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A Study of Tax Loss in China

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CERTIFICATE OF ORIGINALITY

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ABSTRACT

Tax loss implies that governments lose their revenue because the tax authorities have failed to obtain taxes owed from taxable economic activities. Measuring the size of tax loss will not only disclose the actual government revenue situation, but also guide tax authorities toward improving the taxation system and enhancing efficiency in tax collection. In China, very few researches on tax loss have been accomplished because of the political issues and insufficient information resources. The thesis developed a new methodology to disclose the seriousness of tax loss, and proposed an effective countermeasure to control tax loss in China.

The main contributions of this thesis are as follows:

1. A unique methodology and two approaches - income-expenditure and fuzzy logic - have been developed to evaluate the size of tax loss with insufficient available data in China. The analysis results show that the ratio of tax loss to tax revenue is mutative among 6.7% to 32.4% in China during the year 1987 to 2003, and the situation has improved in the last few years.

2. A clinical study on the tax loss situation of Xiaogan, a city in middle area of China, is introduced. This should be the first actual case study carried out for academic purposes in China. As such, it provides rather concrete evidence on how serious the tax loss situation is in China. With the help of local tax authorities, the tax compliance situation was investigated through an applied tax audit on taxpayers. About 200 taxpayers were randomly sampled from the audit

results, and based on their data the probability of tax evasion and the relationship between tax loss and its possible causes were analyzed using the regression method.

3. A new countermeasure to prevent tax loss in China is proposed. According to observation, falsifying invoices has become the most popular method for evading taxes in China. The deficiencies with the existing VAT invoicing terminal are discussed, and a new anti-counterfeit VAT invoicing system, recently adopted in China, is described in detail.

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CHAPTER 1. INTRODUCTION

“Tax loss” means that governments lose their revenue from taxes because taxpayers have inaccurately reported their taxable economic activities to the tax authorities. Tax loss is also caused by inefficient collection of taxes and weaknesses in the taxation system. The presence of tax loss is not only related to unobserved economic activities, but also allied with various complex factors such as the political system, economic development level, and even the moral culture of the society. Our research will pass over the larger legal and ethical issues and just focus on the economic issues in China.

Studying tax loss is a great challenge for both academic development and practical implementation because there is insufficient data available and a lack of recognized benchmarks in the domain. The analysis results will disclose the actual situation of tax loss, which can guide tax authorities toward improving their taxation system and enhancing efficiency in tax collection. Furthermore, our research can also contribute a creative methodology to the field of accounting, which is always looking for the feasible approaches to identify the real statement of accounts when the available data is insufficient.

The direct way of measuring tax loss should be to conduct a tax audit on every taxpayer; however, it is obviously not efficient to adopt the method nationally for a very large number of taxpayers. To get around this problem, it is first necessary to

identify some countable indicators that can represent the situation of tax loss in a given country. Tax loss is the inevitable outcome of “unobserved” economic activity, also known as underground economic activity, which is unsupervised by government authorities or regulators. Since a common feature of tax loss is that participants always do their utmost to avoid the regulation and observation of taxation authorities, measuring the size of the unobserved economy could be an effective way of estimating the tax lost. In many cases, unobserved economic activities are always related to crimes such as drug dealing, gambling, and prostitution. Therefore, the unobserved economic activities may only be used as an indicator to describe the seriousness of tax loss, because the unobserved incomes are not all taxable.

Measuring the unobserved economy has become a particularly hot topic over the last 40 years. Cagan (1958) was the first scholar to use the cash-saving approach to measure the unobserved income quantitatively. Using the same approach, Gutmann (1977) estimated that the total amount of unobserved income was 10% of the U.S. GDP in 1976. Although the U.S. Internal Revenue Service (IRS) disagreed with some of the assumptions inherent in this approach, the IRS also obtained similar results when they used their own evaluation formula. Since the 1970s, a number of studies have been carried out in different countries. In the UK, O’Higgins (1980) analyzed the unobserved economy using the cash-saving approach, and found that the total amount of unobserved income was 2.5% to 15% of the GDP in the 1970s. Using the same approach, Langfeldt (1982) evaluated the unobserved economy in West Germany, and his results indicated that unobserved income totaled about 3.375% of that country’s GDP in 1980. Schneider (2000) used various methods to estimate the size of the unobserved economy in 76 developing, transitional, and

OECD countries. The results of his analysis showed that the average size of the unobserved economy (in terms of percent of official GDP) from 1989 to 1993 was 39% in developing countries, 23% in transitional countries, and 14.1% in OECD countries. In 2003, sponsored by the World Bank, he came up with the following figures shown in Table 1.1.

Africa/Central and South America/Asia (Average 1989-1990)		**Former Soviet Union, Central and Eastern Europe (Average 1994-1995)**		**OECD-Countries (Average 1997-1998)**	
Egypt	68		59.3	Australia	14
Morocco	39	Belarus	19.1	Austria	9
South Africa	9	Estonia	18.5	Belgium	22.5
Tanzania	31	Georgia	63	Canada	16.2
Argentina	21.8	Kazakhstan	34.2	Denmark	18.3
Bolivia	65.6	Latvia	34.8	Finland	18.9
Brazil	29	Lithuania	25.2	France	14.9
Chile	37	Moldavia	37.7	Germany	14.9
Colombia	25	Russia	41	Great Britain	13
Mexico	49	Ukraine	47.3	Greece	29
Peru	44	Uzbekistan	8	Ireland	16.2
Venezuela	30	Bulgaria	32.7	Italy	27.3
India	22.4	Croatia	28.5	Japan	11.1
Israel	29	Czech Republic	14.5	Netherlands	13.5
Malaysia	39	Hungary	28.4	New Zealand	11.9
Philippines	50	Poland	13.9	Norway	19.6
Hong Kong	13	Romania	18.3	Portugal	23.1
South Korea	38	Slovakia	10.2	Spain	23.1
Taiwan	16.5			Sweden	19.9
Thailand	71			Switzerland	8.1
				USA	8.9

(Unit: The percent of unobserved income to observed income)

Table 1.1 Size of unobserved economies in different countries
(Source: Friedrich Schneider, 2003)

Schneider had done the most comprehensive research on unobserved economies, but his study did not cover China. Since the social opening-up and reform of the economy system, which started in 1978, the economy has been growing rapidly and tax revenue has increased speedily in order to fulfill the requirements of the government's budget in China. Meanwhile, however, tax loss has become increasingly serious and harder to be controlled. In March of 2005, the head of the Chinese State Administration of Taxation disclosed that the amount of evaded taxation that had been detected and repaid was 35 billion RMB in 2004. This amount, however, is just the tip of the iceberg. Until today, tax loss in China has been a puzzle to economists, and very little information that describes how serious the situation is has been released. The main difficulty for our research is that due to political issues there is limited data about tax loss found in official Chinese publications, which has prevented substantial research on tax loss. This thesis presents a creative study in which we will not only develop, for academic purposes, new methodologies to disclose the seriousness of tax loss but also contribute a more effective countermeasure to control tax loss in China.

Our research is divided into three steps:

First, as a macro analysis, the overall situation of tax loss in the whole country is estimated. Specifically, two new approaches - income-expenditure and fuzzy logic - are redeveloped to evaluate the amount of tax loss in China. The income-expenditure method has been well used in the literatures with some limitations, while the fuzzy logic method is relatively new. Using these approaches with entirely different algorithms and data, our research can be crosschecked to verify its creditability and reliability. The analysis results show that the percent of tax loss to tax revenue is

mutative among 6.7% to 32.4% in China during the years 1987 to 2003. The situation has improved in the last few years, but it is still at a very serious level. It is gratifying to find that these two approaches came to very similar results, which do not only certify the accuracy of our analysis results but also demonstrate the feasibility of these approaches in China.

Second, in order to illustrate the real situation of tax loss by looking at concrete evidence, a clinical study was implemented in one typical city in China where taxpayers are investigated through tax audits. Based on the data from 200 taxpayers, who were sampled randomly from the audit results, the probability of tax evasion was analyzed using the binary logistic regression method. Furthermore, our linear regression analysis also indicates the relationship between tax loss and its possible causes, such as taxpayers' ownership, business category, payment method, and tax burden. This should be the first actual case study carried out for academic purposes in China.

Third, to give practical relevancy to our study we develop an effective countermeasure to prevent tax loss by using fake invoices in China. The new concept of the anti-counterfeit VAT invoicing system, which uses innovative information technology, is described in detail.

The thesis consists of four chapters. Chapter 1 introduces the background information, methodology, and primary achievements of our research. Chapter 2 starts with a literature review, and then demonstrates our new analytical approaches and the methodology for estimating the overall situation of tax loss throughout the

country. Chapter 3 is a clinical study: the tax loss possibility and tax evaders' behavior were analyzed using statistical tools and audit data in Xiaogan, a typical city in central China. Following the actual case study, in Chapter 4 we offer a new countermeasure against tax evasion, and describe a new system configuration to prohibit the forging of VAT invoices.

CHAPTER 2. EVALUATING TAX LOSS IN CHINA

In order to disclose the seriousness of tax loss in China, two analysis approaches - income-expenditure and fuzzy logic - are specifically developed in this chapter. They are successfully adopted to evaluate the overall situation of tax loss based on the available data in China. The credibility of our analysis is verified with unique methodology at the end of the chapter.

2.1 Literature Review

Measuring tax loss is a great challenge, both academically and practically, because of insufficient information and a lack of recognized benchmarks. The direct way to evaluate tax loss would be to conduct a tax audit on every taxpayer; however, it is obviously not efficient to adopt this method nationally due to the very large number of taxpayers. To get around this problem it is first necessary to identify some countable indicators that can represent the situation of tax loss indirectly in a given country. As a natural feature, tax loss is the inevitable outcome of “unobserved” economic activity, also known as underground economic activity, which is unsupervised by government authorities or regulators. Measuring the unobserved economy is an effective way of estimating the size of tax loss. In practice, the unobserved economy is not only related to normal economic activities but also to crimes such as drug smuggling, gambling, and prostitution. Therefore, the unobserved economy has to be treated carefully because the unobserved incomes are

not all taxable. Measuring the unobserved economy has become a particularly hot topic over the last 40 years. Various methods for estimating the size of the unobserved economy have been widely adopted in many countries. In the following sub-sections, the most representative approaches to measure tax loss are briefly described and their feasibility in China is discussed separately.

2.1.1 The Cash-Saving Approach

This is the most primitive method, which is derived from a basic assumption: when taxpayers want to avoid paying taxes, they will try to eliminate any evidence that can be traced by the taxation authorities. The most popular way of doing this is to hide transaction records by paying in cash. Therefore, if other conditions are invariable, a rise in the cash ratio could signify an increase in unobserved economic activity. Based on this hypothesis, Cagan (1975) developed the cash-saving approach.

Consider the following equations:

(2.1.1) $C = C_u + C_o$

(2.1.2) $D = D_u + D_o$

(2.1.3) $K_o = C_o/D_o$

(2.1.4) $K_u = C_u/D_u$

(2.1.5) $V_o = Y_o/(C_o + D_o)$

(2.1.6) $V_u = Y_u/(C_u + D_u)$

Combining (2.1.5) with (2.1.6), we have

(2.1.7) $Y_u = Y_o V_u (C_u+D_u)/[V_o(C_o+D_o)]$

$$= Y_o V_u (K_u+1)(C-K_oD)/[V_o(K_o+1)(K_uD-C)]$$

Where:

C = total amount of cash

C_o = total amount of cash used for observed transactions

C_u = total amount of cash used for unobserved transactions

D = total amount of current savings deposits

D_o = total amount of current savings deposits used for observed transactions

D_u = total amount of current savings deposits used for unobserved transactions

Y_o = observed yield

Y_u = unobserved yield

K_o = the rate of cash to current savings deposits in observed economy areas

K_u = the rate of cash to current savings deposits in unobserved economy areas

V_o = the turnover rate of yield in observed economy areas

V_u = the turnover rate of yield in unobserved economy areas

For the sake of simplicity, the following assumptions are made:

1) Cash is the only way to pay for transactions in unobserved economic activities.

That means:

(2.1.8) $D_u \to 0$

(2.1.9) $K_u \to \infty$

2) The yield per dollar in unobserved economy activities is equal to the yield per dollar in observed economic activities.

That means:

(2.1.10) $V_u = V_o$

3) If the business environment is invariable, the cash requirement for relevant economic activities will be fixed; therefore, the ratio of total cash to savings in the bank could be constant. So we can assume,

(2.1.11) K_o = constant

Based on these assumptions, the total amount of unobserved yield can be simplified as below:

(2.1.12) $Y_u = Y_o (C-K_oD)/[(K_o+1)D]$

Gutmann (1977) used this model to estimate the size of domestic unobserved income in the U.S. Using a 1940 cash rate to deposit as K_o, his results were very close to those reported by U.S. tax authorities, which had been estimated using their own methodology.

While the cash-saving approach is a simple approach for estimating unobserved economic activities, there are some fundamental problems with this approach.

First, as a basic assumption, the cash-saving approach assumes that yield per dollar in the observed economy is the same as in the unobserved economy; however, there is no evidence to prove the reasonableness or reliability of this assumption.

Second, based on (2.1.12), the ratio of currency to savings deposits, K_o, is a critical parameter that can significantly affect the analysis result of the unobserved yield. If K_o cannot be conclusively determined, this method will be useless. Nevertheless, according to (2.1.3) we have:

(2.1.13) $K_o = C_o/D_o = (C-C_u)/D$

This means K_o is also a variable relative to the total amount of cash used for unobserved transactions. Based on the third assumption of this approach, if there are no unobserved economy activities the rate of cash to savings deposits should be the smallest constant; otherwise, formula (2.1.12) cannot be used to calculate the unobserved economy. Cagan, the developer of this approach, conducted evaluations using the ratio of currency to savings deposits in the early 1950s, when tax loss was regularly overlooked. Obviously, there were few (if any) unobserved economic activities in China before the economic system reformation in the 1980's. Using the 1978 cash rate to current deposit as K_o for all of the observed economy should be a reasonable choice. In order to check the feasibility of this approach in China, we collected relevant data shown in the following table:

Year	GDP	Cash	Current Deposit	Rate of Cash to Deposit	Increase Rate of Cash	Increase Rate of Current Deposit
1978	3624.10	1352.60	81.70	16.5557		
1985	8964.40	5694.80	397.40	14.3301		
1986	10202.20	6843.90	508.40	13.4616	20.18%	27.93%
1987	11962.50	9015.70	717.00	12.5742	31.73%	41.03%
1988	14928.30	13490.00	964.80	13.9822	49.63%	34.56%
1989	16909.20	15267.60	964.80	15.8246	13.18%	0.00%
1990	18547.90	17471.40	1182.90	14.7700	14.43%	22.61%
1991	21617.80	21998.50	1508.30	14.5850	25.91%	27.51%
1992	26638.10	32406.20	2257.20	14.3568	47.31%	49.65%
1993	34634.40	50412.50	3134.50	16.0831	55.56%	38.87%
1994	46759.40	72671.00	4680.20	15.5273	44.15%	49.31%
1995	58478.10	97322.30	5884.01	16.5401	33.92%	25.72%
1996	67884.60	121179.90	7647.64	15.8454	24.51%	29.97%
1997	74772.40	142988.30	10053.06	14.2234	18.00%	31.45%

(Unit: 100,000,000 RMB Source: China Statistical Yearbook, 1998

Table 2.1.1 Cash and deposit amounts in China

Based on (2.1.7), we have

(2.1.14) $Y_u = Y_o (C-K_oD)/[(K_o+1)D] = Y_o (K – K_o)/(K_o + 1)$

Where:

K = C/D: the rate of total cash to all current deposits.

Referring to the data in Table 2.1.1, we find that K_o, which is the ratio of cash to saving in 1978, is always greater than K within the years 1985 to 1997, which means the cash-saving approach cannot be adopted in China.

This is different from the developed countries, where the economic system is already well established and unobserved economic activity is the primary force that changes the rate of cash to deposit. However, in China the economic reformation has meant

that the way businesses are run has been changed frequently during the last twenty years. Instead of cash payments, more and more enterprises have disbursed their accounts using bank services, which in turn have caused a big increase in deposits and a reduction of the ratio of cash to deposits. The rate of cash to current deposits in China, then, cannot directly reflect the actual situation of the unobserved economy.

2.1.2 The Transaction Approach

Since Cagan developed the cash-saving approach, there have been many arguments about his assumptions and challenges to the unbelievable results of his analysis, which were widely seen as too high to be true. As a result, in 1979, E. L. Feige developed a new method, the transaction approach, to evaluate the level of the unobserved economy. This approach supposes that there is a constant correlation between the total amount of transactions and the total GNP in the country. With some assumptions, Feige described his idea quantitatively; i.e., that the total amount of money used for transactions should be equal to the total value of transactions. This means:

(2.1.15) $M*V = p*T$

Where:

M = total amount of cash issued

V = velocity of cash currency

p = average volume of transactions

T = the number of transactions

The unobserved GNP can be figured by subtracting the observed GNP from the total GNP:

(2.1.16) Unobserved GNP = Total GNP – Observed GNP
= k*M*V – Official GNP

Here:

k = the correlation constant between GNP and the total value of transactions.

Using this approach requires defining a base year in which there was no unobserved economy and the ratio of the total value of transactions to the total GNP was typical and would have been invariable over time. The transaction approach has some disadvantages, such as the selection of a base year and the assumption that the correlation is constant over time. Moreover, in order to make a reliable estimate of the unobserved economy, precise data concerning the total value of transactions must be obtainable; this is probably very difficult to do, especially for cash transactions.

In general, compared with the cash-saving approach, the transaction approach has some theoretical advantages because it makes fewer assumptions. However, it is almost impossible to use this approach for our research because there is no information about monetary velocity and the empirical requirements are so difficult to fulfill that it would be dubious in China.

2.1.3 The Cash Currency Demand Approach

The cash currency demand approach was developed by Cagan (1958), who evaluated the correlation coefficients between currency demand and tax pressure (as the major

cause of tax loss) in the United States from 1919 to 1955. Twenty years later, Tanzi (1980, 1983) developed this approach further; he assumed that tax evaders always intend to pay for transactions with cash to avoid drawing the attention of the tax authorities. The excess demand for cash currency will then be synchronized with the activity in the unobserved economy. In order to identify this extra cash requirement for the unobserved economy, a time series equation for cash demand was designed, based on econometrics. Many potential causes for tax loss, such as income, expenditure, direct and indirect tax burden, and interest on savings, are comprised in the equation. The regression equation for the currency demand proposed by Tanzi (1983) is as follows:

(2.1.17) $$\ln (C / M_2)_t = b_O + b_1 \ln (1 + TW)_t + b_2 \ln (WS / Y)_t + b_3 \ln R_t + b_4 \ln (Y / N)_t + u_t$$

with $b_1 > 0$, $b_2 > 0$, $b_3 < 0$, $b_4 > 0$

where

ln = natural logarithms

C / M_2 = the ratio of cash holdings to current and deposit accounts

TW = a weighted average tax rate (to proxy changes in the size of the unobserved economy)

WS/Y = a proportion of wages and salaries in national income (to capture changing payments and money-holding patterns)

R = the interest paid on savings deposits (to capture the opportunity cost of holding cash) and Y/N is the per capita income

Y / N = the per capita income.

An excess rise in the cash currency can be ascribed to an increase in unobserved economy transactions. The amount and progress of the unobserved economy can be evaluated by comparing the differences in cash currency demands in the lowest tax loss periods over time.

The cash currency demand approach is one of the most popular methods for estimating tax loss worldwide. This approach has been deployed in many OECD countries, but there are also some doubts about it for various reasons. The biggest question concerning this approach is that not all transactions in the unobserved economy are paid in cash. Another objection is that the cash currency demand approach considers only one cause, the tax burden, as the key factor in the unobserved economy. Other factors, such as the effect of tax collection, taxpayers' morality, tax regulation, and so on, are not included, because these reliable data are not available in most countries. If such factors also have an impact on the unobserved economy (which seems likely), the amount of unobserved activity might be higher than previously estimated. Frey and Pommerehne (1984) and Thomas (1986, 1992, 1999) censured that estimating the parameters in Tanzi's equation is not very stable.

In China, the bank information infrastructure is presently not set up very well, so the tax authorities cannot use it to effectively track unobserved economic activities. Most tax evaders do not care whether they make payments using checks or cash, which

was also proven with our investigation in Xiaogan. Because of this fundamental difference, the cash currency demand approach is also not feasible in China.

2.1.4 The Labor Force Approach

It is a fundamental assumption that the labor force supply is constant. Therefore, a decrease in the labor participation in the observed economy could be seen as an indicator of an increase in unobserved economic activity. F. Schneider（2000) used this method to estimate the size of the unobserved economy in India; however, differences in the rate of participation may also have other causes, and people can work in the informal economy and still have a job in the formal economy. Estimates gained via this method are therefore seen as weak indicators of the unobserved economy.

China’s economy has been reformed since 1987. More and more farmers are continuously moving to urban areas to look for jobs, and a precise measurement of the actual labor force is therefore impossible. This means that the labor force approach is not applicable to China.

2.1.5 The Energy Consumption Approach

In order to measure the overall situation of the unobserved economy, Kaufmann and Kaliberda (1996) selected the consumption of electricity as the simplest indicator. Throughout the world, economic development and energy consumption have been

practically recognized as being in lockstep. This means that an increase in energy consumption can represent the expansion of total (observed and unobserved) economic activities; the difference in the growth ratio between the observed GDP and energy consumption will indicate development of the unobserved economy.

Lackó (1996, 1998, 1999) supposes that the unobserved economy, which is the indicator refracting the size of tax loss, is associated directly with the electricity consumption in a country. Lackó's electricity consumption approach (1998) can be described through the following two equations:

(2.1.18) $\ln E_i = a_1 \ln C_i + a_2 \ln PR_i + a_3 G_i + a_4 Q_i + a_5 H_i + u_i$ (1)

with $a_1 > 0$, $a_2 < 0$, $a_3 > 0$, $a_4 < 0$, $a_5 > 0$

(2.1.19) $H_i = b_1 T_i + b_2 (S_i - T_i) + b_3 D_i$ (2)

with $b_1 > 0$, $b_2 < 0$, $b_3 > 0$

where

I = the number assigned to the country

E_i = per capita household electricity consumption in country i

C_i = per capita real consumption of households without the consumption of electricity in country i in U.S. dollars (at purchasing power parity)

PR_i = the real price of consumption of 1 kWh of residential electricity in U.S. dollars (at purchasing power parity)

G_i = the relative frequency of months during which houses need to be heated in country i

Q_i = the ratio of energy sources other than electricity energy to all energy sources in household energy consumption

H_i = the per capita output of the hidden economy

T_i = the ratio of the sum of paid personal income, corporate profit, and taxes on goods and services to GDP

S_i = the ratio of public social welfare expenditures to GDP

D_i = the sum of number of dependents over 14 years and of inactive earners, both per 100 active earners.

Combining these two equations with a large amount of data collected from various countries and choosing the U.S. as the benchmark, Lackó calculated the size of the unobserved economy in some countries.

This approach is very straightforward and attractive, but also has some obvious weaknesses. The fundamental problem with this approach is that not all increases in economic activity will consume the relevant amount of energy (e.g., personal services). If this is the case, using this approach can only catch some of the activities in the unobserved economy. As technology progresses, both the production and utilization of energy will be more and more efficient in both observed and unobserved economic activities. Over time, therefore, the differences or changes in the elasticity of energy utilization and GDP have to be considered when using the energy consumption approach.

In China, energy consumption is not increased at the same rate as the economy, because the GDP is mostly generated by economic activities that are labor intensive. While some data show an opposite trend between GDP growth and power consumption in recent years, the energy consumption approach is obviously not suitable for China at this stage.

2.1.6 The DYMIMIC Approach

The DYMIMIC (dynamic multiple-indicators multiple-causes) approach estimates tax loss over time, considering multiple causes and multiple indicators. The approach consists of two basic models: the correlation equations model, which associates unknown variables with observed indicators, and the structural equations model, which defines causal factors allied with the unknown variables. In our research, there is only one unknown variable: the magnitude of tax loss, which can be represented by a set of indicators over time. The structural relevancy of tax loss with all causal factors can be observed, which may be useful for forecasting the future development of tax loss. At time t, the interactions among causes C_{it} (i = 1, 2, ..., k), the volume of the tax loss X_t, and the indicators Y_{jt} (j = 1, 2, ..., p) can be described as below,

(2.1.20) $$[X] = [A][C_i] + r \qquad (i = 1, 2, ..., k)$$

$$[Y_j] = [B][X] + g \qquad (j = 1, 2, ..., p)$$

There are some potential causal factors for tax loss:

1. The total tax burden.

   Exceeding the tax burden provokes taxpayers to evade taxes.

2. The impacts of regulation.

   Obviously, enhancing supervision can strongly discourage taxpayers from involvement in the unobserved economy.

3. “Tax ethics,” which describes the willingness of taxpayers to comply with taxation.

Waning tax ethics lead to a boost in the size of tax loss.

The movement of the tax loss may be reflected by the following indicators:

1. Change in cash demand: if activities in the unobserved economy increase, cash dealings increase.
2. Change in tax revenue: an increase in government revenue reflects a decrease in tax losses, if the taxation burden is invariable.

Change in savings amount: surplus savings exceeding an increase in GDP results in an increase in unobserved income from the unobserved economy.

Recent applications of the DYMIMIC approach have been undertaken by Giles, Linsey, and Gupsa (1999), who developed a comprehensive MIMIC model in order to create a time-sensitive index of the unobserved economy in New Zealand and Canada. Their study was different from former experiential studies on unobserved economies in that Giles, Linsey, and Gupsa made more of an effort to integrate the time-sensitive data in both models of the MIMIC method. They then combined the currency demand with the MIMIC approach, using different velocities of cash currency to determine the level of the unobserved economy.

Based on the above description, the DYMIMIC approach has to work with many indicators and their historical data. The availability of these data related to tax loss, such as the monetary velocity, the strength of tax regulations, and the benchmark of tax compliance, will be the greatest factor obstructing the use of this approach in China.

The results of literatures review are summarized in the next table.

Approaches (Main developer)	Basic assumptions and algorithms	Strongpoint	Weakness	Adaptability in China
Transactions & yield (Feige, 1986,1994)	Total(observed and un-observed) GNP = total amount of transactions M*V = P*T	Concept is clear and approach doesn't need to couple with many assumptions.	It is difficult to find out the normal ratio of transaction constant over time.	Can't find the velocity of money.
Cash currency demand (Cagan. 1958; Tanzi. 1983)	Hidden transactions are mostly undertaken with cash. The excess demand for cash currency will then be synchronized with the activity in the unobserved economy	Analysis result is more close to real situation, because it can describe tax loss couple with multiple causes. The most common mouthed used in OECD countries.	Not all hidden transactions have to be paid in cash in most developing countries.	The payment method is not key issuer for tax loss, because of the faulty bank information system in China.
DYMIMC (Dynamic Multiple-Indicates and Multiple Causes) (Zillen, 1970; Giles, 1999; Linsey & Gupsa, 1999)	The size of hidden economy [X] is affected by a set of causes [C], which also be described by indicators [Y]: [X] = [A][C] + [r] [Y] = [B][X] + [g]	It can incorporate several causes and indictors that influence tax loss, and to determine their relative significance simultaneously. The method can present the situation of tax loss factually.	The complex combination of variables in two correlated regression models. The collection of time series data for this model is the most challengeable process.	There is not enough available data to apply this method in China, because the taxation system had been changed several times for last ten years.
Labor force (F. Schneider 2000)	Estimate of the discrepancy between the official and actual labor force.	Single indicator that can indirectly refract the size of economy activity.	There are many factors caused change of the demand of labor force, such as technology development.	There are too many labors that are employed informally in China.
Energy consumption (Kaufmann. 1996)	Estimate of the discrepancy between the GDP increase ratio and increase ratio of energies consumption.	Single indicator that can indirectly refract the size of economy activity.	Week indicator, the discrepancy can be caused by efficiency improvement of energy utility.	A lot of economy activities dose not require a considerable amount of energy in China.

Table 2.1.2 The summery of existed analysis methods to evaluate tax loss

2.2 Development of Analysis Approaches and Research Methodology

According to the above literature review, we unfortunately find that most approaches for measuring tax loss are not feasible in China because of differences in the economic environment and insufficient available data resources. To estimate tax loss in China we have to redevelop two new approaches - the income-expenditure method and the Fuzzy logic method - that have been described in the literature. However, they both come with some limitation or bug. Using these independent approaches with completely different algorithms and data resources, the analysis results can be crosschecked to verify the credibility and reliability of our estimations.

2.2.1 New Development of the Income-Expenditure Approach

Dilnot Morris developed this method in 1981; it is a macro-analytical approach, also known as a signal indicator approach. The income-expenditure approach assumes that GNP income should be equal to GNP expenditures in national accounting. If an independent estimate of the expenditures of the national accounts is available, the discrepancies between expenditures and income can be used as an indicator of the unobserved economy. Dilnot's income-expenditure approach can be summarized as below:

(2.2.1) Total income = observed income + unobserved income

= Total expenditure

However, consumers' behavior has always been affected by their expectations of future income. Therefore, it will be very difficult to identify the exact expenditures that correspond to a particular income without a binding period. When we consider the time period issue, the income-expenditure approach can be improved as below:

Total annual income = observed annual income + unobserved annual income
= total annual expenditures
= total annual consumption + net increased amount of savings at year-end + net increased amount of cash at year end

where:

(2.2.2) Total unobserved annual income = Total annual consumption + net increased amount of savings at year end + net increased amount of cash on hand at year end - observed annual income

In China, all necessary data relative to this approach can be extracted from national statistical yearbooks and social survey reports. Once the size of unobserved income is evaluated, the relevant amount of tax loss can be estimated by using a regress model for tax revenue and observed income, because most tax ratios are proportional in China.

If all expenditure components were measured without error, this approach would come up with a good estimate of the size of the unobserved income. Unfortunately, since national accounts statisticians tend to minimize such discrepancies (which might be modified for this purpose) rather than publish them, the discrepancies may reflect oversights caused by the national account statistics, which will also affect the accuracy of the approach. Therefore, the estimation results may be crude, and their

reliability might be questionable. For the reasons mentioned above, we have to develop another independent approach, the fuzzy logic method, to create an independent benchmark for crosschecking purposes.

2.2.2 New Developments to the Fuzzy Logic Approach

Different from the income-expenditure approach, the fuzzy logic approach can quantitatively grade tax loss by combining multiple indicators, even with non-statistical factors (such as government policy and degree of regulation). The fuzzy theory has been applied to many disciplines since the fundamental contributions of Zadeh (1965, 1987) and his followers. Its applications are particularly extensive in computer science, systems analysis, electrical and electronic engineering, and related fields. Although fuzzy theory is not widely applied to economics, Robert Draeseke and David E.A. Giles (2001) are two pioneers who tried to illustrate the size of the unobserved economy in New Zealand using the fuzzy set theory and fuzzy logic. The most recent application of this approach was done by Tiffany Yu, David Wang, and Sujane Chen (2006), where they modeled the underground economy in Taiwan by using exactly the same model and indicators that Draeseke and Giles had used.

Although these researchers came up with an innovative and enlightening idea in the development of a consummate fuzzy logic approach to estimating tax loss, they still made obvious mistakes in their studies. Thus, we have to redevelop the fuzzy logic approach based on the basic theory of fuzzy logic.

Indicator, indicator vector, and its fuzzy matrix:

To use the fuzzy logic approach, it is first necessary to identify some countable indicators, **V**, which can represent the circumstances of tax loss. Referring to the study in New Zealand and Taiwan, the researchers chose tax revenue and the government budget as the indictors to identify the seriousness of the tax loss. Nevertheless, in China, the government budget is supported not only by tax revenues, but also by government administration fees, which can be over 50% of the total revenue in some years. For our study, the ratio of tax revenue to GDP, and the ratio of the increased amount of total surplus income (including savings and the new currency issued during the year) to GDP have been selected as the indicators to evaluate the size of tax loss in China. The first indicator can represent the degree of tax compliance: a higher ratio of tax revenue normally means a lower tax loss, if the tax ratio is unaltered. The second indicator may indirectly reflect the level of unobserved income, because if there is no hidden income caused by tax evasion, the change in amount of surplus income should be synchronized with the GDP. However, savings will also be affected by expectations for future income and inflation, while surplus income might be a weak indicator. These issues can be adjusted by the weight factor in the relationship matrix that will be discussed later.

Considering a period of n years, we use n=17, which represents the years from 1987 to 2003. In our case, the time series data of the indicator V can be formed as a vector **[V]**, called an indicator vector:

(2.2.1) $\mathbf{[V]} = [v_1\ v_2 \ldots\ldots v_n]$

v_i represents the value of the indicator at year i (i = 1,2,…n).

To portray the indicator using fuzzy logic, we defined and gathered **L,** called a fuzzy set, which divides the degree of the indicator at five different fuzzy levels in our research: “Very high”, “High”, “Normal”, “Low”, and “Very low”. The fuzzy level of the indicator at every year can be quantitatively described with different values corresponding to every fuzzy level, called the values of a fuzzy set or fuzzy values. According to the definition of a fuzzy set, the fuzzy level of the indicators in every particular year should be ascertained by comparing all values within the whole period, which can be determined by various methods that are subject to the target pattern of the indictor.

Former researchers defined their fuzzy set based only on the mean of six years ahead, which caused the analysis results in individual years to be non-comparable with each other within the entire time series. Tax loss cannot be prevented completely, but is at least partially controllable through social behavior, bringing it close to the normal distribution pattern. Corresponding to indicator **[V]**, we can determine the value of **L** as below:

(2.2.2) $\mathbf{L} = (l_1, l_2, l_3, l_4, l_5)$

Where:

l_1 (represents very high level) = M +2*D

l_2 (represents high level) = M+D

l_3 (represents normal level) = M

l_4 (represents low level) = M-D

l_5 (represents very low level) = M-2*D

$M = (\sum_{i=1}^{n} V_i)/n$

$D = \{[\sum_{i=1}^{n} (M - V_i)^2]/n\}^{1/2}$

Comparing indicator **V** with fuzzy set **L**, we can create a fuzzy value matrix **[I]** to represent the n years time series of the fuzzy value for indicator vector **[V]**.

(2.2.3)

$$[\,I\,] = \begin{vmatrix} i_{11} & i_{12} & i_{13} & i_{14} & i_{15} \\ i_{21} & i_{22} & i_{23} & i_{24} & i_{25} \\ \cdot & \cdot & \cdot & \cdot & \cdot \\ i_{n1} & i_{n2} & i_{n3} & i_{n4} & i_{n5} \end{vmatrix}$$

here:

If $l_j > \text{value of } V_i > l_{j+1}$ (i = 1,2,…,n; j = 1,2,3,4,5)

Then $i_{i,j} = (l_j - V_i)/ D$

$i_{i,j+1} = (V_i - l_{j+1})/ D$

else

$i_{i,j} = 0.$

In the same way, the fuzzy value of tax loss within a period of n years can also be described with a (n x 5) matrix, called a fuzzy matrix of tax loss.

Relationship matrix and fuzzy logic operation

According to fuzzy logic theory, a relationship matrix has to be developed in order to determine the particular levels of association for every pair of the fuzzy value in the fuzzy matrix of indicators. They can then be combined to form the fuzzy level of tax loss in individual years. The following table shows us a relationship matrix especially for tax revenue and surplus income:

		Tax Revenue				
		Very low	**Low**	**Normal**	**High**	**Very high**
		Very high	Very high	High	High	Normal
	Very High	1	0.5	1	0.5	1
		Very high	High	High	Normal	Low
Surplus Income	**High**	0.5	1	0.5	1	0.5
		High	High	Normal	Low	Low
	Normal	1	0.5	1	0.5	1
		High	Normal	Low	Low	Very low
	Low	0.5	1	0.5	1	0.5
		Normal	Low	Low	Very low	Very Low
	Very Low	1	0.5	1	0.5	1

Table 2.2.1 The relationship matrix between tax revenue and surplus income

There are two parameters in every cell of the relationship matrix. The top represents the fuzzy level of tax loss caused by the combination of those two indicators, and the lower is the weight factor. For example, very high-level tax compliance combined with a very low-level surplus income will posit a very low tax loss. Because that is an extreme situation, the relevant weight factor is 1. If the tax revenue goes up to a high level, but the surplus income remains very low, the tax loss will still be very small but its weight factor has to be reduced to 0.5, which means that the fuzzy level of tax loss could be somewhere between “very small” and “small”.

The determination of parameters in the relationship matrix relies totally on the correlation between every pair of indicators, so selecting the indicator and creating a homological relationship matrix are the biggest challenges when applying the fuzzy logic approach. The former researchers defined some contradictory parameters for relationship matrix, which are the fundamental criteria needed to identify the combination results of fuzzy sets. For example, according to Draeseke and Giles, the "very high" level of tax loss associated with the "very high" level of government regulation and the "very high" level tax rate; the "low" level of tax loss is associated with the "very high" level of government regulation and the "low" level tax rate. Therefore, the fuzzy level of tax loss associated with the "very high" level of government regulation and the "very low" level tax rate logically should be "very low", but their result was "normal". This mistake made their analysis results suspect.

Using the fuzzy logic operation, we can quantify the magnitude of fuzzy levels of tax loss in every particular year:

(2.2.3) Fuzzy value of tax loss for every pair of indicators at every fuzzy level

= [MIN(Indicator 1 × weight factor, Indicator 2 × weight factor)]

The associated fuzzy value will be used to unify the multiple values of each level:

(2.2.4) Associated fuzzy value of tax loss at every fuzzy level

= [MAX (all fuzzy value of tax loss at same fuzzy level)]

In order to compare the fuzzy analysis results with other approaches, the associated fuzzy tax loss value, which represents the seriousness of the tax loss at the fuzzy

level, can be quantified by attaching the values 0.0, 0.25, 0.5, 0.75, and 1.0 to the "Very low," "Low," " Normal," " High," and "Very High" levels of the associated fuzzy value. Therefore, we have:

(2.2.5) The fuzzy value of tax loss in a particular year

= (small level value × 0.25 + normal level value × 0.5 + high-level value × 0.75 + very high-level value) / (total value for all fuzzy levels)

One (1) represents the highest-level tax loss in a whole period, while zero (0) means there has been no tax loss in that particular year.

There is a very important concept to be emphasized here: the fuzzy logic approach is only a useful tool for evaluating the movement (tendency) of tax loss, but not for calculating the exact amount of the tax loss. The former researchers attempted to convert their results into the actual monetary amount of tax loss and then compare them with results gained directly from another approach, which is completely meaningless.

2.2.3 Analysis Methodology

For our study, the income-expenditure approach will be applied to measure the total amount of tax loss in China. Due to a lack of recognized data concerning tax loss, and the fact that no benchmark has been available for academic purposes in China, we cannot rely on a single approach to measure the seriousness of the tax loss. To verify the credibility of our study, crosschecking the analysis results and using these

two different algorithms and independent data sources is our new idea. The process can be expressed as the following flowchart:

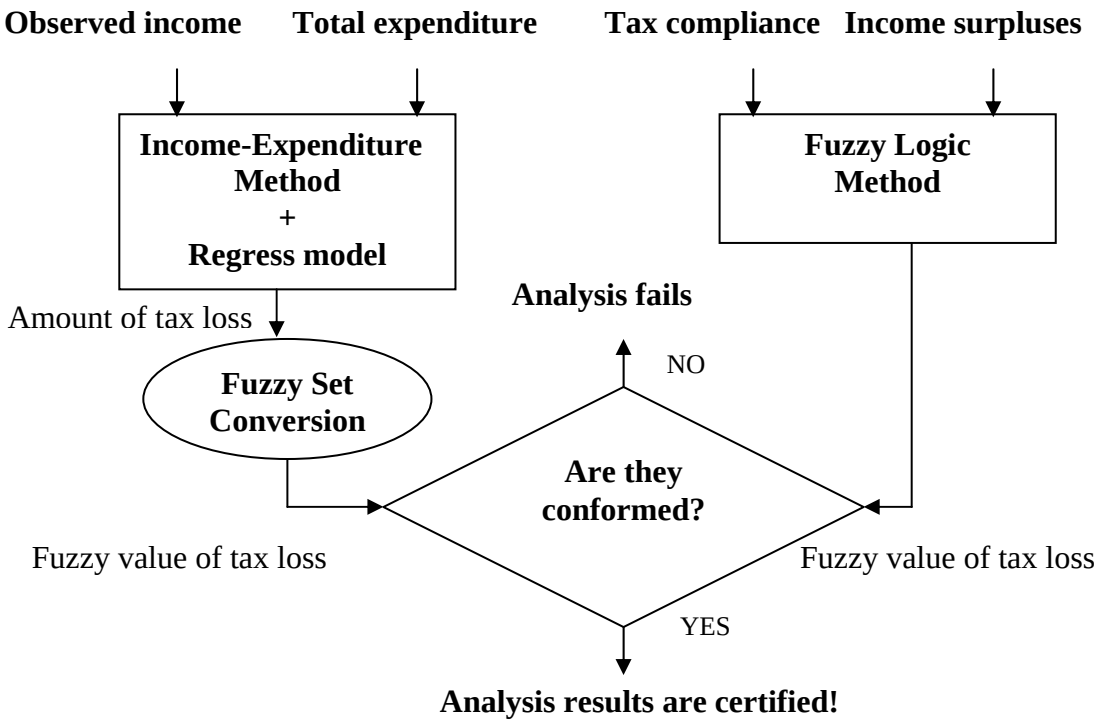

Figure 2.2.1 The flowchart of research methodology

This methodology may not only be useful for verifying the credibility of our research, but can also be used in the field of accounting as a universal process for cases in which there is insufficient relevant information for benchmarking.

2.3. Estimating Tax Loss in China

2.3.1 Data Analysis

In China, there are two independent professional statistics teams under the National Bureau of Statistics; one concentrates on statistics related to national productivity and revenue, based on the data provided by the Business Administration Bureau,

while the other works on market price and consumption expenses via social surveys. This ensures that all data resources are independent and representative. Referring to our new definition of the income-expenditure approach, all the necessary data used for this approach can be extracted from national statistical yearbooks and social survey reports. We can use those data to estimate the amount of unobserved income shown in following table:

Year	Declared Income	Declared Expenditure	Increased amount of savings	Increased amount of cash Issued	Total amount of expenditure	Unobserved Income	Tax revenue
1987	6544.06	5961.2	842.9	236.1	7040.2	496.1	2140
1988	7865.52	7633.1	740.8	679.5	9053.4	1187.9	2390
1989	9060.82	8523.5	1374.2	210	10107.7	1046.9	2727
1990	10334.44	9113.2	1923.4	300.4	11337.0	1002.6	2822
1991	11302.56	10315.9	2121.8	533.4	12971.1	1668.5	2990
1992	13184.27	12459.8	2517.8	1158.2	16135.8	2951.5	3297
1993	16415.31	15682.4	3444.1	1528.7	20655.2	4239.9	4255
1994	22407.82	20809.8	6315.3	1423.9	28549.0	6141.2	5127
1995	28624.88	26944.5	8143.5	596.8	35684.8	7059.9	6038
1996	34439.25	32152.3	8858.5	916.6	41927.4	7488.1	6910
1997	37950.70	34854.6	7758.96	1375.7	43989.3	6038.6	8234
1998	40550.43	36921.1	7615.4	1026.6	45563.1	5012.7	9263
1999	43743.03	39334.4	6253	2251.33	47838.7	4095.7	10683
2000	47044.78	42895.6	4976.7	1197.2	49069.5	2024.7	12582
2001	51797.77	45898.1	9457.6	1036.1	56391.8	4594.0	15301
2002	58046.64	48881.6	13233.2	1589.2	63704.0	5657.4	17636
2003	64525.86	52678.5	16631.9	2468	71778.4	7252.5	20017

(Unit: RMB 100,000,000)

Table 2.3.1 Unobserved income in China

To estimate the relative amount of tax loss, we need to build a regress model, as below:

(2.3.1) Tax revenue = F (income)

Where:

F = regress model of tax revenue

Various models could be used to present the correlation between tax revenue and observed income. By using the curve estimation regression tool and the data in Table 2.3.1, all possible regression models and their accuracy are evaluated, and the results are compared in following Table.

Independent variable: **Tax**							
Dependent Variable:	Regress model	R square	F	P - value	B_1	B_2	B_3
Tax revenue	Linear	0.98	848.52	0.000	0.2701		
	Logarithmic	0.713	42.16	0.000	782.648		
	Inverse	0.137	2.7	0.119	4.40E+7		
	Quadratic	0.991	922.63	0.000	0.1686	2.10E-6	
	Cubic	0.996	1209.31	0.000	0.2921	-4.00E-6	7.60E-11
	Compound	0.769	56.59	0.000	1.0002		
	S	0.564	22.01	0.000	83821.3		
	Growth	0.769	56.59	0.000	0.0002		
	Exponential	0.769	56.59	0.000	0.0002		

Table 2.3.2 The regress model of tax revenue in China

Referring to the analysis results shown in Table 2.3.2, the cubic model should be the one with the highest accuracy (99.6% goodness of fit and significant degree of redeem ($p< 0.001$), so we have our tax loss regress model, as below:

(3.2.2) Tax loss = b_1*(undeclared income) + b_2*(undeclared income)^2

+ b_3*(undeclared income)^3

Where:

b_1 = 0.2921

b_2 = -4E-06

b_3 = 7.6E-11

The amount of tax loss in China can be calculated using this model and the data in Table 2.3.1. The results are shown in following table:

Year	Declared income	Tax revenue	Undeclared income	Tax loss	Tax loss/tax revenue
1987	6544	2140	496	144	6.7%
1988	7866	2390	1188	341	14.3%
1989	9061	2727	1047	301	11.1%
1990	10334	2822	1003	289	10.2%
1991	11303	2990	1669	477	15.9%
1992	13184	3297	2952	829	25.2%
1993	16415	4255	4240	1172	27.6%
1994	22408	5127	6141	1661	32.4%
1995	28625	6038	7060	1890	31.3%
1996	34439	6910	7488	1995	28.9%
1997	37951	8234	6039	1635	19.9%
1998	40550	9263	5013	1373	14.8%
1999	43743	10683	4096	1134	10.6%
2000	47045	12582	2025	576	4.6%
2001	51798	15301	4594	1265	8.3%
2002	58047	17636	5657	1538	8.7%
2003	64526	20017	7253	1937	9.7%

(Unit: RMB 100,000,000)

Table 2.3.3 The amount of tax loss in China

Because there is no benchmark to verify the credibility of this analysis result directly, the fuzzy logic method, which uses a completely different algorithm and data resource from the income-expenditure method, has been chosen as an independent approach to crosscheck the analysis results. To conduct the fuzzy logic approach, two sets of independent data (tax compliance and surplus income) were selected as

the indicators to evaluate the tax loss in China. The ratio of tax revenue to GDP is a clear indicator that represents the tax compliance level when the tax ratio is constant. The ratio of surplus income (increased savings and cash) to GDP should be another indirect indicator that represents the hidden portion of the total personal income that exceeds the increase in GDP. The fuzzy value of those indicators is calculated, and the results are shown in the following tables:

Year	Surplus Income to GDP	Very High	High	Normal	Low	Very Low
1987	0.0902	0	0	0	0.947886	0.052114
1988	0.0951	0	0	0.108129	0.891871	0
1989	0.0937	0	0	0.061031	0.938969	0
1990	0.1199	0	0	0.910607	0.089393	0
1991	0.1228	0	0	1	0	0
1992	0.1380	0	0.497478	0.502522	0	0
1993	0.1436	0	0.678438	0.321562	0	0
1994	0.1655	0.38942	0.610577	0	0	0
1995	0.1495	0	0.869157	0.130843	0	0
1996	0.1440	0	0.691926	0.308074	0	0
1997	0.1227	0	0.000714	0.999286	0	0
1998	0.1103	0	0	0.599767	0.400233	0
1999	0.1038	0	0	0.389611	0.610389	0
2000	0.0700	0	0	0	0.29165	0.70835
2001	0.1096	0	0	0.577508	0.422492	0
2002	0.1426	0	0.647057	0.352943	0	0
2003	0.1638	0.33403	0.665967	0	0	0
Fuzzy Value of Indicator		0.18434	0.153499	0.122652	0.091806	0.06096

Table 2.3.4 Fuzzy matrix of surplus income

Year	Tax Revenue to GDP	Very Low	Low	Normal	High	Very High
1987	0.1789	0	0	0	0.374373	0.625627
1988	0.1601	0	0	0.130798	0.869202	0
1989	0.1613	0	0	0.083835	0.916165	0
1990	0.1521	0	0	0.45245	0.54755	0
1991	0.1383	0	0.008697	0.991303	0	0
1992	0.1238	0	0.594483	0.405517	0	0
1993	0.1229	0	0.630843	0.369157	0	0
1994	0.1096	0.162952	0.837048	0	0	0
1995	0.1033	0.420193	0.579807	0	0	0
1996	0.1018	0.479173	0.520827	0	0	0
1997	0.1106	0.125289	0.874711	0	0	0
1998	0.1182	0	0.817321	0.182679	0	0
1999	0.1304	0	0.326795	0.673205	0	0
2000	0.1426	0	0	0.161987	0.838013	0
2001	0.1598	0	0	0.142376	0.857624	0
2002	0.1697	0	0	0	0.746124	0.253876
2003	0.1717	0	0	0	0.666284	0.333716
Fuzzy Value of Indicator		0.088848	0.113692	0.138536	0.16338	0.188223

Table 2.3.5 Fuzzy matrix of tax compliance

Using the fuzzy logic method described in a former section and the relationship matrix in Table 2.2.1, we get the fuzzy value of tax loss, shown in Table 2.3.6

Year	Very Big	Big	Average	Small	Very Small	Fuzzy Value of Tax Loss
1987	0	0	0	0.374373	0.312813	0.136198
1988	0	0	0.108129	0.869202	0	0.277659
1989	0	0	0.061031	0.916165	0	0.265614
1990	0	0	0.45245	0.273775	0	0.405754
1991	0	0.004349	0.991303	0	0	0.501092
1992	0	0.497478	0.405517	0	0	0.63773
1993	0	0.630843	0.321562	0	0	0.665592
1994	0.194711	0.610577	0	0	0	0.810448
1995	0.210097	0.579807	0	0	0	0.816494
1996	0.239587	0.520827	0	0	0	0.828769
1997	0.000357	0.437356	0	0	0	0.750204
1998	0	0.299883	0.400233	0.09134	0	0.565873
1999	0	0.163398	0.389611	0.305194	0	0.458694
2000	0	0	0	0.29165	0.354175	0.112898
2001	0	0	0.142376	0.422492	0	0.313013
2002	0	0	0.647057	0.253876	0	0.429552
2003	0	0.167017	0.665967	0.166858	0	0.50004

Table 2.3.6 Fuzzy value of tax loss, evaluated using fuzzy logic method

Based on our analysis methodology described in section 2.2.3, the results of the income-expenditure method have to be converted to the fuzzy value, and then we can put it into the same chart comparing it with the results of the fuzzy logic method. Table 2.3.7 shows the fuzzy value of tax loss based on the data on the Table 2.3.3.

	Very high	High	Normal	Low	Very high	Fuzzy value of tax loss
1987	0	0	0	0.892016	0.10798375	0.22300
1988	0	0	0.75502	0.244984		0.43875
1989	0	0	0.20646	0.793545		0.30161
1990	0	0	0.30207	0.697928		0.32551
1991	0	0	0.92179	0.078206		0.48044
1992	0	0.971589	0.02841	0		0.74289
1993	0.2400456	0.759954	0	0		0.81001
1994	0.7817583	0.218242	0	0		0.94543
1995	0.6591522	0.340848	0	0		0.91478
1996	0.3878203	0.61218	0	0		0.84695
1997	0	0.378427	0.62157	0		0.59460
1998	0	0	0.8156	0.184396		0.45390
1999	0	0	0.34481	0.655187	0	0.33620
2000	0	0	0	0.668187	0.33181315	0.16704
2001	0	0	0.08135	0.918645		0.27033
2002	0	0	0.13236	0.867637		0.28309
2003	0	0	0.23926	0.760743		0.30981

Table 2.3.7 Fuzzy value of tax loss, calculated using income-expenditure method

Discussions

The income-expenditure approach is a useful tool for estimating the amount of unobserved income and tax loss, which in turn can be used to evaluate the real tax loss situation in China. Based on formula (2.2.2), we have found that net cash incensement is one item that is classified as a part of income. Unfortunately, there is no clear way to identify how much cash was kept by residences at year-end. Referring to the different assumption of cash on hand at year-end, Figure 2.3.1 shows a set of curves that represent the different values of the ratio of unobserved income to observed income.

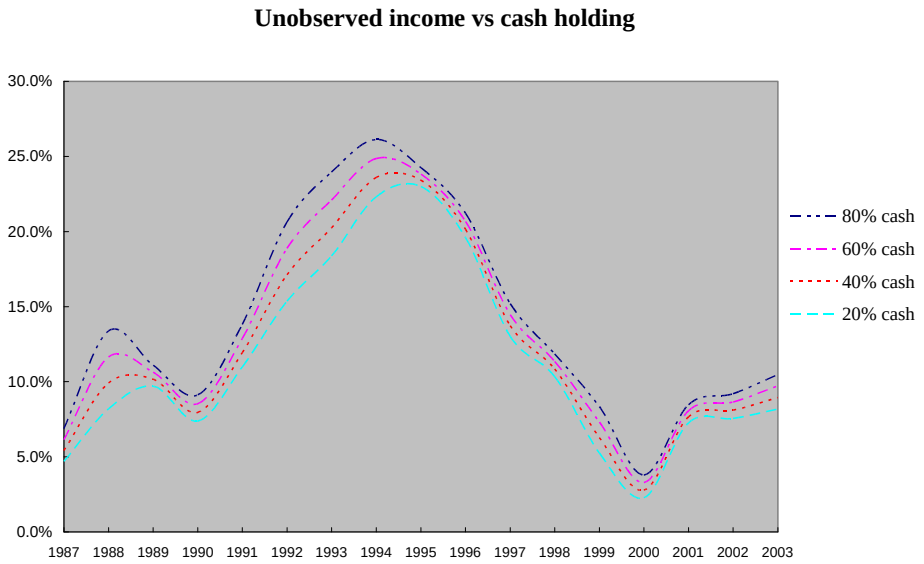

Figure 2.3.1 Unobserved income vs. percentage of cash on hand at year-end

Referring to the curves in Figure 2.3.1, we are sure that the amount of cash held does not significantly influence the total amount of unobserved income. According to a survey report made by the National Bureau of Statistics, which applied a social survey to the income and expenditures of households in urban areas of China, we see that the average amount of cash kept on hand was ¥258.7 at the beginning of 1996 and ¥395.49 at the end of 1996. The net increment of cash on hand was therefore almost 53.6% of the total cash issued in 1996. Extrapolating from the cash held by households in rural areas, we believe that the total cash held by all households should total more than 80% of all issued cash, because people in rural areas prefer to hold their cash rather than put it in the bank. Therefore, we assumed all new issued cash became a part of income at year-end. According to the data in Table 2.3.3, our estimation about tax loss in China is shown in Figure 2.3.2.

The ratio of tax loss to total tax revenue in China

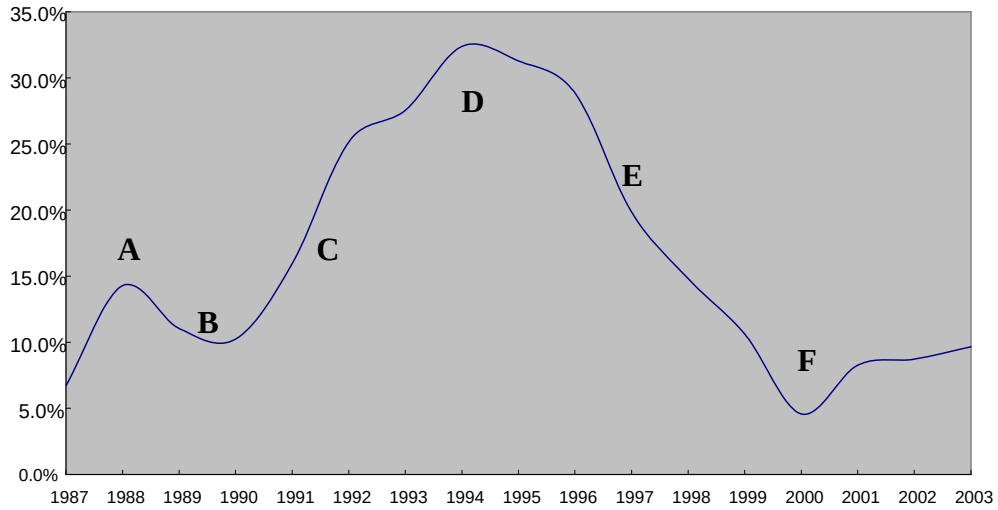

Figure 2.3.2 Tax loss in China

There are some critical points in this figure that can rationally describe the development of tax loss in China:

A. Corresponding to the social opening-up and economic reform in China, unobserved income grew rapidly, increasing 100% from year 1987 to 1988.

B. The events in Tiananmen Square caused the Chinese government to tighten control over all economic activity, and tax loss decreased over the subsequent two years.

C. In 1992, Mr. Deng Xiaoping performed inspections in southern China and pushed the government to speed up the economic reformation process. The economy began to grow again and tax loss also started to increase rapidly.

D. In 1994, the Chinese government began reforming the banking system in order to cool down over-heated economic activity. The underground economic activity was simultaneously curtailed.

E. The economy was continuously downsized because of the Asian financial crisis in 1997.

F. In order to eliminate deflation, the government spurred economic development by increasing direct investment and encouraging private economy at the end of the 1990s. Since then, the Chinese economy has experienced a boost, but once again so has tax loss.

Our analysis result show the movement of tax loss in China over the last 17 years, and accurately reflects the real situation of Chinese tax loss. Since there is no way to ascertain the exact amount of expenditure, our analysis may disclose only the downside of the total unobserved income in China. Combining the data in Table 2.3.6 and Table 2.3.7, we come up with the following chart:

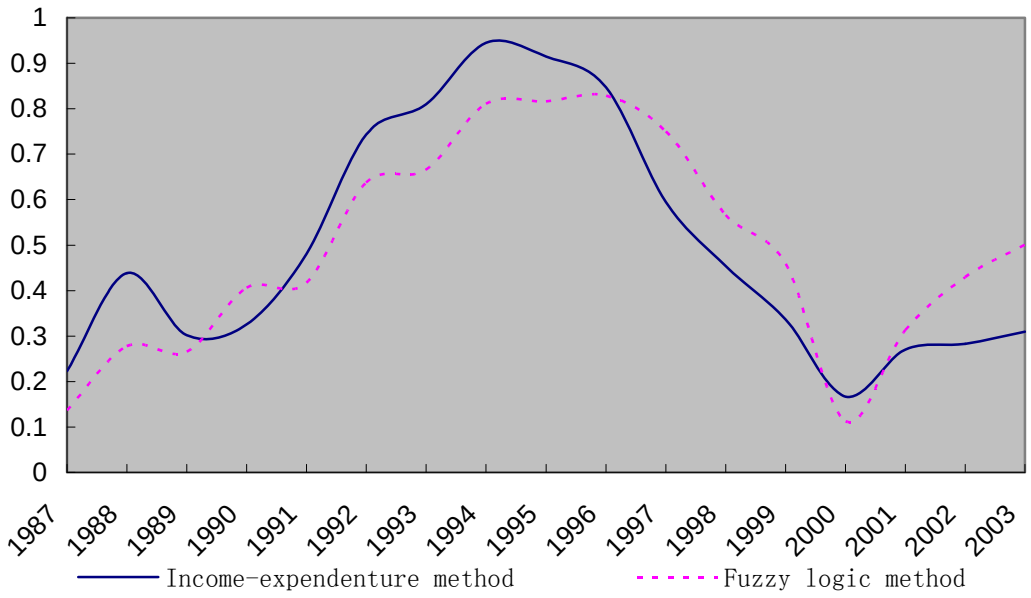

Figure 2.3.3 Analysis results comparison between two approaches

Figure 2.3.3 shows two similar curves of tax loss, even when they were evaluated with two independent approaches that make use of different algorithms and disparate data sources. Comparing the data in Tables 2.3.6 and 2.3.7, there are only small differences in the fuzzy value of the tax loss in most years. Almost every peak or low point of both curves in Figure 2.3.3 appears with the same fuzzy level and in the same year. Since the 21st century, more and more money, which is mostly collected through corruption and bribes, is being transferred abroad through underground channels that cannot be discovered through the income-expenditure method, but the fuzzy logic approach can still track their impacts to the tax loss.

Figure 2.3.3 not only demonstrates the creditability of our analysis results, but also proves the adaptability of these approaches in China. The income-expenditure approach could be an effective tool with which to measure the actual value of the tax loss in China, but this approach seems to be too secretive to account for any statistical errors. The fuzzy logic approach, conversely, is a brand-new approach in this field and can qualitatively evaluate the tendency of tax loss without many of the restrictions of data collection. For most economic policymakers, the latter method should be more useful, because it can be used to formulate guidelines with which to combat tax loss more effectively.

CHAPTER 3. A CLINICAL STUDY: INVESTIGATING TAX LOSS IN XIAOGAN

The overall situation of tax loss in China has been evaluated by using some indirect approaches in the last chapter. Without a doubt, a tax audit would be the most direct way to ascertain the real situation regarding tax loss; but there is almost no chance for academic researchers to get involved with these activities, which have to be performed by the tax authorities in China. Furthermore, the results of a tax audit are generally not disclosed to the public for political reasons. As a primary designer of the anti-counterfeit Value Added Tax invoicing system, we spent four years (1994 to 1998) studying taxpayers' behavior in various cities in China. With the assistance and consent of the local tax authority, we had a rare and precious opportunity to gather very useful data on tax loss of the city Xiaogan. In this chapter we will use such valuable data to pursue a clinical study with empirical tests to show the real situation of tax loss and taxpayers' behaviors in this particular city. The purpose of our research is not only to disclose the seriousness of tax loss, but also to ascertain the main causes of tax loss in Xiaogan, which may shed light on the general tax loss situation in China. As far as I know, this is the first real case study on tax loss done for academic purposes in China.

3.1 Introduction to Xiaogan[1]

Xiaogan is a city situated in the northeast Hubei Province. To the east is “the thoroughfare of nine provinces”—Wuhan City, and the south gate of Henan Province—Xinyang City to the north, and to the west, the ancient cities of Xiangfan and Jinzhou, and the motor-city—Shiyan.

As a newly founded, developing, medium-sized city, Xiaogan now governs four county-level cities (Hanchuan, Yingcheng, Anlu, and Guangshui), three counties (Yunmeng, Dawu, and Xiaochang), and the Xiaonan District. Xiaogan covers an area of 11,600 square kilometers, and has a total population of 5.80 million. Of these, urban dwellers total 0.3 million.

Xiaogan has the perfect foundation for economic development. The city has the potential to build a “high-quality, large quantity, and high efficiency” production base of farm products, mass production of automobiles, optics, electronics, new-type building materials, and salt and phosphate chemicals. Xiaogan also boasts achievements in science, technology, and education; cultural and sports facilities; sound medical and health care organizations; and varied dining and entertainment options. The city’s market and social welfare systems have been created to support a market-oriented economy.

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[1] Some information in this section is based on information from the city government website: http://www.hb-chengda.com/xiaogan.html.

With good investment opportunities and a favorable geographic location, Xiaogan has attracted 260 foreign-invested enterprises through Sino-foreign joint ventures, cooperation, and foreign ventures, which has accelerated economic development in the city. In 1996, the city's GDP was 26.25 billion RMB, and the city's total government revenue was 1.378 billion RMB.

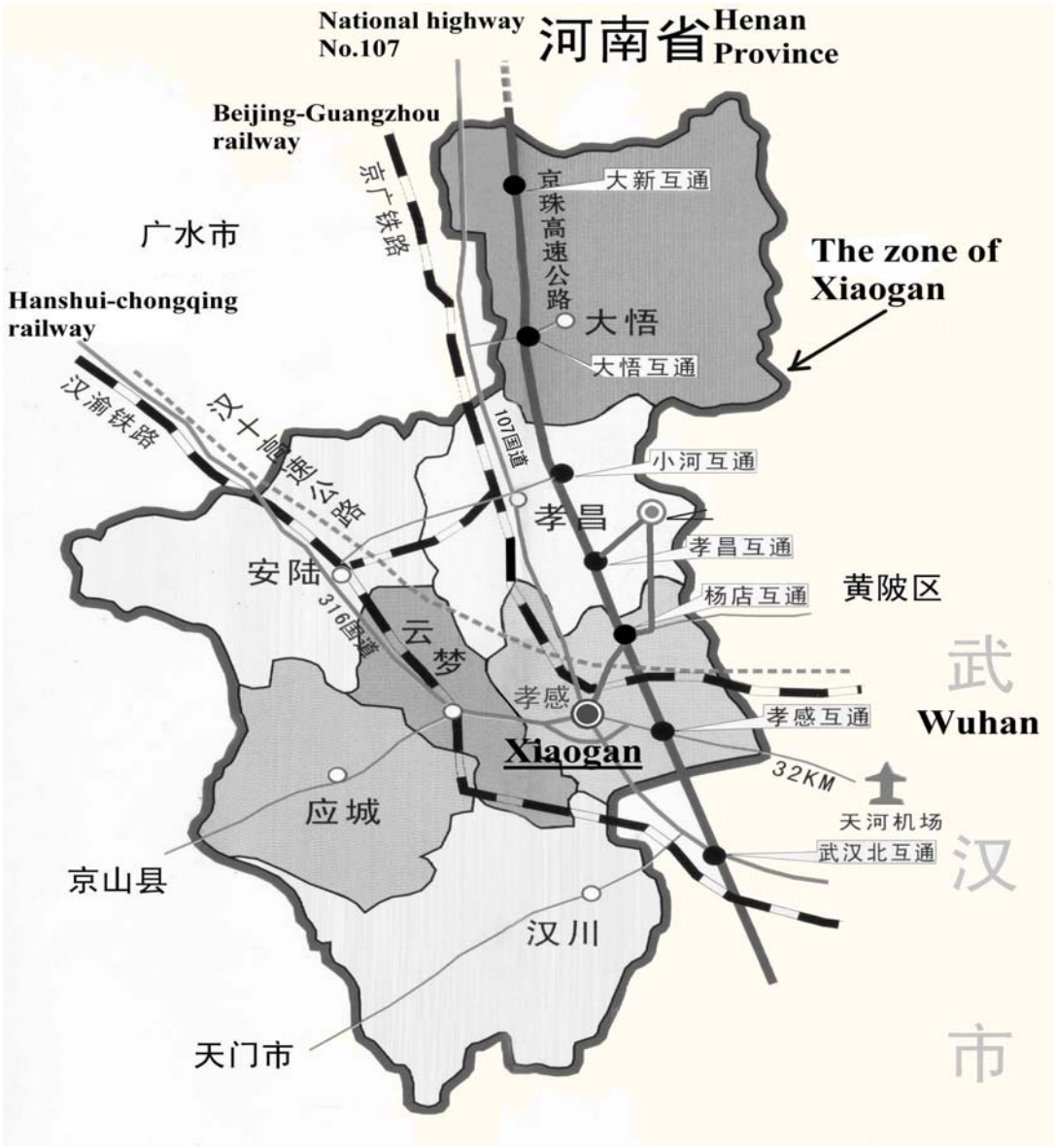


Figure 3.1.1 Map of Xiaogan

According to taxation law, the Chinese taxation system can be categorized in the following table:

Administrator	Function	Types of Tax	Tax Revenue Sharing (C: Central government L: Local government)
Taxation Administration Departments	Turnover Tax (State tax)	1. Value-Added Tax	C: 75%
			L: 25%
		2. Consumption Tax	Central government
		3. Business Tax	Local government
	Income Tax (State tax)	4. Enterprise Income Tax	L: Local enterprises C: Others
		5. Income Tax for foreign investment firms	L: Local enterprises C: Others
		6. Individual Income Tax	Local government
	Wealth Tax (Regional tax)	7. Real Estate Tax	Local government
		8. Urban Land and House Tax	Local government
		9. Vehicle and Vessel Use Tax	Local government
		10. Vehicle and Vessel License Plate Tax	Local government
		11. Land Use Tax	Local government
	Resource Tax (State tax)	12. Resource Tax	C: Offshore oil drilling L: Others
	Special-purpose Tax (Regional tax)	13. Real Property Gains Tax	Local government
		14. Banquet Tax	Local government
		15. City and Rural Area Maintenance and Constriction Tax	C: Railway, bank and insurance companies
			L: Others
		16. Capital investment Regulatory Tax (domestic enterprise only)	Local government
		17. Stamp Duty	C: 50% L: 50%
		18. Slaughter Tax	Local government
Custom Office	Custom Duties (State tax)	19. Tariff on Imports and Exports	Central Government
		20. Vessel Tonnage Tax	Central Government
Finance Department	Income Tax (Regional tax)	21. Agricultural and Animal Husbandry	Local government
	Special-purpose Tax (Regional tax)	22. Farmland Use Tax	Local government
		23. Deed Tax	Local government

Table 3.1.1 Tax regime in China
(Source: S. Cho, 1998, Taxation Reforms in China)

Referring to the China Statistical Yearbook, in 1996 state taxes was the main part of revenue, which contributed more than 70% of total government income in China. Therefore, our investigation in Xiaogan will also focus on the state taxes only.

3.2 Data Collection

The analysis in this part is based on the survey data done by tax collectors who did tax audits on individual taxpayers. The direct method of using survey data to measure tax loss has been used in a number of countries, including China. For instance, Raymond Fisman and Shang-Jin Wei (2001) describe a “losses gap” in the tariff (and relevant VAT) schedule at the product level by surveying the total value of products that were imported and exported between Mainland China and Hong Kong.

The main advantage of the direct approach is that detailed information can be acquired directly about tax loss, but the usefulness of the analysis result depends greatly on the questionnaire’s design and auditor’s skill. As with all investigations, the precision of the tax survey depends heavily on the respondents’ willingness to cooperate. It is difficult to assess the reliability of the responses from a direct questionnaire, because most taxpayers interviewed tend to deny their behaviors deceptively. Compared with a tax survey, a tax audit is more accurate for measuring the amount of tax loss, because all results are elicited directly from taxpayers’ accounting data.

The main disadvantage of the direct approach is that it is less efficient, because a tax audit or a survey requires a lot of time and a huge amount of manpower to collect and analyze the data on tax loss. When available resources of the tax authorities are limited, selecting taxpayers for the audit is not random, but rather tends to be taxpayers that the authorities suspect of tax evasion. That may cause auditors to bias the estimation of the tax loss, because the results reflect only the portion of the tax loss that the authorities have disclosed, and the movement of tax loss over a longer period cannot be evaluated.

Back to our data collection process; it started from the tax authorities in Xiaogan, who audited a number of taxpayers in 1998. Their working process can be described in the following flowchart:

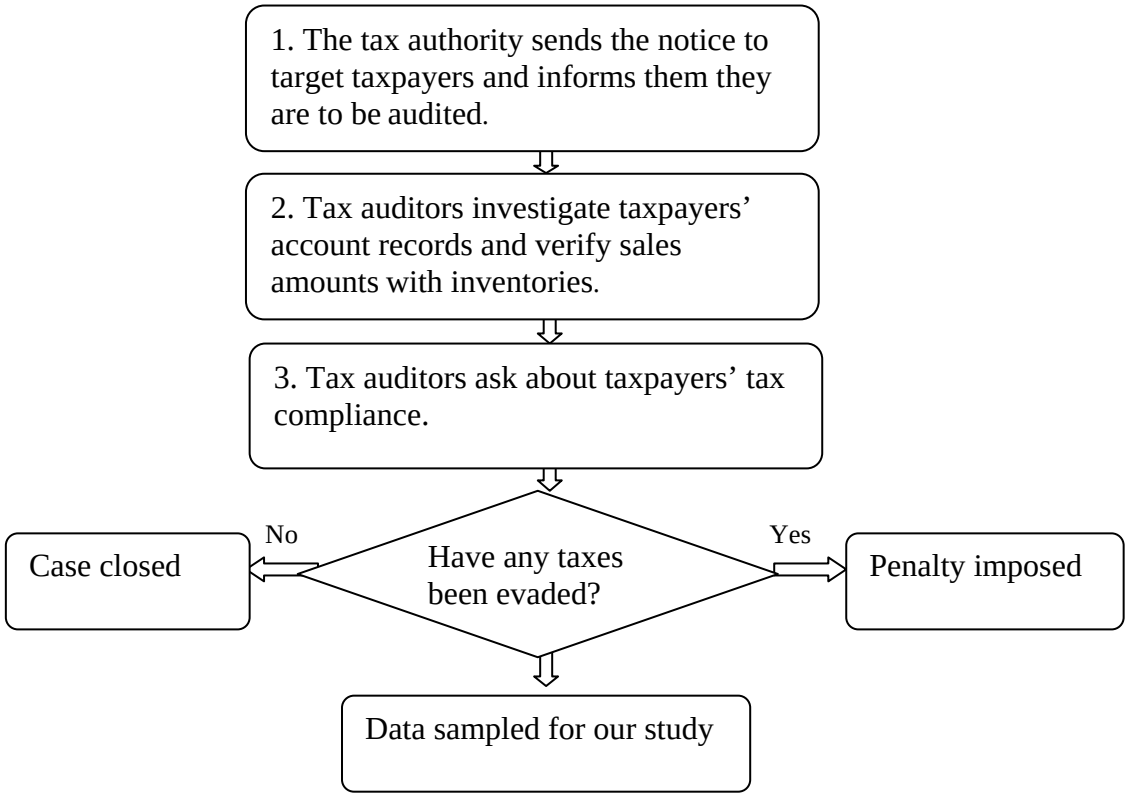


Figure 3.2.1 Working process of tax audit and survey in Xiaogan

The following illustrates how the tax authority typically applied the tax audit to taxpayers in Xiaogan. As a first step, the local tax authority will send a notice letter to inform the taxpayer when his firm will be audited; the taxpayer has to prepare all accounting data before the deadline. The tax auditor will stay in the firm to verify all taxation records and proof every transaction item by item.


Tax audit notice letter

_____税务局

税 务 稽 查 通 知 书

( ) 税 字第 号

Taxpayer

根据《中华人民共和国税收征收管理法》，我局决定从九八年 3 月 31 日起对你(单位)九七年 元 月 一 日至九八年 三 月 一 日期间执行税法的情况进行检查，请届时将纳税资料准备齐全，接受检查。

说明：本通知书一式两份，一份交稽查对象，一份存档。

Tax audit record

税 务 稽 查 记 录 底 稿

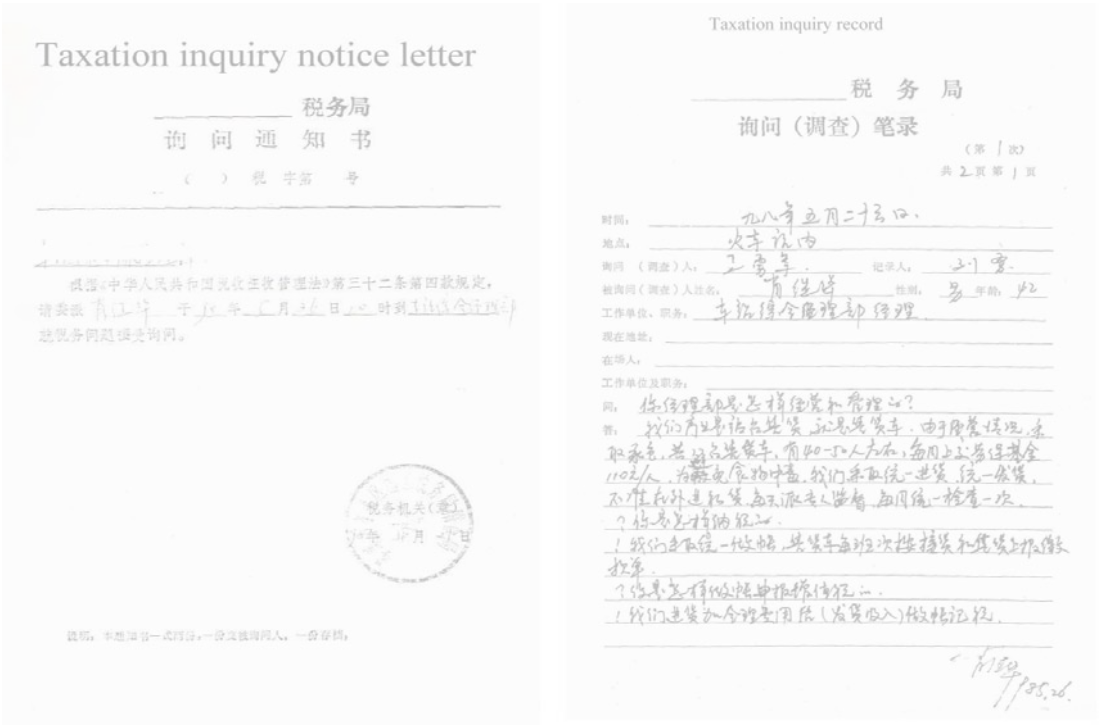
检查单位：

检查项目：

月	日	凭证号	帐务科目	事项摘要	金额
97年 5	31	银1			
6	30	银1	〃	〃	
7	31	银1	〃	〃	
8	31	银1	〃	〃	
9	30	银1	〃	〃	
10	31	银1	〃	〃	
11	30	银1	〃	〃	
12	31	银1	〃	〃	
			合计		
98年 5	31	银1			
6	30	银1	〃	〃	
6	30	银2	〃	〃	
7	31	银2	〃	〃	
		银1/2	〃	〃	
8	31	银1	〃	〃	
11	30	银1	〃	〃	

Figure 3.2.2 The samples of a tax audit notice and a tax auditing form

Once the tax auditor inspects the accounting data, the taxpayer will be queried. The tax auditor will ask many detailed questions about the taxpayers' business and crosscheck all evidences provided by the taxpayer. Figure 3.2.3 shows the documents of tax investigation used in Xiaogan.


Taxation inquiry notice letter

税务局

询 问 通 知 书

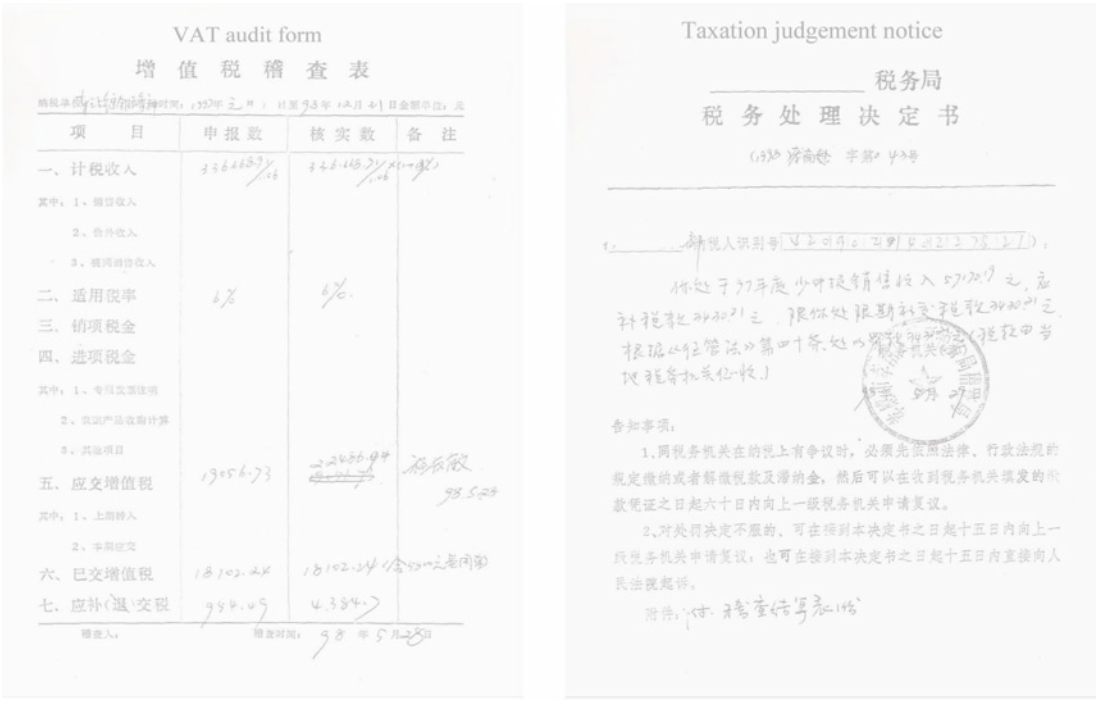
Taxation inquiry record

税 务 局

询问（调查）笔录

Figure 3.2.3 The samples of a tax investigation notice and an inquiry record

Finally, the tax authority will conduct the punishment verdict, if there are any evaded taxes. Samples of a tax audit report and taxation judgment form are shown in Figure 3.2.4.


VAT audit form

增 值 税 稽 查 表

项 目	申报数	核实数	备 注
一、计税收入			
二、适用税率	6%	6%	
三、销项税金			
四、进项税金			
五、应交增值税	1956.73		
六、已交增值税	18102.24	18102.24	
七、应补（退）交税	958.09	4384.7	

Taxation judgement notice

税务局

税 务 处 理 决 定 书

Figure 3.2.4 The samples of VAT audit report and taxation judgment notice

In Xiaogan, the tax audit results showed us that the situation of tax loss was very serious. The tax authorities have applied tax audits on 946 taxpayers (just 4% of the total taxpayers in the area) and it was found that 846 of them (more than 89% of the audited taxpayers) evaded taxes. The amount of evaded taxes totaled 18,677,000 RMB, or 3.13% of total state tax revenue in the entire city for that year. To be fair, most of the audited taxpayers were already suspected by the tax authorities. The overall situation with respect to all the taxpayers in the whole city might not be as bad as we found, but the situation is still egregious.

To collect data for our study, a survey form was designed and distributed to different tax bureaus in Xiaogan. Based on previous studies, we designed a survey form, which targets four categories of data that have been found to have obvious impacts on taxpayers' behavior.

a. Ownership

Tax evasion is regarded as an adventure that can create extra benefits for the taxpayers, which means different taxpayers may have different motivations for engaging in tax evasion. David Joulfaian and Mark Rider (1998) examine the tax compliance patterns of small businesses. Specifically, it focuses on the voluntary reporting of income from proprietorship, farm, and rental real estate activities. They find that differential taxation due to self-employment taxes (SECA) plays an important role in explaining the observed pattern of noncompliance. There is also a similar concept in China; private firms are conceived as the main entities to evade taxes. To improve the mode of tax collection administration of the self-employed

private economy and the intensification of tax collection on audits of accounts, the state council has approved the “Suggestions on Strengthening the Work of Tax Collection Administration of Self-employed Private Economy and Intensifying Tax Collection on Audit of Accounts”, proposed by the state taxation administration in 1997. In Xiaogan there are four types of ownership for economic entities: state, collective, joint venture, and private firm. Our research will identify true correlation between the tax loss and the firm’s ownership.

b. Business Category

Klarita Gërxhani and Arthur Schram (2003) have conducted an experimental study in Albania and Netherlands. They found that the tax supervision plays a very important roll in controlling tax loss even if there are very different tax attitudes or cultures in these countries. The tax authorities chase different taxpayers with various levels of attempt, according to their business category. Some businesses may contribute a very small part of government revenue, so it is not worth it to the tax authorities to apply much effort supervising these taxpayers. In contrast, in different businesses, taxpayers will also take different risks to evade taxes because of the differences based on their business models. In Xiaogan, the types of business can be categorized as manufacture, agriculture, retail, wholesale, service, and other business.

c. Payment Methods

In developed countries, most unobserved transactions are carried out in cash in order to avoid drawing the attention of the tax authorities, so cash payment must be the most popular way to evade taxes. That is why Cagan (1975) chose the demand of

cash as the fundamental indicator to evaluate the scale of the unobserved economy. Using the interview and survey data, Andrei Yakovlev (2001) examined the mechanics of tax evasion schemas in Russia. He found that the biggest problem facing the Russian economy is a weak and insufficient tax system that has stimulated the development of tax evasion. In Russia, tax evasion with cash payment is possible and widespread among small and medium-sized enterprises rather than large enterprises; this is because, in economic terms, cash payment raises opportunity costs of capital and creates an additional budget constraint on firms. As the risk of detection rises in relation to the size of the firm, no-monetary exchange methods, or barter-based virtual economies, have been chosen by large enterprises to reduce their costs by tax arrears and evasion. In our research, based on the investigation results, we will discuss the correlation between tax loss and payment methods.

d. Tax Burden

There is much literature that discusses positive correlation between tax loss and tax burden, which mainly stand for marginal tax rate and the ratio of tax to profit or turnover. David Joulfaian and Mark Rider (1998) examined the tax compliance pattern of small business; they pointed out that the difference of taxation due to different turnover might explain the reason of tax incompliance. According to the Chinese taxation system, some taxes (such as value added tax) are levied only on turnover. In order to maximize profit, taxpayers may engage in different types of activities to comply with the taxation based on their turnover. Joel Slemrod (1986) developed a methodology that uses the data from individual tax returns to test the presence of tax evasion. He has find that the tax evasion and the taxpayers' burden,

such as tax rate, are positively correlative. In China, a firm's turnover is locked directly with income tax and value added tax, which forms the greatest part of the government's revenue. Our investigation will disclose the relationship between tax loss and tax burden, which consists of the ratio of total taxes to turnover and various taxpayers' ownership and business.

The specific survey form is shown in Table 3.2.1.

Name of Taxpayer	Ownership	Business	Payment Method	Turnover	Profit	Tax Paid	Tax Evaded

SURVEY FORM (For tax authority) CITY:_____, DATA_____

Remark: Some items in this form are represented by numeric numbers for statistical purpose

Ownership:

1=listed firm
2=state-owned firm
3=collective firm
4=joint venture firm
5=private firm
6=self-employed firm (less than five employees)
7=other

Business category:

1=manufacturing
2=agriculture
3=energy
4=transportation
5=material
6=retail
7=service
8=wholesale
9=other

Payment method:

1=cash only
2=check only
3=either cash or check

Tax burden:

turnover
profit
tax paid
tax evaded

Table 3.2.1 Survey form for Xiaogan case study

There are nine local tax bureaus in the Xiaogan area to which we sent our survey forms. The tax authorities filled out this survey form with all the related data based on their audit records of the taxpayers, and then sent back the filled forms. After eliminating the incomplete ones, we had information for a total of 200 taxpayers with full set data available for the study. A sample of a filled survey form is shown in Figure 3.2.5.

偷漏税情况调查表

地区：　　年度：

纳税人编码	纳税人名称	企业性质(1)	所属行业(2)	核算方式(3)	年营业额(万元)	毛利(万元)	增值税(元) 上交	增值税(元) 偷漏	营业税(元) 上交	营业税(元) 偷漏	所得税(元) 上交	所得税(元) 偷漏	其它税(元) 上交	其它税(元) 偷漏	偷漏税方式(4)
合计					63258	7355	13296367	4223547	877040	32349	55633	5963			
011374	食品物资有限	3	13	2	135	37	21842								
011375	生资公司	3	11	2	28579	23	1930								
011376	中药材公司	3	11	3	5	2	1116								
011378	新华书店	2	13	2	1456	91	387941	47445							1
011379	粮油副食品公司	2	8	3	31	6	32910								
C 1383	粮油议管公司	2	8	2	12	5	28000								
011385	粮贸轮渡经营部	2	8	2	29	7	50000	50000							2
011386	运安车队	2	4	3	9	2	13600								
011388	应山粮管所	2	8	2	335	110	370000	30000							2
011389	城郊粮管所	2	8	2	252	80	95383	3816							2
011390	石油公司	2	3	2	2083	140	238954	8452							1
011391	对外经济贸易公司	2	11	2	246	26	34293								
011392	一二东示	2	13	2	282	80	134386	23864							1
011394	粮茶公司	2	5	2	7365	254	598496				55633	5963			3
C 1385	郑州产油公司	2	5	2	2655	300	2850000	1850000							1
011398	电力一处经销公司	2	3	2	184	37	66885	18980							2
011421	水产总公司	2	2	3	159	18	65874								
011422	石化物资公司	2	8	2	302	25	51563	7830							3
011424	出口联社	3	1	2	59	11	30622								
011426	一中油脂化学厂	3	1	2	54	8	40236								
011427	新联物资公司	3	8	2	43	5	12001								
011428	当阳服务站	2	13	3	33	3	8407								

Figure 3.2.5 Tax evasion survey form that has been filled by the local tax authority

3.3 Data Analysis, Research Methodology, and Results

Based on the detailed information of the 200 taxpayers randomly sampled out of the 946 audited taxpayers, a summary of the survey data and their basic summary statistics are shown in the following tables.

	Number of samples	Turnover	Profit	Tax paid	Tax evaded
Total	200	821200600	114929200	32362175	9640988
Ownership					
State	75	558510000	85177000	21324747	6470486
Collective	79	191508300	23484000	7097673	2080923
Joint venture	14	53562800	2229600	3478825	864059
Private	32	17619500	4038600	460930	225520
Business					
Manufacture	69	181423300	17161600	10027263	2823919
Agriculture	34	138130000	15803000	5276459	297907
Retail	32	83231500	2545600	3285095	1397325
Service	6	1019800	-116000	31315	1840
Wholesale	31	357461000	73114000	12338030	4732935
Others	28	59935000	6421000	1404013	387062
Payment					
Cash only	40	25953800	5372600	728786	82840
Check only	91	598676800	90540600	24574894	8621660
Cash & check	69	196570000	19016000	7058495	936488

Table 3.3.1 Summary of survey on tax loss in Xiaogan

		State own	Collective	JV	Private
No of samples		75	79	14	32
Mean		86273.15	26340.80	61718.50	7047.50
Std. Error of Mean		32633.826	8714.315	30874.902	2216.865
Median		3810.00	150.00	3219.00	952.50
Std. Deviation		282617.219	77454.529	115523.306	12540.480
Minimum		0	0	0	0
Maximum		1850000	534528	334029	54052
Sum		6470486	2080923	864059	225520
Percentiles	25	.00	.00	.00	500.00
	50	3810.00	150.00	3219.00	952.50
	75	38545.00	7830.00	64211.25	11525.00

Table 3.3.2 Statistical results for tax loss versus ownership

		Manufactory	Agriculture	Retail	Service	Wholesale	Others
Number of sample		70	34	32	6	31	28
Mean		80683.40	8761.97	43666.4	306.67	152675.	13823.6
Std. Error of Mean		41349.818	3214.538	29855.9	146.006	71633.8	5825.54
Median		975.00	.00	820.00	185.00	4280.00	1395.00
Std. Deviation		345957.40	18743.81	168890.	357.640	398840.	30825.8
Minimum		0	0	0	0	0	0
Maximum		2823919	73000	957762	900	1850000	151933
Sum		5647838	297907	1397325	1840	4732935	387062
Percentiles	25	.00	.00	179.00	.00	.00	.00
	50	975.00	.00	820.00	185.00	4280.00	1395.00
	75	47106.50	6350.00	26631.7	652.50	79443.0	12855.0

Table 3.3.3 Statistical results for tax loss versus business categories

		Cash only	Check only	Cash & check
Number of samples		40	91	69
Mean		2071.00	94743.52	13572.29
Std. Error of Mean		683.970	27840.375	3145.207
Median		.00	4280.00	570.00
Std. Deviation		4325.808	265580.247	26126.051
Minimum		0	0	0
Maximum		15000	1850000	132806
Sum		82840	8621660	936488
Percentiles	25	.00	.00	.00
	50	.00	4280.00	570.00
	75	1090.00	57615.00	12529.00

Table 3.3.4 Statistical results for tax loss versus payment methods

With 200 taxpayers and 14 different items (four kinds of ownerships, six types of business, three different payment methods, and one for tax burden), we came up with 2,800 data points to perform two regression analyses.

3.3.1 Binary Logistic Regression Analysis

The first regression analysis addresses the question of which taxpayers are the most likely to evade taxes. To achieve this, we developed a binary logistic regression model in terms of taxpayers' ownership, business, payment methods, and their tax burden, which is the ratio of total taxes to turnover. The general logistic model for the probability of tax evasion looks as follows:

(3.3.1) $\Omega = p/(1-p) = e^{\beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_n X_n}$

Where

p: The indicator of tax evasion

p = 1 when the taxpayer evaded tax, and then Ω is inclined to infinity.

p = 0 when the taxpayer did not evade tax, and then Ω is run to zero.

β: Regression coefficient

X: Independent variables

The probability of tax loss Ω can also be represented as:

(3.3.2) $\ln \Omega = \ln(p/(1-p))$

$= \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_n X_n$

In our setting, the specific model is as follows:

(3.3.3) $\ln \Omega = \beta_0 + \beta_1 TTT + \beta_2 STO + \beta_3 CLO + \beta_4 JVO + \beta_5 PRO + \beta_6 MAB +$

$\beta_7 AGB + \beta_8 REB + \beta_9 SEB + \beta_{10} WHB + \beta_{11} OTB + \beta_{12} CAC +$

$\beta_{13} CHC + \beta_{14} CCC$

Where:

β_i= the regression coefficient (i= 0,1,2,…14)

TTT= the ratio of the taxes (paid and evaded) to turnover

STO = 1 when the taxpayer is a state-owned firm

= 0 when the taxpayer is not a state-owned firm

CLO = 1 when the taxpayer is a collective firm

= 0 when the taxpayer is not a collective firm

JVO = 1 when the taxpayer is a joint venture firm

= 0 when the taxpayer is not a joint venture firm

PRO = 1 when the taxpayer is privately owned firm

= 0 when the taxpayer is not privately owned firm

MAB = 1 when the taxpayer's business is manufacturing

= 0 when the taxpayer's business is not manufacturing

AGB = 1 when the taxpayer's business is agriculture

= 0 when the taxpayer's business is not agriculture

REB = 1 when the taxpayer's business is retail

= 0 when the taxpayer's business is not retail

SEB = 1 when the taxpayer's business is service

= 0 when the taxpayer's business is not service

WHB = 1 when the taxpayer's business is wholesale

= 0 when the taxpayer's business is not wholesale

OTB = 1 when the taxpayer's business is other

= 0 when the taxpayer's business is not other

CAC = 1 when the taxpayer's transactions are paid with cash only

= 0 when the taxpayer's transactions are not paid with cash

CHC = 1 when the taxpayer's transactions are paid with cheques only

= 0 when the taxpayer's transactions are not paid with cheques

CCC = 1 when the taxpayer are paid with cash and cheques

= 0 when the taxpayer are not paid with cash and cheques

Our goal is to correctly predict the probability of tax evasion for individual cases using the most parsimonious model. To accomplish this goal, logistic regression can test the fit of the model after each coefficient is added or deleted, which is called stepwise regression. Forward stepwise regression appears to be the preferred method of exploratory analyses, where the analysis begins with an empty model and variables are added into the model in an iterative process. The fitness of the model is tested after the accession of each variable to ensure that the model still adequately fits the data. When no more variables are worth being injected into the model, the analysis has been completed. Using the stepwise regression analysis method, the collinear variables can be eliminated from final regression model. Our analysis results are presented in Table 3.3.7.

Hosmer and Lemeshow Test

Step	Chi-square	Df	Sig.
1	.000	0	.
2	11.170	2	.004
3	5.247	2	.073
4	28.520	8	.000

Classification Table(a)

	Observed		Predicted		
			tax evader		
			0	1	Percentage Correct
Step 1	tax evader	0	0	80	.0
		1	0	120	100.0
	Overall Percentage				60.0
Step 2	tax evader	0	20	60	25.0
		1	2	118	98.3
	Overall Percentage				69.0
Step 3	tax evader	0	20	60	25.0
		1	2	118	98.3
	Overall Percentage				69.0
Step 4	tax evader	0	38	42	47.5
		1	14	106	88.3
	Overall Percentage				72.0

a The cut value is .500

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 4	Private	3.171	.845	14.089	1	.000	23.830
	Retail	1.679	.660	6.472	1	.011	5.359
	Cash only	-2.265	.640	12.543	1	.000	.104
	Tax burden	5.433	2.491	4.757	1	.029	228.859
	Constant	-.095	.235	.162	1	.687	.910

a Variable(s) entered on step 1: Private.
b Variable(s) entered on step 2: Cash payment only.
c Variable(s) entered on step 3: Retail.
d Variable(s) entered on step 4: Tax burden.

Table 3.3.5 The analysis results of the binary logistic regression

In order to verify our model, the Hosmer-Lemshow test has to be performed to evaluate the goodness-of-fit by creating 10 ordered groups of subjects and then comparing the number actually in the each group (observed) to the number predicted by the logistic regression model (predicted). Thus, the test statistic is a chi-square statistic with a desirable outcome of non-significance. According to the data in Table 3.3.7, the results of the Hosmer & Lemeshow test indicated that the prediction of our model does not significantly differ from the observation, the significance level of which is less than 5%. Referring to the classification table, which tells us how many of the cases have been predicted correctly, the overall percentage of predication for our model is 72%, which is a satisfactory degree for our study. Furthermore, the correct ratio of our prediction for tax evasion (p = 1) is as high as 88.3%, which shows that our model can be used to precisely indicate the probability of tax evasion in our case. Based on formula 3.3.1, instead of regression coefficients, the probability of tax evasion is laid completely on the value of the exponent of the regression coefficient that is described as Exp (β) in Table 3.3.7. So the probability of tax evasion Ω in our case can be represented as:

(3.3.4) $\ln \Omega = -0.095 + 5.433TTT + 3.171PRO + 1.679REO - 2.265CAC$

(3.3.5) $\Omega = \text{Exp}(-0.095 + 5.433TTT + 3.171PRO + 1.679REO - 2.265CAC)$

$= e^{(-0.095)} e^{(5.433TTT)} e^{(3.171PRO)} e^{(1.679REO)} e^{(-2.265CAC)}$

$= 0.91 e^{(5.433TTT)} e^{(3.171PRO)} e^{(1.679REO)} e^{(-2.265CAC)}$

Where,

TTT = the ratio of taxes to turnover

PRO = 1, if taxpayers' ownership is private

= 0, if taxpayers' ownership is not private

REO = 1, if taxpayers' business is retail

= 0, if taxpayers' business is not retail

CAC = 1, if taxpayers' payment is cash only

= 0, if taxpayers' payment is not cash only

The other variables in our primitive model are excluded in the final regression model due to their lower significances. Our analysis results can be explained rationally:

a. Tax burden seems to be the most important factor for tax loss because it has the largest value coefficient (β=5.443). In reality, tax burden has been limited to certain level; it still has a very big effect on taxpayers' behaviors. For example, if there is no other condition changed, when tax burden is increased 1%, according to 3.3.5, we have:

$$\Omega_{(TTT+0.01)}/\Omega_{(TTT)} = [0.91e^{[5.433(TTT+0.01)]}e^{(3.171PRO)}e^{(1.679REO)}e^{(-2.265CAC)}]/$$

$$[0.91e^{(5.433(TTT)}e^{(3.171PRO)}e^{(1.679REO)}e^{(-2.265CAC)})$$

$$= 0.91e^{5.433*(0.01)}$$

$$= 1.056$$

Therefore, the possibility of tax evasion will be increased 5.6% due to 1% increment of tax burden.

b. The taxpayers in private firms are the most possible tax evaders, because they have the big value of regression coefficient (β=3.171) in our case. According to its high value ($e^{(3.171)} = 23.83$) of Exp (β), the possibility of tax evasion for private taxpayers will be over 20 times higher than the other one no matter if it is

a state, collective, or joint venture firm. Considering the social issues in our study, we can understand why the taxpayers in private firms have more tendency and motivation to evade taxes than any others do, because they can benefit from incompliance of taxation.

c. Retail seems to be the business that most likely tended to evade taxes because of the larger value of its regression coefficient ($\beta = 1.679$ and $e^{(1.679)} = 5.359$). The probability for tax evasion in the retail business could be over four times higher than in other businesses. In China, retail is the most popular business with the smallest supervision by tax authorities because of their resource limitation. That makes taxpayers in retail business have more chances to get rid of taxation than taxpayers in other businesses.

Somewhat surprising is that, unlike the developed countries, cash payment in our case actually lowers the probability of tax evasion since the coefficient bears a negative sign across various specifications. However, the economic significance is limited due to its low value of the exponent of regression coefficient ($e^{-2.265} = 0.104$). One possible explanation is that the bank information system is not so efficient to trace the transaction records for taxation in Xiaogan; therefore, payment methods will not come with a clear effect on the probability of tax evasion.

The results from logistic regression analysis shows us that the probability of tax evasion is mostly dependant on who can benefit from tax evasion; therefore, the benefit allocation should be the main motivation for tax evaders. No different from our anticipation, tax burden seems to be the main issue for the probability of tax

evasion in our case, because there are significant coefficients corresponding to tax burden in our regression model. There is no way to impede tax evasion completely because of the greediness of taxpayers; the only thing we can do is make the taxes not worth evasion because tax evaders have to bear more costs than the benefits gained from tax evasion.

3.3.2 Linear Regression Analysis

In this part, we go a step further to investigate which taxpayers caused the highest portion of tax loss. To answer the question, a linear regression model to analyze the relationship between tax loss and its possible causes is developed:

(3.3.6) $$\text{Tax loss} = \beta_0 + \beta_1 TTT + \beta_2 STO + \beta_3 CLO + \beta_4 JVO + \beta_5 PRO + \beta_6 MAB + \beta_7 AGB + \beta_8 REB + \beta_9 SEB + \beta_{10} WHB + \beta_{11} OTB + \beta_{12} CAC + \beta_{13} CHC + \beta_{14} CCC$$

Where:

β_i=the regression coefficient (i= 0,1,2,…14)

TTT = the ratio of the taxes (paid and evaded) to turnover

STO = 1 when the taxpayer is a state-owned firm

= 0 when the taxpayer is not a state-owned firm

CLO = 1 when the taxpayer is a collective firm

= 0 when the taxpayer is not a collective firm

JVO = 1 when the taxpayer is a joint venture firm

= 0 when the taxpayer is not a joint venture firm

PRO = 1 when the taxpayer is a privately owned firm

= 0 when the taxpayer is not a privately owned firm

MAB = 1 when the taxpayer's business is manufacturing

= 0 when the taxpayer's business is not manufacturing

AGB = 1 when the taxpayer's business is agriculture

= 0 when the taxpayer's business is not agriculture

REB = 1 when the taxpayer's business is retail

= 0 when the taxpayer's business is not retail

SEB = 1 when the taxpayer's business is service

= 0 when the taxpayer's business is not service

WHB = 1 when the taxpayer's business is wholesale

= 0 when the taxpayer's business is not wholesale

OTB = 1 when the taxpayer's business is other

= 0 when the taxpayer's business is not other

CAC = 1 when the taxpayer's transactions are paid with cash only

= 0 when the taxpayer's transactions are not paid with cash

CHC = 1 when the taxpayer's transactions are paid with cheques only

= 0 when the taxpayer's transactions are not paid with cheques

CCC = 1 when the taxpayer are paid with cash and cheques

= 0 when the taxpayer are not paid with cash and cheques

In order to conduct linear regression analyses, it is necessary that all variables, excluding dichotomous predictors, be in normal distribution. There are two ordinary

variables in our case that presented the evaded taxes and tax burden; their histograms are shown in Figure 3.3.1.

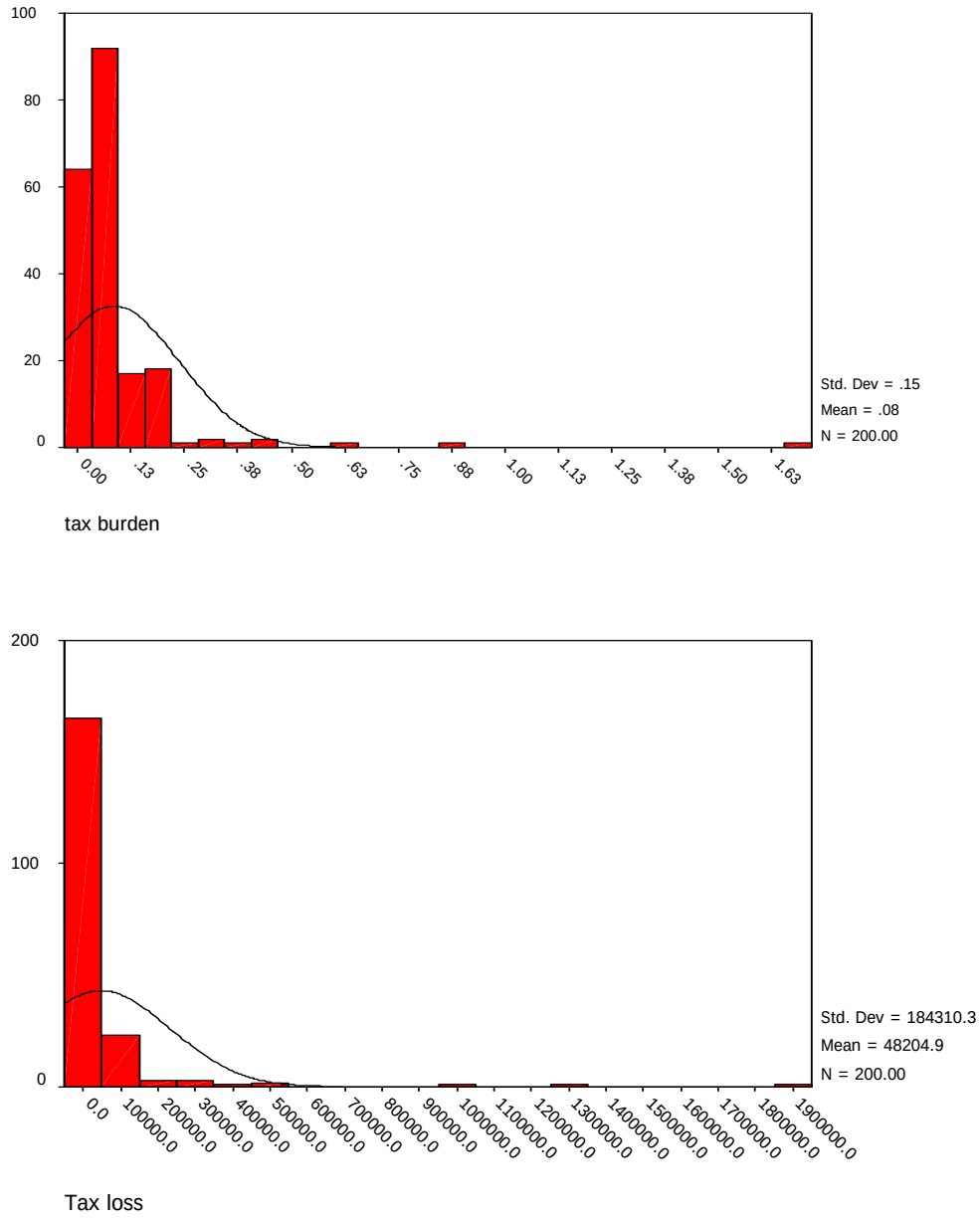


Figure 3.3.1 The histograms of tax loss and tax burden

Referring to Figure 3.3.1, the distributions of both tax burden and tax loss are not normal but exponential. Therefore, we can use the logarithm to transform their distribution from exponential to normal as in following figure:

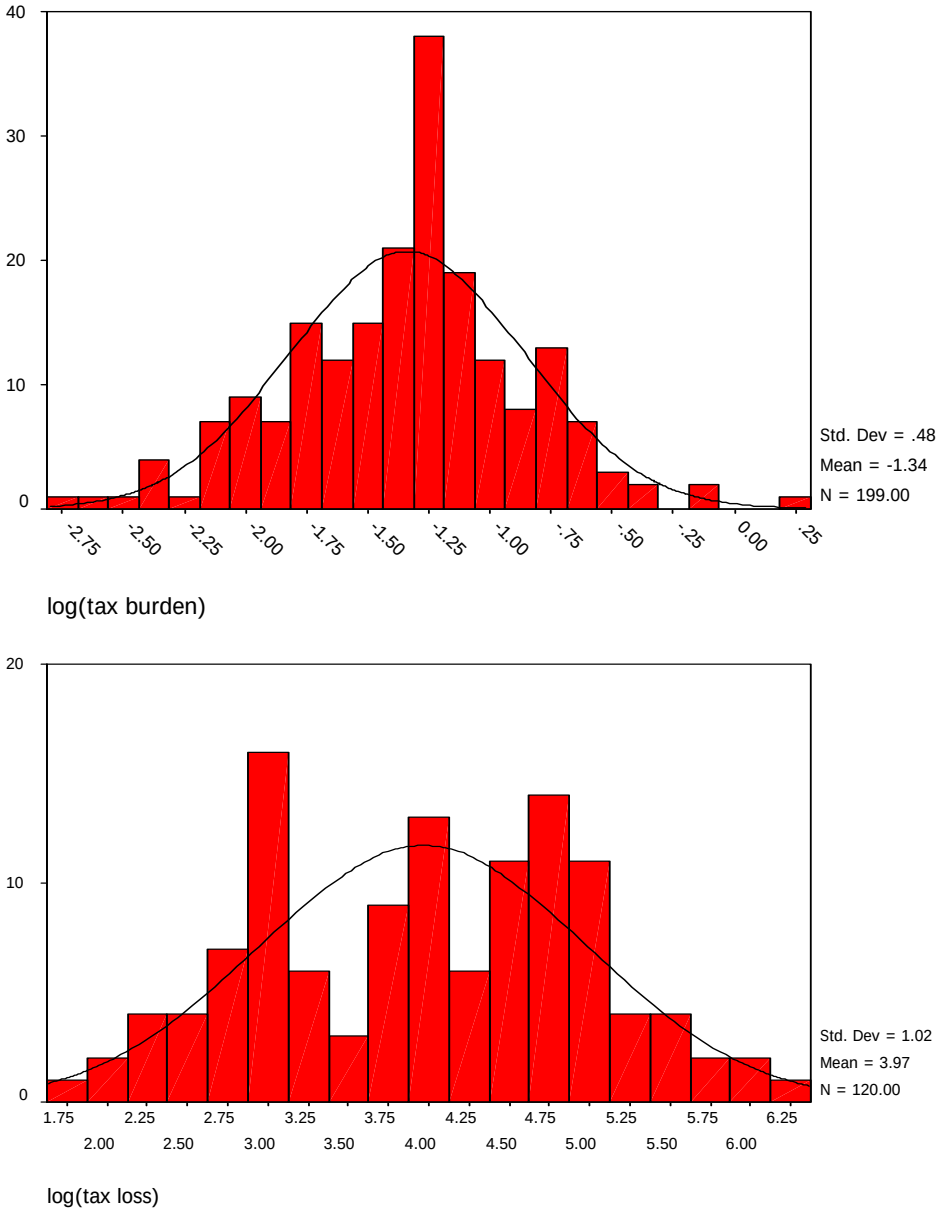


Figure 3.3.2 The histograms of log (tax burden) and log (tax loss)

Figure 3.3.2 showed the log(tax burden) and log(tax loss) are both perfectly in normal distribution. Therefore, we can modify our original linear regression model:

(3.3.7) $\text{Log (tax loss)} = \beta_o + \beta_1 \text{Log(tax burden)} + \beta_2 \text{STO} + \beta_3 \text{CLO} + \beta_4 \text{JVO}$

$+ \beta_5 \text{PRO} + \beta_6 \text{MAB} + \beta_7 \text{AGB} + \beta_8 \text{REB} + \beta_9 \text{SEB} + \beta_{10} \text{WH}$

$+ \beta_{11} \text{OTB} + \beta_{12} \text{CAC} + \beta_{13} \text{CHC} + \beta_{14} \text{CCC} + \text{error}$

Furthermore, based on our survey data, the goodness of fit for this model has been tested and the results are shown in Table 3.3.8:

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.670(a)	.449	.393	.79396

Predictors: (Constant), LOG (tax burden), service, state, joint venture, other-business, wholesale, collective firm, check-only, retail, agriculture, cash only, check only, private firm

Table 3.3.6 The test result of model fitness

The model summary shows a poor fitness of this model because of its lower value of R Square, which stands in less than 45% for our model to fit in our case. According to the definition of our model, if all predictors are all nonexistent, there will be no tax loss. Therefore, the constant, called as the initial regression coefficient β_0 that represents the initial value of tax loss, has to be zero. The new model used for our analysis is shown as:

(3.3.8) $\text{Log(tax loss)} = \beta_1\text{Log(tax burden)} + \beta_2\text{STO} + \beta_3\text{CLO} + \beta_4\text{JVO} + \beta_5\text{PRO}$

$+ \beta_6\text{MAB} + \beta_7\text{AGB} + \beta_8\text{REB} + \beta_9\text{SEB} + \beta_{10}\text{WHB}$

$+ \beta_{11}\text{OTB} + \beta_{12}\text{CAC} + \beta_{13}\text{CHC} + \beta_{14}\text{CCC} + \text{error}$

After an 11-step forward linear regression analysis, our regression results are presented in Table 3.3.9.

Model Summary

Model	R	R Square(a)	Adjusted R Square	Std. Error of the Estimate
11	.983(l)	.966	.963	.79070

a For regression through the origin (the no-intercept model)

ANOVA(m,n)

Model		Sum of Squares	df	Mean Square	F	Sig.
11	Regression	1942.533	11	176.594	282.456	.000(l)
	Residual	68.148	109	.625		
	Total	2010.681 (b)	120			

Coefficients(a,b,c)

Model		Unstandardized Coefficients		Standardized Coefficients	T- value	P-Value
		Beta	Std. Error	Beta		
Step 11	check-only	-.030	.233	-.005	-.128	.899
	private	3.543	.228	.425	15.562	.000
	agriculture	-.844	.334	-.073	-2.523	.013
	collective firm	3.929	.210	.561	18.671	.000
	state	4.426	.271	.632	16.334	.000
	joint venture	4.242	.337	.284	12.597	.000
	Log(tax burden)	.279	.080	.073	3.510	.001
	service	-1.346	.436	-.060	-3.087	.003
	wholesale	.607	.234	.057	2.599	.011
	other-business	.730	.264	.063	2.769	.007
	cash-only	-.671	.306	-.065	-2.194	.030

a Dependent Variable: LOG(tax evaded)
b Linear Regression through the Origin
C Number of observed cases of tax loss: 120

Table 3.3.7. The analysis results of linear regression

Referring to the results shown in Table 3.3.9, after 11 steps forward calculation, the adjusted R Square is 0.96, which showed our model has a 96% goodness of fit, and the degree of redemption is significant ($P_{(11,109)}$=282.456, p<0.001). Those test results indicate that our model satisfies our study. According to the coefficients shown in Table 3.3.9, our final linear regression model can be represents as:

(3.3.9) Log(tax loss) = 0.279Log(tax burden) + 4.426STO + 3.929CLO + 4.242JVO + 3.543PRO–1.346SEB + 0.607WHB+ 0.73OTB -0.671CAC -0.03CHC

Based on (3.3.9), we can determine the relationship between tax loss and its main causes.

1. The state-owned firms have a larger coefficient (β=4.426) than private firms do (β=3.543) at the same satisfied significant level. According to formula (3.3.9), if all other conditions are the same, the difference of tax loss caused by a state firm and a private firm can be described as:

   log (tax loss caused by state firm) – log (tax loss caused by private firm)

   = log (tax loss caused by state firm/tax loss caused by private firm)

   = β_2STO - β_5PRO = 4.426 – 3.543

   Hence, we have:

   Tax loss caused by state firm/tax loss caused by private firm = $10^{(\beta 2 - \beta 5)}$

   $=10^{(4.426-3.543)}$ = 7.638358 =763.36%

   That means the state-owned taxpayer will cause 663.36% more tax loss than a private firm taxpayer. Therefore, state-owned firms should be the main taxpayers responsible for tax loss due to their major contribution of government revenue. In China, most people believe that the taxpayers in private firms are more likely to evade taxes than others because they can gain all the extra benefits from tax savings directly. Nevertheless, in fact, the private taxpayers are not the main entity responsible for tax loss, because they contribute just a very small portion (less than 2.5% of total taxes in our case, referring to table 3.3.1) of tax revenue.

2. Using same process, we can also determine the relationship between tax burden and tax loss.

   If tax burden is increased 1% under the same conditions, we can know:

   The increase ratio of tax loss = $10^{0.279 \log (1.01)}$=1.00278

That means a 1% increment of tax burden just causes 0.278% extra tax loss, so tax burden does not have a big impact on the size of tax loss, or we can say the most part of tax loss is not caused by tax burden in our case.

3. The negative coefficients show us that the payment method is not a factor causing tax loss, which is normally what happens in developed countries. According to our regression analysis, nevertheless, the cash payment is evidently not the main effect on the tendency toward tax evasion in our case. This is because tax authorities cannot directly access banking systems to look for evidence of tax evasion; local banks were reluctant to jeopardize their customer relationships by cooperating with “troublesome” tax collectors. Therefore, the correlation between tax loss and cash payment is not remarkable.

The probability of tax evasion and the relationship between tax loss and its potential causes have been discussed with regression analysis methodologies. Our analysis results reasonably interpret the real situation we found in Xiaogan, notwithstanding that its deductibility was restricted by the lack of statistical significance in our survey data.

3.4 Main Criminal Activities Causing Tax Loss in Xiaogan

There are many tricks resulting in taxes loss in Xiaogan. According to our investigation, the tax evaders intended to violate tax regulations and evaded taxes through various methods, which included defrauding, forging, altering, and destroying account records (such as bills, invoices, and other account vouchers); concealing payable items, sales income, or profits; increasing the costs by incorrectly

amortizing expenditures; transferring income and profit to other accounts, etc. To sum up, the tax evaders in Xiaogan mainly operated in the following ways.

(1) Cheated tax authorities by falsifying their accounting records

In order to evade payment of value added tax, business tax, and income tax, some taxpayers had their finance clerks make dual accounting records, one of which was false and used especially for taxation purposes. This practice was very popular in self-employed firms and private enterprises.

(2) Hid payable taxes behind ongoing payments

Some sales incomes were left chronically in their receivable accounts, even when the buyers had already made payment. The credit balance was not transferred to the sales accounts as revenue for a long time, in order to evade sales tax. Some offset sales income was still counted as other receivables on the credit side, or was added as payable on the debit side in the current period.

(3) Deducted VAT by hiding inventory loss

Based on the regulation, paid VAT could be used to deduct the total payable VAT for new transactions. Some taxpayers intended to conceal inventory loss as part of the operating cost, but still kept the paid taxes for the VAT deduction.

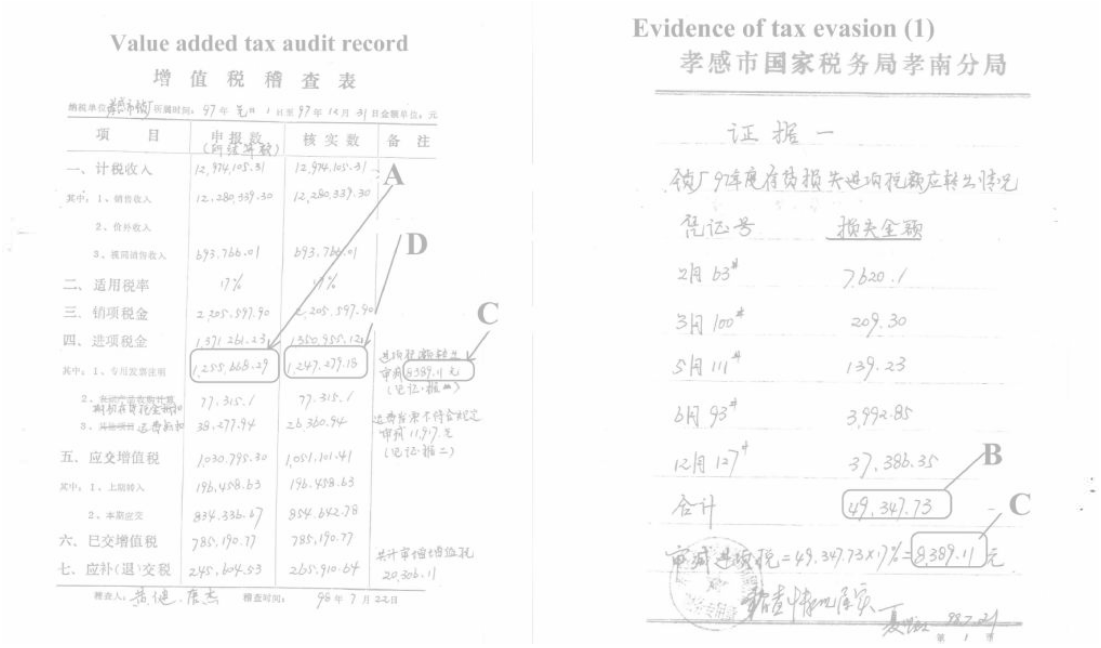


Figure 3.4.1 Evidence 1: Tax evasion by hidden inventory loss

A real case found in our survey is shown in Figure 3.4.1. The alphabetic numbers represent the conditions for taxation purposes:

A. The deductible value of VAT declared by the taxpayer = ¥1,255,668.29

B. Total amount of inventory loss within the taxation period = ¥49,347.73

C. The eliminated amount of VAT relative to inventory loss = ¥8,389.11

D. The deductible volume of VAT certified by the tax authorities = ¥1,247,279.18

In this case, the tax auditor disclosed that this taxpayer attempted to evade ¥8,389.11 of VAT by eliminating inventory loss.

(4) Abridging profits by modifying sale price or purchase cost

According to the regulations, VAT must be calculated based on the total amount of added value (actual sales price minus original cost), and no intermediate cost can be included in this amount. However, some taxpayers increased their purchase cost and transferred the margin to the supplier's current accounts, thereby reducing profits and allowing for tax evasion. In one real example from Xiaogan, a wholesale company purchased a batch of goods for a total of 1 million RMB; its retail price should have been 1.5 million RMB. However, the taxpayer transferred the 0.5 million RMB margin to the supplier's cost as payment for other business, and corrected the accounting payable record to be 1.5 million RMB. The goods were finally sold at a total price of 1.575 million RMB, which meant that:

a. VAT was evaded.

Taxes that should have been paid: (1575000-1000000) ×10.8%=62,100RMB

(10.8% is the ratio of value added tax for this company)

Taxes actually paid: (1575000-1500000) ×10.8%=8,100RMB

Total amount of evaded tax: 62100-8100=54,000RMB

b. Profits were hidden.

Actual profit =

[1575000-(1575000-1000000) x 10.8%]-1000000=512,900RMB

Recorded profits =

[1575000-(1575000-1500000) x10.8%]-1000000=66,900RMB

Hidden profit =

512900−66900=446,000RMB

c. 0.5 million RMB was counted as payment for other business, but was actually used by the payer for a long time, and free of tax.

(5) Evaded taxation by forging VAT invoices

Account records are the most important evidence for taxation. Any taxpayers attempting to evade paying taxes will first draw up incorrect accounting records.

The following case is a typical example.

Figure 3.4.2 Evidence 2: accounting voucher of tax deduction

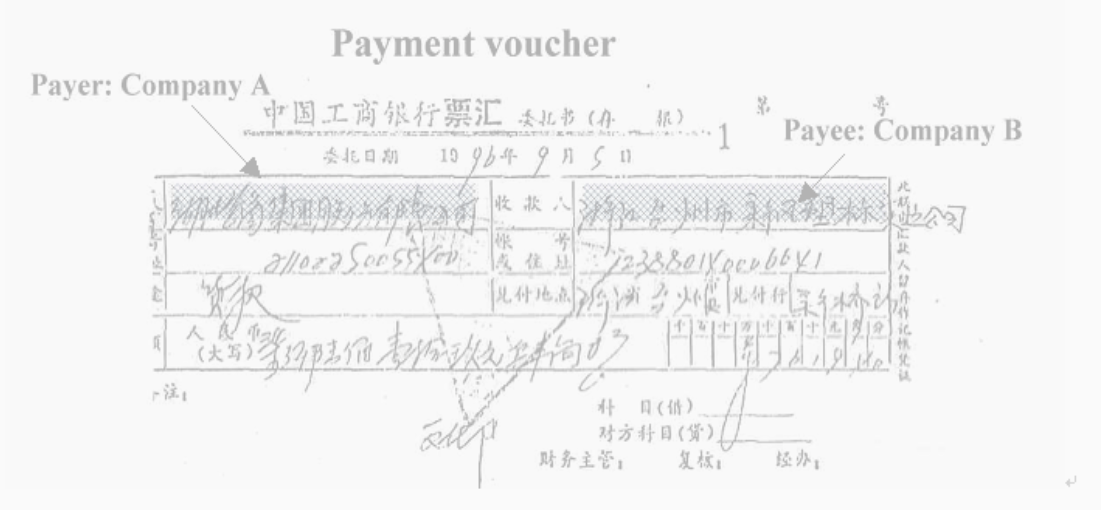


Figure 3.4.3 Evidence 3: the payment record for a real transaction

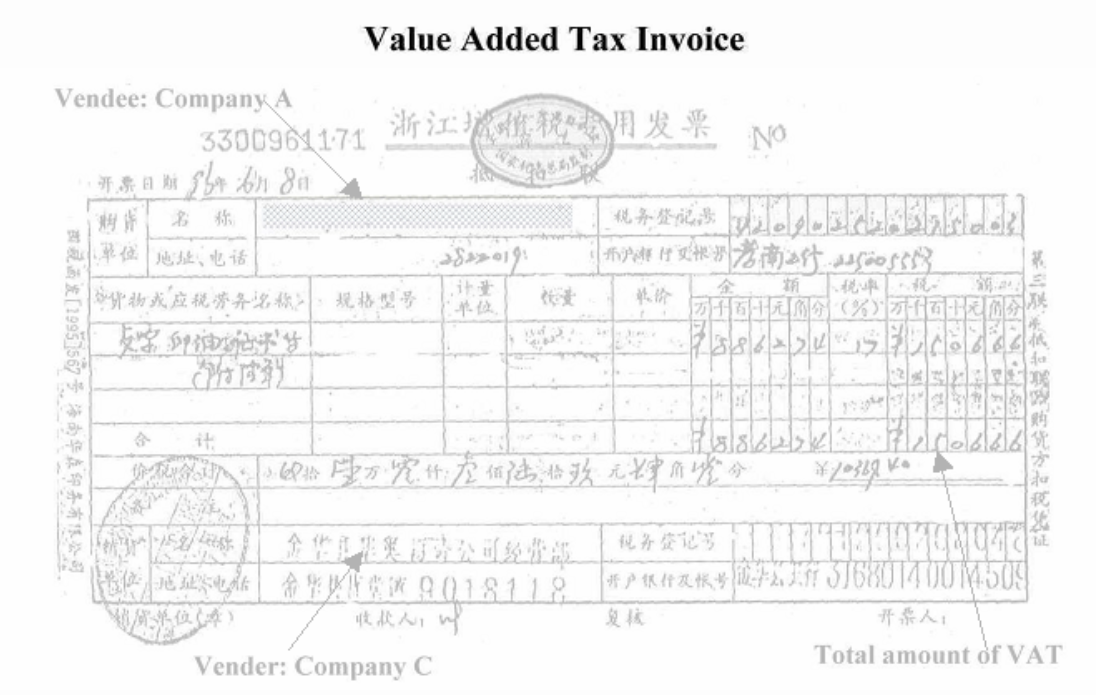


Figure 3.4.4 Evidence 4: fake VAT invoice issued by company C

Figures 3.4.2, 3.4.3, and 3.3.4 show us the following case:

Company A bought goods from company B, and they booked a deductible VAT of RMB1,506.66 on the debit side in their account records, as shown in Figure 3.4.2. The payment to company B for this transaction was done by company A with the

check shown in Figure 3.4.3. Figure 3.4.4 is a copy of the VAT invoice provided by company B, which includes RMB1,506.66 of VAT, but issued by company C. The tax auditor recognized that this VAT invoice was fake, because company A did not have any business with company C. In that case, the fake VAT invoice was then canceled, and company A had to pay all of the VAT, plus the same amount in fines, as punishment.

Conclusions

The conclusions concerning our clinical study are summarized below.

1. The tax audit is very useful for evaluating the amount of tax loss and disclosing the tax evasion situation, but the approach is so inefficient that it takes nine months for the tax auditors to investigate only 4% of the total taxpayers in Xiaogan.

2. Tax loss is a very serious situation in Xiaogan. The total amount of tax evasion can be up to 30% of total paid taxes. With limited resource for tax collection, tax authorities have to focus their attention on those taxpayers who are contributing the primary part of tax revenue, such as state firms, because they cause the most tax loss.

3. Greed is human nature; the possibility for taxpayers to evade taxes mainly depends on the allocation of benefits and easiness of tax evasion. Tax burden seems to be the main force to drive taxpayers into evading taxes, but almost no

impact on the amount of tax loss. The most effective way of controlling tax loss is to develop some countermeasures that can make tax evaders bear more costs that are even higher than the potential benefits.

4. Many cases in our investigation showed us that invoice counterfeiting has become the most popular way of evading value added taxes, because invoices are so easy to fabricate and difficult to identify. The best countermeasure against tax evasion is to find the most effective way of preventing fake invoices in China. This will be discussed in detail in the next chapter.

CHAPTER 4. AN EFFECTIVE METHOD FOR REDUCING TAX LOSS IN CHINA

According to our analysis in the previous chapters, tax loss has become a very serious problem in China; although the situation seems to be improving significantly because of the unremitting efforts of the government in recent years, tax loss is still high. In this last chapter, as a practical approach, we will contribute a countermeasure for reducing tax loss by using innovative information technology in China.

4.1 The Effective Way to Control Tax Loss

There are some potential methods to control tax loss; enforcing punishment and enhancing supervision are both useful actions to prevent tax evasion, but which one is more effective?

From the taxpayer's point of view, the expected income can be described as below:

(4.1.1) $In = It - T + Te - Ce - Pe$

Where;

In: Net income

It: Total income

T: Total taxes

Te: Taxes evaded

Ce: Cost of tax evasion

Pe: Fine for punishment of tax evasion

(4.1.2) $Pe = b*P$

Where,

b: Probability of being tracked by tax authority

P: Punishment for tax evasion

If Te = 0, that means no tax has been evaded. Ce and Pe will be 0, too, and then the net income for a taxpayer should be It – T.

The extra benefit arising from tax evasion is that Te – Ce – Pe. Ce + Pe represents the total cost of tax evasion, so the required condition for tax evasion is Te > Ce + Pe. Therefore, raising the fine for tax evasion seems to be a greater incentive for taxpayers to pay their taxes; the Chinese government has created statutes that penalize taxpayers who fail to comply with taxation administrative regulations. The principal penalties are summarized below.

Type of Violation	Basic Penalty	Penalty to Repeated Offender	Serious Offender
Failure to perform change or cancel tax registration	RMB 5000 or less	RMB 10000 or less	Criminal offense
Failure to submit accounting details	RMB 5000	RMB 10000	Criminal offense
Failure to submit tax or withholding tax returns or financial statements	RMB 5000 or less	RMB 10000 or less	Criminal offense
Failure to withhold tax or under-withhold tax	100% of tax	Not specified	Criminal offense
Failure to remit tax withheld	RMB 5000 or less	RMB 10000 or less	Criminal offense
Failure to pay tax despite repeated reminders	-	500% of tax unpaid or less	Criminal offense
Tax loss by concealment or deception	-	500% of tax unpaid or less	Criminal offense

Table 4.1.1 Principal penalties for non-compliance by income tax regulations

However, just enforcing the fine for tax evasion will not have a big impact on tax evaders unless there is also a greater possibility that they will be caught. While efforts for tax supervision are enhanced, tax evaders will have to make more efforts to hide their taxable income, which means that the associated expenses and probability of the punishment will obviously be increased. Hence, enforcing tax supervision can significantly increase the total cost for the tax evader and then prevents tax evasion effectively.

From the tax authority's point of view, the revenue model is best described as shown below:

(4.1.3) $Rn = Rt - Te - Ca - Cc + Pe$

where,

Rn: Net tax revenue

Rt: Total tax revenue

Te: Taxes evaded

Ca: Cost of tax supervision

Cc: Cost of tax collection

Pe: Fine for punishment of tax evasion

If there is no tax loss, this means that Te, Ca, and Pe all are 0, and the tax collector gets the maximum tax revenue, equal to Rt – Cc. (Cc+Ca-Pe). This represents the total cost of tax collection. Increasing the fine is the simplest and lowest-cost method of maximizing the total tax revenue, but it cannot exceed the tax evader's ability to pay, and the punishment will alarm tax evaders only slightly if tax supervision is not also enhanced simultaneously. Carrying out more tax supervision will require an increase in the budget that should be balanced by the reduction of tax loss. This means the cost of tax supervision should not exceed the reduction of tax loss.

Unfortunately, due to social issues in China, the inefficiency of the tax administration system always tends to counteract efforts on tax supervision. According to the Chinese taxation and administrative regulations, the State Administration of Taxation (SAT) and its the government entities are exclusively in charge of the general administration of taxation for the whole country. Performing tax audits, collections, and returns, conversely, are the responsibilities of its regional tax bureaus in their respective territories. In general, the state tax bureau and the

local tax bureau concurrently levy different taxes in every city. A new tax division system was introduced on March 1, 1996, making the state tax bureau responsible for the collection of value added tax, consumption tax, and foreign enterprise income tax, and the local tax bureaus responsible for collecting business taxes, individual income taxes, and land use taxes. However, the duty partition of the tax authorities is also subject to local variations. The taxation administration system in China is described below:

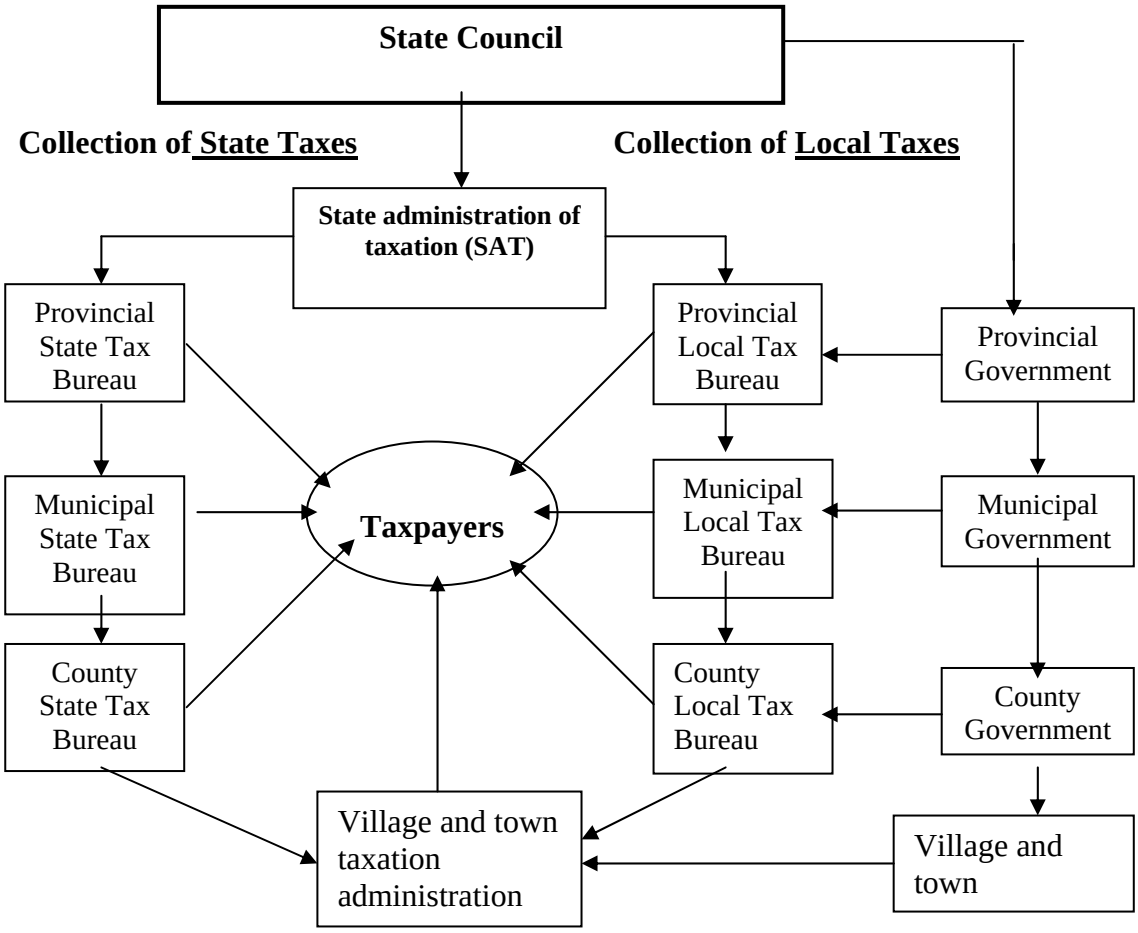


Figure 4.1.1 Block diagram of the tax collection system in China

There are two parallel tax administrations in China; competition between the central and local governments always hampers the efficiency of tax collection in many areas in China.

With respect to the above analysis, we believe that the best way to prevent tax loss is to develop an effective method for enhancement of tax supervision, while keeping costs as low as possible. Using information technology to prevent tax evasion may be the best choice in China.

4.2 The Most Effective Way of Preventing Tax Evasion in China

As discussed in previous chapters, VAT comprises the primary portion of the total tax revenue and is imposed at every stage of a business transaction. In China, a VAT invoice is the only recognized evidence of taxation; it carries all information about transactions and can be gradually used for VAT deduction. Therefore, forging VAT invoices has become the most popular method for people who wish to avoid paying their value added taxes. In order to counteract this situation, in the mid-1990s the Chinese government promulgated a new regulation that promoted an invoicing machine using information technology to prevent the forgery of VAT invoices, called the VAT invoicing terminal. The configuration of the terminal is shown below:

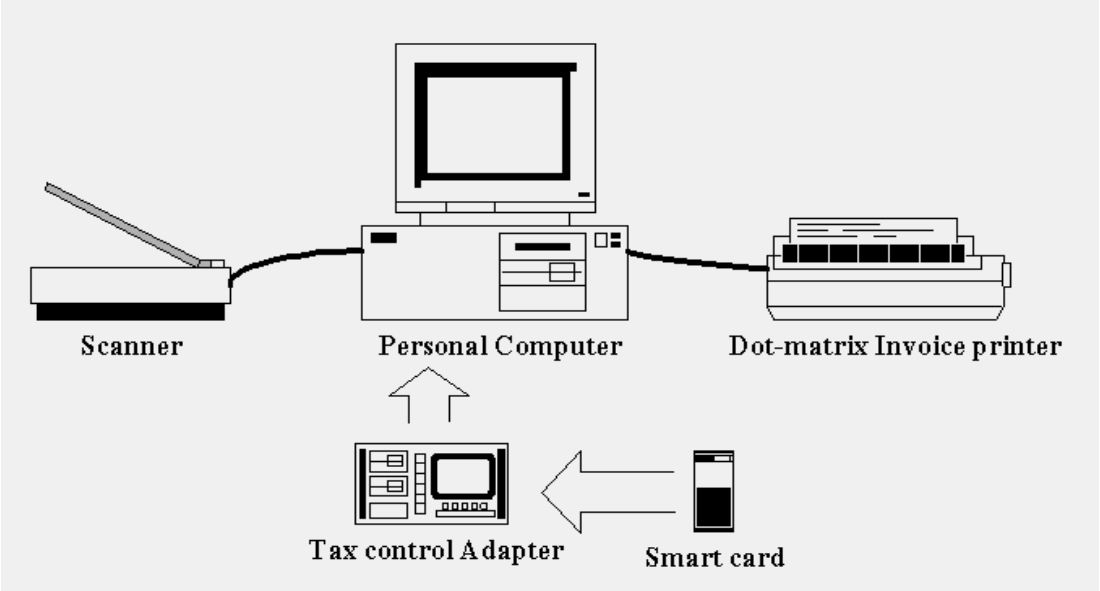


Figure 4.2.1 Configuration of a VAT invoicing terminal

The VAT invoicing terminal is a normal PC coupled with some peripherals, including a printer, a scanner, and a special device called a tax control adapter. The tax control adapter is a circuit board equipped with a digital signal processor used for data encryption, which is installed inside the PC. Based on the data relative to every transaction, the adapter can generate a security code, which includes all homologous information about this transaction printed on the VAT invoice. These data will also be saved as an electronic record for taxation purposes by means of a smart card inserted into the adapter. To prevent the forgery of invoices, all VAT invoices will be printed with a dot-matrix invoice printer and read back via the scanner. Using the VAT invoicing terminal, any forged invoice can be identified very easily. The following graphic shows a real sample of an anti-counterfeit invoice:

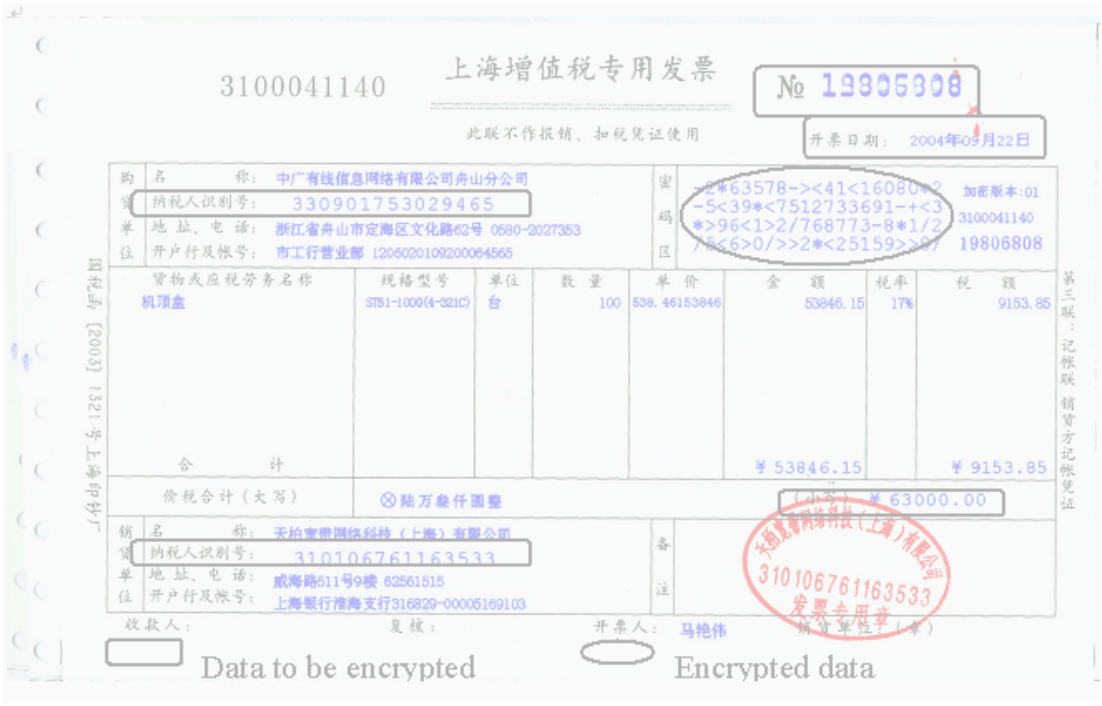


Figure 4.2.2 Sample of an anti-counterfeit VAT invoice

The terminal works as follows:

1. When a firm is set up, the taxpayer will apply for taxation registration, and the tax authorities will sell him a VAT invoicing terminal with some blank VAT invoices. The serial numbers on the blank invoices will be pre-recorded on the smart card, together with the invoicing terminal ID, and the VAT invoicing terminal will work only with those invoice numbers. This prevents taxpayers from using forged VAT invoices.
2. When a transaction is completed, the taxpayer will input all the necessary data into the computer to fill out the VAT invoice. Before the invoice is printed, the tax control adapter will extract all data related to taxation, and then generate a security code using the digital encryption algorithm. A number of data will be encrypted:

   Tax ID of seller and buyer,

VAT invoice series number,

Transaction volume and data, and

VAT volume.

The security code is also printed on the invoice as a necessary part of the formal VAT invoice, and all of the data printed on the invoice will be recorded on the smart card as evidence of taxation. Figure 4.3.2 shows a sample of the new VAT invoice. Because the security code can be decoded and recovered by the original non-encrypted data using the invoicing machine, any forged items on the invoice will miss-match with the recovered results. This is a very effective method of identifying forged invoices.

3. When new invoices are needed or the tax period rolls around, taxpayers have to bring their smart cards to the tax bureau. The tax collector will download and check all of the data recorded on the smart cards, and then reauthorize them. Because the data stored in the smart card can only be read by computer, the tax audit process will be very easy and effective.

In order to prevent VAT invoices from being forged, the government has stipulated that all VAT invoices must be issued by the VAT invoicing terminal; otherwise, they cannot be used as vouchers for taxation purposes. The government also requires all major VAT payers to install the terminal. Since 1995, more than 100,000 VAT invoicing machines have been sold and used as powerful tools against tax evasion in China. However, there are fundamental defects in the VAT invoicing terminal that have caused some serious problems in China.

In a typical case, according to a report from the Xinhua news agency, some taxpayers formed companies in Shantou, a mid-sized city in Guangdong province, in 1999. They registered for taxes, and bought VAT invoicing terminals from the local tax bureau using forged personal identification documents. These companies' only business was to issue VAT invoices based on fictitious transactions; taxpayers used the forged invoices to deduct VAT from the tax bureau in other areas. Because all of those invoices were issued by official invoice terminals, they were recognized and used for tax compensation over the whole country. A few months later, the regional tax collector went to collect taxes and discovered that all of the companies had been closed. According to statistics, about 16 billion false VAT invoices were issued using these terminals, and the total tax loss for the country was over 270 million RMB. In the last few years, this kind of situation has occurred frequently in different cities in China. The VAT invoicing terminal has become a dangerous weapon against government tax revenue.

The major problem with the VAT invoicing terminal is that there is no way to control a taxpayer's activities in advance. The terminal provides anti-counterfeit invoices, but it cannot ensure that the taxes will be paid.

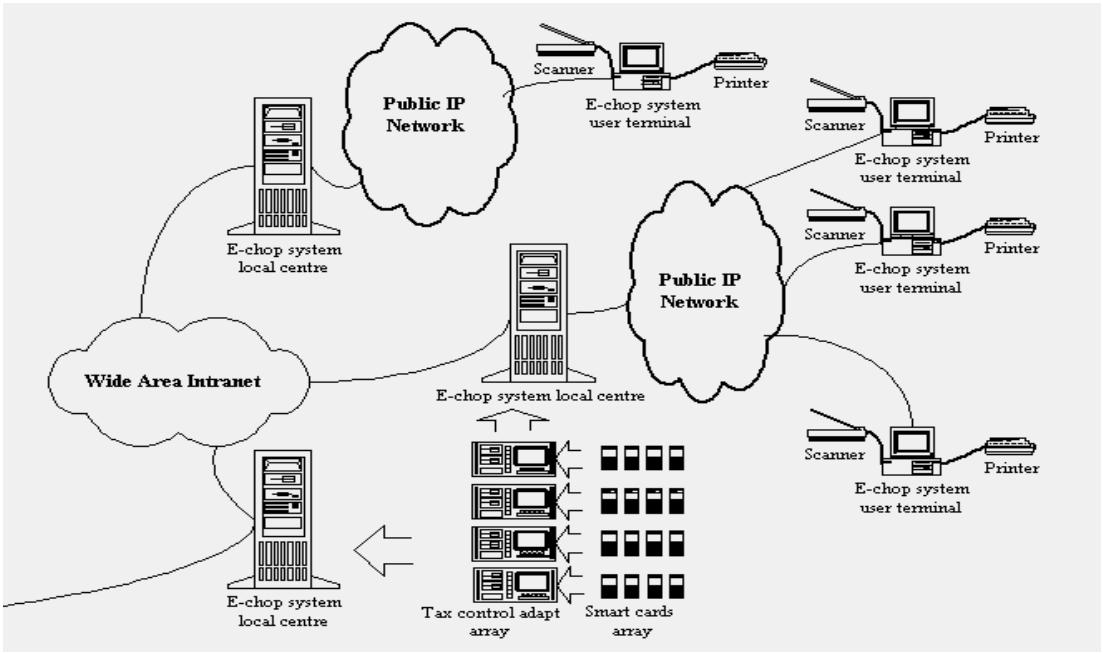


Figure 4.2.3 Configuration of anti-counterfeit VAT invoicing system

Unlike the VAT invoicing terminal, the new anti-counterfeit VAT invoicing system, which is named as E-chop system and whose configuration is shown in figure 4.2.3, is a network-based distribution system. The user terminal could be a low-end PC with a dot matrix printer and a communication interface to the local taxation center. All the necessary data for a formal VAT invoice are filled in using the PC, and are then transferred to a local e-chop system center, which is controlled by tax authority in local via the IP network. The local VAT center is equipped with a VAT control array that combines dozens of processors and smart cards, which are similar things already used for individual VAT invoicing terminals. When a transaction takes place, all data on the VAT invoice have to be sent to the local e-chop center and processed using the VAT control array; the encrypted security code generated by the control array is then sent back to the user terminal and printed on the VAT invoice. The whole procedure is the same as that with the VAT invoicing terminal, but all invoices

have to be issued under direct monitoring by the tax authority. If the creditability of taxpayers is not trusted, according to their prepaid VAT, the tax authority can limit the total value of VAT invoices that they can issue. The local center can handle a large number of transactions simultaneously, because the number of processors and smart cards can be easily increased based on the working load.

Using VAT invoicing system, all local centers in China can be linked together and any transaction data will be automatically collected for taxation purposes before a VAT invoice is issued. Based on this system, tax authorities will not only control tax collection more effectively, but also carry out real-time online audits throughout the country.

Postscript

Through unremitting hard work over the last seven years, we have successfully developed a new methodology and two approaches to evaluate the amount of tax loss, and our analysis results show that they are satisfyingly accurate and feasible for China. This thesis disclosed the situation regarding tax loss, the probability of tax evasion, the relationship between tax loss and its potential causes; it also described a new countermeasure against tax evasion in China. Our research led us to believe that there is no way to stop tax loss entirely, but that tax loss can be controlled more effectively with information technology. As circumstantial evidence, in 2004 the Chinese government also started to deploy a tax control POS (Point of Sale) system, which used the similar configuration that has been proposed in this thesis. It connects

with the regional tax control center for online certification via the IP network. This idea has become the most important component of the system specifications issued by the State Authority of Taxation, which is a great reward for our ongoing efforts over the past several years.

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