FOREIGN DIRECT INVESTMENT AND POLLUTION HAVENS
Evaluating the Evidence from China

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Abstract

One of the most contentious debates today is whether pollution-intensive industries seek locations with weak environmental standards, turning these locations into "pollution havens." Empirical studies to date show little evidence to support the pollution haven hypothesis, but suffer potentially from omitted variable bias, specification, and measurement errors. This paper estimates the strength of pollution-haven behavior by examining inter-provincial FDI flows into China. We derive a location choice model from a theoretical framework that incorporates the firm's production and abatement decision, agglomeration and factor abundance. We estimate a conditional logit model using new data sets containing information on a sample of joint venture projects, effective environmental levies on water pollution, and estimates of Chinese emissions and abatement costs for 3-digit ISIC industries. Results from 626 manufacturing joint-venture projects in 1996 show FDI from all source countries flows to provinces with high concentrations of foreign investment, high levels of per capita income, concentrations of foreign firms, and special tax incentives. FDI originating from Hong Kong, Macao and Taiwan is attracted to provinces with a relative abundance of low-skilled labor, and relatively weak environmental controls. In contrast, FDI from non-Chinese sources is attracted by high levels of skilled labor and by high pollution levies—the reverse of the pollution haven hypothesis. We discuss the likely role of technological differences in explaining these results.

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I. Introduction

One of the most contentious issues debated today is whether inter-country differences in environmental regulations are turning poor countries into "pollution havens." The main argument is that stringent environmental standards in industrial countries drive firms to close plants at home and establish them instead in developing countries, where standards are relatively weaker. Since more pollution-intensive industries will have a larger incentive to move, a haven of such industries will build up in poor countries. A corollary is that developing countries may purposely undervalue environmental damage, in order to attract more foreign direct investment (FDI). This, in turn, could generate a "race to the bottom"– with all countries lowering environmental standards in order to attract and retain investment.

Early empirical studies suggest that environmental stringency has no discernible effect on location choice.[1] Though there was FDI in pollution-intensive industries, there was little evidence that it had been influenced by differing pollution abatement costs, or had flowed faster into developing countries relative to industrial countries.[2] Recent econometric studies have adopted one of three approaches to investigate whether or not FDI flows have resulted in pollution havens: inter-state plant location choice; inter-industry FDI flows within a country; inter-country FDI location choice.[3] The results are mixed. In his review of four studies of US plant location choice, Levinson (1996a) finds little evidence that inter-state differences in environmental regulations affect the location of plants in the US. Levinson (1996b) finds only one of six environmental stringency indicators has a significant impact on the location of new branch plants across US states, and its impact is small. However, controlling for unobserved state characteristics and adjusting their abatement cost measure for inter-state differences in industrial

[1] See Walter, 1982; Pearson, 1987. Reviews of the literature can be found in Dean (1992, 2001).
[2] Leonard (1988) found some evidence that governments used lenient environmental regulations to attract FDI in the 1970s, but he also found that incentives were not substantial enough to offset other determinants of location choice, particularly labor productivity, infrastructure and stability.
[3] Researchers have also examined the effect of environmental regulations on trade patterns, as in Levinson and Taylor (2001), and how openness to trade influences pollution concentrations, as in Antweiler, Copeland, and Taylor (2001) and Dean (2002).

composition, Keller and Levinson (2003) find robust evidence that pollution costs have a moderate deterrent effect on foreign investment into US states.

Eskeland and Harrison (2003) examine the pattern of foreign investment across industries within Mexico, Venezuela, Morocco, and Cote d'Ivoire. They find that abatement costs are not significant determinants of the distribution of foreign investment among manufacturing industries within a country. The relationship between FDI and pollution-intensity depends upon the pollutant.[4] Within an industry, foreign ownership is actually significantly and robustly associated with lower energy use (a proxy for lower pollution-intensity). Smarzynska and Wei (2001) evaluate the foreign investment choices of multinational firms locating across Eastern Europe and the former Soviet Union. They emphasize the problem of omitted variable bias in previous work: corruption may deter FDI, but may be correlated with laxity of environmental controls. The authors control for the role of corruption, but find little support for the hypothesis that lower environmental standards attract investment, nor for the hypothesis that lower standards are more attractive to pollution-intensive FDI. Results are highly sensitive to the measures chosen to proxy environmental stringency and pollution-intensity.[5]

Four potential problems in this literature suggest the need for more empirical testing. First, work by Markusen and Zhang (1999), Head and Ries (1996) and Cheng and Kwan (2001), demonstrates the importance of relative factor abundance and agglomeration in explaining FDI incidence. The absence of these variables may lead to omitted variable bias. Second, most studies have only been loosely motivated by the theoretical literature on pollution emissions and abatement, giving rise to specification error. Third (as Smarzynska and Wei (2001) note), many studies have had to rely on highly aggregated FDI data, and very broad proxies for environmental stringency or pollution-intensity, potentially causing measurement error. Finally, Keller and Levinson (2002) and Levinson and Taylor (2001) illustrate the empirical importance of controlling for unobserved location and industry characteristics.

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[4] While there is some evidence of a positive relation between FDI share and air pollution-intensity, there is a negative relation between FDI share and both water pollution and toxic-release intensity.

[5] Measuring stringency and pollution-intensity by participation in international treaties and an emissions index, the authors find dirty projects more likely to locate in areas with low stringency. However, this result is not robust to alternative measures such as actual standards and an abatement index.

This study estimates the strength of pollution-haven-seeking behavior by foreign firms using foreign direct investment inflows to Chinese provinces. We derive and estimate a model of FDI location choice in the presence of inter-provincial differences in environmental stringency. We develop a theoretical framework based upon Copeland and Taylor's (2003) firm production and abatement decision model, amended to include agglomeration and relative factor abundance. From this model, we derive an econometric approach based on conditional logit estimation.

The model is estimated using two unique datasets. The first dataset contains information on 626 manufacturing joint-venture investments in China in 1996. We have identified both provincial location and industry classification of these projects, permitting us to observe the provincial and industrial distribution of FDI flows into China. The second dataset contains collected water pollution levies which allow us to construct effective water pollution levy rates to measure environmental stringency for each province. It also contains Chinese water pollution-intensities at the 3 digit ISIC industry level, which we use to measure industrial pollution intensity.

Results from the sample of 1996 joint-venture projects suggest an important linkage between technology and pollution-haven behavior.[6] For the sample of projects with partners from the OECD and other countries, we find no evidence of pollution-haven-seeking behavior by foreign firms. In fact this type of FDI is attracted to provinces with more stringent pollution taxes. In contrast, FDI originating from Chinese sources (Hong Kong, Macao, and Taiwan) appears to be deterred by higher pollution taxes. One possible explanation for this finding, supported by evidence from other studies, is that investment from advanced countries is more likely to embody new technology and is more likely to produce products for the local market. This evidence provides some support for the pollution haven hypothesis but suggests that the attraction of weak environmental regulations is conditioned by access to advanced technology and by the firm's relationship to local markets.

[6] Our intention is to extend the analysis to a sample of joint-venture projects over the period 1992-1996, permitting us to account for the possibility of unobserved location and industry characteristics.

In the next section, we describe FDI flows into China and China's Pollution Levy System. In the third section, we derive our estimating equation from a model of location choice, incorporating the firm's endogenous response to pollution taxes, local factor prices, and local market conditions. Next, we present the results of the conditional logit analysis. Finally, we interpret our results and suggest some likely explanations for the differences we find in firm behavior.

II. FDI Flows and Environmental Stringency in China

Because China has been the largest recipient of FDI in the developing world since 1990, receiving 42.3 % of net FDI flows into developing countries in 1996 (Broadman and Sun, 1997; Henley, *et al*., 1999), China is an appealing country in which to test for evidence of pollution havens. The distribution of investment within China is highly uneven, raising obvious questions about the factors that attract capital inflows. Henley *et al.* report that 80% of cumulative FDI inflows have located in one of China's ten eastern provinces. The 500 foreign enterprises with the largest sales are distributed among all provinces, but 91% are located along the eastern coast. This distribution clearly reflects the effects of special incentive programs,[7] as well as new guidelines issued by the Chinese national government in 1995.[8] However, it may also be influenced by environmental regulations which vary across provinces and types of pollutants.

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[7]In 1979, the Chinese national government established four SEZs within Guangdong and Fujian provinces. In 1984, fourteen coastal cities received special incentive programs for FDI. Additional zones have been established since to encourage development of interior locations. As Head and Ries (1996) note, however, after 1986 certain incentives were available anywhere in China.

[8] The 1995 rules grouped investment into three categories. "Encouraged" investment includes new agricultural technology; construction of energy, communications, and raw materials projects for local industry; projects that enhance exports; projects that use renewable resources or involve new technology or equipment for pollution control or prevention; and investments developing the central and western parts of China. "Restricted" investment includes projects already developed, where the technology has already been imported and capacity can meet demand; projects in industries where the state is experimenting with foreign investment while a state monopoly still exists; exploration and/or extraction of minerals; and projects in industries requiring central planning. "Prohibited" investment includes dangerous, polluting, or wasteful processes. See Henley, *et al*. (1999).

According to Henley, *et al*. (1999) between 1985 and 1996, 66.4% of FDI into China came from Hong Kong, Macau, and Taiwan.[9] Much of this investment was small scale, involving labor-intensive processing of imported inputs for re-export. During the same time period, only 8% of FDI came from the United States and 8% from Japan.[10] Investments from Japan and the West tend to be undertaken by transnational corporations that produce goods for the Chinese market.

Figure 1 shows FDI actually utilized,[11] in millions of dollars, from 1987 to 1995, for China as a whole. The rapid increase in inflows into China is seen clearly, with particular acceleration after 1992.[12] Since most of the FDI literature suggests that there is a positive correlation between FDI inflows and income levels, Figure 2 shows provinces grouped into three income levels, based on income averages throughout the period.[13] In 1987, nearly 80% of foreign investment located in provinces with relatively high GDP per capita, while only 8% located in one of the lowest-income provinces. A similarly large gap is found in 1995, with high-income provinces receiving 64% of FDI while the lowest-income provinces only received 9%. A closer look, however, reveals that the rich-province share declines fairly steadily throughout the period. Flows into the low-income group appear stagnant, while the share of FDI flowing to the moderate-income group nearly doubles.

Coughlin and Segev (2000) use provincial-level data to explain the pattern of FDI location in China. Accounting for spatial autocorrelation, they find that economic size, labor productivity, and a coastal location attract FDI, while higher wages and illiteracy deter it. They find no significant relationship between measures of transportation infrastructure and the level of FDI inflows. Using data on joint

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[9]An unknown proportion of this investment originated in mainland China and found its way back to China in a practice known as 'roundtripping.'

[10] No other country provided more than 3% of the total FDI flowing into China during 1985-96. See Henley, *et al*., Table 7.

[11]FDI inflow in a given year is not necessarily utilized immediately, since its use requires approval.

[12]This surge coincides with the 1992 initiation of significant liberalization in the trade and foreign exchange market, which also entailed some new favorable terms for FDI as well (Shuguang, et al., 1998).

[13] Hainan and Tibet are excluded due to lack of data.

venture projects undertaken by investors other than overseas Chinese, Head and Ries (1996) find evidence that high labor productivity, prior foreign investment, and a large pool of local suppliers make a city more attractive to investors. Their results provide no support for the notion that foreign investors seek locations offering low industrial wages. They do, however, find evidence that investors are drawn to cities with transportation facilities for exports.

We know of no previous study that estimates the strength of environmental regulation in shaping foreign investment flows within China.[14] The Chinese pollution levy system, described in Appendix A, is the broadest application of a tax-based pollution control mechanism in the developing world. The effective tax rate varies by province, allowing identification of the response of foreign investors to differences in environmental stringency. There are four sources of provincial variation in effective levy rates. First, concentration standards, which determine the extent of "excess" pollution, are determined jointly by the national and local governments. Second, standards differ by effluent, thus differences in the concentration of industries across provinces will lead to different effective tax rates. Thirdly, there are significant differences in enforcement capacity at the local level. Finally, the levy can be reduced or eliminated at the discretion of local regulators after inspection and, thus, vary with the weight placed upon environmental protection by local authorities. These features of the system combine to produce significant variation in effective rates.

The relationship between FDI flows and two indicators of environmental stringency are shown in Figures 3 and 4. In Figure 3, provinces are grouped by average water pollution levy (collected levies per unit of excess wastewater) during the period. It is quite clear that the highest shares of FDI inflows are found in provinces with the most stringent environmental regulations. The differential is quite large, and holds for every year in the period. Figure 4 groups provinces by average discharge intensity (tons of COD discharge per million yuan output (1990 yuan)) over the period. To the extent that discharge

[14] Levinson (1996a, 1996b) and Keller and Levinson (2002) perform such studies using US data. Because state rules and implementation differ, they are able to identify the impact of controls on firm location. The US does not rely primarily on a price-based system, however, and these studies rely on stringency measures such as actual abatement costs.

intensity is an indicator of laxity of standards and/or concentration of pollution-intensive industries, it appears that neither of these factors attract FDI. Most FDI flows to provinces with relatively low discharge intensity.

These trends hardly prove that environmental rules play no role in the location decisions of foreign firms. Since per capita income and pollution levies are strongly correlated (Dean, 2002; Wheeler and Wang 1996, 2002), it is not clear from this evidence the extent to which each of these characteristics influences location choice. It is clear that FDI is *not* flowing to provinces with the least stringent regulations. Over time, however, there is a reduction in the share of FDI going to provinces with high pollution levies (low discharge intensity), and an increase in the share going to the group with moderate pollution levies (moderate discharge intensity). Since each province within the stringent regulation group shows increased levies over time, the trends in Figures 3 and 4 could indicate that FDI moves in response to stricter environmental regulations over time.

III. Theoretical Model

A Model of Production and Emissions

Like Smarzyska and Wei, (2001) we consider a multinational firm that wants to invest one unit of capital to produce somewhere in a given region.[15] We assume that China has been chosen because it is the lowest-cost region in which to produce. Therefore, the decision for the firm is to choose the host province within China that produces the highest profit.

We treat foreign firms as price takers with respect to pollution taxes. Local variations in enforcement raise the possibility that firms may negotiate over pollution levies with local authorities. However, as explained in Appendix A, such negotiations occur after production and emissions decisions have been made by the firm, following an inspection by local authorities. Moreover, the projects in our dataset take the form of joint ventures (as opposed to wholly-owned subsidiaries), and, therefore, their

[15]We take the decision to produce abroad, as well as the region in which the project will be located, as made in a prior stage. Zhang and Markusen (1999) consider the firm's choice of producing at home and exporting or producing abroad.

bargaining power may be limited. We assume, therefore, that at the time that a location decision is made by the firm, the exact levy rate it will be charged is unknown but that the firm has information on the effective rate per unit that provincial regulators actually charge local firms. As this rate is influenced both by the statutory rate and by enforcement practices, we use this effective rate as an indicator of the stringency of provincial environmental regulatory system.

Our treatment of production follows Copeland and Taylor (2003). We consider a firm that jointly produces two outputs, good *X* and emissions *Z*, using variable inputs of unskilled labor, skilled labor, and intermediate (locally-provided) services. The capital input is embodied in the original investment and is fixed in the short run. Abatement of emissions is possible, so emission intensity is a choice for the firm. We assume that the firm can allocate an endogenous fraction, θ, of its inputs to abatement activity. This implies that abatement and production use factors in the same proportion. If $\theta = 0$, there is no abatement and, by choice of units, each unit of output generates one unit of pollution. The joint production technology is given by:

$$\begin{aligned} X &= (1-\theta)F\big(L_{x,}, H_x, I_x(s)\big), \\ Z &= \phi(\theta)F\big(L_x, H_x, I_x(s)\big), \end{aligned} \tag{1}$$

where *L* is unskilled labor, *H* is skilled labor, and *s* is a vector of locally provided services. The function $I_x(s)$ aggregates these local service varieties into an intermediate input for the foreign firm. We assume that F is increasing and concave, and $0 \le \theta \le 1, \phi(0) = 1, \phi(1) = 0$.

To aid our ability to derive an estimating equation, we follow Copeland and Taylor (2003) and assume that the relation between abatement activity and emissions is given by

$$\phi(\theta) = (1-\theta)^{1/\alpha}, \tag{2}$$

where $0 \le \alpha \le 1$. Using this form, we can eliminate theta and invert the joint production technology to obtain a net production function in which emissions is treated as an input:

$$X = Z_x^{\alpha}[F(L_x, H_x, I_x(s))]^{(1-\alpha)}. \tag{3}$$

If we assume that the production function is generalized Cobb-Douglas,

$$F(L_x, H_x, I_x) = AL_x^b H_x^d (I_x(s))^e, \tag{4}$$

where *b*, *d*, and *e* are constants, and *A* is a measure of Hicks neutral technological progress, the net production function becomes

$$X = Z_x^{\alpha} A^{(1-\alpha)} L_x^{\beta} H_x^{\delta} (I_x(s))^{\varepsilon}, \tag{5}$$

where $\beta = b(1-\alpha), \delta = d(1-\alpha),$ and $\varepsilon = e(1-\alpha)$. We note that $\alpha, \beta, \delta, \varepsilon$ are factor shares and in particular that α is the share of pollution taxes in the value of output.

Profit maximization implies cost minimization. Let τ be the emissions tax rate, *u* the wage for unskilled labor, *h* the wage for skilled labor, and $\tilde{p}_s$ a price index for locally-provided services. Using the net production function, the cost of producing X units in province *j* is

$$C_X(\tau_j, u_j, h_j, \tilde{p}_{sj}, X) = KA^{\frac{-(1-\alpha)}{\gamma}} \tau_j^{\frac{\alpha}{\gamma}} w_j^{\frac{\beta}{\gamma}} h_j^{\frac{\delta}{\gamma}} \tilde{p}_j^{\frac{\varepsilon}{\gamma}} X^{\frac{1}{\gamma}} = Kc_X(\vec{w}_j) X^{\frac{1}{\gamma}}, \tag{6}$$

where $\gamma = \alpha + \beta + \delta + \varepsilon < 1$ and the vector $\vec{w} = (\tau, u, h, \tilde{p}_s)$. To begin, we assume that the firm produces only for export to a third market, so the price of the final good produced by the project, p^f, does not vary by province. The maximum profit earned on fixed capital investment in any province *j* is given by the profit function:

$$\pi_{Xj}(p^f, \vec{w}_j) = \left[\gamma^{\frac{\gamma}{1-\gamma}} - \gamma^{\frac{1}{1-\gamma}} \right] \left[p^f \right]^{\frac{1}{1-\gamma}} \left[\frac{1}{Kc_X(\vec{w}_j)} \right]^{\frac{\gamma}{1-\gamma}}. \tag{7}$$

This profit function is multiplicative and, therefore, linear in logs.

Using (7), we can explore how an increase in the emissions tax rate changes the maximum profit that an investor can earn in that province. The emissions tax rate enters the cost function, $c_X(\vec{w})$, so using Shepard's lemma and denoting proportionate changes with a "∧",

$$\frac{\hat{\pi}_{Xj}}{\hat{\tau}_j} = -\frac{1}{1-\gamma}\frac{\tau_j Z_X(p^f,\vec{w}_j)}{c_X(\vec{w}_j)X(p^f,\vec{w}_j)^{\frac{1}{\gamma}}} = -\frac{1}{1-\gamma}\frac{\alpha}{\gamma} < 0. \qquad (8)$$

The maximum profit that can be earned in province *j* falls in response to a 1 percent increase in the emissions tax. Additionally, this effect is proportional to the share of pollution taxes in total variable costs when the firm chooses inputs optimally.

Equation (8) leads to the following proposition.

PROPOSITION 1: The effect of a higher pollution levy on potential profits:

(a) is larger for industries in which emissions are a larger relative cost share;
(b) is larger for firms that are less efficient in their ability to abate pollution.

PROOF: This proposition follows directly from the properties of the profit function. Part a can be easily proved by comparing two industries that have the same abatement efficiency (the same value for α) but different values for the sum of *b*, *d*, and *e*. The industry with the smaller sum has a larger cost share for emissions (a larger value for $\frac{\alpha}{\gamma}$). Statement (a) then follows from equation (8): the effect of a levy increase on potential profits is larger for industries that have higher emissions cost shares relative to other factor cost shares.

For part b, we note that the efficiency of a firm in abating pollution is governed by the abatement function (2). A less efficient firm has a higher α value, but the same factor shares *b*, *d*, and *e* as other firms in the same industry. Therefore, the less efficient firm has a larger $\frac{\alpha}{\gamma}$ than a more efficient firm and an increase in the pollution tax has a more pronounced effect on the potential profits of the less efficient firm.

This proposition provides us with the basis for testable hypotheses about location choice. Part a of the proposition leads to the hypothesis that industries with highly polluting production technology will be more sensitive than low-polluting industries to differences across provinces in pollution regulations.

Part b suggests the hypothesis that, within an industry, firms with older, less efficient technologies will be more sensitive to differences in pollution regulations.

Foreign Investment and Local Suppliers

Previous research by Head and Ries (1996) suggests that firms have higher profits when they locate in areas where other foreign firms have located. Cheng and Kwan (2000) also find a strong self-reinforcing effect of FDI on itself in Chinese regions. We incorporate agglomeration into our model using the derivation in Head and Ries. The function, *I(s)*, aggregates local service varieties, s_i, into a composite intermediate good. It is assumed to take a constant elasticity of substitution form with the substitution elasticity given by σ. Positing a standard monopolistic competition framework for the market for local services, Head and Ries assume that all service providers face the same unit cost function, $c_S(\vec{w})$. If the number of suppliers is large, each firm faces an iso-elastic demand curve and sets the price $P_s = c_s(\vec{w}) / \sigma$. Given this symmetry, each service provider sets the same price and produces the same quantity. Moreover, final goods producers use the same amount of each variety, leading to the aggregated service input, $I(s) = N_s^{1/\sigma} s$ where *s* is the common quantity of each service variety.

We now develop an intermediates price index, which appears in the profit function and which measures the price per effective service unit. Note that the total amount paid by a final-good producer for intermediates is $P_s N_s s$, while the number of effective units is given by *I(s)*. Dividing the total amount paid by effective units provides the price index, $\tilde{p}_s = P_s N_s^{(\sigma-1)/\sigma}$. This price index is decreasing in the number of service providers, which reflects the notion that effective costs may be lowered by an increase in the number of varieties as well as by a reduction in the price of a representative variety.

Head and Ries derive the equilibrium number of local service providers by assuming that they must invest in costly upgrading in order to serve foreign-invested firms. The net profits obtained by an entrant into the intermediates sector depend on the direct costs of upgrading to satisfy foreign quality requirements and on the value of any foregone opportunity. The total cost of upgrading is assumed to vary across potential entrants. Within this context, Head and Ries show that the number of local service firms is a function of local factor prices (because profits fall as costs rise), the final goods price, P^f, and the number of foreign-invested firms producing final goods, N^f, (because profits rise with a higher demand for intermediates from final-goods producers), and the number of potential suppliers, $\overline{N}_s$ (which implies a larger number of local firms that can profitably upgrade).[16] Thus, in equilibrium,

$$N_s = \zeta(\vec{w}, P^f, N^f, \overline{N}_s), \tag{9}$$

where the function $\zeta(\cdot)$ is multiplicative. Assuming that intermediates are produced with skilled and unskilled labor in a Cobb-Douglas technology and adopting the Head and Ries assumption that upgrading costs are uniformly distributed among potential entrants, it can be shown that the price index takes the form

$$\tilde{p}_s = \frac{c_s(\vec{w})}{\sigma}\left[\zeta(\vec{w}, P^f, N^f, \overline{N}_s)\right]^{(\sigma-1)/\sigma} = \left[K_2 u^{\mu} h^{\nu}(P^f) N^f \overline{N}_s\right]^{\rho}, \tag{10}$$

where K_2 is a constant and the exponents are functions of the underlying final-goods and intermediates production parameters.

Substituting this expression back into the foreign firm's profit function (7) yields a expression that is multiplicative in its arguments and, thus, linear in logs. The coefficients in the linearized profit function reflect the underlying production parameters. Under the assumption that local service providers do not pollute or are not subject to pollution fees, the pollution levy coefficient indicates the share of pollution fees in total variable cost. If local service providers do pollute and are subject to pollution fees, this coefficient reflects the share of direct plus indirect pollution fees in total variable cost. This coefficient can be estimated and used to test hypotheses based on Proposition 1.

[16]The derivation is contained in Head and Ries (1996), pages 42-44 and the appendix A.

Other Provincial Characteristics

Clearly other province-specific characteristics, such as special investment incentives, transport costs, and infrastructure, must be included in the overall location choice problem of the firm. Following Head and Ries (1996), incentives can be added as a proportionate shift factor to the profit function. We also introduce variables that capture transportation costs, which we implicitly assume are lower in provinces with larger infrastructure stocks.

Finally, we relax the assumption that firms receive the same output price in every province. The literature indicates that some firms, particularly those with joint venture partners based in the United States and Japan, produce for the local market. To capture the attractiveness of the local market, we introduce additional arguments to the profit function that attempt to measure local income and market size.

III. A Location Choice Model

Thus far, the model assumes that all foreign investors within an industry are identical. Consequently, one province will be the highest profit site for all projects *within* an industry. Sample data, however, show considerable variation in the location choices within industries. To explain this, we posit that there are unobservable features of each firm that make some provinces more attractive than others. Suppose that for each investor *i* the attractiveness of province *j* depends on the sum of ln π_{ij} and a host of unobserved idiosyncratic features ε_{ij}. If ε_{ij} are distributed independently according to a Type I Extreme Value distribution (whose density is given by exp[-exp(ε)], then the probability, P_{ij} , that investor *i* chooses province *j* where *j* is a member of choice set *J* is given by

$$P_{ij} = F_{ij}(\ln \pi_{ij}) = \frac{\exp\left(\ln \pi_{ij}\right)}{\sum_{j \in J} \exp(\ln \pi_{ij})} \tag{11}$$

and we represent π_{ij} by equation (7).

Equation (11) is estimated with conditional logit, using data on 626 manufacturing sector investments made in 1996 across 21 provinces and 27 3-digit ISIC industries. Based on the previous literature, we divide our sample into two sub-samples. The first sample includes only projects with partners from "Chinese" sources. We include among these projects any with partners from Hong Kong, Macao, Taiwan, Malaysia, Indonesia, and the Philippines.[17] The second sample contains projects with partners from "non-Chinese" sources and includes those from the United States, Japan, and other industrial countries.

There are a number of reasons to split the sample in this manner. First, as Head and Ries (1996) emphasize, some of the investment from Chinese sources is 'roundtripping' and its location choice decision may be influenced by the location of mainland connections.[18] Secondly, the previous literature identifies Chinese investment as generally comprising comparatively small-scale investments that use cheap labor for an export platform while investments by transnational corporations generally target the local market (*e.g.* Henley, *et al*.). Thirdly, partners based in high-environmental-stringency countries may be held by their shareholders to source-country standards in their foreign operations. These concerns may weaken their response to low standards abroad. Finally, there is evidence of significant differences in the technology transferred to China by Chinese and non-Chinese sources. Comprehensive comparisons of technology transfer by source are not available, but survey data collected and reported by Loren Brandt and Susan Zhu suggests important technological differences among foreign parents.[19] While Brandt and Zhu find that performance requirements were common among joint ventures initiated during 1987-1993, they discovered a sharp contrast between investors from Hong Kong and those from developed countries. Brandt and Zhu (undated) write:

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[17] From our original data source, we identified projects as Chinese, other South East Asian, or non-Chinese in origin. The first two groups were designated "Chinese." We were not able to identify the source for 78 projects, which were scattered across nearly all provinces. Since Chinese FDI constituted about two-thirds of total FDI to China in 1996, these projects were assumed to be of Chinese origin.

[18] For this reason, Head and Ries (1996) exclude projects with partners from Hong Kong, Macau, and Singapore from their analysis of FDI flows in 1984-1991.

[19] Our thanks to Susan Zhu for making this information available.

> For the joint ventures that have investors from Hong Kong, only 35% were required to transfer advanced technology from foreign parent and 5% were required to transfer a patent from foreign parent. For the joint ventures having investors from developed countries, 76% were required to transfer advanced technology and 29% were required to transfer a patent from foreign parent. Only 6% of the firms having partners from Hong Kong were required to manufacture certain components or final products in China, while 42% of the firms with partners from developed countries had this requirement. From this we may infer that the technology flow will be larger for the joint ventures that have foreign parents from developed countries. (p. 7)

Along similar lines, Eskeland and Harrison (2003) find that foreign plants are significantly more energy efficient and use cleaner types of energy than domestic firms in developing countries. To the extent that Chinese joint ventures represent "roundtripping," non-Chinese joint ventures will use newer, and perhaps cleaner, technologies than Chinese joint ventures. These technological differences imply that the two sub-samples may show different behavioral responses to variation in environmental stringency and other provincial characteristics.

IV. Data Description and Sources

A complete description of all variable definitions and sources is provided in Appendix B. We compiled foreign direct investment data for a sample of joint venture investments undertaken in1996, using project descriptions available from the Chinese Ministry of Foreign Trade and Economy (MOFTEC). We have been unable to learn the criteria used by MOFTEC to select this sample. To check whether or not the sample is representative, we compare the provincial shares of total contracted FDI from our sample of joint ventures to the provincial shares for all contracted FDI.[20] Figure 5 shows this comparison, using average shares over the 1992-1996 period. The simple correlation between the two distributions is about 0.82. However, from Figure 5 it appears that MOFTEC may have chosen projects to under-sample areas where special incentives were implemented the earliest, including Fuijian, Guangdong, Shanghai, Tianjin, and Hainan, and to over-sample areas where investment was encouraged at a later stage in the "open door" policy.

[20] Data on total contracted equity joint ventures by province was unavailable. Thus, we use data on total contracted FDI in 1980 constant prices from Coughlin and Segev (2000). These data include wholly foreign-owned enterprises, cooperative enterprises, and offshore oil ventures, as well as equity joint ventures.

The 1996 sample includes 1,030 joint venture investments made across 21 provinces and across 27 3-digit ISIC classifications.[21] Our analysis was performed using the subset of 626 manufacturing joint venture investments. Summary data for the sample of manufacturing investments are shown in Table 1. Figures 6 and 7 provide the distribution of 1996 manufacturing FDI across provinces by source and by 2-digit ISIC industry, respectively. Figure 6 shows that equity joint ventures in most provinces are fairly evenly split between Chinese and non-Chinese sources, with the exception of Guangxi, where there is no non-Chinese investment, and Hubei, where there is no Chinese investment. Figure 7 provides some insight into these exceptions, as both Hubei and Guangxi are highly specialized in one or more industries. Most provinces, however, received investment in a wide range of industries.

Figure 8 shows the distribution of 1996 manufacturing FDI across 3-digit ISIC industries by source. Here, it is clear that FDI in apparel (322), wood products and furniture (331, 332), paper products (341), industrial chemicals (351), and scientific instruments (385) is predominantly from Chinese sources. In contrast, FDI in leather goods (323), ferrous and non-ferrous metals (371, 372), petroleum refining and plastic products (353, 356), pottery, glass, and other mineral products (361, 362, 365), and electrical and non-electrical machinery (382,383) comes from the U.S., Japan, and other non-Chinese sources.

Our theoretical framework indicates that our estimating equation should include controls for factor prices, the stock of FDI, the number of potential domestic suppliers, the presence of FDI incentives, infrastructure, and local market size. The *Chinese Statistical Yearbook* (various years) was used to compile data on labor supplies, agglomeration, and availability of intermediates suppliers, infrastructure and incentives. Summary data for these provincial characteristics are shown in Table 2. Although provincial wage data is available, it is not differentiated across labor types. However, a distribution of the labor force by educational attainment categories is available for each province. Since labor mobility between provinces is still low, we assume that relative labor supplies will proxy relative wages in each province. We define the lowest educational level, illiterate, as unskilled labor, and the two top

[21] We identified the ISIC classification from the product descriptions provided by MOFTEC.

educational categories, senior secondary education and college and beyond, as skilled labor. We then construct relative factor supplies as the percentage of skilled (unskilled) labor relative to the percentage of semi-skilled labor (the sum of the remaining categories, primary level and junior secondary level).

To account for agglomeration and availability of intermediate suppliers, we include as regressors the value of cumulative FDI and the number of domestic enterprises. The value of cumulative FDI is measured for the period 1982-1996 for each province, and expressed as a share of cumulative FDI in the country as a whole. To represent the availability of potential suppliers of intermediate goods, we include the number of domestic enterprises. We create this measure by taking the total number of enterprises at the township level and above (thereby capturing larger enterprises that may have the capacity to supply a foreign-invested plant) and subtracting the number of enterprises that are wholly or partly foreign owned.[22]

As in other studies, we also include two measures of infrastructure, roads (adjusted for provincial size), and telephones per person. Given the numerous incentives given to FDI in China, an incentive dummy was created that takes a value of one if there is a special economic zone or open coastal city in the province.

Table 2 also shows the effective water pollution levy collected in each province in 1995. These effective levies vary quite widely, from a high of 0.47 yuan per ton of wastewater above standard in Tianjin to a low of 0.04 yuan in Hunan. As a share of total output value, the levies are not large. For example, a survey of firms found that in Beijing total wastewater levies were about 0.06% of the value of total industrial output.[23] Because the water pollution data (measured in COD) and collected levies on wastewater are the most readily available, these initial estimations include only water pollution taxes. Subsequent estimation will include air pollution levies also. As the table below indicates, industries are

[22] I.e., we subtract those firms which are classified as "foreign-funded" or "funded by entrepreneurs from Hong Kong, Macao, or Taiwan."

[23] This share was calculated from data available at http:/www.worldbank.org/nipr/china/status.htm.

quite varied in their water-pollution intensity, with ISIC 34 (paper and paper products, printing) by far the worst polluter.

Pollution Intensity by 2-digit ISIC Industry, 1995 COD (kg.)/Real output (1,000 yuan)								
31	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**
7.7	1.2	NA	51.7	2.3	0.4	0.8	0.1	0.9

Source: World Bank. Details in Data Appendix.

In Figure 9, we plot both the share of FDI flowing to each province and the levy rate in the province. No obvious relationship between these shares and the levies emerges in the unconditional data.

Our expectations for the signs and significance of our explanatory variables follow the properties of the profit function and Proposition 1. Because the pollution levy has a similar effect to a factor price, we would expect all firms to be attracted to areas with low levies. However, by Proposition 1a, we expect this effect to be stronger for high-polluting industries than for low-polluting industries. Given our sample size, we are not able to estimate conditional logit coefficients for each industry separately. Instead, we group industries into three industry groups, low, moderate, and high polluting, on the basis of the 2-digit pollution intensities given above, and we run separate estimation procedures for each industry group. We expect the attraction of low levies to be greatest for the high-polluting industries, all else equal.

Proposition 1b suggests that the attraction of weak environmental regulations depends on the technological sophistication of the firm within a given industry. As discussed above, there is prior to evidence that suggests that projects from Chinese sources may embody less advanced technology than do projects from non-Chinese sources. Consequently, we further divide our sample into Chinese and non-Chinese-sourced projects and we run separate estimation procedures for each group. Our hypothesis is that the levy will have a stronger impact on Chinese firm location decisions than on non-Chinese firms, all else equal.

We expect that Chinese joint ventures, which are characterized in the literature as seeking a low-wage export platform, will be attracted to provinces with high relative supplies of unskilled workers (where the unskilled wage is low relative to the semi-skilled wage) and will avoid provinces with high relative supplies of skilled workers (where the skilled wage is relatively low). For non-Chinese joint ventures, we expect the opposite pattern, since these projects are expected to be more skill-intensive. Based on the work of Head and Ries (1996) and Cheng and Kwan (2001), we would expect all firms to be attracted to provinces with large stocks of FDI and large numbers of potential suppliers, as well as provinces with special incentives for foreign investment and good infrastructure. Finally, we expect that firms seeking to sell into the local market will be attracted to areas with richer populations, as measured by provincial consumption per capita.

V. Results

We estimate the parameters of the linearized profit function using the conditional logit method. Estimation proceeds by maximizing the likelihood of the provincial choices made by the 626 joint ventures in our sample. Results showing the determinants of FDI location choice by source are found in Tables 3 and 4. Each table shows results for the full sample, and three sub-samples: industries with low, moderate, and moderate and high pollution-intensities.[24]

We begin by comparing the results for the two full samples, by source. Given that non-Chinese joint ventures have been characterized as embodying more advanced technology, we would expect the attraction of low pollution levies to be weak and, perhaps insignificant, for this sample. In Table 3, we see that non-Chinese FDI is actually strongly attracted to provinces with higher pollution levies--the opposite of the pollution-haven hypothesis. This result is similar for the low, moderate, and the moderate and high pollution intensity sub-samples. These counter-intuitive results suggest the potential endogeneity of the levy, and the importance of controlling for unobserved provincial characteristics. Further empirical work will tackle this problem.

[24] Only one industry, ISIC 34, can be described as a high polluter and there are not enough ventures to estimate the model for this sub-sample alone. Note that due to lack of data on the pollution intensity for ISIC 33, these observations were dropped from the sub-samples.

Given differences in technology, within industries one would expect non-Chinese FDI to be concentrated in relatively more skilled-labor intensive activities. Table 3 shows non-Chinese FDI strongly attracted to provinces with high relative endowments of skilled labor, and avoiding those provinces with high relative endowments of low-skilled labor, although this later effect is not significant in the industry group sub-samples. As in previous studies, agglomeration and incentives are significant, positive determinants of FDI. Provinces with higher stocks of foreign investment, and a larger pool of potential intermediate suppliers (as measured by the number of domestic enterprises) are more likely to attract new non-Chinese FDI. The dummy for incentives is also strongly significant in all sub-samples.

With Chinese FDI seeking to reduce production costs for export, low pollution levies may attract this type of FDI. Table 4 provides empirical support for this contention as it shows Chinese FDI significantly less likely to locate in provinces with high pollution levies. The size and significance of this effect is larger for the group of industries characterized as moderately polluting. Adding the most pollution-intensive industry to the sample, paper and paper products and printing, reduces the size of the levy coefficient but maintains its significance. If severe pollution-intensity is a signal of a technology which allows little ability to abate, this industry may be less sensitive to pollution levies than those in the moderate and low intensity groups.

Because Chinese FDI is more likely to produce for export and may embody less advanced technology, one would expect Chinese FDI to be concentrated in relatively unskilled labor-intensive activities, even with an industry grouping. Table 4 shows Chinese FDI significantly attracted to provinces with relatively high relative endowments of unskilled labor, and significantly repelled by relative availability of high skilled labor. These results appear in all three sub-samples of the Chinese joint ventures, although the negative effect for skilled labor is not significant for the low-pollution-intensity group while the positive attraction of high unskilled labor endowment is weak for the moderate-intensity group. As before, agglomeration, availability of suppliers, and incentives are highly significant determinants of location.

The infrastructure variables chosen, telephones per person and density-adjusted roads, do not generally perform well in any of the regressions for the non-Chinese joint ventures, suggesting a need for alternative measures. Moreover, our measure of market richness, consumption per capita, has a surprisingly negative effect on the probability that a province will be chosen by a joint venture in the more pollution-intensive industries. Our results indicate that provinces with high consumption per capita are attractive only to low-pollution-intensity, non-Chinese joint ventures. There may be structural reasons for these patterns that we can uncover with further investigation.

Finally, the predictive power of all the regressions is poor, when evaluated based on commonly-used criteria. This is most likely due to the unbalanced nature of the sample. Greene (2000) notes that the prediction rule, "predict $Y_i = j$ if the probability of j is the maximum of the predicted probabilities," will likely predict all observations with the same value when the sample is unbalanced. With respect to our full-sample specifications in both Tables 3 and 4, this rule predicts all observations to locate in either Guangxi or Guangdong. As Table 1 indicates, these two provinces have the largest number of observations in the sample data.

VI. Conclusion

Tests of the pollution haven hypothesis require data on both foreign direct investment flows and environmental stringency. Because it is the host of a large share of FDI flows to the developing world, and because environmental stringency varies among its provinces, China is an excellent subject for testing the pollution haven hypothesis. We have created and used a new compilation of foreign joint ventures into China, categorized by industry and province. Data from manufacturing projects utilized in 1996 show a wide dispersion of FDI across 3-digit industries and provinces. We divide projects into those funded from non-Chinese and Chinese source countries. Our evidence from conditional logit analysis suggests that both types of investment are attracted to cumulative investment, the number of local suppliers, and special incentives. Non-Chinese-sourced investment appears to be attracted to provinces with high endowments of high-skilled labor, while Chinese-sourced investment appears to be attracted to provinces with high endowments of low-skilled labor.

We also find that Chinese-sourced investment is attracted to provinces with low pollution taxes, while non-Chinese-sourced investment is attracted to provinces with higher pollution taxes. Since there is general evidence that locations with higher incomes attract more FDI and have higher pollution levies, the pollution levy variable may be endogenous. This leads us to view these results as provisional. Data on projects for other years will soon be available, increasing our ability to control for unobserved provincial and industry characteristics as well as enable us to account for the potential endogeneity of pollution levies. Nevertheless, our results are strongly indicative of significant variation in firms' pollution-haven behavior and they are consistent with an important role for technology in shaping their response to inter-jurisdictional variations in environmental regulation.

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APPENDIX A
THE CHINESE POLLUTION LEVY SYSTEM[25]

China's State Environmental Protection Administration (SEPA) estimates that industrial pollution accounts for over 70% of the national total, including 70% of organic water pollution (COD, or chemical oxygen demand); 72% of SO_2 emissions; and 75% of flue dust (a major component of suspended particulates) in 1995. One of China's responses to this problem is its pollution charge, or levy system. Almost all of China's counties and cities have implemented the levy. Charges are levied for water and air pollution, solid and radioactive waste, and noise. Water pollution charges contribute the largest share of the total. Funds from the pollution levy are used for pollution source control, damage remediation and development of environmental institutions. Despite recognized weaknesses, the Chinese levy system is by far the broadest application of price-based pollution control instruments in the developing world.

The levy system is based on a discharge standard system, and only discharges exceeding the standards were subject to a fee before 1993.[26] Discharge standards are considered stringent. In 1993, among the 3000 biggest industrial water polluters in China, about 90% were violating the discharge standards and, therefore, paying levies. Air pollution emission standards are less stringent than those for water pollution and pollutant charge rates are lower. In 1993, only approximately 50% of the biggest air polluters violated the emission standards.[27]

Under the levy system, polluters report their emissions and local (municipal and county) environmental authorities are responsible for verification and collection. All polluters are required to register with local environmental authorities, and to provide information in the following categories: 1) basic economic information (sector, major products and raw materials); 2) production process diagrams; 3) volume of water use and waste water discharge; pollutant concentrations in waste water; 4) waste gas volume and air pollutant concentrations (before and after treatment); 5) noise pollution by source; 6)

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[25] The material in this appendix is drawn from Wang and Wheeler (2002a), where additional details can be found.
[26] There is also a standard unit fee for wastewater discharge starting from 1993. In 1993, a maximum charge of 0.05 yuan per ton of waste water discharge was announced by the national government. Since 1996, charges have been assessed on SO_2 (sulfur dioxide) emissions, even if they meet the regulatory standard. Additional proposals for reform of the levy system are under study.
[27] Information on polluters is drawn from Wang and Wheeler (2002a), who report results of a plant-level survey.

discharge of solid wastes; 7) others. The local environmental authorities check polluters' reports in several ways, including internal consistency, consistency with material balance models, historical data from the facility, direct monitoring, and surprise inspections. Penalties are imposed for false reporting and for non-cooperation with government inspections.

The water discharge levy varies by both concentration and volume as it calculates a pollutant-specific discharge factor, P, based on both total waste water discharge and the degree to which pollutant concentration, C, exceeds the standard, C_s. The precise national levy formula for water discharges is:

$$\text{(A1)} \quad \begin{aligned} P_{ij} &= D_i \frac{C_{ij} - C_{sj}}{C_{sj}} \\ W_{ij} &= \left.\begin{matrix} W_{0j} + R_{1j} P_{ij} \\ R_{2j} P_{ij} \end{matrix}\right\} \begin{cases} P_{ij} > T_j \\ P_{ij} < T_j \end{cases} \end{aligned}$$

where for facility i and pollutant j:

P_{ij} = Discharge factor	D_i = Total wastewater discharge
C_{ij} = Pollutant concentration	C_{sj} = Concentration standard
W_{ij} = Total water levy	W_{0j} = Fixed payment factor
T_j = Regulatory threshold parameter	

R_1 and R_2 are charge standards with $R_2 > R_1$. For continuity at T_j, $R_{2j}T_j = L_{0j} + R_{1j}T_j$. When a pollutant concentration, C, is less than or equal to the standard, C_s, which is jointly set by the central and local governments, a zero charge is made. The charge rate, R, is determined relative to a critical factor, T. Both R and T are set by the central government and vary by pollutant but not by industry. For each polluter, the potential levy, W_j, is calculated for each pollutant. The actual levy is the greatest of the potential levies. Note that the levy formula (A1) implies that the marginal tax rate is lower for firms with discharge factors above the threshold amount.

The national air pollution levy is implemented in a similar manner to the water levy: the polluter is charged only for the highest of the calculated potential levies, L_j. The levy formula for air pollution is:

$$\text{(A2)} \quad A_{ij} = R_j V_i (C_{ij} - C_{sj})$$

where for facility *i* and pollutant *j*:

R_j = Charge rate for pollutant j
C_{ij} = Pollutant concentration
A_{ij} = Total levy
V_i = Total volume of air emission
C_{sj} = Concentration standard

As in the case of water levies, the concentration standard, C_s, is jointly set by the central and local government while the charge rate, *R*, is set by the central government.

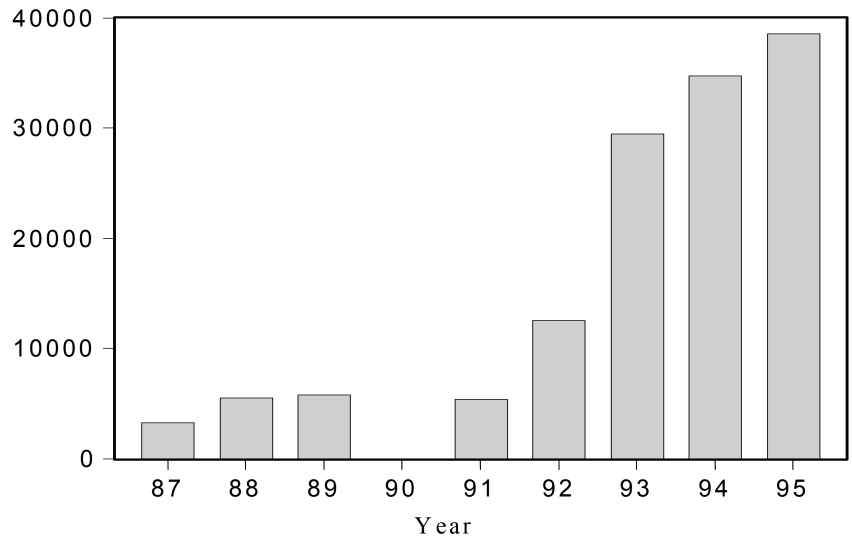
There are four major sources of provincial variation in pollution tax rates. First, as noted above, concentration standards are set jointly by the national and local governments. Second, standards differ by effluent, thus differences in the concentration of industries across provinces will lead to different effective tax rates. Third, there are significant differences in enforcement capacity at the local level. Finally, the levy can be reduced or even eliminated at the discretion of local regulators after appropriate inspections.[28] Such latitude introduces considerable variation into regional enforcement practices. In general, regulation is stricter in areas where incomes are higher, access to information is better, and pollution is heavier. At the provincial level, Wang and Wheeler (2002b) show that effective water levy rates are responsive to measures of ambient quality and development. Studying provincial-level averages over an eight year period, they find striking changes in water pollution control and environmental performance. Real effective levy rates more than doubled in some provinces and fell in others, while the countrywide average increased significantly. Average air and water pollution intensities fell sharply; they fell most rapidly in areas when pollution intensity was initially highest.

[28] The actual levy paid by a firm is the result of bargaining between the government and the firm. Survey evidence suggests that state-owned enterprises pay lower effective rates than privately-owned firms and that levy rates are positively related to firm profitability. For additional detail see Wang, Mamingi, Laplante, and Dasgupta (2003).

Appendix B
Data Definitions and Sources

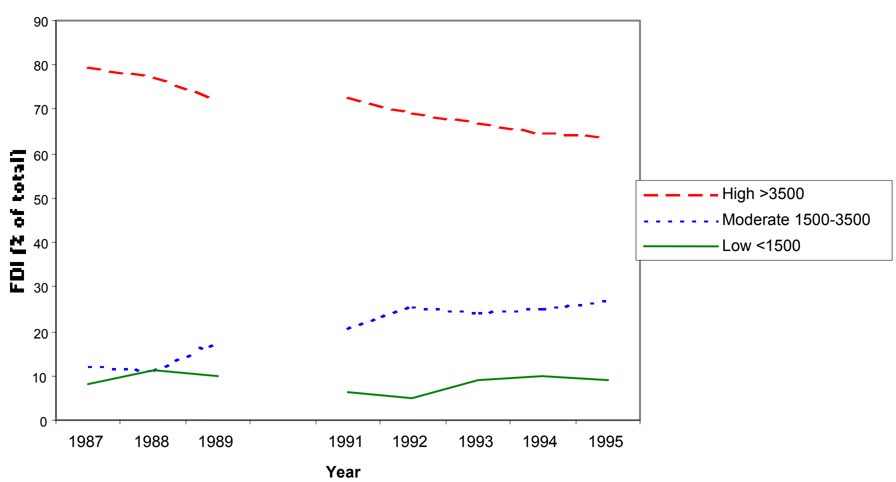
Variable	**Definition**	**Source**
1996 FDI project data: Location Amount Source Industry	 Province Units: $10,000 Chinese=Macao, Taiwan, Hong Kong, other South Asian countries Non-Chinese=all other countries 3-digit ISIC classification	*Almanac of China's Foreign Economic Relations and Trade, 1997-98.* Coded by authors. Coded by authors. Coded by authors.
Levy	Total collected water pollution levies/above standard wastewater (1995, yuan/ton).	World Bank, http://www.worldbank.org/nipr/data/china/status.htm
Skilled labor	Percent of labor force who have a senior secondary school education level or above (1996).	*China Statistical Yearbook*, 1997.
Unskilled labor	Percent of labor force who are illiterate (1996).	*China Statistical Yearbook*, 1997.
Semi-skilled labor	Percent of labor force who have primary or junior secondary education level (1996).	*China Statistical Yearbook*, 1997
Relative abundance of Skilled labor	Skilled labor/Semi-skilled labor.	Constructed by authors.
Relative abundance of Unskilled labor	Unskilled labor/Semi-skilled labor.	Constructed by authors.
Cumulative FDI value	Cumulative value of real contracted FDI, 1983-1995 (in 1980 prices). Expressed as a percent of national cumulative real contracted FDI for same period.	Coughlin, et al. (2000)
Number of domestic enterprises	Number of industrial enterprises-(number of foreign-funded industrial enterprises)-(number of Chinese-funded industrial enterprises). All numbers for the township level and above. (1996, in thousands.)	*China Statistical Yearbook*, 1997.
Telephones	Telephones per 1000 people (1995).	*China Statistical Yearbook,* 1996.
Incentive	Dummy variable for a province with either SEZ or Open Coastal City as of 1996.	Constructed by author
Roads	Highways (km)/land area (km^2) (1995).	*China Statistical Yearbook*, 1997.
Railroads	Railway (km)/land area (km^2) (1995).	*China Statistical Yearbook*, 1997
Pollution-Intensity	COD (kg)/output (thousand 1990 RMB yuan) (1996)	World Bank, http://www.worldbank.org/nipr/data/china/index.htm
Consumption per capita	Consumption (yuan)/population (1996)	*China Statistical Yearbook*, 1997

Figure 1:
China: Total FDI Utilization (Millions of US$)



Note: Data for 1990 are missing.
Source: Calculated from data available at http://www.worldbank.org/nipr/data/china/status.htm

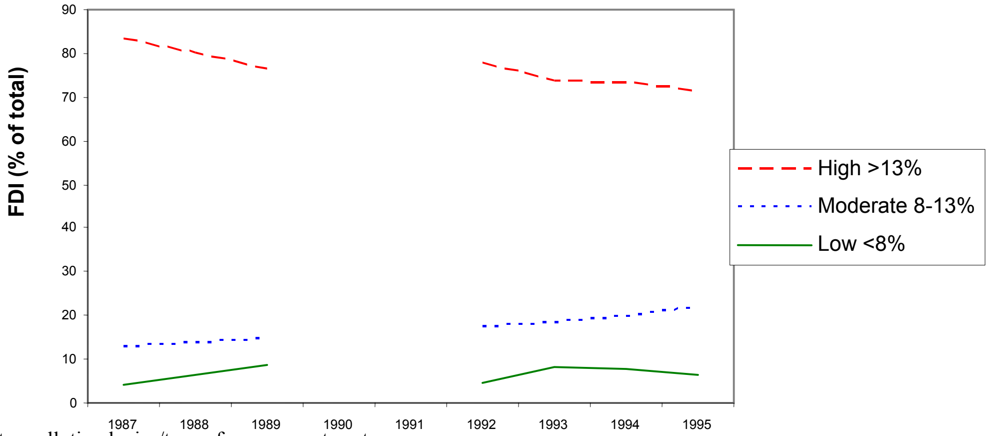
Figure 2: FDI Shares by Income Group[1]



[1]Yuan per capita.
High: Beijing, Guangdong, Jiangsu, Liaoning, Shanghai, Tianjin, Zhejiang
Moderate: Fujian, Hebei, Heilongjiang, Hubei, Hunan, Inner Mongolia, Jilin, Ningxia, Qinghai, Shangdong, Shanxi, Xinjiang
Low: Anhui, Gansu, Guangxi, Guizhou, Henan, Jiangxi, Shaanxi, Sichuan, Yunnan

Source: Calculated from data available at http://www.worldbank.org/nipr/data/china/status.htm

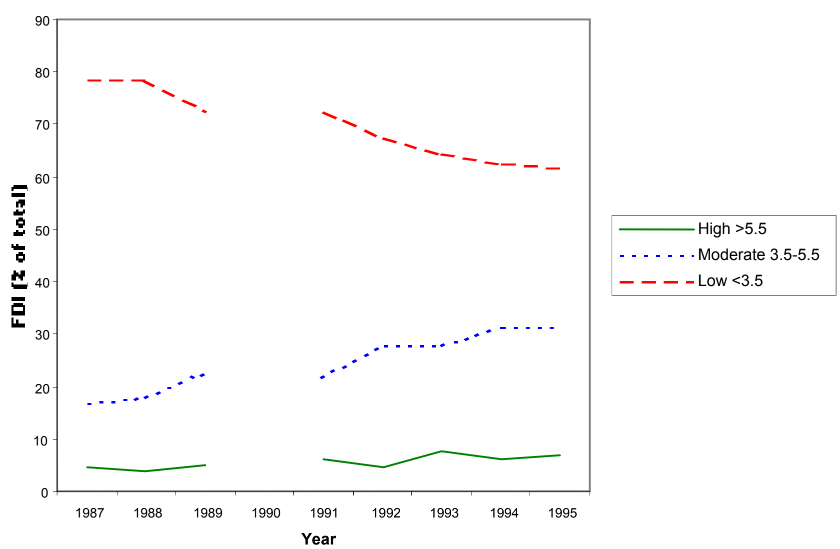
Figure 3: FDI Shares by Pollution Levy



[1]Water pollution levies/tons of excess wastewater.
High: Beijing, Guangdong, Jiangsu, Liaoning, Shangdong, Shanghai, Tianjin, Xinjiang, Zhejiang
Moderate: Anhui, Fujian, Hebei, Heilongjiang, Henan, Hubei, Jilin, Shaanxi, Shanxi, Yunnan
Low: Gansu, Guangxi, Guizhou, Hunan, Inner Mongolia, Jiangxi, Ningxia, Qinghai, Sichuan

Source: Calculated from data available at http://www.worldbank.org/nipr/data/china/status.htm

Figure 4: FDI Shares by Discharge Intensity[1]



[1]Tons of COD per million yuan output (1990 yuan).
High: Anhui, Guangxi, Hunan, Inner Mongolia, Jilin, Xinjiang, Yunnan
Moderate: Fujian, Hebei, Heilongjiang, Henan, Hubei, Jiangxi, Ningxia, Shangdong, Shanxi, Sichuan, Zhejiang
Low: Beijing, Gansu, Guangdong, Gizhou, Jiangsu, Liaoning, Qinghai, Shaanxi, Shanghai, Tianjin

Source: Calculated from data available at http://www.worldbank.org/nipr/data/china/status.htm

Figure 5: Comparison of Joint-Venture Sample (Contract) and Total FDI by Provincial Shares, 1992-1996 Average (Correlation=0.816)

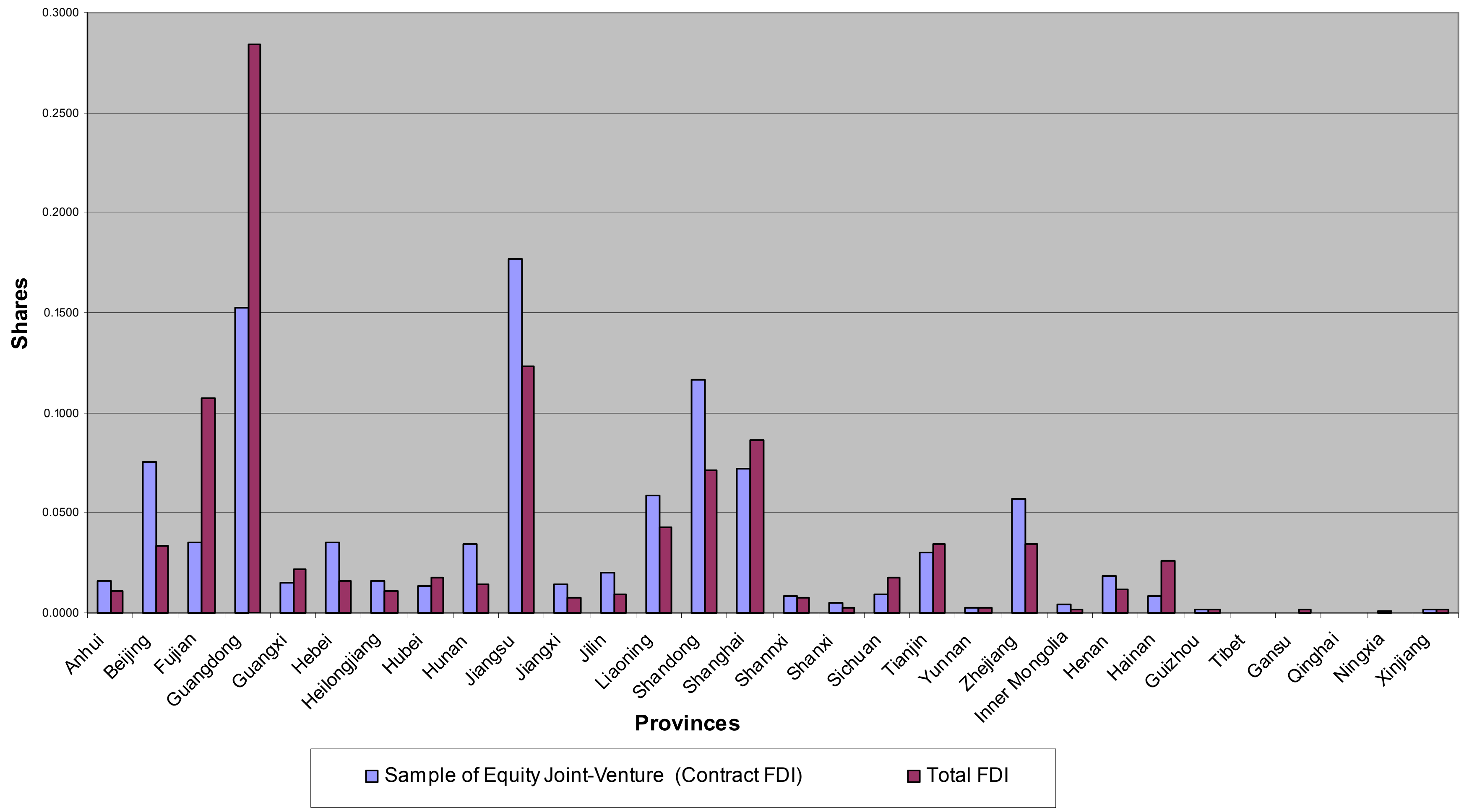


Figure 6. Source distribution of JV sample, by province, 1996

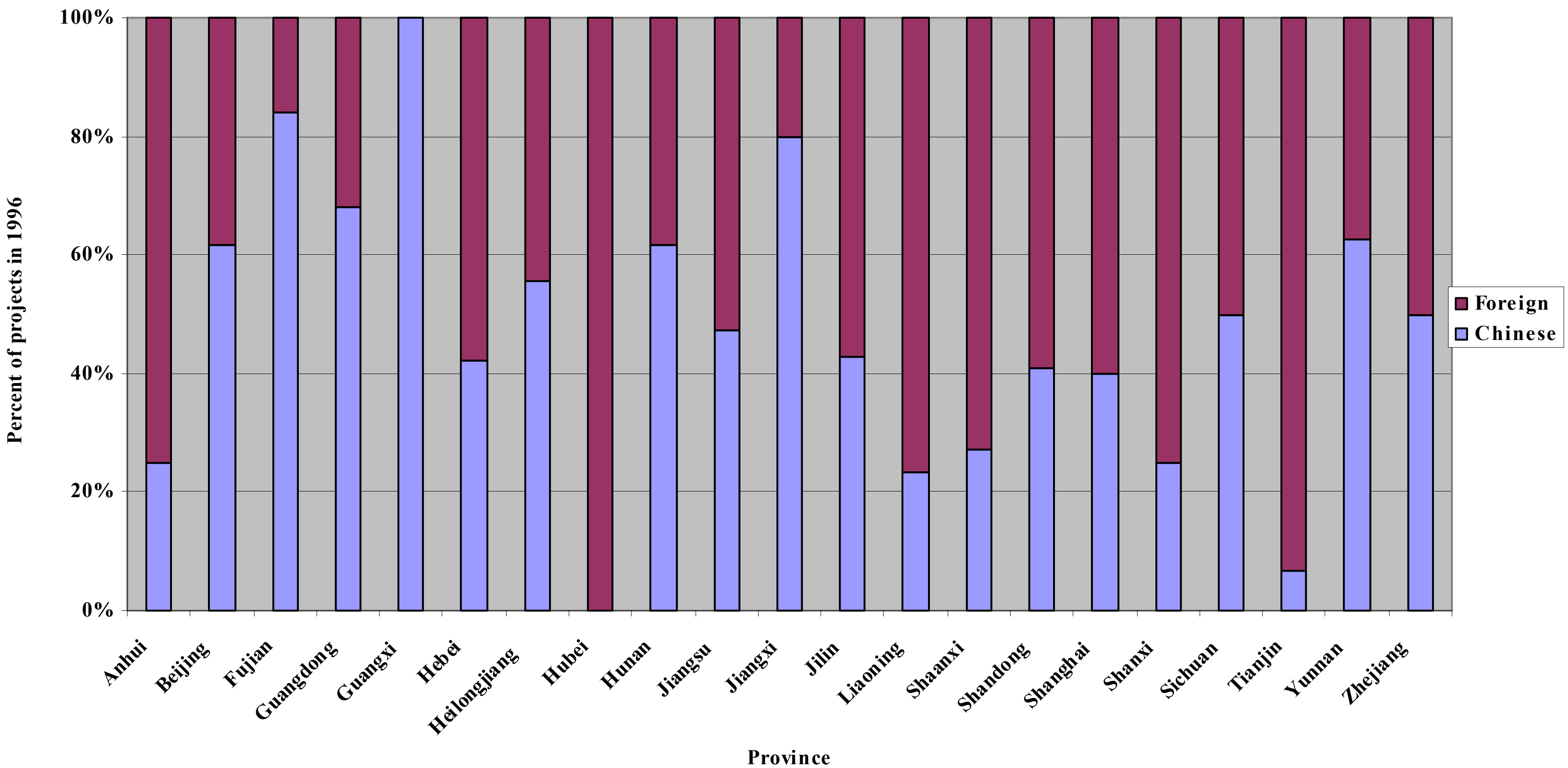


Figure 7. ISIC distribution of JV sample, by province, 1996

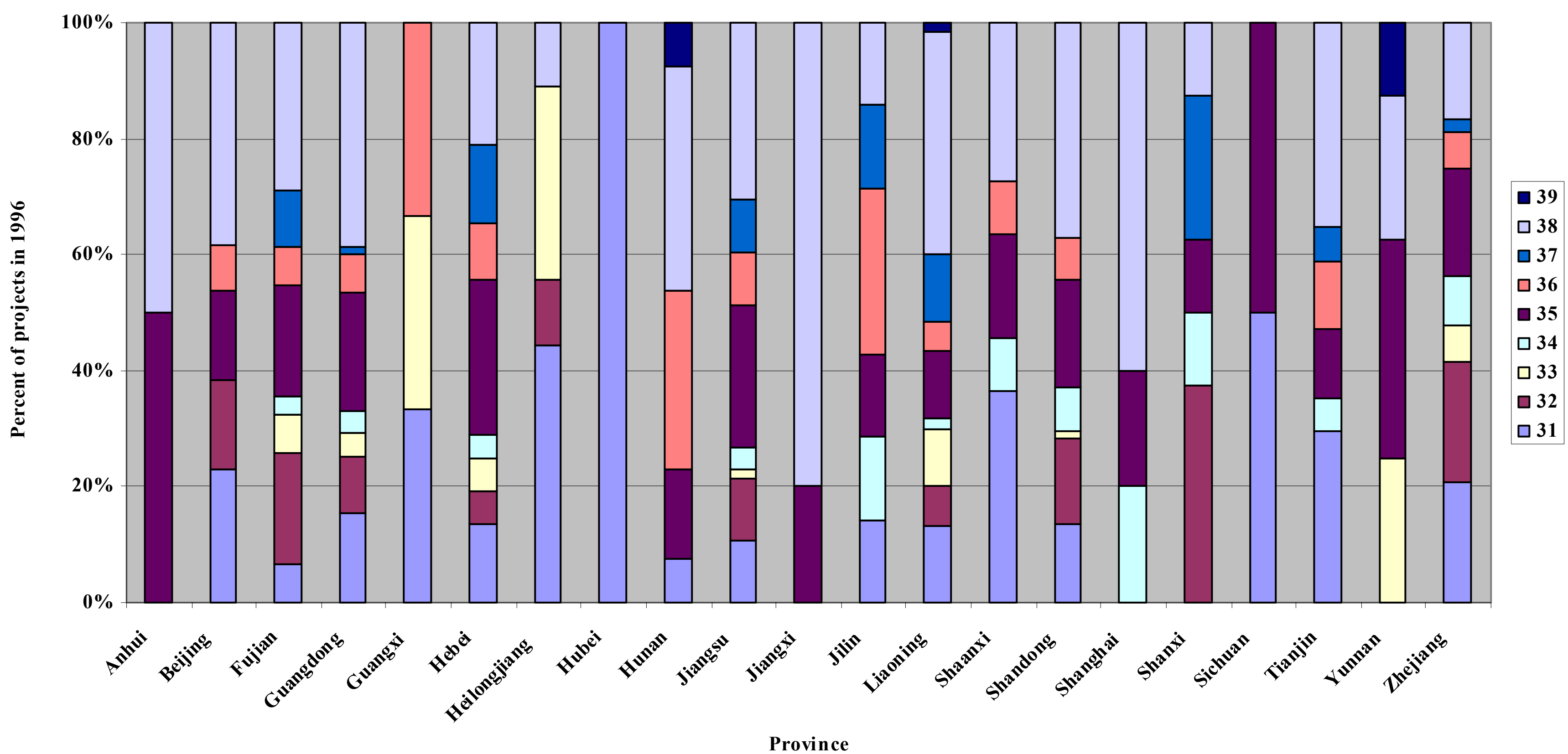
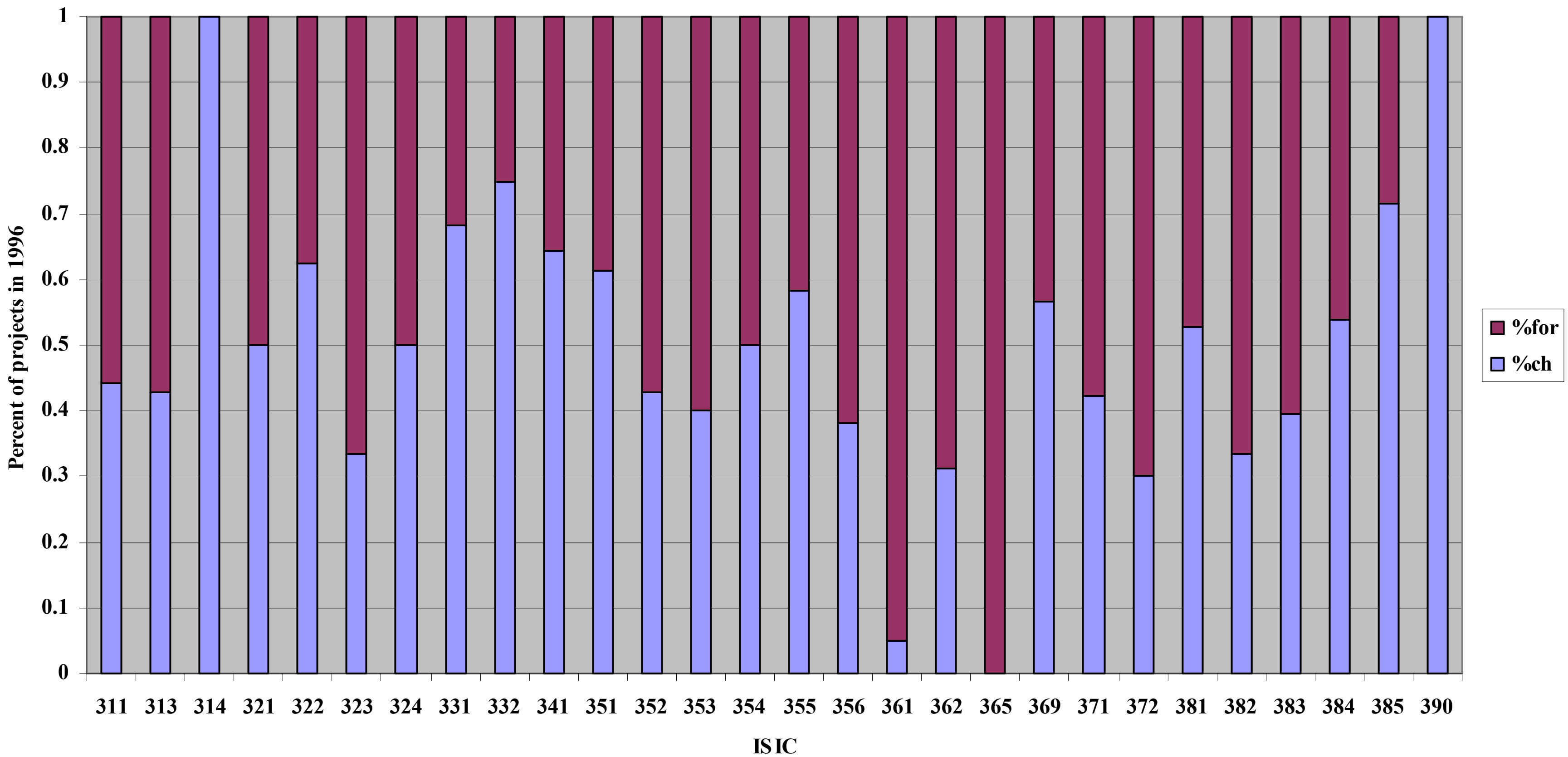


Figure 8. Distribution of JV sample, by industry, 1996



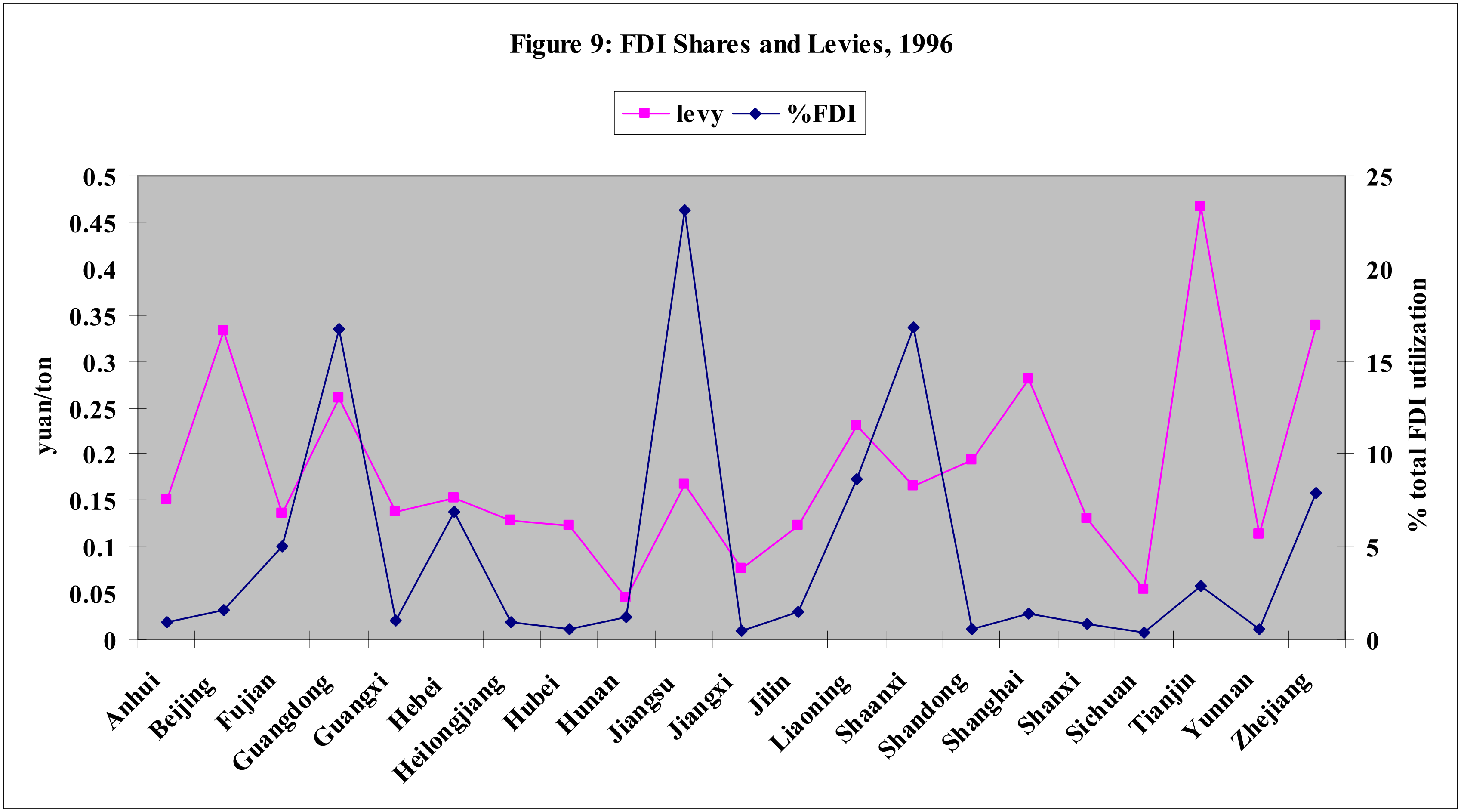


Figure 9: FDI Shares and Levies, 1996
levy
%FDI
yuan/ton
% total FDI utilization
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
25
20
15
10
5
0
Anhui
Beijing
Fujian
Guangdong
Guangxi
Hebei
Heilongjiang
Hubei
Hunan
Jiangsu
Jiangxi
Jilin
Liaoning
Shaanxi
Shandong
Shanghai
Shanxi
Sichuan
Tianjin
Yunnan
Zhejiang

Table 1. Descriptive Statistics of FDI project data

	Projects (number)	Contracted value ($10,000)	Share of contracted value	Value Utilized ($10,000)
Anhui	8	19857.04	2.2	11230.64
Beijing	13	19192.55	2.1	18616.13
Fujian	31	35789.19	3.9	60091.64
Guangdong	103	151373.95	16.7	200340.15
Guangxi	6	6919.38	0.8	12552.48
Hebei	52	73574.80	8.1	82485.52
Heilongjiang	9	9604.80	1.1	11162.88
Hubei	3	5055.99	0.6	6385.59
Hunan	13	11567.66	1.3	14099.67
Jiangsu	131	178418.07	19.7	276916.97
Jiangxi	5	3650.00	0.4	5771.50
Jilin	7	12835.20	1.4	17509.03
Liaoning	60	87502.20	9.7	103646.40
Shaanxi	11	15213.33	1.7	17185.08
Shandong	81	145488.15	16.0	201655.98
Shanghai	5	5755.80	0.6	6913.50
Shanxi	8	13739.52	1.5	9822.24
Sichuan	4	4542.00	0.5	4385.12
Tianjin	20	29148.60	3.2	34286.40
Yunnan	8	13495.68	1.5	6982.00
Zhejiang	48	63883.68	7.0	94154.40
Inner Mong.	0	0.00	0.0	0.00
Henan	0	0.00	0.0	0.00
Hainan	0	0.00	0.0	0.00
Guizhou	0	0.00	0.0	0.00
Tibet	0	0.00	0.0	0.00
Gansu	0	0.00	0.0	0.00
Qinghai	0	0.00	0.0	0.00
Ningxia	0	0.00	0.0	0.00
Xinjiang	0	0.00	0.0	0.00
SUM	**626**	**906607.59**	**100**	**1196193.32**

Table 2. Province	Consumption per capita (yuan)	Water Levy, 1995 (yuan/ton)	Domestic Entrepr.[1] (000s)	Cum. Real FDI 1983-95 (% of total)	Unskilled Employees[2] (%)	Skilled Employees[3] (%)	Telephones per 100 people, 1995	Roads/area 1995 (km/km^2)	SEZ or OCC
Anhui	1945	0.15	24.1	1.0	15.6	51.2	26	0.26	0
Beijing	4208	0.33	14.5	4.1	2	28.7	206	0.75	1
Fujian	3356	0.14	17.3	10.6	15	12.5	70	0.38	1
Gansu	1550	0.09	11.6	0.1	30.5	18	27	0.08	0
Guangdong	4235	0.26	32.7	30.8	7.3	18.8	121	0.49	1
Guangxi	2008	0.14	14.1	2.2	9.6	24	23	0.18	1
Guizhou	1446	0.06	28.2	0.2	28.7	23	12	0.18	0
Hainan	2376	0.25	1.6	3.0	14.2	41.4	58	0.43	1
Hebei	1925	0.15	23.0	1.4	10	16.3	39	0.28	1
Heilongjiang	2994	0.13	20.4	1.1	4.9	11.3	56	0.10	0
Henan	1686	0.12	8.6	1.1	11.7	8.9	22	0.31	0
Hubei	2398	0.12	28.6	1.7	12.4	11.8	40	0.26	0
Hunan	2199	0.04	25.4	1.2	9.3	9.9	31	0.28	0
Inner Mon.	1939	0.08	0.2	0.2	12.9	12.3	38	0.04	0
Jiangsu	3121	0.17	39.1	10.9	13.4	16.3	73	0.26	1
Jiangxi	1857	0.08	20.3	0.7	10.4	13.9	24	0.21	0
Jilin	2643	0.12	13.0	0.8	4.6	11.9	64	0.16	0
Liaoning	3250	0.23	31.9	4.5	3.4	9.7	74	0.30	1
Ningxia	1785	0.10	7.6	0.0	22.5	10.1	44	0.17	0
Qinghai	1967	0.06	2.0	0.0	41.6	9	30	0.02	0
Shaanxi	1594	0.17	13.4	1.0	16.2	16.9	28	0.19	0
Shandong	2287	0.19	28.3	7.0	17.8	14.3	40	0.36	1
Shanghai	7742	0.28	12.6	8.2	3.8	10.9	208	0.59	1
Shanxi	1880	0.13	11.5	0.2	5.6	15.2	31	0.22	0
Sichuan	1924	0.05	44.1	1.8	14.7	11.1	19	0.18	0
Tianjin	4129	0.47	9.2	2.8	5	19	148	0.34	1
Tibet	1312	0.00	1.8	0.0	60.4	17.1	15	0.02	0
Xinjiang	2398	0.23	7.9	0.2	10.7	12.3	41	0.02	0
Yunnan	1800	0.11	9.0	0.3	25	1.4	22	0.19	0
Zhejiang	3412	0.34	32.6	3.1	10.8	22.6	92	0.35	1

[1] Number of industrial entreprises-(number of foreign-funded industrial entreprises)-(number of Chinese-funded industrial entreprises). All numbers for the township level and above.
[2] Percent of labor force who are illiterate. [3] Percent of labor force who have a senior secondary school education level or above.

Table 3: Conditional Logit Results for Non-Chinese Sample[29]

	(1) Full Sample	(2) Low Polluters	(3) Moderate Polluters	(4) Moderate and High Polluters
Levy	7.77 (4.24)	7.65 (3.01)	9.24 (2.91)	8.40 (3.00)
Skilled Labor Ratio	5.11 (4.26)	4.66 (2.63)	5.78 (3.17	5.57 (3.18)
Unskilled Labor Ratio	-0.84 (-0.86)	-0.34 (-0.25)	-2.44 (-1.48)	-1.52 (-1.01)
Cumulative FDI Value	9.50 (5.54)	9.34 (3.66)	12.23 (4.13)	10.11 (4.02)
No.of Domestic Enterprises	0.03 (3.36)	0.03 (1.98)	0.05 (2.79)	0.38 (2.70)
Incentive	2.34 (9.37)	2.40 (6.71)	2.33 (6.27)	2.27 (6.27)
Telephones per capita	-0.03 (-3.37)	-0.03 (-2.49)	-0.02 (-1.50)	-0.03 (-2.17)
Density Adjusted roads	-4.70 (-4.64)	-5.13 (-3.29)	-5.70 (-3.37)	-4.58 (-2.99)
Consumption per capita	-0.03 (-0.14)	0.21 (0.66)	-0.93 (-1.75)	-0.33 (-1.03)
N	313	166	137	147
Log Likelihood	-765.08	-401.98	-331.47	-361.37

[29] Sample divided by pollution intensity (PI) measured by COD/output value. Chemical oxygen demand (COD) is measured in kg. Output value is measured in thousands of 1990 RMB yuan. A low polluting industry is defined by 0<PI<1; a moderately polluting industry is defined by 1<PI<10; a high polluting industry defined by 10<PI. Z-statistic in parenthesis under estimated coefficients.

Table 4: Conditional Logit Results for Chinese Sample[30]

	(1) Full Sample	(2) Low Polluters	(3) Moderate Polluters	(4) Moderate and High Polluters
Levy	-4.84 (-2.56)	-4.01 (-1.40)	-7.10 (-2.52)	-5.85 (-2.25)
Skilled Labor Ratio	-2.81 (-2.29)	-1.08 (-0.57)	-4.77 (-2.67)	-4.17 (-2.46)
Unskilled Labor Ratio	4.39 (3.37)	4.65 (2.68)	3.60 (1.51)	4.10 (1.86)
Cumulative FDI Value	2.64 (1.62)	5.84 (2.26)	-0.98 (-0.41)	0.05 (0.02)
No. of Domestic Enterprises	0.04 (4.25)	0.04 (2.39)	0.05 (3.29)	0.05 (3.44)
Incentive	1.77 (6.88)	1.46 (3.84)	2.13 (5.09)	2.09 (5.45)
Telephones per capita	0.03 (2.66)	-0.02 (-1.29)	0.04 (2.33)	0.04 (2.20)
Density adjusted roads	-0.16 (-0.13)	-0.24 (-0.14)	0.19 (1.45)	-0.08 (-0.05)
Consumption per capita	-0.00 (-2.91)	-0.71 (-1.87)	-0.77 (-1.95)	-0.78 (-2.03)
N	283	136	129	147
Log Likelihood	-675.26	-324.17	-304.52	-347.45

[30] Sample divided by pollution intensity (PI) measured by COD/output value. Chemical oxygen demand (COD) is measured in kg. Output value is measured in thousands of 1990 RMB yuan. A low polluting industry is defined by 0<PI<1; a moderately polluting industry is defined by 1<PI<10; a high polluting industry defined by 10<PI. Z-statistic in parenthesis under estimated coefficients.