Discussion Papers In Economics And Business

Intergovernmental Fiscal Relationships in China:

A Simple Model Based on the Nonsymmetric Nash Solution

Mototsugu FUKUSHIGE and Yingxin SHI

Discussion Paper 13-21

Graduate School of Economics and
Osaka School of International Public Policy (OSIPP)
Osaka University, Toyonaka, Osaka 560-0043, JAPAN

Intergovernmental Fiscal Relationships in China:
A Simple Model Based on the Nonsymmetric Nash Solution

Mototsugu FUKUSHIGE and Yingxin SHI

Discussion Paper 13-21

August 2013

Graduate School of Economics and
Osaka School of International Public Policy (OSIPP)
Osaka University, Toyonaka, Osaka 560-0043, JAPAN

Intergovernmental Fiscal Relationships in China:

A Simple Model Based on the Nonsymmetric Nash Solution [*]

Mototsugu FUKUSHIGE
Graduate School of Economics, Osaka University
1-7, Machikaneyama-cho, Toyonaka, Osaka 560-0043, Japan

Yingxin SHI
Department of Economics & Management, Dalian Nationalities University
18, Liaohe West Road, Jinzhou New Area, Dalian 116600, China

Abstract

We propose a new empirical approach to analyzing fiscal decentralization and apply it to Chinese intergovernmental fiscal relationships between the central government and provincial governments. In calculating budgetary revenue and expenditure shares, we include extra budgetary revenue and expenditure. We find that although an increase in either income inequality or real per capita GDP lowers local governments' bargaining power within the budgetary system, local governments can offset this by obtaining more bargaining power over extra budgetary expenditures. Another finding is that although urbanization increases provincial governments' budgetary revenues, it also restricts the scope for further budgetary expenditure.

JEL Classification: H77, D72, P35.

Keywords: nonsymmetric Nash bargaining, intergovernmental fiscal relationships, China

---

[*] Shi is grateful to SEAC (2013-GM-022) and DLNU (ZJ13RWYB002) for their financial support of the joint research on this topic with Fukushige and Fukushige is grateful to the Japan Society for the Promotion of Science (Grant-in-Aid for Scientific Research A 23243038) for their financial support. Fukushige is also grateful to Professor Noritsugu Nakanishi for his helpful suggestions about nonsymmetric Nash Bargaining solution.

1. Introduction

Having been established after World War Two, (the People's Republic of) China has a history of only 60 years, as have its intergovernmental relationships, which have been changing rapidly, as Man (2011) has pointed out. China has five layers of government, and intergovernmental transfers flow from higher to lower levels of government. If we limit our attention to central–provincial intergovernmental relations, there are several types of intergovernmental fiscal transfer systems, such as the fiscal contract systems that existed between 1979 and 1993, and the fiscal sharing system that has existed since 1994. Revenue and expenditure shares have changed dramatically following the decentralization of the 1980s and by revenue recentralization and expenditure decentralization from 1994. Figure 1 illustrates the trends in local government's shares of revenue and expenditure, both with and without extra budgetary revenues and expenditures. These historical changes complicate the assignment of central and local government responsibilities. (See, for example, Martinez-Vazquez and Qiao (2011) for a discussion.)

Several researchers have investigated these historical changes and their determinants. Of course, no researcher can explain these changes consistently or establish a rule in relation to them. Huang and Chen (2012) pointed out that there is no systematic rule for distributing fiscal

transfers from the central to provincial governments. As Zhang and Zou (1998) pointed out, variations among provinces are too large to form a simple rule or to introduce some incentive mechanism; for example, based on theoretical insights from fiscal federalism.

In this paper, we develop a new approach to analyzing nonsymmetric Nash bargaining. Our approach involves restricting bargaining between the central government and provincial governments over shares of fiscal revenues and expenditures. This simple approach differs from those adopted by researchers on fiscal federalism, or decentralization, but enables us to shed new light on intergovernmental fiscal relationships.

The outline of the paper is as follows. In Section 2, we survey the literature on fiscal federalism, or decentralization, and intergovernmental relationships in China. In Section 3, we develop a two-person bargaining game and use its first-order condition to develop a simple econometric model. In Section 4, we conduct an empirical investigation. In Section 5, we conclude the paper and discuss remaining issues.

2. Literature Survey of Intergovernmental Fiscal Relationships

Much theoretical and empirical investigation of fiscal federalism, or decentralization, followed the seminal paper on fiscal federalism by Oates (1968). Weingast (2009) categorized these studies into first- and second-generation studies based on their theoretical assumptions.

However, from the empirical researcher's point of view, there are two types of studies of fiscal federalism, or decentralization. In one type, the consequences of fiscal federalism, or decentralization, are investigated. In the other type, degrees and causes of fiscal decentralization are investigated.

Examples of the former include the study of Woller and Phillips (1998), who investigated the effect of decentralization on less developed countries' economic growth, and Davoodi and Zou (1998), who investigated the same effect by using panel data on 46 countries. In the Chinese context, Jin et al. (2005), Chen (2013), and Zhang and Zou (1998), who all use panel data, and Zhang (2006), who uses so-called growth regression, investigated the relationship between the fiscal decentralization and economic growth. Feltenstein and Iwata (2005) investigated the effects of economic and fiscal decentralization on macroeconomic indicators such as economic growth and inflation. In the context of China's recent rapid economic growth, Qian and Roland (1998) concluded that China's recent good economic performance was led by the combination of political centralization and the fiscal decentralization of the Chinese Central Government. Zhang (2006) and Zheng et al. (2013) also stress the role of political considerations in China's recent high economic growth. Tochkov (2007) and Tsui (2005) investigated the effects on the dispersion of local governments' expenditures of fiscal transfers by the central

government to local governments. Wei (1996), Kanbur and Zhang (2005), and Huang and Chen (2012) investigated the effects of central government transfers on regional income inequality.

Oates (1972, Chapter 5), who investigated the revenue share of the central government, was one of the first to investigate the degrees and causes of fiscal decentralization. For the purpose of making international comparisons, Panizza (1999) used cross-sectional data on 57 countries to investigate the determinants of fiscal centralization. Arzaghi and Henderson (2005) used panel data on 48 countries to conduct a similar analysis. In relation to the Chinese case, only Zhang and Zheng (2011) and Lin (2011) have investigated the rules governing central government fiscal transfers to local governments. There has so far been no empirical investigation of the factors enabling such fiscal decentralization, or recentralization, or of the economic determinants of such historical movements.

3. The Nonsymmetric Nash Solution and Empirical Modeling

Although Tsui and Wang (2008) developed a game theoretic model of Chinese decentralization, theirs is a theoretical study that lacks empirical investigation. We know of no empirical study in which central and local government fiscal shares are determined based on a game theoretic analysis in which several local governments participate in the bargaining, and each government, including the central government, tries to maximize its objective function.

Such a bargaining model is not easy to implement empirically because of the difficulty of forming a simple estimable equation. In this paper, to simplify bargaining between the central government and several local governments, we develop a two-person bargaining game, in which the central government is one player, and the group of provincial governments is the other player. Then, we use the nonsymmetric Nash solution for the budgetary shares of the central government and the groups of local governments. Denoting the local governments' budget share by R implies that the central government's share is $(1 - \mathrm{R})$. Based on these shares, we set up a nonsymmetric Nash solution as the maximization of the following objective function:

$$\mathrm{R}^{\mathrm{p}}(1 - \mathrm{R})^{1-\mathrm{p}}. \tag{1}$$

This type of function was originally introduced by Kalai (1977). (For details, please refer to Myerson, 1991, pp. 390–394.) However, in this paper, we set both the central and local governments' threshold points to zero. In this model, p represents the relative bargaining power of the local government group. Hence, the central government's relative bargaining power is $1 - \mathrm{p}$. The first-order condition for maximizing the objective function is

$$\frac{R}{1-R} = \frac{p}{1-p}. \tag{2}$$

It is assumed that p is between zero and unity. Given the history of power politics between central and local government, p should vary over time. Hence, we write p as p_t. To simplify the specification of the estimating equation, we further assume that p_t can be approximated by using the following cumulative logistic distribution function:

$$\mathrm{p}_t = \frac{e^{Z_t}}{1+e^{Z_t}}. \tag{3}$$

In addition, we assume that Z_t is a linear function of our independent variables, as follows:

$$Z_t = x_t{}'\beta, \tag{4}$$

where x_t and β are column vectors of the independent variables and their coefficients, respectively. By using equations (3) and (4), equation (2) can be rewritten as

$$\frac{\mathrm{R}_t}{1-\mathrm{R}_t} = e^{x_t{}'\beta}.$$

Logarithmic transformation and the addition of an error term yield

$$ln\left(\frac{\mathrm{R}_t}{1-\mathrm{R}_t}\right) = x_t'\beta + u_t. \tag{5}$$

This is the well-known logistic transformation from econometrics. The dependent variable is similar to the logarithmically transformed decentralization index used by Zhang and Zou (1998). To be specific, they used the ratio of the local governments' expenditures to central government

expenditures as an index of decentralization in their regression model of China's economic growth. Although the index in (5) is not mentioned in the comprehensive discussions of decentralization indices by Zhang and Zou (1998) and Vo (2008), it is intuitively appealing as an index of decentralization. Therefore, estimating equation (5), and its expenditure version described in the next section, constitutes empirical research on the determinants of fiscal decentralization. This is confirmed by the fact that p_t is the parameter that determines the fiscal share of local governments in our bargaining model.

4. Estimation of Intergovernmental Relationships

4.1 Econometric Model

The two shares that represent intergovernmental budgetary relationships are the revenue share and the expenditure share. We restate the revenue share of the local governments group as R and define the expenditure share of the local governments group as E. To simplify the equations, we rewrite equation (5) in terms of the dependent variables E and R as follows:

$$y_{1,t} = ln\left(\frac{\mathrm{R}_t}{1-\mathrm{R}_t}\right) \text{ and } y_{2,t} = ln\left(\frac{\mathrm{E}_t}{1-\mathrm{E}_t}\right).$$

These two equations form the following system of equations for the budgetary shares:

$$y_{1,t} = x_{1,t}'\beta_1 + \varepsilon_{1,t}$$
$$y_{2,t} = x_{2,t}'\beta_2 + \varepsilon_{2,t}' \quad (6)$$

which can be estimated by using the Seemingly Unrelated Regressions (SUR) estimator or another simultaneous-equations estimator. If any of the independent variables are correlated with the error terms, we should apply the instrumental variables (IV) method. To deal with heteroscedasticity and moving average (MA)-type serial correlation in the error terms, we apply generalized method of moments (GMM) estimation to this system of equations.

4.2 Data

We initially calculated the shares of central and local government's fiscal expenditure and revenue for the period 1982–2008 from the Finance Yearbook of China 2012. Defining these fiscal shares requires careful handling of extra budgetary revenues and expenditures. Tsui (2005) and Tochkov (2007) pointed out the reverse effects of central government budgetary transfers and extra budgetary funds on local governments' expenditures. In the next section, we estimate models based on including and excluding extra budgetary items from the shares.

We use eight independent variables: population; real per capita gross domestic product (GDP); real economic growth; inflation; the central government's fiscal deficit; trade openness; the degree of urbanization; and regional income inequality. Below, we explain the rationale for using these independent variables.

Population: This is the national population. Based on cross-sectional analysis of international data, Panizza (1999) found that population size positively affects fiscal decentralization.

Real per capita GDP: Based on cross-sectional analysis of international data, Panizza (1999) found that national income positively affects fiscal decentralization. To allow this variable to have a nonlinear effect on the dependent variable, we used not only real per capita GDP but also its square. Real per capita GDP is calculated by dividing nominal per capita GDP (in 100 million yuan) by the consumer price index (CPI) (1950 = 100).

Economic growth: Because economic growth may affect the central governments' fiscal transfers, we include the annual growth rate of real GDP.

Inflation: Cukierman et al. (1992), for example, pointed out that seigniorage and taxation are substitutable. Hence, inflation affects the bargaining power of the central government through the central government's seigniorage.

Central government's fiscal deficit: Among others, Ahmad (1997, p. 643) and Bahl (1999, p. 75) pointed out that local governments are not permitted to run deficits legally. Although the local governments can bypass this restriction to finance deficits by borrowing money from the market, the central government's fiscal deficit still affects its relative bargaining power.

Trade openness: Trading activity by China's coastal provinces has contributed to its recent rapid economic growth. Therefore, trade promotion may affect the relative bargaining power of the central government and the local government group. There are several ways of measuring trade openness, or trade liberalization (see, for example, Harrison, 1996, and Yanikkaya, 2003). Because of data availability, we use the trade share as a measure of trade openness.

Degree of urbanization: Because Wagner's Law (see Bird, 1971) suggests that urbanization increases the needs for public spending, the degree of urbanization may affect the relative bargaining power of the central government and the local government group.

Regional income inequality: Under fiscal federalism, an important role of the central government is to ease regional economic inequality. If China's central government is to achieve its goal of a "Harmonious Society", then not only income redistribution but also fiscal redistribution is important. To measure regional income inequality, we use Atkinson's (1970) inequality index. To measure income inequality between China's provinces, given population weights for each region ($w_i, \quad i = 1,2,...,M$), the Atkinson measure is

$$A = 1 - \left[\frac{1}{N} \sum_{i=1}^{M} w_i \left(\frac{x_i}{\mu} \right)^{1-\varepsilon} \right]^{\frac{1}{1-\varepsilon}}, \text{ for } \varepsilon > 0 \text{ and } \varepsilon \neq 1,$$

$$A = 1 - \exp\left(\frac{1}{N}\sum_{i=1}^{M} w_i \ln\left(\frac{x_i}{\mu}\right)\right), \text{ for } \varepsilon = 1,$$

where w_i and x_i are the population weights and the average income of the *i*th province, respectively, μ is national average income, and N is the total population. The parameter ε represents the degree of inequality aversion. Atkinson's original measure of ε is based on the social welfare function and represents the degree of inequality aversion, which reflects relative sensitivity to income transfers at different income levels. When ε is high, the weight assigned to an individual with a relatively low (high) level of income is large (small). When $\varepsilon = 0$, which is an extreme case, individuals are indifferent to income redistribution. Treating the social welfare function in this way is an advantage of the Atkinson measure. We obtained the required data from the China Compendium of Statistics 1949–2008, compiled by the Department of Comprehensive Statistics of the National Bureau of Statistics (2010). For estimation, we calculated A based on three different values ($\varepsilon = 0.1,\ 0.5,$ and 0.9). We also used A^2 to allow for a potentially nonlinear effect of the Atkinson measure.

Table 1 defines the independent variables and reports their data sources, and Table 2 reports their summary statistics and those of the dependent variable.

4.3 Estimation Results

To estimate the system of equations given by (6), we used SUR and selected the independent variables based on the Akaike Information Criterion (AIC). To check the robustness of the estimation results, we estimated the chosen model by using the IV method and GMM. To apply the IV method in three stages, we first constructed the instruments, then estimated each equation, and then estimated the system of equations. (The method is often referred to as "three stage least squares".) For both IV and GMM estimation, we used lagged independent variables as instruments. We used one lag of the independent variables for IV and used two lags for GMM; this is because we needed one MA lag for the error terms. We used two types of fiscal shares for the dependent variables: budgetary revenue and expenditure shares based on excluding and including extra budgetary revenues and expenditures. Figure 1 illustrates both. They exhibit similar trends, but there are apparent differences over time. As mentioned earlier, Tsui (2005) and Tochkov (2007) pointed out the reverse effects of central government budgetary transfers and extra budgetary funds on local governments' expenditures

Table 3 reports the estimation results for the budgetary shares, and Table 4 reports the results of the robustness checks. The sample period covered is from 1982 to 2008, primarily because of data availability on Atkinson's measure and on extra budgetary revenues and

expenditures. Table 5 reports estimation results based on including extra budgetary revenues and expenditures in the shares, and Table 6 reports the results of the robustness checks. In all cases, the model that includes the Atkinson measure "Atkins09" generates the lowest AIC, so we report only these results. Before discussing the sources of relative bargaining power, we make two points. The first relates to the goodness of fit of the estimated equations. Whether extra budgetary items are included or excluded, the estimated revenue functions do not fit the data well. This may be because the shares changed dramatically between 1993 and 1994. Unobservable political factors may have affected these shares. When extra budgetary items are included, the fit of the revenue function deteriorates. This suggests that political factors might have played a role in determining extra budgetary revenue. The second point concerns the robustness of the estimation results. According to the robustness checks reported in Tables 4 and 6, with some exceptions, the estimated coefficients have the same signs, are of similar magnitudes, and are equally statistically significant. Exceptions are the coefficients of "Def" in the budgetary expenditure function and the revenue function based on including extra budgetary items. In the budgetary share function, the robustness checks generate larger coefficients of "Growth", "Infl", and "Atkins09" than before. In the expenditure function based on including extra budgetary items, following the robustness checks, the coefficient of "Pgdp" increases, and that of "Growth"

decreases. These changes might signal some correlation between the independent variables and the error term.

Comparing the estimated coefficients based on including and excluding extra budgetary items reveals three main findings. First, in the expenditure functions, the coefficients of "Atkins09" are negative when excluding extra items but positive when including them. (The variable is not selected for the revenue functions.) This suggests that an increase in income inequality does not affect revenue shares but does reduce local governments' budgetary expenditure shares. This may be because greater income inequality lowers local governments' bargaining power within the budgetary system. However, this reduced bargaining power is offset by gaining more bargaining power over extra budgetary expenditures. This is consistent with Tochkov's (2007) finding relating to the smoothing of provincial expenditures. Second, the coefficients of "Pgdp" are negative in the budgetary expenditure functions when excluding extra budgetary items but are positive when including them. Our interpretation of this is based on consideration of the coefficient of "Growth" in the expenditure function based on including extra items. As with "Atkins09," although an increase in real per capita GDP lowers local governments' relative bargaining power within the budgetary system, this decrease is offset by the extra bargaining power over extra budgetary expenditures. However, the latter additional bargaining power is abated when macroeconomic performance is good (when economic growth is high). The

third finding relates to the coefficients of "UrbanR". This variable has a positive coefficient in both the budgetary revenue function (without extra items) and the budgetary expenditure function (including extra items), but otherwise, the variable is not selected by the AIC. This suggests that although urbanization increases budgetary revenues for provincial governments, it also narrows the scope for extra budgetary expenditures; hence, urbanization lowers local governments' relative bargaining power over extra budgetary expenditure.

5. Conclusion

In this paper, we proposed a new empirical approach to analyzing fiscal decentralization and applied it to Chinese intergovernmental fiscal relations. In calculating the budgetary shares of the central and provincial governments, we included extra budgetary revenues and expenditures. We obtained a number of important findings. First, an increase in income inequality reduces the relative bargaining power of local governments within the budgetary system. However, this reduction is offset by additional bargaining power over extra budgetary expenditures. Second, an increase in real per capita GDP reduces local governments' relative bargaining power within the budgetary system. This reduction is offset by additional bargaining power over extra budgetary expenditures but to a lesser extent when macroeconomic performance is good. Third, although urbanization increases budgetary revenues for provincial governments,

it also narrows the scope for extra budgetary expenditures, and hence, urbanization lowers the relative bargaining power of local governments in determining extra budgetary expenditures.

Our analysis has limitations. First, we used a simple model to analyze bargaining between the central government and a group of local governments. A model that explains the bargaining process between the central government and local governments simultaneously would be more complex but more applicable to actual data. We plan to do this in the future. A second problem relates to the short period covered by our study (1982–2008), which was limited by data availability on extra budgetary shares and the Atkinson measure of inequality. If more past data on extra budgetary shares become available, and as more data are accumulated in the future, we can reestimate our models and obtain more robust results. This remains a task for future research.

References

Ahmad, E., 1997. China, in: Ter-Minassian, T. (Ed.), Fiscal Federalism in Theory and Practice. IMF, Washington, DC, pp. 634–659.

Arzaghi, M., Henderson, J. V., 2005. Why countries are fiscally decentralizing. J. Public Econ. 89, 1157–1189.

Atkinson, A. B., 1970. On the measurement of inequality. J. Econ. Theory 2, 244–263.

Bahl, R., 1999. Fiscal Policy in China: Taxation and Intergovernmental Fiscal Relations. The 1999 Institute, San Francisco.

Bird, R. M., 1971. Wagner's "law" of expanding state activity. Public Finance 40, 1–26.

Chen, C. H., 2013. Fiscal decentralization, collusion and government size in China's transitional economy. Appl. Econ. Lett. 11, 699–705.

Cukierman, A., Edwards, S., Tabellini, G., 1992. Seigniorage and political instability. Amer. Econ. Rev. 82, 537–555.

Davoodi, H., Zou, H., 1998. Fiscal decentralization and economic growth: a cross-country study. J. Urban Econ. 43, 244–257.

Feltenstein, A., Iwata, S., 2005. Decentralization and macroeconomic performance in China: regional autonomy has its costs. J. Develop. Econ. 76, 481–501.

Harrison, A., 1996. Openness and growth: a time-series, cross-country analysis for developing countries. J. Develop. Econ. 48, 419–447.

Huang, Y., 1996. Central–local relations in China during the reform era: the economic and institutional dimensions. World Develop. 24, 655–672.

Jin, H., Qian, Y., Weingast, B. R., 2005. Regional decentralization and fiscal incentives: federalism, Chinese style. J. Public Econ. 89, 1719–1742.

Kalai, E., 1977. Nonsymmetric Nash solutions and replication of 2-person bargaining. Int. J. Game Theor. 6, 129–133.

Kanbur, R., Zhang, X., 2005. Fifty years of regional inequality in China: a journey through central planning, reform and openness. Rev. Develop. Econ. 9, 87–106.

Lin, S., 2011. Central government transfers: for equity or for growth?, in: Man, J. Y, and Hong, Y.-H. (Eds.), China's Local Public Finance in Transition. Lincoln Institute of Land Policy, Cambridge, MA, pp. 203–226.

Man, J. Y., 2011. Local public finance in China: an overview, in: Man, J. Y, and Hong, Y.-H. (Eds.), China's Local Public Finance in Transition. Lincoln Institute of Land Policy, Cambridge, MA, pp. 3–17.

Martinez-Vazquez, J., Qiao, B., 2011. Assessing the assignment of expenditure responsibilities, in: Man, J. Y, and Hong, Y.-H. (Eds.), China's Local Public Finance in Transition. Lincoln Institute of Land Policy, Cambridge, MA, pp. 21–40.

Myerson, R. B., 1991. Game Theory: Analysis of Conflict. Harvard University Press, Cambridge, MA.

Oates, W. E., 1968. The theory of public finance in a federal system. Canadian J. Econ. 1, 37–54.

Oates, W. E., 1972. Fiscal Federalism. Harcourt Brace Jovanovich, New York.

Panizza, U., 1999. On the determinants of fiscal centralization: theory and evidence. J. Public Econ. 74, 97–139.

Qian, Y., Roland, G., 1998. Federalism and the soft budget constraint. Amer. Econ. Rev. 88, 1143–1162.

Tochkov, K., 2007. Intergovernmental transfers and the smoothing of provincial expenditure in China. China Econ. Rev. 18, 54–65.

Tsui K., 2005. Local tax system, intergovernmental transfers and China's local fiscal disparities. J. Comp. Econ. 33, 173–196.

Tsui, K., Wang, Y., 2008. Decentralization with political trump: vertical control, local accountability and regional disparities in China. China Econ. Rev. 19, 18–31.

Vo, D., 2008. The economics of measuring fiscal decentralization, part II: new fiscal decentralization indices. Discussion Paper 08:14, The University of Western Australia.

Wei Y. A., 1996. Fiscal systems and uneven regional development in China, 1978–1991. Geoforum. 27, 329–344.

Weingast, B. R., 2009. Second generation fiscal federalism: the implication of fiscal incentives. J. Urban. Econ. 65, 279–293.

Woller, G. M., Phillips, K., 1998. Fiscal decentralization and LDC economic growth: an empirical investigation. J. Develop. Stud. 34, 139–148.

Yanikkaya, H., 2007. Trade openness and economic growth: a cross-country empirical investigation. J. Develop. Econ. 72, 57–89.

Zhang, L., Zheng, X., 2011. The determinants of intergovernmental transfer, in: Man, J. Y, and Hong, Y.-H. (Eds.), China's Local Public Finance in Transition. Lincoln Institute of Land Policy, Cambridge, MA, pp. 191–202.

Zhang, T., Zou, H., 1998. Fiscal decentralization, public spending, and economic growth in China. J. Public Econ. 67, 221–240.

Zhang, X., 2006. Fiscal decentralization and political centralization in China: implications for growth and inequality. J. Comp. Econ. 34, 713–736.

Zheng, X., Li, F., Song, S., Yu, Y., 2013. Central government's infrastructure investment across Chinese regions: a dynamic spatial panel data approach. China Econ. Rev., forthcoming.

Table 1. Data Sources

Data for Independent Variables	Definition	Source
Population (Pop)	National population	China Statistical Yearbook
Real per capita GDP (Pgdp)	$\frac{1000 \times \text{GDP (100 million yuan)}}{\text{CPI } (1950 = 100) \times \text{Population}}$	China Statistical Yearbook
Economic growth rate (Growth)	Annual rate of change in real GDP	China Statistical Yearbook
Inflation rate (Infl)	Annual rate of change in CPI (1950 = 100)	China Statistical Yearbook
Central government's fiscal deficit (Def)	$\frac{\text{Government expenditure} - \text{Government revenue}}{\text{Government expenditure}}$	China Statistical Yearbook
Economic openness (Open)	$\frac{\text{National exports} + \text{national imports}}{\text{Nominal GDP}}$	China Statistical Yearbook
Degree of urbanization (UrbanR)	Proportion of urban population	China Statistical Yearbook
Regional income inequality (Atkins0x)	Given in main text	China Compendium of Statistics 1949–2008

Table 2. Summary Statistics

Variables	Mean	Standard Deviation	Maximum	Minimum
$ln\left(\frac{R_t}{1-R_t}\right)$	0.2457	0.4471	–0.2290	1.2646
$ln\left(\frac{R_t}{1-R_t}\right)$: including extra budgetary revenues	0.3908	0.2629	0.0471	1.3361
$ln\left(\frac{E_t}{1-E_t}\right)$	0.7658	0.3338	–0.1559	1.3058
$ln\left(\frac{E_t}{1-E_t}\right)$: including extra budgetary expenditures	0.8505	0.3599	0.1341	1.3900
ln(Pop)	11.6942	0.0793	11.5425	11.7966
Pgdp	1.1272	0.7455	0.3423	2.9896
Growth	0.1024	0.0440	–0.0427	0.1768
Infl	0.0621	0.0685	–0.0140	0.2408
Def	0.0670	0.0444	–0.0309	0.1568
Open	0.3787	0.1486	0.1442	0.6652
UrbanR	0.3230	0.0758	0.2162	0.4568
Atkins01	0.0107	0.0012	0.0083	0.0127
Atkins05	0.0506	0.0062	0.0387	0.0607
Atkins09	0.0857	0.0114	0.0651	0.1038

Table 3. Estimation Results for the Budgetary Shares

	Full Model		Model Selected by AIC	
Variables	Revenue Function	Expenditure Function	Revenue Function	Expenditure Function
Constant	–70.9584*	–75.1135**	–80.7280**	–85.6846**
	(–2.017)	(–4.819)	(–2.861)	(–12.229)
ln(Pop)	5.27796	6.33183**	6.86135**	7.50318**
	(1.701)	(4.508)	(2.825)	(12.327)
Pgdp	–9.32810*	–2.02503	–6.28150**	–.284383**
	(–2.269)	(–1.544)	(–4.041)	(–4.608)
$Pgdp^2$	.340996	.340996	1.13467**	
	(1.281)	(1.281)	(3.934)	
Growth	2.79449	–.628439	3.00981**	
	(1.746)	(–1.215)	(2.596)	
Infl	.949975	.621916		.968167**
	(.812)	(1.295)		(4.162)
Def	–4.39256	–3.76381**	–3.82925	–3.07697**
	(–1.746)	(–4.610)	(–1.899)	(–4.751)
Open	.911166	.203543		
	(.570)	(.453)		
UrbanR	32.7653*	5.40209	17.6969**	
	(2.413)	(1.423)	(2.714)	
Atkins09	138.005	42.6128		–76.6489**
	(.940)	(1.449)		(–3.973)
$Atkins09^2$	–768.463	–14392.6		
	(–.925)	(1.281)		
R^2	.7619	.9555	.7323	.9481
S.E.	.2139	.0689	.2268	.0745
LM-hetero	.0453	.996	.258	2.716
Durbin–Watson	2.233	2.019	1.915	1.755
AIC	–30.105		–42.572	
Log likelihood	37.052		34.176	

Notes: ** and * denote statistical significance at 1% and 5%, respectively.

Total number of observations is 26.

Log likelihood value is produced by the LSE calculation in TSP 5.0.

Table 4. Robustness Checks for the Budgetary Shares

	IV Method		GMM	
Instruments	Lagged independent variables with one lag in Full Model in Table 3		Lagged independent variables with two lags in Full Model in Table 3	
No. of MA lags NMA)	–		NMA = 1	
Variables	Revenue Function	Expenditure Function	Revenue Function	Expenditure Function
Constant	–114.604**	–78.7209**	–63.3838*	–80.2603*
	(–2.867)	(–7.150)	(–2.511)	(–2.511)
ln(Pop)	9.63791**	6.89898**	5.34143*	7.04700**
	(2.816)	(7.256)	(2.428)	(7.987)
Pgdp	–7.59352**	–.203628	–5.57883**	–.204070*
	(–3.528)	(–1.959)	(–4.744)	(–2.335)
$Pgdp^2$	1.15342**		.969575**	
	(2.899)		(4.737)	
Growth	4.74727*		6.48473**	
	(2.396)		(2.619)	
Infl		1.54848**		1.54857**
		(4.253)		(4.710)
Def	–11.2193*	–2.17757	–4.49608**	–1.59382
	(–2.370)	(1.680)	(–2.882)	(–1.386)
UrbanR	27.5069**		16.4978**	
	(2.796)		(2.732)	
Atkins09		–84.5667**		–105.915**
		(–3.188)		(–5.240)
R^2	.6239	.9391	.6054	.9321
S.E.	.2886	.0810	.2897	.0864
Durbin–Watson	2.042	1.598	1.785	1.512
Test of overidentifying restrictions	–		4.910	

Note: ** and * denote statistical significance at 1% and 5%, respectively.

Table 5. Estimation Results for Shares based on Inclusion of Extra Budgetary Items

	Full Model		Model Selected by AIC	
Variables	Revenue Function	Expenditure Function	Revenue Function	Expenditure Function
Constant	–62.1524*	–76.2038**		–67.5556**
	(–2.311)	(–5.259)		(–10.697)
ln(Pop)	5.07422*	6.61348**	.056502**	5.90843**
	(2.145)	(5.073)	(9.436)	(10.620)
Pgdp	–3.89849	–.070671	–.239437**	.342816**
	(–1.244)	(–.057)	(–4.594)	(3.082)
$Pgdp^2$	.687235	.069068		
	(1.120)	(.277)		
Growth	1.31638	–1.32909**		–1.80108**
	(1.078)	(–2.744)		(–5.457)
Infl	.741687	.352423		
	(.829)	(.788)		
Def	–3.37549	–3.05842**		–2.39801**
	(–1.754)	(–3.989)		(–4.145)
Open	–.775042	–4.13882		
	(–.637)	(–1.165)		
UrbanR	11.3221	–4.13882		–6.31107**
	(1.098)	(–1.165)		(–5.135)
Atkins09	58.5486	19.4555		15.2672**
	(.532)	(.718)		(3.082)
$Atkins09^2$	–264.791	–1285.89		
	(–.426)	(–.164)		
R^2	.5971	.9663	.4419	.9615
S.E.	.1636	.0647	.1925	.0692
LM-hetero	4.372*	.188	.226	.056
Durbin–Watson	2.499	2.469	2.108	2.269
AIC	–49.440		–66.023	
Log likelihood	46.720		42.011	

Notes: ** and * denote statistical significance at 1% and 5%, respectively.

Total number of observations is 26.

Log likelihood value is produced by the LSE calculation in TSP 5.0.

Table 6. Robustness Checks for Shares based on Inclusion of Extra Budgetary Items

	IV Method		GMM	
Instruments	Lagged independent variables with one lag in Full Model in Table 3		Lagged independent variables with two lags in Full Model in Table 3	
No. of MA lags (NMA)	–		NMA = 1	
Variables	Revenue Function	Expenditure Function	Revenue Function	Expenditure Function
Constant		–61.8018**		–67.6795**
		(–7.965)		(–10.248)
ln(Pop)	.056445**	5.43945**	.056237**	5.95254**
	(9.424)	(8.069)	(27.890)	(10.247)
Pgdp	–.238845**	.548079**	–.232930**	.521002**
	(–4.581)	(2.918)	(–12.424)	(5.899)
Growth		–2.26641**		–2.04969**
		(–4.679)		(–3.648)
Def		–1.10426		–1.39878*
		(–.880)		(–2.315)
UrbanR		–7.80057**		–7.97662**
		(–4.444)		(–7.678)
Atkins09		14.5818**		14.1752**
		(4.163)		(7.870)
R2	.4419	.9486	.4419	.9552
S.E.	.1925	.0800	.1926	.0747
Durbin–Watson	2.108	2.162	2.105	2.237
Test of overidentifying restrictions	–		10.004	

Note: ** and * denote statistical significance at 1% and 5%, respectively.

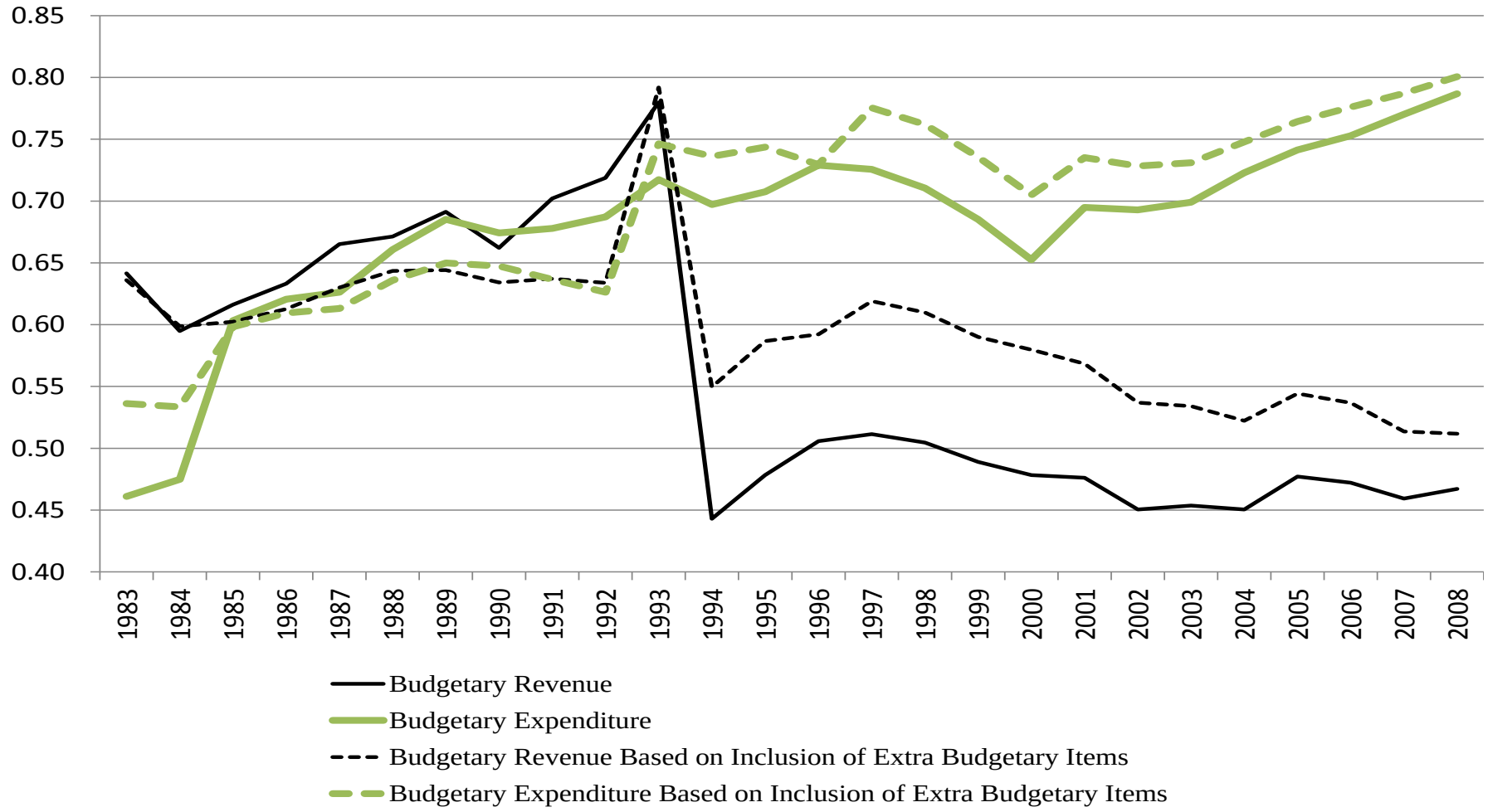

Figure 1. Trends in Budgetary Shares based on Inclusion of Extra Budgetary Items