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The Consequences of Corruption: Evidence from China

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Evidence from China

Bin Dong [a] and Benno Torgler [a,b,c]

[a] *The School of Economics and Finance, Queensland University of Technology, GPO Box 2434, Brisbane, QLD 4001, Australia*

[b] *CREMA – Center for Research in Economics, Management and the Arts, Gellertstrasse 18, CH-4052 Basel, Switzerland*

[c] *CESifo, Poschingerstrasse 5, D-81679 Munich, Germany*

ABSTRACT

With complementary Chinese data sets and alternative corruption measures, we explore the consequences of corruption. Adopting a novel approach we provide evidence that corruption can have both, positive and negative effects, on economic development. The overall impact of corruption might be the balance of the two simultaneous effects within a specific institutional environment ("grease the wheels" and "sand the wheels"). Corruption is observed to considerably increase income inequality in China. We also find that corruption strongly reduces tax revenue. Looking at things from an expenditure point of view we observe that corruption significantly decreases government spending on education, R&D and public health in China. We also observe that regional corruption significantly reduces inbound foreign direct investment in Chinese regions, which indicates that the pollution haven hypothesis may not hold in China. This finding sheds a new light on the "China puzzle" that China is the largest developing host of FDI while it is appears to be very corrupt. Finally we observe that corruption substantially aggravates pollution probably through loosening environment regulation, and that it modifies the effects of trade openness and FDI on the stringency of environmental policy in a manner opposite to that observed in literature to date.

JEL classification: D720; H110; K420

Keywords: Corruption; China; Government; Economic Development; Inequality; Environment

I. INTRODUCTION

States, whether they are benevolent or repressive are in a position of having control over the distribution of benefits and costs and therefore hold a certain level of discretionary power which can in turn lead to corruption (Rose-Ackerman, 1999). Thus, corruption is a widely observe phenomenon in all manner of different societies. In this paper we are going to focus on China. It has been stressed that corruption has become more rampant in China since economic reform was launched in 1978. The Chinese Government has admitted that corruption "is now worse than during any other period since New China was founded in 1949. It has spread into the Party, into Government administration and into every part of society, including politics, economy, ideology and culture" (Guoqing Liang, 1994, p. 122). Widespread corruption has caused severe consequences in China. According to Hu (2001), the economic performance loss due to corruption in China was estimated in the late 1990s to be between 13.2 and 16.8% of Chinese's GDP. Although many papers have emerged about corruption in China (e.g., Yao's 2002 theoretical paper and Cai, Fang and Xu's 2009 empirical paper), there is still a lack of systematic analysis on the consequences of corruption in China. Such a shortcoming reduces the possibility for policy makers to assess the exact magnitude of the harmfulness of corruption in China and therefore to derive anti-corruption strategies that are suitable for China.

In general, there has been an increasing amount of economic studies on the consequences of corruption since the 1990s, most of which focus on the effect of corruption on economic development. The transformation of the socialist economies was one of the main reasons for this surge in interest since institutional weaknesses and corruption surfaced as major obstacles to market reforms and economic development (Abed and Gupta, 2002). Studies have emerged which explored the relationship between economic growth and corruption (Mauro, 1995). Most of these studies work with cross-sectional data using common corruption proxies such as the TI, the ICRG, the World Bank Quality of Governance ratings (control of corruption) or the Global Competitiveness Report. Such indexes reflect an indirect way of measuring corruption focusing mainly as Tanzi (2002, p. 39) stresses on "perceptions and not objective and quantitative measures of corruption". Naturally, one can therefore criticize that such data is subject to many biases. Treisman (2007), for example, pointed out that corruption perception data actually reflects impressions of the intensity of corruption instead of the corruption phenomenon itself. It measures beliefs that may be driven by other social and economic conditions (see also Knack, 2006). In other words, if the meaning of corruption is subjective, the values can vary among countries consequently reducing the possibility of comparing the

level of corruption among countries (Glaeser and Saks, 2006). This therefore also reduces the effectiveness of statistical analysis. Cross-country estimations may also be affected by omitted variable biases. Enormous unobservable or unmeasurable differences in institutions and cultures between countries may also induce estimation biases. Institutional and cultural frameworks that typify specific countries might influence the size of corruption. Such features cannot always be controlled in a satisfactory manner. In other words homogeneity reduces omitted variable biases. It may therefore be useful to complement such studies with within-country data. We therefore present within country evidence focusing on China. Interestingly, not many studies have used within country data. It certainly requires there to exist a significant level of within country variation as well as a regional institutional structure. The U.S. with its 50 states provides, for example, an interesting case study. Glaeser and Saks (2006) therefore explore corruption in America using information on the amount of corruption in each of the states in the U.S. to explore state characteristics that are associated with corruption and how corruption affects the economic development at the state level. Once one focuses on within country data, alternative proxies of corruption can be evaluated. The strength is the ability to focus on more concrete measures of corruption. Glaeser and Saks (2006) use the number of government officials convicted for corruption practices through the Federal justice department. The obvious shortcoming of such a variable is that the proxy is driven by the quality and efficiency of the judicial system itself. If the judicial system is inefficient or even corrupt, a large share of corrupt activities remains unobserved. Regional differences in the efficiency of the judicial system may also bias within country comparisons. One way to deal with this problem is to focus, as done by Glaeser and Saks (2006), on federal convictions where one can assume that the federal judicial system is relatively isolated from local corruption, therefore treating similar people across regions or in their case across states. Nevertheless, it is still unclear whether and to what extent local information and efforts have helped to reveal corruption that was treated at the federal judicial system.

Studying China may provide similar advantages. On the one hand, China is a centralized country with unified legal and administrative systems, which is dominated by the Han nationality with Confucian values in most of its regions (for the detailed evidence, see http://english.gov.cn/about.htm). Specifically, in China the heads of local governments are actually determined by the central government. Moreover their promotions depend mainly on whether they can faithfully carry out the regulations and policies of the central government. Furthermore the Supreme People's Court supervises local people's courts and actually exerts crucial influence on the appointment and removal of the presidents and vice presidents of local

people's courts. In addition to this the Supreme People's Procuratorate has a similar but an even stronger impact on local people's procuratorates. All of these factors ensure the homogeneity of the Chinese political and judicial systems across the various regions. It therefore also minimizes the potentially omitted bias in the econometric analysis. On the other hand, there are great economic differences between the rich Eastern provinces and the poor Western provinces. The American data, which focuses on states, reduces the possibility of generalizing the results to global differences in corruption and on the economic development across countries. Glaeser and Saks (2006, p. 1054), for example, state: "No state today is as poor or as corrupt as many countries in the developing world, and so relying on variation across the states in the US limits research to a small part of the distribution of both independent and dependent variables". Compared to the U.S., we observe in China a stronger variance in the economic conditions which may help to increase the generalizability of the results. Table 1, for example, shows that the GDP per capita of Shanghai, which is close to that of Hungary, is nearly nine times as high as the GDP per capita of Guizhou province, which approximates that of Cameroon.

Table 1
GDP (PPP) per capita of Chinese regions in 2008 (Intl. $)

Beijing	16577	Anhui	3810	Chongqing	4741
Tianjin	14590	Fujian	7922	Sichuan	4044
Hebei	6112	Jiangxi	3887	Guizhou	2321
Shanxi	5365	Shandong	8701	Yunnan	3310
Inner Mongolia	8472	Henan	5153	Tibet	3646
Liaoning	8221	Hubei	5223	Shaanxi	4799
Jilin	6184	Hunan	4608	Gansu	3185
Heilongjiang	5714	Guangdong	9886	Qinghai	4573
Shanghai	19232	Guangxi	3936	Ningxia	4706
Jiangsu	10421	Hainan	4517	Xinjiang	5232
Zhejiang	11102				

The key innovative aspect of our paper is hence to provide within country rather than cross-country evidence, focusing on the impact of corruption on the development in China using both provincial and city-level data. The diversity of China allows us to explore corruption in a within-country environment. This can therefore be better controlled than cross-country studies for unobserved culture or institutional differences, since it holds them constant. Glaeser and Saks (2006) found a weak negative association between corruption and economic growth in the US. Fisman and Svensson (2007), using the survey data from Ugandan firms, found that

bribery is negatively correlated with firm growth. With a survey of Chinese firms (World Bank, 2007), Cai, Fang and Xu (2009) employed the entertainment and travel cost of Chinese firms as a proxy for corruption measure and found that corruption substantially decreases firm performance in China. We will conduct a similar empirical approach as Glaeser and Saks (2006) to increase the comparability of the results. Our paper is structured as follows: Section II reviews related literature. Section III presents empirical analysis. Section IV concludes.

II. LITERATURE REVIEW

Corruption has significant influences on many aspects of societies (Lambsdorff, 2005). We will focus here on its impact on economic development, which is a major concern in China since it is the largest developing country in the world. According to Deardorff (2006), and Myint and Krueger (2009)[1], economic development is the increase in the economic, political, and social well-being of people in a country with sustained growth from a simple, poor country into a modern, prosperous country. Its scope includes economic growth, income distribution, public goods (public expenditures) and environmental quality. Here we will provide a short literature review on the influence of corruption in these subareas of economic development.

Economic growth is a fundamental part of economic development. Economic growth always improves the living standard of the public by increasing both private income and social services. Poor countries may experience economic growth without development in some cases. No country, however, can sustain economic development without growth. It is therefore important to investigate the impact of corruption on economic growth when studying the relationship between corruption and economic development. There is indeed a theoretical debate in existence on the effect of corruption on economic growth. Some authors emphasize that corruption can promote economic growth ("grease the wheels"). Leff (1964) and Huntington (1968) argue that bribes can be used as an incentive instrument to influence public officials, inducing an improvement in the quality of civil services. Lui (1985) also shows in his model that bribes can efficiently accelerate the bureaucratic process. However, one can criticize that bureaucrats have an incentive to delay transactions in order to extract higher payments (see Rose-Ackerman, 1997). Other researchers stress that corruption decreases economic growth ("sand the wheels"). For example, Murphy, Shleifer and Vishny (1991) point out that most

[1] Deardorff, A., 2006. Economic development. Deardorff's Glossary of International Economics. (http://www-personal.umich.edu/~alandear/glossary/e.html)
Myint, H., Krueger, A.O., 2009. Economic development. Encyclopædia Britannica. (http://www.britannica.com/EBchecked/topic/178361/economic-development)

talented people are allocated into rent-seeking activities instead of productive ones in corrupt societies. It therefore lowers economic growth since the unproductive rent seeking activities only bring positive returns to the rent seekers instead of to the whole society (Krueger, 1974). From a different angle, Shleifer and Vishny (1993) stated that corrupt officials may distort investment projects to those offering better opportunities for corruption. In other words, corrupt bureaucracy will not award the services to the most efficient producers, but instead to the producer who offers the largest bribes. In general, most of the empirical literature supports a negative association between corruption and economic growth. Mauro (1995) finds empirically that corruption lowers productive investment significantly thus also reducing economic growth. Mo (2001) reports further that through the channels of political instability, the level of human capital and the share of private investment, corruption significantly hinders economic growth. Pellegrini and Gerlagh (2004) also provide evidence that corruption reduces economic growth via its effect on investment and trade policy. Recently, a number of studies stress that the correlation between corruption and growth is conditional on the institutional quality. Meon and Sekkat (2005) observe that corruption depresses economic growth especially in countries with a low quality of governance. However, Mendez and Sepulveda (2006) find a quadratic relationship between corruption and growth in free countries instead of not-free ones, which implies the existence of the growth maximizing level of corruption. Aidt, Dutta and Sena (2008) using a threshold model report that corruption exerts a significant negative effect on economic growth in regimes with good governance, while having no effect on growth in regimes with poor governance. Moreover, Meon and Weill (2008) provide empirical evidence using a panel of 54 countries that corruption is beneficial (or at least less harmful) in countries with weak institutions. These papers provide indirect evidence that supports the “grease the wheels” hypothesis insofar as corruption is only beneficial in weak institutions while being harmful elsewhere (Aidt, 2009).

As an engine of economic growth, foreign direct investment is suggested to be negatively correlated with corruption in previous literature. Field, Sosa and Wu (2006) employed a Nash bargaining game to find that the corruption in a host country influences the competitiveness of foreign firms and thus also affects their expected profits in the host market. Consequently the decisions of foreign firms to invest in a country are affected by the corruption level of the host. Empirically, using two-year bilateral flows between 14 source and 45 host countries, Wei (2000a) found a significantly negative association between perceived corruption in hosts and inbound foreign direct investment. Corruption acts like a tax on FDI reducing the attractiveness of FDI. Smarzynska and Wei (2000) also provided firm-level evidence that corruption impedes

inbound FDI and moves the ownership structure to joint ventures. Habib and Zurawicki (2002) utilized a sample of 89 countries to found the negative effect of corruption on FDI, while Akcay (2001) failed to identify a statistically significant link between corruption and FDI. Furthermore, Egger and Winner (2005) analysed the impact of corruption on FDI with a sample of 73 countries and detected a clear positive relationship between corruption and inward FDI. However, noting that FDI is an indicator of openness, Larrain and Tavares (2004, 2007) presented cross-country evidence that there exists reverse causation between corruption and FDI. Due to the regional data and regional differences in China we will be able to explore the relationship between corruption and FDI within a country rather than focusing on cross-country evidence.

There is a related strand of literature testing the "pollution havens" hypothesis which according to Javorcik and Wei (2004), refers to the tendency of multinational corporations to relocate to countries with lax environment policies. Recently some researchers have emphasized the impact of corruption of host countries when studying the relationship between FDI and the stringency of the environment policies of host countries. Modelling the interaction between workers, environmentalists and bureaucrats, Fredriksson, List and Millimet (2003) theoretically predicted that corruption influences FDI through two channels: public spending and environmental regulation. With US state-level panel data, they provided empirical evidence that corruption affects both the supply of public goods and the stringency of environmental regulation which eventually influences the FDI location in America. Similarly, Javorcik and Wei (2004) studied 25 economies in Eastern Europe and the former Soviet Union and found that besides its direct impediment to FDI, corruption may relax environmental regulation in host countries.

As an important indicator of economic development, income inequality also influences economic growth (Barro, 2000). Corruption, however, is observed to significantly affect the income inequality. As discussed, in many countries today and in the past, people choose to be active as bureaucrats, as army officers or in other rent seeking activities instead of working in the potentially more productive or entrepreneurial activities (Nabla-Norris and Wade, 2002). Better connected people in society have increased opportunity and incentives to bribe and belong mainly to the high-income groups within a country (Tanzi, 1995). This could lead to a reduction in the level of social services available to the poor (Rose-Ackerman, 1999). For example, in China under the Mandarins, as in medieval Europe, wealthy individuals in society choose their principal career in government services where it was possible to generate bribes and tax revenues for private benefits (Baumol, 1990). Dabla-Norris and Wade (2002) show that

in the absence of credit markets only wealthy agents have the chance o overcome the nonconvexity in income-earning possibilities ("born into rent-seeking", p. 454). Li, Xu and Zou (2000) used a variant of the rent-seeking model developed by Murphy, Shleifer and Vishny (1993) to conclude that corruption influences income inequality in a reversed U-shape way. Furthermore, they presented empirical evidence to support this although the quadratic terms of corruption indicators were not significant in most of their specifications (Begovic, 2006). In general, however, we still observe a lack of empirical evidence on how corruption affects income inequality. Based on the discussion about the channels through which corruption influences income inequality, Gupta, Davoodi and Alonso-Terme (2002) provided robust cross-country evidence that corruption monotonically increases income inequality. We add to the literature an analysis that uses within country data instead of cross-country data to better isolate the unobserved institutional and cultural factors.

Public expenditure actually has a twofold effect on economic development. On the one hand, Public expenditures such as those on infrastructure, education and science stimulate economic growth. On the other hand, public expenditures such as those on health and other social services improve the social wellbeing of the public. Corruption can substantially influence public expenditure. It can "adversely affect the provision of publicly provided social services" (Gupta, Davoodi, and Tiongson, 2002, p. 245). Mauro (1998) stresses that measuring the effects of corruption on the composition of government expenditure may help to quantify the severity of the principal-agent problem between citizens and politicians. He argued that corrupt politicians may increase the government expenditure that it is easier to collect bribes from and decrease the expenditure which provides fewer bribery opportunities. For example, corrupt officials will choose goods whose exact value is difficult to monitor to maintain secrecy (e.g., high-technology goods, large infrastructure projects, health equipment). Moreover, classical rents such as the allocation of transfer and welfare payments enjoy substantial discretionary power. Mauro (1998) presented evidence that corruption significantly reduces government expenditure on education due to the fact that education does not provide as many lucrative opportunities for corrupt officials compared to other spending components. Corruption also reduces spending on operations and maintenance and increases large government capital spending (Tanzi and Davoodi, 1997). On the other hand, Gupta, de Mello and Sharan (2001) using a panel of 120 countries during 1985–1998, found that corruption is positively correlated with government spending on the military.

Corruption not only affects government expenditure but also affects government revenues, which are the main source of the expenditure. It has been stressed that there is no good taxation

without good representation. If taxpayers perceive that their interests (preferences) are not properly represented in political institutions and they receive a reduced or an inefficient supply of public goods, their willingness to contribute (e.g., pay taxes) decreases. A state in which corruption is rampant is one in which citizens have little trust in authority and thus have a low incentive to cooperate. Hindriks, Keen and Muthoo (1999) theoretically deduced that collusion between the taxpayer and the tax inspector through bribery reduces tax revenue. Ghura (1998) studied 39 sub-Saharan countries in the period 1985–1996 and obtained evidence that corruption lowers the tax revenue-GDP ratio in those countries. Tanzi and Davoodi (1997) also support the negative relationship between corruption and government revenue in their cross-country analysis. Recently, Bird, Martinez-Vazquez, and Torgler (2008) provide strong evidence that corruption has a negative impact on tax performance in developing and developed countries.

Now we turn to the relationship between corruption and the environment quality, an important qualitative indicator of economic development. Lopez and Mitra (2000) studied cooperative and non-cooperative interactions between government and private firms and conclude that introducing corruption moves the Kuznets environmental curve up: the pollution level corresponding to every income level is constantly above the socially optimal level due to corruption. Considering both the direct effect of corruption on pollution and the indirect effect of corruption which influences pollution by reducing per capita income, Welsch (2004) found with simultaneous equations that the direct effect of corruption on pollution was positive while the indirect effect of corruption is either positive or negative and was also numerically smaller. Therefore corruption aggravates pollution overall, especially in developing countries. However, with the similar empirical strategy but controlling the endogeneity problems in regressions, Cole (2007) provides cross-country evidence that the positive direct impact of corruption on air pollution emissions is dominated by the negative indirect impact of corruption. The total effect of corruption on air pollution emissions is hence negative in the countries that are not the richest. This contradicting evidence demands an investigation into the actual mechanism for the relationship between corruption and pollution.

It is quite possible that bureaucratic corruption affects pollution mainly through environment policy making, since special interest groups often exert undue influence on policy makers by lobbying and offering bribes. This is another symptom of corruption. Several studies about the influence of corruption on the formation of environment policy have therefore emerged. Pellegrini and Gerlagh (2006) found empirically in a cross sectional sample of 62 countries that corruption has a substantially negative effect which is more significant and larger

in magnitude than that of democracy on the stringency of the environment policy. Furthermore they suggested that democracy might affect the environment policy stringency through reducing corruption. Considering the interactions between corruption and political stability, trade liberalization and FDI respectively, Fredriksson and Svensson (2003), Damania, Fredriksson and List (2003) and Cole, Elliott and Fredriksson (2006) provided both theoretical evidence from the lobbying models and empirical evidence from the cross-country analyses that corruption not only significantly reduces the stringency of environmental policy but also modifies the effects of other determinants of environment policy such as political stability, trade liberalization and FDI. Furthermore Fredriksson, Vollebergh and Dijkgraaf (2004) adopted a similar approach to find theoretically and empirically that corruption reduces the stringency of energy policy thus lowering energy efficiency. Indeed, the existing literature on the linkage between corruption and the stringency of environmental policy concludes that institutional quality influences the way policy makers respond to environmental concerns. Since the formation of environmental policy is likely to be 'representative of many other forms of government decision making' (Fredriksson and Svensson, 2003), results here might be illuminative in the research of the relationship between corruption and other public policies.

III. EMPIRICAL ANALYSIS

3.1 Data and Methodology

China is administratively divided into 22 provinces, 5 autonomous regions and 4 municipalities, all of which are placed directly under the Central Government. A province or an autonomous region is subdivided into (autonomous) prefectures and/or prefecture-level cities. In this paper we will use two different regional data sets to explore the causes of corruption in China. The first one is a province-level data set which consists of all 31 provincial areas in the mainland of China. To ensure the comparability of the data, we collected data only from 1998 to 2007 as the definition and hence the statistical calibre of the crime of corruption and bribery which was changed in 1997 due to an amendment to the Criminal Law of China. It should also be noted that we have not included data from Hongkong, Macao and Taiwan due to the obvious differences in the political and legal systems between these areas and other parts of China.

Corruption data was derived from the *China Procuratorial Yearbooks.* We collected the number of annual registered cases on corruption in procurator's office by region. Glaeser and Saks (2006, p. 1058) state: "Because the conviction data are less subjective, cover a longer time span, and are not subject to the problems of sampling error and survey non-response, we

believe that using these data has distinct advantages over the survey-based evidence". We then divided these registered cases by the regional population in order to obtain the regional registered corruption cases rate per 100,000 people. An overview of ranking corruption levels by region is presented in Table 2. We can observe there is a fairly wide degree of variation across regions ranging from 1.77 in Tibet to 5.01 in Tianjin[2].

Table 2

Average annual registered cases on corruption per capita across regions in China (1998-2007)

Region	Average annual registered cases per 100,000 Pop.	Region	Average annual registered cases per 100,000 Pop.	Region	Average annual registered cases per 100,000 Pop.
Tianjin	5.01	Shaanxi	3.15	Yunnan	2.61
Heilongjiang	4.77	Qinghai	3.08	Hunan	2.59
Jilin	4.50	Ningxia	3.08	Hainan	2.59
Liaoning	4.12	Hubei	3.05	Beijing	2.59
Shanxi	3.83	Guizhou	2.95	Chongqing	2.49
Hebei	3.67	Zhejiang	2.91	Anhui	2.36
Shandong	3.62	Inner Mongolia	2.77	Sichuan	2.35
Xinjiang	3.41	Shanghai	2.77	Gansu	2.05
Fujian	3.40	Jiangsu	2.71	Guangdong	2.05
Henan	3.35	Guangxi	2.64	Tibet	1.77
Jiangxi	3.29				

Glaeser and Saks (2006) have shown that the conviction rates they used are positively correlated with the survey of state house reporters' perception of public corruption. In our case, we check the robustness by using an alternative proxy for corruption. The second data set we use is a data set of 120 prefecture-level cities in China which comes mainly from the survey on the investment climate of Chinese prefecture-level cities conducted by World Bank and the Enterprise Survey Organization of China in 2005 (World Bank, 2007). The survey sampled 100 industrial firms in each city (except in four municipalities where 200 industrial firms were sampled) to evaluate the investment climate of 120 cities covering almost all of the Chinese provinces. In their paper, Cai, Fang and Xu (2009) used the entertainment and travel costs relative to the sales of firms as an indirect measure of corruption in Chinese firms since "Chinese managers commonly use the entertainment and travel costs accounting category to

[2] We here do not use the provincial number of officials investigated in registered cases on corruption per 100,000 population to measure the regional corruption levels in China, which might be closer to the approach of Glaeser and Saks (2006) since this corruption measure is only available in the period from 2003 to 2007. However, the extremely high correlation between this measure and the provincial number of registered cases on corruption per 100,000 population ensures the qualification of the provincial number of registered cases on corruption per 100,000 population as a measure of regional corruption levels in China.

reimburse expenditures used to bribe government officials, to entertain clients and suppliers, or to accommodate managerial excess" (Cai, Fang and Xu, 2009, p.1). Similar to them, we will, in our second data set, utilize the average value of this measure of firms investigated in the above survey in a city as a proxy for the corruption level of the city. The detailed description of other variables in our second set is listed in the appendix.

There are two main problems in our econometric analysis. The first is that of the data noise. Glaeser and Saks (2006) found "the annual fluctuations in convictions to be too noisy to identify any interesting relationships" (p. 1062). We address the similar problem of our first panel data set in two ways. First, similar to Glaeser and Saks (2006), we use the five-year averages of all variables to eliminate data noise, and then to estimate the cross-sectional regressions. This approach, although it effectively reduces data noise, leads to a small sample size (31). The second approach we adopt to control for data noise is to run the fixed-effects panel analysis thereby controlling both time fixed effects and regional fixed effects. This approach can make use of a large sample while its effect on data noise is a bit weaker. The second problem we may find in our analysis is the endogeneity problem, which will be discussed in detail later. There are two approaches addressing the endogeneity problem in econometrics: the fixed-effects and the instrumental variables approaches. The fixed-effects regression can only effectively control for endogeneity due to time invariant effects, while the IV approach is able to address the endogeneity due to both time invariant effects and to time varying effects. In summary, to control for both the data noise and the potential endogeneity bias in our provincial analysis, we have run fixed-effects regressions in our panel analysis and adopted an IV approach, namely instrument provincial corruption levels with geographic factors, in our cross-sectional analysis with the five-year averages of all variables. Since there are no concerns of data noise in our second cross-sectional data set of Chinese cities, we will adopt the IV approach whenever needed in order to resolve the potential endogeneity problem in this analysis. Details will be discussed later.

3.2 Corruption, Economic Growth and Income Distribution

We first test the effect of corruption upon economic growth. Levine and Renelt (1992) identified in their cross-country analysis three variables robust in determining growth: the initial level of real GDP per capita related to the conditional convergence hypothesis, the average share of investment in GDP, the education attainment as a proxy for human capital. Pellegrini and Gerlagh (2004), however, found that trade openness also significantly promotes

economic growth when studying the relationship between corruption and growth. Since China is now a newly industrialized country, the difference in industrialization among the various Chinese regions might be an important reason for the difference in economic growth within them. Our specification for the investigation of the relationship between corruption and economic growth in China therefore is,

$$\begin{aligned}\textit{Growth Rate of Regional GRP per Capita} = {} & \beta_0 + \beta_1 \bullet \textit{Initial Regional GRP per Capital} \\ & + \beta_2 \bullet \textit{Regional Investment Ratio} + \beta_3 \bullet \textit{Regional Education Attainment} \\ & + \beta_4 \bullet \textit{Regional Trade Openness} + \beta_5 \bullet \textit{Regional Corruption Rate}\end{aligned}$$

where we measure regional trade openness using the ratio of import and export to the gross regional product and regional education attainment as the regional share of the population with college completed. The Gross Regional Product will henceforth be referred to as GRP.

We start with the common specification without the corruption variable to test the appropriateness of our basic specification for the explanation of economic growth. Then we focus on the relationship between corruption and economic growth. We run OLS regressions at first to obtain the cross-sectional results since there seems to be no evidence of the reverse causality from economic growth to corruption in literature[3]. Since short-term shocks might mask the long-term growth tendency, we employ the average growth rate during the period from 1998 to 2007 as the dependent variable in the cross-sectional regressions. After completing the cross-sectional analysis, we apply the fixed-effect panel estimation to address the potential omitted bias.

Results are presented in Table 3. Results in columns (2) and (5) are in line with the consensus in growth regressions (Levine and Renelt, 1992). This justifies our specification. In Table 3, the negative parameter on initial income level indicates income convergence among regions in China. Investment and industrialization strongly encourage economic development, while education and openness insignificantly promote economic growth. The substantially negative effect of the *West* dummy, however, reflects the fact that Western regions in China lag far behind other regions in economic development. More importantly, similar to Mo (2001) and

[3] In Mauro (1995), there is no significant difference between the results of OLS and IV approach about the impact of corruption on economic growth. Mo (2001) also argued that economic growth is unlikely to exert a direct effect on the corruption level in cross-sectional studies as "corruption is commonly considered an institutional problem that lasts for a long period." Furthermore Gundlach and Paldam (2009) found that the long-run causality between corruption and income is completely from income to corruption.

Glaeser and Saks (2004), our regressions only provide weak evidence that corruption retards economic growth in China. As can be seen, the coefficient is not statistically significant.

Table 3
Effect of average corruption rate on economic growth: cross-province evidence

	Average Growth Rate (1998-2007) OLS			Annual Growth Rate (1998-2007) Fixed effects		
	(1)	(2)	(3)	(4)	(5)	(6)
Cases	-0.0011		-0.0062*	-0.0032		-0.0010
	(0.0025)		(0.0037)	(0.0027)		(0.0023)
Income		-0.023*	-0.018*		-0.016**	-0.016**
		(0.011)	(0.0096)		(0.0076)	(0.0076)
Education		0.0048	0.0060		0.00065	0.00083
		(0.0058)	(0.0061)		(0.0043)	(0.0043)
Investment		0.16***	0.17***		0.12***	0.12***
		(0.056)	(0.056)		(0.020)	(0.021)
Openness		0.012	0.0025		0.0053	0.0048
		(0.0092)	(0.0090)		(0.0078)	(0.0081)
Industrialization		0.00074**	0.0011***		0.054**	0.058**
		(0.00032)	(0.00035)		(0.026)	(0.028)
West		-0.025**	-0.028**			
		(0.011)	(0.011)			
Constant	0.12***	0.21**	0.18**	0.12***	0.16**	0.16**
	(0.0088)	(0.079)	(0.067)	(0.011)	(0.067)	(0.067)
Observations	31	31	31	310	310	310
R-squared	0.005	0.38	0.46	0.10	0.54	0.54

Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. The education attainment is henceforth expressed in logarithm. All explanatory variables are lagged by one year in our panel estimations hereafter, except that income variable in Columns (5) & (6) is lagged by two years. In the cross-sectional provincial regressions, *Income* is measure by its value in 1997 here. *Corruption* is henceforth gauged by its average value during 1998-2002. All other explanatory variables are measured with their averages for the period 1998-2007 respectively.

Now we use the alternative corruption measure, the average entertainment and travel costs relative to the sales of sample firms in Chinese cities (ETC hereafter), from the city-level data set to re-examine the relationship between corruption and economic growth in China. Cai, Fang and Xu (2009) found that "ETC is a mix that includes 'grease money' to get better government services, 'protection money' to lower tax rates" (p.2), as well as other expenditures. They observed that some components of ETC promote firm performance though the overall effect of ETC is negative. They, however, recognize that their firm-level findings do not necessarily mean that ETC expenditures are socially "grease the wheels" or "sands the wheels". We will make an attempt here to locate the social influence of ETC as an indirect corruption measure by exploring its effect on regional economic growth.

We first investigate the direct effect of corruption on economic growth in Chinese cities.

Since the corruption measure here comes from industrial firms, we will therefore focus on its effect on the growth rate of the industrial output per capita in cities, which is highly correlated with the growth rate of the GDP per capita. Data availability here allows us to adopt a richer specification than in provincial analysis. Following Fisman and Svensson (2007), we control the average tax burden of firms in cities, measured by the average taxes and fees relative to firm sales, in our regressions. Furthermore the industrial contribution to GDP is also added to represent the industrialization of cities. In addition to this we use average city road mileage per 10000 people in 2004 to proxy for the infrastructure endowment of Chinese cities in regressions since Demurger (2001) emphasized the effect of infrastructure on economic development in China. Due to the lack of education data, we however employ local public library collections per 100 people in 2003 to proxy for general education levels in cities.

Table 4

Effect of average ETC on economic growth: cross-city evidence

	Growth rate of industrial output per capita (2004-2007)				
	(1)	(2)	(3)	(4)	(5)
ETC	-0.034	-0.019			-0.059
	(0.042)	(0.040)			(0.039)
Loan pay			0.0051*		0.0077**
			(0.0031)		(0.0033)
Red tape				-0.0011*	-0.0016**
				(0.00065)	(0.00070)
Tax		-0.037**	-0.041***	-0.035**	-0.025
		(0.016)	(0.014)	(0.015)	(0.016)
Industrial output per capita		-0.13***	-0.13***	-0.12***	-0.11***
		(0.031)	(0.033)	(0.030)	(0.031)
Investment		0.38***	0.41***	0.39***	0.48***
		(0.12)	(0.12)	(0.12)	(0.12)
Openness		0.00015	0.00019	0.00013	0.00016
		(0.00031)	(0.00031)	(0.00031)	(0.00030)
Education		0.00030	0.00033	0.00034	0.00035
		(0.00023)	(0.00022)	(0.00025)	(0.00024)
Industrialization		0.0060**	0.0067***	0.0060***	0.0050**
		(0.0024)	(0.0021)	(0.0023)	(0.0024)
Infrastructure		0.0035	0.0098	-0.00041	0.0021
		(0.039)	(0.039)	(0.039)	(0.037)
Constant	0.76***	1.66***	1.55***	1.64***	1.51***
	(0.049)	(0.25)	(0.27)	(0.25)	(0.26)
Observations	120	118	118	118	118
R-squared	0.01	0.32	0.33	0.33	0.37

Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. *ETC, Loan pay, Red tape,* and *Tax* are derived from World Bank (2007). *Investment, Openness,* and *Industrialization* are measured by their averages in the period 2004-2007 respectively. *Education* and *Infrastructure* are henceforth represented by their values in 2003 and 2004 respectively. And we use the 2004 value of *Industrial output per capita* in regressions.

Results in Table 4 generally support those in Table 3. The coefficient of initial industrial output per capita is significantly negative. Investment and industrialization substantially promote economic growth, while education and openness insignificantly encourage economic development. In addition, we find in Table 4 that consistent with Fisman and Svensson (2007), the average tax burden here substantially lowers economic growth, while the effect of regional infrastructure stock on economic growth seems ambiguous. More importantly, similar to our finding in Table 3, corruption measured by ETC also has an insignificantly negative effect on regional economic performance.

However, the share of firms which believe in the need for informal payment to obtain bank loans in cities (*Loan pay*), which in turn can be treated as another indirect corruption measure though constrained to the credit area, does have a significantly positive effect on economic growth ("greases the wheels"). Since the informal payment to obtain bank loans as discussed previously is one of the "grease money" components of the *ETC* measure, the reason for the positive effect of the measure might be that the larger share of firms which believe in the need for informal payment to obtain bank loans in Chinese cities is correlated with a larger opportunity for firms there to illicitly circumvent the appraisals of banks most of which are state-owned in order to finally obtain loans. Compared to those in cities where banks are not corrupt, the firms in cities with corrupt banks make more informal payment to bank officials and hence have easier access to bank loans though at some cost. They consequently also grow faster.

Furthermore, we also found that government red tape proxied by the average days per year that enterprise staff must spend interacting with government bureaucracies in cities (*Red tape*) significantly impedes economic growth. It is natural that firms in cities with more bureaucratic red tape have to spend more time and money to go through or circumvent the red tape. The money that firms have spent on red tape is of course one of the "protection money" parts of ETC. This kind of "protection money" has a socially negative effect on economic performance ("sands the wheels") by a wasting productive resource although an individual firm might benefit from it. It hence can also be labelled as the "sand money".

Table 5

Decomposition of effect of average ETC on economic growth

	Average ETC of firms		Growth of industrial output per capita			
	(1)	(2)	(3)	(4)	(5)	
Loan pay	0.12***					
	(0.0085)					
Red tape		0.017***				
		(0.00087)				
Grease component			0.043*		0.052**	[0.160]
			(0.026)		(0.026)	
Sand component				-0.067*	-0.082**	[-0.161]
				(0.039)	(0.041)	
Tax			-0.041***	-0.035**	-0.035**	[-0.272]
			(0.0140)	(0.0149)	(0.0147)	
Industrial output per capita			-0.13***	-0.12***	-0.12***	[-0.685]
			(0.033)	(0.030)	(0.031)	
Investment			0.41***	0.39***	0.44***	[0.304]
			(0.12)	(0.12)	(0.13)	
Openness			0.00019	0.00013	0.00017	[0.075]
			(0.00031)	(0.00031)	(0.00031)	
Education			0.00033	0.00034	0.00037	[0.114]
			(0.00022)	(0.00025)	(0.00025)	
Industrialization			0.0067***	0.0060***	0.0062***	[0.290]
			(0.0021)	(0.0023)	(0.0022)	
Infrastructure			0.0098	-0.00041	0.0048	[0.013]
			(0.039)	(0.039)	(0.038)	
Constant			1.55***	1.64***	1.52***	
			(0.27)	(0.25)	(0.27)	
Observations	120	120	118	118	118	
R-squared	0.71	0.79	0.33	0.33	0.35	

Notes: Robust standard errors in parentheses . *** p<0.01, ** p<0.05, * p<0.1. Beta coefficients in brackets.

Though ETC includes both "grease money" and "sand money" ("protection money") as discussed before, it is very difficult to completely isolate the two components of ETC since we do not know the detailed composition of ETC of each firm. We will nonetheless try to explore whether the overall corruption measure: ETC greases and sands the wheels simultaneously in Chinese cities since it includes both "grease" and "sand" components. As discussed above the *Loan pay* variable and the *Red tape* variable are highly correlated with both the "grease" component and the "sand" component of ETC respectively. We hence first run two regressions where ETC is a dependent variable and the *Loan pay* (grease aspect) and the *Red tape* (sand component) are the independent factors respectively (see column (1) and (2) in Table 5). Then we use the predictions of ETC as proxies for the "grease" and "sand" component of ETC respectively into the previous growth regressions to test their effects on economic growth. Results in Table 4 confirm previous conjunctures. The proxy for the "grease" component of the

ETC does have a significant positive effect on the economic growth of Chinese cities, while the proxy for the "sand" part of ETC indeed has a substantial negative impact on economic growth showing similar relative strengths when looking at the standardized (beta) coefficients. Such a result is consistent with our previous finding that the corruption measured by ETC has an overall insignificant negative effect on growth.

In summary, these results indicate that corruption greases and sands the wheels simultaneously. The overall effect of corruption on growth depends on which effect dominates. It seems that in China there is a non robust or even insignificant relationship in many cases between growth and corruption. This has been observed by Mauro (1995) and Mo (2001), among others. Recently Mendez and Sepulveda (2006) documented that the effect of corruption on economic growth depends on the quality of the political institutions. Moreover Adit, Dutta and Sena (2008) further observed that corruption has a substantial negative effect on growth in countries with high quality institutions, while it has an insignificant impact on economic growth in countries with low quality institutions.

In general, studies fail to explore single elements of corruption. An analysis as the one done here decomposing potential elements can provide new insights in the literature. It therefore appears that corruption can have both positive and negative effects and that the overall effect may depend on the balance between components, which is probably determined by the institutional quality[4].

An important issue that relates to economic growth is one of income distribution. This is also a key aspect of economic development. We will here turn to investigate the association between corruption and that of income distribution. Since we only have the Gini coefficients of Chinese provinces before 2001, we have to find alternative measures of income inequality in our cross-section provincial analysis. Kanbur and Zhang (1999) and Sicular, Yue, Gustafsson and Li (2007) have found that the urban-rural income gap is the main source of the overall inequality in China. We therefore use this income gap as a proxy for regional income inequality in China. We employ the ratio of the per capita annual consumption expenditure of urban households to that of rural households to measure the income gap in our provincial cross-section analysis. Due to the lack of data, we will not investigate the linkage between corruption and income inequality at the city level.

[4] Actually the corruption measure in our first province-level data set: the regional registered cases on corruption in procurator's office, is also a comprehensive corruption measure since officials involved in corruption cases probably accept "grease money" and/or "sand money". We however cannot decompose this measure as what we have done to the ETC due to the lack of detailed information.

Table 6

Effects of corruption on economic inequality: cross-province evidence

	Province-level			
	Consumption expenditure ratio (2003-2007)		Gini Coefficient (1999-2000)	
	OLS	2SLS	POLS	FE
	(1)	(2)	(3)	(4)
Corruption	0.20*	0.31*	0.015**	0.014**
	(0.11)	(0.17)	(0.0059)	(0.0055)
Income	-0.96***	-0.97***	-0.0047	0.00010
	(0.21)	(0.19)	(0.020)	(0.019)
Education	0.093***	0.11**	-0.0034	-0.00086
	(0.028)	(0.044)	(0.0025)	(0.0023)
Openness	1.13***	1.29***	0.032	0.030
	(0.29)	(0.35)	(0.021)	(0.031)
Industrialization	0.080	-0.33	-0.15*	-0.14
	(1.11)	(0.71)	(0.082)	(0.11)
Expenditure	3.74***	3.81***	-0.18	-0.48**
	(0.84)	(0.78)	(0.17)	(0.19)
Urbanization	-2.47***	-3.16***	0.020	0.0010
	(0.74)	(1.21)	(0.026)	(0.029)
Constant	10.46***	10.44***	0.34*	0.36*
	(1.66)	(1.47)	(0.17)	(0.19)
Observations	31	31	56	56
R-squared	0.73		0.26	0.60

Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Unless noted, all explanatory variables hereafter are measured with their averages for the period 1998-2002 respectively in our cross-sectional provincial regressions.

We have adopted a specification similar to Li, Xu and Zou (2000) in order to examine the relationship between corruption and income inequality. To address the reverse causality from income inequality to corruption we have introduced the latitudes of provincial capitals as an instrument for provincial corruption levels since the latitudes are obviously exogenous and highly correlated with provincial corruption levels. It should be noted that the results in Table 6 are consistent with Li, Xu and Zou (2000) and Gupta, Davoodi and Alonso-Terme (2002) in that corruption substantially increases income inequality. As to other explanatory variables, income basically has a negative impact on income equality, which is in line with most previous findings. Furthermore openness generally increases income inequality, which is also consistent with Barro (2000), and Lundberg and Squire (2003).

3.3 Corruption and Inbound Foreign Direct Investment

Mauro (1995), Mo (2001), and Pellegrini and Gerlagh (2004) have documented the fact that investment is the main channel through which corruption influences economic growth:

"Corruption is found to lower investment, thereby lowering economic growth" (Mauro, 1995, p.681). We will focus here on the effect of corruption upon a special kind of investment: foreign direct investment. Does corruption deter inward foreign direct investment in China as some prior literature would suggest? According to Wei (2000a, b), China seems to be a puzzle in terms of its relationship between corruption and FDI inflows. China has been the largest developing host of FDI for 16 consecutive years while simultaneously being reported in international surveys as being severely corrupt. Wei (2000b) performs a cross-country analysis including a Chinese dummy and concludes that "corruption is just as damaging to FDI into China as it is elsewhere" (p.321) basing this statement on the fact that coefficients on the corruption variable and the Chinese dummy in regressions are significantly negative. This insightful finding, however, is not fully convincing. The negative coefficient on corruption in their cross-country analysis does not necessarily mean that corruption significantly deters FDI inflows in China since China-related data only cover 2% of the sample used. Moreover the negative coefficient on the China dummy might be due to some unobservable factors rather than on corruption since country corruption levels have been controlled simultaneously in their regressions. To make a solid finding of the linkage between corruption and FDI inflows in China, we will perform a within-country analysis here, controlling for the endogeneity problem with both the fixed-effects and instrumental variable approaches.

Similar to Harms and Ursprung (2002), we use the regional average annual FDI inflow per capita as the dependent variable. Besides the key explanatory variable: corruption, we have, following (Wei, 2000a, b), and Egger and Winner (2005), introduced several common controls such as income level and education level in our regressions. We first perform the provincial analysis. We start with OLS regressions. To address the reverse causation between corruption and FDI that Larraín and Tavares (2003, 2007) pointed out, we then perform IV regressions with latitudes of provincial capitals as the instrument for provincial corruption in our cross-sectional analysis, and run fixed effects regressions in our panel analysis. To check the robustness of our provincial results, we also perform the city-level analysis. We routinely run both the OLS regression and the IV regression with the latitudes of the cities and the big city dummy as instruments for the corruption levels of cities.

Table 7

Effect of corruption rate on inbound FDI: cross-province evidence

	FDI per capita					
	Province level (2003-2007)				City level (2004-2007)	
	OLS	2SLS	POLS	FE	OLS	2SLS
	(1)	(2)	(3)	(4)	(5)	(6)
Corruption	-1.44**	-2.53***	-0.088	-0.77***	-8.52***	-32.09**
	(0.53)	(0.91)	(0.19)	(0.27)	(3.24)	(13.85)
Income	6.83***	6.31***	4.96***	5.81***	14.78***	14.62***
	(1.44)	(1.43)	(0.63)	(0.69)	(3.08)	(3.39)
Education	3.17*	2.31	-0.41	0.79**	0.080	0.096**
	(1.85)	(1.69)	(0.46)	(0.36)	(0.049)	(0.045)
Population	0.11	-0.59	-0.37	-1.19***	-8.86*	-12.04**
	(0.91)	(0.98)	(0.28)	(0.39)	(4.54)	(4.82)
Industrialization	17.59*	25.66***	-0.36	8.98**	-0.13	-0.66**
	(8.84)	(9.87)	(3.05)	(3.85)	(0.20)	(0.34)
Infrastructure	0.61***	0.63***	0.27***	0.23***	-9.09**	-8.09*
	(0.083)	(0.078)	(0.031)	(0.034)	(4.55)	(4.37)
Constant	-54.68***	-45.38***	-39.45***	-48.39***	-31.48	39.20
	(14.22)	(15.79)	(5.68)	(6.89)	(54.06)	(68.22)
Observations	31	31	303	303	116	116
R-squared	0.93		0.80	0.88	0.58	

Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. In our city-level analysis, *Income* is represented by its value in 2004 hereafter. And *Population* is measure by its value in 2004 here.

Table 7 shows results that consistent with previous findings. Corruption hinders inward foreign direct investment both significantly and robustly in China. Hence the nexus of corruption and FDI in China, which has seemed to be perplexing in our cross-country comparison, does indeed not contradict prior theoretical and empirical findings. In this sense, China is a normal country. Additionally, in line with previous literature, high levels of income and education stimulate regional FDI levels significantly.

We now include another important determinant of inward FDI namely that of pollution in our study in order to further investigate the relationship between corruption and inward FDI in China. This, in effect, is also the examination of the pollution haven hypothesis in China. According to Javorcik and Wei (2004), the pollution haven hypothesis refers to the probability that international corporations move to regions with lax environmental regulations. Similar to Levinson (1996), we are looking for the within-country evidence of the pollution haven hypothesis. We continue to use the regional FDI per capita to indicate the regional inbound FDI level. Since the environment policy is formulated by the central government, the regional difference of environment stringency in China lies only in the enforcement of the environment policy. Here we use the regional ratio of the industrial waste water meeting discharge standards

to capture the regional difference in the enforcement of environment policy and therefore the environmental stringency in China.

In provincial analysis, we start with OLS regressions and then adopt both the IV approach in the cross-sectional analysis and the fixed effects approach in the panel regressions to address the endogeneity problem. With a similar specification we run OLS and 2SLS regressions in our city-level analysis. From the results in Table 8, we find that corruption continues to exert a significantly negative effect on local attraction to foreign direct investment when considering the environmental stringency. Unfortunately we only have mixed evidence of the pollution haven hypothesis in China. A plausible interpretation of our results can be derived from Dean, Lovely and Wang (2004). They found that Chinese-sourced FDI is discouraged by stringent environmental regulation in Chinese provinces while non-Chinese-sourced FDI is in fact attracted to provinces with stringent environmental policy.

Table 8
Testing the pollution haven hypothesis: cross-province evidence

	FDI per capita					
	Province level (2003-2007)				City level (2004-2007)	
	OLS	2SLS	POLS	FE	OLS	2SLS
	(1)	(2)	(3)	(4)	(5)	(6)
Cases	-1.43**	-2.61***	0.035	-0.76***	-8.52**	-32.24**
	(0.53)	(0.91)	(0.19)	(0.28)	(3.25)	(13.78)
Waste water	5.34	5.24	-4.02**	-2.56**	0.0016	0.0029
	(3.60)	(3.58)	(1.75)	(1.27)	(0.10)	(0.14)
Income	6.58***	6.02***	5.85***	5.67***	14.77***	14.60***
	(1.41)	(1.45)	(0.79)	(0.67)	(3.35)	(3.52)
Education	5.06*	4.10*	-0.52	1.14***	0.080	0.096**
	(2.59)	(2.41)	(0.58)	(0.40)	(0.050)	(0.045)
Population	0.36	-0.40	-0.053	-1.08***	-8.87*	-12.07**
	(0.85)	(0.99)	(0.34)	(0.39)	(4.57)	(4.86)
Industrialization	16.60*	25.36**	-2.55	10.11**	-0.13	-0.66**
	(9.04)	(10.40)	(3.30)	(4.01)	(0.20)	(0.34)
Infrastructure	0.59***	0.61***	0.27***	0.23***	-9.09**	-8.09*
	(0.084)	(0.077)	(0.033)	(0.034)	(4.58)	(4.38)
Constant	-53.90***	-43.86***	-46.45***	-41.28***	-31.49	39.66
	(13.53)	(15.85)	(6.42)	(6.19)	(54.27)	(68.19)
Observations	31	31	301	301	116	116
R-squared	0.93		0.80	0.88	0.58	

Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. The *Waste water* variable is represented with its value in 2003 in the city-level analysis henceforth.

Table 9

Effects of corruption on public finance: cross-province evidence

	Tax revenue/GRP (2003-07)				Education expenditure/GRP (2003-06)				Science expenditure/GRP (2003-06)				Health expenditure/GRP (2003-06)			
	OLS	POLS	2SLS	FE	OLS	POLS	2SLS	FE	OLS	POLS	2SLS	FE	OLS	POLS	2SLS	FE
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Cases	-1.07***	-0.52***	-2.33***	-0.54***	-0.076	-0.18***	-0.32**	-0.16***	-0.014	0.0031	-0.061*	-0.012*	-0.036	-0.081***	-0.12*	-0.080***
	(0.33)	(0.084)	(0.71)	(0.11)	(0.078)	(0.041)	(0.15)	(0.048)	(0.012)	(0.0047)	(0.033)	(0.0065)	(0.037)	(0.014)	(0.069)	(0.020)
Income	1.39	1.24***	-0.16	2.17***	-0.17	-0.22	-0.17	-0.20	0.098*	0.042***	0.091	0.055**	0.0039	0.0012	0.011	0.075
	(1.49)	(0.28)	(1.48)	(0.39)	(0.21)	(0.16)	(0.23)	(0.22)	(0.052)	(0.014)	(0.057)	(0.024)	(0.12)	(0.056)	(0.13)	(0.095)
Population	0.23	-0.58***	-0.18	-0.82***					-0.022	-0.055***	-0.056	-0.071***	-0.15	-0.46***	-0.18	-0.41***
	(0.59)	(0.097)	(0.55)	(0.10)					(0.025)	(0.0066)	(0.037)	(0.0093)	(0.15)	(0.064)	(0.14)	(0.060)
Education	0.49	1.52***	-1.45	1.52***	2.45***	-0.60***	2.18***	-0.81***	0.16***	-0.017	0.12**	-0.036***	0.99***	-0.26***	0.89***	-0.35***
	(1.93)	(0.30)	(1.51)	(0.29)	(0.55)	(0.18)	(0.47)	(0.13)	(0.045)	(0.011)	(0.053)	(0.011)	(0.22)	(0.051)	(0.19)	(0.046)
Urbanization	10.87**	0.95	17.28***	1.83***										0.18**		0.46***
	(4.53)	(0.62)	(4.72)	(0.68)										(0.088)		(0.090)
Industrialization									0.40**		0.72**	0.45***				
									(0.17)		(0.33)	(0.084)				
Students					0.009	-0.038***	0.002	-0.032***								
					(0.001)	(0.004)	(0.009)	(0.003)								
Researchers									0.0074*	0.0045***	0.0093**	0.0049***				
									(0.0042)	(0.0012)	(0.0040)	(0.0012)				
Sick beds													0.022	0.017**	0.023*	0.013*
													(0.014)	(0.0075)	(0.013)	(0.0067)
Central cities									-0.19*	-0.069**	-0.25**					
									(0.10)	(0.031)	(0.098)					
Constant	-6.88	-1.82	8.47	-8.10**	9.03***	6.49***	9.34***	7.55***	-0.29	0.27**	0.0077	0.18	3.77**	4.76***	4.07**	3.68***
	(12.13)	(2.23)	(12.48)	(3.23)	(1.45)	(1.16)	(1.63)	(1.90)	(0.47)	(0.12)	(0.62)	(0.23)	(1.76)	(0.75)	(1.71)	(1.05)
Observations	31	284	31	284	31	248	31	248	31	248	31	248	31	227	31	227
R-squared	0.72	0.58		0.75	0.87	0.48		0.75	0.60	0.29		0.52	0.86	0.70		0.81

Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. *Students* and *Researchers* are gauged with their averages for the period from 2003 to 2007. *Sick beds* are measured with its average value in the period 2003-2006. GRP: Gross Regional Product.

3.4 Corruption and Public Finance

Bureaucratic corruption also affects government revenue and expenditure. Following Tanzi and Davoodi (1997) and Mauro (1998), we examine the effects of corruption on the revenue and expenditure of local governments in China. We first explore whether regional corruption influences the tax revenue of local government. Then we turn to the association between corruption and the composition of government expenditure. Our specification is a bit richer than those found in prior studies. Similar to Mauro (1998), we use ratios of tax revenue and government expenditures to GDP as dependent variables in regressions. Furthermore we use a dummy to indicate municipalities in the regression of tax revenue since they are different from others provinces in taxation. To deal with the potential endogeneity bias, we instrumented provincial corruption rates here with latitudes of provincial capitals as before. Results of IV regressions in Table 9 coincide with those in Tanzi and Davoodi (1997) and Mauro (1998). Corruption has a significantly negative effect on tax revenue and government expenditure on education. Furthermore we find that corruption decreases government expenditure on science and health. These findings are reasonable and consistent with Mauro (1998)'s theoretical analysis.

Table 10

Effects of corruption on government expenditure: cross-city evidence

	Education expenditure/GDP		Science expenditure/GDP	
	OLS	2SLS	OLS	2SLS
	(1)	(2)	(3)	(4)
ETC	-0.039	-0.64*	-0.0040	-0.055*
	(0.10)	(0.35)	(0.0044)	(0.033)
Income	-0.75***	-0.84***	-0.0015	-0.012
	(0.089)	(0.13)	(0.0038)	(0.0092)
Population			0.0048	-0.00012
			(0.0050)	(0.0076)
Education	0.0030***	0.0037***	0.00031***	0.00031***
	(0.00071)	(0.00077)	(0.00005)	(0.00008)
Students	-0.0076	-0.034		
	(0.032)	(0.037)		
Researchers			0.0085	0.025
			(0.023)	(0.026)
Constant	8.30***	9.94***	-0.010	0.18
	(0.87)	(1.48)	(0.049)	(0.15)
Observations	120	120	119	119
R-squared	0.45		0.51	

Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. *Population, Students*, and *Researchers* are represented by their values in 2005 henceforth.

We then retest provincial findings with the city-level data. Due to the lack of data, in this instance we only study the impact of corruption upon government expenditures on education and science in Chinese cities. We employ latitudes of cities and a dummy indicating "big cities" in China (4 municipalities, 31 provincial capitals and 5 cities specifically designated in the state plan) as the instruments of *ETC* since these geographic factors are clearly exogenous and closely correlated with the *ETC*. We conduct first OLS and then IV regressions in order to investigate the effect of *ETC* upon government expenditure on education and science. Results in Table 10 support our cross-province findings in Table 9.

3.5 Corruption and the Environment

In this section we will turn to the relationship between corruption and the environment. We will first study the association between corruption and pollution. Welsch (2004) and Cole (2007) apply simultaneous equations to estimate the effect of corruption on the pollution since they assume that besides its direct effect on pollution, corruption also has an indirect impact on pollution through lowering income level. However, according to Glaeser and Saks (2006), Gundlach and Paldam (2009) and Dong and Torgler (2010), the causality between income and corruption is mainly from income to corruption. We can therefore estimate the effect of corruption on pollution with a single equation. We use SO_2 emission per capita and soot emission per capita as alternative measures for pollution emissions. Due to the existence of the environmental Kuznets curve (Dasgupta, Wang and Wheeler, 2002), we include income per capita, its quadratic term and even cubic term in our specification. Following Fredriksson, Vollebergh and Dijkgraaf (2004), we also investigate the influence of corruption on energy efficiency, an important determinant of the environment in China. We employ the energy intensity index (energy consumption per unit of gross regional product) to measure regional energy efficiency. We set up a specification similar to the previous study and use OLS, 2SLS and fixed effects regressions. The instrumental variables used here are the same as above.

Results in Table 11 show that corruption exerts a positive effect on per capita emissions. It is in line with the findings of Welsch (2004) and Cole (2007) on the direct effect of corruption on pollution. Furthermore, similar to Fredriksson, Vollebergh and Dijkgraaf (2004), we also observe that corruption significantly enhances energy intensity and thus reduces energy efficiency in China.

Table 11

Relationship between corruption and the environment: cross-province evidence

	SO_2 emission per capita (2003-2007)				Soot emission per capita (2003-2007)				Energy efficiency (2005-2007)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(3)	(10)	(11)	(12)
	OLS	2SLS	POLS	FE	OLS	2SLS	POLS	FE	OLS	2SLS	POLS	FE
Cases	1.97	16.74**	0.93	3.01***	3.45*	10.57***	2.15***	1.76***	0.53*	1.57**	0.37***	0.28***
	(3.30)	(8.54)	(0.60)	(0.91)	(1.87)	(4.04)	(0.36)	(0.42)	(0.30)	(0.62)	(0.076)	(0.082)
Income	-199.6	3354	-1818***	-1979***	1111	2826**	-451.0**	-514.3***	-1.68**	-1.81***	-0.18	0.0060
	(1902)	(2893)	(477.1)	(399.9)	(1086)	(1424)	(203.3)	(164.1)	(0.70)	(0.69)	(0.15)	(0.26)
Income ^{2}	14.63	-387.5	195.2***	216.5***	-120.7	-314.8**	49.59**	57.44***				
	(212.1)	(321.4)	(51.60)	(43.01)	(121.1)	(158.3)	(22.00)	(17.67)				
Income ^{3}	-0.30	14.74	-6.96***	-7.875***	4.35	11.60**	-1.82**	-2.13***				
	(7.83)	(11.82)	(1.86)	(1.54)	(4.47)	(5.83)	(0.79)	(0.63)				
Education	-6.99	-3.94	0.81**	0.94**	2.29	3.766	0.44***	0.33**	-6.35	-6.74	-0.22	-0.41*
	(19.19)	(16.76)	(0.36)	(0.37)	(8.32)	(7.67)	(0.15)	(0.16)	(3.91)	(4.23)	(0.14)	(0.21)
Population	-3.92	-2.43	-0.88	-1.39	0.16	0.89	-0.60	-0.54	-0.24	0.14	0.0052	0.055
	(8.13)	(7.72)	(0.98)	(0.97)	(3.08)	(3.34)	(0.41)	(0.49)	(0.87)	(0.71)	(0.12)	(0.11)
Openness	0.72	27.87	-4.12	11.20***	-1.46	11.65	-3.67***	2.81**				
	(12.28)	(19.92)	(2.97)	(3.45)	(6.46)	(10.48)	(1.41)	(1.39)				
Expenditure									72.09**	81.89**	9.38***	8.54***
									(32.74)	(32.74)	(1.36)	(1.77)
Constant	854.7	-9578	5646***	6040***	-3389	-8424**	1373**	1536***	-2.82	-10.34	1.08	0.0058
	(5654)	(8639)	(1467)	(1235)	(3230)	(4253)	(624.4)	(506.9)	(17.92)	(14.36)	(2.16)	(2.44)
Observations	31	31	310	310	31	31	310	310	30	30	120	120
R-squared	0.06		0.10	0.44	0.25		0.21	0.54	0.67		0.66	0.75

Notes. Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

We then check the provincial findings with the city-level data. Here we employ SO_2 emission by industry per capita and soot emission by industry per capita as alternative measures for pollution emissions in Chinese cities as we did not have an overall measure of pollution emissions at a city level. We therefore use the industrial output per worker instead of GRP per capita in our specification in order to explain the pollution emissions. We run OLS regressions and 2SLS regressions with the same instruments as those in the previous city-level analysis. The results in Table 12 clearly support the positive relationship between corruption and pollution.

Table 12
Relationship between corruption and the environment: cross-city evidence

	SO_2 emission by industry per capita (2005)		Soot emission by industry per capita (2005)	
	OLS	2SLS	OLS	2SLS
ETC	0.0520	40.26*	2.602*	27.69**
	(4.250)	(21.43)	(1.522)	(11.73)
Industrial output per worker	26.74	209.6	-153.4	-39.31
	(247.1)	(403.9)	(145.7)	(204.5)
(Industrial output per worker)^2	-1.103	-8.327	6.001	1.493
	(9.681)	(15.86)	(5.677)	(8.019)
Industrialization	0.512***	1.358**	0.166*	0.694**
	(0.172)	(0.566)	(0.0846)	(0.322)
population	-13.47***	-9.365	-3.944***	-1.381
	(4.212)	(6.402)	(1.418)	(2.832)
Constant	-52.09	-1330	1010	212.9
	(1582)	(2605)	(936.3)	(1317)
Observations	120	120	120	120
R-squared	0.29		0.19	

Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. *Industrial output per worker* and *Industrialization* are measured with their values in 2005.

We proceeded to investigate the mechanism through which corruption affects pollution or environmental quality. From a different angle, Damania, Fredriksson and List (2003) and Cole, Elliott and Fredriksson (2006) argued with similar lobbying models that the level of corruption determines the relative importance of bribery versus social welfare to the government. This therefore not only directly reduces the stringency of environmental policy but also modifies the effect of other factors such as trade liberalization and FDI on the environmental policy stringency. Through the mechanisms detailed above corruption reduces the stringency of environmental policy and therefore increases pollution. With the similar specifications to Damania, Fredriksson and List (2003) and Cole, Elliott and Fredriksson

(2006), we look here for the within-country evidence of the mechanisms that they suggested. We measure the stringency of environment policy with the ratio of industrial waste water meeting discharge standards in Chinese regions. We perform OLS, 2SLS, Pooled-OLS and fixed effects regressions in turn. We first follow the path of Damania, Fredriksson and List (2003) and explore the relationship between corruption, trade liberalization and environment policy in Chinese provinces in the first four columns in Table 13. Then similar to Cole, Elliott and Fredriksson (2006), we investigate the linkage between corruption, FDI and environment policy in Chinese provinces in the last four columns of Table 13. The results in Table 13 show that provincial corruption has an overall negative effect on the stringency of environmental policy at the mean level of provincial FDI per capita or regional trade openness. Furthermore the effects of both FDI per capita and trade openness on the regional environmental policy stringency are modified by provincial corruption levels in most of the regressions in Table 13. All these findings are consistent with those of the two previous studies. However, in this instance the manner in which corruption modifies the effects of FDI and trade openness on the environmental policy strictness is opposite to that observed by Damania, Fredriksson and List (2003) and Cole, Elliott and Fredriksson (2006). As shown in Figure 1, the marginal effects of trade openness and FDI on the environmental policy stringency, which are initially negative, increase with local corruption level and become positive at within-sample levels of corruption, which contradicts the two previous studies[5]. A plausible interpretation of our results may be derived from Li and Zhou (2005). They observed that the probability of promotion or termination of local leaders depends mainly on their economic performance in China, where the Central Government essentially controls the mobility of local government leaders. We therefore assume that the local leaders in China may consider both promotion benefits and corrupt incomes when they maximize their utilities. Moreover the regional corruption level determines the relative importance of bribery vs. promotion to the leaders. The local environmental policy to some extent becomes a tool of the provincial leaders in China. When the local level of corruption is low, the regional leader's weight on promotion relative to bribery is added. Since exports and investment are the main source of economic growth in China (WTO, 2006), the local leader is likely to loosen the local environmental policy under the pressure of the export industries in order to earn a promotion. Furthermore foreign-invested companies are likely to sustain and even improve local economic performance so long as export industries and/or the foreign-invested

[5] For example, see Figure 1 in Cole, Elliott and Fredriksson (2006).

companies there play important roles in the local economy. In a highly corrupt region, the relative importance of bribery versus promotion to the local leader rises. He may have an incentive to extort bribes from local firms including foreign-invested companies and export-oriented firms in industries by the reinforcement of local government regulations including environmental ones, provided that there are enough local firms especially those export-oriented and/or foreign-invested so that he can extort lots of bribes without destroying the local economy which may cause his termination. According to this mechanism, trade openness and FDI increase the stringency of environmental policy if the local corruption level is high, while they decrease the stringency of environmental policy if the local corruption level is low. Such an explanation could explain our empirical results. Indeed it is because of the unique Chinese political system with centralized personnel control, one of the "Chinese characteristics", that the analyses of Damania, Fredriksson and List (2003) and Cole, Elliott and Fredriksson (2006) cannot be applied to China.

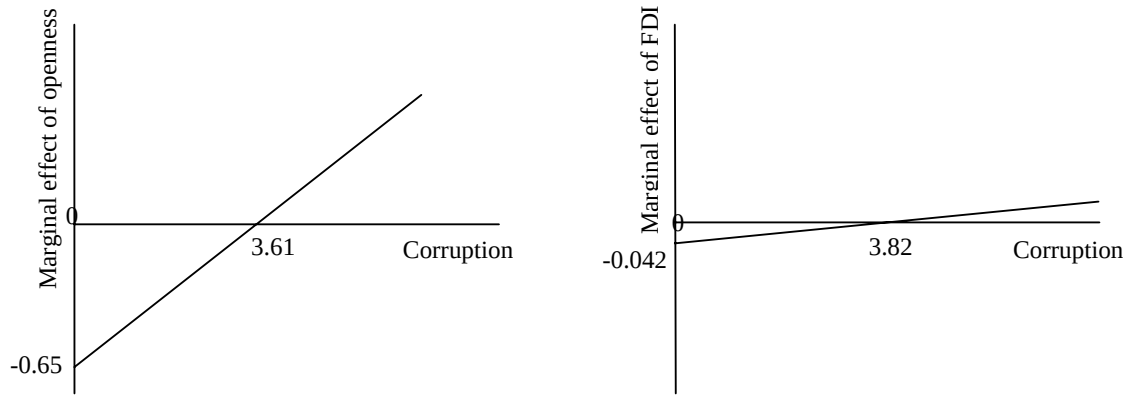
Table 13

Effect of corruption on environment policy: cross-province evidence

	Ratio of industrial waste water meeting discharge standards (2003-2007)							
	OLS	2SLS	POLS	FE	OLS	2SLS	POLS	FE
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Cases	-0.013	-0.12*	-0.018*	-0.023**	-0.0013	-0.10	-0.011	-0.019**
	(0.022)	(0.063)	(0.0093)	(0.010)	(0.020)	(0.069)	(0.0090)	(0.0097)
Openness	-0.20	-0.65**	-0.21***	-0.17**				
	(0.13)	(0.25)	(0.040)	(0.072)				
Cases*Openness	0.052	0.18**	0.061***	0.042***				
	(0.035)	(0.083)	(0.013)	(0.016)				
FDI					-0.0025	-0.042*	-0.0069*	0.00006
					(0.012)	(0.023)	(0.0041)	(0.0032)
Cases*FDI					0.0016	0.011*	0.0031***	0.0014*
					(0.0021)	(0.0060)	(0.00086)	(0.00084)
Income	-0.96	0.92	1.06***	0.64**	-0.96	0.22	1.35***	1.16***
	(1.29)	(1.00)	(0.27)	(0.27)	(1.23)	(1.00)	(0.35)	(0.26)
Income ^{2}	0.055	-0.043	-0.050***	-0.031**	0.053	-0.0047	-0.067***	-0.062***
	(0.068)	(0.052)	(0.0150)	(0.015)	(0.066)	(0.052)	(0.020)	(0.014)
Education	-0.099	0.075	0.045**	0.0068	0.10	0.27	0.059***	0.0033
	(0.17)	(0.15)	(0.022)	(0.019)	(0.20)	(0.20)	(0.020)	(0.019)
Population	-0.0017	0.029	0.052***	-0.013	-0.017	0.0080	0.058***	-0.021
	(0.042)	(0.034)	(0.015)	(0.018)	(0.040)	(0.040)	(0.015)	(0.013)
Expenditure	-1.25***	-1.82***	-0.59***	-0.90***	-3.00**	-3.69***	-0.51***	-0.95***
	(0.42)	(0.41)	(0.11)	(0.14)	(1.19)	(1.04)	(0.11)	(0.12)
Constant	5.01	-3.37	-5.075***	-2.17*	6.00	0.66	-6.37***	-4.64***
	(5.90)	(4.45)	(1.227)	(1.19)	(5.52)	(4.53)	(1.59)	(1.24)
Observations	31	31	303	303	30	30	301	301
R-squared	0.89		0.58	0.74	0.76		0.58	0.76

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Figure 1
Marginal effects of trade openness and FDI on environmental stringency conditional on corruption



Note: Marginal effects are calculated with the 2SLS results in Column (2) & (7) in Table 13.

Now we check the findings above with cross-city data. Here we can include new control variables into our basic specification due to the data availability. The regional average temperature is utilized to control the abundance of water resources since a high regional average temperature is often correlated with rich water resources in China. We also add the open policy dummy which is equal to 1 if a city is designated to open up to the outside world by the central government, and 0 otherwise. This allows controlling for the policy effects in relation to international trade and FDI in China. The results in Table 14 are consistent with the provincial findings. Corruption on average reduces the environment policy stringency. The impacts of trade openness and FDI on the environment regulations are conditional on corruption. Moreover the marginal effects of trade openness and FDI on the stringency of environmental policy increase with the corruption level from initial negative values to final positive values.

It is worth noting that the impact of the regional income level on the stringency of environmental policy is also gauged at both the province level and the city level. As Figure 2 presents, the negative quadratic relationship between the environmental policy stringency and income in our regressions indeed shows that the strictness of environmental policy increases with regional income level within our sample[6].

[6] We add the quadratic term of income level into our specifications only to guarantee the comparability between our findings and those of Damania, Fredriksson and List (2003) and Cole, Elliott and Fredriksson (2006) as both studies included the quadratic term of income in their regressions.

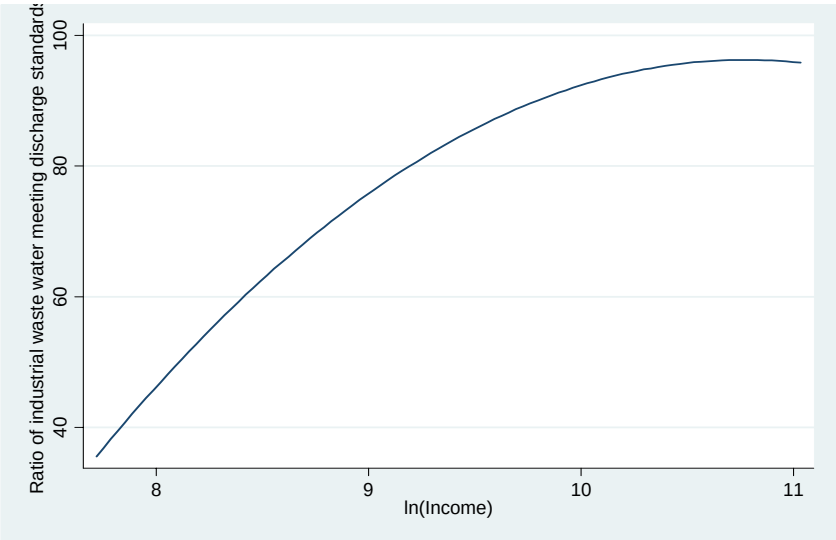
Table 14

Effects of corruption on environment policy: cross-city evidence

	Average ratio of industrial waste water meeting discharge standards (2005)			
	OLS	2SLS	OLS	2SLS
	(1)	(2)	(3)	(4)
ETC	-1.82	-17.36**	-1.46	-18.25**
	(1.44)	(7.36)	(1.70)	(7.49)
Openness	-0.0075	-0.066**		
	(0.012)	(0.031)		
ETC*openness	0.012	0.076**		
	(0.012)	(0.035)		
FDI			-0.022	-0.25**
			(0.042)	(0.11)
ETC*FDI			0.049	0.44**
			(0.066)	(0.19)
Income	59.99**	71.33**	60.50*	94.82**
	(23.95)	(30.84)	(30.63)	(41.42)
$(\text{Income})^2$	-3.09**	-3.85**	-3.10*	-5.19**
	(1.30)	(1.69)	(1.66)	(2.30)
Education	-0.012	0.0016	-0.017	-0.0059
	(0.0097)	(0.0095)	(0.012)	(0.010)
Open policy	1.66	3.38*	2.08	3.17
	(1.23)	(1.99)	(1.38)	(2.03)
Temperature	0.14	-0.085	0.20	-0.11
	(0.14)	(0.232)	(0.16)	(0.24)
Constant	-195.9*	-216.9	-201.0	-318.4*
	(110.9)	(141.1)	(142.2)	(185.2)
Observations	118	118	118	118
R-squared	0.27		0.24	

Notes: Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1. *Openness* and *FDI* are represented by their values in 2004.

Figure 2
The relationship between the ratio of industrial waste water meeting discharge standards and income



Note: The figure is drawn with the provincial panel data.

IV. CONCLUING REMARKS

Cross-country analyses in corruption with subjective survey data are suffering from a number of biases. A comprehensive case study of a representative country may provide a helpful supplement to these studies. In this paper, we investigate the consequences of corruption using two objective data sets and alternative corruption measures across Chinese regions. Glaeser and Saks (2006) pointed out that the noise of corruption data, the small sample size and the narrow variation in cross regions make it difficult for researchers to identify relationships between corruption and other variables in a within-country analysis. The relatively great regional disparity in China mitigates the problem of narrow variation across sub-nations in within-country analysis. We also employ both the instrumental variables approach with 5-year averages of variables and the fixed effects approach with a large panel data set to address data noise and the endogeneity problems which often cannot be controlled in a small sample. The fact that our results are basically consistent with prior findings somehow validates our analysis. Furthermore, two complementary data sets and alternative corruption measures in our analysis guarantee the robustness of our findings.

Our research identifies adverse influences of corruption on economic development which have been observed in cross-country studies. Like prior studies, we first observe that corruption appears to lower economic growth insignificantly. Unlike previous research, we subsequently obtain solid evidence that corruption has both simultaneous positive and negative substantial effects on economic growth. The impact of corruption detected in literature, either negative or positive, might be the balance of the two simultaneous effects in a specific institutional environment. Corruption also affects the income distribution in China which is an important aspect of economic development. Similar to cross-country analyses, we find that corruption considerably increases income inequality in China. We also find that regional corruption significantly reduces inbound foreign direct investment, a main source of economic growth in Chinese regions. This finding sheds new light on the "China puzzle" (Wei, 2000b): the seemingly positive relationship between corruption and FDI inflows in China in the previous cross-country comparison. Moreover the related pollution haven hypothesis might not hold in China since we cannot find supporting evidence for it. As to the impact of corruption on public expenditure, we observe that corruption significantly decreases government spending on education, science and public health. Additionally corruption is also found to substantially reduce tax revenue. Turning to the nexus between corruption and the environment, we observe that corruption substantially aggravates pollution mainly through loosening environment regulations. Furthermore, corruption in China is also observed to modify the effects of trade openness and FDI on the environment policy stringency in a unique way which is quite different from those suggested in previous studies.

In summary, our study casts new light in a broad manner on the consequences of corruption especially in developing countries and hence is a constructive complement to current research about the consequences of corruption.

APPENDIX

Table A1

Data Description

Variable	Data Description	Source
Cases	Regional registered cases on corruption in procurator's office per 100,000 population	China Procuratorial Yearbooks (1998-2008)
ETC	Average entertainment and travel costs relative to sales of investigated firms in cities	World Bank (2007)
Income	Logarithm of per capita real gross regional product	China Statistical Yearbooks (1998-2008) China City Statistical Yearbooks (2003-2008)
Education	Provincial fraction of the population over 6 with college completed Public library collections per 100 people in a city	China Population Statistics Yearbooks (1998-2008) China City Statistical Yearbooks (2004)
Openness	Regional ratio of import and export to gross regional product	Regional Statistical Yearbooks (1998-2008) China City Statistical Yearbooks (2003-2008)
Industrialization	Regional industrial contribution to gross regional product	China Statistical Yearbooks (1998-2008) China City Statistical Yearbooks (2003-2008)
Expenditure	Ratio of regional government expenditure to gross regional product	China Statistical Yearbooks (1998-2008) China Finance Yearbooks (1998-2008)
FDI	Regional inward foreign direct investment per capita	Statistics of Ministry of Commerce of China
Urbanization	Regional share of urban population	China Statistical Yearbooks (1998-2008) China City Statistical Yearbooks (2003-2008)
Investment	Regional investment in the fixed assets/ gross regional product	China Statistical Yearbooks (1998-2008)
Infrastructure	City road mileage per 10000 people;	World Bank (2007)
Loan pay	Average investigated firms' expectation of informal payments for loans in a city	World Bank (2007)
Tax	Average taxes and fees relative to firms' sales of firms investigated in a city	World Bank (2007)
Red tape	Average days per year that enterprise staff must spend interacting with four major government bureaucracies (tax administration, public security, environmental protection, and labour and social security)	World Bank (2007)
Students	Regional number of middle school students	China Statistical Yearbooks (1998-2008) China City Statistical Yearbooks (2003-2008)

Researchers	Regional number of research workers	China Statistical Yearbooks (1998-2008) China City Statistical Yearbooks (2003-2008)
Sick beds	Regional number of sick beds	China Statistical Yearbooks (1998-2008)
population	Regional population	China Statistical Yearbooks (1998-2008) China City Statistical Yearbooks (2003-2008)
Open policy	Dummy which equals 1if a city is among cities designated to open up to the outside world, 0 otherwise	Several documents issued by the State Council of China
West	Dummy which equals 1 when a region is in West China, 0 otherwise	Regional Statistical Yearbook 1998
Capital	Dummy which equals 1if a city is among bigger cities (4 municipalities, 31 provincial capitals and 5 cities specifically designated in the state plan), 0 otherwise	
Latitude	Latitudes of Chinese cities including provincial capitals	Shanghai Astronomical Observatory Online (http://www.astron.sh.cn/)
Temperature	Average temperatures of cities	China Meteorological Data Sharing Service System (http://cdc.cma.gov.cn/)
Others	Industrial output and employment	China City Statistical Yearbooks (2003-2008)
	All relevant data about public finance (tax revenue & public expenditures)	China Finance Yearbooks (1998-2008) China City Statistical Yearbooks (2003-2008)
	All environmental data	China Statistical Yearbooks (1998-2008) China City Statistical Yearbooks (2003-2008)

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