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RESOURCES FOR THE FUTURE

Fiscal Incentives and Environmental Infrastructure in China

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Abstract

This paper provides evidence that China's system of tax revenue sharing is an important explanation for differences in the rate of sewage treatment plant construction among its cities. As a result of the 1994 tax reform, Chinese cities retained different shares of their value-added tax (VAT). Exploiting the persistence of this sharing system, we use the VAT share in 1995 as an instrument for the present fiscal incentives. We find that a 10 percentage point increase in the VAT sharing rate resulted in a 13.8% increase in the construction of sewage treatment capacity. This result suggests that fiscal incentives can play an important role in the provision of pollution-reducing infrastructure.

Keywords: sewage; water pollution; China pollution; fiscal federalism; tax sharing; tax federalism; China VAT sharing

JEL Classification Codes: H4; H54; H77; Q53; Q56

1 Introduction

Sewage treatment in China is important because of its linkages with two important issues: water pollution and public health. Water pollution in China is extensive and serious. Scholars have documented that the water in 54% of China's rivers is not fit for consumption. Water pollution-related damages to health alone cost China 9.47 billion yuan in 2003 (World Bank 2007). The ability to return treated water into the environment is important because China leans heavily on surface sources of water. Between 300 million and 500 million Chinese lack access to piped water, and only 28% of rural households have access to improved sanitation (Vennemo et al 2009).

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Despite the importance of this issue, little is known about why progress in the construction of sewage treatment facilities has been so uneven.[1] Some cities have constructed large amounts of sewage treatment capacity, while others have largely neglected to build additional needed facilities.

Intuition would suggest that factors like population, wealth, and preferences drive the provision of sewage treatment capacity. We find that these explanations are correct and do seem to play an important role. The purpose of this paper is to argue that China's system of tax sharing is a potentially significant factor in explaining the different levels of provision of environmental public infrastructure.

Under China's tax sharing system, some cities are allowed to keep high shares of their value-added tax (VAT), while others keep relatively small shares. Since the VAT is levied on industrial activity, we hypothesize that cities that received relatively high shares were incentivized to direct financial resources toward activities that directly boosted the industrial tax base. One attractive form of investment is the construction of additional infrastructure in the form of sewage treatment capacity. Government officials in China widely believe that providing infrastructure is an important strategy to attract new industrial businesses and expand their tax base. Using a two-stage instrumental variables regression, we find that cities which were assigned higher shares of value added tax (VAT) revenues in 1995 constructed far greater sewage treatment capacity between 2002 and 2008.

To study the impact of fiscal incentives on a long-lived, lumpy type of infrastructure such as sewage treatment plants, we use an empirical specification where the observable growth in sewage treatment capacity, that occurring between 2002 and 2008, is regressed on a measure of city-level fiscal incentives. However, there are several endogeneity problems with using the most direct candidate: a city's share of VAT retained in 2001.

For example, provinces had the right to change or reassign city tax shares. If a city had a budget surplus, its VAT share might be decreased. If a city had a change of leadership, its new leaders might plausibly negotiate a larger VAT share, or a smaller decrease in share than would otherwise be expected. While most cities had fixed VAT shares, some had shares that moved up and down over time.[2]

As a result, we employ an instrumental variables strategy where we use the share of VAT retained in 1995 to proxy for a city's fiscal incentives. The use of this instrument restricts the number of endogenous pathways that can affect both VAT share and the construction of sewage treatment facilities to one: the method by which provinces initially assigned fiscal incentives.

The historical origins of China's current tax system suggest that this instrument is certainly relevant. China's 1994 tax reform installed an entirely new structure for the VAT, but did not address how revenues should be allocated to cities. The authority to allocate fiscal incentives was given to provinces,

[1] See figure 1.
[2] See figure 4.

and each province installed its own system of allocating pools of VAT revenue. We find that provincial tax sharing systems initially installed in 1994 persisted through the time period of our sewage data.

The instrument is validated by the historical accounts of the methods by which provincial authorities assigned fiscal incentives. We confirm these accounts empirically. We look at which provinces chose to pass through all revenues and which chose to withhold revenues. We study the empirical patterns by which provinces initially deployed fiscal incentives for cities within their domain, and find that the most important explanation is "equalization," where poorer cities received higher shares of VAT revenues. We control for the equalization rationale and the routes through which this is likely to affect sewage treatment through the use of covariates.

Our central result is that cities react to higher VAT sharing ratios by expanding their sewage treatment capacity. A 10 percentage point increase in the 1995 VAT sharing ratio (i.e. from 60% to 70%) resulted in 13.8% more growth in sewage treatment capacity during the 2002 to 2008 period. Our results are consistent over a wide set of sensible covariates. A number of alternative explanations are ruled out through tests demonstrating how these results hold for subgroupings of cities in China, such as provincial capitals and coastal cities. Finally, we show that transfer payments, which should be independent of fiscal incentives, are uncorrelated with VAT sharing ratios.

This paper benefits from ideas within the "second generation" fiscal federalism literature (Oates 2005). Rather than presenting local officials as benign decision makers focused entirely on social welfare, this strain of literature models them as revenue-maximizing opportunists who channel effort into functions that reap financial reward. The possible inefficiencies in decentralized government were derived analytically by Gordon (1983), in an elegant optimal tax model of fiscal federalism.

Other papers have used different contexts to connect local fiscal incentives and spending on public goods. Zhuravskaya (2000) argued that local governments with low fiscal incentives have no incentives to increase the tax base or provide public goods. After showing that some cities in Russia must share almost all additional revenues they generate, she connected the absence of fiscal incentives among these cities with inefficient public service provision, in the forms of higher infant mortality and decreased availability of regular schooling. Jin, Qian, and Weingast (2005) tied fiscal incentives to government performance in China at the provincial level, showing how provinces with higher marginal revenue retention rates develop the private sector more and encourage incentive-based compensation.[3]

This paper offers several contributions. First, we explore econometrically the drivers of an important policy topic. Water pollution in China affects hundreds of millions of people; sewage treatment must be a key part of any wide-scale water treatment plan. Second, very few economics papers have focused on

[3] Under the tax system preceding the 1994 reform, provinces had different marginal revenue retention rates. After the 1994 reform, all provinces received the same, fixed share of VAT.

the behavior of political entities at the city level in China. We provide new illumination into China's system of city-level fiscal incentives, and tie these incentives to city-level outcomes.

This paper is organized as follows. Section 2 lays out the history of the 1994 tax reform in China and discusses the history and political economy of VAT sharing. The importance of sewage treatment is also discussed. Section 3 describes the data. Section 4 explains the measure of fiscal incentives used, and describes the empirical methodology and identification strategy of the paper. Section 5 contains empirical results. Section 6 discusses the significance of our findings to environmental policy in China.

2 Institutional Background

2.1 Sewage Treatment in China

2.1.1 Central Government Policy on Sewage

The Chinese central government established the "three synchronizations policy" (*san tongshi zhengce*) in the 1989 PRC Environmental Protection Law. This policy is described in detail in Ma and Ortolano (2000). Under this policy, the design, construction and operation of a new factory or other industrial facility must be accompanied by the design, construction, and operation of appropriate waste treatment facilities. The official data suggest that this policy was followed: the industrial sewage treatment rate was 92.9% in 2006 (SEPA 2007).

Sewage treatment plant construction is funded in part out of a set of fees included in the price of water. The level of the water consumption fee varies with each city. One of the fees within the water consumption fee is split between the operation of wastewater treatment facilities and the construction of new wastewater treatment plants. This fee is collected by government billing agencies and distributed to wastewater treatment plant operators. We control for the possibility that different fee levels influenced sewage plant construction by including per household consumption of water.

The price of water is considered a sensitive political subject in China. Cities cannot arbitrarily raise the price of water to fund the construction of new sewage treatment plants; price rises in cities are usually carefully coordinated with the central government and phased in over an extended period of time.

2.1.2 Local Government Implementation of Sewage Treatment

Local governments have widely adopted the strategy of building sewage treatment facilities to attract industry. One saying, "*qitong yiping*," states that, in order to attract investment, local governments must build seven forms of infrastructure: electricity, roads, water, telecommunications, cable, leveled ground, and waste treatment.

Companies considering a choice of location know that, under the three synchronizations policy, they must provide a means of treating their wastewater

when they build new industrial facilities. However, instead of constructing their own sewage treatment plants, they can take advantage of city-provided sewage treatment plants, providing the benefit of economies of scale and lower costs.

The central government and the provincial governments also have the ability to earmark funds for the construction of sewage treatment plants. More generally, the assignment of responsibilities to different levels of government is vague in China (World Bank 2002). Shah and Shen (2006) analyzed earmarks and found that they are generally regressive; more earmarks are dedicated to richer and more populated areas.

Sewage treatment facilities operated at near-capacity in most cities during the entire period of our sample, 2002-2008. This period represented a building-out stage for sewage treatment facilities; all plants, once built, had demonstrated demand in place. As a result, unused infrastructure was generally not a problem for this type of construction.

A second form of local government incentive to build sewage treatment plants is to prevent environmental disasters for which they can be blamed. When the media reports widely on an environmental disaster, government officials in charge of the environment, such as the head of the local environmental protection agency, can be disciplined or fired.

2.2 Federalism and the Tax System in China

2.2.1 The 1994 Tax Reform

The 1994 Tax Reform represented a watershed change of China's fiscal system. It was aimed at three goals (World Bank 2002). First, it was intended to reverse a longstanding downward trend of central government revenues. Second, it was intended to reduce the distortionary elements of the existing tax structure. Third, it was intended to move China away from a system where negotiation played an important role in central and local government relations, and toward a fixed, stable, and transparent tax system.

To accomplish its first goal, it sharply changed the tax administration system. Rather than relying on local tax authorities to collect taxes and share them with the central government, the 1994 reform gave responsibilities of collecting central taxes and shared taxes to the central government. From that point forward, the central government controlled revenues and shared them downward, rather than relying on upward sharing from local governments.

To accomplish its second goal, the tax reform replaced the prior turnover tax system, which consisted of as many as 37 overlapping and contradictory taxes, and applied different rates to different products (Ma 1997). The new system applied the value-added tax (VAT) to a much broader tax base, and set a uniform rate of 17%. It set a turnover tax on services of between 3% and 5%. Finally, it set new corporate income tax rates and personal income tax rates while eliminating many forms of special treatment, like lower rates for foreign enterprises and individuals.

To accomplish its third goal, it codified a new system of tax sharing that

applied a uniform set of rules to local governments. In the previous system, provinces held one of six forms of revenue-sharing contracts (Agarwala 1992), which resulted in sharply different marginal revenue retention rates. After the reform, each tax was designated as a central tax, a shared tax, or a local tax, depending on who would receive revenues from that tax. Shared taxes had fixed, statutory sharing rules set between the central government and provincial governments. The VAT, designated a shared tax, was split with 75% of VAT revenues accruing to the central government and 25% to the province in which revenues were generated.

2.2.2 The VAT Share as a Measure of Fiscal Incentives

The VAT is the tax at the center of our analysis. The VAT is the most important tax in China in terms of revenue collected, accounting for over 40% of all central government tax revenues. This paper focuses on how fiscal incentives led cities to attract industry through building sewage treatment plants.

Among the streams of revenues received by cities, there are other options that might be potential candidates for our study. For example, cities receive annual rebates from higher levels of government. The amount of these rebates is determined through a formula that grows a base amount according to the combined growth rates of the VAT and the consumption tax (Shah and Shen 2006). The consumption tax in China is a turnover tax, paid by consumers, and is focused on particular types of goods such as tobacco, alcohol, and fireworks. In the formula determining these rebates, the year-over-year growth rates of VAT and of the consumption tax are mixed, making it difficult to extract meaningful information about city incentives.

Another possible candidate might be the corporate income tax, which is also shared between the levels of Chinese government hierarchy. However, the corporate income tax is levied on all corporations, including firms in the services and agricultural industries that would not be attracted to sewage treatment infrastructure. Hence, this paper focuses on the VAT, the only tax focused on firms in the industrial sector,[4] as the most appropriate subject for our study. The VAT is also attractive because the data give clean measures that allow direct observation of VAT sharing rates.

2.2.3 VAT Sharing between Provinces and Cities

The 1994 tax reform, while eliminating many avenues of negotiation between the central government and the provinces, did not specify patterns of tax sharing between provinces and cities. Provinces decided on the allocation of revenues among its subordinate units. Since the central government did not require submission of final accounts for individual local governments (Bahl 1999), provinces had largely unchecked discretion in determining the distribution of revenue between layers of government. The local governments' right to appeal its tax sharing agreement was limited only to egregious cases (World Bank 2002).

[4] The "business tax" is a turnover tax, levied only on services firms.

Although the central government took the same, fixed 75% share out of each province's VAT collections, provinces were able to determine themselves how to apportion the remaining 25%. As a result, a variety of systems proliferated.

An example will facilitate understanding of these systems. Suppose a firm within the city of Zunyi, in the province of Guizhou, pays 100 renmenbi (RMB) of VAT. The central government collects this tax and keeps 75 RMB. It passes 25 RMB to Guizhou, the province where Zunyi is located. Guizhou has an agreement with Zunyi where Zunyi retains 60% of VAT revenues generated in its domain. Hence, out of the 100 RMB in tax revenue that was initially collected from Zunyi, Zunyi retains 15 RMB, or 15%.

Although the city's share of its VAT could seem small, each city's share of VAT revenues represents an important component of its budget. On median, cities derived 15.9% of their total tax base from their share of VAT, and 7.5% of total spending in 2001. For many cities, VAT is the biggest single source of tax revenue.

Table 1 illustrates how VAT was actually shared between provinces and cities in 1995 and in 2001.[5] We draw two conclusions from this table. First, it is clear that provinces make decisions on VAT sharing rates: all cities within a province follow the same basic pattern. Sixteen province-level entities, representing 145 of the 285 cities in our public finance dataset, chose to pass through 100% of local VAT revenues to their cities. The other provinces chose to pass through some smaller share of revenues. For most of the cities in this dataset, their sharing rates were fixed with no regard to factors such as their role within the government hierarchy or the ability of city managers to negotiate.

The second conclusion that can be drawn is that each province's system of VAT sharing in 2001 remained basically constant with the system of sharing established in 1995. At the time of the 1994 reform, each province selected a system of VAT sharing for all cities in its domain. Once a province decided on a method, it generally retained that method through the relevant time period of our analysis.

Nine of the 31 provinces examined here passed less than 100% of VAT revenues, and did so in a manner that assigned different VAT sharing rates to different cities. Among these provinces, the VAT share retained by cities often fluctuated between 1995 and 2001. However, the VAT rate was restricted to the domain of possibilities allowed by the province. These data suggest that provinces changed some city rates in the middle of this time period. Data in these provinces are marked by a period of steady VAT shares, a sudden decline or rise, followed finally by another steady period of VAT shares.

However, for many cities, the VAT shares they received between 1995 and

[5] For much of our analysis, we use the 1995 VAT sharing rate, although the tax reform in China was initiated in 1994. Wong (1997) writes that the 1994 tax reform was implemented only a few months after it was approved. She documents that neither taxpayers nor local tax officials were "prepared" for the transition. Moreover, through 1994, cities and counties were in doubt as to whether the rules of the contract system (the pre-1994 system) would govern the new tax sharing system.

We conclude from this reading that 1994 VAT sharing rates may be unreliable, since they involved a period of transition and, at best, reflect a system in place for only part of the year.

2001 seem almost random. For these cities, it is possible that VAT sharing contracts took a different form than a fixed percentage type of contract. For example, Bahl (1999), who documents a few case studies of revenue-sharing agreements between provinces and cities, found a complex system of sharing between Beijing and its subordinate districts. Beijing receives 25% of initial collections of its districts, where initial collections are defined according to a base year. It then divides incremental revenues (those beyond the base-year level) in an entirely different fashion, with portions going to the central government, the districts, and the city itself. For sharing arrangements like that of Beijing, the VAT sharing data are unlikely to reveal a consistent share.

Why did different provinces decide on different patterns of VAT sharing? Bahl (1999), p. 150, writes:

> With so much discretion, it is not surprising that provincial governments have developed many different systems of revenue sharing. Some provinces seem to stress equalization, others seem to promote regions with greater economic development potential, others seem to emphasize incentives for resource mobilization, and in a few instances, the division of revenues seems almost random.

In summary, VAT sharing systems were determined immediately after the 1994 tax reform. Provinces made decisions on the VAT shares of cities in their domain. They made decisions individually, each selecting a different set of reasons. The VAT sharing systems set up in 1994 were strongly related to the shares eventually observed in 2001, the beginning of the period where we can observe cities building up their sewage treatment capacity.

3 Description of Data

Our sewage panel comprises 111 cities for the period 2002-2008. These cities and years are the sample of sewage treatment outcomes published by the China Environment Yearbooks, a joint publication of the Chinese National Bureau of Statistics and the State Environmental Protection Agency. In general, the CEY report only large cities and "important" cities such as provincial capitals, a subset of all cities in China as reported in the China City Statistical Yearbook. Hence, the results of this study apply only to major cities, all those for which sewage data are reported.

Figure 1 plots populations and sewage treatment capacity per capita in 2007. There are clear differences in both the sizes and treatment levels of the different types of cities. Municipalities are the clearest outliers; Shanghai, Beijing, and Chongqing have far higher populations than other cities. Shenzhen and Xiamen have very high sewage treatment capacity per capita, although their actual treatment capacity is not out of line with other cities.

City public finance revenues are compiled from the Sub-Provincial Public Finance Statistics (*Quanguo Dishixian Caizheng Tongji Ziliao*), an annual publication of China's Ministry of Finance. These publications contain detailed

statistics of city tax revenues, transfers, and expenditures.

Figures 2 and 3 illustrate the geographic distributions of fiscal incentives and sewage treatment capacity growth during our time period. As described earlier, fiscal incentives are strongly correlated within a province, with high fiscal incentives apparently concentrated along the eastern and southern coasts, and in the middle of the country. Sewage treatment capacity growth appears to be more concentrated in the east, and along the major Yellow River and Yangtze River systems.

Other city-level characteristics such as the industrial output, population, and tax revenue are obtained from the China City Statistical Yearbooks, another official publication of the Chinese government. Summary statistics of key variables are presented in table 2.

4 Methodology

4.1 Empirical Specification

In appendix A, we lay out a brief model of the choice of public spending under a system of revenue sharing. The intuition behind this model is that cities with higher shares of revenue retained have higher marginal benefit from directing funds toward activities generating more taxes. As a result, they expand infrastructure more relative to cities with low fiscal incentives.

Our base empirical specification for this model is:

$$log\left(y_{i,2008} - y_{i,2002}\right) = \beta_1 FI_i + \beta_2 x_{i,2001} + \epsilon_i \tag{1}$$

Here, the term $y_{i,2008} - y_{i,2002}$ is the growth in sewage treatment capacity over our sample period for city i. We use the difference between the years 2008 and 2002 as the entire period where sewage treatment data are available. Over this period, total sewage treatment capacity increased more than 200%. $x_{i,2001}$ represents a vector of control variables for city i in the year 2001, obtained from the China City Statistical Yearbooks.

For this empirical context, we think that using a cross-section specification involving the growth in sewage treatment capacity is appropriate. In particular, we considered using a panel dataset with city-level fixed effects. We found this to be inappropriate for several reasons. First, investment in sewage treatment is lumpy. In some cities, constructing even one plant can double or triple a city's treatment capacity. Cities could construct a plant by financing it, which would appear in the data as a burst of growth poorly tied to some change in fiscal sharing rate. Hence, measuring the change in facilities over a period of time is appropriate. In addition, for 60% of cities, their fiscal incentives are virtually constant over the entire period we can observe. Using a panel dataset rather than a cross-section would eliminate the use of these cities.

We also considered using total sewage treatment capacity, $y_{i,2008}$, as the dependent variable. We rejected this specification because sewage treatment facilities are long-lived; sewage plants may have been built for other reasons

outside the years that our data cover. We have data that provides details of some sewage plants. Some of these plants were built before the 1994 fiscal reform, implying that they could not be affected by city fiscal incentives.

The employment of this empirical specification leaves our analysis open to the possibility that unobserved, city-level variation could affect both fiscal incentives and sewage treatment plant construction. We employ our understanding of the history behind the deployment of fiscal incentives along with our instrumental variables specification to limit the possible pathways of this endogeneity to those that are related to the initial assignment of fiscal incentives in 1994.

Our hypothesis is that fiscal incentives are positively related to measures of public spending that expand the city tax base, including sewage treatment infrastructure: β_1 is positive and significant. In addition, fiscal incentives are unrelated to forms of public spending that do not expand public infrastructure, such as transfers.

FI_i is city i's share of VAT retained. The Sub-provincial Public Finance Statistics reports the amount of VAT retained by the city (*gongshang shuishou zengzhishui*) and the figure representing 75% of all VAT collected, which is turned over to the central government (*yiban yusuanshouru zongji zengzhishui* 75%). We can therefore compute the city share of local VAT taxes as:

$$FI_i = \frac{VAT\ Retained_i}{Central\ Government\ Share_i/3} \tag{2}$$

Cities that retain 25% of VAT generated, the entire local share, will have $FI_i = 1$; cities that retain none of their VAT will have $FI_i = 0$. In our instrumental variables approach, we use a city's VAT share in 1995. We also tested VAT shares in 1996 and 1997 to confirm that our finding remains consistent.

4.2 Identification Strategy

Our identification strategy relies on the history and political economy of China's system of prefecture-level fiscal incentives. Between the time a city's VAT share was established, after the 1994 reform, and the time that the city was making visible decisions to build sewage treatment plants, in 2002, many endogenous circumstances could have caused provinces to adjust a city's VAT share.

We use a city's 1995 VAT share as an instrument for its 2001 VAT share. This restricts the endogeneity in determination of VAT share only to the set of reasons by which provinces decided to initially allocate VAT shares in 1994. Provinces adopted a variety of systems, with some provinces designating a complete pass-through, while other provinces decided to keep much of the revenues generated.

While a city's share of VAT retained may have changed between 1994 and 2001, the data suggest that the system of assigning incentives remained essentially constant (see table 1). A city's VAT share in 1995 is *relevant* because provincial systems remained constant over our sample period. We examine the *validity* of our instrument in section 5.2, where we analyze why cities chose 1995 VAT shares and whether they were chosen in a manner independent from sewage treatment capacity.

4.3 Potential Threats to Identification

4.3.1 Equalization and the Mobilization of Economic Development

The primary threat to identification is whether the method by which provinces allocated fiscal incentives is correlated with their sewage treatment capacity. As recounted in section 2.2.3, Bahl (1999) states that provinces did not give out fiscal incentives randomly, but instead had underlying motives. Some provinces stressed equalization (giving higher control of revenues to poorer cities), while others stressed the mobilization of economic development potential (giving higher control of revenues to richer cities).

To test the contrasting hypotheses of equalization and economic mobilization, we analyze the patterns of distributing fiscal incentives. While individual provinces may have had a plan for individual cities in their domain, the most important factor for the purposes of this study is what evidence can be found about fiscal incentives among cities in China as a whole. We then test whether the patterns that can be observed would be likely to influence the development of sewage treatment capacity.

In addition, we utilize China's unique pattern of development, which emphasized the development of some areas, such as coastal cities, over inland cities. These types of cities, which are more similar, are likely be benefited or harmed in the same way by equalization or mobilization. We examine whether the impacts of fiscal incentives can be seen within these subgroups of cities.

4.3.2 Negotiation and Favoritism

One possible consideration is whether cities were able to negotiate their fiscal shares. If a city had an unobservable characteristic, such as a more competent city manager, it might be able to negotiate a higher fiscal share. Simultaneously, this competence would allow it to build greater amounts of sewage treatment capacity. Closely related to this is the concern that some cities are favored by being targeted for development over others. They would then receive both higher fiscal shares and greater development of sewage treatment capacity in the form of infrastructure earmarks.

We address this concern through our study of which cities tend to get higher levels of VAT shares. What patterns of negotiation or favoritism can be observed from the data? Do VAT shares look as if they were negotiated or more as if they were assigned?

4.3.3 Other Forms of Fiscal Incentives

The VAT share is just one part of a broader revenue-sharing arrangement between provinces and cities. If other parts of these contracts, such as corporate income tax sharing, or transfers, are correlated, these could also drive city incentives to build infrastructure.

To address this concern, we argue that other parts of revenue-sharing agreements between provinces and cities are less likely to serve as incentives to build

sewage treatment capacity. Other taxes, such as the corporate income tax or the business sales tax, include in large part nonindustrial sectors that are unlikely to be interested in sewage treatment capacity. Transfers between provinces and cities are tied to the growth rates of both the VAT and the consumption tax, making the marginal incentive to grow the industrial base unclear.

4.3.4 Province-Level Variation in Needs

Since the VAT share is driven strongly by province-level choices, do more needier provinces keep higher shares of VAT revenues for themselves? These poorer and more needy provinces would then be unable or unwilling to supply sewage treatment infrastructure.

To address this concern, we looked closely at which provinces allowed their cities high levels of fiscal incentives, and which provinces kept high shares for themselves. We examined the possibility that the motive driving provinces to assign low VAT shares was based on their own needs.

5 Evidence and Results

5.1 Description of Fiscal Incentives

Our measure of fiscal incentives is the share of local VAT revenues retained by the city. We use equation 2 to calculate the sharing rate for each city in each year. Figure 4 shows the raw data, limiting the sample of cities to the 111 for which sewage treatment outcomes are available.

Significant variation among cities exists. Most cities retain between 50% and 100% of local VAT revenues, with a concentration of cities at 100%. A very small number of cities have VAT sharing ratios in individual years above 1. We do not understand why cities would be able to retain more than the local share of VAT. It is possible that temporary special deals were negotiated with the government; alternatively, data entry errors are known to be present in China's official yearbooks. Since over 99% of these data show a sharing ratio at or below 1, the VAT shares data appear to reflect our expectations well.

Figure 5 graphs the relationship between population and fiscal incentive by province.[6] This graph suggests that province-level variation is not a particular driver of our results. We would be concerned if any one province had both particularly low fiscal incentives and low growth in sewage treatment capacity, indicating that it was an outlier. However, a variety of provinces have cities that are low in fiscal incentives and low in sewage treatment capacity construction.

[6] There are four Directly Controlled Municipalities (DCM): Beijing, Shanghai, Chongqing, and Tianjin. These cities have been given province-level tax and political authority. DCM do not have fiscal incentive ratios at 1 as would be expected since they do not belong to a province.

We believe that DCM use a different method to report budgetary statistics to the Sub-provincial Finance Statistics than other cities. Data from the China City Statistical Yearbook of 2002 match the budgetary information provided in the Sub-provincial Finance Statistics of 2002 for all cities except DCM.

5.2 The Assignment of Fiscal Incentives

We are most concerned about the methods by which provinces assigned fiscal incentives to cities as a result of the 1994 tax reform. Our strategy is to identify these methods and then to account for them in our instrumental variables regressions. The possible methods can be classified into two broad areas. The first is whether the provinces that assigned complete pass-through differed systematically from those that required sharing from their cities. The second is whether the assignment of fiscal incentives within provinces was endogenous in some way to sewage treatment infrastructure.

We tested for endogeneity using the Durban-Wu-Hausman test. Neither VAT sharing ratios in 1995 nor those in 2001 show endogeneity under this test.

We studied the methods by which provinces chose their method of assignment. Table 3 divides the provinces by whether they allowed a 100% pass-through of VAT revenues and illustrates their key characteristics. This table excludes direct-controlled municipalities. We see in this table that provinces that allowed high fiscal incentives are moderately more populous, richer, and have higher spending overall.

However, these means mask the high level of variation within each category. For each set of provinces, there are some provinces that are relatively rich and populous, and some that are poorer and smaller. This helps alleviate the fourth of our threats to identification: that poorer provinces kept higher shares of VAT for themselves and also did not fund sewage treatment instructure.

With the possible exception of the VAT dependence variable, the two groups cannot be distinguished with any significant level of statistical confidence, as reflected by the P-values in the right-hand column of this table. Regressions support these general findings, as shown in table 4. The only variable that is statistically significant in some functional forms is the VAT dependence variable. In provinces that were more dependent on industrial productivity for their taxes, lower shares of VAT revenue were assigned to cities in their domain.

A second area of concern is the methods by which each province assigns fiscal incentives to its cities. We studied within-province variation in the assignment of VAT shares to cities by using a city-level regression that includes province-level fixed effects. These regressions are presented in table 5. These regressions support the hypothesis that "equalization," rather than "economic mobilization," seemed to play a role in within-province assignment of VAT shares; poorer cities receive higher shares of VAT.

These findings are contrary to the second of our threats to identification: that negotiation and favoritism played a significant role. For the large number of cities located in provinces that assigned constant fiscal incentives to all cities in their domain, negotiation and favoritism cannot possibly have played a role. For the cities that offered heterogenous fiscal incentives, cities that were poorer tended to receive higher fiscal incentives, rather than cities that were richer. This finding suggests that VAT shares were assigned as part of a provincial plan to provide more financial resources to less-well-off cities, and not given as a result of well-off cities being able to negotiate good deals for themselves.

To account for possibility that equalization played an important role in both the assignment of fiscal incentives and the growth of sewage treatment capacity, we include variables controlling for the different starting positions of cities: their wealth, their initial existing levels of industrial activity, their initial levels of sewage treatment, and their spending levels.

5.3 Results on the Relationship between Fiscal Incentives and Sewage Treatment Capacity

Ordinary least-squares regressions of the impact of fiscal incentives in 2001 on sewage treatment capacity are presented in table 6. These regressions suggest that fiscal incentives in 2001 are positively correlated with the construction of sewage treatment infrastructure.

Our instrumental variables results are presented in tables 7 and 8. In these tables, we control for factors that might influence both our instrument and the dependent variable. These include VAT dependence, which we found earlier influenced the initial assignment of fiscal incentives. To control for the equalization motive of provinces, we include the initial level of sewage treatment capacity, a city's ability to spend as defined by total expenditures divided by GDP, and each city's absolute level of expenses. To address the possibility that sewage treatment fees are tied to both fiscal incentives and sewage treatment capacity, we include each city's water consumption per capita.[7]

First-stage regression results of fiscal incentives in 2001 and fiscal incentives in 1995 are displayed in table 7. The Cragg-Donald F-statistics for excluded instruments exceed 10 in our primary specifications. This strongly rejects the null hypothesis of weak instruments (Stock et al. 2002).

We display the relationship between fiscal incentives and growth in sewage treatment capacity in figure 6. There are no obvious outliers overall. Results from our instrumental variables regressions of equation 1 are presented in table 8. Our preferred specification is presented in column 3. In this specification, we use the extended set of covariates as discussed in section 5.2, and exclude province-level municipalities, which have different properties than other cities. Our central estimate suggests that a 10 percentage point increase in a city's share of VAT retained (e.g., from 0.6 to 0.7) resulted in an increase in sewage treatment capacity of 13.8% over the sample period.

Relative to the instrumental variables results, the ordinary least-squares results have significantly smaller coefficients. There are several possible mechanisms explaining this finding. We believe the most likely explanation is tied to the rationale behind provincial adjustment of city sharing rates. Some cities may have run fiscal surpluses, or smaller fiscal deficits, after the 1994 tax reform shuffled their revenues. These cities would have been more likely to construct

[7] Sewage treatment fees are collected as a portion of the water consumption fee. These fees fund the construction and operation of treatment plants. Sewage treatment fees are widely regarded as inadequate to pay for the operating costs of sewage treatment. They fall far short of paying for the construction of sewage treatment plants (Lee 2009).

sewage treatment facilities, and may have had their tax sharing rates adjusted downward in years following the tax reform.

The ideal natural experiment would be to have two identical bins of cities separated only by their exogenously imparted fiscal incentives. By placing cities within subgroups and then controlling for important differentiating factors like population and wealth, we attempt to econometrically construct these bins. Cities within the same bin are likely to experience similar degrees of favoritism, isolating the impact of fiscal incentives.

We tested equation 1 on subgroups of cities. We tested three subgroups: provincial capitals (25 cities), coastal cities (17 cities), and subprovincial cities (15 cities). While these samples are too small to obtain reliable estimates, we found that a positive and quantitatively significant relationship exists for each of these smaller groupings. The magnitude of the coefficient is actually bigger for each of these subgroups than for our main result reported in table 8, suggesting that, as the group of cities being compared becomes more similar, the impact of fiscal incentives is more important.

This robustness check rejects the notion that factors such as favoritism or negotiation, potentially associated with the provincial assignment of fiscal incentives in 1994, played a significant role in the construction of sewage treatment facilities. Since fiscal incentives played a significant role even with groups of cities that occupied similar spots within the Chinese administrative hierarchy, we believe they responded to their fiscal incentives in their sewage treatment construction decisions.

5.3.1 Other Significant Covariates

All control variables in table 6 are the level of that variable in 2001. As expected, cities that were larger in population and richer also grew their sewage treatment capacity more. These cities may have higher needs for wastewater treatment and greater ability to build infrastructure.

Also, the initial level of sewage treatment capacity provided in 2002 appeared to be negatively related to growth over the time period examined. As noted before, sewage treatment investment is lumpy, with some cities constructing only one or two plants. Having high capacity at the beginning of the sample may indicate some slack in capacity, with relatively less need required in the future.

5.4 Results on the Relationship between Fiscal Incentives and Transfers

Our regressions using transfer payments of cities act as a placebo test, ensuring that our methods do not produce a false positive result against forms of spending that should be unrelated to fiscal incentives. Since spending on transfers is generally a function of underlying demographic characteristics, cities can exercise only limited discretionary control. Moreover, increases in spending on transfers do not build the tax base. We expected a null result.

Our testing, displayed in table 9, shows a moderately positive relationship between fiscal incentives and spending on education and science. It finds statistically insignificant relationships for spending on pensions. It finds a statistically negative relationship between spending on social security and fiscal incentives. Most tests actually have a moderately negative result for these coefficients.

These results suggest that the relationships between spending and fiscal incentives that we have found are not purely income effects caused by increased levels of spending. Cities appear to substitute among different types of spending as their incentives go up. They increase types of spending that may be attractive to expanding their tax base, like infrastructure and education, and decrease types of spending that have no impact on tax base, like transfers.

6 Conclusion

China's need for a systematic water treatment plan is enormous and growing. China has over 300 cities with more than 1 million people; its industry shows no signs of slowing down. Sewage treatment plants must play a key role in any coordinated response to these needs.

This paper has demonstrated that cities in China respond to higher fiscal incentives by building more sewage treatment infrastructure. This suggests that financial incentives might be part of the solution to pressing water pollution treatment issues. While city-level fiscal incentives are too broad a weapon to level at these problems, targeted financial incentives might be provided to cities in key geographic areas, such as those upstream from large populations, or to cities sharing a common-pool water resource.

More broadly, China has seen an increasing devolution of expenditures to local authorities, coupled with an increasing centralization of revenues to the central government. If fiscal incentives are an important driver of local government behavior, decreasing the local share of revenues may have significant unintended consequences. Since, on the margin, local governments will participate less in the gains of their investments, they may choose to invest less of their scarce resources in important infrastructure projects.

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Appendix A: A Model of Revenue Sharing and Infrastructure

We use a simple model similar to that of Zhuravskaya (2000) to demonstrate our points.

Consider a city manager deciding where to spend public funds. Spending on public infrastructure, S, expands the tax revenues of the city according to the function $g(S)$, with the city retaining only a share α of these revenues. It also increases city welfare by aS, where a is an exogenous constant. The cost of purchasing and operating the public infrastructure is a convex function $I(S)$.

Cities can also choose to spend public funds through other means, such as transfers. Transferring an amount E provides non-financial benefits to the city E.

The city manager's problem is then to maximize $aS + E$ subject to the constraint $I(S) + E \leq \alpha g(S)$.

Labeling the optimal choice of spending on public infrastructure S^*, we prove that $\frac{dS^*}{d\alpha} > 0$ using the following assumptions:

1. $I(S) > 0$, $I^{'}(S) > 0$, $I^{"}(S) > 0$
2. $g^{'}(S) > 0$, $g^{"}(S) < 0$

Proofs: The first-order condition with respect to S yields:

$$a + \alpha g^{'}(S) = I^{'}(S)$$

Differentiating this equation with respect to α, we find $g^{'}(S) + \alpha g^{"}(S) \frac{dS}{d\alpha} = I^{'}(S) \frac{dS}{d\alpha}$.

Solving for $\frac{dS}{d\alpha}$:

$$\frac{dS}{d\alpha} = \frac{g^{'}(S)}{-\alpha g^{"}(S) + I'(S)}$$

Under assumptions 1 and 2 above, $\frac{dS}{d\alpha} > 0$. $\square$

The city manager receives a positive net benefit from spending on E. Any funds that are not spent on S are spent on E. However, the change in the amount of funds spent on E as a result of changes in fiscal incentives α is ambiguous. On one hand, a higher sharing increases the financial resources of the city $\alpha g(S)$. On the other hand, higher sharing rates also increase subsitution toward S away from E.

We see from this simple model that increasing the share of revenue retained should increase spending on revenue-producing forms of spending, with an ambiguous relationship between fiscal incentives and other forms of spending.

Data Appendix

- There appear to be several typos in the 2008 China Environment Yearbooks, where a figure for the same city drops 90% between years. The most obvious error relating to sewage treatment capacity is in Shanghai, where the sewage capacity reported in CEY 2008 is 539,100, an inexplicable drop from CEY 2007's figure of 4,704,105. In CEY 2009, Shanghai reports 6,488,400. The most reasonable explanation is that a "0" has been omitted from the 2008 figure. Results are largely robust to either a correction of the CEY 2008 figure to "5,391,000" or dropping the observation altogether.

- Some cities shrank sewage treatment capacity or did not change over the 2002-2008 sample time frame. To incorporate this into our analysis, we took the biggest drop in sewage treatment capacity within a city, and added this figure to the sewage capacity increase in each city. With this correction, all cities receive positive numbers for $log\,(y_{i,2008} - y_{i,2002})$, except the city with the largest drop in sewage treatment capacity, which is excluded from the results presented. Our results are robust to this correction or to simply dropping cities that did not increase sewage treatment capacity.

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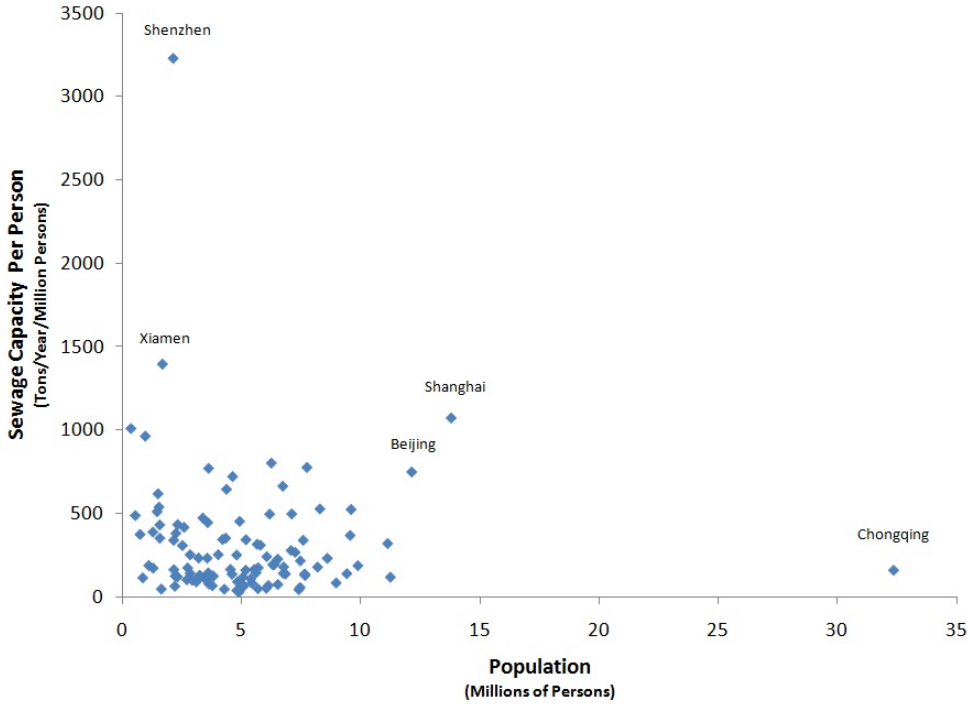
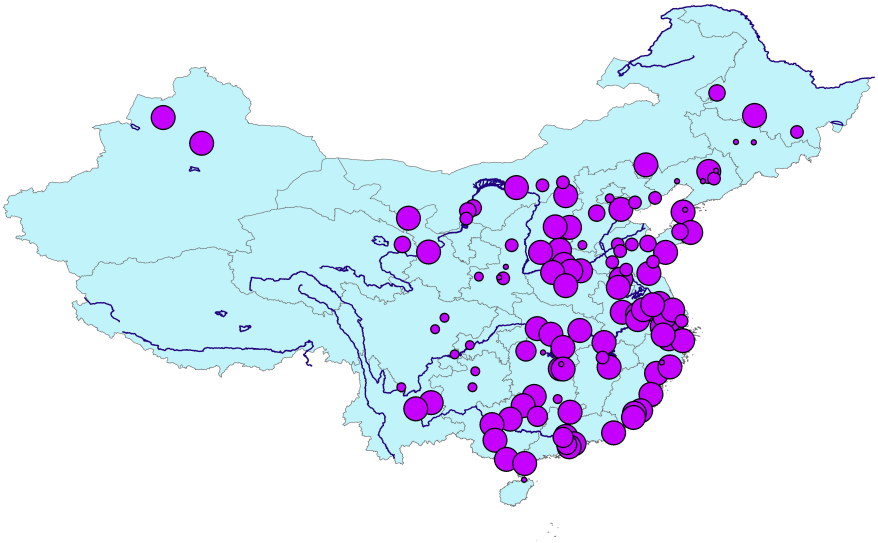
Figure 1: Populations and Sewage Treatment Capacity per Person, plotted by City, in 2007



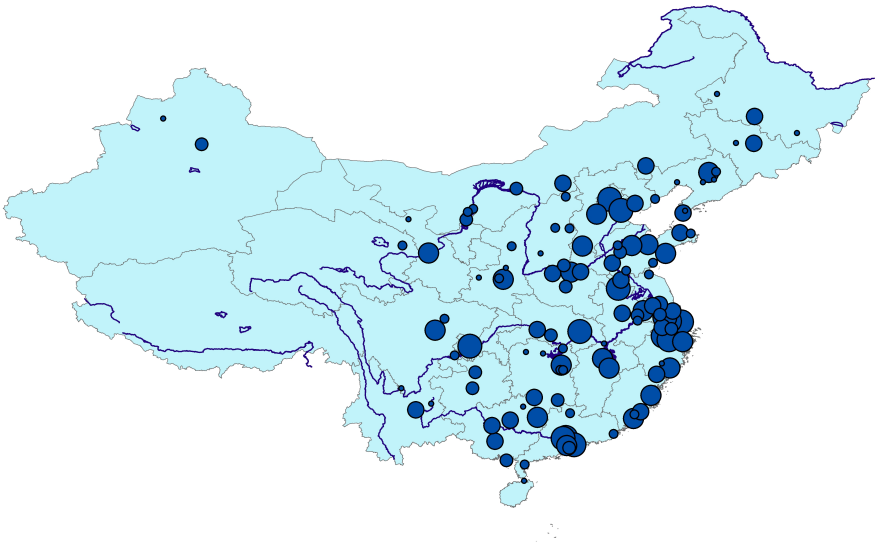
Source: SEPA 2008.

Figure 2: The Geographic Distribution of Fiscal Incentives



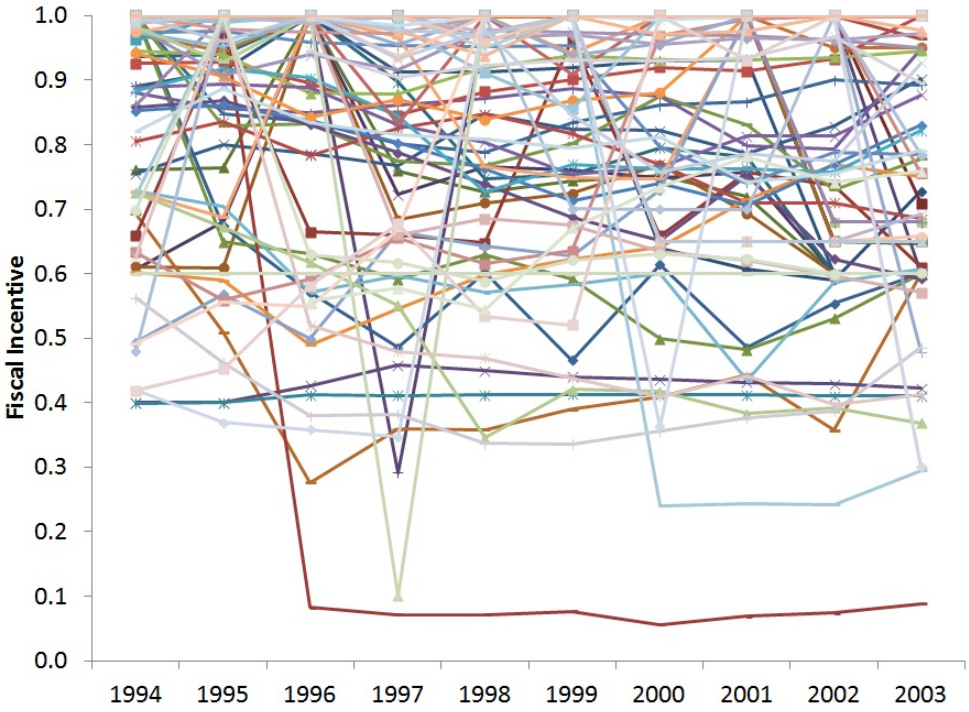
Source: China Sub-provincial Public Finance Statistics.

Figure 3: The Geographic Distribution of Growth in Sewage Treatment



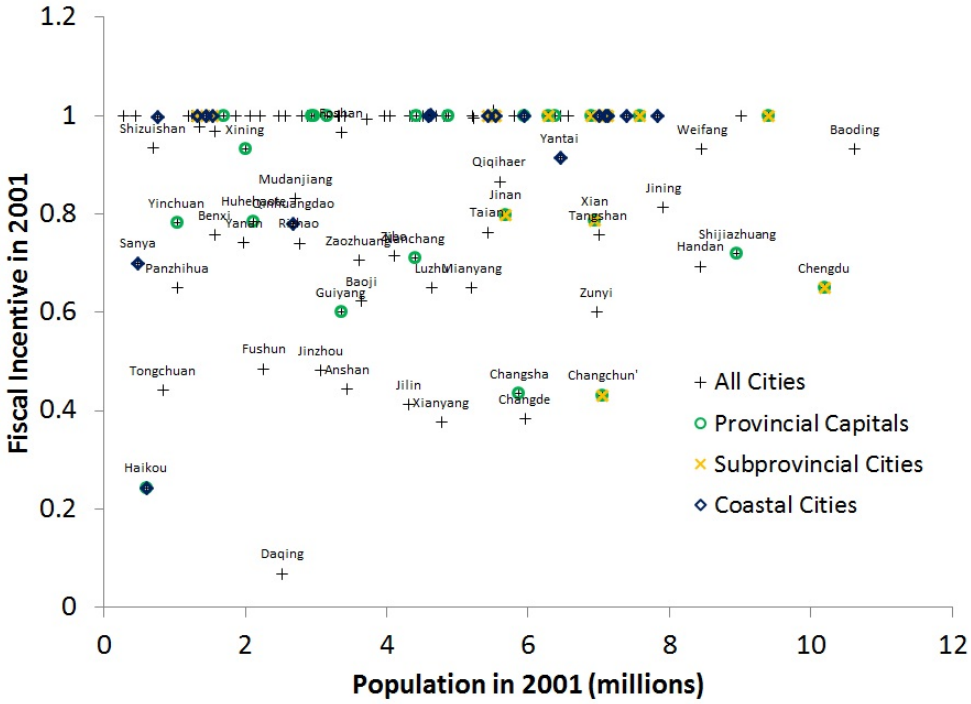
Source: SEPA 2003-2009.

Figure 4: Raw Data for Fiscal Incentives, Plotted by City



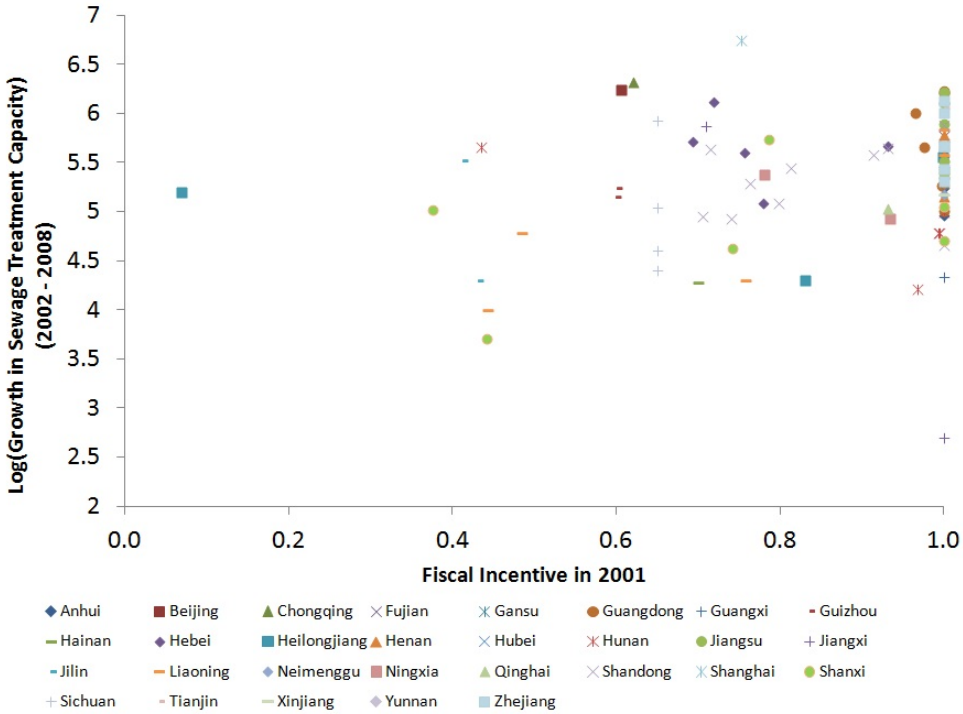
Source: Sub-provincial Public Finance Statistics. See equation 2 in section 4.1 for more details of how the fiscal incentive for each city is derived. Many cities had values marginally higher than 1. These usually fell within the rounding error of the original source. One city in 2002 and one city in 2003, of the 111 cities presented here, had a fiscal incentive value substantially higher than 1. We adjusted the fiscal incentive value to 1 when equation 2 resulted in a ratio higher than 1.

Figure 5: Fiscal Incentive and Population, Plotted by Province, in 2002



Notes: Population figures are drawn from the 2002 China City Statistical Yearbook. Fiscal incentive figures are calculated using equation 2 with data from the 2002 Sub-provincial Finance Statistics.

Figure 6: Fiscal Incentive and Growth in Sewage Treatment Capacity, Plotted by Province



Notes: Fiscal incentive figures are calculated using equation 2 with data from the 2002 Sub-provincial Finance Statistics. Sewage treatment capacity figures are obtained using China Environment Yearbooks.

Table 1: Patterns of Fiscal Incentives by Province

Province	Number of Cities	VAT Share Retained by City	
		In 1995	In 2001
Beijing	1	Not reported	61%
Tianjin	1	100%	100%
Hebei	11	Range: from 61% to 94%	Range: from 53% to 93%
Shanxi	11	All 100%	All 100%
Neimenggu	8	Huhehaote: 80%; all others 100%	Huhehaote: 79%; all others 100%
Liaoning	14	Range: from 23% to 100%	Range: from 17% to 100%
Jilin	8	All 40%	Range: from 41% to 100%
Heilongjiang	12	Range: from 82% to 100%	Range: from 83% to 100%
Shanghai	1	87%	75%
Jiangsu	13	All 100%	All 100%
Zhejiang	11	All 100%	All 100%
Anhui	17	All 100%	All 100%
Fujian	9	All 100%	All 100%
Jiangxi	11	Range: from 73% to 100%	Range: from 42% to 100%
Shandong	17	Range: from 12% to 100%	Range: from 14% to 100%
Henan	17	All 100%	All 100%
Hubei	12	All 100%	All 100%
Hunan	13	Range: from 54% to 91%	Range: from 44% to 100%
Guangdong	21	Range: from 90% to 100%	Range: from 95% to 100%
Guangxi	14	All 100%	All 100%
Hainan	2	Both 100%	One 24%, one 70%
Chongqing	1	100%	62%
Sichuan	18	All 100%	All 65%
Guizhou	4	All 60%	All 60%
Yunnan	8	All 100%	All 100%
Tibet	1	100%	100%
Shanxi	10	Range: from 46% to 100%	Range: from 36% to 100%
Gansu	12	Range: from 37% to 100%	Range: from 42% to 100%
Qinghai	1	45%	93%
Ningxia	5	Not reported	Range: from 78% to 100%
Xinjiang	2	Both 100%	Both 100%

Table 2: Summary Statistics of Important City Variables

	2001	2002	2003	2004	2005	2006	2007	2008
Treatment Capacity	N/A	240,166	281,793	336,130	394,019	464,087	531,273	613,270
(tons/day)	N/A	(262,074)	(323,225)	(542,111)	(614,309)	(658,926)	(727,291)	(831,768)
Population	4.7	4.8	4.9	4.9	5.0	5.0	5.1	5.1
(millions)	(3.6)	(3.6)	(3.6)	(3.7)	(3.7)	(3.7)	(3.8)	(3.8)
GDP/Capita	14,973	15,103	17,082	20,765	22,959	26,544	31,260	36,397
(yuan)	(16,510)	(10,740)	(11,979)	(14,329)	(14,887)	(16,946)	(19,117)	(21,089)
City Expenditures	4,095	5,173	7,851	9,447	11,621	13,901	12,640	22,076
(millions of yuan)	(9,320)	(11,042)	(13,450)	(16,576)	(19,816)	(22,317)	(26,650)	(33,187)
Secondary Share	0.475	0.480	0.500	0.518	0.504	0.516	0.523	0.531
	(0.101)	(0.100)	(0.102)	(0.106)	(0.114)	(0.110)	(0.110)	(0.111)
Tertiary Share	0.393	0.395	0.384	0.370	0.390	0.387	0.384	0.380
	(0.085)	(0.085)	(0.082)	(0.084)	(0.098)	(0.099)	(0.101)	(0.103)
Water Consumption	75.5	62.4	58.0	58.8	58.7	54.1	49.1	N/A
(tons/household)	(36.5)	(34.5)	(31.5)	(33.6)	(38.0)	(37.1)	(27.1)	N/A
City Expenditure Ratio	0.053	0.059	0.091	0.090	0.093	0.098	0.065	0.114
	(0.035)	(0.035)	(0.032)	(0.033)	(0.028)	(0.030)	(0.033)	(0.047)

Notes: Unweighted means are reported for each category. The standard deviation for each item is reported in parentheses below the mean of that item. Only cities for which sewage treatment data are reported in the China Environmental Statistical Yearbook are included here; the averages for all cities in China may be different.

Table 3: Key Co-variates of Provinces That Passed through VAT Shares against Provinces that Retained Shares

	Provinces with 100% VAT Sharing	Provinces with <100% VAT Sharing	P-value of Difference
Number of Provinces	15	12	
Population (thousands)	45,629	39,882	0.6964
GDP/Capita (RMB)	3,689	3,227	0.7968
Total City Income (millions of RMB)	20,505	15,818	0.7790
Total City Expenditures (millions of RMB)	19,658	15,214	0.7852
Secondary Share	42.8%	43.3%	0.4442
Tertiary Share	32.5%	31.8%	0.7028
VAT Dependence (VAT Generated/GDP)	4.84%	5.39%	0.1761
Sewage Treatment Capacity (tons/day, in 2001)	759,006	640,065	0.6484

Note: Unweighted means are reported for each category.

Table 4: The Determinants of Province-Level Fiscal Incentives

	(1)	(2)	(3)	(4)
Log(Population)	-0.00901	-0.00781	-0.0220	-0.0189
	(0.0368)	(0.0369)	(0.0429)	(0.0432)
Log(GDP/Capita)	0.0434	0.0199	0.0692	0.0473
	(0.0531)	(0.0547)	(0.0623)	(0.0639)
Log(City Expenses)	0.00153	0.0316	0.0232	0.0524
	(0.0351)	(0.0391)	(0.0418)	(0.0453)
Secondary Share			-0.461	-0.440
			(0.418)	(0.417)
Tertiary Share			-0.526	-0.503
			(0.478)	(0.475)
log(Capacity 2002)			-0.0112	-0.0132
			(0.0233)	(0.0233)
Constant	0.424	0.423	0.593	0.586
	(0.345)	(0.346)	(0.385)	(0.385)
Observations	109	105	109	105

Standard errors in parentheses
All variables are measured in the year 2001. Our measure of fiscal incentives is the dependent variable. Columns 1 and 3 represent the full sample. Columns 2 and 4 represent the full sample less DCM.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 5: The Determinants of City-level Fiscal Incentives

	(1)	(2)	(3)	(4)	(5)	(6)
log(Population)	0.00774	0.00708	0.00774	0.00684	0.00294	0.00712
	(0.0122)	(0.0122)	(0.0122)	(0.0123)	(0.0175)	(0.0177)
GDP/capita	-0.0390**	-0.0685**	-0.0313*	-0.0323*	-0.0382	-0.0875***
	(0.0188)	(0.0270)	(0.0184)	(0.0188)	(0.0239)	(0.0306)
VAT/GDP	-0.200					-0.292*
	(0.149)					(0.154)
Expenditures/GDP		0.474*				0.639**
		(0.269)				(0.286)
City Deficit/GDP			-0.335			-0.374
			(0.237)			(0.240)
Coastal (0/1)				-0.00779		-0.0135
				(0.0245)		(0.0246)
log(Ind. Output)					0.00386	0.00270
					(0.0125)	(0.0131)
r2	0.636	0.638	0.636	0.633	0.633	0.648
F	13.84	13.96	13.86	13.67	13.67	12.54
N	251	251	251	251	251	251

Standard errors in parentheses
All variables are measured in the year 1995. Our measure of fiscal incentives is the dependent variable. Regressions include province-level fixed effects.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 6: Ordinary Least-Squares Regressions: The Relationship between VAT Share in 2001 and Sewage Treatment Capacity

	(1)	(2)	(3)
VAT Share (2001)	0.712**	0.675	0.751*
	(0.342)	(0.407)	(0.439)
log(Population)	0.633***	0.663*	0.717*
	(0.174)	(0.350)	(0.353)
log(GDP/Capita)	0.549**	0.418	0.505
	(0.242)	(0.322)	(0.329)
log(Ind. Output)	0.216	0.319	0.304
	(0.175)	(0.247)	(0.258)
All VAT Revenues/GDP		0.00290	0.00149
		(0.0423)	(0.0443)
log(Capacity 2002)		-0.183***	-0.172***
		(0.0536)	(0.0581)
Water Consump./Capita		-0.623	-0.745
		(2.157)	(2.218)
City Expend./GDP		5.608	7.277
		(4.367)	(5.566)
log(City Expenses)		0.100	0.0180
		(0.250)	(0.254)
Constant	5.152***	7.108***	6.623**
	(1.916)	(2.428)	(2.479)
r2	0.620	0.682	0.626
F	46.37	50.53	58.21
N	109	108	104

Robust standard errors, clustered by province, in parentheses.
The dependent variable is the log of the growth in sewage treatment capacity between the years 2002 and 2008. Each independent variable is the level of that variable in 2001. Columns 1 and 2 include the full sample. Column 3 excludes directly controlled municipalities.

Table 7: First-Stage Instrumental Variables Results: The Relationship between VAT Share in 2001 and VAT Share in 1995

	(1)	(2)	(3)
VAT Share (1995)	0.449**	0.537***	0.543***
	(0.194)	(0.165)	(0.170)
log(Population)	-0.0688	-0.200**	-0.162*
	(0.0713)	(0.0940)	(0.0876)
log(GDP/Capita)	-0.0690	-0.158	-0.153
	(0.118)	(0.119)	(0.110)
log(Ind. Output)	0.0738	0.180***	0.197***
	(0.0654)	(0.0640)	(0.0695)
All VAT Revenues/GDP		-0.0434**	-0.0442**
		(0.0179)	(0.0182)
log(Capacity 2002)		-0.0232	-0.0293
		(0.0228)	(0.0236)
Water Consump./Capita		0.470	0.413
		(0.464)	(0.510)
City Expend./GDP		-0.325	0.753
		(1.859)	(1.990)
log(City Expenses)		0.0116	-0.00956
		(0.0691)	(0.0667)
Constant	0.901	1.828*	1.859**
	(0.981)	(0.919)	(0.898)
r2	0.158	0.286	0.302
F	2.614	5.568	5.306
N	106	105	102

Robust standard errors, clustered by province, in parentheses.
The dependent variable is the log of the growth in sewage treatment capacity between the years 2002 and 2008. Each independent variable is the level of that variable in 2001. Columns 1 and 2 include the full sample. Column 3 excludes directly controlled municipalities.

Table 8: Ordinary Least-Squares Results: The Relationship between VAT Share in 2001 and Growth in Sewage Treatment Capacity.

	(1)	(2)	(3)
VAT Share (2001)	1.732**	1.372*	1.378*
	(0.856)	(0.750)	(0.723)
log(Population)	0.748***	0.864**	0.804**
	(0.201)	(0.393)	(0.360)
log(GDP/Capita)	0.609***	0.542	0.559*
	(0.227)	(0.345)	(0.327)
log(Ind. Output)	0.140	0.215	0.195
	(0.170)	(0.248)	(0.250)
All VAT Revenues/GDP		0.0296	0.0269
		(0.0490)	(0.0490)
log(Capacity 2002)		-0.171***	-0.158***
		(0.0567)	(0.0604)
Water Consump./Capita		-0.583	-0.647
		(1.959)	(2.046)
City Expend./GDP		6.047	4.981
		(4.969)	(4.630)
log(City Expenses)		0.0600	0.0640
		(0.261)	(0.238)
Constant	3.832*	5.454**	5.320**
	(1.970)	(2.651)	(2.562)
r2	0.590	0.671	0.627
F	28.08	27.41	28.54
N	106	105	102

Robust standard errors, clustered by province, in parentheses.
The dependent variable is the log of the growth in sewage treatment capacity between the years 2002 and 2008. Each independent variable is the level of that variable in 2001. Columns 1 and 2 include the full sample. Column 3 excludes directly controlled municipalities.

Table 9: The Relationship between Fiscal Incentives and Other Forms of Public Spending.

	(1) Education	(2) Science	(3) Pension	(4) Soc. Sec.
VAT Share (2001)	0.644*	0.784	-0.348	-2.274**
	(0.386)	(0.534)	(0.360)	(0.906)
log(Population)	0.814***	0.328	0.495	-0.103
	(0.260)	(0.285)	(0.324)	(0.334)
log(GDP/Capita)	0.478*	0.256	-0.243	-0.947**
	(0.261)	(0.256)	(0.341)	(0.436)
log(Ind. Output)	0.0185	0.386*	0.162	0.351
	(0.134)	(0.200)	(0.104)	(0.252)
All VAT Revenues/GDP	0.0496*	0.0533	-0.00296	-0.0497
	(0.0273)	(0.0455)	(0.0331)	(0.0746)
log(Capacity 2002)	0.0713**	0.0420	0.0705**	0.0320
	(0.0340)	(0.0406)	(0.0317)	(0.101)
Water Consump./Capita	0.559	1.401	0.808	-0.262
	(1.041)	(0.879)	(0.964)	(2.916)
City Expend./GDP	2.688	0.291	1.274	-3.192
	(3.714)	(4.237)	(5.222)	(6.389)
log(City Expenses)	-0.0350	0.375**	0.301	0.920***
	(0.168)	(0.182)	(0.225)	(0.238)
Constant	6.455***	2.105	9.457***	14.47***
	(1.861)	(2.084)	(1.890)	(4.078)
r2	0.858	0.874	0.806	0.326
F	52.39	119.3	110.2	20.01
N	103	103	103	103

Robust standard errors, clustered by province, in parentheses.
The dependent variable is the sum of expenditures, between the years 2002 and 2008, on that type of expense. Each independent variable is the level of that variable in 2001.