPHLIP denotes import price in logarithm for the *Philippines*
  LNPSING denotes import price in logarithm for *Singapore*
  LNPTHAI denotes import price in logarithm for *Thailand*

Figure 2.4. Quantity of imports (on a logarithmic scale).



Note:

- Y-axis denotes import quantity in logarithm while X-axis denotes time.
- LNQCN denotes import quantity in logarithm for China
  LNQHK denotes import quantity in logarithm for Hong Kong
  LNQMALAY denotes import quantity in logarithm for Malaysia
  LNQPHLIP denotes import quantity in logarithm for the Philippines
  LNQSING denotes import quantity in logarithm for Singapore
  LNQTHAI denotes import quantity in logarithm for Thailand

These findings are not surprising since Lau et al., (2008) applies the Endogenous Break Augmented Dickey Fuller test of Zivot and Andrews (1992), to trace the date on which the structural break of the series would take place in response to shock, like MFA quota abolishment. The break date in year 2000 is detected, and it takes about 1.6-6.5 months for the repercussion of the shock to diminish to half of its initial impulse. The long-run import demand function of apparel cottons exported to the U.S. for each exporting country takes the form:

$$LM_{i,t} = \alpha_{i,0} + \alpha_{i,1} LP_{i,t} + \alpha_{i,2} LGDP_t + \varepsilon_{i,t} \tag{2.36}$$

where $\alpha_{i,0}$ is the constant intercept term. $\alpha_{i,1}$ is the price elasticity , and $\alpha_{i,2}$ is the income elasticity. $M_{i,t}$ is the import quantity while the lower case i =1…6 represents exporting countries; $P_{i,t}$ is unit price of apparel cotton imported from Mainland China , H.K. and four ASEAN countries; GDP_t is the nominal GDP per capita of the U.S.; $\varepsilon_{i,t}$ is a random disturbance term with its usual classical assumptions and L the natural logarithm transformation operator.

For each country, the model is chosen to ensure that a unique cointegrating relationship exists among price, income, and import quantity. The correct model specification must exhibit correct sign for price and income elasticity with statistical significance. I expect $\alpha 1<0$, $\alpha 2>0$. As it is postulated that import volume and import price are related negatively, holding other constraints constant α_1 is expected to be negative. As the purchasing power of the U.S citizens increases, more MFA items will be imported, subject to other constraints being constant. Hence, α_2 is expected to be positive. However, it is well known that spurious regression becomes problematic if Ordinary Least Squares (OLS) is used when time series of $LM_{i,t}$, $LP_{i,t}$, and $LGDP_t$ are not of the same order of integration. Moreover, if time series have a unit root, it is necessary to take the first difference of variables in equation (2.36) to obtain a stationary series:

$$\Delta LM_{i,t} = \alpha_{i,0} + \alpha_{i,1}\Delta LP_{i,t} + \alpha_{i,2}\Delta LGDP_t + \varepsilon_{i,t} \tag{2.37}$$

For equation (2.37), Δ is the difference transformation operator. $\alpha_{i,0}$ is constant intercept term. $\alpha_{i,1}$ and $\alpha_{i,2}$ are the estimated coefficients for ΔLP and $\Delta LGDP_t$ respectively. It is to be noted that $\alpha_{i,1}$ and $\alpha_{i,2}$ cannot be viewed as elasticity, because they are first differenced variables. Maddala (1992) argues that "long-run information" in the data gets ignored in equation (2.37) once the data is manipulated by taking its first difference. Hence, the "Error Correction" (EC) term should be introduced and this is the central idea of co-integration theory. The one period lagged EC term (i.e. EC_{t-1}), which integrates the short-run dynamics, is introduced in the long-run demand function and equation (2.37) becomes:

$$\Delta LM_{i,t} = \beta_{i,0} + \sum_{j=1}^{j}\beta_{i,j,1}\Delta LM_{i,t-j} + \sum_{j=0}^{j}\beta_{i,j,2}\Delta LP_{i,t-j} + \sum_{j=0}^{j}\beta_{i,j,3}\Delta LGDP_{i,t-j} + \beta_{i,4}EC_{i,t-1} + \varepsilon_{i,t} \tag{2.38}$$

where $EC_{i,t-1}$ is the one period lagged error-correction term and equation (2.38) is the Error Correction Model (ECM). The ECM was estimated to determine the short-run dynamic behavior of import demand. Two features of ECM should be mentioned here. First, all variables included in the ECM are stationary and first differenced to avoid superiors outcome. Second, the sign of the $ECM_{i,t-1}$ must be negative because the change of import volume can diverge from its long equilibrium in the short-run. However, the error term, $EC_{i,t-1}$ will correct such divergent behavior in the next period once such disequilibrium occurs. This implies that the larger the coefficient ($\beta_{1,4}$) of $EC_{i,t-1}$, the higher would be the speed of convergence toward the equilibrium.

2.11.2. Panel Unit Root Test

Unit root tests can be used to determine whether trending data should be first differenced to render the data stationary. Pretesting for unit roots is generally the first step in cointegration modeling which aims to detect long-run equilibrium relationships among nonstationary time series variables. If the variables in question are I (1), then cointegration techniques can be used to model these long-run relations. Useful surveys on issues associated with unit root testing are given in Stock (1994), Maddala and Kim (1998) and Phillips and Xiao (1998).

Stationarity of a time series can be tested by the Augmented Dickey Fuller (ADF) unit root test pioneered by Dickey and Fuller (1979). They show that under the null hypothesis of a unit root, the ADF statistic does not follow the conventional student's t-distribution; also, they have derived the asymptotic results and simulated critical values for various test and sample sizes. The order of integration of the variables in equation (2.37) may be determined by applying ADF test. Consider a series at time t,

$$\Delta q_t = \alpha_0 + b q_{t-1} + \sum_{i=1}^{k} \sigma_i \Delta q_{t-i} + \varepsilon_t \qquad \textbf{(2.39)}$$

where q_t can be replaced by time series $LM_{i,t}$, $LP_{i,t}$, and $LGDP_{i,t}$ for the purpose of pretesting, Δq_t is the series of interest in first difference. $\sum_{i=1}^{k} \sigma_i \Delta q_{t-i}$ is the augmenting term and ε_t the Independently and Identically distributed (IID) error , that is $\varepsilon_t \sim iid(0, \sigma^2)$. Equation (2.39) is estimated by Ordinary Least Square (OLS) technique, and the unit root null hypothesis is rejected when the ADF-statistic is found to be significant for the null: b =0 against the alterative b <0. However, it is well documented in the literature that the ADF test has low power against the stationary alternative. I therefore use panel unit root test which can provide more information by combining time (T) and space (N) dimension. These panel unit root tests are advocated by Levin and Lin (1992), Im, Pesaran and Shin (1997), Maddala and Wu (1999) and Taylor and Sarno (1998) among others.

The findings presented in Table 2.12 and Table 2.13 shows that all variables in this study are nonstationary. Therefore, cointegration and error correction approaches are appropriate to use in the coming sections.

2.11.3 Johansen Fisher Panel Cointegration test and Error Correction Model (ECM)

The empirical model that was used in the 1980s was based on the assumption that the variables in these models were stationary. However, the problem is that statistical inference associated with stationary processes is no longer valid if the time series follows nonstationary processes. Granger and Newbold (1974) points out that the conventional OLS test may often suggest a statistically significant relationship between variables where none in fact exists. They arrive at this conclusion by generating two independent nonstationary series and regression these series on each other using the conventional OLS. Surprisingly, the coefficient estimated is highly statistically significant despite the fact that the variables in the regression are independent. Subsequently, Engle and Granger (1987) considers the problem of testing the null hypothesis of no cointegration between a set of nonstationary variables and provided a rigorous proof for the Granger representation theorem[24].

24 They won the Nobel Prize in Economics in 2003 for their innovation on the framework of cointegration and error correction.

The term "cointegration" can be viewed as the statistical expression of the nature of equilibrium relationships. Variables may drift apart in the short-run, but if they diverge without bound, no equilibrium relationship could be said to have existed. Therefore, economic significance can be defined in terms of testing for equilibrium.

If all series are I(1), the Johansen and Juselius (1990) cointegration test can be applied to see whether any combinations of the variables in equation (2.36) are cointegrated. Given a group of nonstationary series, one may be interested in determining whether the series are cointegrated, and if they are, in identifying the cointegrating (long-run equilibrium) relationships. The Vector Auto-Regressive (VAR) based cointegration tests, as developed by Johansen (1991, 1995), are implemented for the long-run import demand function in equation (2.36).

Consider a VAR of order p:

$$y_t = A_1 y_{t-1} + \ldots + A_p y_{t-p} + \beta x_t + \varepsilon_t \qquad \textbf{(2.40)}$$

where y_t is a k-vector of nonstationary I(1) variables consisting in this case LM_{it}, LP_{it}, and $LGDP_{it}$, X_t a -vector of deterministic variables and ε a vector of innovations. The VAR can be rewritten as:

$$\Delta y_t = \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + \beta x_t + \varepsilon_t \qquad \textbf{(2.41)}$$

where

$$\Pi = \sum_{i=1}^{p} A_i - \mathrm{I} \qquad \text{and} \qquad \Gamma_i = -\sum_{j=i+1}^{p} A_j$$

Granger's representation theorem asserts that if the coefficient matrix Π has a reduced rank $r<k$, then $k \times r$ matrices α and β exist, each with rank r, such that $\Pi=\alpha\beta'$ and $\beta' y_t$ is I(0). r is the number of cointegrating relations (the cointegrating rank) and each column of β is the cointegrating vector. The elements of α are known as the adjustment parameters in the Vector Error Correction (VEC) model. Johansen's method is to estimate the Π matrix from an unrestricted VAR and to test whether one can reject the restrictions imposed by the reduced rank of Π. The empirical evidence on long run cointegration in a panel setup is presented in Table 2.14. In the case of a unique cointegrating relationship, equation (2.38) is estimated to see the short-run dynamic behavior of the import demand function. Empirical findings of ECM are presented in Table 2.15.

2.12. Empirical results

2.12.1 Panel Unit root test

Table 2.12 and Table 2.13 presents the result from panel unit root test on variable LM_{it} and LP_{it}. The number of augmenting terms, namely k, was chosen by using Akaike Information Criterion (AIC) as suggested by Elliot, Rothenberg and Stock (1996). The panel unit root tests have shown that all series are nonstationary. The results are along expected lines because the time series dynamics in Figure 2.3 and Figure 2.4 do not exhibit mean-reverting properties. Due to the fact that all variables are nonstationary, cointegration techniques can be used to model these long-run relations in the next section.

Table 2.12. Panel Unit Root Statistics (Unit prices)

	Statistic	Prob.**	sections	Obs
Null: Unit root				
(assumes common unit root process)				
Levin, Lin & Chu t-stat (2002)	0.12032	0.5479	6	454
Breitung t-stat	2.48998	0.9936	6	448
Null: Unit root				
(assumes individual unit root process)				
Im, Pesaran and Shin W-stat (2003)	1.25748	0.8957	6	454
ADF - Fisher Chi-square	4.52494	0.972	6	454
PP - Fisher Chi-square	9.50515	0.6593	6	474

** Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality.

Table 2.13. Panel Unit Root Statistics (Quantity)

	Statistic	Prob.**	sections	Obs
Null: Unit root				
(assumes common unit root process)				
Levin, Lin & Chu t-stat (2002)	4.07874	1	6	447
Breitung t-stat	4.3921	1	6	441
Null: Unit root				
(assumes individual unit root process)				
Im, Pesaran and Shin W-stat	4.50333	1	6	447
ADF - Fisher Chi-square	6.1052	0.9107	6	447
PP - Fisher Chi-square	13.0582	0.3648	6	474

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

2.12.2 Johansen Fisher Panel Cointegration test and ECM

Since we will estimate a panel regression in the later stage, we first perform the Johansen Fisher panel cointegration test. It is well known that the asymptotic properties of the estimators in the panel cointegrated regression models are different from those of time series cointegrated regression models, and if the data set is not panel cointegrated, then panel regression or time series regression may generate misleading results.[25]

As suggested by Pesaran and Pesaran (1997), a lag of three in level for the Vector Auto-Regressive (VAR) model specification was selected. Table 2.14 presents the findings for price and quantity in logarithm[26]. The p-value of the maximal eigenvalue test for the null hypothesis of no cointegration (r=0) among variables is 0.0223, therefore, we reject the null hypothesis of no cointegration (r=0) and conclude that the results favor the alternative of r=1 at 5% significant level. As the null hypothesis of $r \leq 1$ cannot be rejected at 5% significant level, we conclude that there exists a unique cointegrating relationship among variables LM_{it}, LP_{it}, and $LGDP_{it}$ in the panel data framework. The trace test also gives strong evidence in support of a unique cointegrating relationship among variables LM_{it}, LP_{it}, and $LGDP_{it}$ at 5% significant level.

25 For details, see Phillips and Moon (2000), and Kao and Chiang (2000) among others.

26 We also perform the same testing procedures for price, quantity, and the U.S. per capita income panel data. We find that they also have unique cointegrating relationship but with weaker statistical significance than the relationship between price and quantity.

Table 2.14. Johansen Fisher Panel Cointegration Tests

Unrestricted Cointegration Rank Test (Trace and Maximum Eigenvalue)				
Hypothesized	**Fisher Stat.***		**Fisher Stat.***	
No. of CE(s)	**(from trace test)**	**Prob.**	**(from max-eigen test)**	**Prob.**
None	22.13	0.0361	23.71	0.0223
At most 1	6.881	0.8654	6.881	0.8654

Individual cross section results				
	Trace Test		**Max-Eign Test**	
Cross Section	**Statistics**	**Prob.****	**Statistics**	**Prob.****
Hypothesis of no cointegration				
CN	27.3724	0.0323	20.3744	0.0359
HK	22.6377	0.1200	18.1987	0.0737
SING	15.6699	0.5193	13.4201	0.2953
THAI	16.4915	0.4537	11.7949	0.4345
MALAY	13.2006	0.7224	9.8049	0.6397
PHLIP	28.3964	0.0237	20.6416	0.0327
Hypothesis of at most 1 cointegration relationship				
CN	6.9980	0.3447	6.9980	0.3447
HK	4.4390	0.6780	4.4390	0.6780
SING	2.2498	0.9513	2.2498	0.9513
THAI	4.6966	0.6403	4.6966	0.6403
MALAY	3.3957	0.8265	3.3957	0.8265
PHLIP	7.7548	0.2724	7.7548	0.2724

Note:
**MacKinnon-Haug-Michelis (1999) p-values
CN, HK, SING, THAI, MALAY, and PHLIP denote China, Hong Kong, Singapore, Thailand, Malaysia, and the Philippines respectively.

2.12.3 Estimation of an error-correction model

After confirming that a unique cointegrating relationship exists, the short run dynamic behavior of the import demand function in equation (2.38) is examined. Three lags of the explanatory variables are selected and of the one period lagged error correction term in the right hand side in equation (2.38). Table 2.15 presents the findings. The estimated EC coefficient for China is the most satisfactory and is found to have the correct sign. The larger the EC coefficient in absolute values, the higher would be the speed of convergence of the import volume to the long-run equilibrium. The results in Table 2.15 show that once economic shock occurs, China will exhibit the highest speed of convergence to the equilibrium value in the long run. In China, the EC coefficient is estimated at -0.28, which is statistically significant at 1% level and has the correct sign. The results imply China is the most competitive among other countries because it has a self-adjustment mechanism against external shocks like financial crisis and trade interventions in the long-run.

Table 2.15. Estimated Error-Correction Model

Country	China	Hong Kong	Malaysia	Philippines	Singapore	Thailand
Dependent Variable	**D(LNQ)**	**D(LNQ)**	**D(LNQ)**	**D(LNQ)**	**D(LNQ)**	**D(LNQ)**
CointEq1	-0.2806	0.2290	0.0294	-0.0076	0.0044	-0.0109
	[-4.82438]	[4.48194]	[3.23296]	[-0.96402]	[3.20562]	[-1.43713]
D(LNQCN(-1))	0.3080	0.0402	-0.1885	-0.1940	-0.1290	-0.1113
	[3.04879]	[0.27574]	[-1.33822]	[-1.54162]	[-0.91540]	[-0.92840]
D(LNQCN(-2))	-0.1326	-0.1948	-0.1696	0.0241	-0.1354	0.0915
	[-1.28949]	[-1.36885]	[-1.20616]	[0.19369]	[-0.95158]	[0.72751]
D(LNPCN(-1))	0.3232	0.3487	0.1783	0.3772	-0.2363	-0.1452
	[1.21707]	[0.91942]	[0.74592]	[1.52651]	[-0.79481]	[-0.65166]
D(LNPCN(-2))	0.4910	0.4911	-0.1583	0.1911	0.2144	-0.1707
	[1.82813]	[1.23440]	[-0.66231]	[0.70868]	[0.72995]	[-0.74389]
D(LNCCN(-1))	-1.2029	1.0130	2.3001	0.8148	3.7158	2.1246
	[-0.95692]	[0.60215]	[1.94098]	[0.74750]	[2.14924]	[2.20016]
D(LNCCN(-2))	0.8922	-1.1152	4.8323	0.8271	2.9626	1.5850
	[0.71143]	[-0.63149]	[4.06320]	[0.74334]	[1.61631]	[1.66658]
C	0.0269	-0.0458				
	[1.18506]	[-1.40684]				
R-squared	0.3493	0.4559	0.2303	0.1055	0.0960	0.0955

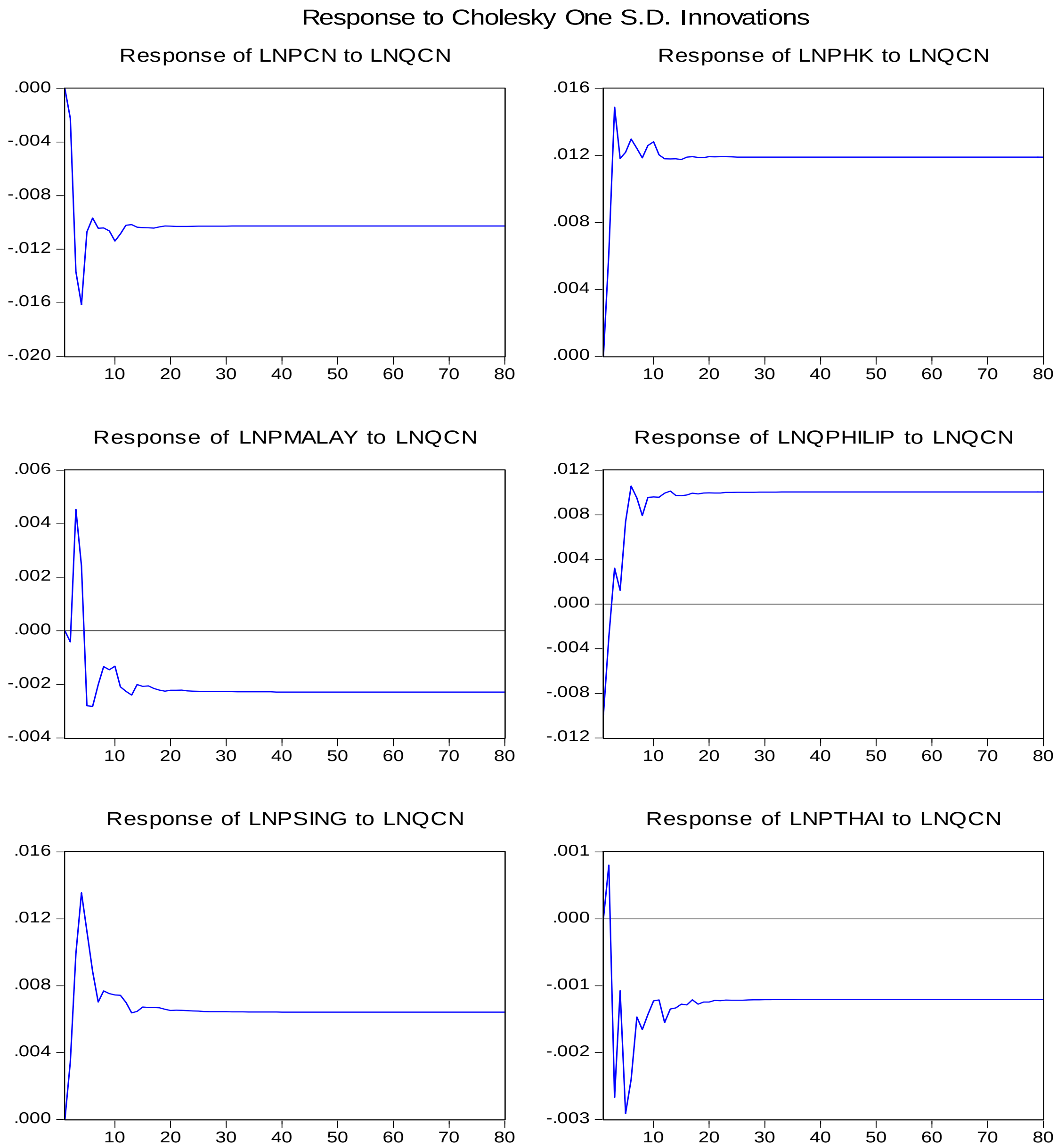
*t-statistics in []

Note: "CointEq1" represents the lagged error term obtained from the long run regression; CN represents China; D denotes the first difference operator; for example D(LNQCN(–1)) means the first difference of one lagged import quantity in logarithm

2.12.4 Impulse Response function

Figures 2.5-2.8 present the impulse-response functions, which highlight the persistence and impact of one standard deviation shock of price, and GDP per capita on import quantity over a given horizon of 20 years (80 quarters).

Figure 2.5. Response of prices to increase in China’s export

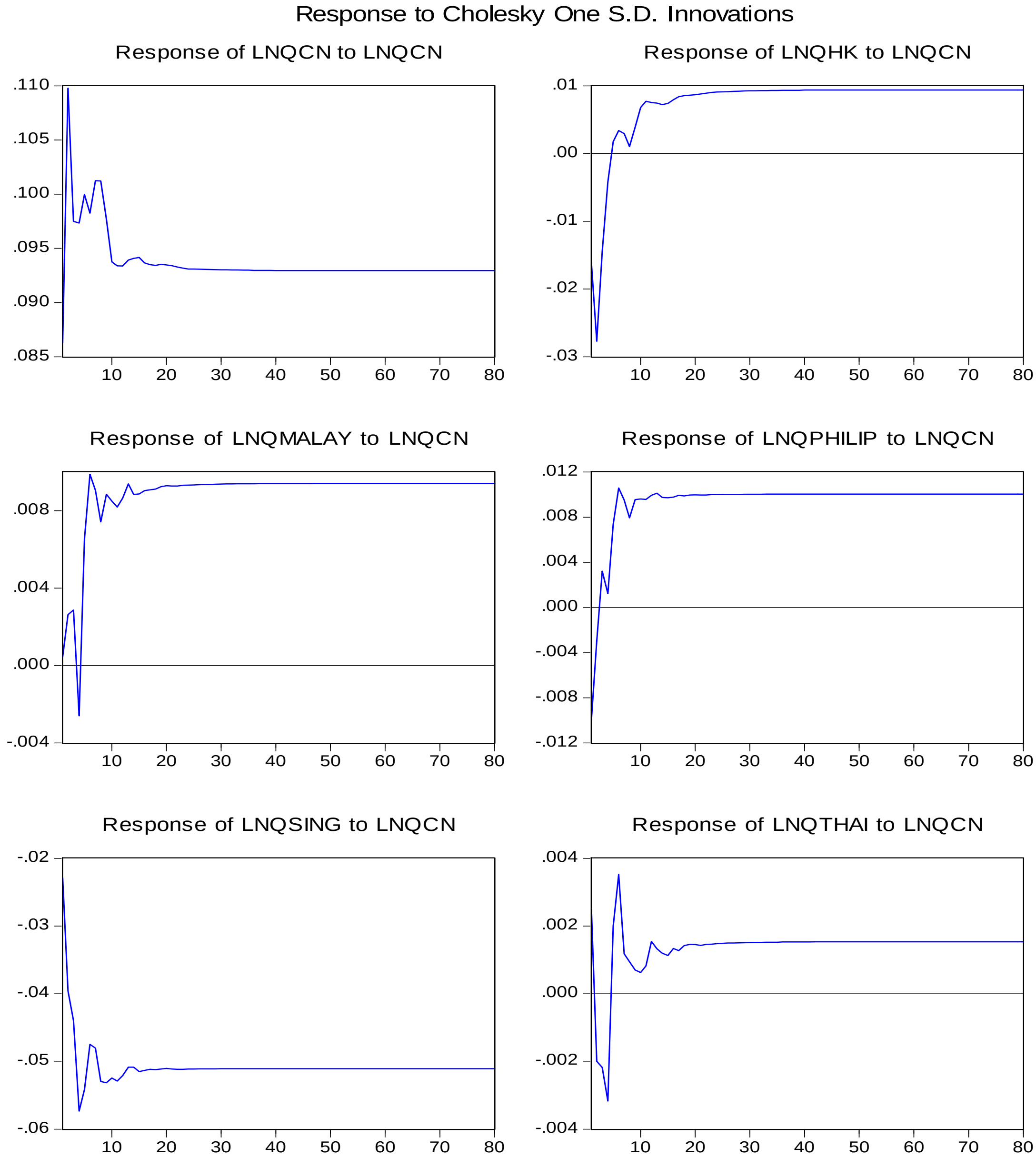


Note:

- Figures in Y-axis multiply 100 proxies percentage change of import price while X-axis denotes the number of quarters.
- LNPCN denotes import price in logarithm for China
  LNPHK denotes import price in logarithm for Hong Kong
  LNPMALAY denotes import price in logarithm for Malaysia
  LNPPHLIP denotes import price in logarithm for the Philippines
  LNPSING denotes import price in logarithm for Singapore
  LNQTHAI denotes import quantity in logarithm for Thailand

Figure 2.5 examines the price response of Hong Kong and four ASEAN countries to a unit shock in China’s change in export volume. In response to a unit shock in China’s increase in export volume of (measured as one standard deviation); we can see that it will result in increase of exporting price for Hong Kong and Singapore, but decrease in exporting price for other exporting countries.

Figure 2.6. Response of quantities to increase in China's export

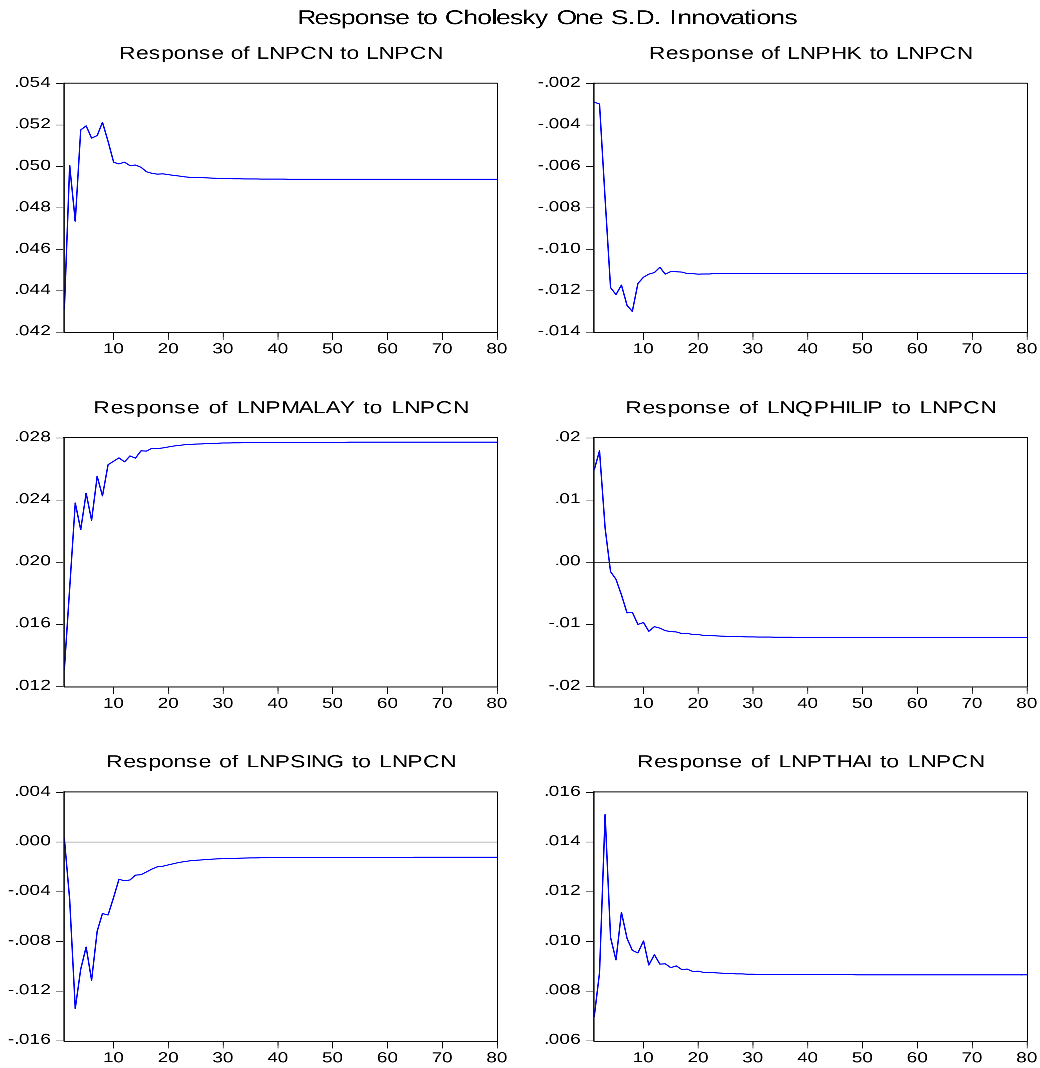


Note:

- Figures in Y-axis multiply 100 proxies percentage change of import quantity while X-axis denotes the number of quarters.
- LNQCN denotes import quantity in logarithm for China
  LNQHK denotes import quantity in logarithm for Hong Kong
  LNQMALAY denotes import quantity in logarithm for Malaysia
  LNQPHLIP denotes import quantity in logarithm for the Philippines
  LNQSING denotes import quantity in logarithm for Singapore
  LNQTHAI denotes import quantity in logarithm for Thailand

Figure 2.6 summarizes the export quantity response of Hong Kong and four ASEAN countries to a unit shock in China's change. In response to a unit shock in China's change in export volume (measured as one standard deviation); we can see that the China's expansion effect is not significant in the long-run. Taking Philippines as an example in Figure 2.6, it can be seen that the initial impact effect of a unit shock of China's export volume (measured as one standard deviation) on import quantity of the Philippines is negative and will have negative impact of 1% on export volume of the Philippines. However, the subsequent effect of the negative shock eventually disappears by the 10th quarter and remained constant thereafter over the rest of the given horizon.

Figure 2.7. Response of prices to increase in China's export price

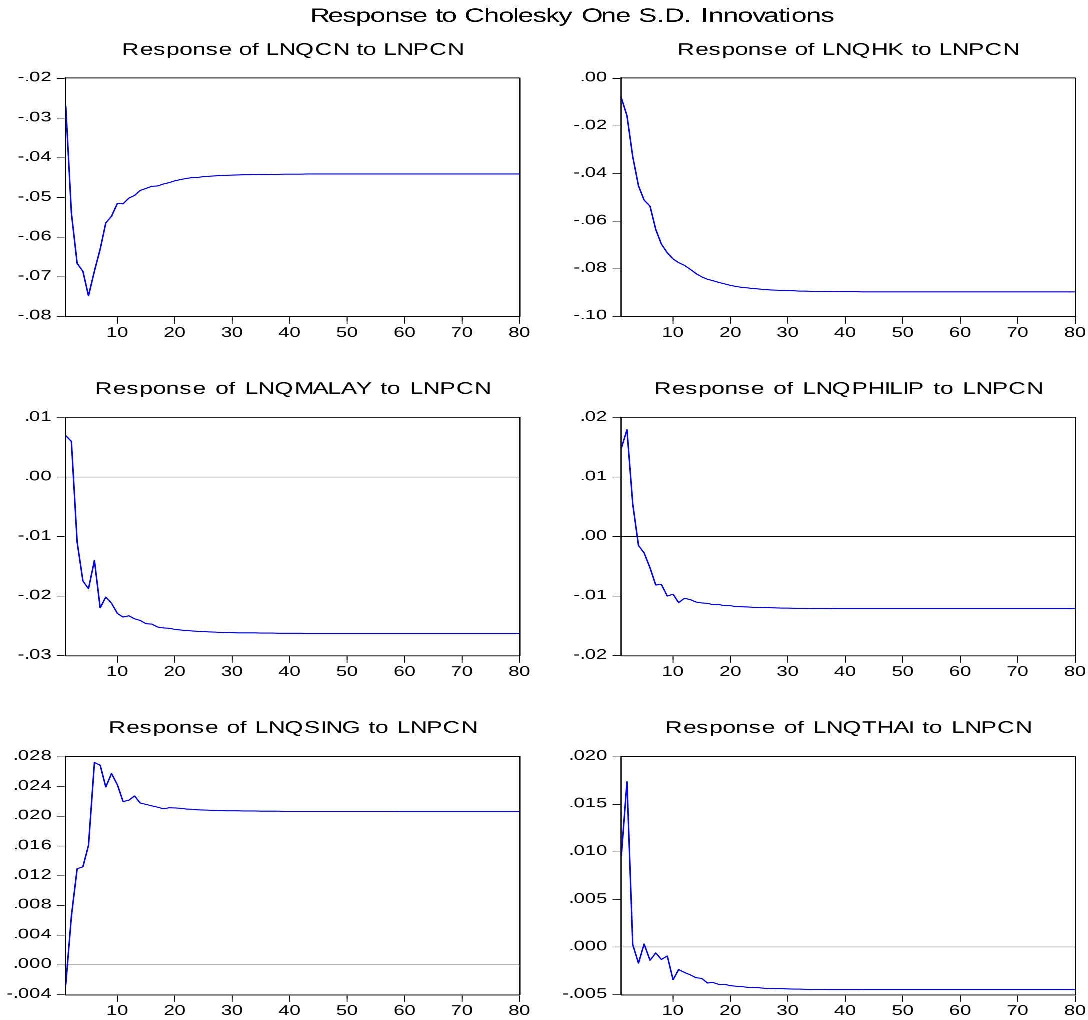


Note:

- Figures in Y-axis multiply 100 proxies percentage change of import price while X-axis denotes the number of quarters.
- LNPCN denotes import price in logarithm for China
  LNPHK denotes import price in logarithm for Hong Kong
  LNPMALAY denotes import price in logarithm for Malaysia
  LNPPHLIP denotes import price in logarithm for the Philippines
  LNPSING denotes import price in logarithm for Singapore
  LNQTHAI denotes import quantity in logarithm for *Thailand*

Figure 2.7 examines the price response of Hong Kong and four ASEAN countries to a unit shock in China's change in export price. Moreover, Figure 2.8 examines the quantity response of Hong Kong and four ASEAN countries to a unit shock in China's change in export price. All the empirical evidence suggests that China's expansion effect on her neighboring is insignificant, and therefore will not threaten their survival on the MFA apparels cottons exporting to the US market.

Figure 2.8. Response of quantities to increase in China's export price



Note:

- Figures in Y-axis multiply 100 proxies percentage change of import price while X-axis denotes the number of quarters.
- LNPCN denotes import price in logarithm for China
  LNPHK denotes import price in logarithm for Hong Kong
  LNPMALAY denotes import price in logarithm for Malaysia
  LNPPHLIP denotes import price in logarithm for the Philippines
  LNPSING denotes import price in logarithm for Singapore
  LNQTHAI denotes import quantity in logarithm for *Thailand*

2.12.5 Long-run price and income elasticity

Table 2.16 presents the estimates (normalized cointegrating coefficients) for Johansen cointegration relation such that:

$$LM_{i,t} + \alpha_{i,1} LP_{i,t} + \alpha_{i,2} LGDP_t = I(0) \quad \textbf{(2.42)}$$

Which means the linear combination of the above variables is stationary. Rewriting equation (2.42) one can have:

$$LM_{i,t} = -\alpha_{i,1} LP_{i,t} - \alpha_{i,2} LGDP_t \quad \textbf{(2.43)}$$

The estimated price and income elasticity can be represented by α1 and α2 respectively. They all exhibit correct sign in all trading partner except that of Thailand. Taking China as an example, the estimates suggest the following long-run relationship:

$$LM_{t-1} = -6.787 - 2.087 * LP_{t-1} + 2.789 * LGDP_{t-1} \quad \textbf{(2.44)}$$

Model (2.44) suggests that the long-run price and income elasticity estimates are highly significant and with expected sign for China. The long-run price elasticity is –2.087, which implies that a reduction of 10% in import prices brings about 21% rise in imports. The long-run income elasticity is 2.789; it implies a 10% increase in GDP per capita in the U.S., which will bring about a 28% rise in imports from China.

Table 2.16. Normalized Cointegrating coefficients

Country	China	Hong Kong	Malaysia	Philippines	Singapore	Thailand
Cointegrating Eq:	**CointEq1**	**CointEq1**	**CointEq1**	**CointEq1**	**CointEq1**	**CointEq1**
LNQ(-1)	1	1	1	1	1	1
LNP(-1)	-2.0867	-0.3980	-0.4369	-2.1598	- 4.790	0.3088
	[-11.41]	[-0.467]	[- 0.353]	[- 0.636]	[-0.293]	[0.155]
LNGDP(-1)	2.7887	0.1055	0.2361	0.2691	0.1356	1.1497
	[17.69]	[0.344]	[0.270]	[0.233]	[0.015]	[-1.324]
C	-6.7870	17.4140	16.9566	14.9038	46.4458	2.9390

*t-statistics in []

Note: "CointEq1" means cointegration equation; C denotes a constant estimate; LNQ(-1) represents the estimate of the one lagged import quantity in logarithm; LNP(-1) represents the estimate of the one lagged import price in logarithm; LNGDP(-1) represents the estimate of the one lagged GDP in the U.S. in logarithm.

Several implications emerge from Table 2.16 for Mainland China. First, income elasticity is elastic for MFA apparel cottons imported from China, which suggests that an increase of 10% in GDP per capita in the U.S. brings more than a 10% rise in imports. Second, consumers in the U.S. are sensitive to price changes of MFA apparel cottons imported from China. Since the price elasticity is approximately -2.1, this finding implies that revenue can be increased by cutting price on average, and this is consistent with the authors' observations. The combination of elastic price elasticity and income elasticity suggest that China maintains a competitive position in the U.S. market.

2.12.6 Panel Regression with Fixed Effect

In econometrics the problem of endogenity occurs once the explanatory variable is correlated with the error term in the regression model because it will provide biased coefficients. Using cross sectional data at the year 1996, Milgram (2005) estimates the impact of the MFA abolishment on European clothing imports from 22 countries for 20 categories. Two Stage Least Squares (2SLS) method is used to control for an endogeneity bias. It is found that the phasing-out of quotas should increase EU imports by 20%. In this paper, the estimation procedure followed here does not suffer from such endogeneity bias because I find no correlation between explanatory variables and the estimated residuals resulted from the panel regression model. All variables in equation (2.45) are expressed in logarithmic form; a fixed effect model may be constructed as follows:

$$LM_{i,t} = \alpha_{i,0} + \alpha_{i,1} LP_{i,t} + \alpha_{i,2} LGDP_t + \varepsilon_{i,t} \qquad \textbf{(2.45)}$$

where $\alpha_{i,0}$ captures all unobserved time-constant factors that affect $LP_{i,t}$, and $LGDP_{i,t}$. $\alpha_{i,0}$ is called unobserved effect or simply fixed effects and it does not change over time. Geographical features, such as the country's location, can be included in α_i.

Many other factors may not be exactly constant, but they might be roughly constant in the short-run. The model is called the fixed effect model. $\epsilon_{i,t}$ is the idiosyncratic error or time-varying error, because it represents unobserved factors that change over time, and affect explanatory variables. Alternatively, we may construct a random effect model as follows:

$$LM_{i,t} = \alpha_{i,0} + \alpha_{i,1} LP_{i,t} + \alpha_{i,2} LGDP_t + \mu_{i,t} \quad \textbf{(2.46)}$$

where the error term, $\mu_{i,t}$ belongs to i'th individual country and is assumed to be constant through the whole sample period.

However, in our import demand function, there is no indication of fixed effect because the export volume should be zero for every exporting country if the export price is zero or the U.S. per capita income is zero. Table 2.17, Table 2.18, and Table 2.19 present estimation results for pooled regression, fixed effect panel regression, and random effect regression respectively. Essentially, we need to determine between fixed and random effect by running a "Hausman specification test" as suggested by Hausman (1978). Normally, fixed effect is reasonable to deal with in panel data because it always gives consistent results, however, random effect is a more efficient estimator, so we should run random effects if it is statistically justifiable to do so. The "Hausman test" checks a more efficient model against a less efficient, but consistent model to make sure that the more efficient model also gives consistent results. The chi-square statistics of the "Hausman test" is 2.78, suggesting that random effect modeling is appropriate as expected. The result suggests that random effect is the appropriate model; it shows that all variables are significant at 5% level. The results also imply that MFA apparel cottons imports will, on average increase 26% as induced by 10% increase in the U.S.'s per capita GDP, whereas with a 10% increase/decrease of exporting price there is 7.5% decrease/increase in imports.

Table 2.17. Pooled Regression

Independent variable: LNQ				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	0.8495	0.2408	3.5275	0.0005
LNP_i	-0.7147	0.0998	-7.1649	0.0000
LNGDP	2.6569	0.7120	3.7317	0.0002
LNQ_i(-1)	1.0067	0.0042	238.1008	0.0000
LNGDP(-1)	-2.7480	0.7073	-3.8855	0.0001
LNP_i(-1)	0.6126	0.1009	6.0727	0.0000
R-squared	**0.9933**	**Durbin-Watson stat**		**1.7256**
Sum squared resid	**4.5693**			

Note:

C denotes a constant estimate; LNQ represents the estimate of the import quantity in logarithm LNQ (-1) represents the estimate of the one lagged import quantity in logarithm; LNP (-1) represents the estimate of the one lagged import price in logarithm; LNGDP (-1) represents the estimate of the one lagged GDP in U.S. in logarithm.

Table 2.18. Fixed Effect Regression

Independent variable: LNQ				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	0.6041	0.2784	2.1702	0.0305
LNP	-0.6839	0.1008	-6.7817	0.0000
LNGDP	2.3966	0.7242	3.3094	0.0010
LNQ(-1)	1.0223	0.0107	95.4969	0.0000
LNGDP(-1)	-2.4990	0.7184	-3.4788	0.0005
LNP(-1)	0.6414	0.1023	6.2689	0.0000
Fixed Effects (Cross)				
CN--C	-0.0079			
HK--C	-0.0394			
MALAY--C	0.0172			
PHLIP--C	-0.0077			
SING--C	0.0194			
THAI--C	0.0183			
R-squared	**0.9934**	**Durbin-Watson**		**1.7726**
Sum squared resid	**4.4877**			

Note:

C denotes a constant estimate; LNQ represents the estimate of the import quantity in logarithm LNQ (-1) represents the estimate of the one lagged import quantity in logarithm; LNP (-1) represents the estimate of the one lagged import price in logarithm; LNGDP (-1) represents the estimate of the one lagged GDP in U.S. in logarithm. CN denotes China; HK denotes Hong Kong; ALAY denotes Malaysia; PHLIP denotes the Philippines; SING denotes Singapore; THAI; denotes Thailand. For example THAI-C means the constant estimate for Thailand.

Table 2.19. Random Effect Regression

Independent variable: LNQ				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	0.800001	0.247674	3.23006	0.0013
LNP	**-0.70526**	0.099865	-7.06215	**0**
LNGDP	**2.597854**	0.712803	3.644561	**0.0003**
LNQ(-1)	1.009524	0.005938	170.0071	0
LNGDP(-1)	-2.69101	0.707885	-3.80148	0.0002
LNP(-1)	0.617839	0.100987	6.118025	0
Random Effects (Cross)				
CN--C	0.003986			
HK--C	-0.01197			
MALAY--C	0.003376			
PHLIP--C	-0.00728			
SING--C	0.003709			
THAI--C	0.008187			
R-squared	**0.987812**	**Durbin-Watson stat**		**1.74185**
Sum squared resid	**0.987687**			

Note:

C denotes a constant estimate; LNQ represents the estimate of the import quantity in logarithm LNQ (-1) represents the estimate of the one lagged import quantity in logarithm; LNP (-1) represents the estimate of the one lagged import price in logarithm; LNGDP (-1) represents the estimate of the one lagged GDP in U.S. in logarithm. CN denotes China; HK denotes Hong Kong; ALAY denotes Malaysia; PHLIP denotes the Philippines; SING denotes Singapore; THAI; denotes Thailand. For example THAI-C means the constant estimate for Thailand.

2.13. Conclusions

This part provides a comprehensive and disaggregated set of elasticity estimates to date in the face of MFA abolishment. The estimates here is at a detailed level of disaggregation should provide researchers with opportunities for future work. In the empirical examination of the MFA apparel cottons exported to the U.S. from Mainland China, Hong Kong and ASEAN countries during the years 1989-2009, I apply cointegration, and error correction approaches to the US's import demand function for textiles items. Several puzzles on the elimination of MFA have been solved. First is the extraction of a unique long-run equilibrium relationship among import quantity demanded, imported price, and U.S. GDP per capita. This implies that the existing trade mechanism is capable of ensuring long-run equilibrium of imported quantity, price, and consumer's income.

Second, the long-run price and income elasticity are found to be significant with expected signs, which are important for most of the trade-policy analyses. In general, MFA abolishment benefits Chinese apparel cottons exports; along with elastic long-run price and income elasticity, it is expected that Chinese firms would earn more revenue in the long -run. The imported price of MFA apparel cottons is subject to downward pressure owing to intensified competition from developing countries after the abolishment of MFA. However, the price elasticity is generally elastic which implies that 1% decrease in unit price will bring more than 1% increase in import volume. This, in turn implies that total revenue will increase, given that other constraints remain constant. Moreover, high-income elasticity also implies that textile items are quite competitive at the current price level.

Third, it is found that Chinese textiles firm reacts quicker than other countries to trade disturbances. An Error Correction Model was estimated to determine the short run dynamics around the equilibrium relationship. From impulse response function, I find that the expansion of Chinese apparel cottons does not threaten the survival of its neighboring countries in the US market, because the negative impact of the China's emergence is only temporary and insignificant. Challenges remain in determining elasticity estimates. However, more advanced models, like those of Markov-Regime Switching models, should be used to endogenalize the effect of trade liberalization in future research.

Chapter 3: A Quantitative Assessment of Real and Financial Integration in China, *AND* New Evidence about Regional Income Divergence in China

This chapter is divided into two parts. The first part examines the degree of real and financial market integration between China, her main trading partners, and four selected ASEAN countries. The second part examines the growth path dynamics and growth determinants in the Chinese economy using the provincial data. I will examine the empirical validity of both beta and sigma unconditional income convergence across Chinese provinces from 1952 to 2005 using both linear and non-linear panel unit root tests.

The competitiveness of the Chinese economy has become increasingly crucial to survive in a globalized world; part one of the current chapter assesses the competitiveness of Chinese economy from the perspective of the degree of integration in the international commodity and financial market. In this part, I examine the tradable goods and financial integration between China, and her four main trading partners, four ASEAN countries[27] using a unit root test that takes into account non-linearity and contemporaneous cross-sectional dependence.

27 Four main trading partners are the United States, European Union, Japan, and United Kingdom. Four ASEAN countries include Singapore, Thailand, Malaysia, and the Philippines.

In the second part of this chapter, I examine the growth path dynamics and growth determinants in the Chinese economy using the provincial data. I examine the empirical validity of both beta and sigma unconditional income convergence across Chinese provinces from 1952 to 2005 using both linear and non-linear panel unit root tests. The provincial growth determinants are also investigated so that the factors affecting domestic competitiveness and growth path can be better understood.

The rest of this chapter is organized as follows. Section 3.1 to section 3.4 devote to the study of real and financial market integration. Section 3.1 introduces the first part and conceptual framework for analyzing degree of integration. Section 3.2 provides information on data and econometrics methodology adopted in this part of study. Section 3.3 discuses empirical evidence on the validity of those three parity conditions, and section 3.4 concludes this part of study.

Section 3.5 to section 3.9 devote to the study of income divergence in China. Section 3.5 introduces the second part. Section 3.6 provides a brief literature review on income convergence. Section 3.7 describes the empirical methodologies that I employ. Section 3.8 evaluates the empirical findings from different unit root tests in determining whether provincial real income per capita is indeed converging or diverging among Chinese provinces in the pre-reform and post-reform periods. The provincial growth determinants are also investigated. Section 3.9 draws the conclusions.

Part 1- A Quantitative Assessment of Real and Financial Integration in China

3.1. Introduction

The competitiveness of the Chinese economy has become increasingly crucial for China to survive in a globalizing world; the current study assesses the competitiveness of Chinese economy from the perspective of the degree of integration in the real (i.e. tradable goods) and financial market. In this part, I examine the empirical validity of real interest parity, uncovered interest parity and purchasing power parity. These three parity conditions define the key links between markets. As Cheung et al., (2003, 2006) mentions, those parity conditions are traditionally used to quantify the degree of integration in capital, financial and goods markets by using the methodology of Augmented Dickey-Fuller (ADF) unit root test. Cheung et al., (2003) studies the real and financial integration between China, Hong Kong, and Taiwan in the period from Feb 1996 and June 2002. They find China and Hong Kong appear to have experienced significant increases in integration. Cheung et al., (2006) extends their study by including Japan and the U.S, and find evidence in favor of real and financial integration between China, Japan, and the U.S.

However, the unit root tests applied in their studies are not appropriate in the sense that they ignore the issues of contemporaneous cross-sectional dependence and non-linear dynamic in the arbitrage process. In my study, I examine the tradable goods and financial integration between China, her four main trading partners, and four

ASEAN countries[28] using a unit root test that takes into account the non-linearity and contemporaneous cross-sectional dependence, and I find evidence in favor of real and financial integration between China and her main trading partners.

Recently, a vast amount of studies have focused on the effect of trade flow issues after China entered the WTO, for example Fernald et al., (1999), Ma (2001), Noland et al (1998), Wang (2003) and Wei et al., (2000), among others. Despite claims about significance of institutional conditions (Tvaronavičienė *et al.,* 2009), there is a lack of thoroughgoing quantitative analyses focusing on the empirical issues of real and financial links between separate countries except for studies conducted by Cheung et al (1994), Cheung et al (2003, 2006), Chinn & Frankel (1994), De Brouwer (1999), Glick & Hutchison (1990) and Kumhof (2001).

Lane and Schmukler (2007) concentrates on the international financial integration of China and India. In his senior thesis, Lei (2006) analyzes the real and financial integration between China and Taiwan basing his research on the empirical validity of real interest parity, uncovered interest parity and relative purchasing power parity. Moreover, Chan et al., (2007) investigates the real and financial integration among East Asian economies. They incorporate the ASEAN-5, South Korea and mainland China with the US and Japan taken as base countries. The researchers have chosen a SURADF panel approach, which complies with one of perceptions expressed by other authors (e.g. Kahraman and Kaya, 2010). Additionally, Cheung et al., (2006) assesses and compares the linkages between China and the other Chinese economies of Hong Kong and Taiwan against the linkages with Japan and the US. They characterize

28 Four main trading partners are the United States, European Union, Japan, and United Kingdom. Four ASEAN countries include Singapore, Thailand, Malaysia, and the Philippines.

the time series behavior of three criteria of integration, namely real interest parity, uncovered interest parity, and relative purchasing power parity.

It is important to study the tradable goods and financial integration of China with her major trading partners for several reasons. Firstly, the international competitiveness has become increasingly significant for countries to sustain their influence and trade position in a globalizing world. The current paper assesses the competitiveness of the Chinese economy from the perspective of the degree of integration in the commodity and financial markets, and hence sheds light on its international competitiveness. Secondly, it is of current interest for researchers to know if China can pull the world, especially the developed countries out of recession in occurrence of economic shocks, for example, the recent financial crisis. Many observers hope China can be the growth engine of the world economy by absorbing tradable goods from and providing capital to the world market, especially after the outbreak of Financial Tsunami in 2008. However, despite the fact that China's phenomenal growth a strong trade link and flow of capital between China and developed economies is a necessary condition for China to become the engine of the world economy.

Furthermore, the financial aspect is also *one of the strong motivations* of this study. We attempt to analyze how financial reforms and the liberalization of capital accounts of China affect the financial integration of China with her major trading partners. As mentioned by Lane and Schmukler (2007), China's international balance sheet is highly skewed. In 2008, China became the third largest FDI recipient country (after the United States and France) in the world. Moreover, China has become an important source of outward investment. There are also large amounts of capital flows and portfolio investments in China and from China to her major trading partners. These all make analyzing the financial integration of China with her major trading partners important.

In this part, I examine the empirical validity of real interest parity, uncovered interest parity and purchasing power parity. These three parity conditions define the key links between markets. As Cheung et al (2003, 2006) mentions, those parity conditions are traditionally used to quantify the degree of integration in capital, financial and goods markets by using the methodology of Augmented Dickey-Fuller (ADF) unit root test. Cheung et al., (2003) studies the real and financial integration between China, Hong Kong, and Taiwan in the period from February 1996 to June 2002. They find China and Hong Kong appear to have experienced significant increases in integration. Cheung et al., (2006) extends their study by including Japan and the US, and find evidence in favor of tradable goods and financial integration between China, Japan, and the US. However, I argue that the unit root tests applied in their studies are not appropriate in the sense that they ignore the issues of contemporaneous cross-sectional dependence and non-linear dynamic in the arbitrage process.

Following the idea of Cheung et al., (1994, 2003, 2006), the evidence of tradable goods integration exists when relative purchasing power parity holds while there is evidence of financial integration where uncovered interest parity holds. Moreover, if both real and financial parity exist simultaneously, the "Real Interest Parity" (RIP) has to hold. The concept of real interest parity is based on the ex ante real interest rate. Hence, theoretically we expect Real Interest Parity differential between two countries:

$$r_{t,j}^{e,d} - r_{t,j}^{e,f} \equiv (i_{t,j}^{d} - i_{t,j}^{f} - \Delta S_{t,j}^{e}) - [\pi_{t,j}^{e,d} - \pi_{t,j}^{e,f} - \Delta s_{t,j}^{e}] \qquad \textbf{(3.1)}$$

where $r_{t,j}^{e,d}$, $i_{t,j}^{d}$ and $\pi_{t,j}^{e,d}$ are the j period expected real interest rate, expected nominal interest rate and expected inflation in the domestic country, respectively. The d and f denote domestic and foreign countries, respectively, whereas e indicates expectation and j period maturity, j being equal to t+1 in this case. The expected depreciation is defined as:

$$\Delta s_{t,t+1}^{e} \equiv s_{t,t+1}^{e} - s_{t} \times 12 \times 100 \qquad \textbf{(3.2)}$$

where $s_{t,j}^{e}$ is the expected nominal foreign exchange rate in logarithm between two countries at time t+1 while s_t is the nominal foreign exchange rate in logarithm at time t. I use Chinese Yen vis-à-vis the currency of other countries, and the annualized domestic expected inflation rate at time t is given by:

$$\pi_{t,j}^{e,d} \equiv (p_{t,t+1}^{d,e} - p_{t}) \times 12 * 100 \qquad \textbf{(3.3)}$$

where $p_{t,t+1}^{d,e}$ and p_t are the price in logarithm expected at time t+1 and the price in logarithm at t, respectively. In the *ex ante* sense, the term $(i_{t,j}^{d} - i_{t,j}^{f} - \Delta s_{t,j}^{e})$ is the expected "Uncovered Interest Parity" (UIP) differential while $[\pi_{t,j}^{e,d} - \pi_{t,j}^{e,f} - \Delta s_{t,j}^{e}]$ is the expected "Relative Purchasing Power Parity" (RPPP) differential.

Unfortunately, in practice, data on expected parity differentials are unavailable so I adopt *ex post* parity differentials instead, assuming rational expectations hold. We have:

$$r_{t,j}^{d} - r_{t,j}^{f} \equiv (i_{t,j}^{d} - i_{t,j}^{f} - \Delta s_{t,j}) - [\pi_{t,j}^{d} - \pi_{t,j}^{f} - \Delta s_{t,j}] \qquad \textbf{(3.4)}$$

The above equations imply that a necessary condition for real interest parity to hold is that uncovered interest parity and relative purchasing power parity have to hold simultaneously. The existence of uncovered interest parity implies financial integration as supported by arbitrage activities. On the other hand, evidence in support of relative purchasing power parity implies real market integration. Therefore, real interest parity is a function of both financial and real market integration (Frankel, 1991). In the following sections, I will provide data description, econometrics methodology, and empirical results on the real and financial integration between China and other trading partners.

3.2. Data Description and Econometrics Methodology

Monthly (end-of-period) data on one-month inter-bank interest rates, nominal bilateral exchange rates and consumer price indices are gathered for China, the European Union, Japan, the United Kingdom and the United States, Singapore, Malaysia, Philippines and Thailand from February 1997 to August 2009.[29]

Parity differentials of Purchasing Power Parity (PPP), Uncovered Interest Parity (UIP) and Rear Interest Parity (RIP) are plotted in Figures 3.1 to 3.6 in annualized percentages for different countries. A preliminary phenomenon can be observed regarding the degree of integration through time. One can observe that the parity differentials fluctuate around mean zero without large volatility, and the parity differentials of all the countries show signs of co-movement for the whole sample period.

Tables 3.1 and 3.2 present descriptive statistics of three parity differentials. Some preliminary results can also be derived on the degree of integration. For example, in Table 3.1, PPP differential between China and the Japan exhibit the smallest mean while China and the EU exhibit the highest mean value. If using these descriptive statistics to infer the degree of integration in goods market, one may concludes that China and Japan exhibits the highest degree of real integration while European Union maintains the

29 The data are gathered from China Information Bank, Data-Stream (electronic version), and International Financial Statistics (IFS).

highest trade barriers towards China, followed by United States. Moreover, Table 3.2 implies that China and Singapore maintains the highest degree of real integration while Malaysia exhibits the highest trade barriers towards China, followed by Thailand.

Table 3. 1. Descriptive statistics: Four main trading partners

	RIPCHEU	RIPCHJAP	RIPCHUK	RIPCHUS
Mean	2.880	3.841	1.032	2.920
Median	2.238	2.262	0.770	2.075
Maximum	33.755	38.722	41.563	39.273
Minimum	-19.803	-20.534	-24.794	-19.628
Std Dev.	8.212	9.077	9.806	9.355
	UIPCHEU	**UIPCHJAP**	**UIPCHUK**	**UIPCHUS**
Mean	0.615	3.315	-0.048	1.487
Median	0.301	10.503	2.261	0.760
Maximum	78.311	91.098	180.451	25.492
Minimum	-103.210	-168.746	-90.287	-8.833
Std Dev.	3.941	4.399	2.804	2.575
	PPPCHEU	**PPPCHJAP**	**PPPCHUK**	**PPPCHUS**
Mean	-2.265	-0.526	-1.080	-1.433
Median	-0.285	6.928	0.402	-1.413
Maximum	65.085	86.485	163.698	23.195
Minimum	-111.885	-176.750	-97.754	-35.830
Std Dev.	33.609	43.898	32.371	9.526

Note:

RIP, UIP, and PPP denotes real interest parity, uncovered interest parity, and purchasing power parity respectively.

For example:

RIPCHEU denotes the time series of real interest parity differential between China and the European Union.

UIPCHJAP denotes the time series of uncovered power parity differential between China and Japan.

PPPCHUK denotes the time series of purchasing power parity differential between China and the United Kingdom.

PPPCHUS denotes the time series of purchasing power parity differential between China and the United States.

Table 3. 2 Descriptive statistics: Four ASEAN countries

	RIPCHSING	RIPCHTHAI	RIPCHPHLIP	RIPCHMALAY
Mean	3.432	1.788	3.902	2.731
Median	2.482	0.946	2.654	1.034
Maximum	32.272	42.712	35.499	53.452
Minimum	-23.092	-20.411	-22.647	-22.098
Std Dev.	8.137	10.215	9.943	9.682
	UIPCHSING	**UIPCHTHAI**	**UIPCHPHLIP**	**UIPCHMALAY**
Mean	3.372	2.169	4.265	4.074
Median	2.433	-0.601	3.358	-0.020
Maximum	69.467	245.309	219.534	185.633
Minimum	-80.024	-224.612	-139.660	-119.411
Std Dev.	21.403	46.284	34.862	27.710
	PPPCHSING	**PPPCHTHAI**	**PPPCHPHLIP**	**PPPCHMALAY**
Mean	-0.060	0.381	0.363	1.344
Median	-0.537	-2.126	-0.488	0.168
Maximum	63.950	246.006	209.356	170.572
Minimum	-85.262	-210.517	-152.203	-131.148
Std Dev.	21.743	46.386	35.517	27.814

Note:

RIP, UIP, and PPP denotes real interest parity, uncovered interest parity, and purchasing power parity respectively.

For example:

RIPCHSING denotes the time series of real interest parity differential between China and Singapore.

UIPCHTHAI denotes the time series of uncovered power parity differential between China and Thailand.

PPPCHPHLIP denotes the time series of purchasing power parity differential between China and the Philippines.

PPPCHMALAY denotes the time series of purchasing power parity differential between China and Malaysia.

Figure 3. 1. Deviation from the Purchasing power parity: Four main trading partners

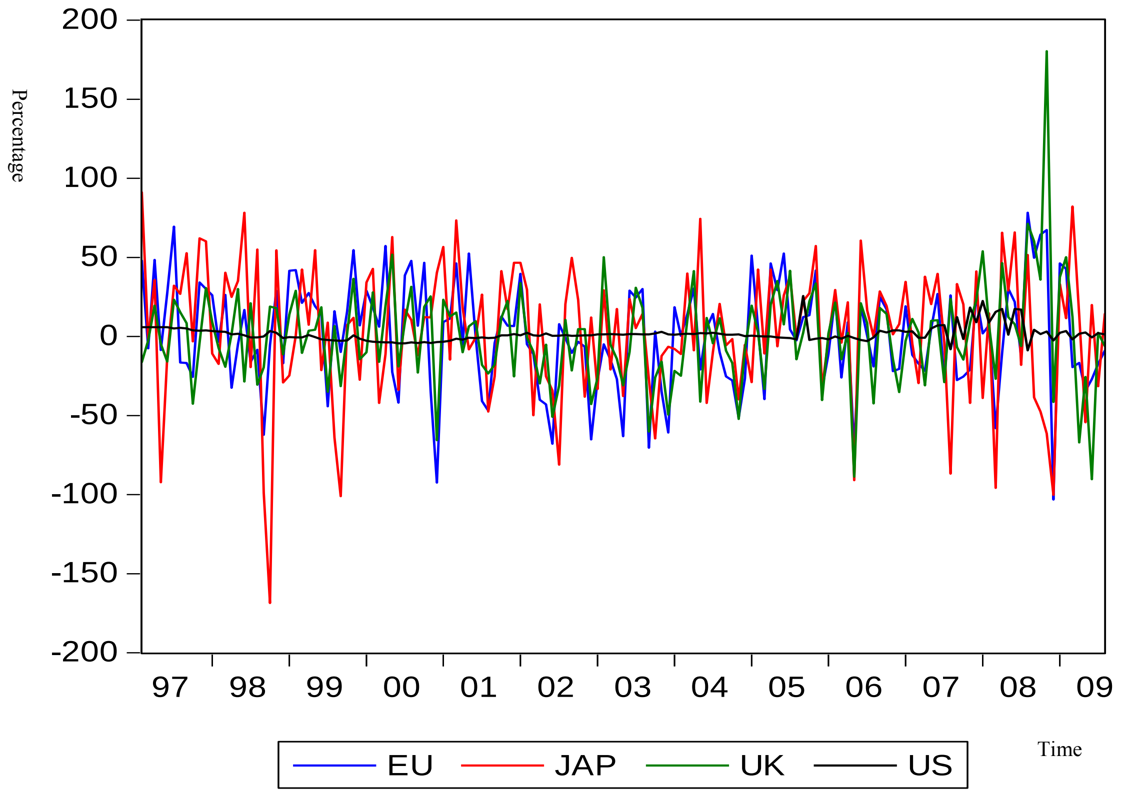


Figure 3. 2. Deviation from the Uncovered interest parity: Four main trading partners

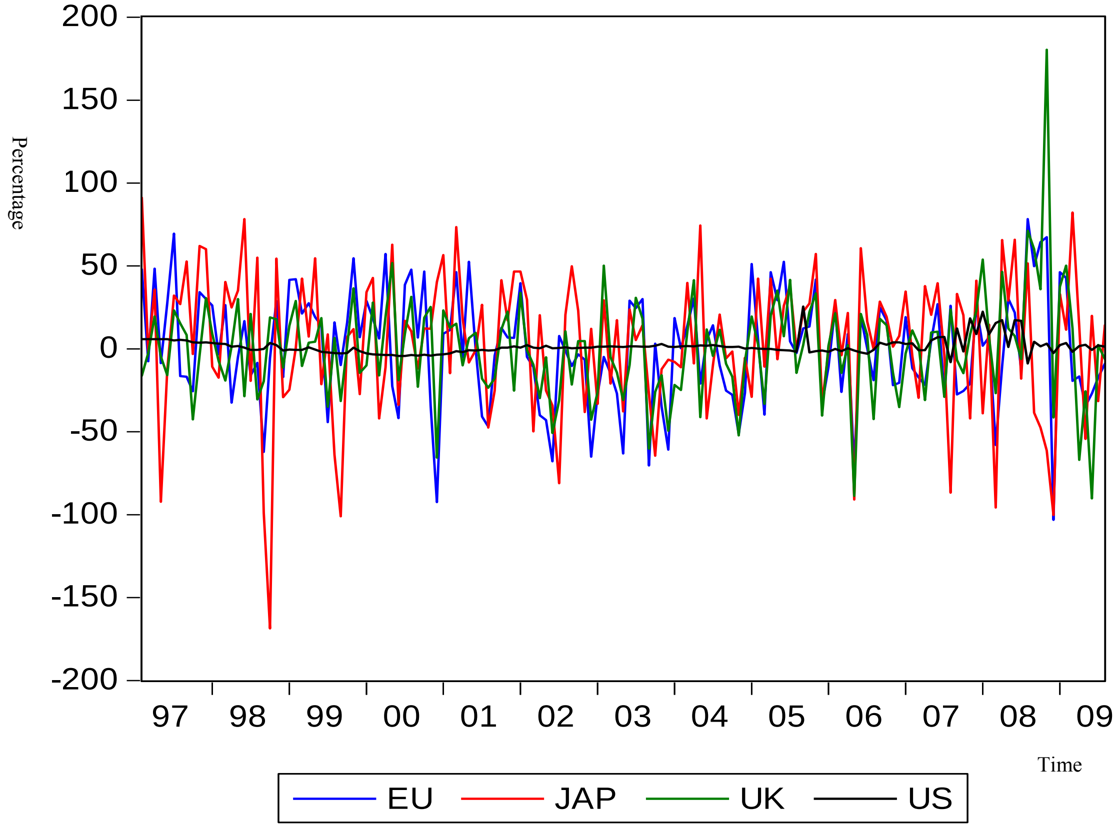


Figure 3. 3. Deviation from the Real interest parity: Four main trading partners

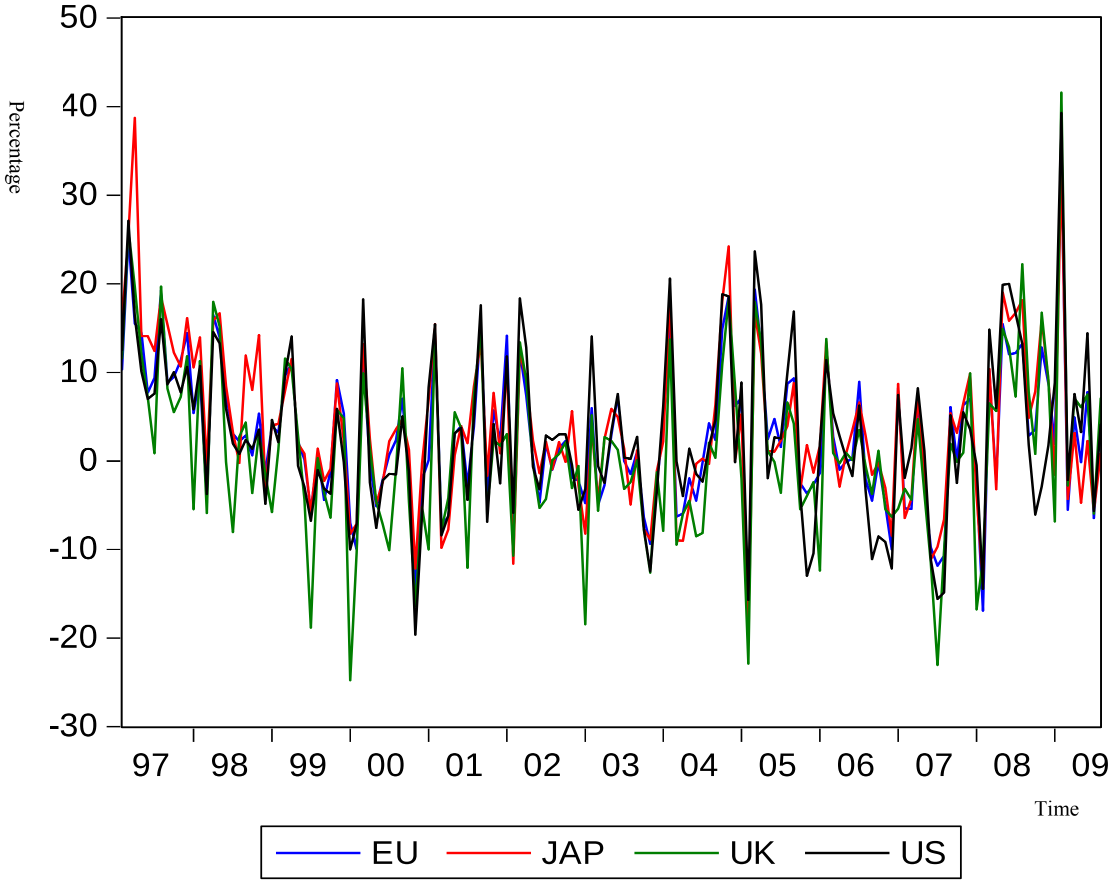


Figure 3. 4. Deviation from the Purchasing power parity: Four ASEAN countries

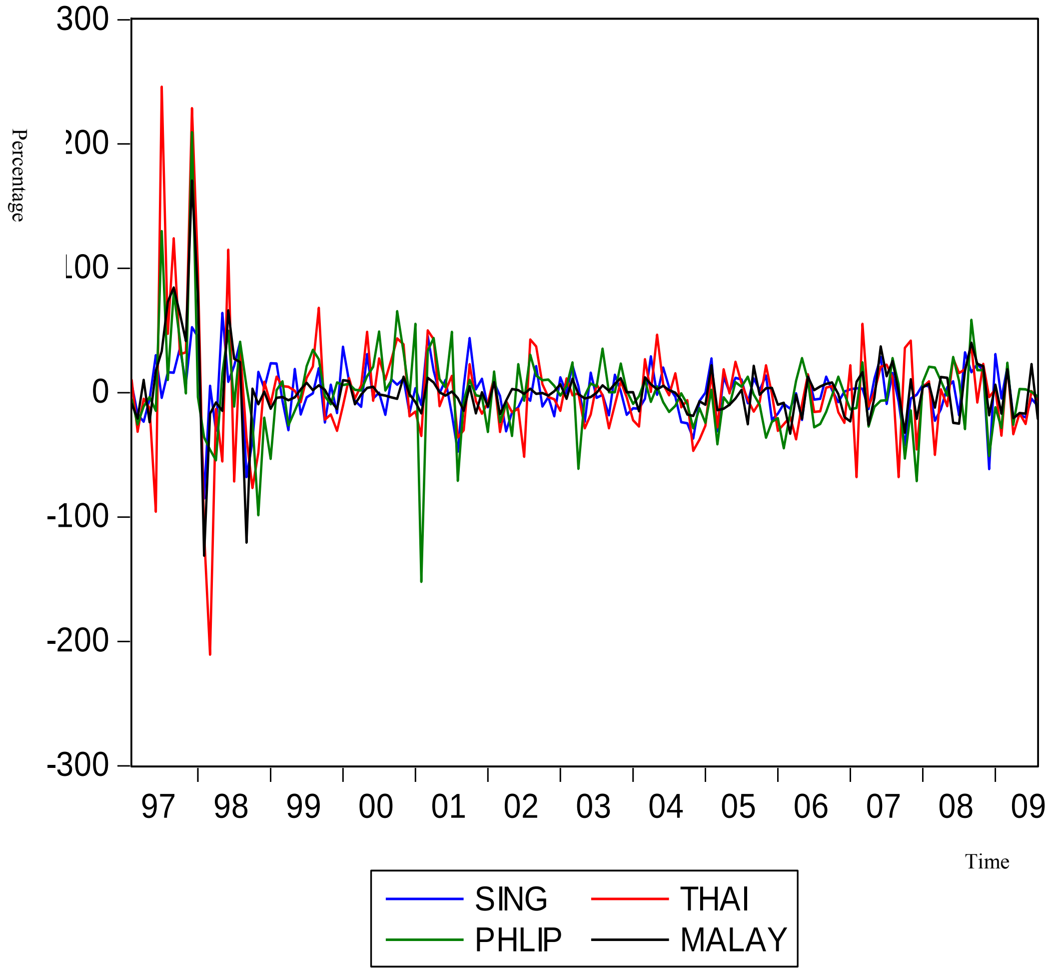


Figure 3. 5. Deviation from the Uncovered interest parity: Four ASEAN countries

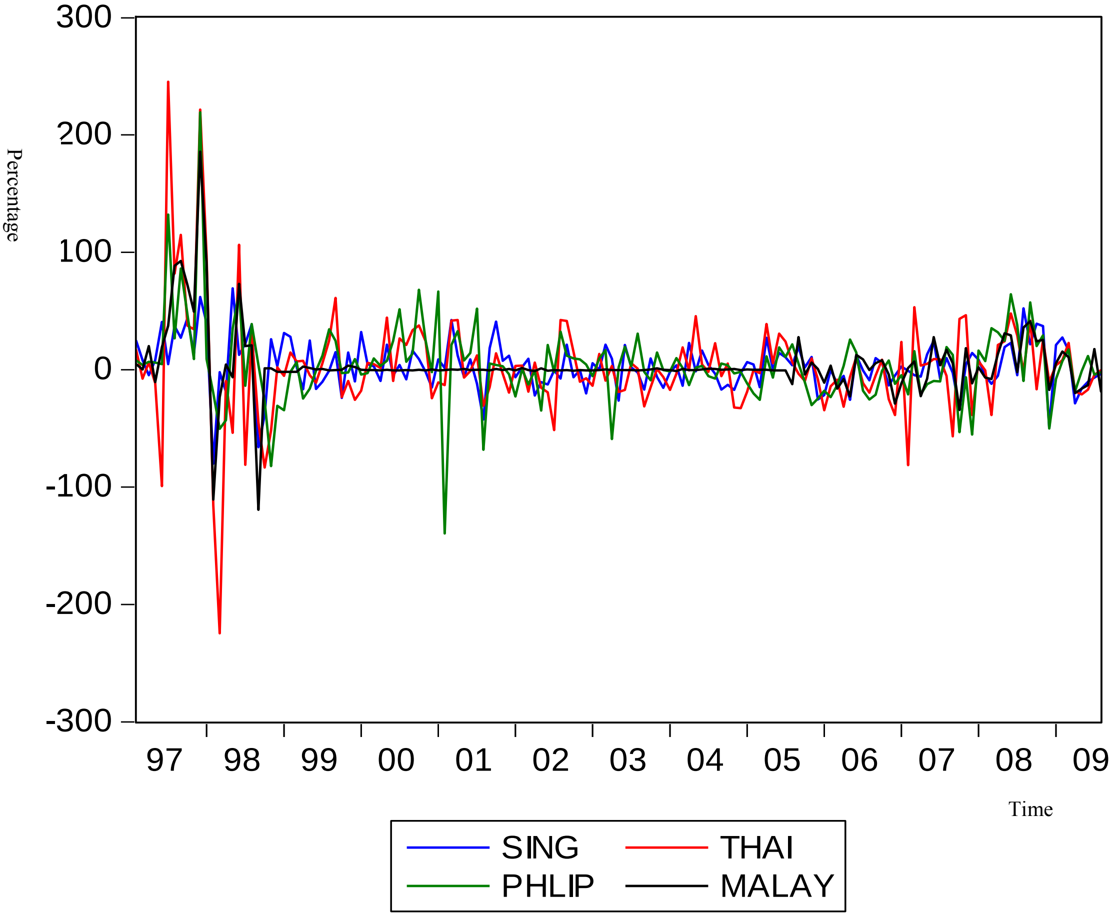
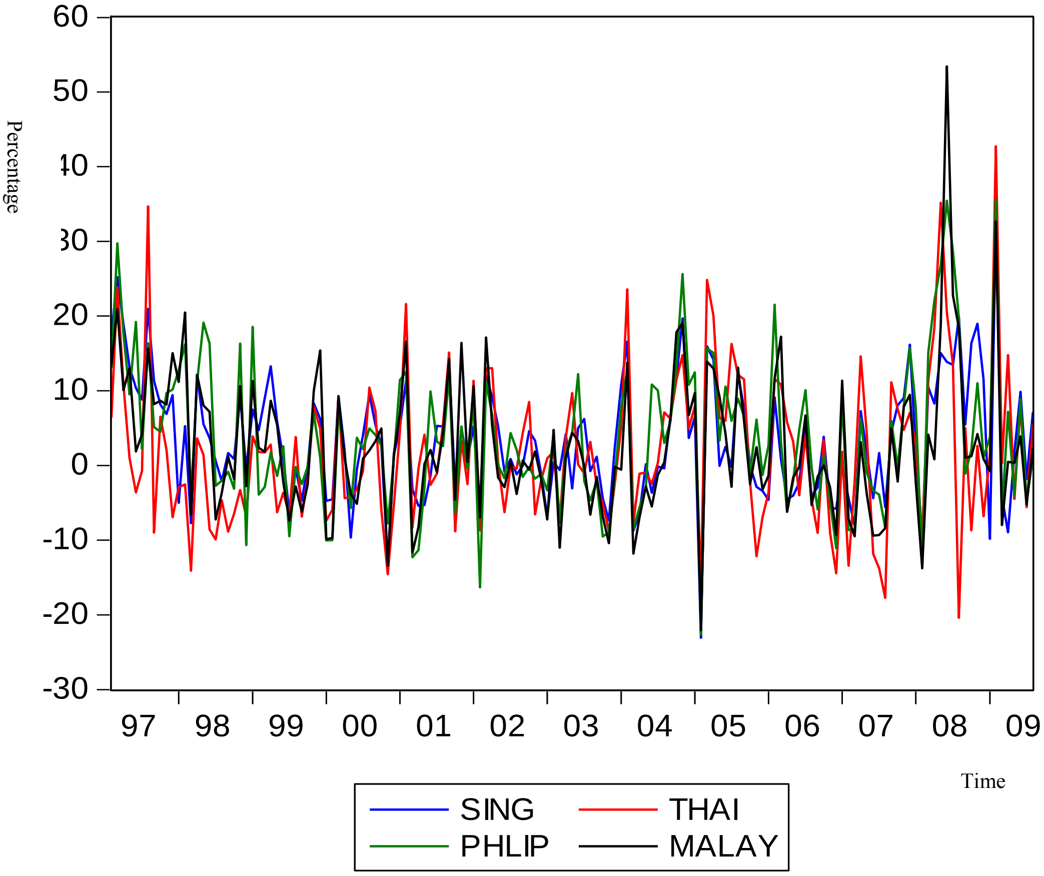


Figure 3. 6. Deviation from the Real interest parity: Four ASEAN countries



The central idea of mean reversion is used as a conceptual context to assess the parity conditions. The idea resides on the possibility that real interest parity differentials are temporary and therefore are allowed in the short run; however, real interest differentials may revert to their equilibrium value over a longer period. In contrast, if real interest differentials are not stationary, shocks will lead to short-run (temporary) as well as long-run (permanent) deviation from the hypothetical equilibrium value. Therefore, "parity conditions" will be evaluated using several unit root tests and "parity conditions" are supported whenever parity differentials are found to be stationary.

3.2.1. Univariate Augmented Dickey–Fuller (ADF) Test

Consider a series at time t,

$$\Delta q_t = \alpha_0 + b q_{t-1} + \delta \Delta q_{t-1} + \varepsilon_t \qquad \textbf{(3.5)}$$

where Δq_t is the series of interested items in first difference, Δq_{t-1} is the augmenting term and ε_t is the IID error term, i.e. $\varepsilon_t \sim id(0, \sigma^2)$. Equation (3.5) is estimated by ordinary least square (OLS) and the unit root null hypothesis is rejected when the ADF statistic is found to be significant for the null b=0 against the alterative b<0.

3.2.2. Some More Powerful Unit Root Tests

However, it is well documented in the literature that the ADF test has low power against the stationary alternative. Maddala and Kim (1998) among others criticizes univariate unit root tests for having low power against the stationary alternative. This problem even becomes severe when the sample sizes used are relatively small. Two solutions have been considered so far in the literature. The first approach is to adopt the modified version of UADF tests advocated by Elliott et al., (1996), Park and Fuller (2008) and Perron and Ng (1996), based on a weighted symmetric estimator, and the max test suggested by Leybourne (1995); Kwiatkowski et al., (1992) also suggests that taking stationarity as the null can improve power.

The second approach is to explore more information by combining time (T) and space (N) dimension. These panel unit root tests are advocated by Levin and Lin (1992), Im, Pesaran and Shin (1997), Maddala and Wu (1999) and Taylor and Sarno (1998) among others. This chapter follows the second approach and presents a panel data estimation procedure that is of more practical importance to researchers. The primary motivation behind the application of panel data unit root tests, as opposed to standard univariate unit root tests is to explore more information by combining time and space dimension to get procedures that are more powerful. The general model for N series and T time periods that of interest is

$$\begin{aligned} \Delta q_{1,t} &= \alpha_1 + b_1 q_{1,t-1} + \delta_1 \Delta q_{1,t-1} + \mu_{1,t} && t = 1,...,T \\ &\vdots && \vdots \\ \Delta q_{N,t} &= \alpha_N + b_N q_{N,t-1} + \delta_N \Delta q_{N,t-1} + \mu_{N,t} && t = 1,...,T \end{aligned} \tag{3.6}$$

Based on the mean of the individual ADF t-statistics of each member in the panel, Im, Pesaran and Shin (1997) assumes that all series have a unit root under the null hypothesis while there are at least one series is stationary as its alternative. That is:

$H_{0,IPS} : b_i = b = 0$ (i=1,2,…,N)

$H_{1,IPS} : b_i = b < 0$ for i=1,2,…, N_1 and $\beta_i = 0$ for i= N_1+1,…,N

However, the IPS panel data unit root test has some drawbacks. Firstly, IPS test assumes the data generating process are generated independently across individual so that the error term $\mu_{N,t}$ is not cross-correlated. Unfortunately, when shocks occurred in one country, it is likely that the degree of parity differential will be affected in other countries. When this assumption of no cross-correlation is violated, the IPS test statistics follow an unknown distribution and therefore the statistical inferences are unreliable. Secondly, if a panel contains both I(0) and I(1) series, rejecting the null hypothesis can only suggest that there is at least one stationary series in the panel, but they do not indicate how many and which particular panel members are stationary.

3.2.3. Illustration of use of non-linear panel unit root test

One solution to the above problems is to develop a panel data unit root test that taking into account of contemporaneous cross-sectional dependence. The test proposed is named as Seemingly Unrelated ADF (SURADF) test. The model of seemingly unrelated regression (SUR) considers contemporaneous cross-correlation dependence when testing the null hypothesis of having a unit root as developed by Breuer et al. (2001) and Lau (2009). Unavoidably, bootstrapping technique will be involved as to derive the empirical distribution of SURADF statistics. The procedures of developing the test are described in details in the previous chapter **(Chapter 2)**, and will not repeated here. Table 3.3 presents the result of linear panel unit toot test as developed by Lau (2009) for parity differentials, and it concludes that all, for instance, the purchasing power parity differential is stationary for China and her main trading partners with a 5% significance level.

Table 3. 3. Linear panel unit root test for purchasing power parity conditions

Linear panel unit root test	Test Stat.	Simulated critical values			Conclusion
Country		**1%**	**5%**	**10%**	
European Union	-11.067	-3.990	-3.387	-3.058	I(0)
Japan	-8.726	-3.711	-3.078	-2.762	I(0)
United Kingdom	-9.810	-4.013	-3.389	-3.070	I(0)
United States	-8.066	-3.647	-3.037	-2.726	I(0)

Note: All test statistics are significant at 1% significance level

More importantly, there is a growing body of literature on the study of non-linear dynamics of macroeconomic variables recently. The equalization dynamics of prices of goods and factors of production follow a non-linear dynamics, as shown by many researchers (e.g. Michael et al., 1997; Sarno et al., 2004). These models suggest that exchange rate adjustment follows a non-linear path due to the existence of "bands of inaction" in the exchange rate adjustment process. Within the bands, arbitrage of tradable good is not profitable because transaction cost (i.e. the sum of transportation cost, cost of trade barriers, and distribution cost) is greater than the price difference (Krugman, 1993). The same idea of "bands of inaction" could also be applied to financial market, and I propose a null hypothesis that all parity differentials follow a non-linear adjustment dynamic path. In this chapter, I test three parity conditions between China and her four main trading partners, and four ASEAN countries using the newly developed non-linear panel unit root (LAUNONLIN) test as described in chapter two. The LAUNONLIN test is able to indicate how many and which particular panel members are stationary while taking into account of contemporaneous cross-correlation dependence and non-linear adjustment dynamic.

3.3. Discussions

Table 3.4, table 3.5, and table 3.6 presents LAUNONLIN test statistics for PPP, UIP, and RIP for all countries, with its critical values generated from 50000 simulations. Since all parity differentials are found to be I(0) I therefore conclude that real and financial integration is well established between China and other trading partners. These findings provide supportive evidence in favor of competitiveness of the Chinese economy from the angle of the degree of integration in the commodity and financial market.

Table 3. 4. Nonlinear panel unit root test for purchasing power parity conditions

Non-linear panel unit root test	Test Stat.	Simulated Critical Values			Conclusion
Country		**1%**	**5%**	**10%**	
European Union	-5.495	-3.994	-3.374	-3.060	I(0)***
Japan	-4.954	-3.740	-3.106	-2.796	I(0)***
United Kingdom	-3.297	-4.031	-3.396	-3.079	I(0)*
United States	-4.831	-3.720	-3.096	-2.781	I(0)***
Singapore	-3.967	-3.873	-3.274	-2.950	I(0)***
Thailand	-4.531	-4.146	-3.424	-3.084	I(0)***
Philippines	-5.247	-4.008	-3.354	-3.023	I(0)***
Malaysia	-5.479	-4.196	-3.495	-3.127	I(0)***

* and *** denotes significance at 10% and 1% significance level.

Table 3 .5. Nonlinear panel unit root test for uncovered interest parity conditions

Non-linear panel unit root test	Test Stat.	Simulated Critical Values			Conclusion
Country		**1%**	**5%**	**10%**	
European Union	-6.59	-3.96	-3.34	-3.04	I(0)***
Japan	-5.61	-3.68	-3.09	-2.79	I(0)***
United Kingdom	-3.46	-3.98	-3.35	-3.02	I(0)**
United States	-4.48	-3.94	-3.12	-2.75	I(0)***
Singapore	-3.747	-3.895	-3.247	-2.928	I(0)**
Thailand	-4.333	-4.137	-3.413	-3.064	I(0)***
Philippines	-4.812	-4.005	-3.326	-2.992	I(0)***
Malaysia	-4.563	-4.248	-3.492	-3.143	I(0)***

* *and *** denotes significance at 5% and 1% significance level.

Table 3. 6. Nonlinear panel unit root test for real interest parity conditions

Non-linear panel unit root test	Test Stat.	Simulated Critical Values			Conclusion
Country		**1%**	**5%**	**10%**	
European Union	-7.285	-4.738	-4.108	-3.772	I(0)***
Japan	-6.174	-4.554	-3.916	-3.566	I(0)***
United Kingdom	-4.539	-4.288	-3.681	-3.348	I(0)***
United States	-7.132	-4.466	-3.847	-3.507	I(0)***
Singapore	-4.414	-4.326	-3.679	-3.335	I(0)***
Thailand	-5.287	-4.136	-3.516	-3.178	I(0)***
Philippines	-4.335	-4.329	-3.724	-3.387	I(0)***
Malaysia	-4.294	-4.501	-3.793	-3.434	I(0)**

* *and *** denotes significance at 5% and 1% significance level.

The two well-established theoretical literatures on economic globalization are regional integration and optimal currency areas as emphasized by Li (2006). Balassa (1961) provides a classical framework for the formation of regional economic integration. The first step towards economic globalization is to build up a free trade area (FTA), which aims to abolish tariffs and quotas between members[30]. There are two implications derived from my empirical findings. Firstly, China is well prepared integrating into the world market despite the presence of the world's most integrated trade bloc like North America Free Trade Agreement (NAFTA) and the European Common Market (ECM). Secondly, The linkage for real and financial integration into China and ASEAN trading bloc is well established, which implies these economies have considerable scope for cooperation and market integration in future.

The second step towards economic globalization is to build up a monetary union for members countries having common currency and monetary policy. Some seminal studies on optimal currency areas (Mundell 1961, McKinnon 1963) argue that successful convergence of key macroeconomics variables such as real interest rate is a necessary condition for the formation of a monetary union with a common currency and a common monetary policy for member economies. My findings suggest that China has this prerequisite for moving towards a proposed common regional currency in ASEAN, which aims to reinforce stability and market integration in Southeast Asia. To a larger extend China even has the potential to moving toward the world currency unit (WCU) as proposed by Coats (1989) and Ho (2000)[31].

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30 One example the formation of the North American Free Trade Area (NAFTA) by the US, Canada, and Mexico in the early 1990s. Another example is the establishment of the ASEAN Free Trade Area (AFTA) in 1992.

31 WCU is an indexed unit of account that stands for a unit of real global purchasing power a debt instrument that is issued globally and subscribed by people and institutions around the world. Since each unit by design represents a unit of real purchasing power, using the WCU to denominate bonds improves the transparency of real interest rates.

Furthermore, many observers anticipate that China can be the growth engine of the world economy and pull the world out of recession, especially when some developed economies are in serious trouble during financial crisis. China started its open-door policy in 1978 and entered WTO in 2001, and the Chinese economy will continuously play a significant role in the globe market in future. However, despite of China's own phenomenal growth continues, a strong link between China and other economies is the necessary condition for China to have influential economics spillover effects on developed economies and its Asian neighbors.

In my view, further research on the areas of both econometrics modeling and the determinants of deviations in parity conditions should be encouraged. For the usefulness of practical application, I suggest that future research should be directed to a Markov Switching type of panel unit root test, which can simultaneously take into account of regime switching, non-linearity, and contemporaneous cross-sectional dependence. Lau (2010d) uses his new Markov Switching Unit Root test to examine the status of real and financial integration of China, Japan, the European Union, and the United States based on the empirical validity of real interest parity, uncovered interest parity, and relative purchasing power parity. He finds strong evidence in favor of those parity conditions and hence concludes that real and financial integration between China and other four countries is well established.

Last but not the least; determinants of the degree of integration can be examined using panel regression econometrics technique. Cheung et al., (2006) suggests that capital controls, foreign direct investment linkages as well as exchange rate volatility are the main determinants of the degree of financial and real integration. We can further examine the effect of financial crisis on the deviation of real and financial parity.

3.4. Conclusion

In this paper, I develop a new panel unit root test to overcome the pitfalls of old-fashioned panel unit root tests like that of IPS panel unit root test by making it possible for researchers to test individual series for a unit root while taking contemporaneous cross- sectional dependence and non-linear dynamic into account. The “LAUNONLIN” test avoids researchers drawing wrong conclusion, and making bias towards the null hypothesis of having a unit root when contemporaneous cross-correlation dependence and non-linear adjustment dynamic exists.

Using the “LAUNONLIN” test developed in chapter 2 I examine the status of real and financial integration between China other economies based on the empirical validity of real interest parity, uncovered interest parity, and relative purchasing power parity. I found that real and financial integration between China and other trading partners are well established. These findings provide supportive evidence in favor of competitiveness of the Chinese economy from the angle of the degree of integration in the commodity and financial market.

There are several implications for policy makers and investors when planning economic policies and investment decisions. Firstly, the high degree of integration of China into global real and financial markets raises international competitiveness of China, and the imposition of tariff and non-tariff barriers on particular commodities will not have significant impact on the overall degree of integration in the Chinese markets.

Secondly, China may pull the world, especially the developed countries out of recession in occurrence of economic shocks, for example like, the current financial crisis, provided that China could be the engine of the world economy in future. We find evidence that China maintains a strong link with developed economies, a necessary condition for China to become the engine of the world economy. Since both commodity and financial markets are integrated between China and developed economies, this implies Chinese real and financial markets are relatively efficient, and therefore the Chinese markets may have growth potentials for both corporate and individual investors.

Finally, the process of integration with other economies will continue, and requires more political engagement and cooperation. We suggest further research on the determinants of integration, such that resources could devote to those determinants in an efficient way.

Part-2: New Evidence about Regional Income Divergence in China

3.5. Introduction

Neo-classical growth models predict that a poor economy tends to grow faster than a rich one. Initialed by Solow's model (1956), there are a vast amount of studies devoted to the research on economic growth and convergence hypothesis (see Baumol, 1986; Barro, 1991; Barro and Sala-i-Martin, 1991; Mankiw et al., 1992; Jones, 1997; Pritchett, 1997 among others). The assumption of diminishing returns is crucial for the convergence hypothesis to hold. This is because economic agents will allocate resources (i.e. labor and capital) across different locations so as to maximize their wealth. As a result, differences in returns to labor or capital among different regions will diminish over time. However, I argue in this study that only when all economies are able to access to the same technology it may eventually leads to convergence in the long-run.

One channel for technology spillover across borders is through the inter-regional trade of manufactured goods and production specialization. Fan (2004) provides a basic analytical framework, which builds on the work of Dixit and Stiglitz (1977). The major theoretical implication of the model is that economies with very different structures will converge to the same equilibrium in the long-run in a non-linear dynamic. Fan (2004) also incorporates the role of product quality and international trade to explain the East Asian miracle and the empirical finding of conditional convergence. It is assumed that quality is a superior goods and the demand for it increases with income. Following the implications of the model, it suggests a conflict in the preferences for the ideal quality of consumption between rich and poor regions. However, a poor region may choose an "inferior" autarkic production technology so that a greater quantity of "low" quality goods could be produced given the resources' availability. By making such a decision, the poor region forgoes the opportunity of joining the "global" markets and catching up with its neighbors by division of labor, production specialization and technology spillover.

Nevertheless, the poor economies will grow eventually when their human capital accumulates though time. When the human capital of the poor region approaches the average levels of other regions, the chance of participating in "global" industrial specialization may occur. I denote a threshold level, "c", of human capital accumulation at which the economy will experience a "jump" in its per capita human capital and income. Therefore, in my study, I model the growth dynamics of Chinese provinces in such a way that the economy may only experience a high economic growth rate when it reaches the threshold level of human capital accumulation and starts to engage in trade with other regions. I use the Exponential Smooth Transition Autoregressive (ESTAR) model to estimate the growth dynamics across states so as to capture the likelihood that the growth rate of different regions will converge provided that they reach the threshold level of human capital accumulation.

The rest of this chapter is organized as follows. Section 3.6 provides a brief literature review on income convergence. Section 3.7 describes the empirical methodologies that I employ. Section 3.8 evaluates the empirical findings from different unit root tests in determining whether provincial real income per capita is indeed converging or diverging among Chinese provinces in the pre- and post-reform periods. The provincial growth determinants are also investigated. Section 3.9 draws the conclusions.

3.6. Income Convergence

The conditions of free factor mobility and free trade are essential, and they contribute to the acceleration of the convergence process through the equalization of the prices of goods and factors of production. In this context, the tendency for income disparities to decline over time is explained by the hypothesis that factor costs are lower and profit opportunities are higher in poor regions as compared to rich regions. Therefore, low-income regions will tend to grow faster and catch up with the leading regions. In the long-run, factor prices, income differences, and growth rates will be equalized across regions.

3.6.1. Unconditional Beta Convergence

The most common measures of convergence are beta (β) and sigma (σ) convergence in their conditional and unconditional versions[32]. Beta convergence identifies a negative relationship between the growth of per capita incomes and the initial level of income across regions over a give time period. Some empirical studies find evidence in support of unconditional beta convergence across states (Barro and Sala-i-Martin, 1991). However, I believe that unconditional convergence may not be expected when heterogeneous factors' endowment across countries is obvious. Therefore, I expect conditional convergence instead of its unconditional version as

32 The hypothesis of "unconditional/absolute convergence" states that poor regions eventually catch up to rich regions regardless of the initial difference in capital-labor ratios. All regions should converge with the same capital-labor ratio, output per worker, and consumption per worker. On the other hand, if the convergence process occurs only for regions which have similar factors like human capital, infrastructure, and technological progress is called "conditional convergence".

shown by Barro and Sala-i-Martin (1995).

In order to control for differences in the steady-state growth path, Barro (1991), Barro and Sala-i-Martin (1991, 1992), and Mankiw et al., (1992) includes explanatory variables that change across countries, like population growth, rate of capital depreciation, and technological progress, in their studies. The universal consensus is that, while there is no evidence of unconditional convergence among countries with very different initial endowments, evidence in support of conditional convergence is found for groups of countries with homogenous endowment. Barro and Sala-i-Martin (1991) find evidence in support of unconditional beta convergence as well as conditional beta convergence for states by introducing regional and sectoral dummy variables to capture the origin of the heterogeneous characteristics across states. In the same notion, Mankiw et al., (1992) also finds evidence of unconditional as well as conditional beta convergence for different countries by introducing saving, population growth, and human capital accumulation variables.

Apart from studies in the United States, Cheung and Pascual (2004) uses output differential series on the G7 countries. The decision regarding the output convergence hypothesis is based on whether an output differential series is stationary or has a unit root. It finds that the evidence is mixed, and depends on the power of the unit root test applied. Pedroni and Yao (2006) finds evidence in support of the view that inter-provincial inequalities have been widening since 1978 by using the provincial income data set from 1952 to 1997. In this study, I use the same data set as Pedroni and Yao (2006) but use a non-linear unit root test instead.

3.6.2. Unconditional Sigma Convergence

Another measure of convergence is sigma convergence; its magnitude is measured by the standard deviation of per capita income across states over time (Quah, 1993). A continuous decline in annual standard deviations of income across states over time implies sigma convergence. Moreover, the use of cross-sectional regression for testing beta convergence may commit Galton's fallacy of regression to the mean and it implies biased estimates and invalid test statistics, this fallacy will not occur in my study because panel data is used. In response to this fallacy, Friedman (1992) and Quah (1993) argues that sigma convergence is the only valid measure of convergence. Barro and Sala-i-Martin (1991) tests for sigma convergence using state per capita income data from 1880 to 1988. Their results support sigma convergence for all decades except the 1920s and the 1980s by using standard deviation of the log of per capita income as the series of interest in cross-section regression. In contrast, Drennan et al., (2004) finds evidence against sigma convergence using data for all the metropolitan areas in the continental United States for the period 1969–2001. The data adopted in their study is the standard deviation of the natural logarithm of metropolitan regions; however, the use of the standard deviation is not satisfactory due to limited observations and the bias of outliers.

Therefore, in this part of study, I test both unconditional and conditional beta convergence so as to provide robust results. The reason for using both methods is that, on one hand, I believe that the legal system, language, currency, financial markets, and culture are likely to be homogeneous across regions, and therefore resulted in unconditional beta convergence. On the other hand, there are possible heterogeneous factor differences across provinces, which may hinder beta convergence across regions.

Those factors may include inflation rate, infrastructure, human capital, degree of openness, and amount of foreign capital inflow.

Starting from the 1960s, there are vast amounts of studies concerning income convergence in which the hypothesis is examined for States (Borts, 1960; Borts and Stein, 1964) and for regions (Perloff, 1963). In most cases, there is evidence in support of income convergence. In contrast, numerous studies find evidence against the convergence hypothesis across States (e.g. Browne, 1989; Barro and Sala-i-Martin, 1991; Blanchard and Katz, 1992; Carlino, 1992; Mallick, 2006; Crihfield and Panggabean, 1995; Glaeser et al., 1995; Vohra, 1996; Drennan and Lobo, 1999; Lau, 2010b). Lau (2010b) examines the empirical validity of both beta and sigma convergence across the States using states' per capita personal income during the period 1929 to 2005. Using both linear and panel non-linear unit root tests, the author finds evidence in support of beta and sigma convergence across States on average, and subsequently suggests some possible explanations for why this is not held for some States. Firstly, as argued by Drennan et al., (2004), transportation technology may be one important factor affecting the convergence process. After the mid-1970s, transportation technology did not improve significantly. In contrast, the transaction costs of exchanging services and manufactured goods across states were reduced dramatically from 1940 to 1970. For example, railroads, trucks, refrigeration cars, the interstate highway system and jet air transportation served to raise the mobility of labour, capital and commodities, and hence to equalize returns and prices across states. However, I believe that this convergence process follows a non-linear dynamics as supported by various empirical studies in the field of the law of one price (LOP) across States. I believe the above arguments are also valid for provincial growth dynamics in the transitional economy of China.

Secondly, the conclusion of unconditional convergence could be derived from the neoclassical growth model only if certain assumptions hold in the nature of input factors and agents' maximizing behavior (Mankiw et al., 1992). The model assumes diminishing marginal returns to labour and capital, which in turn imply income convergence across states because labour and capital are moving around seeking the highest returns. However, Acemoglu (2002) argues that skill-biased technical change might favor rich regions and lead to the violation of diminishing marginal returns to labour at the initial stage of technical progress. Therefore, I would expect a sudden jump in the growth rate when the income level of a region exceeds a particular threshold level. Again, this suggests that I should model the growth dynamics in a non-linear set-up.

Lastly, product quality and intra-regional trade may play a role in explaining conditional convergence. There may be a conflict between the preferences for the ideal quality of consumption between rich and poor metropolitan areas across states. A poor region may choose an inferior autarkic production technology so that a greater quantity of low quality goods can be produced with the given resources' availability. By making such a decision, the poor region forgoes the opportunity to join the global markets and boosts its growth by division of labour, production specialization and technology spillover. Again, I would expect a sudden jump in the growth rate when the income level of a region exceeds a particular threshold level.

This research on growth dynamics differs from other research on regional income convergence and growth in China by several major attributes. Firstly, I use provincial data so that the trend of China's regional convergence is better understood. Secondly, I allow the convergence process to follow nonlinear dynamics across provinces because the convergence process occurs through the equalization of prices of goods and factors of production, and the "Law of One price" follows nonlinear dynamics as supported by recent empirical evidence.

One major obstacle to regional convergence is local protectionism. Young (2000) argues that there is increasing local protectionism in China, and this observation of new distortion is unavoidable in the process of transition:

> *In a partially reformed economy, distortions beget distortions. Segments of the economy that are freed from centralized control respond to the rent-seeking opportunities implicit in the remaining distortions of the economy. The battle to capture, and then protect, these rents leads to the creation of new distortions, even as the reform process tries to move forward. In this paper I illustrate this idea with a study of the People's Republic of China. (p. 1091, abstract)*

If the author's argument is legitimate, we should observe income divergence across provinces over time, and this harms the national competitiveness of the Chinese economy because the processes of technology spillover effects, economies of scale, division of labor and production specialization are prohibited, and results in a slow provincial growth rate and income inequality. In this study, I indirectly examine the hypothesis of increasing local protectionism as proposed by Young (2000).

3.7. Econometrics Methodology

The data set used in this study consists of annual panel data of the provincial GDP for twenty-eight provinces (see Table 3.7) in China for the period 1952 to 2003, which are collected from various issues of the China Statistics Yearbook. The real per capita GDP in each province are computed by using a provincial GDP deflator, taking the year 2000 as the base year. Table 3.7 provides information on China's provinces and geographical locations. Following Evans (1998), the term of income convergence may be defined as the convergence of long-run output differences as the forecasting horizon increases. It implies that the per capita GDP in any pair of provinces tends to converge to the same level in the long-run. In statistical terms, the convergence to the provincial per capita income means that the income gap between any two provinces must be mean-reverting or stationary. Some empirical methodologies are introduced in the following sections.

Table 3. 7. List of China's Mainland Provinces and Geographic Location

Code	Province	Location	-Pref. Level	Code	Province	Location	-Pref. Level
1	Beijing	Interior-Central	medium	16	Henan	Interior-Central	low
2	Tianjing	Coastal-Central	high	17	Hubei	Interior-Central	medium
3	Hebei	Coastal-Central	high	18	Hunan	Interior-Central	low
4	Shanxi	Interior-Central	low	19	Guangdong	Coastal-Central	high
5	Inner Mongolia	Interior-NW	medium	20	Guangxi	Coastal-SW	high
6	Liaoning	Coastal-NE	high	21	Chongqing	Interior-SW	medium
7	Jilin	Interior-NE	medium	22	Guizhou	Interior-SW	low
8	Heilongjiang	Interior-NE	medium	23	Yunnan	Interior-SW	medium
9	Shanghai	Coastal-Central	high	24	Shaanxi	Interior-NW	low
10	Jiangsu	Coastal-Central	high	25	Gansu	Interior-NW	low
11	Zhejiang	Coastal-Central	high	26	Qinghai	Interior-NW	low
12	Anhui	Interior-Central	medium	27	Ningxia	Interior-NW	low
13	Fujian	Coastal-Central	high	28	Xinjiang	Interior	
14	Jiangxi	Interior-Central	low				
15	Shandong	Coastal-Central	high				

3.7.1. Unconditional Beta Convergence

Traditionally, the most commonly used regressions in growth studies are cross sectional (see Baumol (1986) for beta convergence). The basic idea is to estimate the coefficients of the following equation and evaluate the null hypothesis of divergence (that is, $\beta = 0$) against the alternative hypothesis of convergence, when $\beta \in (-1, 0)$. The pooled data regression is represented in equation (3.7):

$$\frac{y_{i,T} - y_{i,0}}{T} = \alpha + \beta y_{i,0} + u_{i,0} \qquad i = 1,\ldots, N \tag{3.7}$$

where α is a constant (which captures the regions' steady state), β captures the rate or speed of convergence and $u_{i,0}$ is a disturbance term. Note that I only consider the growth rate of output in the whole period of analysis (between t = 0 and T = 1). One modification of equation (3.7) is the panel data regression represented as:

$$\frac{y_{i,T} - y_{i,t-1}}{T} = \alpha + \beta y_{i,t-1} + u_{i,t} \tag{3.8}$$

where, in this case, T denotes the number of periods or years between t and t – 1. One of the benefits of this technique is that it lets us take advantage not only of the cross-sectional dimension but also of the time dimension, thus providing greater degrees of freedom and informational content. However, a criticism of regressions between the per capita GDP growth rate and initial per capita GDP is that the test does not have a standard distribution under the null hypothesis (β = 0), so making a comparison using the conventional statistics and related critical values can lead to an erroneous conclusion. Following Evan (1998), the term of income convergence may be defined as the convergence of long-run output differences as the forecasting horizon increases. It implies that the per capita GDP in any pair of provinces tends to converge to the same level in the long-run. In statistical terms, the convergence to the provincial per capita income means that the income gap between any two provinces must be mean-reverting or stationary.

Therefore, one possibility is to examine whether each regional income series independently presents a unit root (Dickey and Fuller, 1976). However, it is well known that such a procedure suffers from serious power problems; see for example the Fisher–ADF and Fisher–Phillips–Perron tests proposed by Maddala and Wu (1999); Choi (2001); Levin, Lin and Chu (2002); and Breitung and Das (2004).

3.7.2. Linear Panel Unit Root Tests

As suggested by Evans (1998), suppose $y_{i,t}$ is the log per capita output for province (cross-sectional unit) i at time t (i=1,…,N, t=1,…,T). Next I consider the difference between y_{it} and the mean value of $y_{i,t}$ over i=1,…,N, which is defined as $\overline{y}_{it} = y_{it} - \overline{y}_t$, where $\overline{y}_t = \mathrm{N}^{-1}\sum_{i=1}^{N} y_{it}$.

As proved by Evans (1998), since $y_{it} - \overline{y}_t$ = $\mathrm{N}^{-1}\sum_{i=1}^{N}(y_{it} - y_{jt})$, if $y_{it} - y_{jt}$ is stationary for all pairs of provinces i and j, $y_{it} - \overline{y}_t$ is also stationary for all i. The converse proof is also valid: since $y_{it} - y_{jt} = (y_{it} - \overline{y}_t) - (y_{jt} - \overline{y}_t)$, if $y_{it} - \overline{y}_t$ is stationary for all i, $y_{it} - y_{jt}$ is also stationary for all pairs (i,j). By using these results of equivalence, we can focus on examining the stochastic properties of $\overline{y}_{it} \equiv y_{it} - \overline{y}_t$ for all i instead of $y_{it} - y_{jt}$ for all pairs of i and j. The standard ADF regression takes the form:

$$\bar{y}_{i,t} = \alpha_j + \theta_j \bar{y}_{i,t-1} + \sum_{k=1}^{K} \delta_{i,k} \Delta \bar{y}_{i,t-k} + \mu_{i,t} \qquad t = 1,...,T\ ; i = 1,..., N \qquad \textbf{(3.9)}$$

Rearranging equation (3.9) becomes:

$$\Delta \bar{y}_{i,t} = \alpha_i + \beta_i \Delta \bar{y}_{i,t-1} + \sum_{k=1}^{K} \delta_{i,k} \Delta \bar{y}_{i,t-k} + \mu_{i,t} \qquad t = 1,...,T\ ; i = 1,..., N \qquad \textbf{(3.10)}$$

where Δ is the first difference operator, k is the number of augmenting terms and $\{u_{i,t}\}$ $(i = 1, 2.., N)$ are white noise series independently distributed across N = 28 provinces, i.e. $u_{i,t} \sim iid(0, \sigma^2_{i,t})$. The number of augmenting terms is determined using the Akaiki's information criteria (AIC)[33]. We need to include a constant term, α, for each city in order to account for province-specific fixed effects such as initial capital endowment, employees' educational attainment and the preferential policy implemented by the central government for different regions. The purpose of including the constant term is to differentiate between the concept of conditional convergence (α ≠ 0) and unconditional convergence (α = 0).

There are numerous linear types of panel unit root tests, as referring to second-generation unit root test are developed, for example, Levin and Lin (1992); Im, Pesaran, and Shin (1997); Maddala and Wu (1999). Levin and Lin (1992) developed a panel unit root test that assumes each panel member shares the same AR(1) coefficient while allowing for individual effects, time effects and possibly a time trend. Lagged augmentation terms may be introduced to correct for serial correlation in the errors. However, $\{u_{i,t}\}$ must be i.i.d. for all panel members in order to enable LL test statistics to have proper asymptotic and finite sample properties. This implies that no assumption of contemporaneous cross-correlation among panel members is allowed in this set-up.

33 AIC (Akakai's information Criterion) is one of the models which identify the suitability of the model, and the optimal lag lengths are selected based on FPE (Final Prediction Error).

The LL test specifies the unit root null hypothesis and the alternative as:

$$H_{0,LL} : \beta_i = \beta = 0 , \quad H_{1,LL} : \beta_i = \beta < 0 \quad \text{for} \quad \forall i \qquad \textbf{(3.11)}$$

The LL test provides little information to researchers due to two reasons. First, it does not make sense to assume that all provincial incomes are converging at the same rate under the alternative. In addition, assuming all provincial income differentials contain a unit root is inappropriate under the null. Second, the assumption of cross-sectional independence does not make sense because cross-sectional dependence can always be the case due to global shocks, for example open-door policies and financial crisis. In practice, the variance–covariance matrix of errors is rarely of zero off-diagonal elements. Once the time series exhibit contemporaneous cross correlation, the LL test is invalid due to inappropriate critical values being used.

Im, Pesaran and Shin (1997) modifies the LL test and, based on the mean of the individual ADF t-statistics of each member in the panel, the IPS test assumes that all series are non-stationary under the null hypothesis. In contrast to the LL test, the IPS test assumes that under the alternative hypothesis there is at least one series that is stationary. That is:

$$H_{0,IPS} : \beta_i = \beta = 0 \quad (i = 1,2,..., N)$$

$$H_{1,IPS} : \beta_i = \beta < 0 \quad \text{for} \ \ i = 1,2,..., N_1 \ \ \text{and} \ \ \beta_i = 0 \ \ \text{for} \ \ i = N_1 + 1,..., N \qquad \textbf{(3.12)}$$

However, similar to the LL test, the IPS test fails to take contemporaneous cross correlation among panel members into account.

Maddala and Wu (1999) combines Fisher-type tests and the IPS test so that an unbalanced panel can be used to test for the unit root hypothesis. The MW test is a non-parametric test and, once the observed p-values are available, the MW test statistic can be calculated such that:

$$MW = -2\sum_{i=1}^{N} \ln p_i \qquad \textbf{(3.13)}$$

where p_i is the p-value from the individual equations from equation (3.10). The MW statistics are proved to have a X^2 distribution with 2N degrees of freedom under the assumption of cross-sectional independence. Pesaran (2007) develops a simple panel unit root test called cross-sectionally augmented ADF statistics (CADF), which takes into account cross-sectional dependence across panel members. It is also shown that the individual CADF statistics are asymptotically similar and do not depend on the factor loadings.

3.7.3. Nonlinear Panel Unit Root Test with Cross Section Dependence

I believe that the growth dynamics across Chinese provinces follows non-linear patterns. Firstly, I anticipate that the economy may only experience a high growth rate when it reaches the threshold level of human capital accumulation and starts to engage in trade with other regions. Secondly, the equalization of prices of goods and factors of production follows a non-linear dynamics as shown by many researchers (e.g. Michael, Nobay and Peel, 1997; Taylor, Peel and Sarno, 2001; Sarno et al., 2004).

Therefore, I use the Exponential Smooth Transition Autoregressive (ESTAR) model to specify the growth dynamics across states so as to capture the likelihood that the growth of different regions will converge only if the region reaches a threshold level of growth rate. Cerrato et al., (2009) developed a new non-linear panel ADF test under cross-sectional dependence, which is based on the following ESTAR specification, and the model is applied to the de-meaned data series of interest in my study: in its general form, we have:

$$\bar{y}_{it} = \xi_i \bar{y}_{i,t-1} + \xi_i^* \bar{y}_{i,t-1} Z(\theta_i; \bar{y}_{i,t-d}) + \mu_{it} \qquad t = 1,...,T \quad i = 1,...,N\,, \tag{3.14}$$

where

$$Z(\theta_i; \bar{y}_{i,t-d}) = 1 - \exp[-\theta_i (\bar{y}_{i,t-d} - c)^2] \tag{3.15}$$

where θ_i is a positive coefficient and c is the equilibrium value of income difference between region i and the mean difference across provinces due to heterogeneous human capital accumulation between region i and the mean value. The initial value, $\tilde{y}_{i0}$, is given, and the error term, μ_{it}, has the one-factor structure:

$$\mu_{it} = \gamma_i f_t + \varepsilon_{it}\,,$$

$$(\varepsilon_{it})_t \sim i.i.d.(0, \sigma_i^2) \tag{3.16}$$

in which f_t is the unobserved common factor, and ε_{it} is the individual-specific (idiosyncratic) error. Following the existing literature, the delay parameter d is set to be equal to one so that equation (3.14) may be rewritten in first difference form in general as:

$$\Delta \bar{y}_{i,t} = \alpha_i + \xi_i \bar{y}_{i,t-1} + \sum_{h=1}^{h-1} \delta_{ijh} \Delta \bar{y}_{ij,t-h} + (\bar{\alpha}_i^* + \xi_i^* \bar{y}_{i,t-1} + \sum_{h=1}^{h-1} \delta_{ih}^* \Delta \bar{y}_{i,t-h}) * Z(\theta_i; \bar{y}_{i,t-d}) + \gamma_i f_t + \varepsilon_{it} \tag{3.17}$$

notice that when $\tilde{y}_{i,t-d} = c$, $Z(\cdot) = 0$ and equation (3.17) is equivalent to a standard linear ADF model of equation (3.9). However, when the magnitude of income divergence between $\tilde{y}_{i,t-d}$ and c becomes too large, $Z(\cdot) \approx 1$ will generate a new linear ADF model with parameter $\beta_i = \xi_i + \xi_i^*$. In contrast, when income divergence is negligible, ${\xi^*}_i$ affects the flow of the income differential in this case. However, when the income divergence becomes more serious, ξ_i^* plays a more important role in governing the adjustment process. We should take note that $\xi_i + \xi_i^* < 0$ is the necessary condition for "global stability" to hold. Once the condition of $\xi_i + \xi_i^* < 0$ is fulfilled, it is legitimate to have $\xi_i \geq 0$; if this occurs, the implication is that the income divergence follows a non-stationary growth path (e.g. a random walk or an explosive innovation within the "band of inaction" of c) and eventually it converges back to its equilibrium once the magnitude of income divergence is outside the "band". If we assume that $\tilde{y}_{i,t}$ follows a unit root process in the middle regime, then $\xi_i = 0$ and equation (3.17) can be rewritten as:

$$\Delta\bar{y}_{i,t} = \xi_i^* \bar{y}_{i,t-1}\left[1 - \exp(-\theta_i \bar{y}_{i,t-1}^2)\right] + \gamma_i f_t + \varepsilon_{i,t} \tag{3.18}$$

The null hypothesis of non-stationarity is $H_0 : \theta_i = 0 \forall i,$ against the alternative of : $H_1 : \theta_i > 0$ for i = 1,2,…, N_1 and $\theta_i = 0$ for i = N_1 + *1,…,N.*

Because ξ_i^* in equation (3.18) is not identified under the null, it is not feasible to test the null hypothesis directly. Thus, Cerrato et al., (2009) reparameterize equation (3.18) by using a first-order Taylor series approximation and obtain the auxiliary regression

$$\Delta\bar{y}_{i,t} = a_i + \delta\bar{y}_{i,t-1}^3 + \gamma_i f_t + \varepsilon_{i,t} \tag{3.19}$$

For a more general case where the errors are serially correlated, equation (3.19) is extended to:

$$\Delta\bar{y}_{i,t} = a_i + \delta\bar{y}_{i,t-1}^3 + \sum_{h=1}^{h-1} \vartheta_{ih} \Delta y_{i,t-h} + \gamma_i f_t + \varepsilon_{i,t} \tag{3.20}$$

Cerrato et al., further prove that the common factor f_t can be approximated by

$$f_t \approx \frac{1}{\approx\atop\gamma} \Delta \overset{\approx}{y}_t - \frac{\bar{b}}{\bar{\gamma}} \overset{\approx}{y}{}_{t-1}^{3} \tag{3.21}$$

where $\tilde{\tilde{y}}_t$ is the mean of $\tilde{y}_t$ and $\bar{b} = \frac{1}{N}\sum_{i=1}^{N} b_i$.

Therefore, it follows that equation (3.20) can be written as the following non-linear cross-sectionally augmented DF (NCADF) regression:

$$\Delta\bar{y}_{i,t} = a_i + b_i\bar{y}_{i,t-1}^3 + c_i\Delta\tilde{\tilde{y}}_t + d_i\Delta\tilde{\tilde{y}}_{t-1}^3 + \varepsilon_{i,t} \quad \textbf{(3.22)}$$

Given the framework above, the authors develop a unit root test in the heterogeneous panel model based on equation (3.22). Extending the idea of Kapetanios, Shin and Snell (2003), the authors derive t-statistics on $\hat{b}_i$, which are denoted by:

$$t_{iNL}(N,T) = \frac{\hat{b}_i}{s.e.(\hat{b}_i)}, \quad \textbf{(3.23)}$$

where $\hat{b}_i$ is the OLS estimate of b_i, and $s.e.(\hat{b}_i)$ is its associated standard error. Following Pesaran (2007), the t-statistic in equation (3.23) can be used to construct a panel unit root test by averaging the individual test statistics:

$$\bar{t}_{iNL}(N,T) = \frac{1}{N}\sum_{i=1}^{N} t_{iNL}(N,T) \quad \textbf{(3.24)}$$

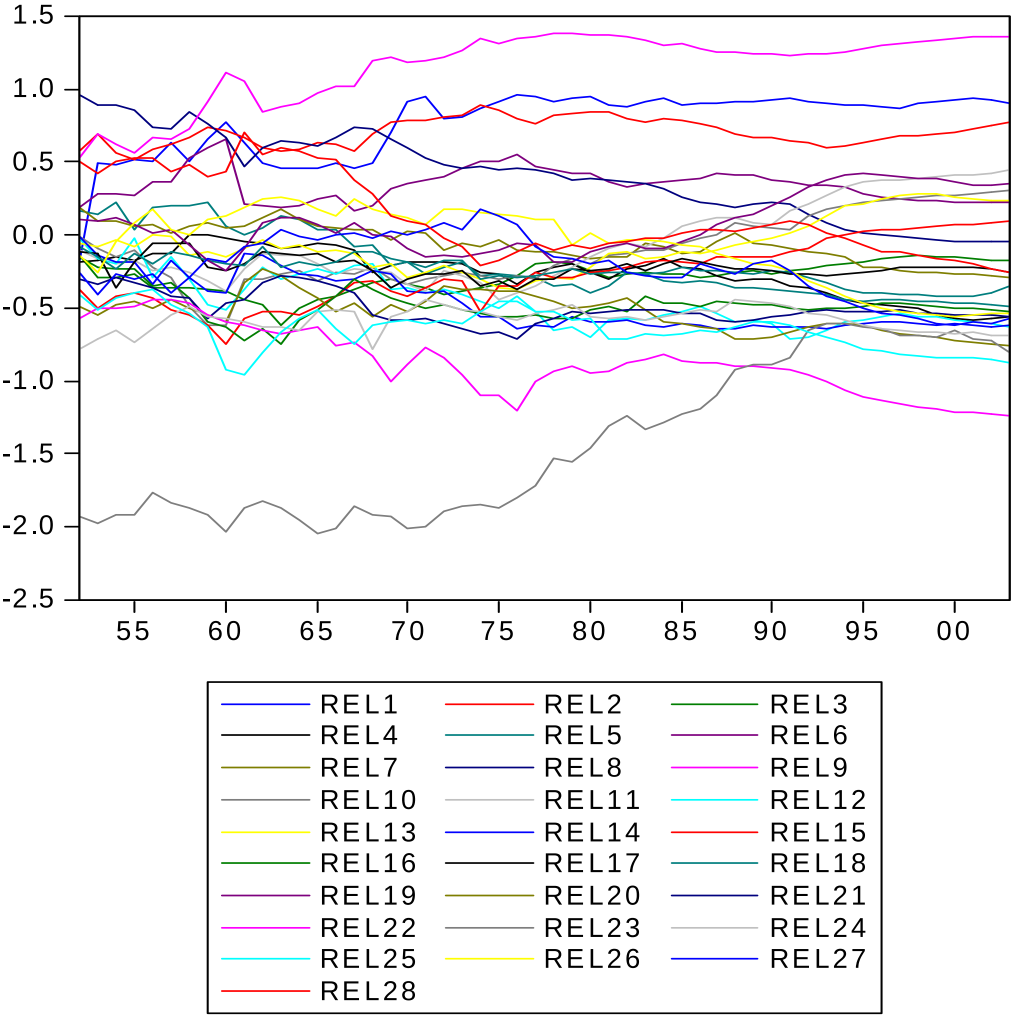
This is a non-linear cross-sectionally augmented version of the IPS test (NCIPS). Consequently, Pesaran (2007) calculates critical values of both individual and panel NCADF tests for varying cross section and time dimensions.

3.8. Empirical Results

3.8.1. Unconditional Beta Convergence

In the case of regional output, the period of analysis is from 1952 to 2003. Figure 3.7 shows the provincial income differences relative to the mean income level across provinces. No conclusion regarding the degree of income convergence could be derived from the diagram.

Figure 3. 7. Provincial incomes relative to mean income



Note:

For names of series please refer to Table 3.7, for example REL1 is income differences relative to the provincial mean income level for Beijing

Table 3.8 shows evidence of income convergence among provinces using a univariate ADF test. In the pre-reform period, 6 out of 28 provinces reject the null hypothesis of a unit root, indicating that about 21% of provinces are converging to the mean income level at the 10% significance level. In contrast, 7 out of 28 provinces or 25% show evidence of convergence in the post-reform period. The evidence implies an insignificant improvement regarding income convergence in the post-reform period.

Table 3. 8. Test of Beta Convergence -Univariate ADF test-Comparison of Pre and Post Reform Period

Pre-Reform Period				Post-Reform Period			
Provinces	**Prob.**		**Lag**	**Provinces**	**Prob.**		**Lag**
REL1	0.5547		1	**REL1**	0.0251	**	4
REL2	0.1195		1	**REL2**	0.981		1
REL3	0.5937		0	**REL3**	0.1204		1
REL4	0.4566		0	**REL4**	0.5559		3
REL5	0.0885	*	0	**REL5**	0.7123		0
REL6	0.5246		0	**REL6**	0.0202	**	4
REL7	0.2017		0	**REL7**	0.7709		0
REL8	0.3558		4	**REL8**	0.0492	**	1
REL9	0.035	**	1	**REL9**	0.0065	***	4
REL10	0.2206		2	**REL10**	0.5749		0
REL11	0.1114		1	**REL11**	0.2195		1
REL12	0.1026		0	**REL12**	0.0834	*	3
REL13	0.8789		5	**REL13**	0.1268		4
REL14	0.2714		0	**REL14**	0.099	*	0
REL15	0.2419		0	**REL15**	0.4821		1
REL16	0.0468	***	3	**REL16**	0.3585		1
REL17	0.0016		2	**REL17**	0.1073		0
REL18	0.0182	**	0	**REL18**	0.0647	*	4
REL19	0.1731		1	**REL19**	0.9303		1
REL20	0.1345		2	**REL20**	0.2982		1
REL21	0.1715		2	**REL21**	0.2402		2
REL22	0.0831	*	5	**REL22**	0.4263		3
REL23	1		4	**REL23**	0.9932		0
REL24	0.0785	*	2	**REL24**	0.8252		0
REL25	0.3221		1	**REL25**	0.1072		4
REL26	0.4389		0	**REL26**	0.7966		2
REL27	0.483		0	**REL27**	0.5821		1
REL28	0.7359		0	**REL28**	0.9187		0

Note : ***, **, & * denote 1%, 5%, & 10% critical values respectively.

Table 3.9 shows that all of the first-generation panel unit tests reject the unit root hypothesis of no convergence in both the pre- and post-reform periods. However, these conventional unit root tests do not take cross-section dependence into account, and the conclusion derived could be spurious.

Table 3. 9. Tests for β Convergence in Income: Panel Unit Root Tests

Test	Test-Stat. (Pre-reform)	Test-Stat. (Post-reform)
Levin and Lin (1992)	-1.621	-4.08623
p-value	0.0525	0
Im, Pesaran and Shin (2003)	-3.393	-4.26342
p-value	0	0
Fisher-ADF	97.868	124.397
p-value	0.0005	0

Note : ***, **, & * denote 1%, 5%, & 10% critical values respectively.

The critical values for 1%, 5%, & 10% critical values are -3.48,-2.93, & -2.66 respectively.

Furthermore, Table 3.10 reports the CADF test results as proposed by Pesaran (2007). In the pre-reform period, 9 out of 28 provinces reject the null hypothesis of a unit root, indicating that about 32% of provinces are converging to the mean income level at the 10% significance level. In contrast, 5 out of 28 provinces or 19% show evidence of convergence in the post-reform period. The evidence even implies deterioration of income convergence in the post-reform period.

Table 3. 10. Test of Beta Convergence- Pesaran's CADF -Comparison of Pre and Post Reform Period

Pre-Reform Period			Post-Reform Period		
Provinces	**t-stat**		**Provinces**	**t-stat.**	
REL1	-7.16103	***	**REL1**	-2.4784	
REL2	-1.63549		**REL2**	-2.15052	
REL3	-2.38213		**REL3**	0.084508	
REL4	-1.60447		**REL4**	-1.27769	
REL5	-2.19192		**REL5**	-3.03407	*
REL6	-2.26044		**REL6**	-0.6609	
REL7	-2.23803		**REL7**	-1.41915	
REL8	-4.55955	***	**REL8**	-1.09551	
REL9	-1.73157		**REL9**	-3.15117	*
REL10	-2.26738		**REL10**	0.049923	
REL11	-3.07529	*	**REL11**	-2.30596	
REL12	-5.16462	***	**REL12**	-2.03523	
REL13	-1.45791		**REL13**	-1.33583	
REL14	-1.76177		**REL14**	-4.29817	***
REL15	-0.79359		**REL15**	-1.91176	
REL16	-2.2486		**REL16**	-3.38996	**
REL17	-3.44149	**	**REL17**	-3.77589	**
REL18	-3.82764	**	**REL18**	-1.81583	
REL19	-1.77751		**REL19**	-1.96438	
REL20	-3.857	**	**REL20**	-1.31878	
REL21	-0.2492		**REL21**	-2.04813	
REL22	-1.20996		**REL22**	-0.8088	
REL23	-1.57267		**REL23**	-0.73166	
REL24	-3.36831	*	**REL24**	-2.4885	
REL25	-1.6862		**REL25**	-1.48301	
REL26	-2.65917		**REL26**	-1.10742	
REL27	-1.69994		**REL27**	-1.6596	
REL28	0.712362		**REL28**	0.149642	
CIPS Stat.	-2.39895	***	**CIPS Stat.**	-1.76651	

Note : ***, **, & * denote 1%, 5%, & 10% critical values respectively.

Next, I further examine the convergence hypothesis using Cerrato et al.'s (2009) NCADF test. Table 3.11 shows that, when non-linearity is incorporated into the testing procedure, the non-linear test rejects beta convergence more often than using a linear ADF test. The findings suggest that the growth dynamics across Chinese provinces doe not follow non-linear dynamics. The empirical finding for China is in contrast with that of a similar study conducted by Lau (2010b). Lau (2010b) brings new information to beta income convergence literature in the United States by using nonlinear panel unit root test of the Exponential Smooth Auto-Regressive Augmented Dickey-Fuller (ESTAR-ADF) unit root test on the time series data for the period 1929-2005. The results find evidence of stationarity for time series and thereby support beta and sigma convergence among states in a nonlinear setup. The current finding for Chinese provincial growth dynamics suggests further study on conditional convergence, whereas heterogeneous factor difference may hinder beta convergence across provinces. Those factors may include inflation rate, infrastructure, human capital, degree of openness, and use of foreign capital among provinces.

The proportion of provinces that support the convergence hypothesis increases slightly from 32% to 36% in the pre-reform period when using a non-linear unit root test. In contrast, the proportion of provinces that support the convergence hypothesis even decreases slightly from 19% to 18% in the post-reform period. The evidence clearly shows that fewer provinces support income convergence in the post-reform period compared with the pre-reform period. Table 3.12 presents Cerrato et al.'s (2009) panel NCAD test, which fails to reject the unit root null at all levels of significance in the post-reform period, implying non-mean reversion in the whole panel of per capita income in the post-reform period. In contrast to earlier studies, my findings support the view that inter-provincial inequalities have been widening since 1978. The findings are also consistent with the study of Pedroni and Yao (2006), which uses a first-generation panel unit root test with the same set of data spanning from 1952 to 1997.

Table 3. 11. Test of Beta Convergence - Individual NCADF -Comparison of Pre and Post Reform Period

Pre-Reform Period			Post-Reform Period		
Provinces	**t-stat**		**Provinces**	**t-stat.**	
REL1	-7.859	***	**REL1**	-3.383	**
REL2	-3.137	**	**REL2**	-1.221	
REL3	-3.498	**	**REL3**	-1.352	
REL4	-1.932		**REL4**	-2.489	
REL5	-3.430	**	**REL5**	-0.049	
REL6	-4.404	***	**REL6**	-1.811	
REL7	-1.846		**REL7**	-1.806	
REL8	-2.617		**REL8**	-1.332	
REL9	0.974		**REL9**	-2.064	
REL10	-2.683		**REL10**	-2.797	*
REL11	-1.866		**REL11**	-1.940	
REL12	-1.671		**REL12**	-2.317	
REL13	-2.806	*	**REL13**	-0.730	
REL14	-4.066	***	**REL14**	-3.195	**
REL15	-0.642		**REL15**	-1.559	
REL16	-1.611		**REL16**	-2.318	
REL17	-2.519		**REL17**	-3.677	**
REL18	-2.859	*	**REL18**	-3.123	*
REL19	-0.974		**REL19**	-1.216	
REL20	-2.159		**REL20**	-1.664	
REL21	-2.398		**REL21**	-1.462	
REL22	-4.344	***	**REL22**	-0.933	
REL23	-1.835		**REL23**	-0.473	
REL24	-3.292	**	**REL24**	-1.117	
REL25	-0.910		**REL25**	-2.075	
REL26	-2.579		**REL26**	-2.357	
REL27	-1.825		**REL27**	-1.005	
REL28	-2.407		**REL28**	-2.032	
Critical Values (N=30, T= 30) :					
1%	-3.86				
5%	-3.14				
10%	-2.73				

Note : ***, **, & * denote 1%, 5%, & 10% critical values respectively. Source: Cerrato et al., (Table 11, pp. 18, 2009)

Table 3. 12. Panel Test of Beta Convergence

Pre-Reform Period		Post-Reform Period	
Provinces	**t-stat**	**Provinces**	**t-stat.**
NCADF	**-2.543*** **	**NCADF**	**-1.839**
Critical Values (N=30, T= 30) :			
1%	-2.07		
5%	-1.95		
10%	-1.88		

Note: *** denote 1% critical value.

As a robustness check for the above results, I also perform an NCADF test using different provinces as the benchmarking province. Table 3.13 and Table 3.14 show that interprovincial inequalities have been widening in the post-reform period, where the column provinces are the benchmarking provinces. My findings support the implication of the proposition suggested by Young (2000) that there is increasing local protectionism in China.

Table 3. 13. NCADF test (Pre Reform)

	Beijing	Tianjing	Hebei	Shanxi	Inner Mongolia	Liaoning
Beijing	N/A	**-5.951**	**-7.074**	**-5.306**	**-6.062**	**-7.84**
Tianjing	-0.907	N/A	**-3.352**	-2.791	-1.722	**-3.523**
Hebei	-2.624	-3.032	N/A	-3.108	-3.233	-0.286
Shanxi	-2.436	-2.574	-1.067	N/A	-3.118	**-4.405**
Inner Mongolia	-1.208	-1.914	-1.573	-2.975	N/A	-1.523
Liaoning	-2.02	**-6.051**	**-4.249**	-3.006	**-4.688**	N/A
Jilin	-2.257	-1.381	-1.724	-2.396	**-4.414**	-1.291
Heilongjiang	0.291	-0.522	**-3.397**	-2.836	-2.787	0.349
Shanghai	-2.041	-2.108	**-3.381**	-2.762	-3.02	**-3.403**
Jiangsu	-1.742	-2.204	-2.345	-1.923	-2.324	-1.178
Zhejiang	0.579	-1.228	-1.174	-2.261	-0.751	-0.044
Anhui	-0.818	-0.766	-1.849	-2.328	-1.245	-0.267
Fujian	-0.825	-1.945	0.069	-2.021	-1.598	-1.408
Jiangxi	-1.48	-1.701	-2.064	-1.534	-1.8	-1.219
Shandong	0.362	-0.751	-2.69	**-3.223**	-1.878	1.206
Henan	0.382	0.026	-1.024	-2.49	-3.047	0.429
Hubei	-0.588	-1.807	-2.747	-3.047	-2.764	-1.249
Hunan	-0.111	-0.063	-2.769	-1.661	-1.15	-0.314
Guangdong	-0.217	-0.835	-1.838	-1.466	-1.218	0.299
Guangxi	-2.138	-2.308	-0.026	-2.668	0.032	-2.08
Chongqing	-1.218	-2.38	-0.796	-2.476	-2.975	-1.776
Guizhou	-1.445	-2.241	-2.07	-2.77	-1.79	**-3.625**
Yunnan	0.519	-1.685	0.246	-2.012	-0.331	0.139
Shaanxi	-2.154	**-5.371**	-2.24	**-4.094**	-3.27	**-5.077**
Gansu	0.627	-0.335	-0.594	-2.694	-1.207	0.168
Qinghai	**-3.799**	-2.235	-0.301	**-3.979**	-1.329	-3.011
Ninghai	-2.073	-2.144	-1.403	-2.942	-2.335	-2.588
Xinjiang	-2.069	-1.679	-1.134	-2.257	-2.148	-1.649

	Jilin	Heilongjiang	Shanghai	Jiangsu	Zhejiang	Anhui
Beijing	**-6.62**	**-6.355**	**-7.522**	**-7.154**	**-6.268**	**-6.394**
Tianjing	-1.266	-2.783	-0.357	-2.058	-1.112	-0.779
Hebei	**-4.48**	**-3.183**	-0.489	-1.903	-1.995	-2.469
Shanxi	-1.264	-1.419	-0.932	0.039	-0.436	0.611
Inner Mongolia	-2.813	-2.355	-0.016	-1.912	-2.601	-2.119
Liaoning	**-3.433**	**-3.548**	-2.007	**-5.083**	**-3.691**	**-3.19**
Jilin	N/A	-0.137	-0.357	-0.649	-1.034	-0.2
Heilongjiang	-2.262	N/A	0.307	0.045	-2.23	-1.343
Shanghai	-1.962	**-3.802**	N/A	-3.02	-0.63	-1.263
Jiangsu	-2.79	-0.84	**-4.393**	N/A	-1.715	-0.989
Zhejiang	-1.766	0.891	-2.001	-0.731	N/A	-1.092
Anhui	-2.707	-1.13	-1.283	-1.966	**-3.642**	N/A
Fujian	-1.499	0.745	-1.06	-1.365	-1.085	-0.865
Jiangxi	-2.991	0.064	**-3.865**	-2.238	**-3.147**	-1.159
Shandong	-2.608	-2.305	-1.06	-3.602	-1.996	**-3.146**
Henan	**-3.168**	-2.743	1.079	-2.885	-2.281	-1.743
Hubei	-2.362	-2.109	-0.653	-2.84	-2.916	-3.31
Hunan	-1.276	-1.362	0.362	-0.339	-1.471	-0.673
Guangdong	-1.754	0.071	-1.954	-1.549	-1.909	-1.282
Guangxi	-1.497	0.582	**-4.799**	-1.965	-1.965	-2.008
Chongqing	-2.797	-0.201	-1.37	-1.033	-1.233	-0.168
Guizhou	-2.181	-2.197	-0.908	-1.595	-2.053	-1.395
Yunnan	-1.734	-0.571	-1.502	-1.865	-1.514	-2.755
Shaanxi	-2.554	-3.075	-2.269	-2.622	**-3.232**	-2.403
Gansu	-1.564	-1.852	0.688	-2.144	-2.117	**-3.352**
Qinghai	-2.196	-0.53	-2.75	-1.694	-2.251	-0.633
Ninghai	-2.63	-0.714	-1.666	-2.676	-1.089	-0.132
Xinjiang	-2.509	-1.339	-2.225	-1.603	-1.603	-1.598

	Fujian	Jiangxi	Shandong	Henan	Hubei	Hunan
Beijing	**-5.774**	**-5.892**	**-5.626**	**-6.425**	**-7.022**	**-6.804**
Tianjing	-1.996	-0.932	-0.958	-2.772	-1.558	-2.308
Hebei	-2.974	-1.355	-1.889	-2.071	-2.773	-1.011
Shanxi	-0.624	-0.043	-2.048	-1.304	-2.03	-1.506
Inner Mongolia	-2.004	-1.139	**-3.284**	-2.281	-2.728	-2.549
Liaoning	**-3.16**	-1.623	**-4.384**	**-3.907**	**-3.856**	**-4.028**
Jilin	-2.058	-1.469	-2.526	-1.14	-2.342	-2.009
Heilongjiang	-2.545	-2.018	**-4.183**	-2.614	-2.592	-2.476
Shanghai	-1.641	-0.359	-1.28	**-3.563**	-1.971	-2.658
Jiangsu	-2.734	-2.733	-0.922	-2.101	-1.224	-2.542
Zhejiang	-2.656	**-3.544**	-1.998	-1.605	-0.25	-1.592
Anhui	**-3.493**	-3.1	-2.752	-2.41	-3.13	-2.239
Fujian	N/A	-0.513	-1.179	-1.785	-0.762	-1.342
Jiangxi	-3.002	N/A	**-3.201**	-1.996	-2.538	-2.622
Shandong	-2.765	-1.948	N/A	-2.933	-2.3	-2.856
Henan	-2.21	-1.791	**-3.319**	N/A	-2.463	-1.416
Hubei	-2.929	-1.686	-2.668	-3.052	N/A	-2.23
Hunan	-2.594	-2.095	-3.07	-1.57	-2.582	N/A
Guangdong	-2.043	**-4.259**	-1.237	-2.845	-0.009	-1.931
Guangxi	-1.855	-1.729	-2.15	-1.614	0.113	-1.621
Chongqing	-2.772	-1.389	-0.756	-2.538	-1.17	-1.143
Guizhou	-2.586	-1.955	-2.522	-1.977	**-3.56**	-2.719
Yunnan	-1.948	-1.652	-1.94	-0.865	-0.558	-1.276
Shaanxi	-3.038	-2.722	**-3.44**	**-3.427**	**-3.556**	-3.067
Gansu	-1.968	-2.076	-2.397	-2.085	-2.131	-2.38
Qinghai	-2.532	-1.468	-1.528	-1.474	-1.966	-2.408
Ninghai	-1.914	-1.187	-1.821	-1.251	-1.41	-1.391
Xinjiang	-2.098	-1.054	**-4.232**	**-4.037**	-2.568	-0.882

	Guangdong	Guangxi	Chongqing	Guizhou	Yunnan	Shaanxi
Beijing	**-5.11**	**-5.374**	**-4.277**	**-4.256**	**-6.321**	**-5.365**
Tianjing	-1.47	-0.401	0.108	-1.436	-2.293	-2.852
Hebei	-2.684	-0.311	**-3.693**	-2.671	-1.459	-1.51
Shanxi	-0.622	-1.28	-0.801	-1.927	-1.97	**-3.192**
Inner Mongolia	-2.477	**-4.085**	-1.728	-1.402	-1.747	-2.213
Liaoning	**-4.35**	-2.178	-1.524	**-3.755**	**-5.007**	**-4.897**
Jilin	-0.657	-2.401	-0.423	-2.437	-0.153	-2.055
Heilongjiang	**-3.541**	-1.742	-2.344	-1.626	-1.633	-1.02
Shanghai	-0.188	0.558	-0.461	-2.456	-1.141	-1.815
Jiangsu	-1.876	-2.016	**-3.756**	-1.749	-1.332	-1.318
Zhejiang	-1.617	-1.243	-1.811	-2.555	-1.768	-0.6
Anhui	-3.915	-2.315	**-4.169**	-1.925	-2.235	-1.262
Fujian	-0.312	-1.765	-1.4	-2.644	-2.147	-1.705
Jiangxi	-2.016	-1.696	-1.909	-2.708	-3.056	-0.153
Shandong	-1.416	-0.925	-1.989	-2.654	**-3.473**	-1.183
Henan	-1.683	-1.127	-2.817	-1.744	-1.817	-1.218
Hubei	-3.08	-3.045	-2.79	-2.58	-2.142	-2.927
Hunan	-2.159	-1.278	-1.009	-1.346	-1.737	0.235
Guangdong	N/A	-2.049	-2.951	-0.806	-0.961	-0.712
Guangxi	-1.914	N/A	-0.124	-2.194	-2.903	-2.352
Chongqing	-1.395	-2.048	N/A	-1.977	-0.743	-1.423
Guizhou	-2.31	-2.468	-1.944	N/A	**-3.881**	**-4.341**
Yunnan	-2.175	-1.196	-1.214	-0.977	N/A	-2.096
Shaanxi	-2.687	-1.41	-1.812	**-4.334**	-3.147	N/A
Gansu	-2.894	-1.347	**-3.412**	-1.445	-1.837	-0.651
Qinghai	-1.685	-2.664	-1.811	-2.622	-2.677	-2.957
Ninghai	-0.343	-1.949	-0.56	-2.392	-1.496	-2.047
Xinjiang	-1.665	-2.231	**-3.188**	-2.01	-1.918	-1.829

	Gansu	Qinghai	Ninghai	Xinjiang
Beijing	**-6.038**	-2.578	**-5.835**	-1.03
Tianjing	-1.832	-2.293	-1.548	-1.138
Hebei	-1.052	-1.138	-1.7	**-3.871**
Shanxi	0.11	-0.115	0.686	-0.474
Inner Mongolia	-2.758	-1.53	-0.415	-0.879
Liaoning	**-5.115**	-2.357	-2.427	-0.124
Jilin	-0.655	-1.189	-2.383	-1.611
Heilongjiang	-2.302	-1.303	-1.753	-1.086
Shanghai	-2.738	-1.802	-1.828	-1.85
Jiangsu	-1.489	-2.075	-2.821	-2.343
Zhejiang	-2.233	-1.852	-2.161	-2.759
Anhui	**-3.202**	-1.751	-2.735	-2.515
Fujian	-0.476	-0.314	-2.654	-1.37
Jiangxi	**-5.571**	**-3.249**	-2.434	-1.878
Shandong	-2.171	-0.924	-1.978	-2.443
Henan	-1.245	-0.728	-2.553	-1.797
Hubei	-2.596	**-6.417**	-1.152	-2.22
Hunan	**-5.325**	-3.036	-0.26	-1.991
Guangdong	-2.219	-1.079	-2.323	-2.624
Guangxi	-1.915	-2.498	-2.156	-0.92
Chongqing	-0.091	-0.97	-2.901	-2.66
Guizhou	-2.447	-1.567	-0.498	-1.34
Yunnan	-0.764	-1.03	-1.051	-1.598
Shaanxi	-0.929	**-3.218**	-1.241	-2.058
Gansu	N/A	-0.29	-1.7	-1.629
Qinghai	-1.483	N/A	-1.15	-1.544
Ninghai	-1.882	-1.411	N/A	-1.545
Xinjiang	**-3.762**	-2.211	-1.584	N/A

Note: The highlighted figures in yellow color are in 5% sig. Level.

Table 3. 14. NCADF test (Post Reform)

	Beijing	Tianjing	Hebei	Shanxi	Inner Mongolia	Liaoning
Beijing	N/A	-1.513	-2.022	-2.443	-3.071	-1.406
Tianjing	-0.774	N/A	-0.527	-1.479	-0.59	-0.599
Hebei	-0.884	-0.877	N/A	-1.856	-3.352	-2.613
Shanxi	-1.168	-2.371	-2.043	N/A	-4.918	-0.902
Inner Mongolia	-0.171	-2.014	-0.577	**-4.098**	N/A	0.061
Liaoning	-1.577	-1.786	-2.134	-2.356	**-5.073**	N/A
Jilin	-1.862	-2.505	-2.044	-1.93	**-4.723**	-2.812
Heilongjiang	-1.274	-2.552	-1.006	-0.018	-1.054	-0.715
Shanghai	-1.116	-0.19	-2.364	-0.458	-2.617	-1.597
Jiangsu	**-3.155**	-0.563	-2.039	-0.836	-1.982	-2.303
Zhejiang	-1.556	0.734	-1.218	-1.375	-1.255	-1.614
Anhui	-1.333	-2.453	-0.744	-0.984	-1.259	-1.146
Fujian	-0.522	0.716	-1.509	1.126	1.088	-1.486
Jiangxi	-1.278	0.141	**-4.83**	-0.98	-1.412	-1.502
Shandong	-1.296	0.115	-1.531	-1.333	-1.488	-0.413
Henan	-3.037	-0.967	-1.223	-1.636	0.33	-2.369
Hubei	-2.953	-1.524	**-3.353**	-0.284	-0.34	-1.67
Hunan	-0.081	-1.233	-1.881	0.199	-1.14	-0.051
Guangdong	-0.602	0.266	1.485	-0.389	-0.127	-0.719
Guangxi	-1.904	-0.075	-1.684	-0.06	-1.122	-1.49
Chongqing	-1.179	0.019	-2.465	-1.046	-0.622	-0.347
Guizhou	-1.515	-1.007	-1.979	-2.182	**-4.52**	-1.459
Yunnan	-0.539	-0.085	0.449	-0.842	-0.53	-0.006
Shaanxi	-1.017	-2.01	-2.479	-1.79	-1.908	-1.334
Gansu	-1.641	-2.247	-1.486	-2.623	**-6.511**	-1.859
Qinghai	-2.322	**-3.705**	-2.599	**-8.163**	**-4.487**	-2.734
Ninghai	-1.166	-1.098	-1.168	-1.871	-2.19	-1.852
Xinjiang	-1.826	-0.681	-1.824	-3.099	-2.896	-1.412

	Jilin	Heilongjiang	Shanghai	Jiangsu	Zhejiang	Anhui
Beijing	-2.67	-1.968	-1.303	-2.236	0.358	-1.848
Tianjing	-0.322	1.008	-2.264	-1.384	-0.938	-0.243
Hebei	**-3.531**	-0.72	**-3.358**	-2.644	-1.413	-1.519
Shanxi	-0.771	-2.782	-1.944	-2.166	-1.208	-0.887
Inner Mongolia	-0.539	-2.271	-0.551	-0.85	-0.611	-0.685
Liaoning	**-4.457**	-2.286	-1.895	-0.77	-0.942	0.478
Jilin	N/A	-1.807	-1.829	-1.3	-1.66	-1.276
Heilongjiang	-2.028	N/A	-1.31	-0.777	0.544	-0.751
Shanghai	-2.784	0.234	N/A	-3.031	-2.066	0.298
Jiangsu	-2.762	-0.781	-2.887	N/A	-2.192	-1.581
Zhejiang	-1.312	-1.312	-1.751	-1.614	N/A	-0.752
Anhui	-0.725	-0.251	-3.036	-1.864	-2.777	N/A
Fujian	-0.704	0.319	-0.846	-1.486	-1.259	-0.73
Jiangxi	-1.823	-0.155	**-7.334**	-2.096	-1.577	-0.872
Shandong	-1.638	-1.125	-0.544	-0.004	-1.71	-1.347
Henan	-1.97	-1.083	-1.765	-2.688	-2.672	-2.099
Hubei	1.351	-0.694	**-4.051**	-2.013	-1.719	-1.743
Hunan	-2.518	-0.193	-2.519	-1.519	-1.355	0.051
Guangdong	-0.951	-0.376	-0.55	0.461	-0.356	-1.21
Guangxi	**-3.267**	-2.281	-0.787	-0.782	-1.525	-0.23
Chongqing	-0.644	-0.984	-1.569	-0.789	1.331	-0.009
Guizhou	-1.597	-1.44	-0.378	-1.524	-0.353	-1.361
Yunnan	-0.4	-0.372	-1.087	-1.061	-0.741	-1.223
Shaanxi	-2.88	-0.334	-1.766	-2.11	-0.644	0.076
Gansu	**-4.161**	-2.052	-1.712	-0.754	-0.107	-0.081
Qinghai	-1.99	-2.81	-2.814	-0.881	-0.452	-0.872
Ninghai	-1.518	-1.269	-1.336	-1.764	-0.571	-0.774
Xinjiang	-2.06	-0.816	-1.239	-0.835	0.026	-1.466

	Fujian	Jiangxi	Shandong	Henan	Hubei	Hunan
Beijing	-0.982	-2.57	-0.985	-1.185	-1.751	**-3.741**
Tianjing	-1.005	-1.22	-2.521	0.685	-0.379	0.917
Hebei	-3.064	-1.567	-2.887	-2.468	-1.598	-0.885
Shanxi	-3.104	-2.124	-2.007	-2.75	-2.512	-2.878
Inner Mongolia	-2.689	-0.116	-0.897	-2.579	-0.622	-1.77
Liaoning	0.164	-1.516	-1.232	-1.046	-1.344	-2.169
Jilin	-1.581	-1.144	-1.665	-1.764	-3.082	-2.132
Heilongjiang	-0.319	-1.756	-0.465	-0.878	-0.447	-1.933
Shanghai	-3.027	-4.25	-3.864	-0.545	-1.083	-0.056
Jiangsu	-1.648	-3.132	-2.316	-1.027	-1.967	-0.764
Zhejiang	-2.177	-2.632	-2.024	-1.498	-1.318	-0.603
Anhui	-2.656	-2.284	-2.892	-2.502	-2.61	-1.912
Fujian	N/A	-1.603	-1.716	-1.525	-0.111	0.881
Jiangxi	-2.203	N/A	-2.707	-2.4	-0.811	-1.523
Shandong	-0.849	-0.741	N/A	-2.906	-0.389	-0.609
Henan	-3.407	-2.376	-2.133	N/A	-2.972	**-3.244**
Hubei	-3.032	-0.924	**-4.66**	-2.597	N/A	-2.406
Hunan	-2.132	-2.772	-1.36	-0.94	-0.786	N/A
Guangdong	0.795	-0.427	-0.501	-0.298	-1.755	0.555
Guangxi	-1.023	-1.685	-2.24	-1.931	-0.817	-1.598
Chongqing	-1.309	-2.184	-2.126	-0.481	-1.479	-0.711
Guizhou	-2.983	-0.116	-1.294	-2.834	-0.471	-1.868
Yunnan	-1.772	-1.461	-0.708	-0.468	-1.01	0.379
Shaanxi	-0.372	-2.231	-0.901	-0.705	-0.678	-0.984
Gansu	0	-1.63	-0.552	-0.624	-1.445	-1.353
Qinghai	-0.023	-1.203	-1.433	-1.691	**-4.476**	**-3.168**
Ninghai	-0.715	-1.34	-0.292	-1.104	-1.538	-1.39
Xinjiang	-0.8	-1.592	0.135	-1.968	-0.676	-0.517

	Guangdong	Guangxi	Chongqing	Guizhou	Yunnan	Shaanxi
Beijing	-0.372	-1.498	-3.039	-2.121	0.102	-2.264
Tianjing	0.259	-1.895	-0.212	0.421	0.215	-0.859
Hebei	-2.589	-2.927	-1.003	-2.156	-1.778	-2.513
Shanxi	-1.142	-3.087	-2.192	-1.731	0.395	-1.279
Inner Mongolia	0.522	-1.747	-1.659	-2.709	1.794	-0.137
Liaoning	1.189	-2.332	-2.112	-2.715	0.615	-2.253
Jilin	-1.269	-2.109	-2.519	-3.232	0.292	-0.707
Heilongjiang	0.48	-0.319	-1.076	-1.505	1.356	-2.601
Shanghai	-1.429	-2.849	-1.685	0.226	-0.211	-2.266
Jiangsu	-2.777	-1.82	-2.595	-1.579	-1.737	-2.179
Zhejiang	-1.481	-1.973	-2.738	-1.279	-2.282	-0.708
Anhui	-2.837	-2.356	-2.18	-0.668	-2.477	-0.753
Fujian	-1.717	-0.039	-1.04	1.008	-2.68	-0.222
Jiangxi	-1.557	-0.87	-2.901	-0.545	-1.592	-1.2
Shandong	-2.551	-3.006	**-4.672**	-1.616	-2.301	-0.17
Henan	-2.212	-2.342	**-3.187**	0.071	-1.264	-1.029
Hubei	-1.704	-2.687	-1.429	0.213	-1.416	0.055
Hunan	-0.537	-1.602	-1.517	0.616	-0.085	-1.386
Guangdong	N/A	1.254	0.357	-0.857	-1.765	-0.893
Guangxi	-1.279	N/A	**-3.355**	-0.989	-1.126	-1.71
Chongqing	-1.802	-2.556	N/A	-0.771	-1.477	-1.227
Guizhou	-1.006	-0.591	-1.881	N/A	1.328	-1.029
Yunnan	-1.39	0.077	-0.39	-1.126	N/A	-0.57
Shaanxi	0.309	-0.301	**-3.198**	-2.194	-0.143	N/A
Gansu	0.053	-1.33	-1.773	-3.254	0.533	-8.435
Qinghai	0.968	-2.145	-2.362	-4.675	0.977	-2.185
Ninghai	0.858	-0.472	-1.889	-1.702	1.435	-3.292
Xinjiang	0.05	1.234	-1.772	-3.052	1.169	-1.812

	Gansu	Qinghai	Ninghai	Xinjiang
Beijing	-1.93	0.3	-1.377	-2.262
Tianjing	-1.19	1.418	-0.223	-1.368
Hebei	-1.927	-1.961	-1.088	-1.556
Shanxi	-1.74	-4.678	-0.911	-1.613
Inner Mongolia	-0.64	-2.8	-0.739	0.704
Liaoning	-1.26	-1.572	-0.014	-1.468
Jilin	-1.524	-2.529	-1.633	-1.962
Heilongjiang	-0.958	-0.386	-2.325	-0.678
Shanghai	-2.69	0.913	-0.849	-3.536
Jiangsu	-1.321	-1.212	0.058	-1.478
Zhejiang	-1.505	-0.902	-1.208	-1.855
Anhui	0.209	-0.305	0.233	-2.536
Fujian	-1.344	0.432	-0.266	-0.003
Jiangxi	-1.044	0.452	-0.4	-1.793
Shandong	-1.167	-0.509	-0.911	-1.812
Henan	-1.58	-0.546	-0.286	-1.397
Hubei	-0.564	1.001	1.045	-2.359
Hunan	-0.461	0.312	-1.03	-2.083
Guangdong	-1.239	-0.629	-1.974	-1.508
Guangxi	-2.463	-0.885	-2.9	-1.786
Chongqing	-1.916	0.266	-1.659	-1.806
Guizhou	-1.857	-2.478	-1.593	-2
Yunnan	-0.321	-0.13	-1.479	-1.667
Shaanxi	-2.51	-3.002	-1.393	-1.602
Gansu	N/A	-1.729	-2.337	-2.822
Qinghai	-2.596	N/A	-0.926	-1.862
Ninghai	-2.587	-1.891	N/A	-0.828
Xinjiang	-1.679	-2.606	-3.449	N/A

Note: The highlighted figures in yellow color are in 5% sig. Level.

3.8.2. Conditional Beta Convergence

Temple (1999) states that panel data techniques are allowed to control for the omitted variables that are persistent over time in the regression model. The regression that tests beta convergence is specified as:

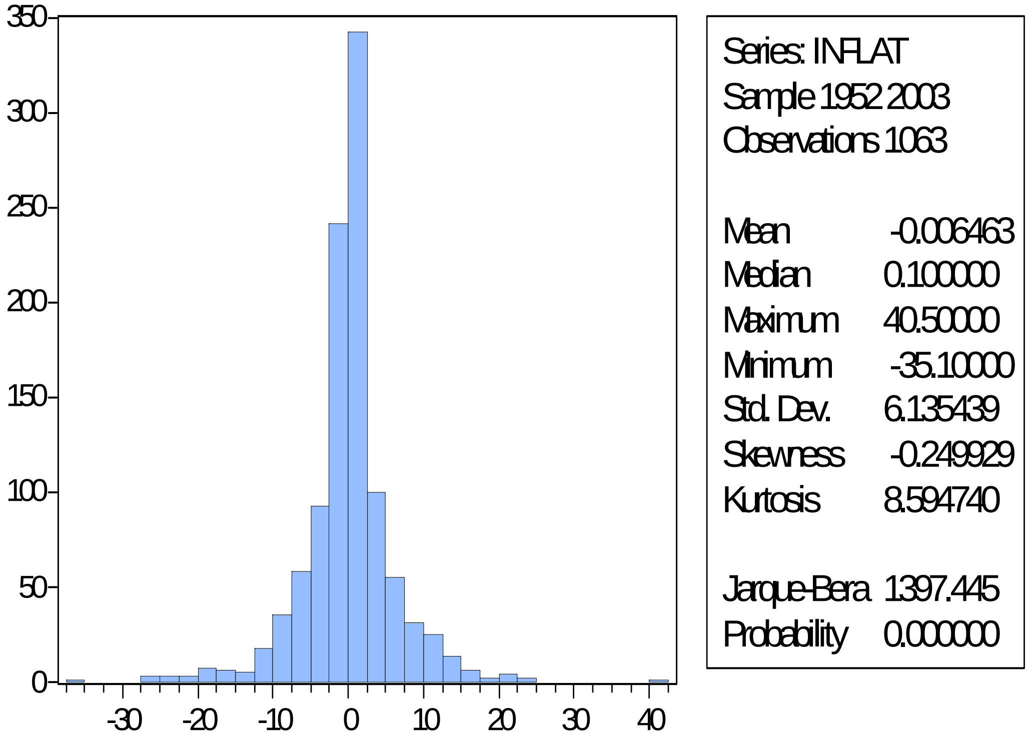
$$\ln y_{it} = \alpha_i + \beta \ln y_{it-1} + \omega x_{it} + \upsilon_{it} \qquad \textbf{(3.25)}$$

where $\ln y_{it}$ denotes the dependent variable, the real GDP growth per capita; $\ln y_{it-1}$ is the log of one period lagged GDP per capita; i and t denote individual province and time period, respectively; β is the convergence coefficient; and X_{it} is a vector that controls factors of heterogeneity across provinces. This vector incorporates potential growth determinants both inside and outside the standard Solow's model. The hypothesis of conditional convergence is valid if $\beta < 0$ and $\omega > 0$. Also, unconditional convergence holds if $\beta < 0$ and $\omega = 0$. Since there are insufficient data, equation (3.25) are estimated from 1952 to 2003. Table 3.15 shows that there is strong evidence in favour of conditional convergence with β significantly negative, and the growth rate is conditional on the following factors.

Inflation Rate: It is generally accepted that inflation and growth are negatively related.[34] However, Fischer (1993) finds a non-linear relationship between the inflation rate and the growth rate. The relationship is initially positive when the inflation rate is relatively low, and it becomes negative when the inflation rate increases. Khan and Senhadji (2000) examines the threshold effects in the relationship between inflation and growth. The authors find that the threshold is 1–3% for industrial countries and 7–11% for developing countries. Figure 3.8 shows the distribution for inflation; we can see that the inflation rate *"(INFLAT)"* is relatively low on average.

34 See Fischer (1983, 1993) and Barro (1991).

Figure 3. 8. Inflation Rate (1952-2003)



Therefore, my hypothesis is that the growth rate is positively related to inflation rate, and Table 3.15, column 5 confirms my hypothesis.

Table 3. 15. Conditional Convergence in China (1952-2003)-Fixed Effect

Dependent Variable: GDPGROWTH	GDP growth		GDP growth		GDP growth		GDP growth		GDP growth	
	(1)		(2)		(3)		(4)		(5)	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
LNGDP(-1)	-0.267	0.000	-0.236	0.000	-0.201	-6.098	-0.234	0.000	-0.257	0.000
GDPGROWTH(-1)	0.131	0.014	0.131	0.016	0.090	1.319	0.129	0.021	0.118	0.174
INFLAT	0.002	0.024	0.002	0.033	0.002	1.655	0.002	0.018	0.001	0.074
LN(TEPHONE/POP)	-0.086	0.021	-0.126	0.001	-0.014	-0.301	-0.112	0.003	-0.018	0.707
LN(TELSUB)	0.082	0.006	0.080	0.008	0.102	2.642	0.069	0.022	0.071	0.105
LN(TEL/POP)	-0.145	0.010	-0.106	0.062	-0.305	-3.839	-0.135	0.014	-0.062	0.565
LN(HIGH/POP)	-0.093	0.008	-0.106	0.003	-0.108	-1.774	-0.092	0.011	-0.141	0.009
LN(RAIL/POP)	-0.031	0.038	-0.004	0.783	0.066	1.726	-0.006	0.635	0.074	0.002
LN(PRIED/POP)	0.083	0.002							0.130	0.020
PRITE/PRIED	0.000	0.370							0.000	0.051
(SECED/POP)			-0.001	0.957					-0.124	0.093
(SECTE/SECED)			0.000	0.528					0.000	0.054
(HIGHED/POP)					-0.001	0.921			0.004	0.693
(HIGHTE/HIGHED)					-0.010	0.283			-0.010	0.076
(BOOK/POP)							0.009	0.637	-0.063	0.002
LN(IANDE/POP)	0.214	0.000	0.190	0.000	0.191	0.000	0.186	0.000	0.216	0.000
LN(FOREIGN/POP)	-0.008	0.397	-0.011	0.281	-0.016	0.330	-0.008	0.417	0.000	0.978
LN(FIXED/POP)	0.109	0.000	0.092	0.004	0.031	0.502	0.091	0.002	0.066	0.149
PPGRO	-0.005	0.375	-0.004	0.480	-0.003	0.792	-0.010	0.109	0.002	0.732
LN(ENIN/GOVEXP/POP)	0.039	0.049	0.029	0.107	0.028	0.301	0.043	0.026	0.007	0.633
LN(ELECT/POP)	-0.005	0.237	-0.003	0.428	-0.002	0.651	-0.003	0.389	0.001	0.841
LN(SOE/POP)	0.014	0.221	0.017	0.120	-0.009	0.505	0.018	0.108	-0.007	0.631
LN(TAX/POP)	0.013	0.421	0.014	0.416	-0.022	0.461	0.020	0.237	-0.040	0.057
C	2.804	0.000	1.914	0.003	1.999	0.029	2.260	0.000	1.930	0.075
Observations	354		353		257		345		256	
Adjusted_R^2	0.635		0.624		0.608		0.64		0.658	
D-W Stat.	1.823		1.838		1.993		1.855		1.954	

Note: The dependent variable is GDP growth rate (GDPGROWTH). In order to take dynamic growth into account I include the one lagged GDP in level (LNGDP (-1)) and one lagged GDP growth (LNGDPGROWTH (-1)), these figures are in natural logarithm.

Infrastructure: Ding and Haynes (2006, 2008) investigate the role that infrastructure and telecommunication infrastructure play in Chinese regional growth. In their research, they measure telecommunications infrastructure by using tele-density, i.e. the number of telephone sets per 100 inhabitants including both fixed line and mobile phones, and find that it contributes to growth. However, their studies ignore the real utilization rate of those telephone lines. In addition to the number of telephone lines *"(TEPHONE/POP)"* per capita, where *"POP"* denotes population, the model also includes the number of subscribers *"(TELSUB)"* to capture the actual utilization rate and the business volume of post and telecommunication services per capita *"(TEL/POP)"*. Interestingly, my findings (Table 3.15, column 5) indicate that TEL/POP and TEPHONE/POP have no significant contribution to growth at the 10% significance level. TELSUB imposes a marginal positive effect on growth at the marginal 10% significance level. This finding implies that telecommunication investment by itself cannot contribute to growth, and that the utilization rate of such infrastructure does impose a positive effect on growth. Other control variables that I added to the empirical model are the length of highway per capita *"(HIGH/POP)"* and the length of railway per capita *"(RAIL/POP)"*. The findings indicate that railways have positive effects on growth while highways impose negative effects on growth and imply that railways are more efficient than highways in promoting growth.

Human Capital: The endogenous growth model identifies human capital as the key engine for the growth process and it is the source of increasing return-to-scale characteristics.[35] My study introduces the notion of non-linearity between human capital and growth in the sense that at low levels of human capital the effect on growth

35 See for example, Romer (1986, 1989) and Lucas (1988).

is negative and they become positive at middle levels, as suggested by Kalaitzidakis et al., (2001) and Cravo and Soukiazis (2009). In my empirical model, I use the number of primary school students per inhabitant *"(PRIED/POP)"* to represent the lowest level of human capital that is necessary for performing simple economic activities.

I also use the ratio of primary teachers to students *"(PRITE/PRIED)"* as a proxy for educational quality. The number of students involved in secondary school per capita *"(SECED/POP)"* is used to represent the level of human capital related to the skills necessary to perform activities that require secondary knowledge, while using the teacher-to-student ratio *"(SECTE/SECED)"* to represent its educational quality. In the same fashion, the number of students involved in higher education per capita *"(HIGHED/POP)"* is used to represent the level of human capital related to the skills necessary to perform activities that require specialized knowledge, while using the teacher-to-student ratio *"(HIGHTE/HIGHED)"* to represent its educational quality. Finally, the amount of books published is used to represent creativity, research and development, and new ideas. To avoid the potential problem of multicolinearity, I estimate separately the effect of different levels of human capital proxies on growth, and Table 3.15 presents the empirical results.

The estimated coefficient associated with the lowest education attainment is positive and significant as expected, suggesting that the higher the rate of basic education attainment, the higher is the growth of per capita income (Column 1). The results suggest an insignificant impact on growth when only secondary education was adopted (Column 2). When I consider the effect of higher education on growth, the effect is again insignificant, indicating that using the human capital at the tertiary level alone is not able to explain the convergence process among the Chinese provinces (Column 3).

In addition, the estimate for the rate of book publications per inhabitant *"(BOOK/POP)"* suggests that there is no significant effect of the highest level of human capital on growth in China, although it has the expected positive sign (Column 4). The result indicates that the ability to develop new ideas and creativity cannot influence growth in China at the current development stage. My results are in line with those of Lau et al., (1993) that the existence of educational threshold is at an intermediate level of human capital. The results could be explained by the fact that "BOOK" is not related to the intermediate level of human capital in China and hence does not affect growth.

Finally, Column 5 summarizes the empirical results on human capita of different levels. The results show that PRI dominates and is the only level of human capital that has a positive effect on growth and is statistically significant, suggesting that schooling at the primary level is the relative intermediate level of human capital that triggers economic growth in China. In contrast, *"SECED"* and *"BOOK"* have a negative impact on growth, indicating that investments in secondary and higher levels of human capital do not favor economic growth.

Openness: Many studies examine the role of trade in economic growth. Based on the export-led growth (ELG) hypothesis, Ljungwall (2006) concludes that the ELG hypothesis holds for 13 out of 27 Chinese provinces, mainly located in the export-oriented eastern coastal areas. Using panel data, Li, Chang and Su (2009) find that a 10% decline in export growth leads to a decrease of 2.5% in Chinese provincial GDP growth after controlling for some potential control factors. However, I suspect that openness (i.e. trade volume/POP) is a better measure than exports alone. If exports are measured alone, the estimate may be biased because imports also contribute to growth.

Ram (1990) finds that imports contribute significantly to growth in most countries in his cross-section study. Using cross-section data, Frankel and Romer (1999) find a positive relationship between trade volume and income level among selected countries. My study finds that a 10% increase in openness *"(IANDE/NGDP)"* leads to an increase of 2.2% in Chinese provincial GDP growth.

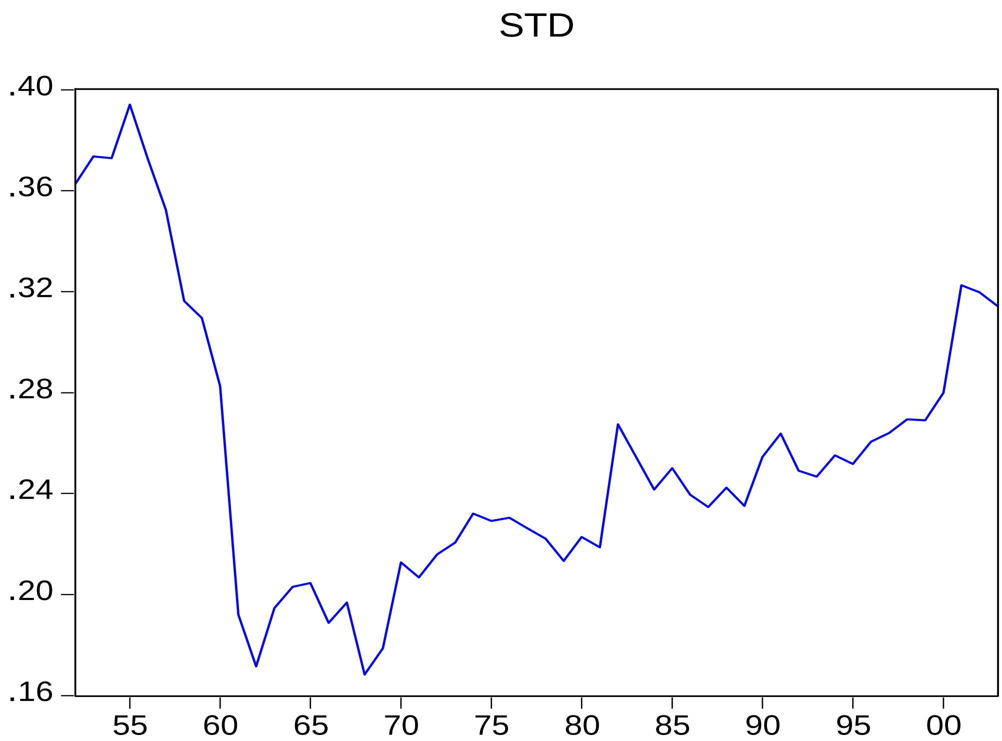
Foreign Capital: According to Krugman's (1993) argument that foreign capital only accounts for a fractional share of gross capital formation, it could hardly be the engine of growth. My study confirms that the amount of actually used foreign capital per capita *"(FOREIGN/POP)"* has an insignificant effect on regional growth. There it implies that domestic factors seem to be the most important factors affecting growth in China, in comparison with the driving forces of globalization.

Other Control Variables: Physical capital as represented by fixed assets per capita *"(FIXED/POP)"* is significant and positively related to growth in the Chinese provinces. On the other hand, the results for population growth *"(PPGRO)"* are not significant, and this finding may be attributed to the fact that income level is the main determinant of migration in China, especially after the central government took steps to speed up the relaxing of the official "hukou", or household registration system. Also, the ratio of expenditure for enterprises' innovation per dollar of government expenditure *"(ENIN/GOVEXP/POP)"*, generated electricity volume *"(ELECT/POP)"* and the number of stated-owned enterprises (SOE/POP) are all found to be insignificant. Tax per capita *"(TAX/POP)"* is found to be negatively related to growth, as expected.

3.8.3. Sigma Convergence

Figure 3.9 plots the standard deviation of the natural logarithm of provincial per capita GDP in China from 1952 to 2003. Over 52 years, if the theory of sigma convergence is correct, one would expect to see a persistent downward trend in the variable. It shows very clearly that provincial income is converging before the pre-reform period while diverging over time after the post-reform period.

Figure 3. 9. Standard Deviation of the Natural Logarithm of Provincial Per Capita GDP in China (1952 -2003)



3.9. Conclusion

Competitiveness is a polysemous concept. Economists are inclined to define and measure competitiveness at three hierarchical levels: those of enterprise, industry and nation. Krugman (1994, p. 44) criticizes that competitiveness should be regarded as a domestic productivity problem (Krugman, 1997). In this paper, I examine the dynamics of the growth path and the growth determinants in the Chinese economy using provincial data. I examine the empirical validity of both beta and sigma convergence across China using provincial per capita personal income during 1952 to 2005. Using both linear and non-linear unit root tests, I identify converging and diverging Chinese provinces. I confirm the view of Pedroni and Yao (2006) that interprovincial inequalities have been widening since 1978, and the implication of the proposition suggested by Young (2000) is that there is increasing local protectionism in China.

My result suggests that future research should be carried out on the question of why income is not converging for some provinces in the long-run. There could be some possible explanations for the above puzzle. Firstly, as argued by Drennan et al., (2004), transportation technology may be one important factor affecting the convergence process. After the mid-1970s, transportation technology does not improve significantly. In contrast, the transaction costs of exchanging services and manufactured goods across states are reduced dramatically. For example, railroads, trucks and the inter-province highway system served to raise the mobility of labour, capital and commodities, and hence to equalize returns and prices across provinces. However, I believe that this convergence process follows a non-linear dynamics as supported by various empirical studies in the field of the law of one price (LOP).

Secondly, the conclusion of unconditional convergence could be derived from a neoclassical growth model only if certain assumptions hold in the nature of input factors and agents' maximizing behavior (Mankiw et al., 1992). The model assumes diminishing marginal returns to labor and capital, which in turn imply income convergence across states because labor and capital are moving around seeking the highest returns. However, Acemoglu (2002) argues that skill-biased technical change might favor rich regions and lead to the violation of diminishing marginal returns to labor at the initial stage of technical progress. Therefore, I would expect a "sudden jump" in the growth rate when the income level of a region exceeds a particular threshold level. Again, this suggests that I should model growth dynamics in a non-linear set-up.

Lastly, product quality and intra-regional trade may play a role in explaining conditional convergence. There may be a conflict in the preferences for the ideal quality of consumption between rich and poor metropolitan areas across states. A poor region may choose an "inferior" autarkic production technology so that a greater quantity of "low" quality goods can be produced given resources' availability. By making such a decision, the poor region forgoes the opportunity to join the "global" markets and boosts its growth by division of labor, production specialization and technology spillover. Again, I would expect a "sudden jump" in the growth rate when the income level of a region exceeds a particular threshold level.

In addition, I also examine the determinants of conditional convergence in China. The results indicate that low inflation, transport and telecommunication infrastructure, and trade openness could stimulate economic growth in China. Human capital also plays a significant role in growth, and it exhibits non-linearity between human capital and growth in the sense that at low levels of human capital the effect on growth is negative and it becomes positive at middle levels.

Chapter 4: Technology Transfer and Enterprise Performance: A Firm-Level Analysis in China, *AND* Determinants of Firm's Performance and Competitiveness: Observations in China's Manufacturing Industries

This chapter in general explores the determinants of firm's performance and competitiveness in the transitional economy of China. In particular it attempts to explore key determinants of competitiveness in the textiles and apparels industries in China.

This chapter proceeds as follows. First, I review and discuss the relationship between openness and firm's performance. Then I describe the data set used in this study, and provide research methodology and constructs key variables for analysis. Empirical results and its implications will be discussed in section 4.5 and section 4.6 concludes the first part.

In section 4.7 to 4.11, I put forth the measure of key determinants of firm's competitiveness especially in the textile and apparel industries. Again I first review the published literature on conceptual and measurement issues of competitiveness, and related empirical studies at the industry level. Further I investigate and propose firm-specific determinants of competitiveness for the study of China's textile and apparel industries. I describe the survey data, methodology, empirical results, and discussion on policy implications. Finally, conclusions and discussions are provided.

Part 1- Technology Transfer and Enterprise Performance: A Firm-Level Analysis in China

4.1 Introduction

Solow's (1956) model concludes that growth rate of output in the long-run depends upon the rate at which technological change occurs. Exports of goods and services, imports of machinery and capital, and foreign direct investment (FDI) are channels through which technology and hence economic performance could be enhanced. A number of studies document a direct relationship between trade and economic growth using cross-country data[36]. Recently, a number of papers have empirically examined the relationship between exporting and economic performance using firm-level panel data. Studies find evidence that exporting firms achieve higher productivity than non-exporters[37], and exporting activities Granger-cause productivity[38]. Fan and Hu (2008) examines the relationship between firm's productivity and imports through which technological progress occurred for Chinese enterprises. However, there is still lack of literatures on comparing the efficiency of different channels on enhancing firm's performance, and my study attempts to fill this gap.

36 The relevant empirical literature includes Sachs and Warner (1995), Edwards (1998), and Frankel and Romer (1999).

37 For example, Bernard and Jensen (1999) and Clerides, Lach, and Tybout (1998)

38 See for example, Aw et el. (2008,2009), Alvarez and Lopez (2005, 2008), Castellani (2002), Fernandez and Isgut (2005), Girma et al (2004), Kraay (1999), Van Biesebroeck (2005), and Zhang (2005).

4.2. Impact of globalization on firm's productivity

4.2.1 Exporting Activities

Exporting activity may affect firm productivity for the following reasons: First, Grossman and Helpman (1991) and Evenson and Westphal (1995) suggests that overseas importers may provide technical assistance to domestic exporting firms and hence improving firm productivity. Second, Clerides, Lach and Tybout (1998) argues in their model that active involvement of exporting firms in the international market could improve firm productivity because of easier access to world frontier technology at lower cost. Third, higher international standards on product quality could motivate exporting firms to upgrade their production technology (Verhoogen, 2008). Fourth, participation in the export market could reduce information cost on new product innovation and market demand (Fafchamps et al., 2002; Maurin et al., 2002).

4.2.2 Importing Activities

The casual relationship between imports of capital and productivity has not been examined extensively in the current literature, in particular at the firm level[39]. Previous studies have shown a positive relation between import of capital and economic growth at the national level as a channel for technological diffusion (Coe and Helpman, 1995; Coe et al., 1997), while Eaton and Kortum (1996, 1997), Keller (2002, 2004), and Keller (2000) uses disaggregated data in their study. Among those studies, Coe et al., (1997) concentrates on developing countries.

39 Relevant studies using cross-country data include Eaton and Kortum (2001), Liu, Burridge and Sinclair (2002), Caselli and Wilson (2004), Lupez and Shnchez (2005), and Narayanan (2006).

4.3. Data Sources and Description

The data used in this part is constructed from a World Bank latest survey for Chinese manufacturing firms during the period of 2000-2002. The survey covers 1609 manufacturing firms, including 353 textile and clothing firms. The surveyed firms are located in five major cities (Beijing, Guangzhou, Shanghai, Tianjin, and Chengdu). The surveyed enterprises are randomly drawn from 6 manufacturing sectors (apparel and garments, food and beverage, metals and machinery, electronic components, vehicles and vehicle parts, and chemicals and pharmaceutics).

Table 4.1 summarizes the average output, profit and labour productivity; they amount to 144.7 million, 25.1 million and 69.2 thousand RMB, respectively, in our sample. Furthermore, I use three variables to proxy three important production inputs in the production function:

i) capital is proxied by the value of fixed assets;

ii) labour is proxied by the number of employees; and

iii) the value of intermediate goods, Capital, labour, and intermediate goods, respectively, averaged 87.0 million RMB, 459 workers and 87.0 million RMB with large variations among sampled firms.

Table 4. 1. Summary Statistics

Variable	Unit	Mean	Std. Dev.
Output	**Million RMB**	144718.10	834790.20
Profit	**Million RMB**	25055.51	315233.00
Profit per Employee	**Thousand RMB**	69.23	1724.94
Capital	**Million RMB**	87010.16	471461.50
Labor	**Worker**	459.39	1095.99
Intermediate Goods	**Million RMB**	79076.92	363388.40
Age	**Year**	16.58	14.02
SOE Dummy	**Dummy(0-1)**	0.29	0.45
OWN Dummy	**Dummy(0-1)**	0.16	0.37
Exporter	**Dummy(0-1)**	0.13	0.33
Importer	**Dummy(0-1)**	0.31	0.46

In order to capture the demographic effect on firm productivity we further create three variables:

i) the age of the firm (AGE);

ii) the state owned enterprises (SOE) dummy; and

iii) the foreign company owned enterprise dummy (OWN).

The sampled firms aged 16.6 years on average in our sample. SOE dummy takes the value of 1 or 0; it equals 1 if a firm is a state-owned enterprise and 0 if not. In our sample, about 28.7% of the firms are SOEs. Also, OWN dummy takes the value of 1 or 0; it equals 1 if a firm is a foreign-owned enterprise and 0 if not. In our sample, about 16.4% of the firms are foreign company owned enterprises. In addition, one third of the sampled firms import machinery and equipment from advanced countries, and 12.8% of firms belongs to exporting firms and the averaged export sales amounted to 31.9 million RMB.

4.4. Empirical Methodologies

4.4.1. Econometrics Methodologies

I use two standard approaches that are adopted in the existing literature in estimating firm performance. The first approach examines total factor productivity (TFP) by estimating a standard Cobb-Douglas production function. The second investigates the effects the proposed regressors on firm's performance indicators.

$$\begin{aligned} \ln(Output)_{it} &= a_0 + a_1 \ln(Labor_{it}) + a_2 \ln(IntermediateGoods_{it}) + a_3 \ln(Capital_{it}) \\ &+ a_4 Export_{it} + a_5 Import_{it} + a_6 X_{it} + \varepsilon_{it} \qquad \textbf{(4.1)} \end{aligned}$$

where i and t denote firm i and time t, respectively, and ε_{it} is the error term, and are used to proxy for TFP. Import is a dummy variable, which takes the value of one if a firm imports machinery/equipment. Export is also a dummy variable, which takes the value of one if a firm exports merchandised goods. X is a vector of firm characteristics such as age, state-owned enterprise (SOE) dummy, and ownership (OWN) dummy in our regressions. As the intercept varies across firms the panel model is adopted to take into account of individual (unobserved) heterogeneity problem. I also assume that errors are homoscedastic and serially independent both within and between individuals.

Assuming that all firms have the same intercept, by using OLS, the coefficient on all factor inputs is highly significant. However, firm-specific characteristics may correlate with the regressors and therefore we should use the panel model. The overall significance of the panel regression is good, as shown by the F-test in table 4.2. This F test does not include the firm-specific effects, but it only includes the impact of factor inputs. Individual coefficients are also significant and of the expected sign, broadly in line with the Ordinary Least Square (OLS) estimates. Note that we can reject the null hypothesis that the fixed effects are zero.

Next we have to choose between the fixed and random effect. The random effects estimator assumes that intercepts are uncorrelated with the regressors. To test if the average of the fixed and between estimates is the same as the random effects estimate, we can use the "Hausman test". The Hausman test is essentially testing whether estimates for the fixed effect model are the same for the between effect model. The result indicates that the fixed and between estimates differ from one another, and therefore the fixed effect model should be used. Results are available upon request.

For the second approach, the empirical model can be specified and written as:

$$\ln Y_{it} = a_0 + a_1 Import_{it} + a_2 \ln(Capital_{it}) + a_3 Export_{it} + a_4 X_{it} + a_5 IndustryD + a_6 YearD + e_{it} \tag{4.2}$$

where Y_{it} denotes firm profit and labour productivity. Capital is used to control for the size of the firm, X is firm characteristics including age, ownership dummy, and SOE dummy, and IndustryD and YearD are the industry and year dummies, respectively. Equations (4.1) and (4.2) are estimated by using the fixed effect panel regression method, which takes into account of heterogeneous firm characteristics. I also apply "White-corrected standard errors" to deal with potential heteroskedasticity.

4.5. Empirical Results and Discussion

Table 4.2 provides the regression results on the relationship between firm productivity, export activity, and import activity.

Table 4. 2. Regressions on the Relationship between Firm Performance and Imports of Machinery/Equipment

Dependent Variables	Ln(Output)		Ln(Profit)		Ln(Profit/Labor)	
Constant	2.13	***	0.22		0.22	
Ln (Labor)	0.30	***	0.33	***	-0.67	***
Ln (Intermediate Goods)	0.56	***	0.42	***	0.42	***
Ln (Capital)	0.18	***	0.27	**	0.27	**
Exports of merchandized Goods	0.09	**	-0.16	**	-0.16	**
Imports of Machinery/Equipment	0.12	***	0.21	***	0.21	***
SOE Dummy	0.02		-0.07		-0.07	
Ownership Dummy	0.18	***	0.30	***	0.30	***
Ln(Age)	-0.23	***	-0.26	***	-0.26	***
Observations	3367		2915		2915	
Adjusted R-squared	0.86		0.69		0.42	

Note: *** denotes 1% significance.

Model 1-3 shows that imports of machinery/equipment are positively and significantly associated with a firm's output, profit and labour productivity. Based on cross countries data, some studies claim that firms can benefit from technological spillover by importing machinery from developed countries, and hence improving productivity (Eaton and Kortum, 2001; Caselli and Wilson, 2004; EKCW thereafter). Our empirical evidence is consistent with those of EKCW. Fan and Hu (2008) use the same set of data covering the time period of 1998-2000 and reach the same conclusion that importing machinery could improve firm performance. However, our study complements the existing literature by using the latest data set, and more importantly, by comparing and contrasting the role of exports, and examining the effects of exports of tradable goods and importing machinery on firm performance. Several important observations are made. First, the overall result indicates that export activities do not improve firm performance; it contradicts the evidence of existing literature[40]. Second, the import of machinery and equipment improves firm performance and this result is consistent with existing literature[41].

On drawback of the current study may attribute to aggregation bias. Greenaway and Yu (2004) investigates interactions between exporting and productivity at the firm level, using a panel of firms in the UK chemical industry. They find that exporters are more productive than non-exporters. Further research is needed for the current study to examine the effect of export activities on firm performance by using

40 For Cross countries studies, see for example: Sachs and Warner (1995); Edwards (1998); Frankel and Romer (1999). For firm specific level studies, see for example: Bernard and Jensen (1999); and Kraay (1999) and Zhang (2005).

41 See for example: Eaton and Kortum (2001), Liu, Burridge and Sinclair (2002), Lupez and Shnchez (2005), and Narayanan (2006).

data from disaggregated sectors. I suspect that the aggregation bias is caused by a different degree of capital intensity for different industries because only the highly technology-intensive exporting sector may benefit from exporting. Even I find evidence for improving firm performance by importing machinery and equipment; however, I still cannot draw a conclusion on which sector benefits the most from such a machinery importing behaviour.

4.6. Conclusion

In this part, I have evaluated the links between imports, exports and productivity at the firm level, focusing on Chinese enterprises, which have high profitability growth over the last decade. I find that exporters are not efficient than non-export enterprises and this finding may come from aggregation bias. By estimating a panel survey data set from 2000-2002, I find that being a Stated-Owned Enterprise will not trigger on firm performance, while firm's age and ownership status does matter. I also find that the association between imports of machinery and equipment and firm performance is positive and significant. Finally, I find that exporters are not more efficient than non-export enterprises and this finding may come from aggregation bias.

Part 2-Determinants of Competitiveness: Observations in China’s Textile and Apparel Industries

4.7. Introduction

Competitiveness has long been a popular topic of discussion in national performance research. However, comprehensive studies regarding the determinants of competitiveness from the point of view of entrepreneurs’ are lacking. Hence, the authors attempt to explore the micro foundations of enterprises’ competitiveness. China’s textile and apparel industries are among the largest and fastest growing exporters of textiles and apparel worldwide. They account for one-fifth of the world’s total production. According to the China National Textile and Council (CNTAC, 2004), total sales of the industries in 2004 amounted to RMB2640bn, having grown by 22.8 percent from 2003. Relying on low cost and skilled labor, the textile and apparel industries in China are particularly export-oriented. In 2005, textiles and apparel accounted for 11 percent of the total export of the economy and 21 percent of the world’s total export value of textiles and garments. In 2005, these industries employed 19 million people in China, including 13.5 million from rural areas. Hence, the textile and apparel industries have become one of the pillar industries of China’s economy (Zhang et al., 2004). The results of this research might help policy-markers and stakeholders of China’s textile and apparel industries to formulate their own optimal strategic plans.

4.8. Literature Review

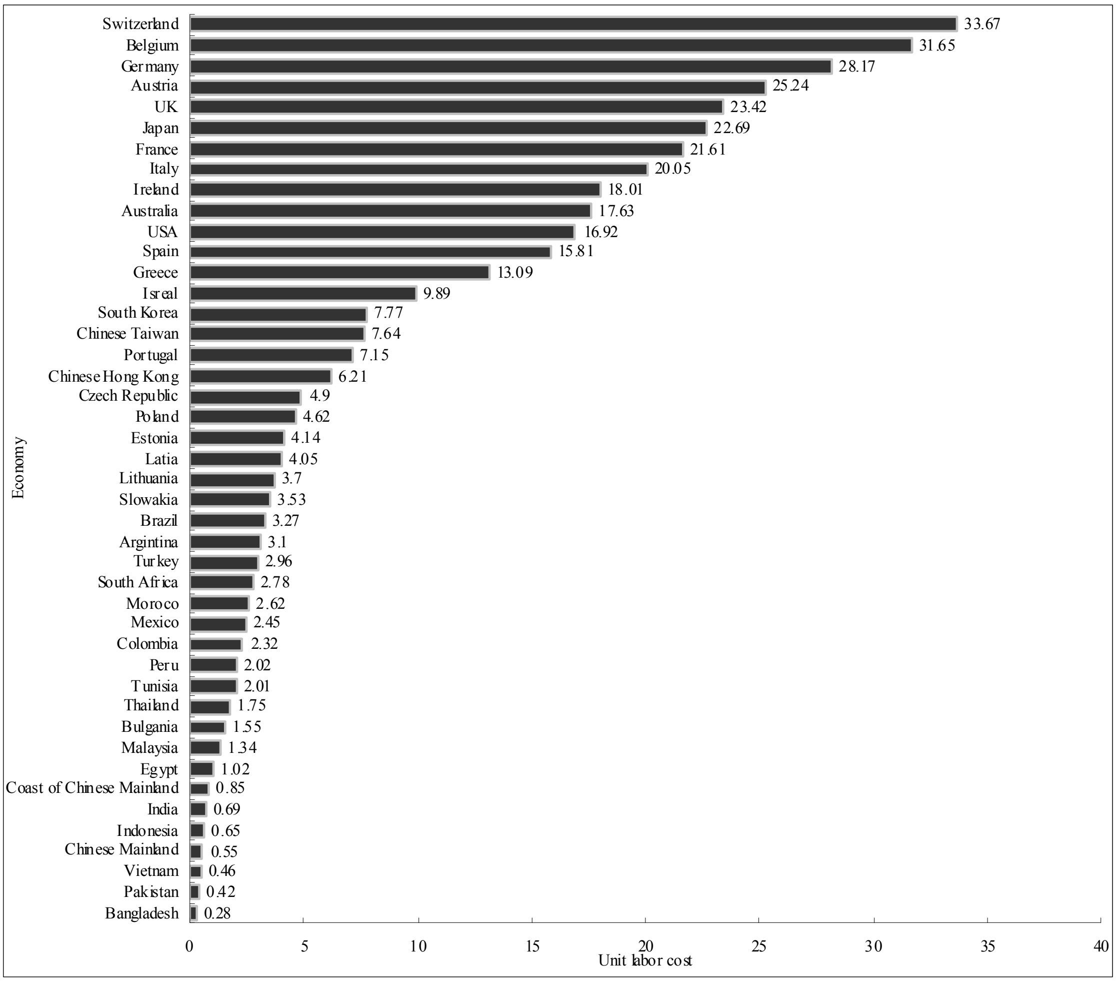
Competitiveness is a polysemous concept. Economists are inclined to define and measure competitiveness at three hierarchical levels: that of enterprise, industry and nation. The prevalent definition of competitiveness is related to the sizes of market share, profitability and growth of the enterprise. However, it is ambiguous when applied to a nation. Krugman (1994, p. 44) criticizes the misinterpretation of competitiveness leading to “flirtation with industrial policy” in the early stage of Clinton’s presidency, concluding that “competitiveness is a meaningless word when applied to national economies,” and that “the obsession with competitiveness is both wrong and dangerous.” Competitiveness should be regarded as a domestic productivity problem (Krugman, 1997). Therefore, in the present study I concern about the competitiveness of industries and enterprises in China’s textile and apparel sectors.

The conventional view of enterprises’ competitiveness focuses on costs: those enterprises that are able to deliver the lowest product prices to markets are likely the most competitive. The most widely adopted approaches for measuring industrial competitiveness apply indices of total factor productivity (TFP), labor productivity (LP), and unit labor cost (ULC).[42] Measuring TFP and ULC growth are probably the simplest, most convenient methods, as they can compare cost of production across enterprises and industries.

42 LP is the ratio of real output to the number of workers engaged; ULC is the ratio of payroll per person to labor productivity; TFP is the residual factor by subtracting physical inputs from enterprise’s total output, which may include technological advancement and efficiency.

Traditionally, competitiveness is viewed and modeled as being dependent on the possession of abundant natural resources and labor. However, this view of competitiveness cannot explain the more recent economic performance of many countries. Switzerland and Sweden have the highest per capita nominal wages among the OECD countries and their national competitiveness is always ranked in the first tier of the world. Therefore, the measurement of ULC alone cannot explain the essence of competitiveness. Static analysis of UCL does not provide a comprehensive picture of international competitiveness. Taking the world textile and apparel industries as an example, Italy's labor costs in 2007 were above those of China, India and other developing countries. However, the textile and apparel industries in Italy still ranks number one in the world for wool exports. The fashion industry in Italy is the pillar industry of its economy (see Figure 4.1).

Figure 4. 1. Labor Cost Comparison in the Textile Industry, 2007 (US$)



Source: Werner International (2007). 43

43 Cities in coastal region include: Beijing, Tianjing, Shijiazhuang, Dalian , Shanghai, Nanjing, Hangzhou, Ningbo, Fuzhou, Xiamen, Jinan, Qingdao, Guangzhou, Shenzhen, Haikou, Nanning. These cities are located in China's coastal provinces: Hebei, Liaoning, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong, Guangxi and Haninan.

Dodsworth and Mihaljek (1997) uses UCL and LP indices to examine Hong Kong's real output growth, productivity, and the profitability of industries, covering individual industries of both tradable and non-tradable sectors. Using statistical data of real output, deflator, employment, and labor productivity for the period 1982–1994, the authors find that Hong Kong experienced rising labor costs and falling competitiveness in the sample period. In contrast, the reallocation of labor-intensive operations to southern China, and the upgrading of skills (supervisory, technical, design and marketing) in industries that remained in Hong Kong resulted in increased productivity.

Hu and McAleer (2004) analyzes and evaluates TFP growth and technical efficiency in the five sectors that cover the full spectrum of the Chinese economy. A production function is estimated using a random effects panel data model, which assumes a constant rate of technological progress, to quantify TFP growth and technical efficiency (TE). The paper uses a random effects panel data model with a time variable to capture technological progress. The panel spans from 1991–1997 and consists of data from 30 Chinese provinces on output, capital and labor for: (i) agriculture; (ii) industry; (iii) construction; (iv) transportation, post and telecommunications; and (v) services. The authors find that over the sample period strong TFP growth is recorded in agriculture and transportation, post and telecommunications. In the other three sectors, TFP growth slowed down and even declined.

Another indicator that is widely used to identify competitiveness in external markets is the index of revealed comparative advantage (RCA). Balassa's RCA is the share of a country's exports of a specific product category to its total exports as compared to the share of total world exports of the specific category in world exports of all goods (Balassa, 1965). The underlying factors behind RCA are capital intensity and human development of a particular sector under investigation (Balassa, 1979). If the estimated RCA is greater than 1, the suggestion is that the country's exports are moving closer to the pattern of the world's exports at a relatively fast pace.

Yue and Hua (2002) computes RCA indices for China (1980–2000) and some Chinese provinces (1990–1998) using the 10 three-digit standard international trade classification products of China's exports. These are then incorporated separately into a reduced form export equation. The panel data estimation results show that, in addition to the effects of the effective exchange rate, world demand and domestic supply, RCA play an important role in explaining Chinese export performance.

Gerard et al., (2006) evaluates several theories regarding China's success in the world export markets. Firstly, Naughton (1996) argues that the critical factor responsible for the growth of Chinese exports is the 1994 devaluation of the Chinese currency from 5.8 to 8.3 RMB yuen per US dollar, however Gerard et al., (2006) shows that appreciating the exchange rate even by substantial amount will not likely to greatly diminish Chinese competitiveness due to the country's huge pool of cheap and increasingly mobile labour. (Gerard et al., p.120). Secondly, Thompson (2003) argues that foreign direct investment (FDI) results in important knowledge externality like internationally-used technologies and experienced workers in China, Gerard et al., (2006) finds significant relationship between FDI and export by province in 1999 (Gerard et al., p.117), and concludes that increased competitiveness is dependant on, but not limited to several factors, including RCA, exchange rate undervaluation, low wage rates and abundant labor resources. In particular, the authors argue that FDI has played an important role in enhancing international competitiveness and in increasing the production of products that meet world market specifications. Moreover, FDI has brought new technology and foreign management to local enterprises. However, as Gerard et al., (2006) argues, RCA is an ex-post measure, demonstrating but not explaining the underlying trends. When using RCA or the real exchange rate to proxy international competitiveness we need to make a crucial assumption: that the economy is at the equilibrium exchange rate and that purchasing power parity (PPP) is being held constant. When the nation's trade balance is not in equilibrium this approach is not appropriate, and a misaligned exchange rate distorts the pattern of specialization and trade. Therefore, changes in RCA over time might only reflect such distortions rather than changes in the underlying competitive position of a nation.

Hu et al., (2004) examines contributions and interactions between internal R&D, technology transfers and FDI towards the productivity of Chinese industries. Using enterprise data for 29 two-digit manufacturing industries and over 400 four-digit industries over the period of 1995–1999, they find that the internal R&D of an enterprise could significantly replace the effect of a technology transfer of FDI.

4.9. Some Critical Determinants of Competitiveness at the Enterprise Level

4.9.1. Productivity

Although reaching weak consensus about the assessment of competitiveness at the national level, scholars are more in line regarding the determinants of competitiveness at the enterprise level (Porter, 1990; Charitou and Markides, 2003). Productivity enhancement is related to competitiveness improvement. Increments in productivity allow a nation to support high wages, strong currency, and attractive returns to capital, and, therefore, to enjoy a high standard of living (Porter, 1994). As enterprise forms the basic production unit of a country, a nation's high standard of living could not be achieved without increments in enterprises' productivity.

The success of an economy involves two stages: the initial stage of enhancing competitiveness depends on abundant natural resources and labor force; and the second stage comprises competitive processes. From the experience of OECD countries and some newly-developed economies in Asia, effective management of the later development stage, including product quality control, speedy delivery, product customization, and after-sales service, is of vital importance to competitiveness. The concepts of business reengineering, advocated by Hammer (1990), and now widely embraced by international companies, are based precisely on the idea of radically redesigning or transforming processes so as to achieve dramatic improvements in performance. Essentially, this means enterprise business processes achieving high productivity. By contrast, Reinert (1995) insists that productivity and competitiveness could not be used to measure national wealth because there is little evidence of a causal relationship between the absolute level of enterprises' productivity and national wealth.

4.9.2. Supply-side Determinants

Porter (1994, p. 37) argues that: "An improving business environment gives rise to the formation of clusters. Clusters are geographically proximate groups of interconnected enterprises, suppliers, service providers and associated institutions in a particular field, linked by commonalities and complementarities."

The “cluster effect” enhances competitiveness in three broad ways. First, it increases the productivity of constituent enterprises or industries. Enterprises within industrial cluster have more efficient access to specialized suppliers, employees, information and training than their competitors located elsewhere. In such a way, transaction costs are reduced and higher profit margins are enjoyed (Zhang et al., 2004). Also, the availability of a full range of inputs, machinery, skills and knowledge can promote greater efficiency and flexibility than in vertical integration or in enterprises that have relationships with distant suppliers. Second, industrial clusters increase the capacity for innovation and productivity growth. Opportunities for innovation are available at lower cost within clusters; capital assets like machines, human resources and technology are easier to obtain at lower cost. Third, industrial clusters stimulate and enable new business formation that supports innovation and expands clusters. The local presence of experienced workers and easier access to essential raw materials could reduce the possibility of trade barriers and, hence, the entry cost to the industry. The OECD (1999, 2001) treats industrial clusters as the drivers of national economic growth, and as a key policy tool for boosting national competitiveness. Schmitz and Nadvi (1999) examines industrial clusters in developing countries in order to specify the circumstances in which clustering boosts industrial growth and competitiveness. Although there is no generally accepted definition of an industry cluster, the broadest sense it denotes “the geographical and sectoral concentration of enterprises” with potential benefits for the smallest enterprises (Nadvi and Schmitz, 1994; Zhang and To, 2004, p.3). Research has shown geographical and sectoral concentration breeds positive externalities and induces to cooperation among enterprises (Mishan, 1971, Schmitz, 1995).

4.9.3. Demand-side Determinants

Another school of thought about competitiveness concentrates on demand-side determinants. In the last two decades, the growth of domestic demand has been an important driving force of competitiveness and economic growth. According to Krugman (1997) and Turner (2001), more and more locally produced goods are now consumed domestically rather than being exported to foreign markets. A higher share of GDP is consumed in the domestic market, which implies that a smaller share of output is used for trade. Krugman (1997) estimates that the amount of export is only accounted for a quarter of Los Angeles' GDP in 1996, implying that household consumption is a crucial factor for GDP growth. According to NBS (1979-2003) the average per annum percentage of household consumption to GDP in China was roughly 50 percent during 1978–2002, suggesting that domestic demand is an important factor contributing to GDP growth.

Domestic demand plays an important role in determining competitiveness for two reasons. First, the quality of local demand (i.e. the sophistication of buyers, the development of marketing channels and the intensity of competition) affects the development of advanced products, quality management and marketing skills. Second, the size of the domestic market might influence the manufactured goods being exported (i.e. high-technology goods or low-end products). Some forms of technological learning activities require cooperation among enterprises in the local market. Moreover, a larger domestic market would also attract larger foreign multinational corporations and FDI. This can further enhance the competitiveness of the economy.

With a population of 1.3 billion and rapid economic growth, China has the largest potential market for textiles and clothing in the world. In 2006, the total value of textiles and clothing exports accounted for 27.54 percent of the total national output value (NBS, 2007).

4.10. Methodology and Empirical Results

4.10.1. Questionnaire

In the present study, I conducted a survey to explore the key determining factors conducive to competitiveness. In the process, I applied exploratory factor analysis (EFA). The enterprises surveyed are mainly located in two regions: Pearl River Delta in Guangdong Province and Yangtze River Delta in Zhejiang and Jiangsu Provinces, where textiles and apparel clusters are well established. Most enterprises are export-oriented and compete in worldwide marketplaces. The questionnaire is designed to measure productivity, supply-side and demand-side determinants' effect on competitiveness.

Table 4. 3. Determinants of Competitiveness in Textile and Clothing Enterprises

Productivity	**A) Capital intensity**
	B) Quality of labor and capital inputs
	B.i) Education and training
	B.ii) Capital structure
	B.iii) Industrial restructuring
	B.iv) Technical progress
Supply-side determinants	**A) External Economies**
	A.i) Specialized labor market
	A.ii) Local availability of inputs
	A.iii) Easy access to information
	A.iv) Foreign market availability
	B) Joint action and technology upgrading
	B.i)Backward and forward vertical linkages
	B.ii)Horizontal bilateral and multilateral linkages
	B.iii)Product process
	B.iv)Cluster and market management
	B.v) Preferential policies
Demand-side determinants	**A) Product quality**
	B)Marketability at home and abroad
	C)Foreign competition
	D)Exporting
	E) Product differentiation

Notes: This table presents an extended framework of determinants affecting competitiveness in textile and clothing enterprises.

For factor analysis, the responses collected across sampled companies are designed in a 5-point Likert measurement scale.

(1)Productivity

Two factors that affect productivity are considered. The first is capital intensity; item A in the table, that is, the amount of capital (machinery and equipment) available to enterprises. The second is the quality of the labor and capital inputs available, item B in the table, which is determined by the following factors: (B.i) skill level of the workforce as a result of education and training; (B.ii) amount of productive physical assets in the capital structure; (B.iii) extent of industrial restructuring toward higher value-added activities; and (B.iv) degree of technical progress, which reflects advances in knowledge, innovation, and other qualitative improvements including work attitude.

(2) Supply-side Determinants

There are three main factors considered: (A) external economies; (B)joint action and technology upgrading. External economies include A.i)specialized labor markets, A.ii) local availability of inputs, A.iii) easy access to information, and A.iv) foreign market availability . Joint action includes Bi) backward and forward vertical linkages, B.ii) horizontal bilateral, and multilateral linkages for joint action. Technology upgrading refers to B.iii)all levels of product, process, functional and inter-sectoral upgrading, or improvements, B.iv) cluster management, and B.v) Preferential policies.

(3) Demand-side Determinants

These determinants concern how enterprises compete with their counterparts domestically and internationally. In this respect, five indicating factors are measured: (A) product quality; (B) marketability at home and abroad; (C) foreign competition; and (D) exporting, and (E) Product differentiation. The essence here is to determine the degree to which enterprises make efforts to win local or foreign markets.

4.10.2. Statistical Description of the Survey Data

This section presents the empirical data and analytic results. The results of the data analyses include descriptive statistics and factor analysis. Of the 120 industry scale surveys delivered, 67 were returned. Among those returned, 51 were deemed valid and allowable for statistical analysis. Respondents were asked to use a 5-point Likert-type psychometrical scale ranging from disagree (1) to agree (5) to answer the questions in the questionnaire.

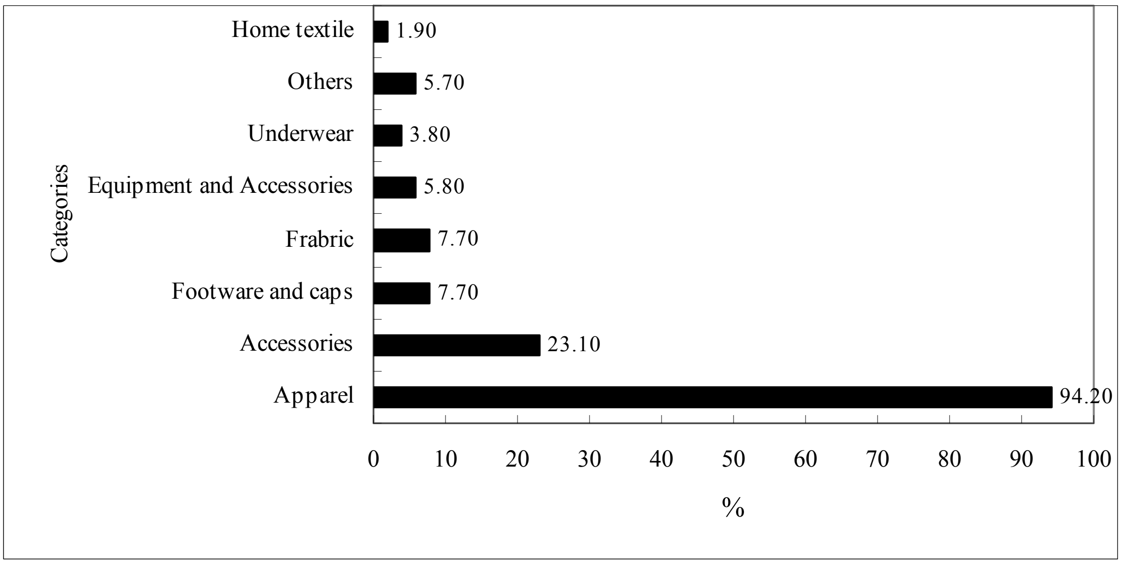
In my survey, 68.1 percent of enterprises' total assets amount to less than RMB10m. Those with assets between RMB10m to RMB50m comprise 21.3 percent of the sample and those with assets above RMB50m make up 10.6 percent (see Table 4.4). Privately-owned enterprises account for 83.7 percentage of the sample, and the percentages of joint venture and other types of enterprises are 10.2 and 6.1 percent, respectively. The product categories consist of apparel, accessory, footwear and caps, fabrics, equipment and accessory, underwear, home textiles, and others. Of the responding enterprises, 94.2 percentage are apparel manufacturers (see Figure 4.2)

Table 4. 4. Total Assets Distribution of the Surveyed Enterprises (RMB10, 000)

Total assets	No. Of surveyed enterprises	Percentage %
Under 1000	32	68.1
1000–5000	10	21.3
5001–10 000	4	8.5
Above 10 000	1	2.1
Total	47	100.0

Source: Author's calculation.

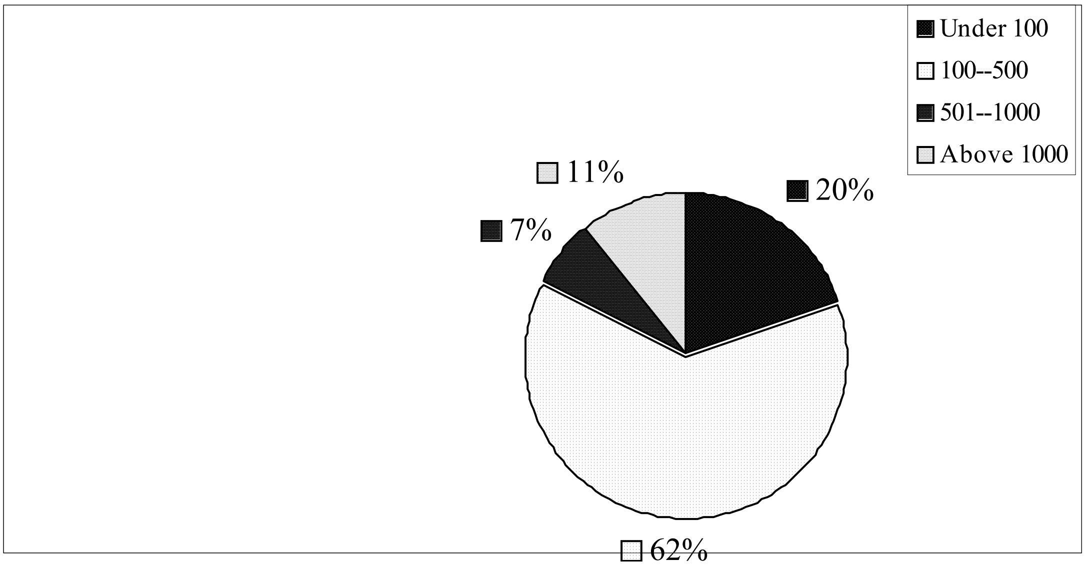
Figure 4. 2. Primary Operation Category of the Surveyed Enterprises



Source: Author’s calculation.

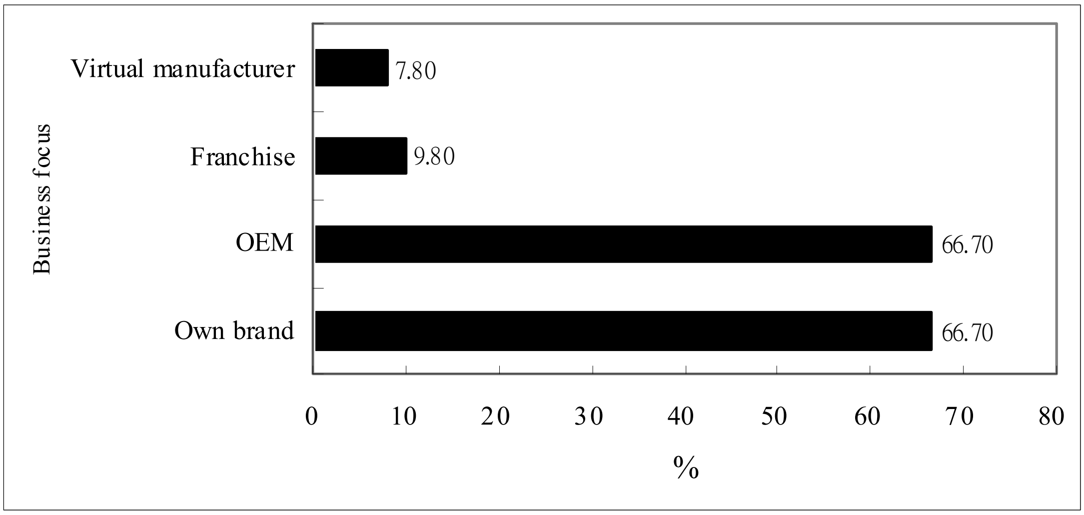
The number of employees employed by the enterprises ranges from 100 or fewer to 1000 and above. Among surveyed samples, 62.0 percent of the enterprises indicate that the numbers of employees are between 100 and 500 persons. Of the sample, 20 percent employ fewer than 100 people (see Figure 4.3). Enterprises are also asked to classify themselves in terms of brand focus with options of own-brand, original equipment manufacturer (OEM), franchisee, and virtual manufacturer. The own-brand and OEM categories have the highest response rate, 66.7 percent, followed by franchisee and virtual manufacturer, which are at 9.8 and 7.8 percent, respectively (see Figure 4.4).

Figure 4. 3. Employment



Source: Author's calculation.

Figure 4. 4. Business Focuses



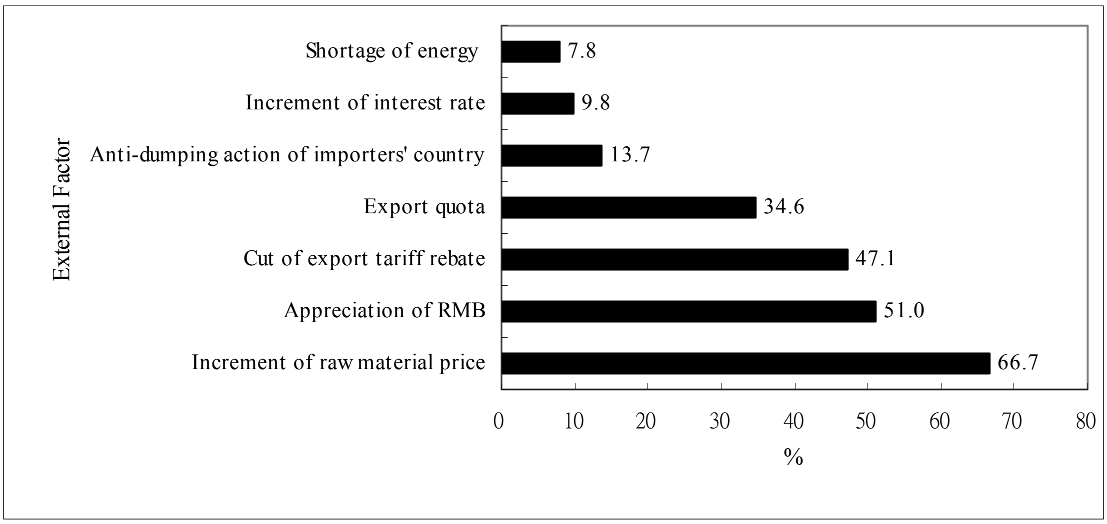
Source: Author's calculation.

Note: OEM, original equipment manufacturer.

When asked about the enterprise's future development strategy, 60.8 percent express their intention to expand production to benefit from economies of scale. Also, 31.4 percent of enterprises indicate their willingness to devote resources to exploring new markets. As for the monthly wage rate that enterprises pay to their workers, it ranges from RMB1000 or less to RMB2000; 60 percent of the enterprises pay between RMB1000 and RMB1500 per worker monthly.

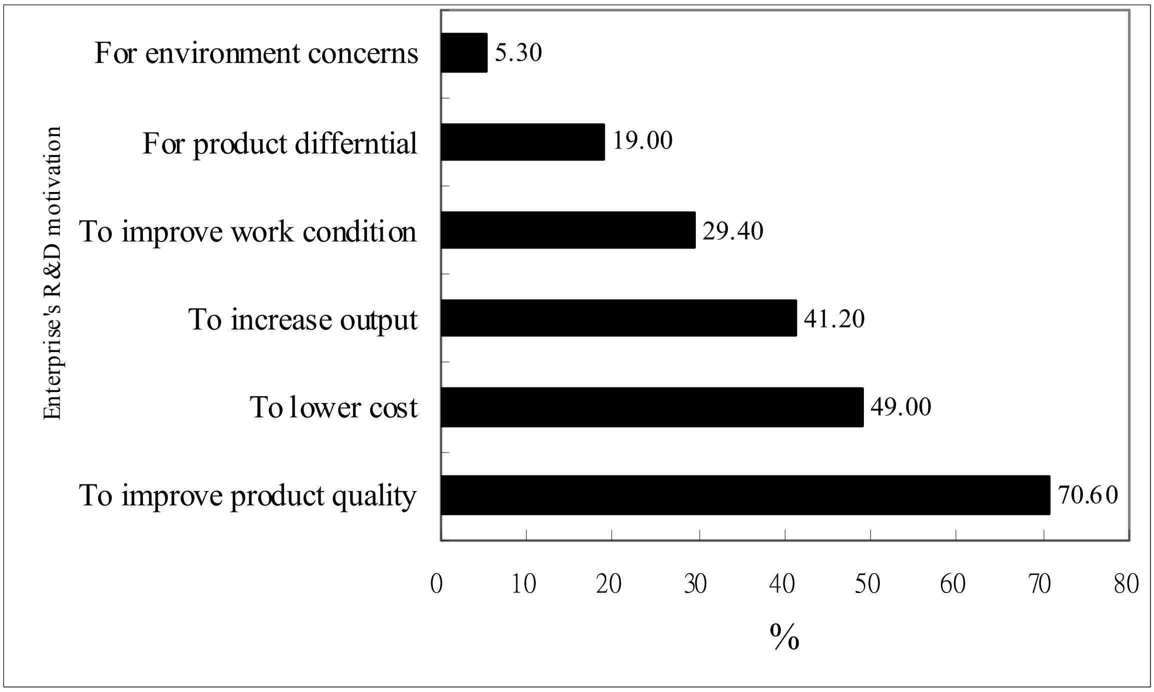
With regard to price competitiveness, Figure 4.5 shows that most enterprises indicate the increased raw materials price (66.7 percent) and the appreciation of the RMB (51.0 percent) as the main factors contributing to the decrease in products' competitiveness in the international market. For non-price competitiveness, most of the enterprises claim that they use the Electronic Data Interchange System (56.9 percent), followed by the Customer Relationship Management System (27.5 percent). Figure 4.6 shows that the initiative for undergoing R&D activities is positive. Of respondents, 70.6 percent indicate that improving product quality is their first development strategy, followed by lowering costs (49.0 percent).

Figure 4. 5. External Factors Affecting Competitiveness



Source: Author's calculation.

Figure 4. 6. Enterprises' Research and Develop Motivation



Source: Author's calculation.

4.10.3. Contributing Factors in Competitiveness

Table 4.5 shows that the data reliability of my surveyed sample is satisfactory. Therefore, key contributing factors are extracted using the exploratory factor analysis technique.

Table 4. 5. Reliability Analysis Results

<table>
<tr><th>Determinants</th><th colspan="2">Indicators</th><th>Cronbach's alpha</th></tr>
<tr><td rowspan="5">Productivity</td><td colspan="2">Education and training</td><td rowspan="5">0.5328</td></tr>
<tr><td colspan="2">Industrial restructuring</td></tr>
<tr><td colspan="2">Infrastructures</td></tr>
<tr><td colspan="2">Capital intensity</td></tr>
<tr><td colspan="2">Technical progress</td></tr>
<tr><td rowspan="10">Supply-side</td><td colspan="2">Specialized labor market</td><td rowspan="7">0.5882</td></tr>
<tr><td colspan="2">Local availability of inputs</td></tr>
<tr><td colspan="2">Backward and forward vertical linkages</td></tr>
<tr><td colspan="2">Horizontal bilateral and multilateral linkages</td></tr>
<tr><td colspan="2">Cluster and market management</td></tr>
<tr><td colspan="2">Market for external economy</td></tr>
<tr><td colspan="2">Preferential policies</td></tr>
<tr><td rowspan="3">Product process</td><td>Product quality managem ent</td><td rowspan="3">0.8043</td></tr>
<tr><td>Supply chain managem ent</td></tr>
<tr><td>R&D innovation</td></tr>
<tr><td rowspan="4">Demand-side</td><td colspan="2">Domestic demand</td><td rowspan="4">0.4535</td></tr>
<tr><td colspan="2">Abroad demand</td></tr>
<tr><td colspan="2">Marketability at home and abroad</td></tr>
<tr><td colspan="2">Product deferential</td></tr>
</table>

In the analysis, I intend to evaluate the main determinants of competitiveness. I group similar characteristics among 19 questions when asking about factors that affect enterprises' competitiveness (see Table 4.5). Using the extraction method of principal component analysis with the rotation method of varimax, six factors are generalized. A varimax rotation is used as an orthogonal rotation technique to create the final competitiveness constructs, which are devised by maximizing the variance of the loadings and minimizing the cross loadings of items that would load on more than one factor. I use Bartlett's test and find it be significant, indicating common factors exists and further analysis could be conducted. I use Kaiser–Myer–Olkin (KMO) test statistic to measure sampling adequacy. In this case, the KMO value is 0.618, which indicates that factors are appropriate (see Table 4.6).

Table 4. 6. Kaiser–Myer–Olkin and Bartlett's Test

Kaiser–Meyer–Olkin measure of sampling adequacy		0.618
Bartlett's test	Approximate χ^2	427.104
	Degree of freedom	171
	Significance	0.000

Examining evidence for "covariance" is one method by which factors are identified using item variance to establish convergence on a factor, with convergence and loading factors at the acceptable level of 1.00 or higher. Table 4.7 shows that a substantial gap occurred between factor loadings around 1.021; therefore, I use only the first six factors for further investigation in my study.

Table 4. 7. Total Variance Explained

	Initial Eigenvalues			Extraction sums of squared loadings			Rotation sums of squared loadings		
	Total	% of variance	Cumulative (%)	Total	% of variance	Cumulative (%)	Total	% of variance	Cumulative (%)
1	8.168	42.988	42.988	8.168	42.988	42.988	3.563	18.753	18.753
2	1.917	10.092	53.079	1.917	10.092	53.079	3.506	18.452	37.205
3	1.792	9.432	62.511	1.792	9.432	62.511	2.999	15.786	52.991
4	1.451	7.639	70.150	1.451	7.639	70.150	2.362	12.431	65.422
5	1.257	6.613	76.763	1.257	6.613	76.763	1.817	9.562	74.985
6	1.021	5.375	82.138	1.021	5.375	82.138	1.359	7.153	82.138
7	0.823	4.330	86.468						
8	0.577	3.039	89.507						
9	0.396	2.085	91.592						
10	0.355	1.866	93.458						
11	0.315	1.656	95.114						
12	0.224	1.176	96.290						
13	0.181	0.952	97.242						
14	0.142	0.748	97.990						
15	0.125	0.656	98.646						
16	0.112	0.591	99.237						
17	0.066	0.347	99.584						
18	0.056	0.293	99.878						
19	0.023	0.122	100.000						

Note: Extraction method: Principal component analysis.

Factor 1 is labeled as factor conditions and is characterized by specialized labor markets, education and training, local availability of inputs; capital intensity and infrastructure (see Table 4.8). These items identify the local operational environment of enterprises in the textile and clothing industry. Factor 2 is government and related supporting industries, and is characterized by industrial restructuring, cluster and market management, horizontal bilateral and multilateral linkages, preferential policies, backward and forward vertical linkages and markets for external economy. These items consider whether the spatial proximity of upstream or downstream industries facilitates the exchange of information and promotes continuous opportunities and innovations. Factor 3 is product upgrading strategy, and is characterized by product quality management, R&D innovation, advanced technology and equipment. These items improve output productivity. Factor 4 is company marketability strategy, and is characterized by product deferential, marketability at home and abroad, and supply chain management. Factors 5 and 6 are domestic demand and abroad demand, respectively.

Table 4. 8. Rotated Component Matrix (a)

	Component					
	1	2	3	4	5	6
Specialized labor market	0.856	0.0294	− 0.026	0.053	− 0.237	− 0.110
Education and training	0.783	− 0.013	− 0.230	− 0.232	0.117	0.101
Local availability of inputs	0.740	0.279	− 0.420	− 0.222	− 0.063	− 0.102
Capital intensity	0.659	0.329	− 0.162	− 0.123	− 0.472	0.032
Infrastructure	0.592	0.565	− 0.066	− 0.016	0.135	− 0.254
Industrial restructuring	0.194	0.732	− 0.072	− 0.277	− 0.151	0.061
Cluster and market management	0.255	0.731	0.081	− 0.205	− 0.329	0.053
Horizontal bilateral and multilateral linkages	− 0.031	0.726	− 0.600	0.085	− 0.015	− 0.056
Preferential policies	0.208	0.692	− 0.183	− 0.082	− 0.412	− 0.162
Backward and forward vertical linkages	0.334	0.603	− 0.507	− 0.165	0.237	− 0.222
Market for external economy	0.532	0.558	− 0.325	− 0.339	0.165	0.198
Product quality management	− 0.400	− 0.184	0.807	0.148	0.184	0.042
R&D innovation	− 0.317	− 0.059	0.776	0.322	0.089	− 0.166
Advanced technology and equipment	0.030	− 0.109	0.671	0.226	0.431	0.437
Product differential	− 0.103	− 0.223	0.026	0.891	0.114	0.103
Marketability at home and abroad	− 0.256	− 0.062	0.396	0.754	− 0.201	0.160
Supply chain management	− 0.045	− 0.193	0.308	0.639	0.432	− 0.002
Domestic demand	− 0.047	− 0.148	0.120	0.044	0.790	− 0.170
Abroad demand	− 0.051	− 0.038	0.032	0.128	− 0.157	0.923

Notes: Extraction method: Principal component analysis; rotation method: Varimax with Kaiser normalization; a rotation converged in nine iterations.

The six factors are hence identified as “competitiveness constructs.” The ratings of the six competitiveness constructs are calculated by aggregating the rating of the survey items that constitute the competitiveness construct; for example, factor 1 consists of five items, so its rating is the sum of the ratings of the five items divided by five, simply the arithmetic average. By doing this I generate six individual ratings, with the factor conditions as 3.45, the government and related supporting industries as 4.01, the product upgrading strategy as 2.52, the company marketability strategy as 2.95, the domestic demand as 3.79, and the abroad demand as 2.92 (see Table 4.9).

Table 4. 9. Mean of Rating on Each Competitiveness Construct

	Factor conditions	Government and related supporting industries	Product upgrading strategy	Company marketability strategy	Domestic demand	Abroad demand
Mean	3.4492	4.0074	2.5229	2.9553	3.7895	2.9211

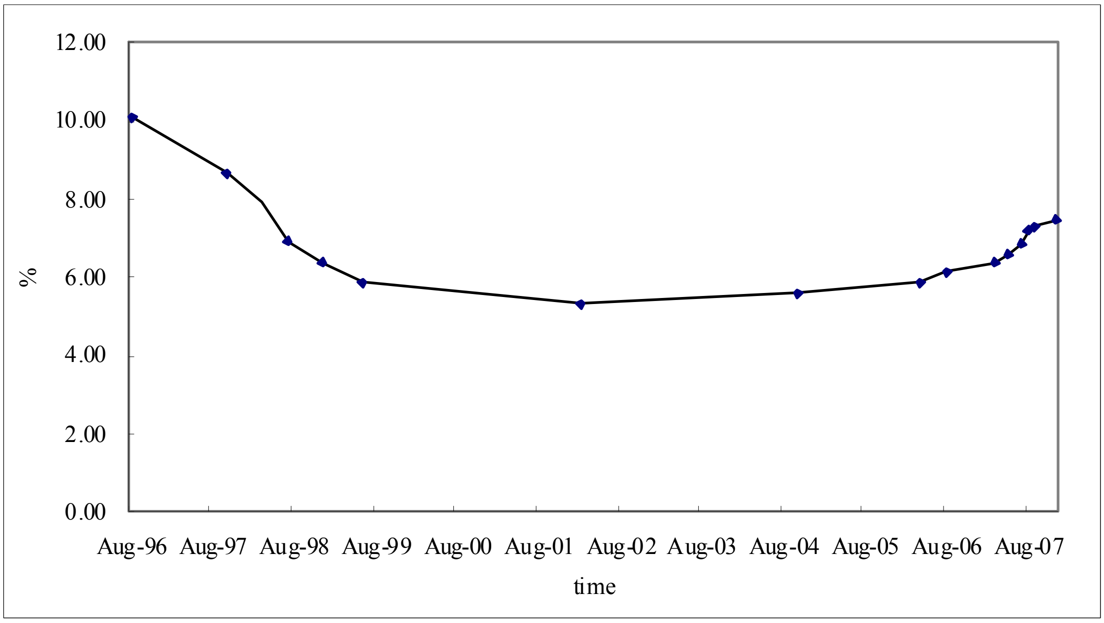
Source: Author's calculation.

The results suggest that the government should support industries that are related to the textile and clothing industries, because the factor conditions are identified as the most important determinant of competitiveness, followed by domestic demand. Evidently, the respondents in the survey shared a similar point of view: the government should intensify and speed up their infrastructure construction work, and improve their public services, such as to shorten the business days for dealing with licensing and registration. Moreover, more attention should be paid to domestic markets. The results further suggest that some government policies should be implemented to strengthen inter-enterprise cooperation and to improve local government services for the textile and clothing industries. This should be combined with a set of fiscal and monetary policies.

First, a stable fiscal and monetary policy is needed. A stable financial market with stable interest rates provides incentives for investors to save and invest. Also, low profit tax encourages enterprises to invest in R&D, which leads to rising productivity and competitiveness. After the Asian financial crisis in 1998, proactive fiscal and monetary policies and prudent monetary policy were adopted to counteract the destructive impacts of prospective financial turmoil. In the meantime, domestic demand has been stimulated, and has contributed 1.5–2.0 percent of national output growth each year from 1998 to 2002. Even though the Chinese economy recorded continuous double digit growth from 2003 to 2007, the annual consumer price index is estimated to remain at 4.5–4.6 percent, overrunning the warning threshold by more than 1 percent.

In the face of rapid growth in bank loans, investment and foreign reserves, China has been carrying out prudent fiscal and monetary measures to prevent its economy from overheating. At the end of 2007, the Chinese Government further tightened monetary policy. In addition, the government used various macroeconomic measures to intensify credit control. In doing so, the interest rate fluctuated in accordance with the national fiscal and monetary polices. Figure 4.7 shows that the 1-year lending interest rate dropped from 10.08 percent in 1996 to 5.31 percent in 2002. In addition, from 2002, the interest rate has been raised significantly as a result of increasing inflationary pressure. In 2007, China's central bank raised the interest rate five times, hiking it to 7.47 percent by the end of the year, as shown in Figure 4.7.

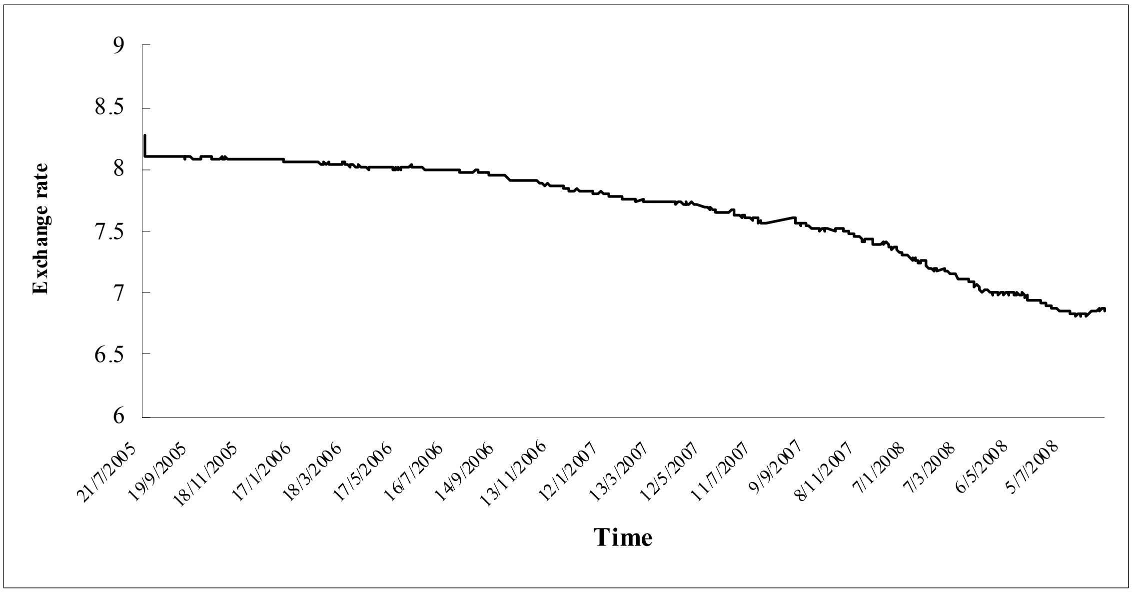
Figure 4. 7. The Fluctuation of China's 1-year Lending Interest Rate, 1996–2007



Source: NBS (1996–2008).

In my survey, 51 percent of respondents claimed to be worried about the appreciation of the RMB when asked about what external constraint will most affect their business. Since the RMB's first appreciation in September 2005, the quoted rate has appreciated several times. It reached 7.25 yuan per US$1 by the end of 2007 (see Figure 4.8). This continuous trend could weaken the competitiveness of enterprises.

Figure 4. 8. Exchange Rate of RMB against the US Dollar, 2005–2008



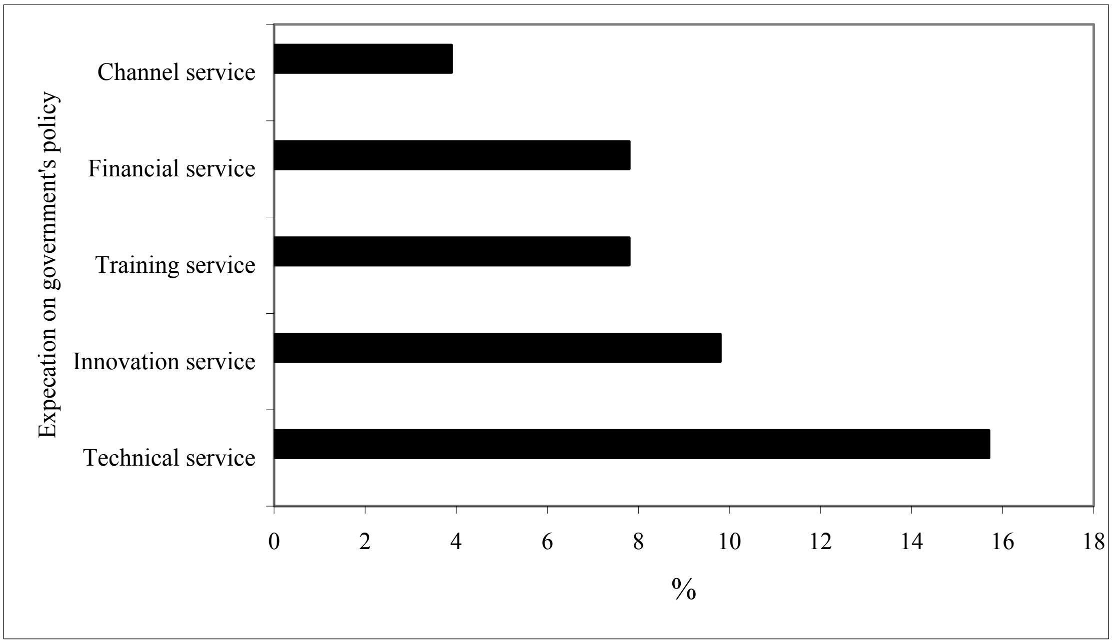
Source: NBS (2005–2008).

Undoubtedly, interest rates and nominal exchange rates could become more market driven in the face of domestic and external pressure, and the government will aim to maintain macroeconomic stability. Some enterprises are concerned that the possibility of increases in taxes as a result of financial reform will impose a heavier burden on enterprises. A lower tax rate on initial profits allows enterprises to retain some earnings and to increase investment.

Second, policies that improve the business environment, such as speeding up infrastructure construction and reducing license fees, are crucial to the success of business. Of the constraints faced by enterprises in textile and clothing industries, deficient infrastructure seems to be the most dominant. Most of China's textile and apparel clusters are located close to major cities, particularly Hong Kong, Guangzhou and Shanghai. However, as a result of the gradual increase in labor costs in recent years and the pursuit of economies of scale, many enterprises plan to move their manufacturing bases to central and western regions of Mainland China. Therefore, to attract more investment, local governments should develop information network, communication and transportation infrastructure. Moreover, deficient local government facilities, such as energy supply (water and electricity), are further major constraints that industrial clusters face. The situation is especially severe in Zhejiang province. Hangzhou municipal government has already paid more attention to this problem and encourages the local plants to set up their own electricity generation facilities by giving them subsidies. In doing so, most large and medium-scale textile and clothing manufacturers in Hangzhou have successfully overcome this constraint.

Third, intermediary institutions play an important role in enterprise access to production techniques and innovation, and are source of financing. In Italy, the intermediary institution supported by the government plays an important role in helping the development of the textile and clothing industries. Intermediary institutions play roles in all areas of services, including technology transfer, labor, training, finance support, and foreign market exploration. Approximately 15.70 percent of respondents hope that the government or intermediary institutions will be able to provide them with technical assistance. Another 9.80 percent would like innovation services (see Figure 4.9).

Figure 4. 9. Expectation on Public Services Provided by the Government



Source: Author's calculation.

From a demand-side perspective, domestic enterprises need to make more effort to drive domestic demand because there is still huge market potential. The strong growth of the apparel market has been underpinned by rapid economic growth. Consumers are becoming increasingly focused on medium-end to high-end products, and this will further boost the demand for different kinds of textile and apparel products. Moreover, significant improvements in farmers' income and the rural retailing environment will encourage rural consumption and will unleash huge potential in the rural markets. The growing number of young working women is a key driver in the expansion of China's apparel markets. Mainland women are now increasingly image-conscious and are becoming more financially independent; they can afford high-end clothing products and, therefore, the demand for women's clothing will be greater than ever.

4.11. Conclusion

In my study, among the six crucial determining factors of competitiveness in textile and apparel industries, factor conditions and government coordination are found to play a significant role in enhancing industry competitiveness. The study further suggests that some government policies should be implemented to strengthen inter-enterprise cooperation and to improve local government services within the textile and clothing industries. This should be combined with a set of fiscal and monetary policies to improve the business environment.

It is worth exploring factors of competitiveness in other countries and regions, for example in Brazil and in other Asian countries; they are China's textiles and clothing enterprises' main potential competitors. Apart from a multi-country study, a confirmatory factor analysis could be conducted to build a structural model, to analyze the structural relationships among those explored variables.

Concluding Remarks

This thesis comprises four chapters that examine issues on developing new panel unit root tests, determinants contributing economic growth and competitiveness in China as well as and factors affecting China's apparel cotton trade performance in the US market. The ***first part in Chapter 2*** develops two new panel unit root tests. The first test overcomes the pitfalls of the old-fashioned panel unit root tests and makes it possible for researchers to test individual series for a unit root while taking *contemporaneous correlations* into account. The second test takes non-linear dynamics into account. The proposed tests are, indeed, more powerful than the univariate augmented Dickey-Fuller (ADF) test and some conventional panel unit root tests in rejecting false I(1) time series. I applied these panel unit root tests to the long-run purchasing power parity (PPP) hypothesis of OECD countries and China's four main trading partners, and the finite sample performance of the new test is examined though Monte Carlo Simulation, which is found to be superior compared to that of the single ADF unit root test. By using a newly developed linear panel unit root test, I conclude that Spain and Netherlands violate PPP, while Denmark and Norway show evidence of PPP towards the United States. Moreover, evidence of PPP for China's four trading partners is examined by using the newly developed non-linear panel unit root test, and I find that the EU, UK, Japan and the US show evidence of PPP towards China.

The new tests enable researchers to carry out empirical applications on purchasing power parity, unconditional income convergence hypothesis, and financial market bubbles, corporate profit persistence, and financial leverage mean reversion behavior when the data generating process exhibits nonlinearity and contemporaneous cross- sectional dependence. It is well known that structural breaks in the deterministic components of stochastic process and initial value condition tend to inflict on conventional unit root tests biasing toward the unit root null hypothesis, therefore further research is needed to develop a new unit root test, which can incorporate nonlinearity, contemporaneous cross-sectional dependence, structural break, and initial value conditions.

The second part in Chapter 2 further develops a model for estimating trade elasticity, which overcomes the pitfalls of conventional models. In my empirical examination of the MFA apparel cottons exported to the US from mainland China, Hong Kong and four ASEAN countries during the years 1989–2009, I apply panel cointegration techniques, error correction approaches, panel estimation methods, and the impulse response function to the US's import demand function. I draw some important conclusions from this study. First, I extracted a unique long-run equilibrium relationship among import quantity demanded, imported price and US GDP per capita. This implies that the existing trade mechanism is capable of ensuring co-movement/equilibrium of imported quantity, price and income in the long-run. Second, the long-run price and income elasticity is found to be significant with expected signs, which are important for most trade–policy analyses. Third, the increasing amount of Chinese MFA apparel cottons export do not threaten the survival of its neighboring countries in the US market, because the negative impact of China's emergence is only temporary and insignificant.

This part provides a comprehensive and disaggregated set of elasticity estimates to date. The estimate made here is at a detailed level of disaggregation, and should provide researchers with opportunities for future work. However, challenges remain in determining elasticity estimates, and advanced morels, like those of 'Markov-Regime

Switching' models, should be developed to endogenalize the effect of trade liberalization in future research.

The first part in Chapter 3 examines the status of real and financial integration between China, her four main trading partners and ASEAN economies based on the empirical validity of real interest parity, uncovered interest parity and relative purchasing power parity. I find that real and financial integration between China and other trading partners are well established. These findings provide supporting evidence in favor of the international competitiveness of the Chinese economy from the perspective of degree of integration in the commodity and financial markets.

This part provides further information in the literature of international integration for Chinese economy by using a unit root test that takes into account the non-linearity and contemporaneous cross-sectional dependence to examine the degree of real and financial links. In addition, I extend the geographical coverage to China's four main trading partners, and four ASEAN countries, such that the study is of current interest to readers in the era of globalization. One future research topic is to identify and examine the factors that are driving the integration process.

Upon affirming the degree of the international integration of the Chinese economy, the second part in Chapter 3 examines the growth path dynamics and growth determinants in the Chinese economy using provincial data. I analyze the empirical validity of both beta and sigma unconditional income convergence across Chinese provinces from 1952 to 2005. Using both linear and non-linear panel unit root tests, I find that interprovincial inequalities have been widening since 1978 and such an observation is in line with Pedroni and Yao's (2006) findings. In addition, I examine the determinants of conditional convergence in China and find that low inflation, the quality of human capital, improvement in transport and telecommunication infrastructures, and trade openness stimulate economic growth in China. Interestingly, the dynamic played by human capital is non-linear in pattern in that economic growth becomes negative when the human capital are at low levels and becomes positive when the levels are raised to the middle ones.

Thus far, there is no empirical research devoted to studying the possibility of non-linear growth dynamics as regards the above two channels. In this article, I model the growth dynamics of Chinese provinces in such a way that the economy may only experience a high economic growth rate when it reaches the threshold level of human capital accumulation and starts to engage in trade with other regions. I use the exponential smooth transition autoregressive (ESTAR) model to estimate the growth dynamics across provinces so as to capture the likelihood that the growth rate of different localities will converge provided that they reach the threshold level of human capital accumulation. However, future research should be carried out on the question of why income is not converging for some provinces in the long-run.

Chapter 4 focuses to the micro aspect to investigate the interrelationships among firm-related characteristics, business environments and firms' performance in China using survey data obtained by the World Bank. At first, I use a panel data regression technique to identify factors that determine a firm's performance. The first observation is that being a State-Owned Enterprise has no bearing on a firm's performance; however, a firm's age and ownership status does. The second observation is that there exists a positive relationship between a firm's performance and its importation of machinery and equipment for production purposes. The third observation is linked to exporting firms.

Literature shows that a firm's performance is linked to whether or not a firm is performing exporting activities; however, in my observation, this condition does not exist. Probably, this has been due to a different approach I have taken to categorize the Work Bank data.

There is lack of literature on comparing the efficiency of different channels on enhancing firm's performance, and my study filled this gap. One future research topic is to compare and contrast the interrelationships among firm-related characteristics, business environments and firms' performance in different countries and regions using a longer panel data set. Moreover, sector specific study should be conducted so that aggregation bias could be minimized.

Finally, the second part in Chapter 4 explores key determinants of competitiveness in the textile and apparel industries in the Chinese mainland. I conduct a survey that uses productivity, supply-side and demand-side determinants to measure enterprises' competitiveness. The collected survey data is then analyzed using factor analysis to capture the related determining factors indicative of competitiveness at the enterprise level. The findings demonstrate that government policies and related industry infrastructure are the most important competitiveness determinants in the textile and apparel industries, followed by domestic demand. This suggests that the improvement of industry infrastructure can foster industry performance and that more resources should be endowed to enhance the domestic business competitiveness of local enterprises. The development of domestic demand will foster the competitiveness of the textile and apparel industries on a more sustainable basis.

Despite the fact that competitiveness has long been a popular topic of discussion in national performance research, comprehensive studies regarding the determinants of competitiveness from the point of view of entrepreneurs' are, however, lacking. In this article, I explore the micro foundations of enterprises' competitiveness by examining the perceived factors of competitiveness for Chinese textile firms.

This part provides evidence for determinants of competitiveness from firm and industry specific aspect. However, it is worth exploring factors of competitiveness of China's textiles and clothing enterprises' main potential competitors for comparison purpose. Apart from a multi-country study, a confirmatory factor analysis could be conducted to build a structural model, to analyze the structural relationships among those explored variables.

In this thesis, rigorous and robust empirical findings on growth and competitiveness in China are provided by studying macroeconomics and macroeconomics issues. The findings of this study have a number of important implications for academia and policy practitioners. First, researchers should be cautious about making spurious regression when conducing research encountering in time series data. Second, the finding of provincial inequality implies that government should implement preferential policies to promote economic growth in lagging regions in China. Once the low income regions grow faster and catch up with the leading regions the demand for domestic produced goods could be increased, and textile and clothing trade will also be increased among provinces. With an increase in domestic demand, the floating band for the RMB can expand such that the pressure of revaluation from the U.S. could be released. The findings of this study also suggest that government should adopt a targeted approach to help the low income regions, and more resources should be devoted to human capital, transport and telecommunication infrastructures, and trade openness among provinces. Third, the evidence from this study suggests that Chinese apparel cottons market in the U.S. is in long run equilibrium, and its export expansion has only temporary displacement effect on the exports performance of ASEAN countries. As the economic integration between China and ASEAN countries in both goods and capital market is well established, this implies that the China–ASEAN Free Trade Area (CAFTA) will be effective on trade creation within and outside the trade zone, and therefore the textile and clothing sector in China will further expand.

Lastly, an implication from microeconomics study is the possibility that technology spillover effect could enhance firm's productivity though the channels of foreign direct investment (FDI) and importation of equipments for production purpose. The empirical result also implies that the government should intensify and speed up their infrastructure construction work, and improve their public services, such as to shorten the business days for dealing with licensing and registration. Equally important, China should treat domestic demand as the "long-term" development strategy and take further measures to stimulate consumer spending.

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