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Foreign Direct Investment and Pollution Havens: Evaluating the Evidence from China

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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 the location choices of equity joint venture (EJV) projects in 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 conditional logit and nested multinomial logit models using new data sets containing information on a sample of EJV projects, effective environmental levies on water pollution, and estimates of Chinese emissions and abatement costs for 3-digit ISIC industries. Results from 2886 manufacturing joint venture projects during 1993-1996 show EJVs from all source countries go into provinces with high concentrations of foreign investment, relatively abundant stocks of skilled workers, concentrations of foreign firms, and special incentives. Environmental stringency does affect location choice, but not in the manner described by the pollution haven hypothesis. Relatively weak environmental levies are a significant attraction for joint ventures with partners from Hong Kong, Macao, Taiwan, and other Southeast Asian developing countries. In contrast, joint ventures with partners from industrial country sources (e.g., US, UK and Japan) are actually attracted by stringent environmental levies, regardless of the pollution intensity of the industry. 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 FDI in pollution-intensive industries did occur, 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; and inter-country FDI location choice.[3] Results from these

studies are mixed. In his review of four studies that use the first approach to study 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

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[1] 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] 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.

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measure for inter-state differences in industrial 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) adopt the second approach, examining 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. Additionally, 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) adopt the third approach, evaluating 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. However, these results are 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 Zhang and Markusen (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 been loosely motivated by the theoretical literature on pollution emissions and abatement, potentially 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

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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.

measurement error. Finally, Keller and Levinson (2002) and Levinson and Taylor (2001) illustrate the empirical importance of controlling for unobserved location and industry characteristics.

This study estimates the strength of pollution-haven-seeking behavior by foreign firms investing in China. We derive and estimate a model of FDI location choice in the presence of inter-provincial differences in environmental stringency. Our theoretical framework is built 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 2886 manufacturing foreign equity joint venture (EJV) projects in China during 1993-1996. 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 this sample of joint venture projects suggest an important linkage between technology and pollution-haven behavior. 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. Pollution levies do not significantly deter these partners, regardless of the pollution intensity of the industry. In contrast, projects funded from Chinese sources (Hong Kong, Macao, and Taiwan) are significantly deterred by pollution taxes, regardless of pollution intensity. One possible explanation for this finding, supported by evidence from other studies, is that investment from advanced countries embodies newer technology, implying lower costs for abatement and a higher probability that a given plant will meet standards and avoid taxation. This evidence provides some support for the pollution haven hypothesis but

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suggests that the attraction of weak environmental regulations is conditioned by access to advanced technology.

In the next section, we describe FDI flows into China and China's Pollution Levy System. In the third section, we present a model of location choice, incorporating the firm's endogenous response to pollution taxes, local factor prices, and local market conditions. We specify a profit function and we derive a proposition that forms the basis for our empirical work. In the fourth section, we describe our econometric approach and describe the data. Next, we present the results of the conditional and nested multinomial 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,[6] as well as new guidelines issued by the Chinese national government in 1995.[7] However, it may also be influenced by environmental regulations which vary across provinces and types of pollutants.

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[6]In 1979, the Chinese national government began accepting foreign investment and in 1980 established four special economic zones (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 the issue in 1986 of a new legal framework governing foreign investment, certain incentives were available anywhere in China to foreign enterprises that produced for export or introduced advanced technology.

[7] 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

According to Henley, *et al.* (1999) between 1985 and 1996, 66.4% of FDI into China came from Hong Kong, Macau, and Taiwan.[8] 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.[9] 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,[10] 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.[11] 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.[12] 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

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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).

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

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

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

[11]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).

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

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.

Several recent studies examine inter-provincial FDI flows distinguished by source country and, as in the present study, find significant differences in location choice. Fung, Iizaka, and Parker (2002) compare the determinants of investment from Japan and the U.S. to those from Hong Kong and Taiwan. They find investment from Japan and the U.S. is sensitive to provincial labor quality, while investment from Hong Kong and Taiwan is not significantly influenced by labor quality but is more sensitive to labor costs. Similar results are found in Fung, Iizaka, Lin, and Siu (2002) and Gao (2002), who uses more comprehensive measures of labor quality.

One previous study has used data on equity joint ventures to study location choice. Using data on EJVs undertaken by non-Chinese investors, 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.[13] The Chinese pollution levy system, described in Appendix A, is the broadest application of a price-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. Secondly, standards differ by effluent, thus differences in the concentration of industries across provinces will lead to different effective tax rates. Thirdly, there are

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[13] 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 outcome measures such as actual abatement costs.

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 intensity is an indicator of laxity of standards and/or concentration of pollution-intensive industries, it appears that neither of these factors attracts 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; Wang and Wheeler 1996, 2002b), 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.[14] 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 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 have actually charged local firms in the past. As this rate is influenced both by the statutory rate and by enforcement practices, we use this effective rate as the firm's indicator of provincial environmental regulatory stringency.

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, q, of its inputs to abatement activity. This implies that abatement and production use factors in the same proportion. If $q = 0$, there is no abatement

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[14]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.

and, by choice of units, each unit of output generates one unit of pollution. The joint production technology is given by:

$$X = (1-q)F\left(L_{x,}, H_x, I_x(s)\right),$$
$$Z = f(q)F\left(L_x, H_x, I_x(s)\right),$$

(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 $0 \leq q \leq 1, f(0) = 1, f(1) = 0$.

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

$$f(q) = (1-q)^{1/a},$$

(2)

where $0 \leq a \leq 1$. 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:

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

(3)

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

$$F(L_x, H_x, I_x) = AL_x^b H_x^d (I_x(s))^e,$$

(4)

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

$$X = Z_x^a A^{(1-a)} L_x^b H_x^d (I_x(s))^e,$$

(5)

where $b = b(1-a), d = d(1-a),$ and $e = e(1-a)$. We note that a, b, d, e 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

$$C_X(t_j, u_j, h_j, \tilde{p}_{sj}, X) = KA^{\frac{-(1-a)}{g}} t_j^{\frac{a}{g}} w_j^{\frac{b}{g}} h_j^{\frac{d}{g}} \tilde{p}_j^{\frac{e}{g}} X^{\frac{1}{g}} = Kc_X(\vec{w}_j)X^{\frac{1}{g}}, \tag{6}$$

where $g = a + b + d + e < 1$ and the vector $\vec{w} = (t, u, h, \tilde{p}_s)$. 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:

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

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 a given province. The emissions tax rate enters the cost function, $c_X(\vec{w})$, so using Shepard's lemma and denoting proportionate changes with a "^",

$$\frac{\hat{p}_{Xj}}{\hat{t}_j} = -\frac{1}{1-g} \frac{t_j Z_X(p^f, \vec{w}_j)}{c_X(\vec{w}_j)X(p^f, \vec{w}_j)^{\frac{1}{g}}} = -\frac{1}{1-g}\frac{a}{g} < 0. \tag{8}$$

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 effic ient 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 $\frac{a}{g}$). 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 $\frac{a}{g}$ 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. 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,

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$c_S(\vec{w})$. If the number of suppliers is large, each firm faces an iso-elastic demand curve and sets the price $P_s = c_s(\vec{w})/\boldsymbol{s}$. 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, $I(s) = N_s^{1/\boldsymbol{s}} s$ 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, $\tilde{p}_s = P_s N_s^{(\boldsymbol{s}-1)/\boldsymbol{s}}$. 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).[15] Thus, in equilibrium,

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

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

where the function $z(\cdot)$ 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

$$\tilde{p}_s = \frac{c_s(\vec{w})}{s}\left[z(\vec{w}, P^f, N^f, \overline{N}_s)\right]^{(s-1)/s} = \left[K_2 u^m h^n (P^f) N^f \overline{N}_s\right]^r, \tag{10}$$

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.

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 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 arguments to the profit function that attempt to measure local income and market size.

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IV. Econometric Method and Data Description

Estimation Method

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 p_{ij} and a host of unobserved idiosyncratic features e_{ij}. If e_{ij} are distributed independently according to a Type I Extreme Value distribution (whose density is given by exp[-exp(e)]), then the probability, P_{ij}, that investor i chooses province j where j is a member of choice set J is given by

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

and we represent p_{ij} by equation (7). Our baseline estimation of equation (11) is a standard conditional (or multinomial) logit. Because the standard conditional logit estimation implies the "independence of irrelevant alternatives" (IIA) property, we also allow the e_{ij} to have a generalized extreme-value distribution, which avoids the IIA assumption and we use a nested multinomial logit procedure.[16]

We use data on 2886 manufacturing equity joint ventures undertaken during 1993-1996 across 28 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

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[16] Further discussion of the application of these methods to modeling firm location decisions can be found in Ondrich and Wasylenko (1993).

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:

> 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)

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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 out of 626 projects in 1996, 113 out of 682 in 1995, 79 out of 801 in 1994, and 22 out of 777 in 1993. These projects are 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.

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 data for a sample of equity joint venture investments undertaken during 1993-1996, using project descriptions available from the Chinese Ministry of Foreign Trade and Economic Cooperation (MOFTEC).[20] We have been unable to learn the criteria used by MOFTEC to select this sample. To gauge the consistency of the sample with what is known about the provincial distribution of foreign investment, we compare the provincial shares of total contracted EJV value in our sample to the provincial shares for all contracted FDI.[21] Figure 5 shows this comparison, using average shares over the 1993-1996 period. The simple correlation between the two distributions is 0.74. 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, and Hainan, (although not Tianjin) and to over-sample areas where investment was encouraged at a later stage in the "open door" policy.

Our analysis is performed using information on 2886 manufacturing joint venture investments. The distribution of the sample of EJVs across provinces is shown in Table 1. Figures 6 and 7 provide the distribution of the EJV sample across provinces by source and by 2-digit ISIC industrial sectors,

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[20] Equity joint ventures are limited liability companies incorporated in China, in which foreign and Mainland Chinese investors hold equity. For further details, see Fung (1997).

[21] Data on total contracted equity joint ventures by province is unavailable. Our sample appears to be the only available information on the distribution of EJVs by province and industry. Despite obvious difficulties in comparison, 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.

respectively. Figure 6 shows that both Chinese and non-Chinese partners engage in equity joint ventures in all provinces. Investment into the southeastern provinces of Fujian and Guangdong is predominantly Chinese, reflecting both the geographic location and early opening of these provinces. In contrast, investment into Shanxi and Tianjin is predominantly from non-Chinese sources, a feature sometimes linked to the industrial concentration there. Figure 7, however, shows that the source distribution is unlikely to be driven by industrial concentration to any great extent. As most provinces received investment in a wide range of sectors. Separate calculations show that the distribution of Chinese and non-Chinese projects across industries grouped by pollution intensity is very similar. The correlation between the Chinese and non-Chinese industry shares is 0.99.

Figure 8 shows the distribution of EJVs across 3-digit ISIC industries by source. Here, it is clear that investment roughly follows the national trend. For most sectors, about two-thirds of investment is from Chinese sources, with the remaining third from non-Chinese sources. Sectors with predominantly Chinese investment include tobacco (314), leather goods (323), printing and publishing (342), and other manufactured products (390). In contrast, sectors with predominantly non-Chinese investment include petroleum refineries (353), machinery, transport equipment, and professional and scientific instruments (382-385). To some extent this pattern follows prior expectations regarding differences in comparative advantage across Chinese and non-Chinese source countries.

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 the provincial characteristics associated with projects undertaken in 1996 are shown in Table 2.   Although provincial wage data is available, it is not differentiated across labor types. However, a distribution of the population by educational attainment categories is available for each province from the 1990 Population Census and a 1% sample of the population performed in

1995.[22] 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 (and less than primary education), as unskilled labor, and the two top 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 to the year before the project is undertaken for each province. 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.[23]

As in other studies, we also include two measures of infrastructure, roads (adjusted for provincial size), and telephone access (urban subscribers to telephone service, as percent of population). 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. These incentives do not vary during the 1993-1996 period.

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

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[22] We interpolate between these years to develop a time series.
[23] Specifically, we subtract those firms which are classified as "foreign-funded" or "funded by entrepreneurs from Hong Kong, Macao, or Taiwan."

total industrial output.[24] As the table below indicates, industries are 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 in 1993 and in 1996. There is a positive relationship in the unconditional data: investment shares are larger for provinces with higher water pollution taxes.

Our expectations for the signs and significance of our explanatory variables follow the properties of the profit function. 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. To test this, we group industries into three industry groups, low, moderate, and high polluting, using a combination of 3-digit and 2-digit pollution intensities, and we interact the pollution levy with indicator variables 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 evidence that projects from Chinese sources embody less advanced technology than do projects from non-Chinese sources. Consequently, we divide our sample into Chinese and non-Chinese-sourced projects

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

[27] These regions are as follow. Metro: Beijing, Tianjin, Shanghai; Northeast: Heilongjiang, Jilin, Liaoning; Coastal: Hebei, Shangong, Jiangsu, Zhejiang, Fujian, Guangdong, Hainan; Central: Shanxi, Henan, Anhui, Hubei, Hunan, and Jiangxi; Northwest: Inner Mongolia, Shaanxi, Ningxia, Gansu, Qinghai, Xinjiang, Tibet; Southwest: Sichuan, Yunnan, Guizhou, Guangxi.

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 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 that have rich and growing local markets, as measured by provincial consumption per capita and lagged real provincial GDP growth. When we estimate nested multinomial logits, we also need to specify the determinants of regional choice. We began by grouping provinces into six regions, as defined by Demurger, *et al.* (2002).[27] The region-specific determinants of investment we identify are average regional consumption per capita, average regional population density, and average regional lagged real income growth. All of these variables should be associated with the economic size of the local market and its economic growth potential.

V. Results

We estimate the parameters of the linearized profit function using both conditional logit and nested logit methods. Table 3.1 shows the conditional logit results for the full sample, and two subsamples—foreign (non-Chinese), and Chinese. Results for the full sample validate what many previous authors have found regarding EJV location in China. EJVs are strongly attracted to provinces with high agglomeration, large numbers of local suppliers, special incentives, and relatively abundant skilled workers. EJVs are more likely to locate in the northeast, coastal and central provinces than in the metro region, and are strongly less likely to locate in the northwest during this time period. There is also

some evidence that EJVs locate in lower income provinces with relatively high real growth rates. Results for the infrastructure variables are at odds with expectations, appearing either insignificant or wrongly signed. There is little difference in the non-Chinese and Chinese subsamples with respect to these variables, though the Chinese EJVs appears more strongly influenced by per capita consumption levels and by real income growth.

The most striking result in table 3.1 is the strong positive response of EJVs to the pollution levy. This suggests that EJVs are attracted to provinces with relatively stringent standards, even after controlling for income level and income growth, which are often associated with better pollution regulation. This is clearly the opposite of the pollution haven hypothesis. Interestingly, the subsample results show that the non-Chinese and Chinese respond quite differently to the levy. Given that non-Chinese EJVs 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. Yet in Table 3.1, we see that non-Chinese EJVs are strongly attracted to provinces with higher pollution levies. In contrast, Chinese EJVs location choice seems to be uninfluenced by the water pollution levy.

Using the data on COD-intensity of Chinese industrial output at the 3-digit level,[28] we divide the sample into low, medium and high water-polluting industries. Water pollution intensity (PI) is defined as low if it is below 1 kg per thousand yuan output (1990 yuan). About 60 percent of the EJV projects in the sample are in industries designated as low polluters. Another 24 percent of the sample are in industries with $1 < PI < 3.5$, and are classified as medium polluters. The final 16 percent are in industries with $PI > 7$, and are denoted high polluters. Interestingly, the non-Chinese and Chinese subsamples of EJVs show a similar distribution across pollution intensities.[29] We construct three dummy variables to represent these three ranges of pollution-intensity, and we interact the levy variable with these pollution-intensity dummies to test whether these groups respond differently to pollution regulation.[30]

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[28] When 3-digit pollution-intensity information is unavailable, the 2-digit value is used.
[29] The simple correlation between the distributions of the two sub-samples across pollution-intensities is about 0.90.
[30] The conversion to three dummies is due to the lack of high within-group variation in pollution-intensity, despite

Table 3.2 again shows results for the full sample, and the non-Chinese and Chinese sub-samples. The full sample results still reveal a strong positive attraction between location choice and pollution levy, but the magnitude is signficantly smaller for medium polluting industries and is almost completely negated if the industry is a high polluter. EJVs from non-Chinese sources also reveal a strong positive attraction to provinces with high levies, but this occurs across all types of industries, regardless of the pollution intensity. In contrast, EJVs from Chinese sources are marginally attracted by high pollution levies, but less so as the pollution-intensity of the industry rises. Chinese EJVs in high-polluting industries appear significantly deterred by high water pollution levies.

It is possible that the decision to locate EJVs in China is actually a nested one. Since the Chinese government progressively implemented incentives toward EJVs over time, starting with the coastal areas and exanding towards the central and then western provinces, it may be that investors first chose a region to invest in, and then a province within that region. If so, it may be that our counter-intuitive result that non-Chinese EJVs are attracted to high pollution levies is simply an artifact of choosing high income regions within which to invest. To explore this possibility, we re-estimated the specifications shown in tables 3.1 and 3.2 using nested logits. The results are reported in tables 4.1 and 4.2.

In Table 4.1 results show that for all samples, the null hypothesis that the IV=1--that the decision is not nested--is strongly rejected. Non-Chinese investors are attracted to regions that have higher consumption per capita, and higher real income growth, while Chinese investors appear to locate in slower growing regions. Within a region, the characteristics that attract investors follow the same patterns as were shown in the conditional logit results. The results regarding pollution levies are striking. In contrast to the conditional logit results, the overall sample shows no influence of pollution levies on EJV location choice. However, there is a strong and opposite response for each subsample. Even after accounting for a nested decision process, EJVs from non-Chinese sources are strongly attracted to provinces with high pollution levies, while EJVs from Chinese sources are strongly deterred.

high between-group variation.

In table 4.2 the industries are again allowed a varying response based on pollution-intensity. Once again, the null hypothesis that the IV=1--that the decision is not nested--is strongly rejected for all samples. Response to regional and provincial variables is similar to the results in table 4.1. In contrast to the conditional logit results, the nested logit estimation yields an overall negative reaction to the levy for the full sample. This negative reaction is larger for medium polluters but not significantly different for the high polluting industries. These results would appear to validate the pollution-haven hypothesis. However, the non-Chinese and Chinese sub-samples persistently show different behavior. EJVs from non-Chinese sources are still attracted to provinces with high pollution levies, regardless of the pollution-intensity of the industry. EJVs from Chinese sources are again deterred from provinces with stringent water pollution levies, and this, too, is regardless of pollution-intensity.

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 location 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 from 1993- 1996 show a wide dispersion of EJVs 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 and nested logit analysis suggests that both types of investment are attracted to cumulative investment, the number of local suppliers, and special incentives. Both non-Chinese-sourced and Chinese-sourced investment appears to be attracted to provinces with high relative endowments of skilled labor.

Conditional logit analysis provides some evidence that Chinese-sourced FDI is deterred by relatively stringent pollution regulation, particular in highly polluting industries. This supports the pollution haven hypothesis. However, FDI from non-Chinese sources is actually attracted to provinces

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with more stringent environmental regulations, regardless of pollution-intensity--the opposite of the pollution haven hypothesis. Nested logit results indicate that investors first look for high income, and to some extent, fast growing regions in which to locate. They then choose a province within that region based on agglomeration, relative endowments of skilled labor, special incentives and rapid income growth. However even after correcting for this nested decision, environmental stringency still strongly attracts non-Chinese FDI while strongly deterring Chinese FDI, regardless of pollution-intensity.

Our results suggest the importance of accounting for firm heterogeneity in considering the attraction of weak environmental regulations. Firms in industries that use low-polluting processes are unlikely to be responsive to pollution taxes. Firms in heavily polluting processes, however, can be expected to respond to the implied factor-price difference. We have shown, however, that industry heterogeneity is not the full story. Our evidence is consistent with the view that important international differences in production processes and pollution-control technology exist. While we have no direct measure of technological sophistication, the contrasting results we find for Chinese-sourced and non-Chinese-sourced investment, coupled with other evidence on the extent of technology transfer, suggest that technology mediates the link between low standards and firm location decisions.

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APPENDIX A
THE CHINESE POLLUTION LEVY SYSTEM[31]

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.[32] 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.[33]

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

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[31] The material in this appendix is drawn from Wang and Wheeler (2002a), where additional details can be found.
[32] 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.
[33] Information on polluters is drawn from Wang and Wheeler (2002a), who report results of a plant-level survey.

volume and air pollutant concentrations (before and after treatment); 5) noise pollution by source; 6) 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:

(A1)
$$P_{ij} = D_i \frac{C_{ij} - C_{sj}}{C_{sj}}$$

$$W_{ij} = \left. \begin{matrix} W_{0j} + R_{1j}P_{ij} \\ R_{2j}P_{ij} \end{matrix} \right\} \left\{ \begin{matrix} P_{ij} > T_j \\ P_{ij} < T_j \end{matrix} \right.$$

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, $R_{2j}T_j = W_{0j} + R_{1j}T_j$. 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.

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

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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.[34]

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.

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[34] 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

EJV 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, various years
		Coded by authors
		
		Coded by authors
		Coded by authors

Levy	Total collected water pollution levies/above standard wastewater (yuan/ton)	World Bank, http://www.worldbank.org/nipr/data/china/status.htm
Skilled labor	Percent of population who have a senior secondary school education level or above	*China Statistical Yearbook*, various years, and calculations by authors
Unskilled labor	Percent of population who are either illiterate or have less than primarly level education	*China Statistical Yearbook*, various years, and calculations by authors
Semi-skilled labor	Percent of population who have primary or junior secondary education level	*China Statistical Yearbook*, various years, and calculations by authors
Cumulative FDI value	Cumulative value of real contracted FDI, from 1983 until t-1 (in 1980 prices)	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 for the township level and above. (in thousands)	*China Statistical Yearbook*, various years
Telephones	Number of year-end urban subscribers/population, lagged one year	*China Statistical Yearbook,* various years
Incentive	Dummy variable for a province with either SEZ or Open Coastal City (as of 1996)	Constructed by authors.
Roads	Highways (km)/land area (km^2)	*China Statistical Yearbook*, various years
Railroads	Railway (km)/land area (km^2)	*China Statistical Yearbook*, various years
Pollution-Intensity	COD (kg)/output (thousand 1990 RMB yuan)	World Bank, http://www.worldbank.org/nipr/data/china/index.htm
Consumption per capita	Consumption (1000 yuan)/population	*China Statistical Yearbook*, various years
Growth rate of real GDP	Percentage change in annual real industrial output (1990 yuan), lagged one year	World Bank, http://www.worldbank.org/nipr/data/china/status.htm

Figure 1:
China: Total FDI Utilization (Millions of US$)
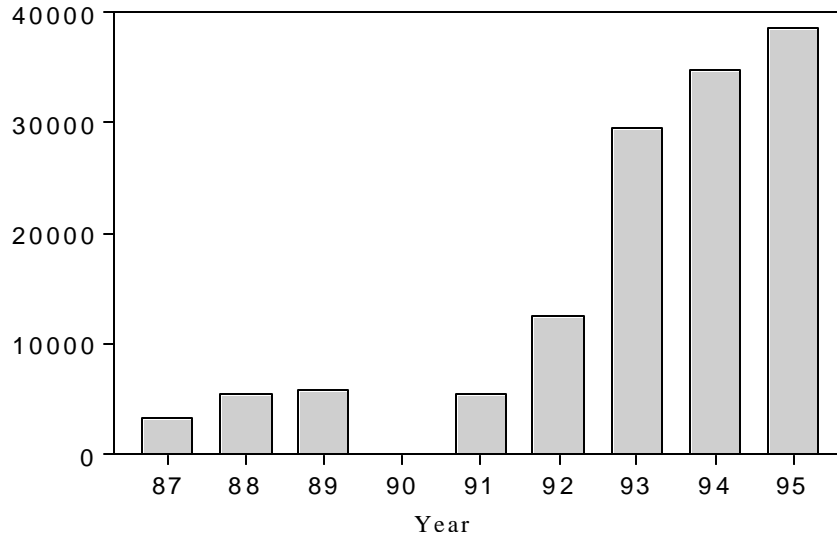
Note: Data for 1990 are missing.
Source: Calculated from data available at http://www.worldbank.org/nipr/data/china/status.htm

Figure 2: FDI Shares by Income Group [1]
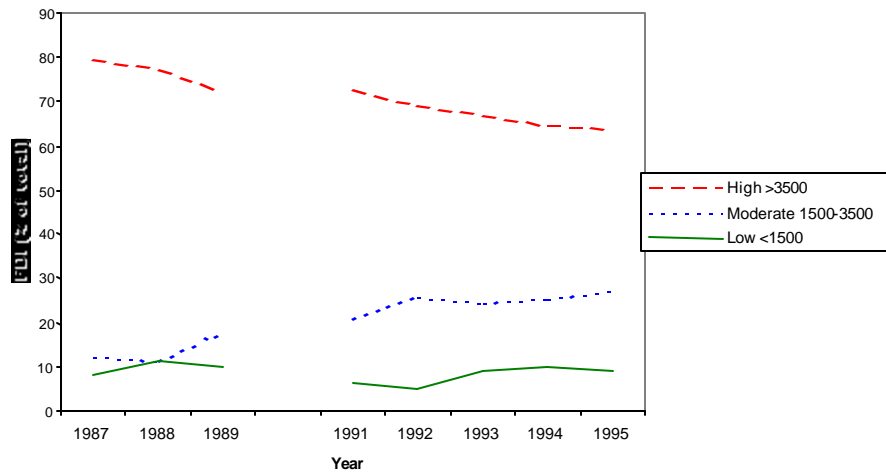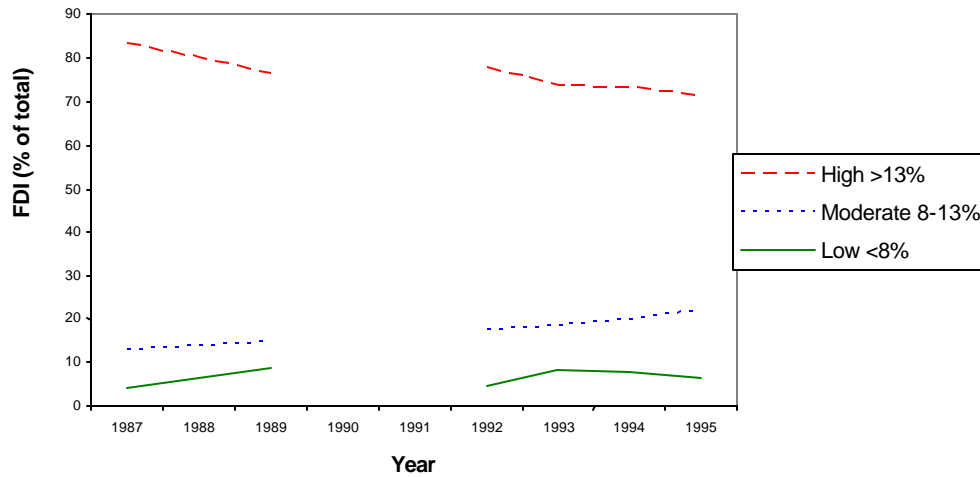

[1]Yuan per capita.
High: Beijing, Guangdong, Jiangsu, Liaoning, Shanghai, Tianjin, Zhejiang
Moderate: Fujian, Hebei, Heilongjiang, Hubei, Hunan, Inner Mongolia, Jilin, Ningxia, Qinghai, Shangdong, Shanxi,
          Xinjiang
Low: Anhui, Gansu, Guangxi, Guizhou, Henan, Jiangxi, Shaanxi, Sichuan, Yunnan

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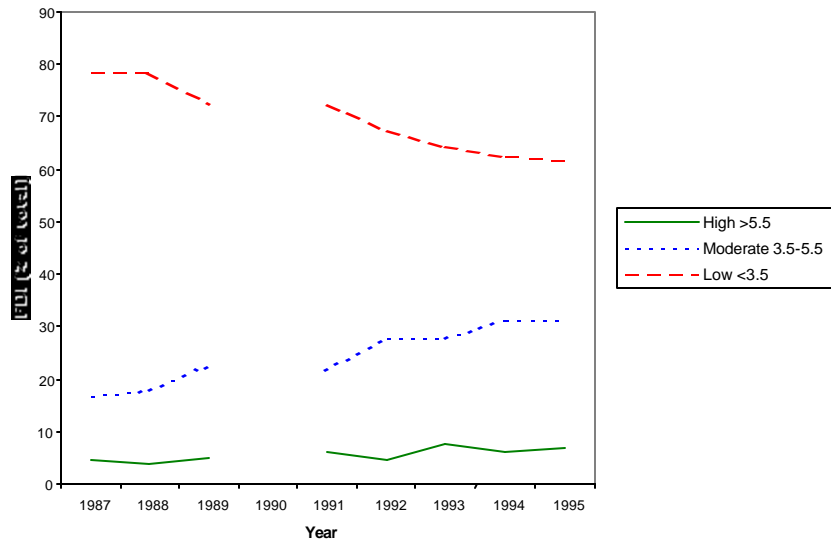
[1]Tons of COD per million yuan output (1990 yuan).
High: Anhui, Guangxi, Hunan, Inner Mongolia, Jilin, Xinjiang, Yunnan
Moderate: Fujian, Hebei, Heilongjiang, Henan, Hubei, Jiangxi, Ningxia, Shangdong, Shanxi, Sichuan, Zhejiang
Low: Beijing, Gansu, Guangdong, Gizhou, Jiangsu, Liaoning, Qinghai, Shaanxi,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

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

Figure 5: Comparison of EquityJoint Venture Sample (Utilized) and Total FDI
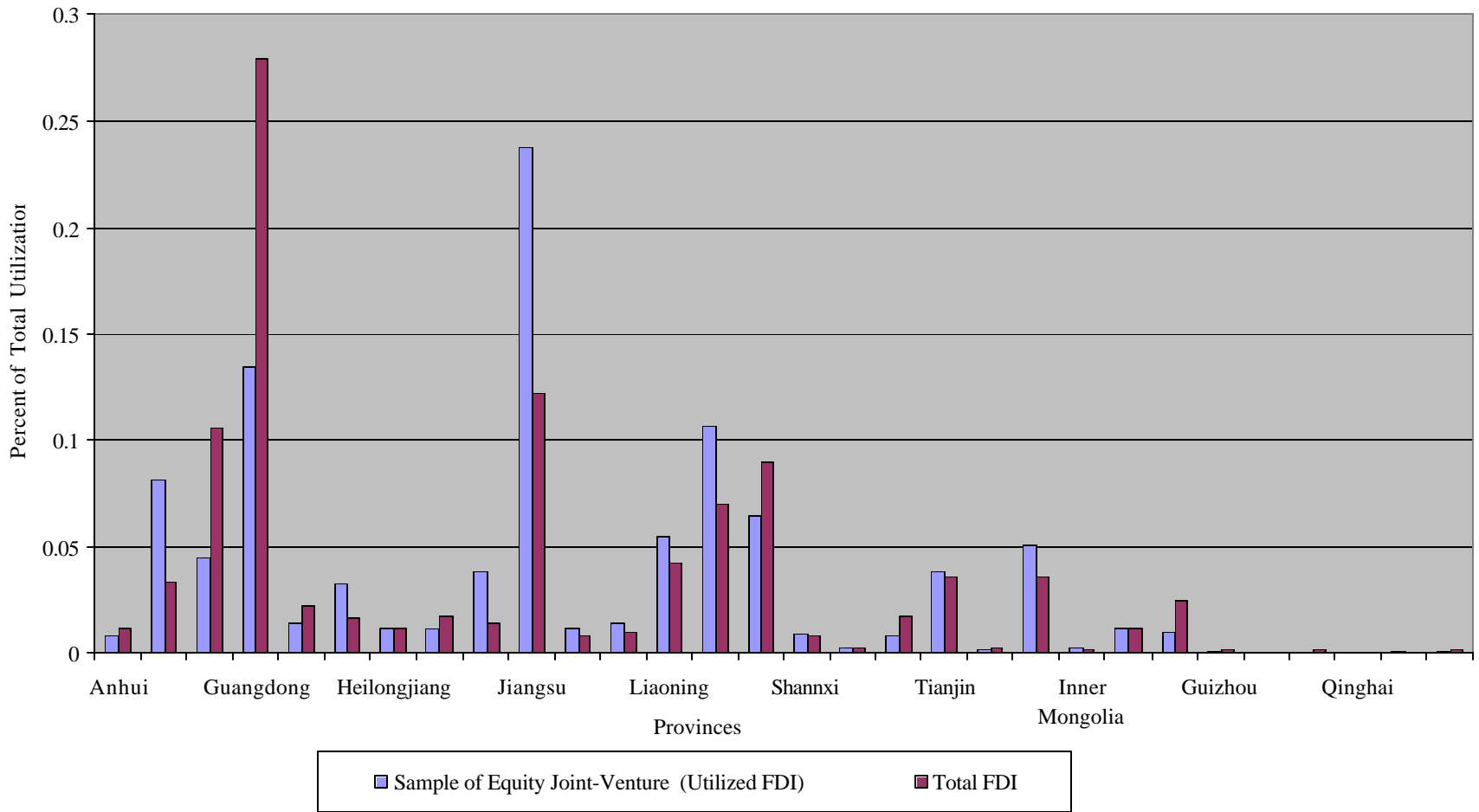by Provincial Shares, 1993-1996 Average (Correlation=0.74)

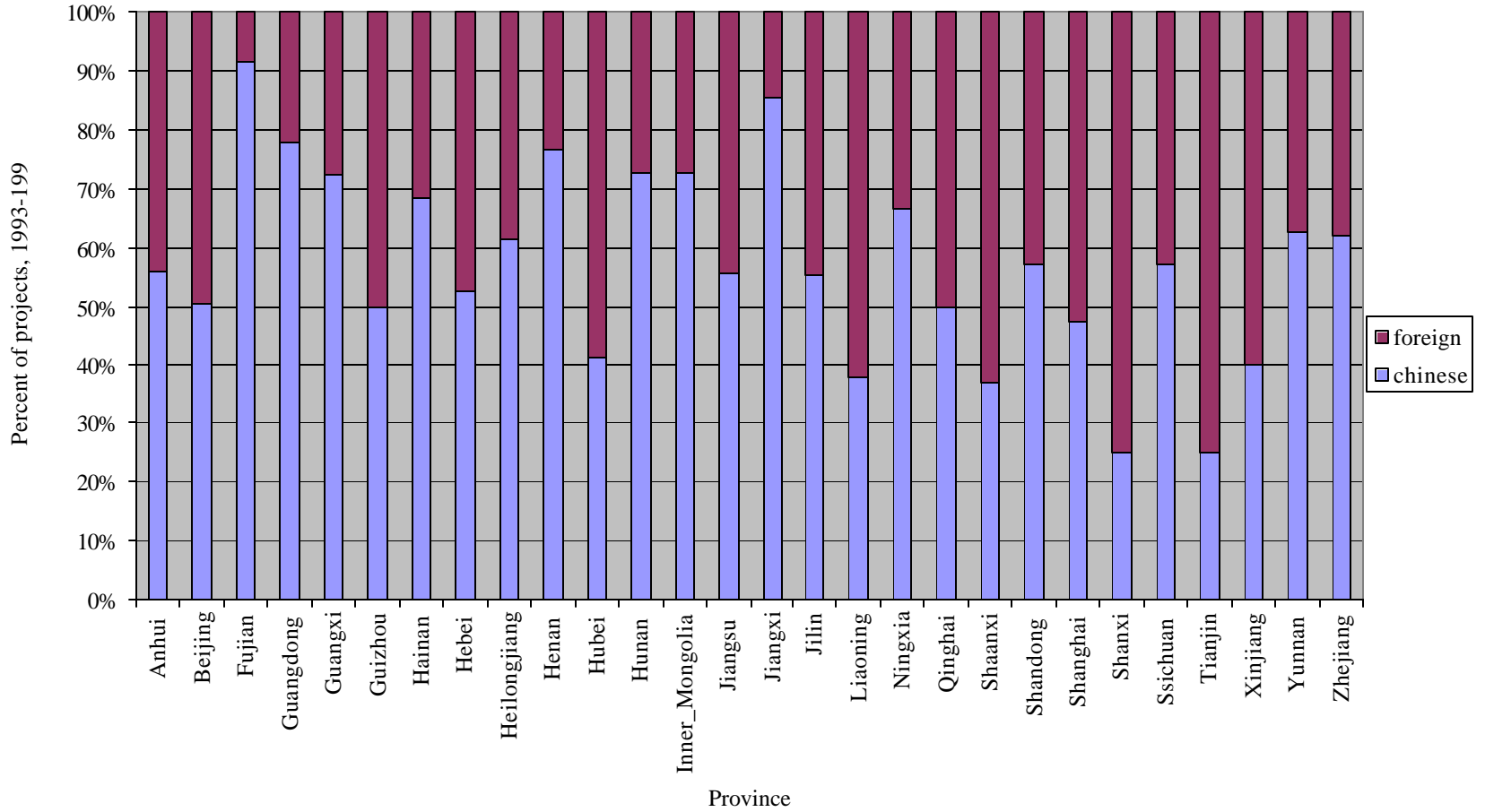**Figure 6: Source Distribution of EJV Sample, by Province, 1993-1996**

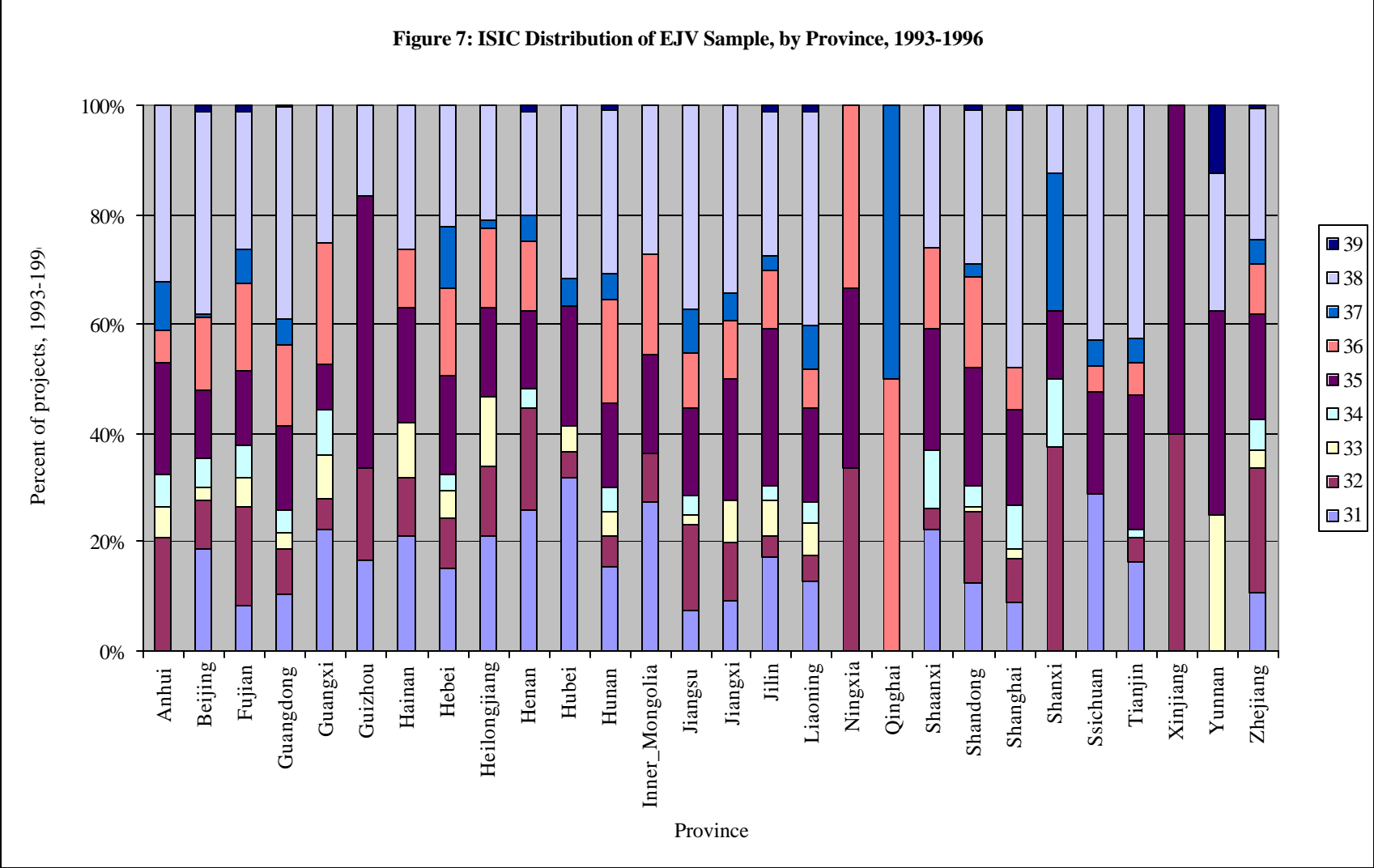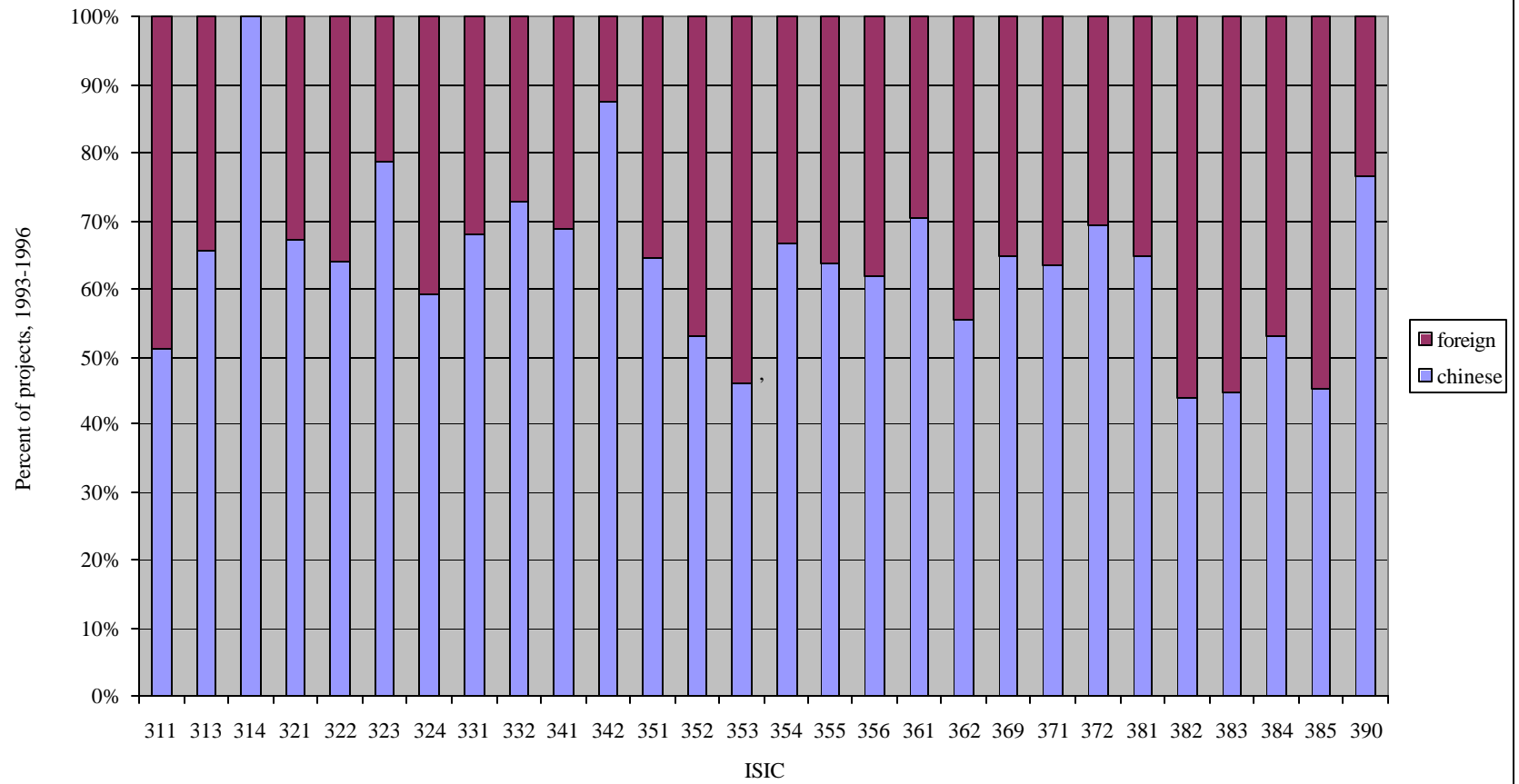**Figure 7: ISIC Distribution of EJV Sample, by Province, 1993-1996**

Figure 8: Source Distribution of EJV Sample, by ISIC code, 1993-1996

Figure 9a: EJV Shares and Levies, 1993

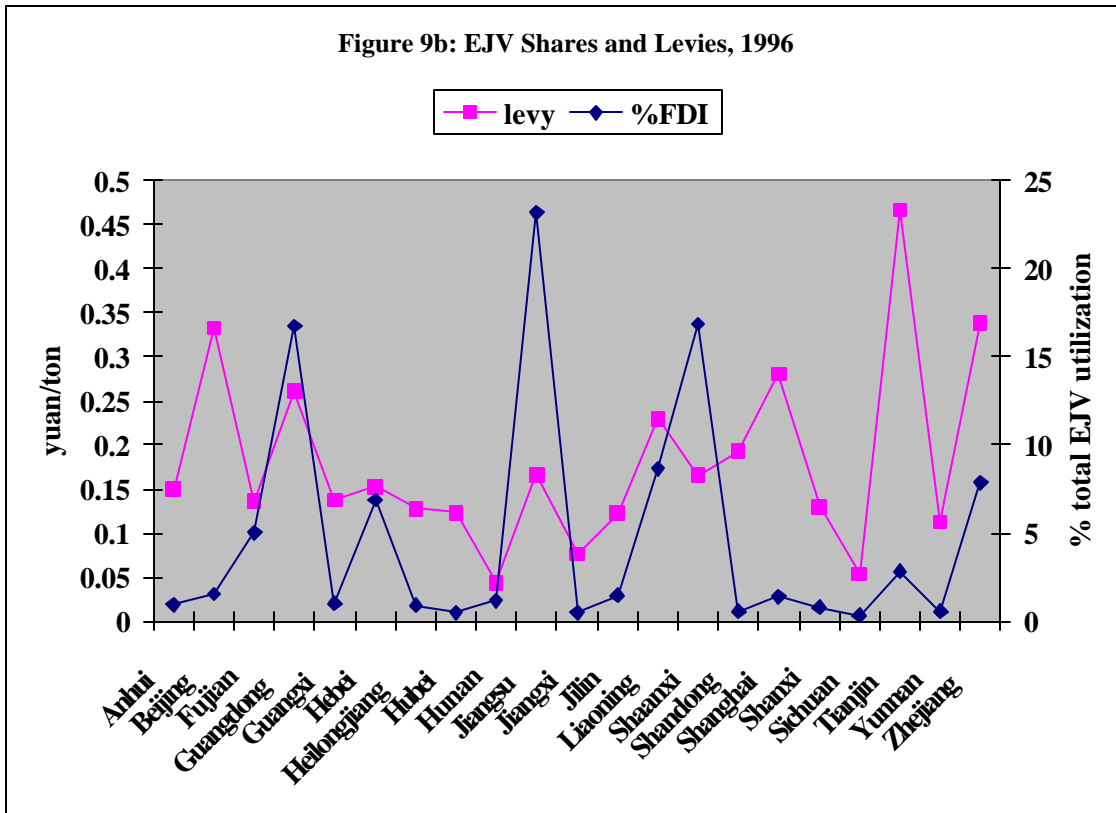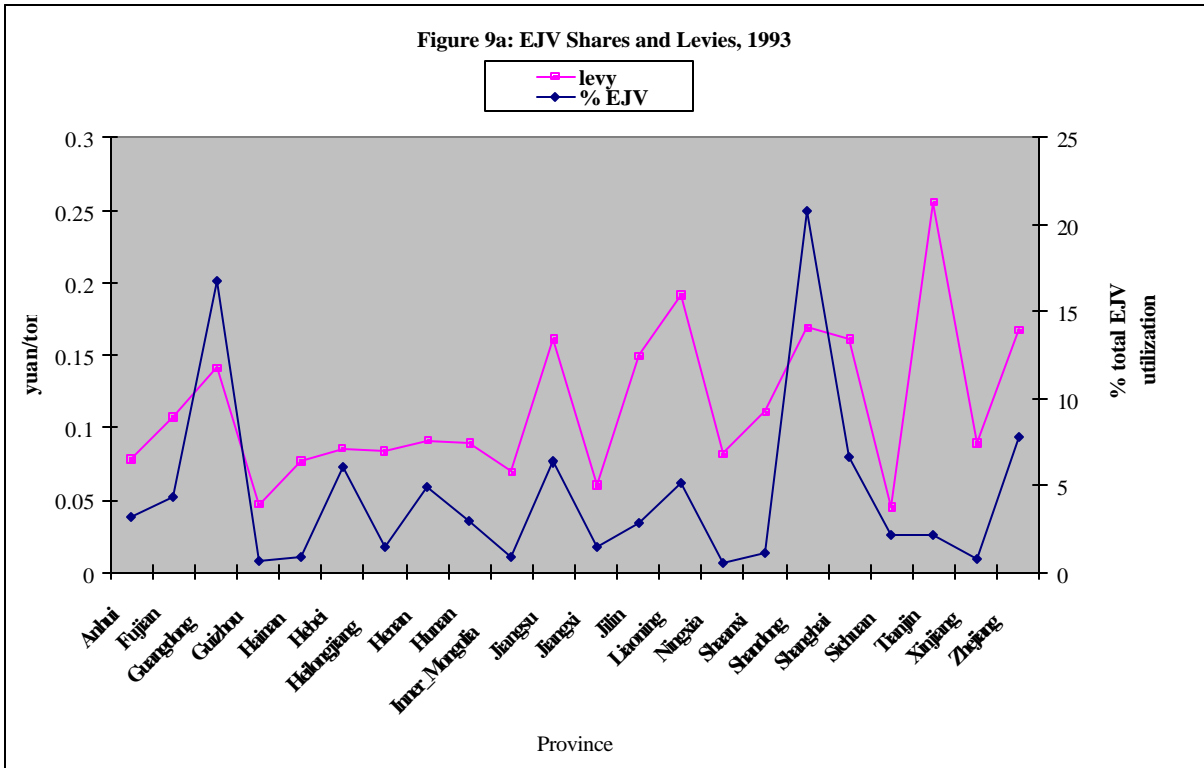Figure 9b: EJV Shares and Levies, 1996

Table 1: Equity Joint Venture Sample, by Province, 1993-1996

	Number of Projects	Contracted Value	Shares of Contract Value	Utilized FDI	Shares of Utilized FDI
Anhui	34	8432.7	0.0133	5200.6	0.0076
Beijing	248	49787	0.0787	55358.7	0.0808
Fujian	95	20908.3	0.0331	30247.2	0.0442
Guangdong	325	86095.4	0.1361	91830.7	0.1341
Guangxi	36	9816.1	0.0155	9858.3	0.0144
Hebei	99	22547.5	0.0356	22430.3	0.0327
Heilongjiang	62	11201	0.0177	8339	0.0122
Hubei	41	8360.2	0.0132	7461.8	0.0109
Hunan	110	23289.1	0.0368	26248.5	0.0383
Jiangsu	565	122013.3	0.1929	162205	0.2368
Jiangxi	76	9893.4	0.0156	8284.1	0.0121
Jilin	76	13381.4	0.0212	9593.8	0.014
Liaoning	166	37223.9	0.0588	37875.8	0.0553
Shandong	400	78368.1	0.1239	73166	0.1068
Shanghai	114	40148.3	0.0635	44075.3	0.0643
Shaanxi	27	5677.7	0.009	5734.8	0.0084
Shanxi	8	2542	0.004	1822.4	0.0027
Sichuan	21	5702.7	0.009	5301.9	0.0077
Tianjin	68	20830	0.0329	25944.6	0.0379
Yunnan	8	1973.9	0.0031	1064.1	0.0016
Zhejiang	176	31768.4	0.0502	34860.3	0.0509
Inner Mongolia	11	2905.4	0.0046	1812	0.0026
Henan	85	12249.5	0.0194	8357.3	0.0122
Hainan	19	4237	0.0067	6495.6	0.0095
Guizhou	6	1182.7	0.0019	437	0.0006
Tibet	0	0	0	0	0
Gansu	0	0	0	0	0
Qinghai	2	291.1	0.0005	150.5	0.0002
Ningxia	3	781.4	0.0012	365.7	0.0005
Xinjiang	5	927.1	0.0015	526.3	0.0008
SUM	2886	632534.5	1	685047	1

Notes: All the values are in 1990 constant price.

Table 2: Provincial Characteristics for Equity Joint Ventures Undertaken in 1996

Province	Consumption / capita	Water Levy	Domestic Entrepr.	Cum. Real FDI, 1983-95	Unskilled	Skilled	Telephones	Highlways/land area,	SEZ or OCC
	(yuan)	(yuan/ton), 1995	(000s)	(% of total)	(%)	(%)	Per 100 ppl.,1995	(km/km2), 1995	
Anhui	1945	0.15	24.1	1.0	42	11	1.7	0.26	0
Beijing	4208	0.33	14.5	4.1	23	65	12	0.75	1
Fujian	3356	0.14	17.3	10.6	37	14	3.8	0.38	1
Gansu	1550	0.09	11.6	0.1	70	20	1.65	0.08	0
Guangdong	4235	0.26	32.7	30.8	28	18	5.25	0.49	1
Guangxi	2008	0.14	14.1	2.2	27	13	1.67	0.18	1
Guizhou	1446	0.06	28.2	0.2	54	11	0.74	0.18	0
Hainan	2376	0.25	1.6	3.0	35	20	3.4	0.43	1
Hebei	1925	0.15	23.0	1.4	27	13	2.35	0.28	1
Heilongjiang	2994	0.13	20.4	1.1	23	23	3.84	0.10	0
Henan	1686	0.12	8.6	1.1	31	13	1.28	0.31	0
Hubei	2398	0.12	28.6	1.7	33	17	2.4	0.26	0
Hunan	2199	0.04	25.4	1.2	26	14	2.06	0.28	0
Inner Mon.	1939	0.08	0.2	0.2	33	21	2.8	0.04	0
Jiangsu	3121	0.17	39.1	10.9	28	21	3.2	0.26	1
Jiangxi	1857	0.08	20.3	0.7	35	13	1.55	0.21	0
Jilin	2643	0.12	13.0	0.8	23	28	4.2	0.16	0
Liaoning	3250	0.23	31.9	4.5	21	21	4.8	0.30	1
Ningxia	1785	0.10	7.6	0.0	59	22	3	0.17	0
Qinghai	1967	0.06	2.0	0.0	90	25	1.9	0.02	0
Shaanxi	1594	0.17	13.4	1.0	36	20	1.7	0.19	0
Shandong	2287	0.19	28.3	7.0	32	16	1.9	0.36	1
Shanghai	7742	0.28	12.6	8.2	23	55	15.77	0.59	1
Shanxi	1880	0.13	11.5	0.2	27	19	1.9	0.22	0
Sichuan	1924	0.05	44.1	1.8	33	11	1.2	0.18	0
Tianjin	4129	0.47	9.2	2.8	23	39	8.25	0.34	1
Tibet	1312	0.00	1.8	0.0	231	13	1.1	0.02	0
Xinjiang	2398	0.23	7.9	0.2	37	24	2.53	0.02	0
Yunnan	1800	0.11	9.0	0.3	53	9	1.6	0.19	0
Zhejiang	3412	0.34	32.6	3.1	28	15	3.86	0.35	1

Table 3.1: The Impact of Water Pollution Levies on EJV Location Choice in China [1]

Conditional Logit	Full Sample		Foreign Sample		Chinese Sample	
	Coefficient	*z*	*Coefficient*	*z*	*Coefficient*	*z*
Levy[2]	1.35	2.50	2.50	3.07	0.41	0.55
# Local Firms	0.04	14.32	0.05	10.58	0.04	9.90
Agglomeration[3]	0.06	9.28	0.04	3.48	0.08	8.59
Rel. Share Skilled Workers	7.49	11.28	9.17	8.76	6.82	7.74
Rel. Share Unskilled Workers	-0.64	-1.38	-0.69	-0.92	-0.81	-1.33
Incentives	0.98	7.54	1.17	5.81	0.71	4.05
Telephones[2]	-0.01	-0.23	-0.17	-3.29	0.05	1.08
Roads	-1.25	-3.19	-2.17	-3.60	-0.47	-0.89
Railroads	-11.07	-2.17	2.38	0.28	-16.63	-2.63
Consumption per capita	-0.36	-5.22	-0.13	-1.25	-0.45	-4.72
Real Income Growth[2]	0.38	1.41	0.11	0.27	0.77	2.16
Northeast	0.78	3.52	0.93	2.82	0.76	2.45
Coastal	1.11	3.91	1.12	2.60	1.30	3.39
Central	1.13	3.55	1.14	2.30	1.19	2.79
Northwest	-0.77	-2.45	-0.26	-0.57	-0.96	-2.18
Southwest	-0.30	-0.85	-0.19	-0.34	-0.20	-0.42
obs	80808		32844		47964	
LR	3243.21		1447.87		1959.62	
Log likelihood	-7995.14		-3184.74		-4726.86	
Pseudo R2	0.17		0.19		0.17	

[1] z-statistics in parentheses.
[2] Levy, telephones, and real income growth are lagged one year.
[3] Agglomeration is calculated from 1983 until t-1.

Table 3.2: The Impact of Water Pollution Levies on EJV Location Choice in China, by Pollution Intensity[1]						
Conditional Logit	**Full Sample**		**Foreign Sample**		**Chinese Sample**	
	Coefficient.	*z*	*Coefficient*	*z*	*Coefficient*	*z*
Levy[2]	2.00	3.27	2.68	2.96	1.40	1.64
Levy[2]***Medium Pollution Int.**[4]	-1.06	-1.44	-0.52	-0.49	-1.22	-1.21
Levy[2]***High Pollution Int.**[5]	-1.77	-2.24	-0.26	-0.23	-3.02	-2.73
# Local Firms	0.04	14.28	0.05	10.57	0.03	9.84
Agglomeration[3]	0.06	9.29	0.04	3.48	0.08	8.62
Rel. Share Skilled Workers	7.52	11.31	9.17	8.77	6.87	7.79
Rel. Share Unskilled Workers	-0.63	-1.36	-0.68	-0.92	-0.79	-1.31
Incentives	0.98	7.53	1.17	5.80	0.71	4.04
Telephones[2]	-0.01	-0.19	-0.16	-3.28	0.05	1.13
Roads	-1.26	-3.21	-2.18	-3.60	-0.48	-0.91
Railroads	-10.97	-2.15	2.42	0.28	-16.45	-2.61
Consumption per capita	-0.36	-5.23	-0.13	-1.25	-0.45	-4.73
Real Income Growth[2]	0.38	1.41	0.11	0.26	0.76	2.15
Northeast	0.80	3.59	0.94	2.83	0.80	2.56
Coastal	1.13	3.99	1.13	2.62	1.34	3.50
Central	1.16	3.62	1.15	2.31	1.24	2.89
Northwest	-0.76	-2.39	-0.26	-0.56	-0.93	-2.11
Southwest	-0.28	-0.78	-0.18	-0.32	-0.16	-0.33
Obs	80808		32844		47964	
LR	3248.94		1448.11		1967.30	
Log likelihood	-7992.27		-3184.62		-4724.42	
Pseudo R2	0.17		0.19		0.17	

[1]z-statistics in parentheses.
[2]Levy, telephones, and real income growth are lagged one year.
[3]Agglomeration is calculated from 1983 until t-1.
[4]Medium pollution intensity is defined as 1<PI<7, where PI =COD(kg.)/real output(thousand 1990 yuan).
[5]High pollution intensity is defined as PI>7, where PI =COD(kg.)/real output(thousand 1990 yuan).

Table 4.1. The Impact of Water Pollution Levies on EJV Location Choice in China [1]

Nested Multinomial Logit	Full Sample		Foreign Sample		Chinese Sample	
	Coefficient	*z*	*Coefficient*	*z*	*Coefficient*	*z*
Provincial						
Levy [2]	0.49	0.43	4.52	2.66	-2.30	-2.98
# Local Firms	0.04	14.40	0.06	8.22	0.04	12.49
Agglomeration [3]	0.07	9.41	0.04	3.47	0.09	10.87
Rel. Share Skilled Workers	8.33	9.67	5.96	2.20	4.94	3.81
Rel. Share Unskilled Workers	-0.82	-1.72	-0.53	-0.30	-0.61	-1.14
Incentives	0.81	6.26	0.86	2.56	0.61	3.52
Telephones [2]	-0.36	-4.87	0.21	2.18	0.02	0.19
Roads	-0.27	-0.66	-2.70	-3.78	-0.85	-1.85
Consumption per capita	0.01	0.06	-0.63	-4.23	-0.42	-3.51
Real Income Growth [2]	0.74	1.17	-2.22	-4.58	2.02	6.49
Regional [4]						
Av. Consumption p.c.	0.75	1.79	3.60	2.94	1.50	3.53
Av. Population Density	-931.33	na	128.80	0.10	-835.50	na
Av. Real Income Growth	-2.45	-2.32	5.21	2.17	-3.58	-2.09
IV Parameters						
Metro	0.41	1.16	-2.29	-4.19	2.76	3.02
Northeast	0.46	0.76	-1.18	-1.43	3.84	3.42
Coastal	0.82	1.94	-0.64	-0.81	3.00	5.13
Central	0.81	1.17	-0.59	-0.34	4.01	4.52
Northwest	0.10	0.12	-0.97	-0.68	3.69	3.27
Southwest	0.34	0.44	-1.05	-0.58	3.63	4.06
Obs	80808		32844		47964	
LR	3316.90		1582.709		2000.95	
LR test of IV=1	239.88		152.71		192.13	
Log likelihood	-7958.29		-3117.32		-4707.59	

[1] z-statistics in parentheses.
[2] Levy, telephones, and real income growth are lagged one year.
[3] Agglomeration is calculated from 1983 until t-1.
[4] All regional variables averaged by region by year. Population density=population/land area (squared km).

Table 4.2 The Impact of Water Pollution Levies on EJV Location Choice in China, by Pollution Intensity [1]

Nested Multinomial Logit	Full Sample		Foreign Sample		Chinese Sample	
	Coefficient	*z*	*Coefficient*	*z*	*Coefficient*	*z*
Provincial						
Levy[2]	-1.49	-3.41	4.15	1.98	-1.33	-2.09
Levy[2]*Medium Polluters	-0.31	-2.15	0.47	0.89	-0.28	-1.21
Levy[2]*High Polluters	-0.09	-0.60	0.00	0.01	-0.26	-0.92
# Local Firms	0.04	18.62	0.06	7.80	0.04	12.80
Agglomeration[3]	0.06	11.18	0.04	3.57	0.08	10.06
Rel. Share Skilled Workers	6.45	9.40	5.60	1.82	5.80	6.04
Rel. Share Unskilled Workers	-0.90	-2.24	-0.79	-0.30	-1.01	-1.87
Incentives	0.99	9.07	0.83	1.97	0.64	4.16
Telephones[2]	-0.09	-3.18	0.22	3.20	0.01	0.17
Roads	-1.10	-3.85	-2.62	-2.74	-0.70	-1.71
Consumption per capita	-0.26	-5.11	-0.64	-5.19	-0.31	-4.23
Real Income Growth[2]	2.44	12.57	-2.17	-3.35	2.24	8.07
Regional[4]						
Av. Consumption p.c.	6.68	10.33	3.67	2.59	3.19	4.07
Av. Population Density	-22.45	-7.14	128.89	na	-17.05	-4.14
Av. Real Income Growth[2]	4.00	2.57	5.26	2.67	-1.62	-0.79
IV Parameters						
Metro	7.14	8.46	-2.36	-2.69	6.41	5.39
Northeast	4.26	7.24	-1.06	-0.90	3.78	4.98
Coastal	4.45	8.97	-0.52	-0.48	4.11	6.87
Central	7.23	8.88	-0.36	-0.15	5.70	6.25
Northwest	5.57	7.36	-0.78	-0.36	3.90	4.06
Southwest	5.95	8.34	-0.81	-0.31	4.73	5.40
Obs	80808		32844		47964	
LR	3428.38		1584.44		2032.53	
LR test of IV=1	346.59		154.22		217.44	
Log likelihood	-7902.55		-3116.46		-4691.8	

[1] **z-statistics in parentheses.**
[2] **Levy, telephones, and real income growth are lagged one year.**
[3] **Agglomeration is calculated from 1983 until t-1.**
[4] **All regional variables averaged by region by year. Population density=population/land area (squared km).**