FOREIGN DIRECT INVESTMENT, GOVERNANCE, AND THE ENVIRONMENT IN CHINA: REGIONAL DIMENSIONS

By

JING ZHANG

A thesis submitted to The University of Birmingham for the degree of DOCTOR OF PHILOSOPHY

Department of Economics
School of Social Sciences
The University of Birmingham
June 2008

ABSTRACT

This thesis includes four empirical studies related to foreign direct investment (FDI), governance, economic growth and the environment. We firstly investigate the existence of the so called pollution haven hypothesis (PHH) in China, i.e. the impact of regional environmental regulations (ER) on FDI inflows. We then examine the other determinants of FDI: regional government effort to tackle corruption and government efficiency. It then extends the methodology of the first two studies and revisits the PHH issues by treating ER as endogenous. Finally, we observe the effects of economic growth and foreign direct investment on the environmental quality across Chinese cities. After addressing the weaknesses in previous literature, our findings provide the following results. First, an intra-country pollution haven effect does exist in China. Such an effect is also found when ER is treated as endogenous but not robust for the sensitivity checks using different instrumental variables and estimators. Second, FDI is attracted to regions that have made more effort on fighting against corruption and that have more efficient government. Third, government variables do not have a significant impact on ER. Fourth, economic growth has a negative effect on environmental quality at current income levels in China. Finally, foreign investment has positive effects on water pollutants and a neutral effect on air pollutants. Such effects vary across pollutants and investment from different sources.

For my parents and Chao

ACKNOWLEDGEMENTS

My appreciation goes primarily to my supervisors Robert Elliott and Matthew Cole for their inspiration, patient guidance throughout my PhD research, and for their support in every possible way during my time at Birmingham.

Special thanks go to Professor Richard Green, Dr. David Maddison and Dr. Toby Kendall, who are the members of Trade, Energy and Environment research group in the department, for their suggestions at my presentation in the group workshop. My thanks also go to other members of the department and research students for their comments on the PhD workshops.

I would also like to express my gratitude to Professor Oliver Morrissey and Dr. Zhihong Yu, both from Nottingham University, for their useful comments at the GEP postgraduate conferences.

I am grateful to the Department for providing full PhD scholarship. I would like to thank the secretarial staff for all their assistance.

Finally, special thanks go to my parents and beloved sister Chao, for their love, constant support, patience, and encouragement during the writing of this thesis.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS

AR	Autonomous Region
AR(1)	Autoregressive process of order one
BI	Business International
BLUE	Best linear unbiased estimator
BOD	Biochemical oxygen demand
CBS	Copenhagen Business School
CO	Carbon monoxide
CO_2	Carbon dioxide
COD	Chemical oxygen demand
CPC	Communist Party of China
CPI	Corruption perception index
CSPP	China's Supreme People's Procuratorate
DM	Davidson-MacKinnon test
EKC	Environmental Kuznets Curve
EPL	Environment Protection Law
FCPA	Foreign Corrupt Practices Act
FDI	Foreign direct investment
FGLS	Feasible generalised least square
G2SLS	Generalised two-stage least square
GDP	Gross domestic product
GLS	Generalised least square
GMM	Generalised Method of Moment
IAACA	International Association of Anti-Corruption Authorities
ICAC	Independent Commission Against Corruption
ICRG	International Country Risk Guide
IMD	Institute for Management Development
IMF	International Monetary Fund
IV	Instrumental variable
MNC	Multinational corporation
NO_2	Nitrogen dioxide

NO_x	Nitrogen oxide
OECD	Organisation of Economic Co-operation and Development
OLS	Ordinary least square
PHH	Pollution haven hypothesis
PM_{10}	Particulate matter less than 10 microns in diameter
PPP	Purchasing power parity
R&D	Research and Development
RMB	Renminbi (currency of the mainland of China)
SEPA	State Environmental Protection Administration
SEZ	Special Economic Zone
SO_2	Sulphur dioxide
SPM	Suspended particulate matter
STD	The standardised value of government efficiency indices
TI	Transparency International
UN	United Nations
UNCTAD	United Nations Conference on Trade and Development
US	United States
USD	US dollar
WDR	Word Development Report

CHAPTER ONE

INTRODUCTION

The immediate motivation for this research is to investigate the impact of environmental regulation stringency and the governance quality on the cross-province foreign direct investment (FDI) inflows in China; and the impacts of economic development and foreign investment on the levels of industrial pollution emissions between Chinese cities.

Since 1978 the Chinese government has been reforming its economy from a centrally planned to a market-oriented economy, known as "socialism with Chinese characteristics". The results of this dramatic transformation have been the generation of wealth on a previous unimagined scale and the removal of millions from absolute poverty, bringing the poverty rate down from 53% in 1981 to 8% in 2001 (World Bank).[1] According to the International Monetary Fund (IMF), China is the second largest economy in the world when measured by purchasing power parity (PPP) gross domestic product (GDP), and is the fourth largest in the world when measured by nominal GDP, and is the fastest growing country with a consistent annual GDP growth rate above 10%.[2]

Much of China's success has been driven by a tremendous growth in exports coupled with equally impressive increases in FDI. According to the statistics from United Nations Conference on Trade and Development (UNCTAD), between 1980 and 2000, the volume of China's exports grew by 14.75% a year and at the end of 2004 China's global trade exceeded $1.15 trillion. From then on China became the world's third largest trading nation behind the United States (US) and Germany ($2.344 trillion and 1.629 trillion in 2004, respectively). In addition, China's trade surplus has been stable at around $30 billion from 1999. In terms of FDI, by 2005 Chinese inward FDI flows had reached $72.41 billion, up

---

[1] 'Fighting Poverty: Findings and Lessons from China's Success', World Bank, available online:- http://go.worldbank.org/QXOQI9MP30

[2] In 2006, the nominal GDP of China was $2.64 trillion (4th in the world), and $10.2 trillion (2nd) with PPP. Its per capita income was approximately $2,000 (104th), and $7,800 (86th) with PPP, and rising rapidly.

from an average of $30.10 billion between 1990 and 2000.[3] The stock of FDI has increased similarly, rising from $20.69 billion in 1990 to $272.09 billion in 2005.

The Chinese government launched a range of policies to encourage FDI inflows. In 1979, the government introduced legislation and regulations designed to encourage foreigners to invest in high-priority sectors and regions. The government eliminated restrictions and implemented permissive policies in the early 1980s. It then established Special Economic Zones and opened up coastal cities and development regions in coastal provinces in the mid-1980s. More favourable regulations and treatments have been used to encourage FDI inflows in these regions. In the 1990s, the policies began to promote the high-tech and capital intensive FDI projects in accordance with domestic industrial objectives. More preferential tax treatments were granted for the investment in selected economic zones or in projects encouraged by the government, such as energy, communications and transport. Such preferential policies have resulted in an overwhelming concentration of FDI and rapid economic development in the east. The spillover effects from coastal to the inland provinces are limited, and therefore, the regional development gap has widened.

The huge amount of FDI inflows and unbalanced geographical distribution of FDI have attracted several studies to investigate the determinants of FDI location choice in China (see e.g. Wei *et al.*, 1999; Coughlin and Segev, 2000; Cheng and Kwan, 2000; and Amiti and Javorcik, 2008). In addition to the preferential policies, many factors may have affected where foreign investors locate their production facilities within China, such as labour costs,

---

[3] Before 2005, the FDI data were only for the investment into non-financial sectors. From 2005, Chinese government relaxed the restrictions of the market access of foreign financial institutions and the FDI data started to comprise the investment into financial sectors. Therefore, the inward FDI in 2005 ($72.41 billion) includes the investment into financial sectors ($12.08 billion) and non-financial sectors ($60.33 billion). In addition, from 2005, the statistical scope of FDI was enlarged according to the principles in the IMF *Balance of Payment Manual* (Fifth Edition). Therefore, FDI data shows a jump in 2005. In 2006, the total FDI inflows decreased by 4.1% to $69.47 billion but the FDI in non-financial sectors grew to $63.02 billion.

potential market size, market access, supplier access, infrastructure, productivity, education level, location, and spatial dependence. However, these studies all omitted certain structural determinants of FDI in China, including environmental regulation stringency and government quality.

Some environmental economists and environmentalists claim that firms in developed countries may relocate their "dirty" industries to developing countries to take the advantages of the less stringent environmental regulations (see e.g. Pearson, 1987; Dean, 1992; and Copeland and Taylor, 1994). Such a point of view is known as "the pollution haven hypothesis" (PHH).

In China, the legal system has lagged far behind the overall economic development. Although China has established a comprehensive environmental regulatory framework with a range of laws, regulations and standards, the strength and the enforcement of the regulations are much weaker than those in developed countries. An important issue in the enforcement of environmental regulations is of the government itself violating the law. Some local governments will protect polluting enterprises in the name of local interest. Land appropriation, excessive mining and the failure to carry out environmental impact assessments: such situations continue due to the lack of the environmental awareness among local government officials. Environmental enforcement also suffers from a lack of public participation and social supervision, as well as low awareness of citizens (Ma, 2007). The differences in the performance of local government and the characteristics of the public have led environmental stringency to vary among regions.

Multinational corporations (MNCs) could be attracted by the weak environmental regulations in China. Ma Jun, director of the nongovernmental Institute of Public and

Environmental Affairs (IPE), announced in August 2007 that over 100 multinational corporations were punished by the government for their violation of the environmental laws and regulations in terms of water pollution from 2004. And in January 2008 this figure increased to 260 corporations for water pollution and more than 50 corporations for air pollution. The exposed companies include subsidiaries of world-renowned corporations such as American Standard, Panasonic, Pepsi, Nestle, 3M, Whirlpool, Bosch, Carlsberg, Samsung, Nissin and Kao. These corporations are mostly from Japan, US and Europe. One third of their polluting subsidiaries are located in Shanghai, and others scattered over the country. Liu (2006) reported that according to Lo Sze Ping, campaign director of Greenpeace China, the "words" of multinationals are often better than their deeds. Multinationals are more willing to invest in public relations than in actually cleaning up the manufacturing process. Local governments seek to attract more FDI and hence do not take strict measures to address pollution by multinational corporations. Lo also observes that since multinational corporations typically perform better than the domestic enterprises environmentally, their activities do not attract the attention of the environmental authorities, and hence avoid the supervision.

Therefore, the regional differences in environmental stringency may have a significant impact on the FDI location choice in China, i.e. an intra-country pollution haven effect may exist. Previous empirical studies have adopted different approaches to investigate the PHH (see e.g. Levinson, 1996a & 1996b; List and Co, 2000; Keller and Kevinson, 2002; Xing and Kolstad, 2002; Eskeland and Harrison, 2003; Fredriksson *et al.,* 2003; Dean *et al.,* 2005; and Smarzynska-Javorcik and Wei, 2005). The results are mixed and do not provide robust evidence to support the existence of PHH. However, these studies have several methodological weaknesses and are mostly centred on US data, a few studies look at developing countries and only Dean *et al.* (2005) look at China. Therefore, this thesis, addressing weaknesses of previous studies, makes some contribution to the literature on PHH.

Rapid economic growth with the lagged development of the legal system has resulted in a serious social problem in China – corruption. The transition to a market-based economy has resulted in considerable changes to how firms operate within the new commercial business environment. The huge increase in opportunities in the private sector combined with the traditional power of local and national officials led to a proliferation of corruption at all levels of the Chinese economy. Corruption has been recognised as an emerging challenge to China's economy and social reforms.

Corruption is widely recognised as a deterrent of foreign investment but is only considered in a few empirical studies on a cross-country basis (see e.g. Wheeler and Mody, 1992; Hines, 1995; Wei, 2000; and Smarzynska and Wei, 2000). Although China has received a high volume of foreign capital, corruption has deterred FDI inflows, especially those from Europe and the US. Wei (1997) notes that FDI from the ten largest source countries in the world, all of them members of Organisation of Economic Co-operation and Development (OECD), accounts for a relatively small portion of total FDI going to China, because investors from the major source countries prefer to go to less corrupt countries. Similarly, the corruptibility of local government in China may affect the location of FDI. Moreover, corruption should not be considered in isolation and is strongly correlated with the quality of government (see Globerman and Shapiro, 2002 & 2003; Globerman *et al.,* 2006; and Fan *et al.*, 2007). Thus, government quality is another important determinant of FDI inflows. Therefore, this thesis is the first to examine the effects of inter-regional differences in corruption and government quality on FDI location choice within a large developing country.

Rapid export driven economic growth enhanced by large investment inflows from abroad has come at a cost. A harmful by-product of globalisation has been increased pollution. The State Environmental Protection Administration reported that two thirds of Chinese cities are considered polluted according to the air quality data. Respiratory and heart diseases related to air pollution are the leading causes of death in China. Almost all of the nation's rivers are polluted to some degree and half of the population lacks access to clean water. Water scarcity occurs most in northern China and acid rain falls on 30% of the country. The World Bank estimated that pollution costs about 8-12% of China's GDP each year. Environmental degradation and the increase in poor health are all signs that China's current growth path is unsustainable.[4]

There have been numerous theoretical and empirical studies that examine the relationship between economic growth and various indicators of environmental degradation. The aim of the research is to examine the existence of the "Environmental Kuznets Curve" (i.e. the total amount of environmental impact of economic growth initially increases, reaches a peak and then falls), which is found firstly in Grossman and Krueger (1991). In addition, some researchers have started to use empirical methods to examine the effects of FDI on environmental quality, especially in developing countries. However, the majority ofstudies on both the environmental effects of economic growth and FDI, are cross-country analyses and the results are often inconsistent.

---

[4] Sustainable development refers to development that "meets the needs of the present without compromising the ability of future generations to meet their own needs", which is defined in the UN Report of the World Commission on Environment and Development, 1987 (available online:- http://www.un.org /documents/ga/res/42/ares42-187.htm).

Therefore, in the case of China, the following questions are worthy of consideration. Does the environmental Kuznets curve hold for some pollutants? If it does, where is the threshold income level and how many regions have passed it? As an important driving force of economic growth in China, does FDI benefit/harm environmental quality? These questions have attracted relatively few research using different datasets and methodologies, with mixed results.

This thesis combines various aspects within the broad area of FDI, governance and the environment. It firstly examines the structural determinants of FDI, and then investigates the effects of economic growth and FDI on the environmental quality in China. The thesis is structured as follows.

Chapter two considers environmental regulatory stringency as a structural determinant of FDI. We test the so called pollution haven hypothesis using socioeconomic and environmental data for 30 Chinese regions over the period from 1999 to 2003. We address the methodological weaknesses in the previous literature and employ a feasible generalised least square method that controls for both autocorrelation and heteroskedasticity. The findings provide some evidence to support the existence of a pollution haven effect within China.

Chapter three re-examines the determinants of FDI by allowing regional government corruption and governance quality to have an impact on FDI inflows. However, the lack of a perceptive index of regional government corruption leads us to develop two objective indices, measuring the effort of local government in fighting against corruption and local government efficiency respectively. The empirical results show that government anti-corruption effort and efficiency are both significant determinants of FDI. We retain all the independent variables in Chapter two and obtain consistent results.

Chapter four methodologically extends the work in Chapters two and three. We revisit the pollution haven issue but treat environmental regulations as endogenous. We employ an instrumental variable approach, with the first stage regression examining whether government characteristics affect the environmental stringency. The results confirm the existence of an intra-country pollution haven effect in China but are not robust to a battery of sensitivity checks.

Chapter five examines the relationship between economic growth and a range of industrial pollution emissions in China using data for 112 major cities between 2001 and 2004. After separating foreign investment from Hong Kong, Macao and Taiwan from the investment of other foreign economies, we also observe the environmental effects of different ownership groups of investment. The results provide some evidence that economic growth induces more pollution at current income levels in China. And the environmental effects vary across investment groups.

Chapter six concludes with a review of the results, a discussion of the limitations and improvements in data and methodology, the contributions to the literature, and an outline of the potential for further research.

CHAPTER TWO

FDI AND ENVIRONMENTAL REGULATIONS IN CHINA: DO INTRA-COUNTRY POLLUTION HAVENS EXIST?

2.1 Introduction

Traditional international trade theory tells us that trade is governed by comparative advantage, which postulates that the efficient exchange of goods leads to optimal outcomes. Multinational firms, as agents of free trade, seek cost reductions and respond to market imperfections. Higher domestic costs therefore provide the motivation for multinational corporations to expand their geographical range into other areas.

Stringent environmental standards in developed countries will drive up production costs of those firms with higher sensitivity to the pollution abatement costs by, for example, prohibiting certain inputs and outputs, or where strict emission standards requires the use of specific technologies. It may, therefore, be in the firms' interest to close pollution-intensive plants at home and to relocate their production facilities to those developing countries with lower environmental regulations. The suggestion is that the profit-maximising, pollution-intensive multinational firms will move operations or part of operation to developing countries to take advantage of the less stringent environmental regulations. Such a strategy could trigger competition for lax environmental policies in order to gain competitive advantage in "dirty" goods production. A corollary is that developing countries may join a "race to the bottom" by undervaluing environmental damage in order to attract more FDI. Either way, the result is excessive levels of pollution and environmental degradation (Dean *et al.* 2005). This phenomenon is the so called "*race to the bottom*" hypothesis or *pollution haven* hypothesis.[5]

[5] Aliyu (2005) summarises three dimensions of the pollution haven hypothesis. The first is the relocation of heavy pollution industries from developed countries with stringent environmental regulations to developing countries without or with lax or not enforced regulations. The second dimension is the dumping of hazardous wastes generated from developed countries to developing countries. The third is the unrestrained extraction of non-renewable natural resources in developing countries by multinational firms.

To date, one of the most contentious debates in the FDI and the environment literature focuses on whether inter-country differences in environmental regulations are turning poor countries into "pollution havens". This argument centres on the cost effect of environmental regulations and presumes that there are environmental regulation-induced production cost differentials that encourage a firm to relocate its production facility.[6] Theoretical models of pollution havens, including Pearson (1987) and Baumol and Oates (1988), illustrate that developed countries control pollution emissions whilst developing countries do not, and hence become pollution havens.

Thus far the empirical results for tests of the PHH are mixed. Levinson (1996b), Keller and Levinson (2002), List and Co (2000), and Fredriksson *et al.* (2003) all find evidence that environmental stringency has some impact on inbound FDI locations in the US. Xing and Kolstad (2002) find that environmental regulations in host countries have a significant impact on outbound FDI from the US for heavily polluting industries. In contrast, Levinson (1996a) finds little evidence for inter-state pollution havens in the US, and Eskeland and Harrison (2003) suggest it is difficult to find a robust relationship between pollution abatement and US outbound FDI. For the evidence of other countries, Samarzynska-Javorcik and Wei (2005) find that the overall results are relatively weak when they examine the relationship between FDI and environmental stringency for the firms in Eastern Europe and former Soviet Union; Dean *et al.* (2005) find environmental stringency only affects FDI projects in China that originate from Hong Kong, Macao and Taiwan. In general, previous empirical studies suggest that there is little evidence to support the pollution haven hypothesis.

[6] Esty and Gentry (1997) and Aliyu (2005) outline four types of FDI – market seeking, production platform seeking, resource seeking and low cost seeking FDI. Environmental policy/cost has less impact on the categories of market seeking and production platform seeking, but certainly has an effect on resource seeking and/or low cost seeking FDI.

China has, in recent years, been one of the largest recipients of worldwide FDI inflows. FDI has contributed significantly to economic growth in China since it adopted economic reforms from 1978. However, there remains a significant disparity in the geographical distribution of FDI inflows into China. The majority of the FDI has tended to concentrate in the eastern regions. However, environmental deterioration has become a serious problem associated with rapid economic growth, and industrial pollutant emissions are the major source of the environmental problem. Similarly, pollution emissions also vary across regions. Simultaneously, China's environmental regulation standards are relatively weaker than those in developed countries, and the strength of the enforcement of the environmental regulations is different across regions.

Using provincial socioeconomic and environmental data, this chapter investigates whether there exists an intra-county pollution haven effect for China. It therefore examines whether differences in the stringency of environmental regulations affects the location choice of FDI in China.

In this chapter, we employ three measures of regional environmental stringency that vary across time and province. The first measure is the level of industrial pollution treatment investment by province, the second is the number of administrative punishment cases related to environmental issues by province, and the third is the average level of pollution emission charges by province. In addition we include a standard set of control variables that capture provincial level differences in income, labour costs and quality, infrastructure, agglomeration, population density, etc.

Our results suggest that environmental stringency has a significant and negative effect on FDI, leading us to conclude that, *ceteris paribus*, FDI prefers to locate in regions with relatively weak environmental regulations and provides some support for the existence of a pollution haven consistent effect within China.

This chapter is organised as follows. Section 2.2 discusses the previous theoretical and empirical literature on FDI and the environment. In section 2.3, we describe FDI inflows into China and China's environment problems and environmental regulation system. Section 2.4 presents our methodology and data, while section 2.5 reports and discusses the empirical results. The final section concludes.

2.2 Literature Review

This section commences by reviewing existing theoretical and empirical studies of FDI and the environment. It then discusses some of the empirical findings of research into FDI patterns in China, and finally examines the weaknesses of the previous empirical literature.

2.2.1 Trade and Investment Theory and the Environment

According to the theory of comparative advantage, in order to allocate resources efficiently and hence maximise global output and income, countries should specialise in the production and export of products that use in their production a relatively large amount of the resources that the country has in relative abundance. Therefore, countries should produce and export products for which they have a comparative advantage, and they should import products in which they have a comparative disadvantage.

Pearson (1987) shows that the environmental media (air, water, soil) provides a supply of assimilative capacity for waste disposal. In a country with low income levels, the absence of industry or low competing demand for these environmental services, means that the demand for these services is low relative to supply, and therefore, the economic price of the waste disposal services should also be low. A low price means a relative abundance. Other things being equal, this country would have a comparative advantage in "dirty" production, and a comparative disadvantage in "clean" production. Conversely, countries where assimilative capacity is exhausted and incremental residual discharge has a high cost, would have a comparative disadvantage in dirty production and a comparative advantage in clean production. Thus, specialisation through comparative advantage and international trade (investment) efficiently allocates resources, increases production and improves world welfare. Therefore, the supply and demand for environmental services can be treated as an additional factor of production, and that an efficient pattern of world production will reflect that factor.

Baumol and Oates (1988) set up a simple partial equilibrium model that focuses on the environmental impacts of international trade in a two-country (one rich, one poor), two-good (one whose production can, but need not, be dirty and one whose production is non-polluting) world where the rich country successfully adopts an environmental control programme while the poor country does not. They find several results:

1) The decision to use a dirty production process for dirty goods in a poor country will reduce the world price of that good and hence results in excess of world demand for the dirty good.
2) The poor country will produce more of the dirty good by using a dirty production process.
3) As a result, total world emissions of pollutants will be higher.
4) The long-run consequence will be that the poor country will increase its comparative

advantage in dirty goods by using dirty production processes, while the rich country will specialise in the other, less polluting product.

Baumol and Oates (1988) then claim that developed countries control pollution emissions. Developing countries will, therefore, become "pollution havens". Other theoretical studies (for example, Copeland, 1994) support the findings of Baumol and Oates (1988). However, the resulting pattern of production and trade is based on a general presumption that developing countries neglect the environment and pursue a "pollution haven" strategy which according to Pearson (1987) is ill-founded.

The traditional approach to the trade-environment relationship declares that the environmental damage is a result of market and government failures, or the existence of externalities, rather than the trade itself. Therefore the best solution is to internalise the externalities, that is, prices should reflect both private and social costs. Internalised social costs will generate higher prices for the environmental damaging products, and as a result, will alter production, trade and investment patterns. However, the internalisation is difficult to implement in reality. Runge (1994) points out that it is far easier to recommend that environmental externalities be "internalised" than it is to implement and enforce internalisation.

2.2.2 Empirical Literature on FDI and the Environment

Recently, much of the literature on FDI has provided models of FDI that are concerned about the sensitivity of investment location decisions to different elements, such as factor costs, infrastructures, local demand, and labour quality. A multinational firm is treated as one that wants to invest capital somewhere to maximise its profit, i.e. to minimise production cost. The presumption is that production cost differentials are a sufficient inducement for a firm to relocate. Many empirical studies on FDI believe that stringent environmental regulations increase production costs by, for example, prohibiting certain inputs and outputs, paying levy rates for emissions that exceed certain standards, or using specific technologies to meet strict emission standards. Therefore, the multinational firm will locate in a region with weaker environmental standards. To examine the impact of environmental regulations on the location of FDI, we firstly introduce the frameworks in the FDI empirical research.

2.2.2.1 Three Frameworks of Foreign Direct Investment

In addition to the costs of the main factors of production which impact the investment location choice, are there any other potential determinants that can influence an investment decision? Eskeland and Harrison (2003) concluded that there are three frameworks that explain the potential determinants of foreign investment.

The first is that *factor proportions* explanations for trade can also be used to explain the pattern of foreign investment (Caves, 1982; Helpman, 1984; and Brainard, 1993). Holding everything else equal, foreign firms would like to locate in a country that has cheaper factors of production that they use in high proportions. Then the pattern of FDI can be captured through variables such as skill intensity, capital-labour ratio and wage differentials between countries.

Factor proportions alone, however, cannot satisfactorily explain foreign investment. Other foreign investment theories focus on the role of ownership. An important role is played by intangible assets such as superior knowledge and technology, and managerial abilities. This *intangible asset* theory of FDI is developed by Horstmann and Markusen (1989). To the extent that intangibles are usually linked to advanced technology, multinational firms may be better able to comply at a lower cost than local firms, thereby gaining a comparative advantage. Therefore, to capture the importance of intangibles as a motivation for FDI, factor productivity growth is used when data are available.

The third framework is the *proximity-concentration trade-off* between multinational sales and trade, which is described in more details by Brainard (1997). Some important factors (other than intangible assets and factor prices), such as tariff barriers and transport costs, will make firms locate near the target market. The protection of domestic markets has been one of important attractions for foreign investment. Some trade measures, for example, import penetration and export shares, are often employed to capture the importance of protected markets. Since there is trade-off between the advantages of proximity and the benefits of concentration of production in one location in sectors where there are economies of scale, measures of economies of scale/concentration (for instance, the numbers of employees per plant) are important in such models.

2.2.2.2 Empirical Evidence for the Pollution Haven Hypothesis

Although there are many articles focusing on trade and the environment, few studies have studied the relationship between foreign investment and environmental issues. Of those papers that do examine the relationship between FDI and the environment, most of them are centred on US data, only few studies looking at developing countries and even less that look at China.

Thus far, the empirical evidence for the existence of a pollution haven consistent effect is mixed. Generally, empirical studies suggest that there is little evidence to support the pollution haven hypothesis. Early non-parametric evaluations (Walter, 1982 and Pearson, 1987) find that there is FDI in pollution-intensive industries but little evidence that it is influenced by differing pollution abatement costs, or has flowed faster into developing countries relative to industrial countries. Leonard (1988) finds evidence that governments in developing countries used lenient environmental regulations to attract FDI in the 1970s but this incentive was not substantial enough to offset other main determinants of location such as the level of training of labour, infrastructure and stability.

Dean *et al.* (2005) and Smarzynska-Javorcik and Wei (2005) summarise three approaches which have been adopted in recent econometric studies on whether or not FDI flows are a result of pollution haven effects. They are 1) *inter-state plant location choice*; 2) *inter-industry FDI flows within a country* and; 3) *inter-country FDI location choice*. The results of these studies are mixed.

Using the first approach, Levinson (1996a) finds little evidence that inter-state differences in environmental regulations affect the US plant location choice. Levinson (1996b) employs a conditional logit model and finds only one of six environmental stringency indicators has a significant but small impact on the location choice of new branch plants in the US. A similar approach is adopted by List and Co (2000), who estimate the effect of state environmental regulations on foreign multinational corporations' new plant location decisions from 1986 to 1993, using four measures of regulatory stringency. They find that environmental stringency and attractiveness of a location are inversely related. Keller and Levinson (2002) test whether FDI to US states has responded significantly to relative changes in state's environmental compliance costs. Keller and Levinson (2002) address the main drawbacks in previous studies. They control for unobserved heterogeneity among states and use a panel of pollution abatement cost indices that control for states' industrial composition. It robustly documents moderate effects of pollution abatement costs on capital and employees at foreign-owned manufacturing affiliates, particularly in pollution-intensive industries, and on the number of planned new foreign-owned manufacturing facilities. Similarly, Fredriksson *et al.* (2003), which uses US state-level panel data from four industrial sectors over the period 1977-1987, finds that environmental policy plays a significant role in determining the spatial allocation of inbound US FDI and such effect depends critically on the exogeneity assumption of environmental policy.

There is a scarcity of research that assesses the relationship between the distribution of foreign investment and pollution intensity. One exception is the recent work of Eskeland and Harrison (2003), which adopts the second approach to examine the pattern of FDI across industries in Mexico, Venezuela, Morocco and Cote d'Ivoire. Their results suggest that it is difficult to find a robust relationship between pollution abatement and the volume of US outbound investment. They find a positive relationship between FDI share and air pollution-intensity of an industry but negative relationship between FDI share and both water pollution and toxic release-intensity. They also find foreign ownership is associated both with lower levels of energy use and the use of cleaner types of energy. In addition, the results suggest that any impact of abatement costs on the distribution of FDI is small, if not zero. It is suggested that these results are because pollution abatement costs are only a small fraction of overall costs.

A paper employing the third approach is Xing and Kolstad (2002), which presents a statistical test on how US FDI is influenced by the environmental regulations of foreign host countries. To be specific, they have examined the relationship between the capital outflows of six US manufacturing sectors – including industries with high pollution control costs (chemicals and primary metals) as well as industries with more modest pollution control costs (electrical and non-electrical machinery, transportation equipment, and food products) – and the environmental policy of 22 destination countries. They argue that environmental regulatory stringency is not directly observed and hence use an instrumental variable approach to examine the effect of environmental regulations. The results show that the laxity of environmental regulations in a host country is a significant determinant of FDI from the US for heavily polluting industries and is insignificant for less polluting industries.[7] Their findings provide indirect support for the pollution haven hypothesis. However, the small size of the data and the imperfect coverage of sulphur emissions data mean that care must be taken with the reliability of their results. A more recent paper, Smarzynska-Javorcik and Wei (2005) examines the relationship between cross country FDI flows and environmental stringency for 143 multinational firms in 25 countries in Eastern Europe and the former Soviet Union. In this paper they emphasise a number of omitted variables from previous studies, such as bureaucratic corruption, which deters FDI but at the same time is correlated with laxity of environmental protection. However, they find little evidence for the hypothesis that lower environmental standards attract investment, nor for the hypothesis that these countries are more attractive for pollution-intensive FDI. They find some evidence for the PHH when regressions employing Treaties as the proxy for environmental standards in a host country, but the overall evidence is relatively weak and does not survive numerous robustness checks using other proxies of pollution intensity or regulatory stringency.

[7] Xing and Kolstad (2002) find that there is a negative linear relationship between FDI of the US chemical industry and the stringency of environmental regulation in a foreign host country. Lax environmental policy tends to attract more capital inflows form the US for pollution intensive industries; whilst tough environmental regulations would tend to impede or discourage FDI from these industries.

2.2.2.3 Empirical Evidence on Chinese Data

Recent Empirical Evidence on Intra-Country FDI Location in China

Many researchers have focused on the geographical distribution of aggregate FDI flows among Chinese provinces. Wei *et al.* (1999) analyse the determinants of regional distribution of both pledged and realised FDI within China from 1985 to 1995. The unit root test results indicate the existence of a long run relationship between the spatial distribution of FDI and a number of regional characteristics. The error components (random effect) model results suggest that pledged FDI is positively affected by the level of international trade, the number of scientists and researchers in total employment, GDP growth, preferential investment policy, improvement in infrastructure, and advances in agglomeration; while negatively affected by wage rates and information costs. However, GDP growth, infrastructure and agglomeration do not have significant effects on realised FDI.

Using provincial data between 1990 and 1997, Coughlin and Segev (2000) examine the geographic pattern of FDI location within China. They extend the methodology of pervious studies by introducing some new control variables and test the existence of spatial heterogeneity and spatial dependence. The ordinary least square (OLS) and spatial error regressions both suggest that only spatial dependence exists, i.e. increased FDI in a province has positive effects on FDI in nearby provinces. Their findings on other control variables are consistent with past studies of FDI location choice among Chinese provinces and with studies of FDI location in general: economic size, productivity and coastal location are positive determinants of FDI location; wage and illiterate rate are negative determinants; and their infrastructure measures do not have significant effects on FDI.

Cheng and Kwan (2000) employ a dynamic model of foreign investment and use Generalised Method of Moment (GMM) estimator to investigate the impact of the determinants on the stock of FDI in 29 Chinese regions from 1985 to 1995, and find that a large regional market, good infrastructure, and preferential policies have positive effects but wage has a negative effect on FDI. The effect of education is positive but not significant. They also find a strong self-reinforcing effect of FDI on itself.

Gao (2002) concentrates on the effect of labour quality on the location of FDI within China from 1996 to 1999. Gao (2002) employs OLS, between effects, fixed effects and random effects models and finds that labour quality plays a significant and positive role in attracting FDI. The evidence in this paper also indicates that the location of FDI from developed economies, such as US and Japan, is more sensitive to labour quality than FDI from Asian developing economies. However, the wage is not found to be a significant determinant and even has a positive coefficient in some specifications.

In a similar paper, Fung *et al.* (2002) examine the determinants of US and Japanese FDI location among Chinese regions from 1991 to 1997 using a generalised least square estimator and compare the results with those investments from Hong Kong and Taiwan. GDP and certain policy variables are found to have significant positive impacts on inflows of FDI. Labour quality exerts a larger influence on Japanese investment than on US investment. Lagged wage is negatively related to FDI. However, compared with investment from Hong Kong and Taiwan, US and Japanese investments are more sensitive to the local markets because they are mostly producing for the domestic Chinese market while FDI from Hong Kong and Taiwan is mostly producing for export. Labour quality does not have a strong influence on FDI inflows from Hong Kong and Taiwan because such investment is more concentrated in labour-intensive industries that require relatively low labour skills.

Additionally, good infrastructure has a strong effect of FDI from Hong Kong and Taiwan but only a moderate effect on US investment and no effect on Japanese investment. Fung *et al.* (2003) examine the determinants of Japanese FDI in China using a regional dataset from 1990 to 2000 and form a comparison with investment from Hong Kong. The main results are similar to those in Fung *et al.* (2002).

Amiti and Javorcik (2008) is the latest paper which examines the determinants of entry by foreign firms using a comprehensive dataset that includes 515 industries in 29 Chinese provinces during 1998-2001. The analysis is based on a new economic geography model and focuses on the relative importance of market and supplier access within and outside the province of entry, as well as trade costs and factor costs. The non-linear least square results suggest that market access and supplier access are the key determinants of FDI inflows. The presence of customers and suppliers in the province of entry matters more than the market and supplier access to the rest of China, which is consistent with market fragmentation in China due to underdeveloped transport infrastructure and informal trade barriers. In addition, production costs also play an important role in determining the location of FDI, but the effects are only around a quarter of the market and supplier access effects.

Empirical Evidence on Intra-Country Pollution Havens in China

A recent study that searches for empirical evidence of intra-country pollution havens in China is Dean *et al.* (2005). In this study they estimate whether weak environmental regulations attract foreign investment in China. Dean *et al.* (2005) derive a location choice model containing firm's production and abatement decisions, agglomeration and factor abundance. They estimate a conditional logit model using a dataset that includes information on 2,886 manufacturing joint venture projects, effective environmental levies on water pollution, and estimates of Chinese emissions and abatement costs across 3-digit ISIC industries and provinces between 1993 and 1996. The results show that FDI flows to provinces with high concentrations of foreign investment, relative abundance of skilled labour, concentration of potential local suppliers, special tax incentives, and less state ownership. Environmental stringency just affects certain types of projects in highly polluting industries, with investment originating from Hong Kong, Macao and Taiwan seemingly attracted to provinces with relatively weak environmental controls. This finding is consistent with the pollution haven hypothesis but contradicts the notion that pollution havens are generated by industrial country investors. In contrast, investment from non-Chinese sources appears not to be attracted by low levels of pollution levies, regardless of the pollution intensity of the industry. This is opposite to the pollution haven hypothesis. In sum, the results suggest little evidence for the pollution haven hypothesis.

2.2.2.4 Weaknesses of Previous Work on Pollution Havens

The general lack of support for the pollution haven hypothesis in previous studies can be summarised as follows:

First, as Pearson pointed out, "environmental control costs are a small fraction of production costs in virtually every industry, and the effect on trade will be correspondingly small".[8] This is reinforced by the results of Eskeland and Harrison (1997), where the empirical results show that environment costs may be too small relative to overall costs to impact the location decision. Second, FDI may be combined with new techniques, including the latest abatement technologies, rendering the relative stringency of the host

8 Pearson (1987), pp.124.

country's environmental regulations unimportant. Third, if firms are producing for export, then they may have to meet the environmental product standards of developed countries in order to gain the access to these markets. Finally, firms may predict that there will be future increases in environmental regulations, and hence choose a production process today that will meet the higher standards of the future (Dean *et al.*, 2002).

Smarzynska and Wei (2001) point out there are two possible ways to summarise the existing empirical studies on pollution haven hypothesis. "The first possibility is that the 'pollution haven' hypothesis is after all just a popular myth that does not hold in reality. An alternative view is that the 'pollution haven' hypothesis is valid but the empirical researchers have not tried hard enough to uncover this 'dirty secret'."[9] There exist several weaknesses in previous studies that may have impeded the exposure of the "dirty secret".

First, in some studies, the absence of some important variables, such as relative factor abundance and agglomeration, will lead to omitted variable bias. Markusen and Zhang (1999), Head and Ries (1996), and Cheng and Kwan (2000) have demonstrated the importance of these variables in explaining FDI incidence (Dean *et al.* 2005).

Second, it is difficult to quantify international differences in environmental regulations (Smarzynska and Wei, 2001; and Keller and Levinson, 2002). "This difficulty is further exacerbated by the possibility that laws on the book may not be the laws that are actually enforced".[10]

Third, Keller and Levinson (2002) & Levinson and Taylor (2008) both demonstrate that cross-section analyses cannot control for unobserved heterogeneity among countries.

---

[9] Smarzynska and Wei (2001), pp. 2.

[10] op. cit. pp. 3.

These unobserved characteristics, such as unobserved resources and unobserved protection of polluting industries, may be correlated with both regulatory compliance costs and investment. If the estimation does not allow for these unobserved characteristics, it will generate an omitted variable bias to the predicted effect of regulatory compliances costs on investment. Therefore, using a continuous, time-varying (panel) dataset becomes important.

Finally, most literature uses cost-based measures of environmental standard stringency. Copeland and Taylor (2003) developed a model linking the firm's production and abatement cost. It suggests a particular specification for testing a firm's responsiveness to changes in environmental regulations, which raises the possibility of specification error.

In this chapter, we address a number of those limitations by adopting a five-year panel dataset for 30 provinces in China that includes three measures of environmental regulations that vary across time and province, and a significant number of control variables, including measures of agglomeration and factor abundance. We control for unobserved heterogeneity by using the feasible generalised least square estimator.

2.3 FDI, the Environment and Environmental Regulations in China

Section 2.3.1 firstly lays out the circumstances of foreign investment in China, including its development since 1978 and the characteristics of its uneven distribution. In the second part, it elucidates the environment problems that China faces at present, especially the industrial generated wastewater pollution, air pollution and solid wastes pollution. Following a brief description of environmental investment in China, the environmental regulatory framework, FDI related environmental regulations and the stringency of environmental regulations are expounded in detail.

2.3.1 Foreign Direct Investment in China

Since it launched economic reforms in 1978, China has received enormous FDI flows. In 2005, it received FDI in actually utilised value of $72.41 billion compared with $0.64 billion in 1983 (China Statistical Yearbook).[11] China has been the second-largest recipient of foreign capital ranking after the US.

2.3.1.1 Trends in Chinese FDI

General trends and the characteristics of FDI in China have been reviewed by many studies, e.g. Wu (1999), OECD (2000), Wei and Liu (2001), and Wei (2002). At the beginning of China's economic reforms, FDI inflows were not significant. FDI increased in the mid-1980s and reached a peak level in the early 1990s. Since the mid-1990s China has been a major host country for FDI. Table 2.3.1 shows the number of contracted projects, the

[11] Actually used FDI refers to the amount which has been actually used according to the agreements and contracts, i.e. the realised FDI.

amount of contracted and the amount of actually used FDI and the corresponding annual growth rate from 1979 to 2003. The development path of inward FDI is shown more clearly from Figure 2.3.1. Following the surveys of OECD (2000) and Wei (2002), the general trends can be distinguished by five phases: the experimental stage (1979-1983), the growth stage (1984-1991), the peak stage (1992-1994), the adjustment stage (1995-1999), and the renascent/recovered stage (2000 onwards).

During the first stage, the Chinese government established four Special Economic Zones (SEZs) in Guangdong and Fujian Provinces, and provided special incentive policies in these SEZs.[12] FDI inflows were mainly concentrated in these SEZs; however, the total amount was rather low, only $1.8 billion.

With the successful experiment in the first stage and a satisfactory economic situation nationwide, China formulated a series of laws and regulations to improve the business environment. In 1984, China established another SEZ – Hainan Island (which became a province in 1988) and opened fourteen coastal cities across ten provinces.[13] There was a steady and rapid growth of FDI flows during the second stage, with a growth rate of approximately 20 per cent.

[12] Guangdong and Fujian are both coastal provinces in the southeast of China. The four SEZs are Shenzhen, Zhuhai, Shantou in Guangdong, and Xiamen in Fujian.

[13] The fourteen cities include: Dalian (Liaoning Province), Qinhuangdao (Hebei Province), Tianjin (municipality), Yantai (Shandong Province), Qingdao (Shandong Province), Liangyungang (Jiangsu Province), Nantong (Jiangsu Province), Shanghai (municipality), Ningbo (Zhejiang Province), Wenzhou (Zhejiang Province), Fuzhou (Fujian Province), Guangzhou (Guangdong Province), Zhanjiang (Guangdong Province), and Beihai (Guangxi Province).

Table 2.3.1 FDI Inflows into China 1979-2004

USD billion (Current Price)

Year	# of Project	Growth Rate	Contracted Value	Growth Rate	Actually Used Value	Growth Rate
Total	**508465**		**1096.36**		**560.39**	
1979-1982	922	N/A	6.01	N/A	1.17	N/A
1983	470	N/A	1.73	N/A	0.64	N/A
1984	1856	294.89	2.65	53.18	1.26	96.88
1985	3073	65.57	5.93	123.77	1.66	31.75
1986	1498	-51.25	2.83	-52.28	1.87	12.65
1987	2233	49.07	3.71	31.10	2.31	23.53
1988	5945	166.23	5.30	42.86	3.19	38.10
1989	5779	-2.79	5.60	5.66	3.39	6.27
1990	7273	25.85	6.60	17.86	3.49	2.95
1991	12978	78.44	11.98	81.52	4.37	25.21
1992	48764	275.74	58.12	385.14	11.01	151.95
1993	83437	71.10	111.44	91.74	27.52	149.95
1994	47549	-43.01	82.68	-25.81	33.77	22.71
1995	37011	-22.16	91.28	10.40	37.52	11.10
1996	24556	-33.65	73.28	-19.72	41.73	11.22
1997	21001	-14.48	51.00	-30.40	45.26	8.46
1998	19799	-5.72	52.10	2.16	45.46	0.44
1999	16918	-14.55	41.22	-20.88	40.32	-11.31
2000	22347	32.09	62.38	51.33	40.72	0.99
2001	26140	16.97	69.20	10.93	46.88	15.13
2002	34171	30.72	82.77	19.61	52.74	12.50
2003	41081	20.22	115.07	39.02	53.51	1.46
2004	43664	6.29	153.48	33.38	60.63	13.31

Note: a) The number of project refers to the project numbers of the enterprises with foreign investment. The amount of contracted FDI refers to the amount of project investments supplied by the foreign businessmen in terms of approved or signed contracts. The amount of actually used FDI refers to the amount which has been actually used according to the agreements and contracts.

b) The values for 1979-1986 are different among the China Statistical Yearbooks for various years, possibly due to different measurements. The values presented in the table are collected from the corresponding year's Yearbook so that the total volumes are different from those in the latest Yearbook.

Source: China Statistical Yearbook, various years.

From 1992 to 1994, contracted and actually used FDI increased quickly and exceeded the corresponding figures for the previous years. In 1993, the contracted FDI value reached a peak level of $111.4 billion. This situation was closely associated with a number of events, including Deng Xiaoping's visit to the southern coastal areas and SEZs, nationwide implementation of opening up policies for FDI and the world wide rise in FDI flows.[14]

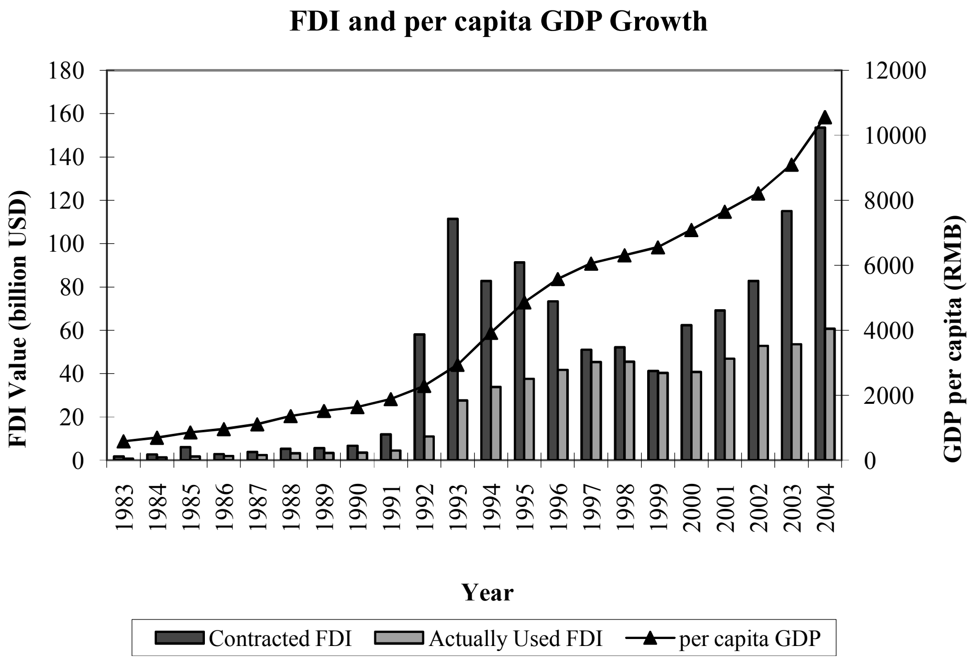
From 1994, the growth rate of actually used FDI slowed down and became negative in 1999. The number of projects and contracted FDI mostly kept falling during the period 1994 to 1999 and both arrived at their lowest point in 1999. This was mainly due to the impact of the Asian financial crisis and the rise of acquisition transactions in both OECD and non-OECD countries.

From 2000 onwards, inflows of FDI into China recovered quickly in terms of both contracted and actually used FDI. In 2003, it overtook the US as the biggest recipient of FDI in the world with contracted value of $115.07 billion and actually used value of $53.51 billion. National Bureau of Statistics of China reported that in 2004 the contracted value of FDI increased to $153.48 billion and the actually utilised amount rose to $60.63 billion, with the rank after US.

It should be noted that the growth of FDI is positively associated with the economic growth in China. It is also illustrated by Figure 2.3.1. FDI and economic growth interact with each other. GDP per capita increased quickly in the stage that FDI was booming, and slowly when FDI inflows decreased.

[14] Deng's visit in the spring of 1992, pushed China's overall economic reform process forward and emphasised China's commitment to the open door policy and market-oriented economic reform. It gave greater confidence to foreign investors in China. From then on, China adopted new approach, which pushed more nationwide implementation of open policies to encourage FDI inflows.

Figure 2.3.1 FDI Inflows into China 1979-2004



Source: China Statistical Yearbook, various years.

2.3.1.2 Unbalanced Distribution of FDI in China

Although the total amount of FDI inflows into China is extremely high, there are significant imbalances in FDI stocks across China in terms of its source, form, geographical and sectoral distribution.

1) Main Countries of Origin of Investment

According to the report from China's Ministry of Commerce (Tables 2.3.2 and 2.3.3), Asian countries contribute most of the FDI inflows into China, which takes up more than 70% of total actually used FDI into China between 1979 and 2003. It is followed by North

America and the EU, with 9.57% and 7.55% respectively. Among those countries with the highest investment in China, the majority of investors were ethnic Chinese, e.g. the share of FDI from Hong Kong, Taiwan and Macao was about 52.69% between 1979 and 2003.[15] Among developed countries, the US and Japan have been the most important investors in China, with about 8.79% and 8.25% respectively. Other developed countries invested lower amounts of FDI in China. In recent years the share of FDI from Hong Kong, Macao and Taiwan has decreased while that of the US and the EU has increased.

2) Forms of Investment

In terms of the form of FDI, the establishment of new enterprises like joint ventures and foreign invested companies seem to be the main types of FDI into China at the current time. From Table 2.3.4, it is clear that until 2003, equity joint ventures accounted for 41% of the inward actually used FDI and wholly owned foreign invested enterprises accounted for appropriately 40%. Cooperative operations have been the third important mode, which took 17.27% in terms of actually used FDI from 1979 to 2003. As mergers and acquisitions have become popular forms of global FDI, they may also have potential for further expansion in China. Additionally, the share of wholly owned foreign invested enterprises shows an increase in China in recent years (OECD 2000).

[15] For historical reasons, Hong Kong Dollar, New Taiwan Dollar and Macao Pataca had been called "foreign currencies", and the investment from Hong Kong, Taiwan and Macao has been counted as "foreign investment" since the 1980s, although Hong Kong, Taiwan and Macao are all part of China. Currently, some researchers have named the investment from these three regions as "non-RMB domestic investment". However, here we follow the traditional statistical classification, and treat all non-RMB investment as "foreign investment".

Table 2.3.2 FDI to China by Major Countries/Regions 1979 - 2003

USD billion

Country (Region)	# of Project	%	Contracted Value	%	Actually Used Value	%
Total	**465277**	**100**	**943.13**	**100**	**501.47**	**100**
Asia	**369789**	**79.48**	**654.14**	**69.36**	**357.41**	**71.27**
Hong Kong	224509	48.25	414.51	43.95	222.58	44.38
Indonesia	1079	0.23	2.58	0.27	1.27	0.25
Japan	28401	6.01	57.49	6.10	41.39	8.25
Macao	8407	1.81	12.09	1.28	5.19	1.03
Malaysia	2888	0.62	7.16	0.76	3.09	0.62
The Philippines	1945	0.42	3.74	0.40	1.65	0.33
Singapore	11871	2.55	43.57	4.62	23.53	4.69
Korea	27128	5.83	36.65	3.89	19.69	3.93
Thailand	3375	0.73	6.32	0.67	2.55	0.51
Taiwan	60186	12.94	70.03	7.43	36.49	7.28
EU	**16158**	**3.47**	**65.94**	**6.99**	**37.87**	**7.55**
Belgium	470	0.10	1.08	0.11	0.67	0.13
Denmark	267	0.06	1.41	0.15	0.52	0.10
UK	3856	0.83	20.84	2.21	11.44	2.28
Germany	3504	0.75	15.71	1.67	8.85	1.76
France	2302	0.49	7.92	0.84	6.15	1.23
Ireland	61	0.01	0.13	0.01	0.05	0.01
Italy	2137	0.46	3.81	0.40	2.55	0.51
Luxembourg	96	0.02	0.61	0.06	0.28	0.06
Netherlands	1254	0.27	9.93	1.05	5.06	1.01
Greece	47	0.01	0.11	0.01	0.03	0.01
Portugal	80	0.02	0.13	0.01	0.07	0.01
Spain	755	0.16	1.36	0.14	0.45	0.09
Austria	573	0.12	1.04	0.11	0.44	0.09
Finland	181	0.04	0.61	0.06	0.39	0.08
Sweden	575	0.12	1.27	0.13	0.93	0.19
North America	**48281**	**10.38**	**98.43**	**10.44**	**48.01**	**9.57**
Canada	6941	1.49	11.99	1.27	3.92	0.78
US	41340	8.89	86.44	9.17	44.09	8.79
Some Free Ports	**11665**	**2.51**	**81.05**	**8.59**	**38.14**	**7.61**
Cayman Islands	923	0.20	11.18	1.18	4.67	0.93
Virgin Islands	8877	1.91	62.01	6.58	30.17	6.02
Samoan	1865	0.40	7.86	0.83	3.30	0.66

Source: http://www.chinafdi.org.cn [Accessed 20/03/2005].

Table 2.3.3 Share of Major Source Countries/Regions of Actually Used FDI in China

Year	Hong Kong & Macao (%)	Taiwan (%)	US (%)	Japan (%)	EU (%)
1986	59.22		14.54	11.74	7.96
1987	69.08		11.36	9.50	2.28
1988	65.60		7.39	16.11	4.92
1989	61.24	4.56	8.38	10.50	5.53
1990	54.87	6.38	13.08	14.44	4.23
1991	59.96	10.68	7.40	12.20	5.63
1992	70.03	9.54	4.64	6.45	2.21
1993	64.91	11.41	7.50	4.81	2.44
1994	59.75	10.04	7.38	6.15	4.55
1995	54.64	8.43	8.22	8.28	5.68
1996	50.95	8.33	8.25	8.82	6.56
1997	46.46	7.27	7.16	9.56	9.22
1998	41.64	6.41	8.58	7.48	8.75
1999	41.35	6.45	10.46	7.37	11.11
2000	38.92	5.64	10.77	7.16	11.00
2001	36.35	6.36	9.46	9.28	8.92
2002	34.75	7.53	10.28	7.94	7.03
2003	33.86	7.35	7.85	9.45	7.35

Source: http://www.chinafdi.org.cn [Accessed 20/03/2005].

Table 2.3.4 FDI in China by Type up to 2003

USD billion

Type	# of Project	%	Contracted Value	%	Actually Used Value	%
Total	**465277**	**100**	**943.13**	**100**	**501.47**	**100**
Joint Ventures Enterprises	238367	51.23	351.84	37.31	206.03	41.08
Cooperative Operation Enterprises	54512	11.72	170.80	18.11	86.62	17.27
Foreign Invested Enterprises	172108	36.99	414.15	43.91	199.00	39.68
Foreign Invested Share Enterprises	67	0.01	1.46	0.15	1.55	0.31
Cooperative Development	191	0.04	4.74	0.50	7.40	1.48
Others	32	0.01	0.15	0.02	0.87	0.17

Source: China Statistical Yearbook, various years, and http://www.chinafdi.org.cn [Accessed 20/03/2005].

3) Geographical Distribution

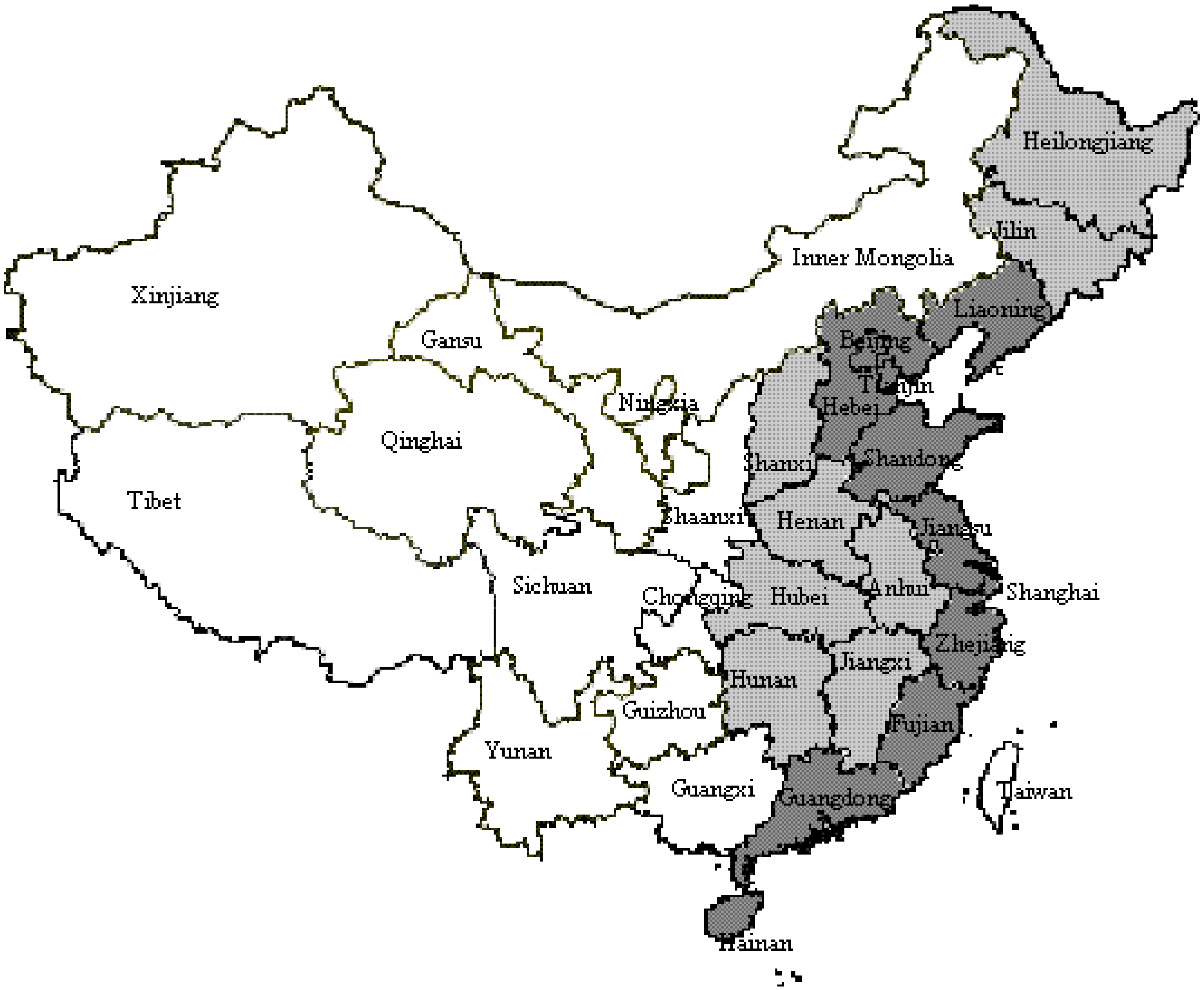
The geographical distribution of FDI in China is very unbalanced. Figure 2.3.2 is a map of China with the names of administrative areas. It shows the traditional division of three regions in China. Eastern regions have received most of the FDI inflows. In addition to the natural and historical advantages of the eastern regions, the government's favourable policies towards FDI also offer a better business environment in this region than the others.[16] Although the central government began to place more attention on the development of central and western China in 2000 and "Western Development Programme" has been implemented, the economic development gap between coastal and inner regions is still large.

Table 2.3.5 demonstrates that 86.27% of cumulative FDI was located in the eastern region, 8.93% in the central region and only 4.80% in the western region between the years 1979 and 2003. Among the eastern region provinces, Guangdong has attracted more than a quarter of the total cumulative FDI (Figure 2.3.3). Jiangsu and Fujian, which have received 14.24% and 8.75% of the total FDI respectively, ranked second and third among thirty-one provinces in mainland China. Other eastern provinces, Shanghai, Shandong, Liaoning, Zhejiang, Beijing, Tianjin and Hebei also ranked in the top group. These eastern provinces are also the richest regions in China, in terms of both GDP and per capita GDP.

---

[16] China has a vast territory with coastal plains in the east and altiplano in the west. Eastern regions have an advantageous geographical position, which is favourable for international trade. The SEZs and fourteen opened coastal cities are the traditional industrial and commercial centres which offer better infrastructure than the inner areas of China. Numerous development zones have been established in eastern region, such as Yangtze River delta, the Pearl River delta, Bohai Sea Coastal Region and Pudong District of Shanghai.

Figure 2.3.2 Map of China



China administers 34 province-level divisions, including 4 municipalities (Beijing, Tianjin, Shanghai, and Chongqing), 23 provinces (Hebei, Shanxi, Liaoning, Jilin, Heilongjiang, Jiangsu, Zhejiang, Anhui, Fujian, Jiangxi, Shandong, Henan, Hubei, Hunan, Guangdong, Hainan, Sichuan, Guizhou, Yunnan, Shaanxi, Gansu, Qinghai, and Taiwan) , 5 autonomous regions (AR) (Inner Mongolia AR, Guangxi Zhuang AR, Tibet AR, Ningxia Hui AR, and Xinjiang Uyghur AR) , and two special administrative regions (SARs) (Hong Kong and Macao). In this thesis, we only consider the 31 divisions in mainland China. Non-RMB domestic investment from Hong Kong, Taiwan and Macao are treated as "*foreign investment*" (see footnote 15).

■ Eastern Regions

■ Central Regions

□ Western Regions

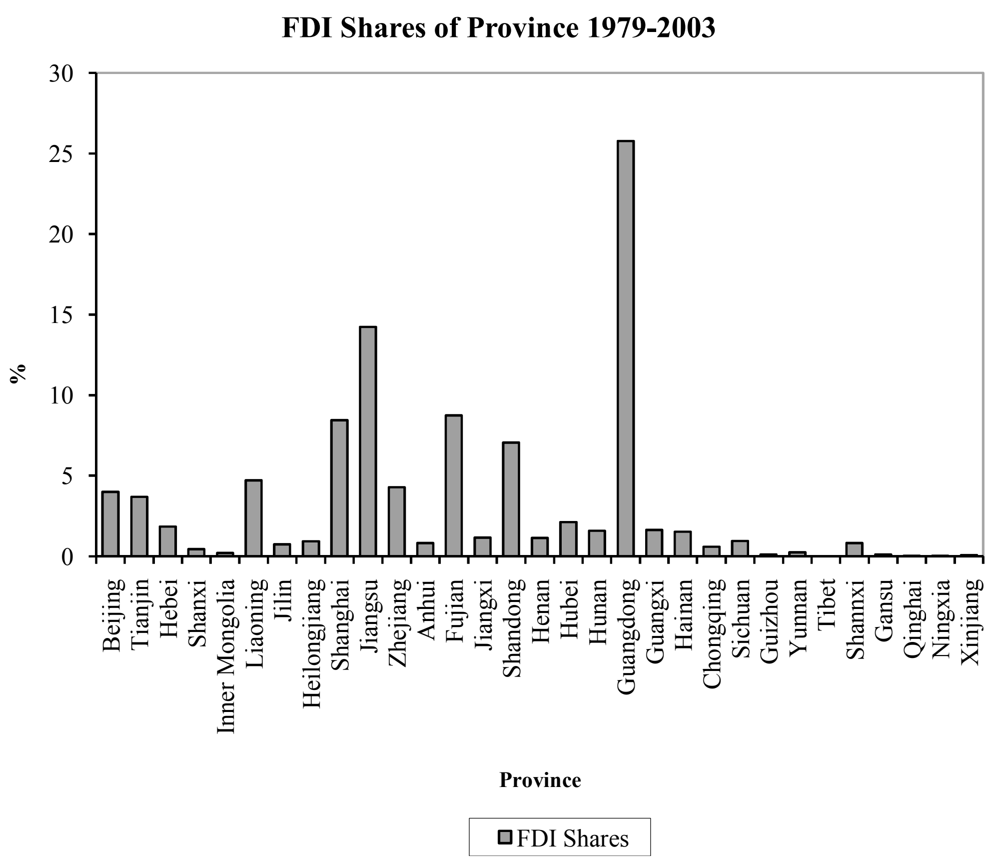
Table 2.3.5 FDI in Different Regions in China up to 2003

USD billion

Region	# of Project	%	Contracted Value	%	Actually Used Value	%
Total	**465277**	**100**	**943.13**	**100**	**501.47**	**100**
Eastern Region	381527	82.00	819.16	86.86	432.61	86.27
Central Region	52424	11.27	71.21	7.55	44.79	8.93
Western Region	31326	6.73	52.75	5.59	24.07	4.80

Source: http://www.chinafdi.org.cn [Accessed 20/03/2005].

Figure 2.3.3 FDI Shares of Provinces 1979-2003



Source: http://www.chinafdi.org.cn [Accessed 20/03/2005].

4) Sectoral Distribution

Chinese industry can be split into three main categories, primary industry, secondary industry and tertiary industry.[17] Thus far, the majority of FDI has flowed into the secondary industry.

Table 2.3.6 shows that among secondary industries, manufacturing has taken 63.66% of the total cumulative contracted FDI by 2003, with construction taking a significant proportion (2.57%). The tertiary industry comes second with the proportion of real estate (the leading sector) accounting for about 20%. The primary industry attracted less than 2% of the total FDI inflows.

According to the analysis of OECD (2002) and Wei (2002), much of FDI in the manufacturing sector was concentrated in labour-intensive sectors such as textiles, clothing and assembly lines of mechanical, electronic and electric products. However, there is a significant increase of FDI inflows into capital- and technology-intensive sectors.

In the future, especially with the accession to the WTO and further liberalisation, service trade, such as finance and insurance, telecommunications, wholesale and retail, are expected to increase. Further investment will also take place in traditional industries. Investment in agriculture depends on the extent of the opening up of the market for agricultural products and the industrialised process of production operations (OECD 2000).

---

[17] Primary industry refers to extraction of natural resources, i.e. agriculture (including farming, forestry, animal husbandry and fishery). Secondary industry involves processing of primary products, i.e. industry (including mining and quarrying, manufacturing, production and supply of electricity power, gas and water) and construction. Tertiary industry refers to all other economic activities not included in primary and secondary industry.

Table 2.3.6 Cumulative FDI in the Three Industries 1979-2003

USD billion

Sector	**# of Project**	**%**	**Contracted Value**	**%**
Total	**465277**	**100**	**943.13**	**100**
Primary Industry	**13333**	**2.87**	**18.04**	**1.91**
Farming, Forestry, Animal Husbandry and Fishery	13333	2.87	18.04	1.91
Secondary Industry	**350170**	**75.26**	**632.01**	**67.01**
Mining and Quarrying	524	0.11	1.68	0.18
Manufacturing	338952	72.85	600.40	63.66
Electricity Power, Gas and Water Production and Supply	654	0.14	5.68	0.60
Construction	10040	2.16	24.25	2.57
Tertiary Industry	**101774**	**21.87**	**293.08**	**31.08**
Transport, Storage, Post and Telecommunication Services	5235	1.13	23.81	2.52
Wholesale & Retail Trade (& Catering Services)	23565	5.06	28.84	3.06
Finance and Insurance	48	0.01	0.87	0.09
Real Estate Management	40941	8.8	180.90	19.18
Renting and Business Services	15438	3.32	30.17	3.20
Scientific Research, Polytechnic Service & Geological Prospecting	3528	0.76	4.16	0.44
Household and other Services	10333	2.22	16.32	1.73
Education (Cultural & Arts, Radio, Film & Television)	1482	0.32	2.59	0.27
Health Care Sports and Social Welfare	1204	0.26	5.43	0.58

Source: http://www.chinafdi.org.cn [Accessed 20/03/2005].

2.3.2 Pollution in China

China has been a large polluting country with rapidly increasing industrial production, domestic and foreign trade and investment. Central and local governments and some industrial managers have recognised the problem and made an effort to reduce pollution and to encourage cleaner production. Environmental protection has been one of the "national fundamental policies" in China. However, economic growth is still the priority. The general public has little awareness of the threats of environmental degradation. Weak and uneven enforcement of environmental laws also discourage industries from reducing pollution and increasing efficiency. The disparity of economic growth and enforcement of environmental regulations has resulted in accumulated environmental problems especially in certain areas.

China's State Environmental Protection Administration (SEPA) reported that five of the ten most polluted cities worldwide are in China; acid rain is falling on one third of the country; half of the water in the seven largest rivers is "completely useless"; a quarter of China's citizens lack access to clean drinking water; one third of the urban population is breathing polluted air; and less than a fifth of the rubbish in cities is treated and processed in an environmentally sustainable way. SEPA officials reported in early August 2006, that China has become the world's top emitter of acid rain causing sulphur dioxide (SO_2), with discharges rising 27 per cent from 2000 to 2005, mostly from coal-burning power stations (Reuters, 16/08/2006).

Industrial pollution is a primary source of the environmental problems. SEPA reported that in 2004 industrial air pollution accounts for over 80% of the national total, including 83.9% of SO_2 emissions and 80.9% of flue dust. Although industrial water pollution has decreased year by year, it still accounts for about 45.8% of national total, including 38.1% of Chemical Oxygen Demand (COD) and 31.7% of Ammonia and Nitrogen.

Table 2.3.7 provides an insight into the discharge levels of industrial wastewater and industrial solid waste disposal from 1987 to 2004, and industrial waste gas emissions (including emissions of industrial SO_2, Soot and Dust) from 1991 to 2004. Figure 2.3.4 presents the emissions of carbon dioxide (CO_2) up to 2004.

These facts clearly show the pollution trend. Industrial wastewater pollution has been declining steadily; solid wastes disposal dropped quickly before the mid-1990s, and then fell slightly but has appeared to rise in recent years.

Air pollution is a serious problem. Waste gas emissions have increased rapidly since early 1990s. Among the air pollutants, industrial soot emission remains relatively stable, except an unexpected rise in 1998. Industrial dust stayed around 6 million tons from 1991 to 1997 and then jumped to over 10 million tons in 1998 and kept at this level until 2004. SO_2 and CO_2 emissions have generally maintained rapid growth and the emissions from the burning of solid fuels have contributed the most to CO_2 emissions.

Table 2.3.8 provides a regional perspective. Observe that the eastern region, which covers only 11.1% of the country's surface, has about 50% of the wastewater and waste gas emissions in 2004. However, in terms of solid wastes, the western region, which covers 70.1% of the country's surface, discharged over 50% of the total volume; while the eastern region only discharged about 5%.[18] Figures 2.3.5 -2.3.7 present a comparison of pollution in levels for 2004. The red coloured provinces have the highest emissions of pollutants in levels, while the yellowed provinces have the lowest emissions.

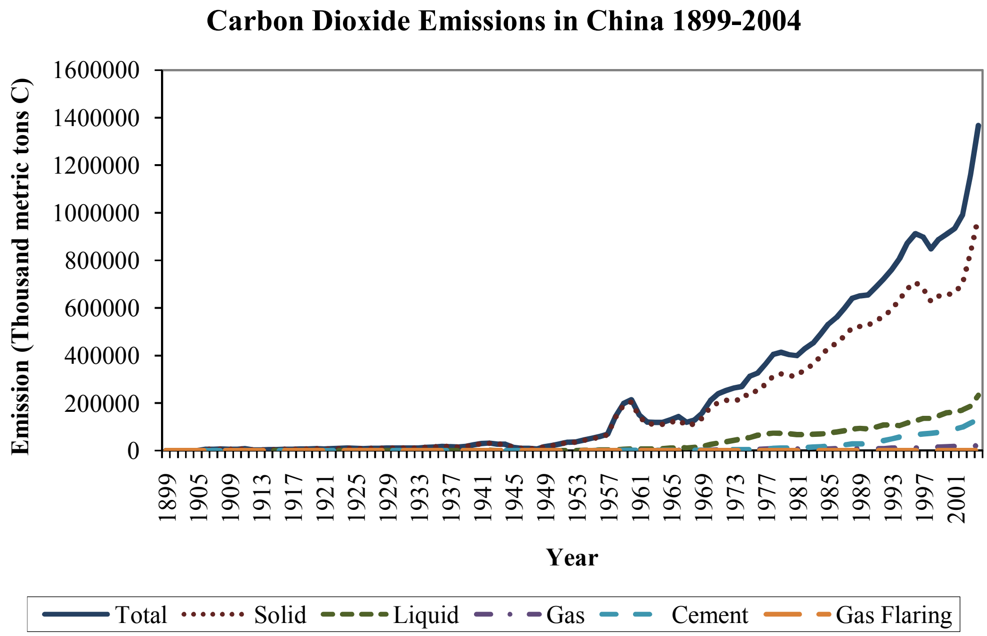
[18] Eastern regions have produced the 42.1% of the total volume of solid wastes. However, the utilise rate and treat rate of solid waste in eastern regions are much higher than the other two regions. Therefore, the discharged volume of solid wastes is low is eastern regions.

Table 2.3.7 Industrial Wastewater, Solid Wastes Discharges and Waste Gas Emissions up to 2004

Year	Wastewater (billion tons)	Solid Wastes (million tons)	Waste Gas (billion cu.m)	SO2 (million tons)	Soot (million tons)	Dust (million tons)
1987	26.38	87.19				
1988	26.84	85.45				
1989	25.27	52.65				
1990	24.87	47.67				
1991	23.57	33.76	8473.4	11.65	8.45	5.79
1992	23.39	25.87	8963.3	13.23	8.70	5.76
1993	21.95	21.52	9342.3	12.92	8.80	6.17
1994	21.55	19.32	9746.3	13.41	8.07	5.83
1995	22.19	22.42	10747.8	14.05	8.38	6.39
1996	20.59	16.90	11119.6	13.64	7.58	5.62
1997	18.83	15.49	11337.5	13.63	6.85	5.48
1998	20.06	18.21	12120.3	15.93	11.75	13.22
1999	19.73	11.54	12680.7	14.60	9.53	11.75
2000	19.42	10.40	13814.5	16.15	9.53	10.92
2001	20.26	28.94	16086.3	15.66	8.52	9.91
2002	20.72	26.35	17525.7	15.62	8.04	9.41
2003	21.24	19.41	19890.6	17.92	8.46	10.21
2004	22.11	17.62	23769.6	18.91	8.86	9.05

Source: China Statistical Yearbook and China Environment Yearbook, various years.

Figure 2.3.4 Carbon Dioxide Emissions in China 1899-2004



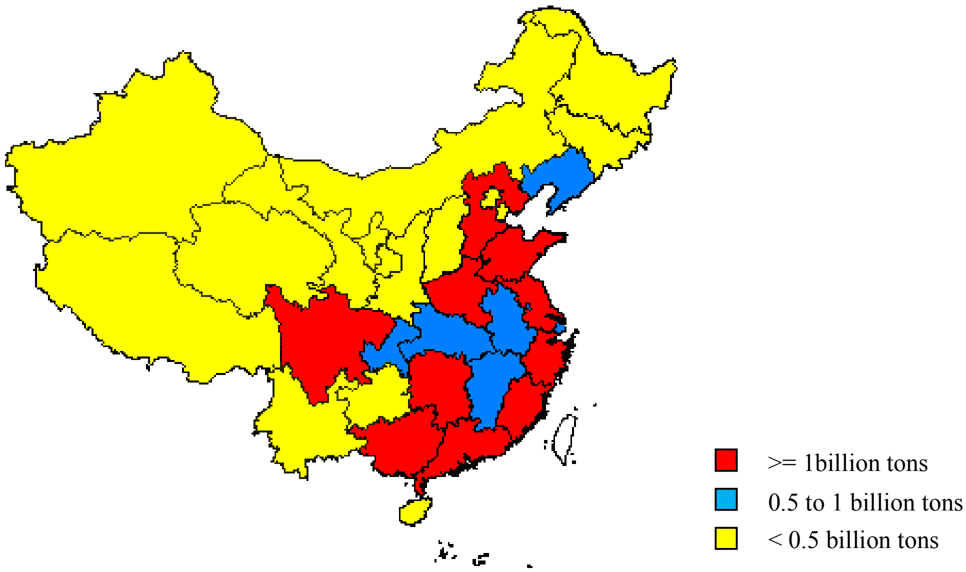
Source: Carbon Dioxide Information Analysis Centre, http://cdiac.esd.ornl.gov/trends/emis/prc.htm [Accessed 02/February/2008].

Table 2.3.8 Regional Comparison of Industrial Pollutions 2004 (proportions of total in brackets)

Region	Area (million km^2)	Wastewater (billion tons)	Waste Gas (trillion cu.m)	Solid Wastes (million tons)
Eastern Regions	1.07 (11.1%)	11.55 (52.2%)	11.79 (49.6%)	0.87 (4.9%)
Central Regions	1.68 (17.5%)	5.67 (25.6%)	6.00 (25.2%)	7.35 (41.7%)
Western Regions	6.73 (70.1%)	4.89 (22.1%)	5.98 (25.1%)	9.39 (53.3%)

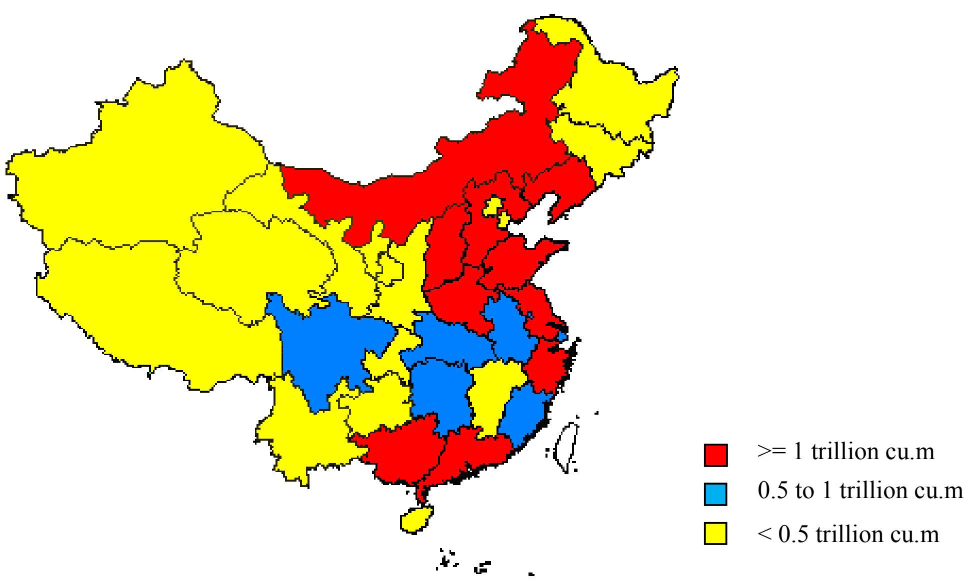
Source: China Environment Yearbook, 2004, and http://www.usacn.com/china/brief/population.htm [Accessed 23/March/2005].

Figure 2.3.5 Wastewater Discharges in Levels in 2004



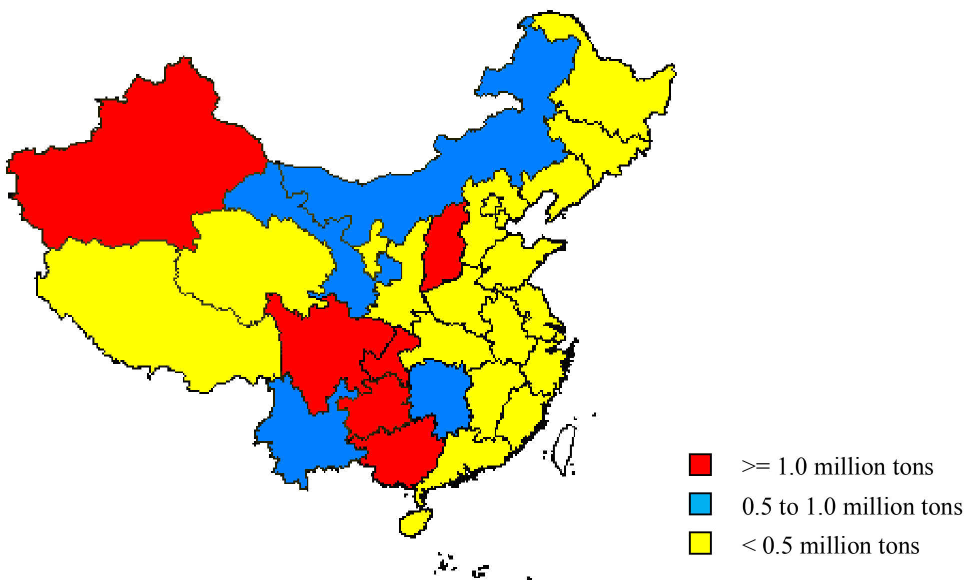
Source: China Environment Yearbook, 2005.

Figure 2.3.6 Waste Gas Emissions in Levels in 2004



Source: China Environment Yearbook, 2005.

Figure 2.3.7 Solid Wastes Disposals in Levels in 2004



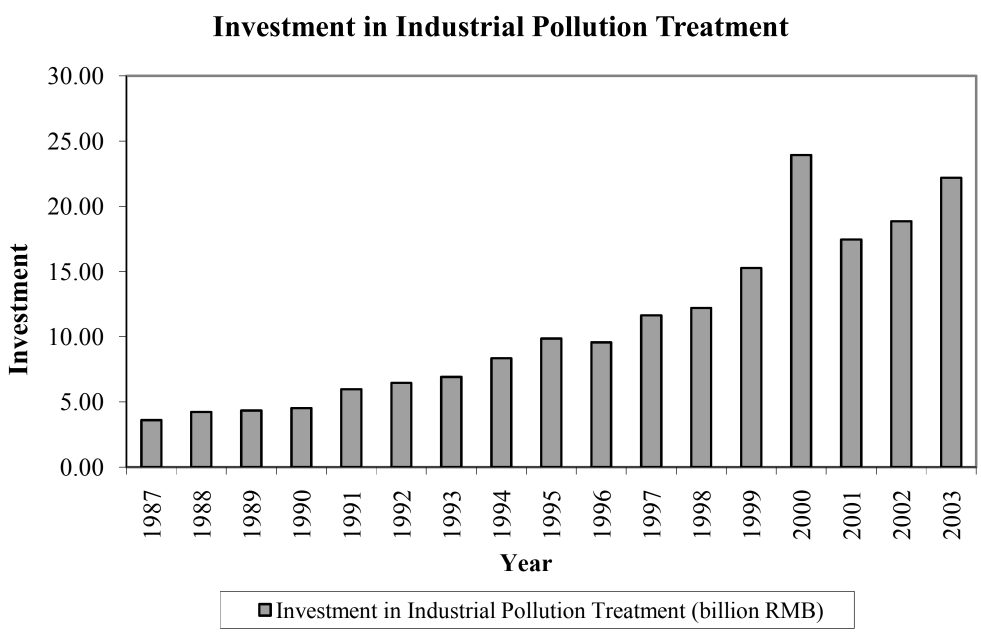
Source: China Environment Yearbook, 2005.

2.3.3 Environmental Investment

Facing such serious environmental problems, China's central and local governments, as well as some enterprises, have invested a great amount of money for environmental pollution treatment every year. In 2004 this investment amount increased to 190.98 billion RMB yuan (about $24.04 billion), which accounted for 1.40% of the country's GDP. Among this investment, 114.1 billion (59.8%) was used for city environmental infrastructural construction. Another 30.8 billion (16.1%) was provided for industrial pollution treatment. Figure 2.3.8 shows the rising trend of investments in industrial pollution treatment from 1987 to 2004. The investment in 2004 was more than eight times the 1987 value.

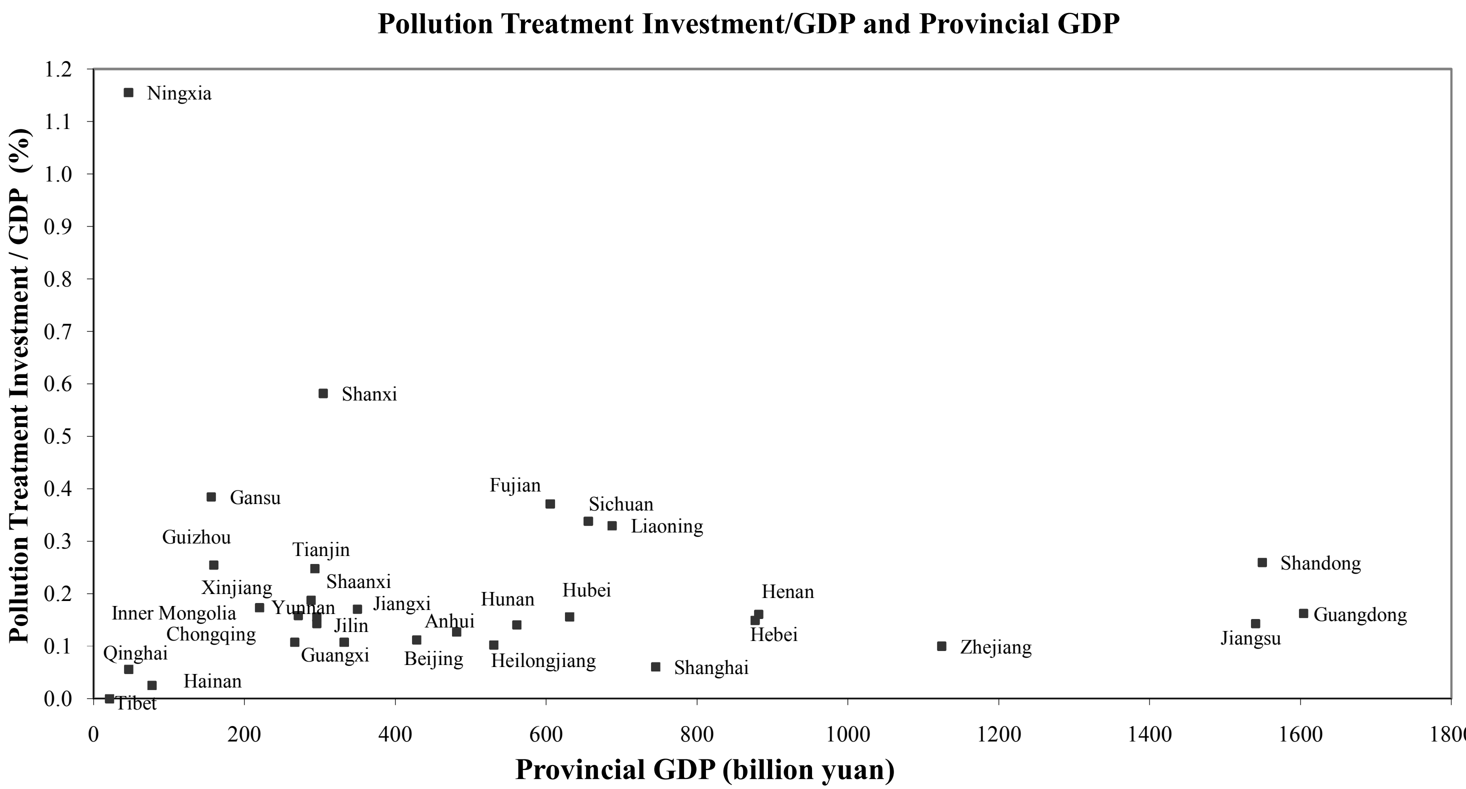
A disparity of investment in industrial pollution treatment also exists across provinces. Figure 2.3.9 shows that the provincial share of pollution treatment investment relative to GDP varies across province, an imbalance that is not consistent with GDP levels.

Figure 2.3.8 Investments in Industrial Pollution Treatment 1987-2004



Source: China Statistical Yearbook, various years.

Figure 2.3.9 Provincial Difference in Pollution Treatment Investment per unit of GDP and GDP in Levels 2004



Source: China Statistical Yearbook, 2005.

2.3.4 Environmental Regulations in China

2.3.4.1 Regulatory Framework

Environmental protection in China began to be the responsibility of the country in 1978 based on the *Constitution of the People's Republic of China*. China established the *Environment Protection Law* (EPL) in 1979 (provisional), and officially enacted it in September 1989. The EPL provides the basic principles governing the prevention of pollution and environmental protection and imposes criminal responsibility for serious environmental pollution. Based on EPL, China has had an established regulatory framework since 1979, with nine environmental protection laws, fifteen resource conservation laws and more than 50 pieces of environmental administrative regulation. Over 660 regulations have been issued by related ministries of central government and local governments. Environmental standards are another important component of this regulatory system. By the end of 2005, China has issued over 800 national environmental standards and more than 30 local environmental standards. All of these have formed a comprehensive and complex legal framework on environmental protection (China Environment Protection 1996-2005, SEPA).

The current environmental management system contains the following four important components:

- The environmental impact report system: every project that has possible negative effects on the environment should go through an environmental impact review process. It is only after the verification by national or local regulatory authorities, that the project can be legally established.

- Three synchronisations: Article 26 of EPL states that the pollution-preventing facility must be designed, constructed and operated simultaneously with the design, construction and operation of the main production line of the project. The environmental authorities are in charge of checking the project design in the review process and monitoring the construction. After inspection and approval of the environmental authorities, the project can start operation.
- The registration and licensing system for the discharge of pollutants (self-reporting system): Article 27 of EPL specifies that institutions and enterprises that emit pollutants must register and report to the environmental protection authorities. They should report six following categories: (1) basic economic information (sector, major products and raw materials); (2) production process diagrams; (3) volume of water use and wastewater discharge and pollutant concentrations in wastewater; (4) waste gas volume and air pollutant concentrations (before and after treatment); (5) noise pollution by source; and (6) discharge of solid wastes. It is an important tool in controlling pollution.
- Pollution levy system: any firm that discharges pollutants exceeding designated standards will be charged an excess effluent fee. Charges are levied for 29 water pollutants and 22 air pollutants, as well as solid wastes, radioactive wastes and noise. Among the pollutants, the major focus for monitoring and levy collection is on chemical oxygen demand and total suspended solids for water, and SO_2 and flue dust for air. Funds from the pollution levy have been used for pollution source control, damage remediation and development of environmental institutions. The lion's share of the levy has been used for pollution abatement. It should be noted that the charge paid for discharging does not legalise the pollution process. After paying the charge the enterprises should also face the costs of controlling and eliminating the pollution. To

encourage pollution reduction, levy charges increase with the duration of non-compliance. After two years of paying the levy, polluters are subject to an annual 5% increase in the charge rate. In the levy system, polluters have to report their emissions (including water and air pollutants, noise pollution, solid wastes, etc.) and the local environmental authorities check the reports and then decide the amount of levy to be collected. Penalties are imposed for false reporting and non-cooperation with the government. The levy design, verification and collection, and the development of levy system are fully described in Wang and Wheeler (2002).

2.3.4.2 Environmental Regulatory Framework towards Foreign Investment

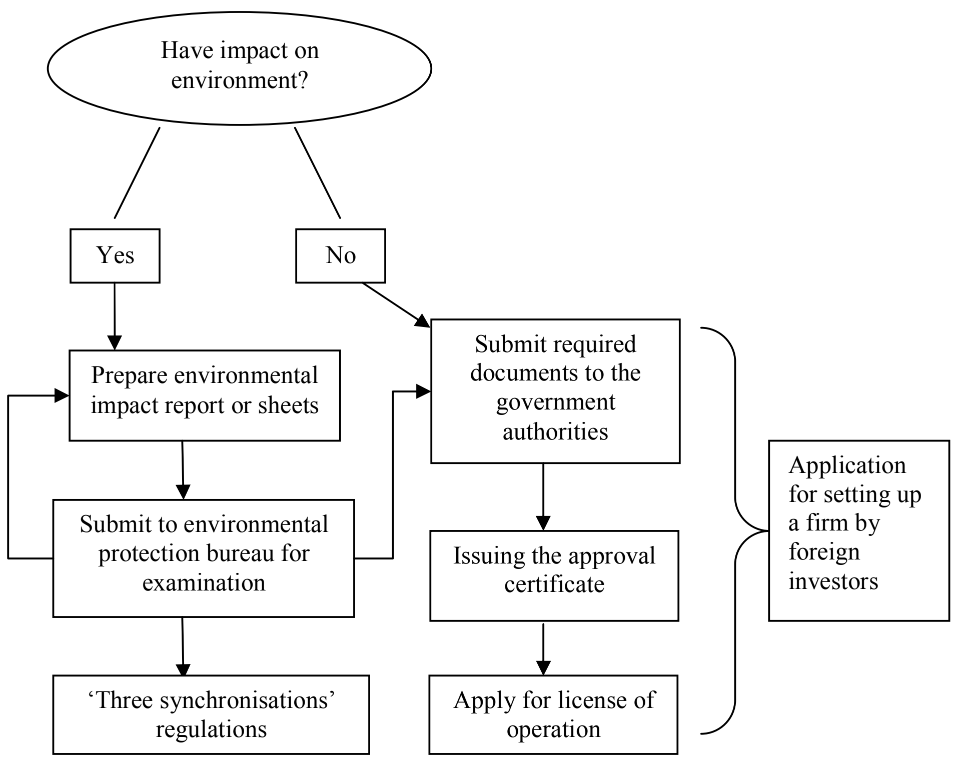
Generally, there are no separate environmental standards for foreign investment, but foreign investors' environmental behaviour must abide by Chinese environmental laws and regulations and meet the environmental standards. There are some specific policies and administrative procedures governing and monitoring of FDI with respect to environmental protection.

The *Provisions on Guiding Foreign Investment Direction* set out environmental protection requirements for foreign investment projects. It encourages investment in environmentally sound technologies and new technologies for controlling environmental pollution. It also limits the foreign investment in exploring rare and precious mineral resources and prohibits investment in those that pollute the environment, threaten human health or destroy natural resources.

Notice on Reinforcing Environmental Protection Management of Foreign Investment Projects, which was issued in 1992, states that foreign investors should abide by Chinese environment protection laws and regulations. They should prevent environmental pollution and ecological damage, and accept monitoring and supervision by environmental protection authorities. There are also other regulations such as Regulations of *Ocean Oil Exploring by Foreign Firms*, *Implementing Regulations on Joint Ventures*, *Project Construction and Operation in Part III of the Application Form for Establishing Foreign Invested Enterprises in China*, etc (Xian *et al.* 1999).

Xian *et al.* (1999) also provides the environmental aspect of approval procedures for FDI projects in China, shown by the following figure.

Figure 2.3.10 The Environmental Aspect of Approval Procedures for FDI Projects



Source: Xian et al., 1999.

2.3.4.3 Implementation of Environmental Regulations

Although the regulatory framework seems comprehensive, enforcement is weak. Ma (2007) points out that the limited power of environmental authorities is one reason for the failure to implement environmental law. SEPA has limited administrative power, and is not allowed to participate fully in national decision making. Local environmental authorities are subordinate to local government. They are reliant on the government for both funding and enforcement, making them hard act freely for local interest and protect the environment. Current legislation only allows the environmental authorities to make suggestions and issue fines. For example, local environmental authorities do not have the power to force a company to make changes within a certain time limit. In addition, the fines are usually small, thus it may cost more to obey the law than to break it.

Environmental policy is set by the government, overseen by the environmental authorities and implemented by various government departments. Such a principle is reasonable but the coordination between the environmental authorities and other departments is poor, mainly because the huge amount of overlap among departments. For example, water pollution is the responsibility of the environmental authorities, but water and groundwater are managed by the Ministry of Water Resource, sewage is dealt with by the Ministry of Construction, which also has the functions of directing the utilise and protection of groundwater in city. This problem has been solved in other countries, through greater departmental communication, but is failing in China due to the lack of legislative clarity of role, power and responsibilities of each department. Additionally, the public lacks awareness of environmental protection and participation in social supervision also to the detriment of enforcing the environmental regulations.

Furthermore, the environmental regulatory stringency varies among regions. The environmental standards are set jointly by local and national regulators. The levy rates are formally established by a national regulator but the actual levies are decided and collected by local regulators. Some local regulators protect the pollution companies for economic interests. Excessive pollution happens in some regions due to the failure of local government. The situation continues because of the lack of awareness of some local government officials about the environment, environmental laws and the rule of laws in general. Therefore, the local levies may vary for identical industries and pollutants. In addition, the discretion of local regulators' inspections varies as well. Some regions have better environmental management systems than others. As a result, regulatory strength varies across regions.

The weak environmental regulatory stringency in China provides an opportunity for some multinational firms to take advantage of weak environmental standards to transfer their out-of-date technologies and pollution-intensive production to China. Xian *et al.* (1999) find that about 30 per cent of the FDI in China was in pollution-intensive industries, of which 13 per cent was from highly-pollution-intensive industries. The recent report from Institute of Public and Environmental Affairs (IPE) in January 2008 also shows that over 300 MNCs have violated environmental regulations in China and only 8 of them passed the examination after controlling the pollution. The majority of these MNCs are from US, Japan and European countries. None of their subsidiaries are polluting firms in their home countries due to the strict environmental standards. The report also shows that a considerable number of these foreign polluting subsidiaries (about one third) are located in Shanghai, which have attracted over 15% of the national cumulative FDI inflows since 1979 (see Figure 2.3.3) and have relatively low environmental investment (see Figure 2.3.9).

It suggests that polluting firms would like to locate in the regions that have paid relatively less attention to the environment protection.

In sum, economic development, FDI inflows, levels of environmental deteriorations, and environmental regulations differ across regions in China. Correlations between these variables are useful if we wish to model the determinants of inter-province foreign plant location choice.

2.4. Methodology

We follow the methodology of previous studies on inter-state plant location choice and investigate the interaction between FDI flows and environmental regulations in China. This section firstly introduces the empirical models. It explains how we construct the explained and explanatory variables and how these variables capture provincial characteristics. Finally, a description of the data used in the empirical estimation is provided and some discussion of the selection of the estimators.

2.4.1 Estimating Models

Esty and Gentry (1997) and Aliyu (2005) outline four types of FDI – market seeking, production platform seeking, resource seeking and low cost seeking. A MNC will view and compare different locations to assess differences in, for example, production costs, market size, government regulations, infrastructure, agglomeration effects and so on. To examine whether FDI is attracted to provinces with relatively weaker environmental enforcement, we observe the location of FDI across 30 administrative areas (for simplicity we refer to these as regions/provinces).[19]

An empirical model that is adopted by some FDI researchers is given by

$$FDI = f(X, \eta, \gamma) \tag{2.4.1}$$

where X is a vector of regional characteristics that may affect the inflows of FDI; η is the unobserved provincial/regional effect; and γ is the unobserved time effect.

When considering the impact of environmental regulations on foreign plant location choice, a variable ***ER*** (the vector of level of environmental stringency) is included in the Equation 2.4.1 to give:

$$FDI = f(ER, X, \eta, \gamma) \tag{2.4.2}$$

where

FDI is the amount of FDI inflow into region i in time period t;

ER is the vector of measures to capture environmental stringency in region i in time period t;

X is the set of other regional characteristics that may affect FDI in region i in time period t;

η is time-invariant regional effects in region i;

γ is location-invariant time effects in time period t; and

ε is the idiosyncratic error term.

[19] Tibet is not included in our estimating sample due to the lack of data on FDI inflows.

FDI inflows are captured by the actually used value of FDI according to the agreements and contracts. It measures total amount of new foreign direct investment of the year, including the investment from Hong Kong, Taiwan and Macao, and the investment from foreign countries. The data are aggregated comprising of the investment in all the sectors in the economy. FDI inflows cannot be broken down by source country or by industrial sector as a result of the data unavailability.

Since the regions vary in size, we normalise the actually used FDI inflows by two measures of regional size, one of which is the value of FDI divided by regional GDP (*FDI/GDP*) and the other is FDI divided by regional population (*FDI/POP*). Scaling FDI by GDP or population does not affect the absolute value of FDI but allows FDI to be comparable across regions and time (see Appendix 2.1 for variable definitions and sources).

Factors that may influence provincial level FDI include environmental stringency, factor prices, infrastructure, and agglomeration effects.

The level of environmental stringency in different provinces is proxied by three variables:

- *EI1* – the share of investment in industrial pollution treatment projects in total innovation investment. Industrial pollution treatment investment is the total investment of enterprises in construction and installation projects, and purchasing of equipment and instruments required in the pollution harnessing projects for the treatments of wastewater, waste gas, solid wastes, noise pollution and other pollution. Industrial pollution treatment investment is accounted in innovation investment, which is one part of the total investment of fixed assets. Environmental regulations require that the pollution treatment facilities have to be designed, constructed and operated simultaneously with the design, construction and operation of the main production line of the projects. A region with more stringent environmental regulations is expected to have relatively more investment in pollution treatment projects. Therefore, investment pollution treatment project could be treated as environmental protection costs for any production project. We use the share of industrial pollution treatment investment in innovation investment to reflect the local government effort on environmental protection. Since a small fraction of the sources of industrial pollution treatment investment comes from state budgetary appropriations on capital construction investment, in our sensitivity analysis we separately normalise industrial pollution treatment investment by the sum of investment in innovation and capital construction (*EI2*) and by total investment in fixed assets (*EI3*). Details are in Appendix 2.2.

- *Punish* – the total number of administrative punishment cases filed by the environmental authorities in each region normalised by the number of enterprises in each region.[20] Administrative punishment cases are those cases that breach environmental protection laws and regulations. According to the Measures on Administrative Penalty for Environmental Offences, the types of administrative punishment includes: 1) warning; 2) fine; 3) confiscation of illegal gains; 4) compelling to stop producing or using; 5) revoking licence/permit or other permission certificates; and 6) other types of administrative punishments from Environmental Protection Law, laws and regulations. If the environmental illegal activity offends the criminal law and is suspected of a crime, the case should be transferred to judicial authority to investigate the criminal responsibility according to law. We normalise the number of cases by the number of enterprises. It is possible that the normalised punishment cases could capture the levels of firms violating the environmental regulations. However, given the

[20] The enterprises are all state-owned and non-state-owned enterprises above a designated size, which refers to enterprises with an annual sales income of over 5 million RMB yuan (about 0.60 million USD).

general weak environmental regulation stringency in China, we expect that the more enterprises are punished the more stringent of the environmental regulations exist in a region. *Punish* measures the prosecution cost of firms if they breach the laws and regulations and hence proxies the strength of enforcement of regional environmental legislation.

- *Charge* – a pollution emission charge normalised by the number of organisations that paid this charge. Pollution emission charge refers to the total amount of 1) pollutant emission charge exceeding the discharge standards; 2) sewage discharge levy; and 3) other four kinds of charges, including increasing levy standards, double charges, overdue charges and compensation fines. Pollutants include water and air pollution, solid wastes, noise and others. Although supervised by central government, the pollution charge is implemented by regional governments. *Charge* measures the penalty costs of firms if they emit pollutants more than the emission standards. Therefore it reflects the provincial differences in implementation of the pollution levy system.

These three measures are time varying, which improves upon the 0-3 type of measure of environmental stringency used in Smarzynska-Javorcik and Wei (2005). Since more stringent environmental regulations will generate higher pollution taxes or higher pollution abatement costs for the firm, the environmental regulation stringency variables should have a similar impact to factor prices on foreign investment location choice. It is expected that FDI is attracted to provinces with weaker regulations, i.e. with a lower share of investment in industrial pollution treatment investment, with a lower number of normalised administrative punishment cases related to environmental issues, and/or with a lower normalised pollution emission charge.

Since the pollution emission charge is more visible to enterprises than administrative punishment cases and environmental investment, we expect that *Charge* has the strongest impact on FDI location choice, followed by *Punish* and *EI1*, respectively.

Our control variables are as follows:

Manufacturing wage is included as a proxy for factor price differences across each region. The quality of labour force in a region is captured by two measures, labour productivity and the illiteracy rate. Population density is employed as a proxy for land prices and potential market size (assuming that labour mobility between provinces is low). The availability and quality of infrastructure also impacts the overall cost on doing business and hence is an attractive factor to FDI location. We include both railway density and road density to measure the quality of regional transportation network and thus to proxy the cost and availability of material inputs. Gross regional product (*GRP*) per capita is included to capture the average quality of the government, general infrastructure and the effect of market size differences across regions. We use regional gross industrial product (GIP) to capture the industrial agglomeration effect whereby firms locate where hubs of economic activity already exist (Bartik, 1988). GIP measures the concentration of the whole industrial sectors and also the regional availability of providing intermediate inputs.[21]

The regional fixed effects capture the effects specified to each region which do not change over time (including the unobserved preferential policies such as tax benefits and subsidies to foreign firms and exports). The year specific effects measure any effects that are common to all provinces but which change over time.

[21] Gross industrial product is the total volume of final industrial products produced and industrial services provided during a given period. It measures the total achievement and overall scale of industrial production during a given period. Industrial enterprise is used as the basic accounting unit. Double counting does not exist within the same enterprise, but may exist between enterprises.

Following the literature, foreign investors are seeking a location with comparative advantages such as cheaper factors that they use in higher proportions. It is expected, that foreign investment will be attracted to provinces with relatively low labour costs, i.e. low manufacturing wages. However, wage has positive relationship with local income levels. Some recent empirical studies on intra-country FDI flows, such as Wei *et al.* (1999), Coughlin and Segev (2000), Cheng and Kwan (2000) and Fung *et al.* (2003), find significantly negative effects of wage on aggregate FDI flows in China. Conversely, wage is also found to be positive related with FDI flows (Gao, 2002). To specify the real impact of wage on FDI inflows, we add wage squared in our estimations and expect an inverted-U relationship between FDI and wage. When wage is below some benchmark, foreign investment are attracted to provinces with high wage level because labour cost is not the most important determinants compared with other factors, such as high regional income and good infrastructure. But when wage is beyond the benchmark, FDI is deterred by wage because it becomes more important in the standard profit function.

Since low labour cost is associated with low labour quality, foreign investment will be attracted by high illiteracy rate and/or low labour quality. However, some previous studies, such as Cheng and Kwan (2000), Gao (2002), and Fung *et al.* (2002), find that FDI prefers to locate into the regions that have high percentage of high education enrolment. Therefore, the impacts of illiteracy rate and productivity are ambiguous.

According to the previous work of Head and Ries (1996) and Dean *et al.* (2005), it is expected that FDI would flow into provinces with better industrial agglomeration and infrastructure. Therefore we expect a positive coefficient on *GIP* and transportation infrastructure variables. In addition, for foreign investors seeking a large local market they may be expected to invest in areas that have large consumption capability and potential which can be proxied by population density and per capita income. However, population density also proxies land price. In more densely populated areas, land price is usually higher than that in less densely populated areas. The sign of population density is therefore expected to be ambiguous.

Our five-year time period panel data help to control for unobserved heterogeneity. We presume that all the control variables are exogenous. However, environmental regulation stringency may be endogenous partly because the regions with relatively low FDI inflows may lower their environmental regulation standards in order to attract more FDI, and partly because FDI is an important engine of growth and hence helps to improve regional environment and environmental standards. Simultaneously, FDI could have an impact on other control variables, such as income, wage, population density and infrastructure quality. We therefore employ a one-year lag for all independent variables to minimise any possible causality links from FDI to the explanatory variables. Another reason to lag the independent variables is that the impact of these variables on FDI is unlikely to be immediate.

The estimating equation is therefore:

$$\begin{aligned}\ln(FDI_{it}) = \alpha &+ \beta_1 \ln(ER_{it-1}) + \beta_2 \ln(GRP\ \ per\ Capita_{it-1}) + \beta_3 \ln(Wage_{it-1}) \\ &+ \beta_4 (\ln(Wage_{it-1}))^2 + \beta_5 \ln(GIP_{it-1}) + \beta_6 \ln(Pop.\ Density_{it-1}) \\ &+ \beta_7 \ln(Rail\ Density_{it-1}) + \beta_8 \ln(Road\ Density_{it-1}) + \beta_9 \ln(Illiterate\ Rate_{it-1}) \\ &+ \beta_{10} \ln(Productivity_{it-1}) + \eta_i + \gamma_t + \varepsilon_{it}\end{aligned} \qquad (2.4.3)$$

where *i* refers to province *t* refers to year.

We firstly regress the model only including the major explanatory variable *ER*, and then add the control variables one by one in accordance with the selection of control variables in previous studies on China's intra-country FDI location choice. Regional GDP per capita and wage rate are commonly used determinants of FDI and hence we introduce them into the model as control variables in the first place. GIP and population density are usually omitted in some studies. We thus add them in the next place in order to check if they have significant and stable impacts on FDI. Infrastructure variables and labour quality variables are also controlled in some previous studies and the selection usually depends on the emphasis of the papers. We therefore subsequently include these variables in the regressions. In addition, adding the independent variables incrementally is helpful to find whether *ERs* have stable and significant effects on FDI inflows.

We use the log transformation model which could help to correct the positive skewness of variables and make the error term close to homoskedestic (see Appendix 2.3 for the level model and results).[22]

If there is no effect of the stringency of environmental regulations on FDI across regions, we would expect $\beta_1=0$. If $\beta_1 < 0$, we cannot reject the hypothesis that FDI is attracted to provinces with lower regulatory stringency.

The expected signs of the coefficients are as follows:

Coefficients	β_1	β_2	β_3	β_4	β_5	β_6	β_7	β_8	β_9	β_{10}
Expected Signs	-	+	+	-	+	-/+	+	+	-/+	-/+

[22] After taking logs, the positive skewness of all the variables is significantly reduced.

2.4.2 Data Description

A complete description of all variables definitions and sources is provided in Appendix 2.1. The China Statistical Yearbook (various years) was used to compile data on the manufacturing wage, illiteracy rate, infrastructure, agglomeration, market size and population data. The China Industrial Economy Statistical Yearbooks provide the labour productivity for all foreign funded enterprises. The raw data for the three environmental regulation standard variables are collected from China Environment Yearbook. Because one year lags are used for all independent variables in the estimation, all the independent variables of 30 regions are from 1998 to 2002. FDI data used for estimations are therefore from 1999 to 2003.

To gauge the consistency of the sample with what is known about the provincial distribution of foreign investment, Table 2.4.1 compares the provincial shares of total actually used FDI value in the sample. It illustrates, consistent with Figure 2.3.3, that most FDI inflows were located in eastern regions/provinces: Guangdong; Jiangsu; Shanghai; Fujian; Shandong; Liaoning; Zhejiang; and Beijing.

Table 2.4.2 shows the summary data for the provincial characteristics in 2002.[23] The maximum value of *EI1* is found in Ningxia with 910 RMB yuan per 10 000 RMB yuan innovation investment, while the lowest investment share is only 31.65 RMB yuan in Shanghai. For *Punish* the most stringent province is Heilongjiang with 5877 cases per 1000 enterprises, and the weakest province is Qinghai with 75. In terms of *Charge*, Shanghai becomes the most stringent province, where the charge is more than 32,793 RMB yuan per organisation, and Hainan is the lowest with a charge 2,775 RMB yuan per organisation. We

[23] Because all independent variable are one year lagged, the value of the two dependent variables, FDI_1 and FDI_2 are the values for 2003.

find that the values of our three environmental stringency variables vary widely across province, and a province could appear to be stringent using one measure of environmental regulations but not using the others. The correlation matrix (See Table 2.4.3) shows that these three environmental stringency variables do not have a strong correlation and we even find insignificant negative correlation between *Punish* and *Charge*.

The correlation matrix also shows that our FDI variables seem to have a negative correlation with *EI* and *Punish*, but a positive correlation with *Charge*. The correlations between the two FDI variables and other independent variables implies that FDI prefers to flow into provinces with better infrastructure, higher population density, higher income level, better agglomeration, higher quality of labour and higher labour costs.

The correlation matrix shows that per capita income is highly correlated with wage, population density and infrastructure variables, probably because per capita income could capture the similar things. Then the effect of income on FDI probably will be accompanied by strong side effects via these variables on FDI. Due to the importance of these variables and the availability of data, we cannot drop any of these variables or enlarge the sample size to remedy to this multicollinearity problem. However, mutlcollinearity does not actually bias the results but just produces large standard errors for income variable, i.e. may cause income becoming insignificant. And we estimate the model using generalised least square estimator, which will produce better results than ordinary least square estimator (see section 2.4.3).

The values of all the data are deflated by the GDP deflator, which is set to 100 for the year 1990.[24] All the FDI data, which are measured in US dollars, are converted to RMB yuan at the middle exchange rate of the year. Table 2.4.4 provides the descriptive statistics for each of our variables.

Table 2.4.1 FDI Distribution by Province, 1997-2003

Province	**FDI at 1990 Constant Price (USD 10 000)**	**FDI at 1990 Constant Price (RMB 10 000)**	**Shares of National FDI (%)**
Beijing	10611	58152	**4.07**
Tianjin	10425	56729	**3.97**
Hebei	5433	29560	2.07
Shanxi	1453	7937	0.56
Inner Mongolia	569	3139	0.22
Liaoning	13082	71982	**5.04**
Jilin	1814	9862	0.69
Heilongjiang	2370	12819	0.90
Shanghai	22473	123330	**8.63**
Jiangsu	41995	231648	**16.21**
Zhejiang	12695	70472	**4.93**
Anhui	1926	10536	0.74
Fujian	21328	116404	**8.15**
Jiangxi	3643	20225	1.42
Shandong	19362	107168	**7.50**
Henan	3089	16822	1.18
Hubei	6275	34616	2.42
Hunan	4687	25673	1.80
Guangdong	63197	345308	**24.17**
Guangxi	3397	18377	1.29
Hainan	3047	16568	1.16
Chongqing	1644	8921	0.62
Sichuan	2374	13100	0.92
Guizhou	222	1208	0.08
Yunnan	698	3789	0.27
Tibet	0	0	0.00
Shaanxi	2036	11064	0.77
Gansu	277	1523	0.11
Qinghai	91	514	0.04
Ningxia	122	671	0.05
Xinjiang	117	640	0.04
Sum	**260450**	**1428755**	**100**

[24] An alternative measure of inflation is consumer price index. However, GDP deflator is a better measure of overall inflation than the consumer price index because it is based on a broader market basket including every item in the GDP.

Table 2.4.2 Provincial Characteristics in 2002 (All values are at 1990 constant price)

Province	FDI/GDP* (yuan /10000 yuan)	FDI/POP (yuan)	EI1 (yuan/ 10000 yuan)	Punish (case/1000 firms)	Charge (yuan/ organisation)	GRP per capita (yuan)
Beijing	495	657	315	229	18916	15312
Tianjin	519	663	611	256	8907	12045
Hebei	112	62	262	433	7266	4906
Shanxi	72	28	418	822	9010	3308
In. Mongolia	34	16	197	1165	4327	3897
Liaoning	389	293	280	4451	11147	6989
Jilin	63	31	305	524	5662	4485
Heilongjiang	60	37	703	5877	6836	5481
Shanghai	724	1395	32	176	32794	21876
Jiangsu	702	623	166	264	13918	7745
Zhejiang	439	465	294	268	3839	9062
Anhui	77	25	191	412	5395	3131
Fujian	411	325	326	267	7084	7264
Jiangxi	471	165	72	460	4041	3137
Shandong	400	288	484	267	14681	6267
Henan	63	24	313	512	9241	3464
Hubei	240	114	222	456	6090	4477
Hunan	182	67	202	660	6195	3533
Guangdong	475	429	210	195	5947	8089
Guangxi	127	38	151	411	6619	2744
Hainan	520	227	78	133	2775	4200
Chongqing	96	36	142	832	11117	3416
Sichuan	63	21	264	255	4628	3103
Guizhou	28	5	157	156	5269	1697
Yunnan	28	8	309	113	7200	2787
Shaanxi	115	39	226	955	5470	2973
Gansu	15	4	373	225	6630	2418
Qinghai	54	21	110	75	3827	3459
Ningxia	37	13	910	1389	9864	3124
Xinjiang	7	3	147	243	4455	4511

Table 2.4.2 continued

Province	Manu. Wage (yuan)	GIP (100 million yuan)	Pop. Density (persons per km^2)	Rail Density (km/10 000km^2)	Road Density (km/10 000km^2)	Illiterate Rate (%)	Productivity (yuan/ person)
Beijing	9497	1708	847	677	8547	5.4	66663
Tianjin	7663	1789	891	603	8581	6.7	61220
Hebei	4736	2311	354	241	3320	7.8	42067
Shanxi	4260	925	211	196	3821	6.4	47136
In. Mongolia	4388	535	22	56	661	13.5	51482
Liaoning	5657	2631	288	261	3298	5.2	44956
Jilin	5487	1169	144	190	2198	4.4	113101
Heilongjiang	4735	1339	81	117	1344	6.5	46886
Shanghai	11885	4166	2621	414	10139	8.2	66363
Jiangsu	6200	7463	719	131	5862	14.3	53099
Zhejiang	7157	5263	456	128	4484	13.5	32884
Anhui	4497	1143	456	160	4860	17.9	60328
Fujian	6133	1979	289	121	4513	13.7	37445
Jiangxi	4475	640	253	142	3643	10.8	26283
Shandong	4716	6188	594	187	4839	11.2	35999
Henan	4218	2316	576	215	4296	9.1	43656
Hubei	4793	1932	320	127	4594	15.1	63844
Hunan	5337	1130	316	131	4038	8.4	41774
Guangdong	7912	8815	423	113	5835	7.0	35459
Guangxi	5360	635	210	119	2448	9.5	47779
Hainan	5053	142	236	63	6140	8.9	42054
Chongqing	5497	661	379	88	3788	10.3	59041
Sichuan	5303	1473	178	60	2293	13.6	49243
Guizhou	5019	429	226	111	2601	18.7	9276
Yunnan	6343	711	110	60	4184	23.1	55359
Shaanxi	5058	810	179	141	2271	15.6	99224
Gansu	5427	557	58	52	894	21.1	39205
Qinghai	5821	112	7	15	333	24.8	81609
Ningxia	5142	145	87	119	1704	17.5	38201
Xinjiang	5590	494	12	17	518	8.2	34454

Table 2.4.3 Correlations of the Variables

	FDI/GDP	FDI/POP	EI1	Punish	Charge	GRP per capita	Wage	$(Wage)^2$	GIP	Pop. Density	Rail Density	Road Density	Illiterate Rate	Productivity
FDI/GDP	1.000													
FDI/POP	0.859	1.000												
EI1	-0.095	-0.120	1.000											
Punish	-0.108	-0.113	0.154	1.000										
Charge	0.294	0.601	0.060	-0.014	1.000									
GRP per capita	0.617	0.904	-0.084	-0.029	0.700	1.000								
Wage	0.511	0.781	-0.108	-0.062	0.568	0.862	1.000							
$(Wage)^2$	0.475	0.791	-0.134	-0.108	-0.162	-0.083	0.654	1.000						
GIP	0.544	0.553	0.019	-0.027	0.409	0.488	0.433	0.409	1.000					
Pop. Density	0.502	0.807	-0.143	-0.157	0.801	0.865	0.674	0.742	0.429	1.000				
Rail Density	0.393	0.616	-0.010	0.007	0.465	0.723	0.555	0.571	0.120	0.606	1.000			
Road Density	0.697	0.798	-0.098	-0.173	0.538	0.771	0.695	0.701	0.456	0.729	0.723	1.000		
Illiterate Rate	-0.321	-0.353	0.004	-0.229	-0.150	-0.421	-0.345	-0.322	-0.266	-0.279	-0.451	-0.430	1.000	
Productivity	0.007	0.148	-0.114	0.054	0.114	0.253	0.359	0.334	-0.002	0.181	0.251	0.159	-0.147	1.000

Table 2.4.4 Descriptive Statistics of the Variables

Variable	Obs.	Mean	Std. Dev.	Min	Medium	Max
FDI/GDP (FDI in RMB yuan per 10 000 RMB yuan GDP)	149	265.80	271.11	6.76	140.66	1140.13
FDI/POP (FDI in RMB yuan per capita)	149	188.62	276.04	3.19	42.89	1395.25
EI1 (yuan per 10 000 RMB yuan innovation investment)	150	342.20	216.12	31.65	289.32	1163.74
EI2 (yuan per 10 000 RMB yuan Inno.Inv.+ Capital Construction Inv.)	150	92.63	57.22	6.19	80.43	285.53
EI3 (yuan per 10 000 RMB yuan total investment in fixed assets)	150	55.04	35.78	4.46	44.71	185.08
Punish (Cases per 1000 enterprises)	148	452.34	701.53	29.18	267.30	5877.36
Charge (RMB yuan per organisation)	150	4319.00	2363.26	1467.24	3679.30	17649.92
GRP per capita (RMB yuan)	150	4765.65	3591.10	1255.09	3376.21	21876.21
Wage (RMB yuan at 1990 price)	150	4720.76	1549.53	2614.68	4399.02	11885.36
GIP (100 million RMB yuan at 1990 price)	150	1556.23	1713.53	79.41	912.00	8815.18
Pop. Density (persons per km^2)	150	376.11	460.55	6.99	251.56	2700.00
Rail Density (km/ 10 000 km^2)	150	151.39	145.08	8.38	109.65	690.83
Road Density (km/ 10 000 km^2)	150	3341.10	2110.37	204.76	3053.05	10138.71
Illiterate Rate (%)	150	13.13	6.46	4.36	12.11	42.92
Productivity (RMB yuan/person at 1990 price)	150	41039.37	18996.94	9276.10	35999.46	156645.80

2.4.3 Selection of Estimators

A problem faced when estimating the model is whether the unobserved individual-specific effects and time effects (η_i and γ_t) should be treated as random variables or as parameters to be estimated for each cross region observation *i* and time *t*. In this chapter we estimate both two-way fixed effects and random effects error component models. For our fixed effects models we initially use the within regression estimator which is a pooled OLS estimator based on time-demeaned variables, or uses the time variation in both dependent and independent variables within each cross-sectional observation (Wooldridge, 2000). For our random effects models we choose the generalised least square (GLS) estimator, which produces a matrix-weighted average of the between and within estimator results.[25]

Few assumptions are required to justify the fixed effects estimator. In the estimation, however, η_i and γ_t are not assumed to have a distribution, but are treated as fixed and estimable. The random effects estimator requires no correlation assumptions, that is η_i ~IID $(0, \sigma_\eta^2)$, γ_t ~IID $(0, \sigma_\gamma^2)$, and ε_{it} ~IID $(0, \sigma_\varepsilon^2)$ are independent of each other. In addition, all the independent variables (***ER*** and ***X*** in equation 2.4.2) are independent of η_i, γ_t, and ε_{it} for all *i* and *t*.

In order to calculate whether ε_{it} are uncorrelated with the independent variables, we use the Hausman specification test under the null hypothesis H_0: $E(\varepsilon_{it} | X_{it}) = 0$.[26] We compare the covariance matrix of the regressors in the fixed effects model with those in

---

[25] The between estimator is obtained by using OLS to estimate the models which use the time-averages for both dependent and independent variables and then runs a cross sectional regression (Wooldridge, 2000, Chapter 14, pp.442). GLS estimators produce more efficient results than between estimators because they use both the within and between information.

[26] Here X_{it} proxies all the independent variables in the estimated model. Since we take one-year lag for all independent variables, the hypothesis is to test whether $E(\varepsilon_{it} | X_{it-1}) = 0$.

the random effects model in order to find out whether the random effects specification is powerful and parsimonious. The Hausman specification test results are reported in Appendix 2.4. The results of Hausman specification tests suggest that, in most cases, the individual effects and time effects could be adequately modelled by random effects models.

When using data on different provinces that have variation of scale, the variance for each of the panels will differ. The Breusch-Pagan test results reject the null hypothesis of homoskedasticity in our models. Both of the fixed effects and random effects estimators can solve the problem of heteroskedasticity across panels. However, neither controls for possible autocorrelation within the panels. In order to test whether or not the errors follow an autoregressive process of order one AR(1), we apply the following dynamic regression model:

$$\varepsilon_{it} = \rho\varepsilon_{it-1} + \nu_{it}, t = 2,\ldots,T. \quad (2.4.4)$$

where $|\rho| < 1$ and $\nu_{it} \sim$ IID(0, σ_{ν}^{2}).

The null hypothesis is H_0: $\rho = 0$. Thus, ρ should be estimated from the regression of ε_{it} on ε_{it-1}, for all t = 2,…,T. The t statistics (see Table 2.4.5) for $\hat{\rho}$ show that we reject the null hypothesis for all log models. That is, there is AR(1) autocorrelation within panels in our log specifications.

One solution of AR(1) autocorrelation is to include the lagged dependent variables in the right-hand-side of Equation 2.4.3 and construct a dynamic model. In that case, an alternative estimation method is system Generalised Method of Moment (GMM) estimator by Blundell and Bond (1998) for AR(1) panel data models. System GMM estimator can tackle the problems of heteroskedasticity and autocorrelation as well as the endogeneity of variables. However, GMM estimator requires two or more lags of all the right-hand-side variables as instruments. Due to our relative short panel we cannot use GMM estimator.

Another solution is to use the feasible generalised least square (FGLS) estimator. In this study, we have a large number of panels (30 provinces) relative to time period (5 years). The FGLS estimator is appropriate for such a case.[27] FGLS models allow cross-sectional correlation and heteroskedasticity. It also allows models with heteroskedasticity and no cross-sectional correlation. In addition, it is possible to relax the assumption of autocorrelation within panels. FGLS is therefore more efficient than the other two estimators mentioned above.

Table 2.4.5 Autocorrelation Tests

	EI1		**Levels** ***Punish***		***Charge***	
	FDI/GDP	FDI/POP	FDI/GDP	FDI/POP	FDI/GDP	FDI/POP
$\hat{\rho}$	0.064	-0.136	0.076	-0.129	0.067	-0.142
t Statistics	0.67	-1.38	0.79	-1.30	0.70	-1.44
p-value	0.504	0.169	0.430	0.197	0.488	0.153
	EI1		**Logs** ***Punish***		***Charge***	
	FDI/GDP	FDI/POP	FDI/GDP	FDI/POP	FDI/GDP	FDI/POP
$\hat{\rho}$	**0.258**	**0.254**	**0.265**	**0.260**	**0.220**	**0.218**
t Statistics	**2.92**	**2.86**	**2.97**	**2.91**	**2.54**	**2.50**
p-value	**0.004**	**0.005**	**0.004**	**0.004**	**0.012**	**0.014**

Since the GLS estimator is less efficient than the FGLS estimator, the random effects results (in Appendix 2.4) are relatively weak even though GLS estimator is not rejected in

[27] David Greenberg, who is an expert in Stata in New York University, states on the Stata Listserver that FGLS is feasible when the number of panels is larger than time period. Clive Nicholas from Newcastle University agrees Greenberg's point of view and specifies that FGLS is efficient when the degree of freedom is larger than 25, which is the case in our model (see Greenberg, 26/January/2004; and Nicholas, 10/August/2004).

most specifications by Hausman specification tests. We therefore concentrate on the FGLS estimation results in the main text. Estimations are run using STATA 9.[28]

2.5 Empirical Results

In this section we only report the FGLS log results because of the advantages outlined above. We also include a series of sensitivity checks. For example, we normalise industrial pollution treatment investment by the sum of investment in innovation and capital construction (*EI2*), and by the total investment in fixed assets (*EI3*). The results are provided in Appendix 2.2. All levels estimations can be found in the Appendix 2.3. The random effects specification is not always efficient and hence are provided in Appendix 5. In this section, we also compare our main results with those in the Appendices as well as those of previous empirical studies.

2.5.1 FGLS Regression Results with Log Specification

Tables 2.5.1- 2.5.6 respectively present the FGLS regression results for the impact of different levels of environmental stringency on two measures of provincial level FDI inflows using data in logs for thirty provinces in China. Tables 2.5.1 and 2.5.2 are the results for *EI1*, Tables 2.5.3 and 2.5.4 for *Punish*, and Tables 2.5.5 and 2.5.6 for *Charge*.[29]

In Table 2.5.1, the dependent variable is the amount of FDI inflows divided by the regional GDP (*FDI/GDP*). The results show that the share of industrial pollution treatment

---

[28] The major syntaxes include *xtreg* with *fe* and *re*, and *xtgls*.

[29] Regional-specific effects and time effects are not reported in all the tables in the main text and appendices.

investment has a negative effect on FDI inflows into a province. The coefficients in each of the nine regressions are relatively stable and statistically significant. In column (10) the coefficient (-0.062) indicates that a 10 per cent increase in the share of environmental investment of a province leads to a 0.62 per cent decrease in the amount of FDI inflows to regional GDP. Therefore, stringent regional environmental regulations have detrimental effects on FDI inflows.

Turning to the other explanatory variables, as expected, per capita income generally has a positive and statistically significant coefficient, which means that the richer the province, the more foreign investment is attracted. Among all the independent variables, per capita income level has the strongest effect on FDI inflows. The coefficient could be treated as the income elasticity of FDI inflows. From column (10), a 10 per cent increase in provincial income level could lead to a more than 34 per cent increase in *FDI/GDP*.

The signs on the coefficients for manufacturing wage and wage square are consistent with our prior expectations, and reveal an inverted-U relationship between FDI and wages. Although they remain relatively stable in absolute values, they are not significantly different from zero in most regressions and only achieve marginal significance in the final two columns. For column (10), the turning point is 8.11, i.e. 3,336 RMB yuan ($698) in level.[30] From the descriptive statistics reported in Table 2.4.4, manufacturing wages in most Chinese provinces are higher than this level. Table 2.4.2 shows that in 2002, the provincial manufacturing wages are all above 4,000 RMB yuan (the lowest wage is found in Henan with 4,218 RMB yuan), that is, high wages currently deter FDI in China.

---

[30] $\exp[6.49/(0.04\times2)] = 3,336$. RMB3,336 at 1990 price is equivalent to $698 at the 1990 middle exchange rate that $1=RMB4.78.

Table 2.5.1 FGLS Regression Results on FDI/GDP for Log Data with EI1

FDI/GDP	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
EI1†	-0.071 -(2.30)**	-0.081 (-2.92)***	-0.083 (-2.93)***	-0.087 (-2.69)***	-0.11 (-3.20)***	-0.11 (-3.16)***	-0.063 (-2.00)**	-0.062 (-2.09)**	-0.063 (-1.94)*	-0.062 (-2.03)**
GRP per capita		2.77 (5.02)***	2.53 (4.10)***	2.82 (4.03)***	3.20 (4.32)***	3.48 (4.66)***	3.41 (4.98)***	3.38 (5.00)***	3.42 (4.78)***	3.44 (4.86)***
Wage			0.23 (0.65)	5.76 (1.56)	5.82 (1.63)	3.22 (0.81)	5.34 (1.45)	5.42 (1.45)	6.41 (1.69)*	6.49 (1.68)*
Wage^2				-0.33 (-1.48)	-0.33 (-1.52)	-0.19 (-0.78)	-0.32 (-1.44)	-0.34 (-1.49)	-0.38 (-1.67)*	-0.40 (-1.71)*
GIP					-0.51 (-1.76)*	-0.60 (-2.00)**	-0.25 (-0.80)	-0.15 (-0.47)	-0.23 (-0.70)	-0.16 (-0.50)
Pop. Density						-1.14 (-1.50)	-1.01 (-1.49)	-1.07 (-1.57)	-1.07 (-1.60)	-1.13 (-1.68)*
Rail Density							-0.21 (-1.98)**	-0.23 (-2.20)**	-0.22 (-2.08)**	-0.25 (-2.32)**
Road Density							0.42 (4.14)***	0.45 (5.03)***	0.42 (4.25)***	0.45 (5.30)***
Illiterate Rate								0.27 (2.36)**		0.27 (2.34)**
Productivity									-0.17 (-1.37)	-0.18 (-1.47)
Constant	6.82 (35.48)***	-18.798 (-3.68)***	-18.56 (-3.64)***	-44.122 (-2.45)**	-44.69 (-2.55)**	-27.27 (-1.28)	-40.74 (-2.11)**	-40.77 (-2.08)**	-43.42 (-2.23)**	-43.51 (-2.20)**
Wald χ^2	4902.89	6449.04	6788.36	5384.91	5486.04	5717.34	7051.28	7398.75	6546.07	7071.95
Observations	149	149	149	149	149	149	149	149	149	149

z-statistics in parentheses; **†** all the independent variables are in logs; *, ** and *** indicate significant at 10%, 5% and 1% level, respectively. Province and time dummies are included.

Table 2.5.2 FGLS Regression Results on FDI/POP for Log Data with EI1

FDI/POP	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
EI1†	-0.079	-0.080	-0.083	-0.094	-0.10	-0.10	-0.062	-0.063	-0.062	-0.062
	(-2.61)***	(-2.59)***	(-2.74)***	(-2.75)***	(-2.97)***	(-2.93)***	(-1.93)*	(-2.02)**	(-1.86)*	(-1.96)**
GRP per capita		3.38	3.04	3.43	3.71	3.99	4.04	3.97	3.98	3.98
		(6.13)***	(4.93)***	(4.93)***	(5.04)***	(5.42)***	(6.04)***	(6.03)***	(5.69)***	(5.74)***
Wage			0.37	7.95	7.87	5.53	7.48	7.52	8.52	8.54
			(0.99)	(2.24)**	(2.25)**	(1.41)	(2.03)**	(2.02)**	(2.25)**	(2.22)**
$Wage^2$				-0.46	-0.45	-0.32	-0.45	-0.46	-0.50	-0.52
				(-2.11)**	(-2.10)**	(-1.36)	(-2.01)**	(-2.04)**	(-2.21)**	(-2.24)**
GIP					-0.35	-0.42	-0.057	0.056	-0.036	0.045
					(-1.13)	(-1.31)	(-0.18)	(0.17)	(-0.11)	(0.13)
Pop. Density						-0.96	-0.88	-0.93	-0.86	-0.92
						(-1.25)	(-1.21)	(-1.28)	(-1.20)	(-1.28)
Rail Density							-0.16	-0.19	-0.17	-0.20
							(-1.43)	(-1.68)*	(-1.52)	(-1.78)*
Road Density							0.45	0.47	0.44	0.47
							(4.47)***	(5.17)***	(4.59)***	(5.47)***
Illiterate Rate								0.27		0.27
								(2.29)**		(2.23)**
Productivity									-0.16	-0.17
									(-1.25)	(-1.34)
Constant	6.79	-24.54	-24.50	-59.51	-59.41	-44.54	-58.28	-58.10	-61.11	-60.91
	(37.03)***	(-4.80)***	(-4.77)***	(-3.43)***	(-3.46)***	(-2.10)**	(-2.96)***	(-2.94)***	(-3.10)***	(-3.05)***
Wald χ^2	8255.26	9891.48	10168.32	8913.67	9078.33	9316.90	12471.36	13105.58	12174.31	13239.35
Observations	149	149	149	149	149	149	149	149	149	149

z-statistics in parentheses; † all the independent variables are in logs; *, ** and *** indicate significant at 10%, 5% and 1% level, respectively. Province and time dummies are included.

Table 2.5.3 FGLS Regression Results on FDI/GDP for Log Data with Punish

FDI/GDP	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Punish†	-0.043	-0.043	-0.041	-0.051	-0.074	-0.078	-0.082	-0.076	-0.081	-0.076
	(-2.06)**	(-1.94)*	(-1.74)	(-2.13)**	(3.05)***	(-3.01)***	(-3.16)***	(-2.79)***	(-3.23)***	(-2.85)***
GRP per capita		2.90	2.92	3.13	3.50	3.79	3.84	3.93	3.70	3.85
		(5.02)***	(4.52)***	(4.51)***	(4.83)***	(5.13)***	(5.94)***	(6.01)***	(5.65)***	(5.75)***
Wage			-0.089	5.42	6.43	3.41	4.78	4.45	5.99	5.73
			(-0.21)	(1.35)	(-1.70)*	(-0.81)	(-1.24)	(-1.14)	(-1.51)	(-1.42)
Wage^2				-0.33	-0.39	-0.21	-0.30	-0.30	-0.36	-0.36
				(-1.36)	(-1.67)*	(-0.84)	(-1.28)	(-1.24)	(-1.50)	(-1.48)
GIP					-0.49	-0.62	-0.41	-0.36	-0.39	-0.36
					(-1.75)*	(-1.98)**	(-1.36)	(-1.19)	(-1.32)	(-1.17)
Pop. Density						-0.94	-0.98	-1.03	-0.97	-1.02
						(-1.26)	(-1.57)	(-1.61)	(-1.58)	(-1.63)
Rail Density							-0.30	-0.31	-0.30	-0.31
							(-2.87)***	(-2.89)***	(-2.86)***	(-2.90)***
Road Density							0.44	0.45	0.44	0.46
							(4.44)***	(5.05)***	(4.58)***	(5.28)***
Illiterate Rate								0.22		0.21
								(1.88)*		(1.83)*
Productivity									-0.14	-0.16
									(-1.16)	(-1.32)
Constant	6.62	-20.24	-19.67	-44.12	-48.62	-31.19	-39.87	-38.85	-43.17	-42.58
	(47.34)***	(-3.78)***	(-3.44)***	(-2.30)**	(-2.66)***	(-1.40)	(-2.00)**	(-1.93)*	(-2.16)**	(-2.10)**
Wald χ^2	5027.47	5287.33	5059.49	4945.25	6701.13	6263.02	8235.71	8374.58	8231.85	8466.13
Observations	147	147	147	147	147	147	147	147	147	147

z-statistics in parentheses; † all the independent variables are in logs; *, ** and *** indicate significant at 10%, 5% and 1% level, respectively. Province and time dummies are included.

Table 2.5.4 FGLS Regression Results on FDI/POP for Log Data with Punish

FDI/POP	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Punish†	-0.043 (-2.20)**	-0.047 (-1.97)**	-0.045 (-1.89)	-0.054 (-2.26)**	-0.074 (-2.78)***	-0.074 (-2.57)**	-0.078 (-2.62)***	-0.071 (-2.33)**	-0.076 (-2.66)***	-0.070 (-2.38)**
GRP per capita		3.55 (6.50)***	3.37 (5.45)***	3.63 (5.34)***	3.95 (5.40)***	4.28 (5.79)***	4.46 (6.99)***	4.46 (6.99)***	4.30 (6.52)***	4.36 (6.58)***
Wage			0.096 (0.23)	7.63 (1.98)**	8.13 (2.17)**	5.54 (1.33)	6.64 (1.72)*	6.49 (1.67)*	7.83 (1.97)**	7.67 (1.91)*
Wage^2				-0.45 (-1.92)*	-0.48 (-2.08)**	-0.34 (-1.33)	-0.41 (-1.73)*	-0.41 (-1.73)*	-0.47 (-1.95)*	-0.47 (-1.94)*
GIP					-0.42 (-1.34)	-0.48 (-1.40)	-0.20 (-0.63)	-0.13 (-0.40)	-0.18 (-0.55)	-0.13 (-0.39)
Pop. Density						-0.69 (-0.90)	-0.82 (-1.18)	-0.83 (-1.19)	-0.76 (-1.11)	-0.77 (-1.13)
Rail Density							-0.26 (-2.25)**	-0.26 (-2.31)**	-0.25 (-2.22)**	-0.26 (-2.28)**
Road Density							0.46 (4.72)***	0.47 (5.17)***	0.46 (4.90)***	0.48 (5.43)***
Illiterate Rate								0.21 (1.77)*		0.20 (1.68)*
Productivity									-0.13 (-1.05)	-0.14 (-1.14)
Constant	6.55 (49.65)***	-26.34 (-5.19)***	-25.52 (-4.72)***	-58.88 (-3.19)***	-61.28 (-3.40)***	-47.77 (-2.16)**	-56.75 (-2.80)***	-56.29 (-2.76)***	-60.33 (-2.97)***	-59.97 (-2.92)***
Wald χ^2	7444.30	9495.49	9524.93	8280.40	8966.73	8852.64	13005.62	13285.83	13022.54	13589.33
Observations	147	147	147	147	147	147	147	147	147	147

z-statistics in parentheses; † all the independent variables are in logs; *, ** and *** indicate significant at 10%, 5% and 1% level, respectively. Province and time dummies are included.

Table 2.5.5 FGLS Regression Results on FDI/GDP for Log Data with Charge

FDI/GDP	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Charge†	-0.054	-0.14	-0.15	-0.12	-0.098	-0.14	-0.22	-0.18	-0.21	-0.18
	(-0.49)	(-1.30)	(-1.40)	(-1.01)	(-0.84)	(-1.16)	(-2.00)**	(-1.66)*	(-1.86)*	(-1.54)
GRP per capita		2.94	2.73	2.89	3.11	3.47	3.50	3.47	3.47	3.47
		(4.87)***	(4.15)***	(3.95)***	(3.98)***	(4.42)***	(5.02)***	(5.01)***	(4.78)***	(4.80)***
Wage			0.14	3.87	4.38	0.49	1.99	2.37	2.89	3.26
			(0.34)	(0.94)	(1.07)	(0.11)	(0.49)	(0.58)	(0.69)	(0.77)
Wage^2				-0.23	-0.26	-0.039	-0.12	-0.15	-0.17	-0.20
				(-0.90)	(-1.03)	(-0.14)	(-0.48)	(-0.61)	(-0.66)	(-0.78)
GIP					-0.23	-0.31	0.13	0.15	0.13	0.14
					(-0.72)	(-0.94)	(0.39)	(0.46)	(0.38)	(0.42)
Pop. Density						-1.39	-1.54	-1.52	-1.63	-1.61
						(-1.67)*	(-2.27)**	(-2.22)**	(-2.40)**	(-2.34)**
Rail Density							-0.37	-0.36	-0.38	-0.37
							(-3.45)***	(-3.34)***	(-3.44)***	(-3.34)***
Road Density							0.42	0.44	0.42	0.44
							(3.92)***	(4.39)***	(3.93)***	(4.46)***
Illiterate Rate								0.22		0.22
								(1.69)*		(1.68)*
Productivity									-0.16	-0.16
									(-1.25)	(-1.32)
Constant	6.90	-19.58	-18.74	-35.64	-38.32	-14.44	-24.28	-26.01	-25.81	-27.59
	(-7.06)***	(-3.57)***	(-3.38)***	(-1.81)*	(-1.95)*	(-0.60)	(-1.15)	(-1.23)	(-1.22)	(-1.29)
Wald χ^2	4233.42	4850.38	5313.72	4558.54	4456.13	4891.34	7336.94	7180.77	6906.39	6817.20
Observations	149	149	149	149	149	149	149	149	149	149

z-statistics in parentheses; † all the independent variables are in logs; *, ** and *** indicate significant at 10%, 5% and 1% level, respectively. Province and time dummies are included.

Table 2.5.6 FGLS Regression Results on FDI/POP for Log Data with Charge

FDI/POP	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Charge†	-0.043	-0.14	-0.16	-0.098	-0.091	-0.13	-0.21	-0.18	-0.20	-0.17
	(-0.38)	(-1.31)	(-1.47)	(-0.84)	(-0.77)	(-1.10)	(-1.92)*	(-1.65)*	(-1.75)*	(-1.50)
GRP per capita		3.65	3.32	3.57	3.67	3.99	4.15	4.06	4.07	4.02
		(6.30)***	(5.18)***	(4.95)***	(4.78)***	(5.25)***	(6.27)***	(6.15)***	(5.85)***	(5.77)***
Wage			0.28	6.69	6.82	3.02	4.18	4.50	5.19	5.47
			(0.68)	(1.67)*	(1.70)*	(0.67)	(1.02)	(1.09)	(1.23)	(1.29)
Wage^2				-0.39	-0.40	-0.19	-0.25	-0.28	-0.31	-0.33
				(-1.59)	(-1.63)	(-0.68)	(-0.99)	(-1.10)	(-1.18)	(-1.28)
GIP					-0.097	-0.15	0.30	0.35	0.31	0.34
					(-0.29)	(-0.45)	(0.89)	(1.02)	(0.88)	(0.97)
Pop. Density						-1.22	-1.42	-1.37	-1.45	-1.41
						(-1.45)	(-1.92)*	(-1.87)*	(-1.96)**	(-1.92)*
Rail Density							-0.31	-0.30	-0.32	-0.31
							(-2.69)***	(-2.65)***	(-2.72)***	(-2.68)***
Road Density							0.45	0.47	0.44	0.46
							(4.20)***	(4.52)***	(4.19)***	(4.57)***
Illiterate Rate								0.21		0.21
								(1.63)		(1.58)
Productivity									-0.15	-0.16
									(-1.19)	(-1.25)
Constant	6.73	-26.23	-25.48	-54.22	-54.99	-32.42	-42.16	-43.47	-44.37	-45.52
	(6.81)***	(-4.93)***	(-4.65)***	(-2.81)***	(-2.85)***	(-1.36)	(-1.96)**	(-2.02)**	(-2.05)**	(-2.09)**
Wald χ^2	6988.72	8136.79	8700.20	7749.89	7766.79	8301.63	12585.14	12298.18	12247.58	12082.78
Observations	149	149	149	149	149	149	149	149	149	149

z-statistics in parentheses; † all the independent variables are in logs; *, ** and *** indicate significant at 10%, 5% and 1% level, respectively. Province and time dummies are included.

GIP is intended to capture the degree of industrial agglomeration in a province and is expected to have a positive effect on FDI. However, none of the coefficients on *GIP* are positive and a statistically significant negative coefficient is found in regressions (5) and (6).[31] The coefficient on population density is found to be negative and only significant at 10% in the final column. It appears that FDI locates in less densely populated areas possibly due to the higher land prices.

We now consider our infrastructure variables. The railway density coefficient is contrary to our prior expectations. It has a significant negative effect on FDI inflows and is also found in all the other regression results in Tables 2.5.2 – 2.5.6 and most of the tables in Appendices 2.2, 2.3 and 2.5. A possible explanation is the relatively lower railway density in some coastal provinces with higher incomes and higher shares of FDI inflows. For example, Guangdong attracted the greatest FDI flows in China and its GDP accounts for about 10% of total. However, the railway length is 2,112.5 km with a density of 0.01 km/km^2, which ranks 11th from bottom and only slightly higher than the average level of the country.[32] The situation in other FDI preferred provinces, such as Hainan, Fujian, Zhejiang and Jiangsu, is similar to that of Guangdong. Although other eastern regions, such as Beijing, Tianjin, Shanghai, Liaoning, Hebei and Shandong, have very high railway densities, these six regions account for 28 per cent of national GDP and 36 per cent of FDI inflows compared with 31 per cent in GDP and 50 per cent in FDI inflows of the

31 We also estimate our regressions using the numbers of enterprises as a proxy of agglomeration. These enterprises include all state-owned and non-state-owned industrial enterprises with an annual sales income of over 5 million RMB yuan. Our main results are unaffected.

32 The average railway density for a province in China is 0.0077 km/km^2 in 2003. The 10 provinces with the lowest railway density are Tibet, Qinghai, Xinjiang, Gansu, Inner Mongolia, Yunnan, Sichuan, Hainan, Chongqing, and Guizhou. These provinces all have geographical restrictions on building railways. Tibet and Qinghai are located on Qinghai-Tibet Plateau; Xinjiang and Gansu both have large areas of Gobi desert; Inner Mongolia has the largest grassland; Yunan, Sichuan, Chongqing and Guizhou are in the mountainous regions; and Hainan is an island province. Except Hainan, the other nine regions are all located in western China.

other five provinces with lower railway densities. In contrast, other measure of a region infrastructure, road density, has a positive and significant coefficient in all regressions in all the six tables. The value of the coefficient remains relatively stable.[33] The different results in railway density and road density are consistent with the real situation of transportation infrastructure in China. During the past 30 years, central and local governments have invested a great amount of money to improve the highway construction (at all classes) because road transportation network is regarded as an important sign for urbanisation and modernisation. "Building road is the fist step to become rich" has been a widely spread common saying since 1980s. Therefore, rich regions always have high road density but do not certainly have high railway density.

The rate of illiteracy in a province has a positive and significant coefficient as expected, indicating that FDI prefers to locate into regions with a high proportion of unskilled labour. Similarly, our measure of productivity has a consistent sign but it is not significant indicating that province level productivity does not appear to play an important role in investment location decision making.

Using the per capita FDI inflows (*FDI/POP*) as our dependent variable, the specifications of Table 2.5.2 are the same as those in Table 2.5.1. The coefficients for *EI1* in these two tables are very similar. Therefore, for both FDI measures, a 10 per cent increase of industrial pollution treatment investment in a province would lead to an approximate 0.62 per cent decrease of the amount of per capita FDI inflows into the province. The coefficients on other independent variables are robust across all regressions, except wage and squared wage which both become more significant. The turning point in the final

[33] We also estimate our regressions including railway density and road density separately but the results were very similar. We also estimated the regressions respectively including numbers of ports in each province and dummy variable for coastal provinces. Both coefficients are positive but not significant.

regression is 8.21, i.e. 3,683 RMB yuan ($770) in level. It again indicates that wage has a negative effect on FDI inflows at current wage level in China.

Tables 2.5.3 and 2.5.4 show the FGLS regression results when we use *Punish* to measure the strictness of environmental regulations. The coefficients on punishment cases are negative and statistically significant in all regressions in Tables 2.5.3 and 2.5.4, and the absolute values are relatively stable. In column (10) of Table 2.5.3, the coefficient is -0.076, which means that a 10 per cent increase in environment litigiousness of the province leads to a 0.76 per cent decreases in the amount of *FDI/GDP*. As a result, the provinces with stricter environmental standards attract less FDI.

The effect of per capita income is still significantly positive. Similar to the *EI1* results, the coefficients on manufacturing wage does not have significant effect on *FDI/GDP* but have significant effect on *FDI/POP*; and the turning point is also below 4,000 RMB yuan (3,497 in regression (10) in Table 2.5.4). *GIP* and population density remain negative and insignificant. The results for railway and road density are similar to the *EI1* regressions. Their coefficients are robust for both signs and magnitude. The performances of rate of illiteracy and productivity are also similar to those in previous tables.

In terms of the results using normalised pollution emission charge, Tables 2.5.5 and 2.5.6 both indicate that foreign investors would like to locate in provinces with lower pollution emission charge standards, i.e. provinces with weaker implementation in environmental standards. However, the results are not as significant as *EI1* and *Punish*. And a 10 percent increase in pollution charge standard may lead to an approximately 1.8 per cent decrease in *FDI/GDP* or *FDI/POP* inflows. Compared to the industrial pollution treatment investment and administrative punishment cases, foreign investors are more sensitive to the pollution emission charge, possibly because it is more visible to the investors and has a more direct impact. The magnitudes of the coefficients on our three measures of environmental regulations are consistent with our expectation that *Charge* has the strongest elasticity, while *EI1* has the weakest. However, the impact of Charge is only significant at 10% level in regressions (7)-(9).

The results of per capita income and infrastructure variables are very similar to those in the previous four tables. However, wage and squared wage are now insignificant in the regressions on both measures of FDI. The *GIP* coefficient becomes positive in most regressions, although it still not different from zero. Population density becomes negatively significant, indicating that foreign investment prefers less populated provinces where land prices are lower. The coefficient on the illiterate rate is less significant but remains stable in magnitude. The results of productivity do not change.

We also apply some additional sensitivity checks to the labour quality and manufacturing wage. We include the percentage of enrolment in different levels of education to substitute for the rate of illiteracy. We find positive but insignificant results for primary school enrolment; positively significant results for junior high school enrolment; and negative but insignificant results for both senior high school and high education enrolments. These results support our premise that FDI is attracted to regions with relatively low education levels. We also include interaction terms for certain variables, for example, wage × income, wage × rate of illiteracy and wage × productivity. The results are remained broadly similar.

2.5.2 Comparison with Results in Appendices 2.2, 2.3 and 2.5

Appendix 2.2

Turning to the two alternative measures of the share of industrial pollution treatment investment, the results in Appendix 2.2 do not change our main results. The coefficients on *EI2* and *EI3* remain negative and stable in magnitude; however, they are not statistically different from zero in some regressions estimating on both measures of FDI inflows. The results of the other independent variables are very similar to those including *EI1*.

Appendix 2.3

Compared to the results using level equations in Appendix 2.3, the log specification results are more significant and robust. *EI1* is found to have significantly negative impacts on *FDI/GDP*. In terms of *FDI/POP*, the share of environmental investment is also found to have negative coefficient but only significant in a few regressions. *Punish* is generally negative but not significant. For *Charge*, we find positive coefficients in some specifications but none are statistically significant.

Per capita income has a significantly positive effect on *FDI/POP*. In the estimations on *FDI/GDP*, we find a positive and significant effect, as well as some negative results in some regressions. However, the negative coefficients are not statistically significant. The coefficients on manufacturing wage and its square when estimating *FDI/POP* including *EI1* and *Charge* (in Tables A2.3.2 and A2.3.6) are not statistically significant. In other estimations we only find a significant coefficient for wage squared in the estimations on *FDI/GDP*.

GIP is now positive in all tables and has significant effect on *FDI/POP*. Population density becomes positive and has relatively stable absolute values, but is only significant in some regressions for *FDI/POP*. The results on railway density and road density are not changed. We find inverse signs for the two measures of labour quality although neither is significant.

Appendix 2.5

Compared to the results using a random effects estimator provided in Appendix 2.5, the FGLS results are more robust. The log specifications of random effects results are roughly consistent with our main results, although they are relatively weak. A possible explanation is the disadvantage of GLS estimator in controlling for AR(1) autocorrelation for the log specifications.

2.5.3 Comparison with Previous Empirical Evidence

In contrast to the majority of existing studies of the PHH we do find consistent support for the existence pollution haven hypothesis within China. When we consider the effect of per capita income on aggregate FDI inflows to Chinese regions we find a strong and positive effect which is consistent with previous studies.

With respect to wage, we firstly include wage squared in the estimating equation and find an inverted-U relationship between FDI and wages. At the current wage level in China, our finding that wage deters FDI inflows are consistent with most empirical studies focusing China. We do not find a robust result for agglomeration effects, which is usually omitted in other studies. The measurement of agglomeration effects varies across empirical studies so in future research we will try alternative measures of agglomeration.

Growth of population density has been used in Wei *et al.* (1999) as a control variable to proxy the improvement in agglomeration effect and is found to be insignificant in all regressions for the realised FDI inflows, and has a negative sign when controlling for autocorrelation. In our case, population density is found to be significantly negative in our main results where a possible explanation is that it reflects regional land prices.

Infrastructure tends to be measured differently in other studies; however, most of them are measured by the characteristics of transportation (densities of highway, paved road, railway, waterway, etc.) and do not get constant significant results. Cheng and Kwan (2000) estimate the regression separately with all roads, paved roads and railways and also find the unexpected sign in the case of railways that is consistent with our findings. Gao (2002) combines the density of roads, railway and waterway together and finds the effects of transportation is not different from zero. A possible explanation for Gao's finding is that the strong negative effect of railway density, which is found in our results, may offset the positive effect of road density.

In terms of our labour quality variables, Coughlin and Segev (2000) employ similar measures and find that labour productivity is a positive determinant of FDI while rate of illiteracy is negative, which are opposite to our findings. Other studies have used the percentage of enrolment in different levels of education as the proxy of education or labour quality (Cheng and Kwan, 2000; Gao, 2002; Fung *et al.* 2002; and Fung *et al.* 2003), and the results are found to be better for junior and senior high schools and higher education than primary school education. Our sensitivity check results using the similar measures are also opposite to those in pervious studies. Cheng and Kwan (2000) argue that it is not surprising because at the beginning of China's open door policy, FDI was attracted not to areas with higher education attainment, but to South China due to preferential government policies and its geographical proximity to Hong Kong. Such a situation also exists during our sample period (1999-2003) even though China had been open for 20 years. This might be a possible explanation for our contrary results. The second reason is that illiteracy rate data is noisy because it measures the education level of household population, which may be affected by labour migration. Another explanation is that we use different normalisation of FDI inflows (*FDI*/*GDP*) and (*FDI*/*POP*) rather than FDI level data in USD at a constant price. Our normalisation does not reflect the absolute level of FDI but the relatively abundance of foreign investment. It may generate the different signs of some control variables.

2.6 Conclusions

This chapter uses provincial data for China to examine whether the foreign investment is more or less likely to be attracted to provinces with stringent environmental regulations.

We employ three proxies of the stringency of environmental regulations across provinces. They are the share of industrial pollution treatment investment in innovation investment in each province, the normalised administrative punishment cases and the normalised pollution emission charge. We also use two measures of FDI inflows, FDI divided by regional GDP and FDI divided by regional population. The regression results from FGLS estimator indicate that industrial pollution treatment investment and administrative punishment cases have significant negative effects on both measures of FDI inflows, while the impact of pollution emission charge is also negative although less significant. That is to say FDI prefers to locate into regions with weaker environmental regulations. Thus, to a certain extent we find evidence to support the existence of intra-country pollution havens within China. These results are robust for data in logs rather than in levels. The results for random effects estimators are somewhat weaker.

The results also find other independent variables are significant determinants of investment. Income level has a strong positive impact on the amount of FDI inflows. FDI is also found to be attracted to provinces with low manufacturing wages, good infrastructure, and a low educational level. FDI is found to prefer to locate into regions with low population density when we include pollution charge to proxy environmental regulations. It shows the importance of reliable infrastructure and factors of production in the investment location decision. Our results for income, wage and infrastructure are consistent with most previous studies; however, the results for population density and quality of labour force are different from others.

Our findings provide some policy implications. Three decades' of fast economic growth under the present growth mode has made China one of the largest pollution producers in the world, with, probably, the dirtiest air and increasingly polluted water resources. In this growth process, FDI has played an important role. It is regarded as an engine or catalyst for economic growth, a carrier of advanced technological and managerial knowledge that can drive the technological upgrading of the economy. Evidence from this chapter suggests that FDI is not always unalloyed blessing. Foreign investors may seek institutional voids in the developing countries and attempt to location in "pollution havens" where environmental regulation is not stringent. If a fast economic development is endurable, a sustainable development policy is needed that requires a rethinking about the location of population centres and types of investment, including the type and sector of foreign direct investment. Policies include encouraging more environmental friendly knowledge and human capital intensive FDI and controlling FDI in high energy consumption and high pollution sectors. The negative effect of environmental stringency on FDI can be offset by the improvement of some factors that are attractive to FDI, for example the quality of infrastructure.

One limitation in this chapter is that the data do not allow us to disaggregate FDI from different sources and/or into different industry sectors. Therefore, we cannot examine whether certain types of FDI from certain countries in certain industrial sectors would like to locate in regions with weak environmental regulations.

The second limitation is that we do not consider some other factors related to government characteristics which may have impact on FDI, such as the provincial difference in corruption. Corruption, as a detriment of FDI inflows, has recently been considered in cross national FDI location choice models. China has been widely recognised as a country with a serious corruption problem, but still attracts a large share of FDI inflows. The next question we wish to ask therefore is whether the difference in provincial level of corruption and governance quality encourage/deter FDI inflows in China.

Another limitation in this chapter is that we assume environmental stringency to be strictly exogenous, although we take one-year lag for all the explanatory variables to control for their endogeneity.

In this chapter we only consider the impact of environmental regulations on FDI inflows into China. However, the overall environmental impact of FDI is a mix of positive and negative effects. In some cases, FDI helps the improvement of China's environment. In other cases, FDI damages the environment and increases environmental risks.

Simultaneously, some other provincial differences, such as income level, also have impact on the environmental status and regulations.

To consider the impact of corruption and bureaucracy and the endogeneity of environmental regulations, therefore becomes our major work in Chapters three and four. And Chapter five investigates the overall environmental effects of economic development and FDI.

In sum, this chapter has addressed a number of limitations in PHH empirical studies. We provide the first study to examine the impacts of regional differences in environmental stringency on the amount of FDI inflows in China.

Appendix 2.1 Variables Definitions and Data Sources

Variable	Definition/Source
FDI/GDP	FDI divided by regional GDP (yuan per 10000 yuan). Source: China Statistical Yearbook.
FDI/POP	FDI divided by regional population (yuan per capita at 1990 price). Source: as above; GDP deflator data from Econ Stats, http://www.econstats.com
EI1	Investment in industrial pollution treatment project divided by total innovation investment (yuan per 10000 yuan). Source: China Environment Yearbook; Innovation investment data as FDI.
Punish	Total number of administrative punishment cases filed by the regional environmental authorities divided by the number of enterprises (cases per 1000 enterprises). Source: China Environment Yearbook; number of enterprises as FDI.
Charge	Pollution emission charge divided by the number of organisations paid the charge (yuan per enterprise, at 1990 price). Source: China Environment Yearbook.
GRP per capita	Gross regional product per capita (yuan at 1990 price). Source: as FDI.
Wage	Average wage of staff and workers in manufacturing (yuan at 1990). Source: as above.
GIP	Regional gross industrial output value (100 million yuan at 1990 price). Source: as above.
Pop. Density	Regional population density (persons per km^2). Source: as above; area data from http://www.usacn.com
Road Density	Regional highway density (km per 10000 km^2). Source: as above.
Rail Density	Regional railway density (km per 10000 km^2). Source: as above.
Illiterate Rate	Regional illiterate rate and semi-illiterate rate aged at 15 and above; values for 2000 are calculated as the average of the values in 1999 and 2001. Source: as FDI.
Productivity	Overall labour productivity for all foreign funded industrial enterprises (yuan per person per year, at 1990 price); values for 1998 are the average of those for 1997 and 1999. Source: China Industrial Economy Statistical Yearbooks.

Appendix 2.2 Normalisation of the Share of the Environmental Investment and the FGLS Regression Results for Log Data with *EI2* and *EI3*

A2.2.1 Alternative Normalisation Methods of *EI1*

The sources of industrial pollution treatment investment are state budgetary appropriations, special fund for environmental protection (which is mainly from the pollution emission charge), and other funds like domestic loans, foreign investment and enterprise fundraising.

The investment monies are spent on construction and installation projects, and purchasing of equipment and instruments required in the pollution harnessing projects for the treatments of wastewater, waste gas, solid wastes, noise pollution and other pollution.

All of these investment monies should be accounted to investment in innovation, which refers in general to the technological innovation of the original facilities (including renewal of fixed assets) by the enterprises and institutions as well as the corresponding supplementary projects for production or welfare facilities and the related activities. It includes the investment in all the projects, arranged both in the plan of innovation and in the plan of capital construction, of moving the whole factory to a new site so as to meet the requirements of urban environmental protection or safe production; and the projects in the state-owned units, listed neither in the plan of capital construction nor in the plan of innovation, of moving the whole factory to a new site so as to meet the requirements of urban environmental protection or safe production (China Statistical Yearbook).

Therefore, we normalise the industrial pollution treatment investment by the investment in innovation, i.e. the variable we used in the main text, *EI1*. But considering a small fraction of the industrial pollution treatment investment comes from state budget in capital construction, we also construct another two alternative variables for the share of environmental investment. *EI2* is normalised by the sum of investment in innovation and capital construction; and *EI3* is normalised by the total investment in fixed assets. Total investment in fixed assets is classified into four parts: investment in capital construction, investment in innovation, investment in real estates development and other investment in fixed assets.

Although the coefficients of *EI2* and *EI3* are less significant than that of *EI1*, the results reported in the following tables are roughly consistent with our main results.

A2.2.2 FGLS Regression Results for Log Data with EI2 and EI3

Table A2.2.1 FGLS Regression Results on FDI/GDP for Log Data with EI2

FDI/GDP	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
EI2†	-0.062	-0.079	-0.078	-0.075	-0.098	-0.099	-0.051	-0.057	-0.052	-0.057
	(-1.77)*	(-2.47)**	(-2.39)**	(-2.09)**	(-2.64)***	(-2.66)***	(-1.50)	(-1.80)*	(-1.49)	(-1.77)*
GRP per capita		2.67	2.62	2.87	3.26	3.56	3.45	3.39	3.47	3.47
		(4.79)***	(4.13)***	(4.03)***	(4.30)***	(4.66)***	(5.00)***	(4.99)***	(4.81)***	(4.85)***
Wage			-0.021	5.51	5.53	2.86	5.27	5.34	6.36	6.43
			(-0.06)	(1.45)	(1.50)	(0.71)	(1.41)	(1.41)	(1.65)*	(1.64)
Wage^2				-0.33	-0.33	-0.18	-0.33	-0.34	-0.39	-0.40
				(-1.44)	(-1.47)	(-0.75)	(-1.44)	(-1.49)	(-1.66)*	(-1.71)*
GIP					-0.51	-0.61	-0.24	-0.14	-0.22	-0.16
					(-1.66)*	(-1.92)*	(-0.76)	(-0.43)	(-0.68)	(-0.47)
Pop. Density						-1.16	-1.03	-1.08	-1.09	-1.15
						(-1.53)	(-1.54)	(-1.62)	(-1.65)*	(-1.73)*
Rail Density							-0.22	-0.25	-0.23	-0.26
							(-2.12)**	(-2.35)**	(-2.18)**	(-2.43)**
Road Density							0.42	0.45	0.42	0.45
							(4.26)***	(5.17)***	(4.39)***	(5.47)***
Illiterate Rate								0.29		0.29
								(2.55)**		(2.48)**
Productivity									-0.16	-0.18
									(-1.32)	(-1.44)
Constant	6.70	-17.91	-17.28	-42.54	-42.92	-25.16	-40.18	-39.92	-43.18	-42.94
	(37.58)***	(-3.47)***	(-3.30)***	(-2.32)**	(-2.39)**	(-1.17)	(-2.06)**	(-2.02)**	(-2.20)**	(-2.15)**
Wald χ^2	4929.07	6149.83	6106.43	4892.73	5063.15	5277.91	6985.84	7401.54	6478.25	7111.56
Observations	149	149	149	149	149	149	149	149	149	149

z-statistics in parentheses; † all the independent variables are in logs; *, ** and *** indicate significant at 10%, 5% and 1% level, respectively. Province and time dummies are included.

Table A2.2.2 FGLS Regression Results on FDI/POP for Log Data with EI2

FDI/POP	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
EI2†	-0.077 (-2.21)**	-0.087 (-2.51)**	-0.085 (-2.49)**	-0.087 (-2.33)**	-0.098 (-2.58)***	-0.099 (-2.57)**	-0.053 (-1.51)	-0.059 (-1.78)*	-0.052 (-1.47)	-0.058 (-1.72)*
GRP per capita		3.31 (5.99)***	3.10 (5.00)***	3.48 (4.95)***	3.76 (5.04)***	4.03 (5.42)***	4.06 (6.08)***	3.97 (6.03)***	4.03 (5.72)***	3.99 (5.73)***
Wage			0.15 (0.39)	7.68 (2.12)**	7.57 (2.12)**	5.23 (1.31)	7.40 (1.99)**	7.46 (1.98)**	8.46 (2.21)**	8.48 (2.18)**
Wage^2				-0.45 (-2.06)**	-0.45 (-2.04)**	-0.32 (-1.32)	-0.45 (-1.99)**	-0.47 (-2.04)**	-0.51 (-2.20)**	-0.52 (-2.23)**
GIP					-0.35 (-1.09)	-0.42 (-1.28)	-0.050 (-0.15)	0.073 (0.22)	-0.031 (-0.09)	0.057 (0.17)
Pop. Density						-0.95 (-1.23)	-0.88 (-1.22)	-0.93 (-1.28)	-0.87 (-1.22)	-0.92 (-1.30)
Rail Density							-0.17 (-1.53)	-0.20 (-1.81)*	-0.17 (-1.58)	-0.21 (-1.87)*
Road Density							0.45 (4.58)***	0.47 (5.28)***	0.45 (4.72)***	0.48 (5.60)***
Illiterate Rate								0.29 (2.46)**		0.28 (2.35)**
Productivity									-0.15 (-1.21)	-0.16 (-1.30)
Constant	6.69 (38.85)***	-23.90 (-4.66)***	-23.29 (-4.49)***	-57.82 (-3.28)***	-57.60 (-3.29)***	-42.74 (-2.00)**	-57.81 (-2.92)***	-57.45 (-2.89)***	-60.92 (-3.07)***	-60.44 (-3.01)***
Wald χ^2	8253.71	9871.67	9920.83	8554.96	8743.28	8915.09	12553.26	13243.52	12242.10	13426.99
Observations	149	149	149	149	149	149	149	149	149	149

z-statistics in parentheses; † all the independent variables are in logs; *, ** and *** indicate significant at 10%, 5% and 1% level, respectively. Province and time dummies are included.

Table A2.2.3 FGLS Regression Results on FDI/GDP for Log Data with EI3

FDI/GDP	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
EI3†	-0.047	-0.071	-0.070	-0.066	-0.084	-0.087	-0.042	-0.048	-0.044	-0.049
	(-1.31)	(-2.12)**	(-2.06)**	(-1.76)*	(-2.19)**	(-2.27)**	(-1.22)	(-1.49)	(-1.22)	(-1.49)
GRP per capita		2.69	2.62	2.88	3.22	3.52	3.41	3.35	3.45	3.45
		(4.74)***	(4.08)***	(4.02)***	(4.21)***	(4.57)***	(4.93)***	(4.92)***	(4.76)***	(4.80)***
Wage			0.0027	5.89	6.06	3.25	5.59	5.64	6.65	6.70
			(0.01)	(1.52)	(1.61)	(0.79)	(1.48)	(1.47)	(1.72)*	(1.69)*
Wage^2				-0.35	-0.36	-0.20	-0.34	-0.36	-0.40	-0.42
				(-1.51)	(-1.57)	(-0.83)	(-1.50)	(-1.54)	(-1.72)*	(-1.75)*
GIP					-0.44	-0.54	-0.19	-0.091	-0.19	-0.12
					(-1.42)	(-1.71)*	(-0.62)	(-0.28)	(-0.57)	(-0.36)
Pop. Density						-1.20	-1.04	-1.10	-1.11	-1.17
						(-1.57)	(-1.58)	(-1.65)*	(-1.69)*	(-1.77)*
Rail Density							-0.23	-0.25	-0.23	-0.26
							(-2.17)**	(-2.38)**	(-2.20)**	(-2.43)**
Road Density							0.43	0.46	0.43	0.46
							(4.44)***	(5.35)***	(4.58)***	(5.67)***
Illiterate Rate								0.28		0.28
								(2.50)**		(2.45)**
Productivity									-0.16	-0.17
									(-1.30)	(-1.40)
Constant	6.59	-18.23	-17.62	-44.30	-45.39	-26.78	-41.62	-41.33	-44.67	-44.36
	(41.91)***	(-3.47)***	(-3.29)***	(-2.37)**	(-2.47)**	(-1.23)	(-2.13)**	(-2.09)**	(-2.28)**	(-2.22)**
Wald χ^2	4824.69	5696.37	5691.95	4709.51	4819.03	5111.18	7015.82	7375.20	6514.12	7123.89
Observations	149	149	149	149	149	149	149	149	149	149

z-statistics in parentheses; † all the independent variables are in logs; *, ** and *** indicate significant at 10%, 5% and 1% level, respectively. Province and time dummies are included.

Table A2.2.4 FGLS Regression Results on FDI/POP for Log Data with EI3

FDI/POP	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
EI3†	-0.063 (-1.79)*	-0.076 (-2.11)**	-0.075 (-2.11)**	-0.076 (-1.97)**	-0.085 (-2.15)**	-0.086 (-2.16)**	-0.044 (-1.22)	-0.050 (-1.46)	-0.044 (-1.21)	-0.050 (-1.44)
GRP per capita		3.35 (5.96)***	3.12 (4.95)***	3.48 (4.93)***	3.71 (4.94)***	3.99 (5.31)***	4.03 (6.01)***	3.94 (5.95)***	4.01 (5.68)***	3.97 (5.68)***
Wage			0.16 (0.43)	8.14 (2.20)**	8.10 (2.22)**	5.61 (1.38)	7.71 (2.05)**	7.76 (2.04)**	8.74 (2.26)**	8.74 (2.23)**
$Wage^2$				-0.48 (-2.13)**	-0.48 (-2.14)**	-0.34 (-1.39)	-0.47 (-2.05)**	-0.48 (-2.09)**	-0.52 (-2.24)**	-0.54 (-2.26)**
GIP					-0.28 (-0.89)	-0.36 (-1.09)	-0.0027 (-0.01)	0.12 (0.36)	0.0067 (0.02)	0.095 (0.27)
Pop. Density						-0.97 (-1.25)	-0.89 (-1.24)	-0.93 (-1.30)	-0.88 (-1.24)	-0.93 (-1.31)
Rail Density							-0.17 (-1.57)	-0.20 (-1.82)*	-0.18 (-1.59)	-0.20 (-1.86)*
Road Density							0.46 (4.76)***	0.48 (5.43)***	0.46 (4.91)***	0.49 (5.77)***
Illiterate Rate								0.28 (2.40)**		0.28 (2.30)**
Productivity									-0.15 (-1.18)	-0.16 (-1.26)
Constant	6.58 (43.52)***	-24.35 (-4.67)***	-23.74 (-4.48)***	-59.94 (-3.35)***	-60.04 (-3.38)***	-44.36 (-2.05)**	-59.38 (-2.99)***	-58.98 (-2.95)***	-62.45 (-3.14)***	-61.89 (-3.07)***
Wald χ^2	7957.08	9294.05	9373.60	8243.57	8391.45	8635.95	12577.41	13130.56	12305.90	13367.50
Observations	149	149	149	149	149	149	149	149	149	149

z-statistics in parentheses; † all the independent variables are in logs; *, ** and *** indicate significant at 10%, 5% and 1% level, respectively. Province and time dummies are included.

Appendix 2.3 FGLS Regression Results for Level Data

Table A2.3.1 FGLS Regression Results on FDI/GDP for Level Data with EI1

FDI/GDP	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
EI1	-0.041 (-2.20)**	-0.040 (-2.23)**	-0.038 (-1.99)**	-0.037 (-1.79)*	-0.033 (-1.59)	-0.034 (-1.72)*	-0.044 (-1.98)**	-0.045 (-2.04)**	-0.044 (-1.96)**	-0.045 (-2.03)**
GRP per capita		0.0078 (0.72)	0.0071 (0.59)	0.013 (0.87)	0.0020 (0.12)	-0.0031 (-0.19)	0.039 (1.85)*	0.042 (1.97)**	0.039 (1.83)*	0.043 (1.97)**
Wage			0.0018 (0.10)	0.044 (1.10)	0.043 (1.08)	0.045 (1.14)	0.078 (1.49)	0.079 (1.51)	0.079 (1.52)	0.081 (1.54)
Wage^2				-2.59e-06 (-0.95)	-2.11e-06 (-0.78)	-2.36e-06 (-0.86)	-8.10e-06 (-2.22)**	-8.30e-06 (-2.27)**	-8.15e-06 (-2.21)**	-8.39e-06 (-2.27)**
GIP					0.023 (1.08)	0.021 (0.98)	0.030 (1.49)	0.028 (1.34)	0.030 (1.48)	0.027 (1.32)
Pop. Density						0.22 (0.67)	0.20 (0.58)	0.18 (0.52)	0.19 (0.57)	0.18 (0.52)
Rail Density							-1.31 (-3.40)***	-1.29 (-3.32)***	-1.32 (-3.40)***	-1.29 (-3.30)***
Road Density							0.025 (2.63)***	0.025 (2.70)***	0.025 (2.62)***	0.025 (2.70)***
Illiterate Rate								-1.51 (-0.75)		-1.59 (-0.79)
Productivity									0.000039 (0.12)	0.000011 (0.03)
Constant	579.59 (13.28)***	484.84 (3.57)***	480.00 (3.17)***	260.99 (1.08)	345.01 (1.40)	231.09 (0.68)	526.58 (1.10)	493.89 (1.03)	522.12 (1.08)	483.67 (1.00)
Wald χ^2	1814.28	1776.79	1806.09	1746.66	1671.93	1802.93	2077.01	2077.02	2079.73	2079.84
Observations	149	149	149	149	149	149	149	149	149	149

z-statistics in parentheses; *, ** and *** indicate significant at 10%, 5% and 1% level, respectively. Province and time dummies are included.

Table A2.3.2 FGLS Regression Results on FDI/POP for Level Data with EI1

FDI/POP	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
EI1	-0.020 (-1.36)	-0.017 (-1.39)	-0.018 (-1.44)	-0.016 (-1.4)	-0.0099 (-0.87)	-0.0098 (-1.04)	-0.013 (-1.69)*	-0.016 (-2.00)**	-0.012 (-1.50)	-0.015 (-1.73)*
GRP per capita		0.045 (4.47)***	0.042 (4.13)***	0.039 (3.87)***	0.021 (1.90)*	0.012 (1.21)	0.026 (1.97)**	0.027 (2.07)**	0.025 (1.90)*	0.026 (1.96)**
Wage			0.0098 (1.06)	-0.022 (-0.93)	-0.023 (-0.95)	-0.020 (-0.84)	-0.011 (-0.39)	-0.011 (-0.38)	-0.012 (-0.42)	-0.011 (-0.39)
$Wage^2$				2.50e-06 (1.38)	3.01e-06 (1.68)*	2.68e-06 (1.52)	8.44e-07 (0.37)	6.74e-07 (0.30)	1.02e-06 (0.45)	8.66e-07 (0.38)
GIP					0.047 (3.34)***	0.047 (3.59)***	0.058 (4.79)***	0.056 (4.74)***	0.058 (4.84)***	0.057 (4.81)***
Pop. Density						0.40 (1.66)*	0.43 (1.67)*	0.42 (1.67)*	0.42 (1.64)	0.42 (1.65)*
Rail Density							-0.64 (-2.93)***	-0.62 (-2.79)***	-0.66 (-2.99)***	-0.64 (-2.87)***
Road Density							0.0095 (1.83)*	0.011 (1.99)**	0.095 (1.83)*	0.010 (1.94)*
Illiterate Rate								-1.05 (-1.09)		-0.85 (-0.85)
Productivity									0.00014 (0.93)	0.00013 (0.91)
Constant	605.00 (19.34)***	72.43 (0.56)	36.01 (0.27)	162.54 (1.05)	285.64 (1.81)*	74.13 (0.31)	282.72 (0.96)	258.76 (0.88)	296.25 (1.00)	276.16 (0.94)
Wald χ^2	1561.23	1935.00	2057.03	1935.39	2185.31	2565.05	2935.79	2964.59	2937.39	2965.54
Observations	149	149	149	149	149	149	149	149	149	149

z-statistics in parentheses; *, ** and *** indicate significant at 10%, 5% and 1% level, respectively. Province and time dummies are included.

Table A2.3.3 FGLS Regression Results on FDI/GDP for Level Data with Punish

FDI/GDP	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Punish	-0.0014 (-0.24)	-0.0017 (-0.29)	-0.00075 (-0.13)	-0.0016 (-0.27)	0.00084 (0.14)	0.0017 (0.29)	-0.0076 (-1.07)	-0.0079 (-1.11)	-0.0078 (-1.09)	-0.0082 (-1.14)
GRP per capita		0.0020 (0.17)	-0.0020 (-0.15)	0.0069 (0.41)	-0.013 (-0.60)	-0.024 (-1.15)	0.042 (1.75)*	0.047 (1.88)*	0.044 (1.80)*	0.049 (1.96)**
Wage			0.013 (0.64)	0.058 (1.31)	0.053 (1.21)	0.056 (1.26)	0.085 (1.51)	0.083 (1.46)	0.096 (1.74)*	0.091 (1.62)
Wage^2				-2.94e-06 (-0.96)	-1.80e-06 (-0.58)	-2.01e-06 (-0.65)	-9.07e-06 (-2.26)**	-9.11e-06 (-2.27)**	-9.62e-06 (-2.40)**	-9.58e-06 (-2.39)**
GIP					0.035 (1.48)	0.035 (1.49)	0.033 (1.62)	0.030 (1.42)	0.032 (1.56)	0.028 (1.34)
Pop. Density						0.36 (1.07)	0.20 (0.57)	0.18 (0.51)	0.19 (0.55)	0.17 (0.49)
Rail Density							-1.37 (-3.41)***	-1.34 (-3.30)***	-1.39 (-3.45)***	-1.34 (-3.29)***
Road Density							0.025 (2.44)**	0.025 (2.51)**	0.025 (2.46)**	0.026 (2.54)**
Illiterate Rate								-1.81 (-0.82)		-2.08 (-0.97)
Productivity									0.00013 (0.40)	0.000078 (0.24)
Constant	568.72 (13.74)***	543.63 (3.74)***	502.00 (3.17)***	243.06 (0.88)	405.60 (1.39)	246.81 (0.67)	500.82 (1.01)	479.03 (0.97)	446.96 (0.90)	428.34 (0.86)
Wald χ^2	1606.60	1579.33	1617.78	1626.47	1596.89	1685.29	2145.62	2146.11	2155.22	2156.02
Observations	147	147	147	147	147	147	147	147	147	147

z-statistics in parentheses; *, ** and *** indicate significant at 10%, 5% and 1% level, respectively. Province and time dummies are included.

Table A2.3.4 FGLS Regression Results on FDI/POP for Level Data with Punish

FDI/POP	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Punish	-0.00092 (-0.19)	-0.0049 (-1.03)	-0.0040 (-0.84)	-0.0037 (-0.75)	-0.00021 (-0.04)	-0.000037 (-0.01)	-0.0037 (-0.72)	-0.0040 (-0.78)	-0.0038 (-0.73)	-0.0040 (-0.77)
GRP per capita		0.044 (4.25)***	0.040 (3.83)***	0.036 (3.39)***	0.012 (0.98)	0.0052 (0.45)	0.032 (2.23)**	0.034 (2.35)**	0.033 (2.30)**	0.034 (2.39)**
Wage			0.0096 (1.04)	-0.014 (-0.58)	-0.019 (-0.76)	-0.017 (-0.68)	0.0055 (0.17)	0.0039 (0.12)	0.011 (0.36)	0.0083 (0.27)
Wage^2				1.90e-06 (0.98)	3.10e-06 (1.54)	2.84e-06 (1.51)	-4.35e-07 (-0.18)	-4.77e-07 (-0.19)	-6.77e-07 (-0.28)	-6.83e-07 (-0.28)
GIP					0.052 (3.57)***	0.050 (3.66)***	0.056 (4.59)***	0.053 (4.44)***	0.056 (4.58)***	0.054 (4.45)***
Pop. Density						0.45 (1.84)*	0.41 (1.54)	0.40 (1.51)	0.40 (1.51)	0.40 (1.51)
Rail Density							-0.56 (-2.51)**	-0.53 (-2.34)**	-0.58 (-2.58)***	-0.54 (-2.37)**
Road Density							0.012 (2.10)**	0.014 (2.25)**	0.013 (2.16)**	0.014 (2.31)**
Illiterate Rate								-1.15 (-1.08)		-1.12 (-1.06)
Productivity									0.00012 (0.81)	0.000086 (0.64)
Constant	599.07 (19.34)***	82.85 (0.62)	56.15 (0.41)	169.37 (1.05)	356.76 (2.03)**	88.89 (0.36)	100.22 (0.32)	77.00 (0.25)	73.52 (0.24)	54.51 (0.18)
Wald χ^2	1571.09	2058.29	2179.97	2046.20	2454.30	2897.49	2840.85	2865.64	2852.37	2875.18
Observations	147	147	147	147	147	147	147	147	147	147

z-statistics in parentheses; *, ** and *** indicate significant at 10%, 5% and 1% level, respectively. Province and time dummies are included.

Table A2.3.5 FGLS Regression Results on FDI/GDP for Level Data with Charge

FDI/GDP	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Charge	0.0021 (0.46)	0.0016 (0.27)	0.00083 (0.14)	-0.00071 (-0.10)	-0.00054 (-0.08)	0.00027 (0.04)	-0.0031 (-0.43)	-0.0028 (-0.38)	-0.0033 (-0.45)	-0.0028 (-0.38)
GRP per capita		0.00080 (0.07)	0.00061 (0.05)	0.0066 (0.42)	-0.0045 (-0.26)	-0.0099 (-0.60)	0.033 (1.46)	0.036 (1.56)	0.034 (1.50)	0.038 (1.62)
Wage			0.0038 (0.22)	0.050 (1.23)	0.048 (1.17)	0.048 (1.18)	0.074 (1.35)	0.073 (1.33)	0.082 (1.52)	0.079 (1.47)
Wage^2				-2.61e-06 (-0.93)	-2.08e-06 (-0.74)	-2.37e-06 (-0.82)	-7.88e-06 (-2.07)**	-7.97e-06 (-2.09)**	-8.25e-06 (-2.16)**	-8.31e-06 (-2.18)**
GIP					0.028 (1.39)	0.027 (1.34)	0.037 (1.95)*	0.035 (1.77)*	0.037 (1.91)*	0.034 (1.71)*
Pop. Density						0.22 (0.67)	0.24 (0.70)	0.23 (0.65)	0.24 (0.68)	0.22 (0.62)
Rail Density							-1.32 (-3.33)***	-1.28 (-3.21)***	-1.33 (-3.37)***	-1.28 (-3.20)***
Road Density							0.025 (2.70)***	0.026 (2.76)***	0.025 (2.70)***	0.026 (2.78)***
Illiterate Rate								-1.49 (-0.69)		-1.75 (-0.83)
Productivity									0.00013 (0.41)	0.000094 (0.28)
Constant	553.59 (10.28)***	545.32 (4.12)***	526.71 (3.44)***	287.05 (1.14)	375.62 (1.46)	271.43 (0.77)	565.99 (1.16)	540.56 (1.11)	527.95 (1.08)	500.04 (1.02)
Wald χ^2	1791.45	1710.22	1722.41	1727.51	1716.63	1768.76	2258.26	2258.22	2265.39	2265.33
Observations	149	149	149	149	149	149	149	149	149	149

z-statistics in parentheses; *, ** and *** indicate significant at 10%, 5% and 1% level, respectively. Province and time dummies are included.

Table A2.3.6 FGLS Regression Results on FDI/POP for Level Data with Charge

FDI/POP	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Charge	0.0066 (1.43)	-0.00011 (-0.03)	-0.00032 (-0.08)	0.000098 (0.03)	-0.00040 (-0.10)	0.0011 (0.32)	0.00014 (-0.04)	0.00053 (0.15)	-0.00024 (-0.07)	0.00025 (0.07)
GRP per capita		0.041 (4.00)***	0.039 (3.78)***	0.035 (3.38)***	0.015 (1.30)	0.0069 (0.67)	0.026 (1.94)*	0.028 (2.04)**	0.027 (1.99)**	0.028 (2.06)**
Wage			0.0094 (0.99)	-0.016 (-0.66)	-0.018 (-0.76)	-0.021 (-0.88)	-0.0025 (-0.08)	-0.0040 (-0.13)	0.0015 (0.05)	-0.00078 (-0.03)
Wage^2				2.08e-06 (1.13)	3.02e-06 (1.57)	2.92e-06 (1.58)	4.13e-07 (0.17)	4.08e-07 (0.17)	2.84e-07 (0.12)	3.03e-07 (0.13)
GIP					0.052 (4.05)***	0.052 (4.40)***	0.060 (5.39)***	0.057 (5.24)***	0.060 (5.39)***	0.058 (5.24)***
Pop. Density						0.41 (1.73)*	0.39 (1.52)	0.38 (1.48)	0.39 (1.50)	0.38 (1.48)
Rail Density							-0.55 (-2.52)**	-0.51 (-2.31)**	-0.56 (-2.59)***	-0.52 (-2.34)**
Road Density							0.012 (2.16)**	0.013 (2.30)**	0.012 (2.18)**	0.013 (2.31)**
Illiterate Rate								-1.10 (-1.04)		-1.07 (-1.01)
Productivity									0.00012 (0.81)	0.000093 (0.66)
Constant	554.97 (11.39)***	108.24 (0.85)	67.60 (0.50)	169.75 (1.09)	319.77 (1.94)*	106.36 (0.45)	174.58 (0.58)	153.61 (0.51)	155.62 (0.52)	138.55 (0.46)
Wald χ^2	1961.15	2221.08	2262.99	2219.06	2657.54	3130.58	3023.00	3054.15	3029.88	3058.95
Observations	149	149	149	149	149	149	149	149	149	149

z-statistics in parentheses; *, ** and *** indicate significant at 10%, 5% and 1% level, respectively. Province and time dummies are included.

Table A2.3.7 FGLS Regression Results on FDI/GDP for Level Data with EI2

FDI/GDP	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
EI2	-0.17	-0.16	-0.15	-0.15	-0.13	-0.13	-0.20	-0.20	-0.20	-0.20
	(-1.89)*	(-1.85)*	(-1.66)*	(-1.60)	(-1.44)	(-1.49)	(-2.02)**	(-2.00)**	(-1.99)**	(-1.98)**
GRP per capita		0.0093	0.0093	0.015	0.0046	-0.00053	0.043	0.046	0.043	0.046
		(0.85)	(0.76)	(1.03)	(0.28)	(-0.03)	(2.08)**	(2.18)**	(2.05)**	(2.16)**
Wage			-0.0011	0.044	0.043	0.045	0.080	0.079	0.079	0.079
			(-0.06)	(1.11)	(1.09)	(1.13)	(1.53)	(1.52)	(1.51)	(1.52)
Wage^2				-2.70e-06	-2.25e-06	-2.42e-06	-8.31e-06	-8.42e-06	-8.26e-06	-8.42e-06
				(-1.00)	(-0.85)	(-0.89)	(-2.29)**	(-2.31)**	(-2.24)**	(-2.28)**
GIP					0.023	0.021	0.028	0.026	0.028	0.026
					(1.07)	(1.00)	(1.38)	(1.26)	(1.39)	(1.25)
Pop. Density						0.19	0.17	0.15	0.16	0.15
						(0.59)	(0.49)	(0.44)	(0.48)	(0.43)
Rail Density							-1.34	-1.31	-1.34	-1.31
							(-3.50)***	(-3.39)***	(-3.49)***	(-3.37)***
Road Density							0.024	0.025	0.024	0.025
							(2.61)***	(2.68)***	(2.60)***	(2.67)***
Illiterate Rate								-1.43		-1.44
								(-0.72)		(-0.72)
Productivity									0.000032	5.69e-06
									(0.10)	(0.02)
Constant	583.05	469.73	476.84	244.21	325.50	230.06	523.13	495.67	529.32	495.40
	(13.09)***	(3.43)***	(3.13)***	(1.02)	(1.34)	(0.68)	(1.10)	(1.03)	(1.10)	(1.02)
Wald χ^2	1821.42	1768.21	1790.55	1763.69	1694.14	1820.48	2112.93	2112.16	2112.94	2112.51
Observations	149	149	149	149	149	149	149	149	149	149

z-statistics in parentheses; *, ** and *** indicate significant at 10%, 5% and 1% level, respectively. Province and time dummies are included.