The Effects of Political Factors on Chinese Local Governments' Science and Technology Budget Expenditure: Focusing on Party Committee Secretaries and Level of Public Corruption

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Abstract   Among a host of countries that have been accelerating public investment to gain first mover's advantage in critical scientific technological areas, China's remarkable speed and accomplishments of S&T development has been not only a subject of intense international recognition in recent years but also intensifying U.S-China rivalry. While such achievements were in large part a product of supremely streamlined nationwide policy implementation structure of the country, it has also been subject to disturbances from increasing political uncertainties in its local governments originating in large part from the central government's enforcement of anti-graft policy. Given the unique confluence of these dynamics that affect China's S&T development, this study aims to analyze the effects of political factors on Chinese local government's science and technology budget expenditure. For this purpose, we construct a 1998 - 2016 panel data of relevant variables and perform empirical analyses using fixed-

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effects and random-effects models. Independent variables in this study include the level of public corruption, appointment of a central government official to party committee secretaryship, party committee secretaries' number of years in office, age at the time of appointment and level of education. The results of our analyses indicate that the level of public corruption and party committee secretary's level of education have significant negative effects on local governments' S&T expenditure while appointment of a central government official to position of the party committee secretary has a significant positive effect. On the other hand, the number of years in office was found to have a non-linear, U-shaped relationship, indicating the need for more stability in provincial leadership. Among control variables, per-capita GRDP, the level of market opening, the level of fiscal independence and the proportion of S&T spending in preceding years' total expenditure had positive effects of statistical significance.

Keywords Chinese Local Governments . Public Corruption . Party Committee Secretary . Science and Technology Expenditure

Introduction

Sustained development of science and technology requires intensive direct and indirect government investments. This is because the science and technology sector cannot attract sufficient level of resources from the private market particularly due to inherent uncertainties involved in the development process, non-specificity of its products and substantial time lags between investment and outcomes. Hence, in various parts of the world, governments at different levels have long been involved in the realm of science and technology to correct a series of market failures and to secure achievement of public interests (Arrow, 1962; Nelson, 1959).

In this context, China's push for science and technology development with its distinct development model renders itself as a very interesting case. Since the 1979 Economic Reform, China achieved an extraordinary economic development by capitalizing upon its cheap labor costs to carry out an export-oriented growth strategy (Zhu, 1998; Sheng & Liao, 2004). Yet, soon faced with the limitations of such strategy rising labor costs and growing competition with new emerging economies (Tao & Liu, 2007; Xu, 2008), the country looked elsewhere for new sources of growth. In July 1993, the country enacted the Law of the People's Republic of China on Science and Technology Progress, and once amended in 2007, the law brought about a substantial increase in government investment for technological innovation and industrial evolution.

What is more interesting is that, contrary to the country's strongly centralized political power structure, China's economic growth strategy hinged on the initiatives of its local governments. Endowed with sufficient autonomy in decisionmaking and implementation (He, 2005; Zhang & Gong, 2005), S&T expenditure by local governments indeed consistently grew and surpassed that of the central government. In 2017, local governments' S&T expenditure accounted for 61% of national S&T spending.[1]

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[1] See theoretical discussions in Section 2 for details.

Nonetheless, in that S&T expenditure is an outcome of policymaking, it is inherently subject to the sway of socioeconomic, political, fiscal and other factors such that it is virtually impossible to identify a single optimal policy alternative to achieve its policy objective (Key, 1949; Lockard, 1959; Niskanen, 1971; Garand, 1988; Painter & Bae, 2001; Lockhart et al., 2008). Moreover, in a country with extensive regional disparities and its unique political structure, political factors such as the level of public corruption and characteristics of party committee secretary can exert disproportionate amount of influence on local governments' S&T spending.

In this context, this study empirically examines the influence of political factors, specifically, the levels of public corruption and characteristics of party committee secretaries, on Chinese local governments' S&T expenditure.

Theoretical Background and Literature Review

Theoretical Background

The Case for Government Intervention in Science and Technology Programs

Government role in area of science and technology is justified from the perspective of market failures that arise due to non-specificity, uncertainty and time lags between input of resources and outputs of innovation (Kay, 1988; Hasimoto & Haneda, 2008).

Non-specificity denotes limited appropriability of the outcomes of fiscal investment that are beyond the use by certain entities or the use in the form of certain products. However, in that non-specificity means that the benefit of S&T investment can be enjoyed by all segments of a society, S&T expenditure is fundamentally different from social services expenditure effects of which are enjoyed only by its beneficiaries (Kay, 1988).

On the other hand, uncertainty involved in S&T investment originates from the difficulty involved in accurately measuring S&T programs' effects. For example, it is challenging to ascertain with fair accuracy the policy effects of a basic science investment prior to seeing the actual results many years after. Thus, S&T investment is characterized by its costliness in that the development of scientific technology takes a very long period of time and requires continuous investment in between (Hasimoto & Haneda, 2008).

Time lags are explained as a certain duration of time between investment of resources for the purpose of research and development and seeing the fruits of the investment. As such, assessing the effects of investment is possible only after a certain period of time (Hasimoto & Haneda, 2008).

Furthermore, insufficient infrastructure for innovation, issues between stakeholders such as businesses, universities, research institutions, and unfavorable legal and administrative system are all circumstances that necessiates government intervention (Smith, 2000; Woolthuis et al., 2005).

China's S&T Expenditure

While China's overall S&T expenditure has consistently increased, benefiting greatly from its authoritarian and streamlined implementation structure, the country's local government-centric economic growth strategy resulted in huge disparities between regions. However, such disparities were made even more pronounced by yet another factor, the distinct fiscal relationship between the central government and local governments.

In 1994, China's central government carried out the Tax Sharing Reform for the purpose of tightening central government's control over local government while simultaneously reducing disparities in regional development. In this scheme characterized by 'centralization of revenue' and 'decentralization of expenditure', however, fiscal imbalance ensued as local governments' direct spending on administrative and social services expenditure grew (Hong et al., 2018). In regions with particularly low levels of fiscal independence and thus greater financial dependence on the central government, secretaries of party committees who are leaders of local governments have been increasingly incentivized to pursue local economic growth (Kong, 2015). This imbalance in the fiscal relationship between the central government and local governments affects local governments' S&T expenditure in two different ways.

First, the share of local governments' S&T expenditure came to account for greater proportion of the country's total S&T spending. As can be seen in Table 1, the share of local government's S&T spending prior to 2011 was lower than 50% of the total. However, since 2012, the share showed a steep growth that by 2017 the spending grew to 4,440 billion renminbi, 61.1% of the country's total, 7,266 billion renminbi.

Table 1 2007-2017 S&T Expenditure by Chinese Local and Central Governments

Year	Total Expenditure (Billion Renminbi)	Central Government's S&T Expenditure Total Value (Billion Renminbi) / Proportion (%)		Local Governments' S&T Expenditure Total Value (Billion Renminbi) / Proportion (%)	
2007	1783.04	924.60	(51.86)	858.44	(48.14)
2008	2129.21	1077.35	(50.60)	1051.86	(49.40)
2009	2744.52	1433.82	(52.24)	1310.70	(47.76)
2010	3250.18	1661.30	(51.11)	1588.88	(48.89)
2011	3828.02	1942.14	(50.73)	1885.88	(49.27)
2012	4452.63	2210.43	(49.64)	2242.20	(50.36)
2013	5084.30	2368.99	(46.59)	2715.31	(53.41)
2014	5314.45	2436.66	(45.85)	2877.79	(54.15)
2015	5862.57	2478.39	(42.27)	3384.18	(57.73)
2016	6563.96	2686.10	(40.92)	3877.86	(59.08)
2017	7266.98	2826.96	(38.90)	4440.02	(61.10)

Source: The National Bureau of Statistics of China

Second, because local governments are incentivized to increase general economic investment that can contribute to economic growth within a short period of time, the share of S&T expenditure in total local government expenditure generally remained relatively low and varied greatly depending on the level of economic development and the level of fiscal dependence. As

Table 2 demonstrates, S&T spending accounted for over 3% of total expenditure in provinces such as Guangdong, Shanghai, Anhui, Beijing, Jiangsu and Tianjin, the same figure in Yunnan, Gansu, Neimenggu, Qinghai and Xizang represented less than 1% of their total expenditure.

Table 2 Sizes and Proportions of S&T Expenditure per Province
(as of 2016, Unit: billion renminbi)

Province	Fiscal Expenditure	S&T Expenditure	Share	Province	Fiscal Expenditure	S&T Expenditure	Share
Guangdong	13446.09	742.97	5.53	Henan	7453.74	96.10	1.29
Shanghai	6918.94	341.71	4.94	Sichuan	8008.89	101.09	1.26
Anhui	5522.95	259.50	4.70	Hebei	6049.53	73.18	1.21
Beijing	6406.77	285.78	4.46	Jilin	3586.09	41.01	1.14
Zhejiagn	6974.26	269.04	3.86	Hainan	1376.48	15.69	1.14
Jiangsu	9981.96	381.02	3.82	Hunan	6339.16	71.44	1.13
Tianjin	3699.43	125.18	3.38	Xinjiang	4138.25	44.98	1.09
Hubei	6422.98	190.11	2.96	Heilongjiang	4227.34	44.92	1.06
Shandong	8755.21	167.00	1.91	Guangxi	4441.70	45.20	1.02
Fujian	4275.40	80.28	1.88	Shanxi	3428.86	34.56	1.01
Jiangxi	4617.40	83.12	1.80	Yunnan	5018.86	46.86	0.93
Guizhou	4262.36	69.30	1.63	Gansu	3150.03	26.23	0.83
Ningxia	1254.54	18.26	1.46	Neimenggu	4512.71	32.38	0.72
Shanxi	4389.37	62.01	1.41	Qinghai	1524.80	10.90	0.71
Liaoning	4577.47	61.61	1.35	Xizang	1587.98	4.81	0.30
Chongqing	4001.81	51.62	1.29				

Source: The National Bureau of Statistics of China

Table 3 Theories on the Determinants of Fiscal Expenditure

Factors	*Main Argument*	*Relevant Studies*
Political	*Characteristics of political structure, political process and political system are important determinants of public policy decision-making. The public choice theory, on the other hand, argues that the rent-seeking behavior of elected politicians and professional bureaucrats determine substances of public policy.*	*Key (1949); Lockard (1959); Niskanen (1971).*
Socioeconomic	*Public policies are determined mostly by the level of available socioeconomic resources and changes in the demand for these resources. According to Wagner's law, public expenditure grow with economic development, increase in income, resulting from the advancement of industrialization.*	*Garand (1988); Painter & Bae (2001)*
Fiscal Capacity	*Fiscal capacity is the most important determinant of the level of local government's expenditure, and such fiscal capacity function as a constraining condition on local government's expenditure. Greater fiscal capacity is correlated with expansion of long-term budget such as social services.*	*Sharkansky et al (1969); Lockhart et al. (2008).*
Budgetary Incrementalism	*The level of budget expenditure in a certain year is determined by that of the preceding year. The notions of base and fair share were introduced to simplify complex budgetary process. In other words, participants in the budgetary process make political compromises and make decisions with incremental changes.*	*Herbert (1984); Wildavsky (1986).*

Determinants of Fiscal Expenditure

As there currently are no standalone theories regarding determinants of fiscal expenditure, we draw on relevant theoretical discussions including theory of policymaking, theory of fiscal capacity and theory of budgetary incrementalism. The primary argument of each theory is summarized in Table 3.

Literature Review

Outside of China

While there are plenty of studies that examined OECD countries' expenditure and expenditure structure have dealt with government spending for general public administration, defense, economy, education, social services, police services, housing and local development, public health, entertainment culture and religion and so on, not much literature can be found that precisely looked into local governments' S&T investment expenditure. Most research on local government expenditure outside of China takes local finance and social services spending as dependent variable (Kalseth et al., 1998; Barrilleaux et al., 2002; Lockhart et al., 2008). What these studies reveal is that various factors – political, socioeconomic, fiscal and budgetary incrementalism – come into play depending on the contexts and characteristics of individual countries.

First, Barrilleaux et al. (2002) looked into the effects of political factors on social services expenditure of 1,000 local governments within the U.S. They found that the Democratic party is more proactive than the Republican party in adopting redistributed policies and the level of political competition while the incumbent is also a democrat also positively influences redistributive policies. On the other hand, no statistically significant changes were found in redistributive programs when the Republican party is in power. On the other hand, Lockhart et al. (2008) used data from 48 U.S. states in 1991, 2001 and 2003 to determine the effects of various factors on Medicaid expenditure. After conducting an OLS regression, they found that Democratic control as political factor and state tax capacity as a fiscal factor had significant positive influences. Bunch (2014) examined the effects of local autonomy on local government expenditure by conducting an OLS regression on 1976 -2006 data from Florida counties. The results showed that county charter and per-capita federal funds had positive effects while per-capita state funds had negative effects. Further, progressive ideology as a political factor and educational distance as a social factor had negative influence.

In Europe, Da Fonseca (2015) found in his study on 278 cities in Portugal that ruling party with over 50% over legislative seats is correlated with higher government revenue and higher budget expenditure. On that other hand, Kalseth et al. (1998) investigated determinants that affect per-capita administrative spending and conducted an OLS regression on data from 175 municipalities in Norway in 1990. As a result, they found that federal government, socialistic government, socialistic local legislatures have significant positive influences on per-capita administrative spending. This finding is also in line with the 2001 study by Allers et al. that found left-wing political party in power did affect the burden of taxation. Cowart et al. (1975)

confirmed the role of budgetary incrementalism in the budgetary process in Italy while Fried (1971) found that the level of economic growth influenced social services expenditure.

In addition, Park et al. (2018) analyzed the determinants of the relative size of local government expenditure in GRDP by means of ridge regression estimation on data from 16 regional local government between 2008 and 2014. They found that among socioeconomic factors, real GDP and population density had negative impact on government expenditure, whereas the percentage of population that is 65 or older, employment rate and the share of service industry had significant negative effects. Likewise, having local government leader from a progressive party and the number of civil servants increased the relative size of public expenditure while a government leader from a conservative party was associated with reduced size. In the category of fiscal capacity factors, the proportion of dependent resources was found to exert a negative influence while the level of debt had positive effects on the public expenditure size.

China

In China, empirical analysis on determinants of public expenditures emerged only in the 1990s and research prior to 2015 did not take holistic approach that simultaneously takes into account social, economic, political and fiscal factors but instead focused on empirical examination of the effects of fiscal and socioeconomic determinants.

Most representatively, Yu's 2010 study looked at the effects of the level of market opening and regional economic growth rate on the levels of local government expenditure and conducted a panel data regression analysis on data from the 28 provinces in China between 1978 and 2007. Their analysis found that while local economic growth rate had a significant positive influence, the level of market opening had a u-shaped, rather than linear, relationship with local governments' public expenditure.

Pang and Pan (2012) widened the scope of independent variables to include socioeconomic variables such as per-capita GDP, aging, population density, the level of market opening and fiscal factors such as decentralization of fiscal revenue and fiscal expenditure. Examining their effects on local governments' social welfare spending by using panel data regression analysis on data from 31 provinces between 1998 and 2009, they found that decentralization of fiscal revenue had a statistically significant negative effect while decentralization of fiscal expenditure had a significant positive influence.

Empirical research on the determinants of Chinese local governments' expenditure that encompassed political factors[2] as importance explanatory variable emerged since 2015. Guo

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[2] The Communist Party of China with its vast size and very vertically oriented structure spanning from the central organization to local groups, is involved in every realm of the society and is the backbone of the government, the National People's Congress (NPC), the Chinese People's Political Consultative Conference (CPPCC), the military, education institutions, private enterprise, public-private enterprises, and civic organizations. Thus, the CPC has effectively achieved 'party-state,' 'party-government,' and 'party-society' integration. Indisputably, such pervasiveness underlies the party's organizational capabilities for crafting national strategies, social integration, political mobilization and distribution of wealth. Given the heavy influence the party exerts in all aspects of the country's society, economy, culture, and politics, it is rather natural that province-level and prefecture-level party secretaries, not governors and mayors, hold the power

and Lin (2017), in their attempt to analyze determinants of Chinese local governments social welfare expenditure in 30 provinces between 1998 and 2015, included in their panel data analysis population density, the percentage of population under age 15, the percentage of population over 65 as social factors, party committee secretary's number of years in office, age and level of education as political factors and the level of fiscal independence as fiscal factor. They found that party committee secretary's number of years in office had statistically significant negative effects while the level of education, age and demographic variables had significant positive effects.

Kong's 2015 study, on the other hand, looked at the determinants of two different areas of local governments' expenditure – social services and economic investment- based on a panel data analysis on data from 31 provinces from 1997 and 2009. Taking as independent variables population density, aging, percentage of population in school, labor force liquidity as social factors, per capita GDP as an economic factor, party committee secretaries and governors' age, level of education, the number of years in office as political factors and the level of fiscal independence as a fiscal factor, the study concludes that the level of education of party committee secretary, population density, and aging had statistically significant positive effects on social services spending while per capita GDP, labor market liquidity, the percentage of population in school, the level of fiscal independence affected the social services expenditure in the opposite direction. On the economic investment expenditure, the results were opposite. Specifically, per capital GDP, labor market liquidity, percentage of students in school had significant positive effects whereas party committee secretary's level of education, population density and aging were found to exert negative effects.

In light of the findings of the existing research, this study attempts to investigate the role of various determinants of S&T expenditure by local governments. What differentiates this study is that this study takes into account in its analytical framework not just factors of socioeconomic, fiscal and budgetary incrementalism, but also the level of public corruption[3] as measured by the number of public corruption cases[4] and appointment of a central government official to party committee secretaryship[5] as important political factors. Further, this study also looks into the possibility of non-linear relationship between party committee secretary's length of service and local government's S&T expenditure.

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of local authorities. Generally, deputy province-level secretary and deputy prefecture-level secretary are respectively appointed to governorship and mayorship (Kong, 2015; Guo & Lin, 2017).

[3] This is based on the findings of previous research that public corruption may distort budgetary decision making because public officials are situated in an environment where they can economically benefit from government policy or licenses/permits (Meier & Holbrook, 1992; Treisman, 2000).

[4] See Appendix 1.

[5] This paper's analytical framework includes China's centralized power structure (Hong et. al., 2018) as well as the characteristics of 'high cost' and 'uncertainty' involved in science and technology expenditure (Hasimoto & Haneda, 2008).

Research Design

Variables

In light of the findings of exiting research, this study takes the proportion of S&T expenditure in each local government's total expenditure as its dependent variable. The level of public corruption, party committee secretary's number of years in office, per-capita income, the level of industrialization, the level of market opening, the level of fiscal independence, preceding year's dependent variable value are accounted for as independent variables. All variables and their operational definitions used in the analytical framework are enumerated along with relevant previous research in Table 4.

Table 4 Variables, Operationalization and Relevant Research

Category	Variables	Operational Definition	Previous Research
Outcome Variable	S&T Expenditure	S&T Expenditure/ Total Expenditure (%)	-
Explanatory Variables	Level of Public Corruption	The Number of Public Corruption Cases/Population/200^6 (%)	-
	Number of Years in Office	The Number of Years Served Since Appointment	Kong(2015)
	Number of Years in Office^2	The Square of the Number of Years Served Since Appointment	-
	Appointment of a Central Government Official to Provincial Party Committee Secretaryship	Appointment of a Central Government Official =1, Otherwise = 0	-
	Age at Appointment	Age at the Time of Appointment	Kong(2015)
	Level of Education	Junior college or less =1, College = 2, Masters = 3,PhD = 4	Kong(2015)
Control Variables	Population	Year-End Population(ln)	Guo & Lin(2018)
	Per-capita GRDP	Per-Capita GRDP(ln)	Fried(1971)
	Level of Industrialization	The Share of Tertiary Industry (%)	Wang & Yang (2008)
	Level of Market Opening	Total Trade Value/GRDP (%)	Pang & Pan(2012)
	Level of Fiscal Independence	Fiscal Revenue/ Fiscal Expenditure (%)	Kong(2015)
	Last Year's S&T Expenditure	The Share of S&T Spending in Preceding Year's Total Expenditure (%)	Wildavsky(1986)

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[6] China does not disclose the exact number of public servants working in its central as well as local governments. However, 'Ministry of Human Resources and Social Security of the People's Republic of China: MOHRSS' made an unusual disclosure that there are a total of roughly 71,670,000 civil servants nationwide, about 1 civil servant per 200 citizens.

The Scope of Research and Data

We set the relevant time period to a 18 year period ranging from 1998 and 2016, considering the availability of information on relevant variables. Data were gathered on all of 31 provinces in China. Information on the number of public corruption cases was obtained from the Office of Central Procuratorate and the Offices of Local Procuratorates while information on individual characteristics of party committee secretaries were obtained from the webpage of each province and People's Daily. Data on province-level socioeconomic variables were obtained from the National Bureau of Statistics of China and CSMAR.

Analytical Framework

For any researchers that conduct non-experimental quantitative research, panel data are the most useful and thus preferred type of data set that generally yields most reliable results. This is because panel data consists of multiple observations from identical subjects, enabling researchers to enhance the efficiency of estimation as the higher number of subjects increases the degree of freedom. Moreover, panel data analysis is an effective solution for the problem of omitted variables because repeated observations of identical subjects allow us to account for those subjects' even unobserved characteristics. For these reasons, this study employs panel data analysis.

   Both fixed-effects and random-effects models are used in the static panel data analysis. The Formula 1 below comprises μ_i that represents time-invariant subject-specific characteristics and e_{it} that changes according to time and observation. While fixed-effects model treats μ_i as a parameter instead of a random variable, random-effects model treats the same as a random variable. The Hausman's specification test is performed in order to distinguish a model that is more fitted to the constructed data set.

   <Formula 1>
   The Share of Science and Technology Expenditure$_{it}$ = α + β_1The level of Public Corruption $_{it}$ + β_2 The Number of Years in Office $_{it}$ + β_3 The Number of Years in Office$^2_{it}$ + β_4 Appointment of a Central Government Official to Party Committee Secretaryship $_{it}$ + β_5 Age at the Time of Appointment $_{it}$ + β_6 Level of Education $_{it}$ + β_7 Population $_{it}$ + β_8 Per Capita GRDP $_{it}$ + β_9 The Level of Industrialization $_{it}$ + β_{10} The Level of Market Opening $_{it}$ + β_{11} The Level of Fiscal Independence $_{it}$ + β_{12} The Preceding Year's Share of S&T Expenditure $_{it}$ + μ_i + e_{it}

Empirical Analysis

Descriptive Statistics

Table 5 presents descriptive statistics of the relevant variables. The average share of S&T spending in total local government expenditure, the dependent variable of this study, is 1.27%

with a minimum of 0.15% and a maximum of 7.20%. Among important explanatory variables, the level of public corruption ranges from 0.05% to 0.35% with an average of 0.14% while province-level party committee secretaries' number of years in office varies from 1 year to 15 years, averaging at 3.3 years. During the relevant time period, 21% of province-level party committee secretaries were former central government officials and the average age at the time of appointment to province-level leadership was 56.61, ranging from 46 and 65. The mean level of education is 2.55.

Among control variables, population (ln) ranged from 5.53 to 9.31, with a mean of 8.06 while per-capita income (ln) varied from 7.77 to 11.68, averaging at 9.83. The level of industrialization also differed, between 28.60% and 80.23% with an average of 40.70%. The level of market opening ranged from 0.00% to a maximum of 92.83 with a means of 11.45% while the average level of fiscal independence was 51.11% and ranged from 5.30% to 95.09%.

Table 5 Descriptive Statistics

Variables	Mean	Std. Dev.	Min	Max
S&T Expenditure	1.27	1.18	0.15	7.20
Level of Public Corruption	0.14	0.04	0.05	0.35
Number of Years in Office	3.30	2.22	1	15
Number of Years in Office^2	15.79	23.26	1	225
Appointment of a Central Government Official to Provincial Party Committee Secretaryship	0.21	0.41	0	1
Age at Appointment	56.61	3.79	46	65
Level of Education	2.55	0.80	1	4
Population	8.06	0.87	5.53	9.31
Per-capita GRDP	9.83	0.88	7.77	11.68
Level of Industrialization	40.70	8.18	28.60	80.23
Level of Market Opening	11.45	18.87	0.00	92.83
Level of Fiscal Independence	51.11	19.87	5.30	95.09
Last Year's S&T Expenditure	1.23	1.15	0.15	7.20

Results

Table 6 lists the results of panel data analyses on the effects of the level of public corruption and characteristics of province-level party committee secretaries on provincial governments' S&T expenditure. Model 1 includes as the explanatory variables only the political factors which are the level of public corruption, appointment of a central government official to a provincial party committee secretaryship, party committee secretary's number of years served in the office, age at the time of appointment and level of education. Model 2 includes, in addition to the explanatory variables in Model 1, socioeconomic control variables such as population, per-capital income, the level of industrialization, the level of market opening. The Model 3 added to variables of Model 2 the level of fiscal independence while Model 4 added preceding year's share of S&T spending as the factor of budgetary incrementalism to the variables of Model 3. Model 5 includes squared value of party committee secretary's number of years in

office in order to test the potentially non-linear relationship between local leaders' length of service and the dependent variable.

While the Hausman's specification test on Model 1 had a p-value of 0.79, indicating that random-effects model is better suited to the given data set, the null hypotheses of Model 2, Model 3, Model 4 and Model 5 were rejected at the 1% significance level, ultimately showing that using fixed-effects model is more appropriate. [7]

Findings from Model 1 analysis are as follows. The level of public corruption was found to have negative effects at the 1% statistical significance level on provincial government's S&T spending, meaning that severer public corruption is correlated with lower S&T investment. The province-level party committee secretary's length of service also showed a negative effects, at the 10% significance level, indicating that longer service term is correlated with lower share of S&T spending. On the other hand, appointment of a central government official to a provincial party committee secretary position, age at the time of appointment and the level of education had positive effects at the 1% significance level. This indicates that appointment to central government position, higher age at the time of appointment to local leadership and higher level of education are correlated with higher proportion of S&T expenditure.

In Model 2, consistent with the results of Model 1, the level of public corruption had negative influence on the share of S&T expenditure at the 1% significance level. Age at the time of appointment showed some positive effects but with no statistical significance while the level of education had a negative influence at the 5% significance level. On the other hand, each of the control variables − population, per capita income, the level of industrialization, and the level of market opening − showed a positive influence at the 1% statistical significance level.

In Model 3, the level of public corruption still showed negative effects on the share of S&T spending at the 1% significance level. Appointing a former central government official to provincial leadership had a positive influence at the 1% significance level and the negative influence of education at the 5% significance level is identical as the result from the Model 2. As for control variables, population, per capita income and the level of urbanization showed positive influences at the 1% significance level, as in the Model 2. On the other hand, the level of market opening had a positive influence, but of no statistical significance, while the level of fiscal independence had a positive influence at the 1% statistical significance level.

Model 4, taking into account the factor of budgetary incrementalism in addition to political factors, socioeconomic factors, fiscal factors, was found to have rendered more reliable analytical results. The results showed that the level of public corruption had a negative influence on the share of S&T spending at the 1% statistical significance level, indicating that higher level of public corruption is correlated with lower shares of S&T spending in total budget expenditure of a provincial government. On the other hand, party committee secretary's length of service had negative influence at the 5% significance level. This may be because provincial leaders with more years of service, exposed to stronger pressure of promotion, are more likely to allocate greater share of government expenditure in areas conducive to short-term economic growth. Moreover, appointment of a central government official to a provincial party committee secretaryship showed a positive influence at the 5% statistical significance level, indicating that local leaders from central government are more likely to expand the proportion of S&T

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[7]   See Table 5 for the results of Hausman's specification tests.

expenditure. Albeit of no statistical significance, party committee secretary's age at the time of appointment was found to have a positive influence while level of education had a negative influence. Among control variables, per-capita GRDP, the level of market opening, the level of fiscal independence and immediately preceding year's share of S&T spending showed positive effects at the 1% significance level. Lastly, population and the level of industrialization, despite little statistical significance, were found to have positive correlations with provincial governments' S&T spending.

Table 6 Results from Model 1 through Model 5

	Model 1 (RE)	Model 2 (FE)	Model 3 (FE)	Model 4 (FE)	Model 5 (FE)
Level of Public Corruption	-7.553***	-2.812***	-3.120***	-1.969***	-2.027***
Number of Years in Office	-0.029*	-0.020	-0.013	-0.020**	-0.075***
Number of Years in Office^2					0.006***
Appointment of a Central Government Official to Provincial Party Committee Secretaryship	0.218**	0.213***	0.232***	0.107**	0.109**
Age at Appointment	0.083***	0.014	0.012	0.008	0.008
Level of Education	0.341***	-0.103**	-0.103**	-0.057	-0.063*
Population		0.498***	0.425***	0.411	0.382
Per-capita GRDP		0.364***	0.432***	0.199***	0.203***
Level of Industrialization		0.020***	0.027***	0.008	0.009
Level of Market Opening		0.009**	0.005	0.010***	0.009***
Level of Fiscal Independence			3.308***	2.264***	2.286***
Last Year's S&T Expenditure				0.709***	0.707***
Constant	-3.355***	-4.569***	-4.141***	-6.410**	-6.152**
Groups	31	31	31	31	31
Observations	589	589	589	589	589
R^2	0.27	0.55	0.59	0.79	0.79
Hausman(P)	0.71	0.00	0.00	0.00	0.00

Legend: * $p < .1$; ** $p < .05$; *** $p < .01$

Model 5 examined a potentially non-linear relationship between province-level party committee secretary's length of service and provincial government's S&T spending. Indeed, we found that the length of service had a negative influence at the 1% significance level while the variable's squared value had a positive relationship at the 1% significance level, thus exhibiting a non-linear, U-shaped relationship between the two variables. In other words, although longer duration of service is initially correlated with lower proportion of S&T spending, the share of S&T expenditure starts to increase after a certain point in the length of service. On the other hand, appointment of a central government official to a province-level party committee secretary showed a positive influence at the 5% significance level, consistent with the result from the Model 4. The level of education showed a negative influence at the 10% significance level. While this could be because of the fact that local government leaders with higher education are

generally more ambitious and thus are more likely to pursue promotion by means of expanding budget expenditure in areas that are favorable for short-term economic growth, the exact nature of this relationship must be separately investigated. On the other hand, the effects of control variables are found to be identical as those in the Model 4.

Conclusion

Summary of Findings

This paper examined the effects of public corruption and local government leader's characteristics on S&T expenditure. For this purpose, we constructed an 18-year (1998-2016) panel data on 31 provinces and conducted empirical analyses using 5 different analytical models. The findings are summarized below.

First, across all models, the level of public corruption was shown to exert a negative influence on the share of S&T expenditure at the 1% significance level, indicating that severer public corruption is correlated with lower shares of S&T spending in provincial budget expenditures. In that the level of public corruption was measured by counting the number of anti-graft enforcement cases and since the number of these cases in part represents the intensity of the central government's anti-graft control over local government, the same result may be interpreted to indicate that higher level of central government's anti-graft enforcement produces higher local government-level political uncertainty, thereby resulting in lower levels of S&T investment expenditure.

Second, appointment of a central government officials to province level governments showed a positive influence at the 1% statistical significance level. This means that provincial party committee secretaries who used to serve in the central government are likely to increase the share of S&T expenditure in the total budget spending. In addition, the level of party secretaries' education was shown to have a negative influence at the 10% significance level, a result opposite from those of Kong (2015) and Guo & Lin (2018). Such result may be viewed as indicating, in line with previous research's finding that younger local leaders show greater aspiration for promotion, that local leaders with higher level of education have higher levels of motivation for promotion and thus incentivized to achieve more short-term economic growth by allocating more budget in non-S&T areas.

Third, the provincial party committee secretary's number of years in office was shown to exert a negative influence at the 1% significance level. Provincial government leaders with more years of service under their belt are more likely to face greater pressure for promotion and therefore allocate larger portion of their budget in non-S&T areas that are more conducive to short-term economic development. On the other hand, the squared value of the service length showed positive effects at the 1% significance level, demonstrating that the length of service in local government leadership and the share of S&T expenditure have a non-linear, U-shaped relationship. In other words, greater number of service in the local leadership position is initially correlated to lower share of S&T expenditure to a certain point and starts to go up once a threshold is reached.

Fourth, among control variables, per-capita GRDP, the level of market opening, the level of fiscal independence and the preceding year's share of S&T expenditure showed positive influences at the 1% significance level. This confirms that Wagner's law that states economic growth affect public expenditure is also applicable to the context of Chinese local governments' S&T spending.

Policy Implications

This study conducted empirical analyses of the effects of public corruption and characteristics of provincial party committee secretaries on provincial government's S&T spending. From the results discussed above, following policy implications are derived.

First, S&T expenditure in China is more subject to the sway of political factors such as the level of public corruption and rent-seeking behaviors of local leadership and than to demand-side determinants such as population, economic development, and industrialization. Thus, efforts to increase S&T investment by local government may first need address the issues of public corruption and political uncertainties.

Second, While provincial leader's length of service was found to have a negative influence in the short term, the long-term effects was in the opposite direction. Hence, providing stronger job security of provincial leaders, rather than frequent replacement, is likely to be more beneficial to the country's effort to advance the state of its science and technology.

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<Appendix 1>

The Number of Province-Level Public Corruption Cases Between 1998 and 2016

Year	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Beijing	271	327	419	408	416	363	403	329	351	356	311	367	413	398	456	373	430	368	468
Tianjin	285	409	532	706	697	530	495	528	442	380	368	358	350	311	582	331	294	279	273
Hebei	2368	1999	2033	1986	3025	2618	2303	2212	1917	1388	1110	1938	1872	1920	1735	1791	2071	1990	1764
Shanxi	1194	1297	1316	1471	1294	1180	1150	1191	1289	1309	1349	1226	1248	1220	1294	1349	1419	1444	1168
Neimenggu	592	570	745	693	773	699	660	624	651	709	631	673	611	615	680	857	959	890	952
Liaoning	1364	1727	2300	2116	2273	1946	1572	1317	1340	1265	1505	1512	1656	1148	1720	1727	1680	1577	1231
Jilin	1199	1350	1474	1377	1292	1149	857	1099	1191	1149	1136	1173	1201	1307	1451	1625	1514	1465	1355
Heilongjiang	1662	1744	2164	2155	2259	2327	1879	1612	1093	944	1371	1296	1144	1171	1496	1518	1535	1342	982
Shanghai	497	458	507	520	488	373	439	421	693	444	473	341	406	336	569	461	390	401	312
Jiangsu	1674	1852	2422	2438	2434	2247	1812	1767	1756	1659	1642	1365	1429	1709	1649	1760	1791	1615	1530
Zhejiang	1232	1371	1370	1458	1451	1394	1368	1216	1214	1338	1453	1337	1229	1287	1456	1371	1426	1187	801
Anhui	1357	1577	1800	1915	1682	1527	1523	1338	1252	1303	1238	1262	1277	1287	1205	1689	1411	1346	1279
Fujian	1154	1164	1336	1264	1257	1192	1146	1099	1081	1197	1138	1007	927	901	993	1078	1171	1269	1080
Jiangxi	1084	1384	1182	1613	1481	2049	1582	1028	1001	973	945	966	915	936	1013	1120	1205	1112	1382
Shandong	3021	3184	3954	4068	3823	2795	2882	2905	2014	2456	2358	2068	2219	2110	2364	2672	2920	3012	2497
Henan	2167	2851	3606	3684	3689	3225	3248	3270	3024	3097	2979	2837	2868	2839	2637	2852	3195	3090	3245
Hubei	1882	1918	2034	2086	1969	1687	1643	1552	1557	1644	1628	1459	1603	1525	1678	1946	2375	2476	1985
Hunan	1637	1796	1953	1710	1743	1394	1640	1557	1580	1556	1611	1566	1353	1429	1119	1476	1380	1593	985
Guangdong	1613	1563	1902	1772	1693	1584	1326	1697	1680	1734	1767	2367	1801	1761	1896	2519	2272	2456	2248
Guangxi	849	1061	1246	1444	1364	1361	1407	1185	1185	1384	1309	1168	1126	1068	1180	1316	1439	1543	1465
Hainan	237	209	250	229	222	189	206	184	177	187	228	175	210	211	215	239	276	295	249
Chongqing	609	849	935	843	794	759	680	596	520	606	648	802	861	696	720	750	751	752	753
Sichuan	1607	1966	2532	2306	2260	2108	2055	1873	1736	1811	1548	1504	1542	1524	1563	1797	1882	2008	1790
Guizhou	993	997	1111	1130	1163	1140	1160	1077	1056	1092	1023	1002	983	929	935	922	1037	1083	1255
Yunnan	1214	1284	1444	1567	1144	1004	920	904	890	901	1289	1341	1445	1487	1504	1596	1394	2122	1497
Xizang	46	64	57	56	37	44	41	42	46	39	29	40	37	34	37	35	-	-	-
Shanxi	1163	1091	1299	1224	1254	1169	1174	1076	1134	1043	1082	1097	1068	1052	976	1421	1153	1345	1383
Gansu	514	539	598	515	452	494	559	550	516	564	522	576	640	678	697	789	869	761	622
Qinghai	167	158	175	173	-	181	176	154	129	126	128	160	142	153	174	171	150	162	138
Ningxia	145	110	128	165	175	147	203	176	224	168	194	258	283	258	258	301	301	303	237
Xinjiang	714	677	640	756	559	644	629	629	662	636	610	735	534	567	562	668	580	655	687