Testing the applicability of Wagner's Law in China based on reconstruction of government expenditure indicators

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Wagner's Law can describe the relationship between government expenditures and economic growth. However, its applicability in China remains controversial. In this paper, we first reconstruct two government expenditure indicators based on the disadvantages of current fiscal expenditure indicators to explain the government scale and then use these indicators to test the applicability of Wagner's Law in China. Results showed that data from the indicators could support Wagner's Law well when considering numerical increases in expenditures from 1989 to 2012. However, in terms of relative size of government expenditures proportional increases with the model, the test results of current expenditure indicator do not support the applicability of Wagner's Law in China. At the same time test results with the two kinds of reconstruction of indicators both can support it well. Overall, the empirical results indicate that new expenditure indicators are more appropriate in testing the applicability of Wagner's Law in China.

Keywords: government expenditure, Wagner's Law, applicability, indicator reconstruction

1. Introduction

Wagner's Law, also called "the law of expansion of government activities", was first proposed by the German economist Adolf Wagner (1835-1917). After studying the public expenditures of the United States, Japan, and many European countries in the 19th century, Wagner found that the range of public activities expands with economic growth according to the increase in central and local government expenditures. In general, Wagner's Law can be derived from the fact that public expenditures increase at a faster rate than the national income.

Wagner's Law provides a theoretical guidance for determining the relationship between government expenditures and economic growth, and its applicability has been examined through various tests and methods over the last hundred years. Demirbas (1999) pointed out at least six versions of Wagner's Law (See Table 1), all of which have been empirically investigated. To date, however, objective criteria with which to determine which of the six versions is the most appropriate and convincing test of the law have been offered. Two methods are commonly used for testing (Wang & Zhang, 2009). The first method assumes that the time-series data are

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stationary and uses classical regression for testing. The second method uses technologies such as cointegration testing and causality testing. Most current studies prefer the second method because using variables such as expenditure and income for regression analysis without testing stationarity may lead to spurious regression results since these variables are mostly non-stationary.

Table 1
Six versions of Wagner's Law

	Functional form	Version
1	LE = a + bLGNI	Peacock-Wiseman (1968)
2	LC = a +bLGNI	Pryor (1969)
3	LE = a + bL(GNI/P)	Goffman (1968)
4	L(E/GNI) = a +bL(GNI/P)	Musgrave (1969)
5	L(E/P) = a + bL(GNI/P)	Gupta (1967)
6	L(E/GNI) = a +bLGNI	Modified version of P-W suggested by Mann (1980)

Notes: L, LN function; E, fiscal expenditure; GNI, Gross National Income; P, population; C, public expenditure.

According to the measurement standard of purchasing power parity, China is the world's second-largest country in terms of GDP. A growing number of foreign researchers have begun to pay closer attention to the applicability of Wagner's Law in China. Tobin (2005) tested Wagner's Law over the period of 1978-2001 using a version similar to model 4 and found support for Wagner's Law in China; in this work, linear regression was applied and the numbers of staff and workers in state-owned units in selected sectors were selected to measure the size of the state sector or the demand for government services. Huang (2006) obtained contrasting conclusions by using fiscal government expenditure data from 1979 to 2002. Narayan et al. (2008) used two versions of models 1 and 4 according to data of 24 provinces from 1952 to 2003 and found that the middle and western provinces could support the law but other provinces, especially the eastern ones, could not.

The results of the applicability of Wagner's Law in China also differ among domestic studies. Li and Pei (2005) found no support for the law in China by using data from 1979 to 2003 and all six models for calculation. A one-way causal relationship between national output and public expenditure could also not be found for the period 1994-2003. Zhao (2008) found that different time periods yield different conclusions; the researcher first used model 4 with data from 1978 to 2006 and found that Wagner's Law could not be supported in China based on vector autoregression (VAR) model cointegration testing and causality testing. However, when the sample range was reduced to 1987-2006 and the growth of the government scale was inelastic, the law seemed to apply. Zheng (2008) analyzed the percentage change of China's fiscal expenditures to GDP from 1978 to 2005 and found that the data from 1996 to 2005 could support the law well; the same study, however, showed that, in general, the law was not applicable to China. Wang and Zhang (2009) discovered that the causal relationship between China's economic and government public expenditure growth is uncertain and the result shows stage characteristics. The same researchers applied the Gibbs sampling method to the data from 1952 to 2006 with

model 1. Li (2009) used data from 1952 to 2007 with a version of model 1, considering the factor of structural breaks, the study concluded that Wagner's Law could not be set up in China.

Why conclusions show completely opposite results among different reports and the applicability of Wagner's Law in China remain unknown. After comparing these studies, we found that, besides differences in the methods and versions used, most of the published papers directly used data on fiscal government expenditures to measure the government spending scale. Different indicators or data measuring the government scale can significantly affect final conclusions. As well, data on China's fiscal government expenditures show many defects in terms of measurement of the government scale. Thus, when studying the applicability of Wagner's Law in China, we must select more appropriate indicators and data. In other words, we must reconstruct a statistical caliber of government expenditures and measure the corresponding data in combination with China's practical situation.

The statistical caliber of China's fiscal public expenditures is much narrower compared with that in western countries. China's current statistical caliber of government expenditures must include general budget expenditures, off-budget expenditures[1], and expenditures related to government and social security funds. Export tax rebates must also be considered in government expenditure. However, all of the studies described above simply used the final fiscal expenditure to measure the government scale; unfortunately, this type of expenditure does not consider other non-budgetary government expenditures. Currently, Ministry of Finance of the People's Republic of China is also considering further promote the implementation of full-caliber budgetary administration reform. After the reform these expenditures will be incorporated into the scope of the government's public expenditure in the future.

New changes have recently been applied in the definition of government expenditure. The *Government Finance Statistics Manual 2014* still uses the definition of government expenditure described in the 2001 version of the manual, in which expense is defined as a decrease in net worth resulting from a transaction. The general government sector features two broad economic responsibilities: (1) to assume responsibility for the provision of selected goods and services to the community, primarily on a nonmarket basis and (2) to redistribute income and wealth by means of transfers. Ge (2012) argued that government-bought non-financial assets are not truly fiscal expenses because these assets would simply change the asset structure in the balance sheet but the net value would remain the same. Zheng and Zhu (2008) also considered that China's definition of government expenditure still stay in the scope of Political Economics and believed that government expenditure must be defined from the perspective of statistical accounting. In fact, the definition of government expense is similar to the consumption of residents' owner-occupied dwelling service. Expenses related to dwellings are not directly accounted as residents' consumption; instead, the imputed rents for owner-occupied dwelling services are recorded as homeowners' consumption (IMF et al., 2008).

In view of the deficiencies present in China's definition of fiscal expenditure, we attempt to reconstruct two reasonable indicators of government expenditure and then use the new data obtained from these indicators to test the applicability of Wagner's Law in China.

[1] Off-budget expenditures have been brought to budget management since 2011.

2. Reconstruction of government expenditure indicators and measurement data

2.1. Full-caliber indicator of government expenditure and measurement data

At present, the government expenditure data published by the Ministry of Finance of the People's Republic of China only include fiscal public expenditures. Government expenditures for performing government duties are also not considered as such (Wang, 2014). The Ministry of Finance carried out the reformation of budgetary administration since 2011, in which the off-budget expenditure was incorporated into budget expenditure. However, government-managed funds expenditure, social insurance fund expenditure, export tax rebates and local government debt increase in net are still outside the statistical diameter of government expenditure. A full-caliber government expenditure indicator including all of the expenditures described above can comprehensively reflect the status of China's government expenditures.

To measure data of full-caliber government expenditures, we must select a reasonable time range. Here, we choose to measure the data of period 1989-2012. This is because in addition to the data of governmental funds expenditures and local government debt increase in net, we can directly obtain all the other data from related statistical yearbooks. Eventually, the data of full-caliber government expenditures from 1989 to 2012 may be obtained. The key consideration in this measure is estimation of the missing data of government-managed fund expenditures and local government debt.

2.1.1. Estimation of government-managed fund expenditures

At present, only data on government-managed fund expenditures from 2008 to 2012 are available, and large amounts of data have yet to be disclosed. Xu and Luo (2013) estimated that government-managed fund expenditures could be composed of central government-managed fund expenditures and land sale revenues but did not provide specific details about the estimation process. Gao et al. (2014) also considered government-managed fund expenditures to be made up of expenditures from land sale revenues and government-managed funds expenditure excludes land sale revenue, they estimated the scale from 2003 to 2012 and gave the specific details about how to calculate the expenditure caused by land sale revenue. We believe the latter research is more reasonable because compensation for demolition will require a large amount of money and this expense is considered part of land sale revenues. Thus, when we calculate the real government expenditure, this compensation expense must be deducted.

According to the data in Table 2, the average proportion of net land sale revenue is about 35.5%. However, the Ministry of Finance published data spanning only 4 years, which complicates our calculations. Fortunately, the Ministry of Land and Resources published data of land sale revenues for over a longer period of 2003-2012. Considering that the numerical difference between these datasets was very small, we can calculate net land sale revenues through data from the Ministry of Land and Resources. For calculating the data from 1989 to 2002, here we assume that the growth rate in this period is identical to the average rate obtained in 2003-2012.

Table 2
Land sale revenue and compensation for demolition (in billion yuan)

Year	2009	2010	2011	2012
Land sale revenue	1423.97	2939.80	3347.70	2888.63
Compensation expense	498.57	1673.22	2405.38	2262.49

Source: Website of Ministry of Finance of the People's Republic of China, http://www.mof.gov.cn/index.htm.

2.1.2. Estimation of China's local government debt increment

While several research studies focusing on the scale of China's local government debt are available, their results vary widely and an accurate figure of the scale of China's local government debt has not been determined. China's officials previously published audit results on the local government debt twice. The first set of audit data showed that all three levels of local government[1] debt totaled 10.72 trillion yuan by the end of 2010. China's local government debt has seen rapid growth in less than three years because the second set of audit data indicated that the local government debt had reached 17.89 trillion yuan. The majority of experts and scholars in this field, however, believed that these audit results underestimate the scale of China's local government debt and that the real scale must be greater than the reported values (Li, 2013; Chen, 2013). Thus, to obtain a more reasonable estimate of local government debt, adjustments must be made according to the current data. Here, we insist that adjustment of the audit data from three aspects, i.e., bank loans of local government financing platforms, bonds, and trust funds, is necessary. It should be noted that, in two times of local government debt audit, some changes occurred in the caliber of debt. Considering the caliber change will make the data estimates very difficult, therefore there is no consideration for this conduct.

Debt data of local government financing platforms, especially in the form of bank loans, are poor of reliability, which is the main reason that causes people to question the results of local government debt. Audit results showed that, at the end of 2010, the local government debt in bank loans was 8.47 trillion yuan and that the total debt of financing platform enterprises was 4.97 trillion yuan. However, bank loan data published by China's Banking Regulatory Commission reported a figure of 9.09 trillion yuan. Although the statistical objects of local government financing platforms include administrative organs, institutions, and enterprises, this difference still cannot explain the variation observed. From the list of local government financing platforms published by China Banking Regulatory Commission in 2013, we find that financing platforms also include a number of institutions related to land purchase and storage, transportation, gas, water supply, and so on. In other words, the statistical caliber of bank loans of financing platforms in China Banking Regulatory Commission is equal to the sum of local government departments and agencies, financing platform companies, and utilities in the audit results. Thus, we can assume that the proportion of each categorical unit is fixed and then estimate the real scale of bank loans from the audit data. According to our calculation results, bank loans were underestimated by about 2.99 trillion yuan at the end of 2010 and by about 3.28 trillion yuan at

[1] The first audit of local government debt included only three levels of local government: province, city, and county. In the second audit, township-level government was included.

the end of June 2013.

China's local government debt involves many types of bonds, including local treasury bonds (issued by the Ministry of Finance) and a variety of urban construction investment bonds. The first audit results showed that the amount of all bonds totaled 756.7 billion yuan at the end of 2010. All of the bonds were divided into three categories in the second audit, but the total amount of corporate bonds, medium-term notes, and short-term financing bonds was only 1.1123 trillion yuan. According to the results of the WIND database, all of the bonds (including short-term financing bonds, convertible bonds, etc.) totaled 701.9 billion yuan at the end of 2010 and 2.2539 trillion yuan at the end of June 2013. Considering local treasury bonds, we found that bonds were underestimated by about 345.2 billion yuan at the end of 2010 and by about 1.1416 trillion yuan at the end of June 2013.

Local government debt-attributed trust funds were not considered in the first debt audit, and 1.4252 trillion yuan of trust-fund debt was reported at the end of June 2013. According to Li et al. (2013), local government debt attributed to trust funds should nearly equal the amount of trust capital flowing into basic industries. According to data published by the China Trustee Association website, trust funds amounted to 994.7 billion yuan at the end of 2010 and 2.3906 trillion yuan at the end of June 2013. Thus, the debt attributed to trust funds in the audit results was underestimated by about 994.7 billion yuan at the end of 2010 and by about 965.4 billion yuan at the end of June 2013.

From the discussion above, the total amount of China's local government debt was about 15.04739 trillion yuan at the end of 2010 and 15.04739 trillion yuan at the end of June 2013. However, after adjustment, the final numbers are significantly higher than the audit results. We can estimate data of local government debt from 1996 to 2009 according to the data of growth rate obtained during the first audit and replace missing growth rate data with the average growth rate. To estimate debt data before 1996, the average growth rate may be used. Finally, we can measure the stock data of China's local government debt from 1988 to 2012 and obtain data of debt increment.

2.2. Government expenses and measurement data

Expense is based on the accounting concept of government expenditure, which is defined as a decrease in net worth resulting from a transaction. Since current investments of government expenditure will not be defined as government expenditures, the depreciation of government capital stock may be considered the actual government expense. According to this definition, government expense may be classified as non-investment components of the full-caliber government expenditure and depreciation of government fixed capital stock.

2.2.1. Estimation of the non-investment scale of full-caliber government expenditures

In a previous section of this paper, we constructed a new indicator of full-caliber government expenditures that takes into account budget expenditures, off-budget expenditures, social insurance fund expenditures, government-managed fund expenditures without land sale revenues, net land sale revenues, increments of local government debt, and export tax rebates (Table 3). Among these expenditures, social insurance fund expenditures and export tax rebates obviously cannot be utilized for investment, while the other five parts expenditures can be used to form fixed assets. Because the use of increments of local government debt and net land sale revenues

is strictly limited, most of the capital is applied to urban and rural infrastructure construction projects, which can be treated as investments. In government-managed fund expenditures without land sale revenues, just a small amount like the additional arrangement of local education spending, disabled employment security expenditure, marine oil pollution damage compensation fund expenditure[1] is not related to construction investment, most of the capital is related to investment. Therefore, the difficulty associated with estimating the non-investment scale mainly lies in measurement of the investment component in budget expenditures, off-budget expenditures, and government-managed fund expenditures.

Table 3

Estimated results of full-caliber government expenditures (unit: billion yuan, current prices)

Year	Budget expenditures	Off-budget expenditures	Social insurance fund expenditures	Government-managed fund expenditures without land sale revenues	Net land sale revenues	Increment of local government debt	Export tax rebates	Full-caliber government expenditures
1989	282.38	250.31	12.09	19.40	9.09	8.84	15.31	597.42
1990	308.36	270.71	15.19	23.02	11.31	11.70	18.56	658.85
1991	338.66	309.23	17.61	27.33	14.06	15.47	25.46	747.82
1992	374.22	364.99	32.71	32.44	17.49	20.47	26.59	868.91
1993	464.23	131.43	48.22	38.51	21.75	27.08	29.97	761.19
1994	579.26	171.04	68.00	45.71	27.04	35.82	45.01	971.88
1995	682.37	233.13	87.71	54.26	33.63	47.39	54.98	1193.47
1996	793.76	383.83	108.24	64.40	41.83	62.69	82.77	1537.52
1997	923.36	268.55	133.92	76.45	52.02	63.75	55.5	1573.55
1998	1079.82	291.83	163.69	90.75	64.69	154.52	43.62	1888.92
1999	1318.77	313.91	210.81	107.72	80.45	211.33	62.67	2305.66
2000	1588.65	352.90	238.56	127.87	100.06	279.79	105.00	2792.83
2001	1890.26	385.00	274.80	151.78	124.44	357.89	108.00	3292.17
2002	2205.32	383.10	347.15	180.17	154.75	441.19	115.00	3826.68
2003	2465.00	415.64	401.64	213.86	192.46	563.48	198.86	4450.94
2004	2848.69	435.17	462.74	251.20	209.24	710.74	348.41	5266.19
2005	3393.03	524.25	540.08	293.62	195.43	885.11	404.89	6236.41
2006	4042.27	586.70	647.74	349.61	272.53	1087.9	487.72	7474.47
2007	4978.14	611.24	788.79	368.14	453.10	1319.3	563.50	9082.21
2008	6259.27	634.64	992.51	526.11	345.66	1486.71	586.59	10831.49
2009	7629.99	622.83	1230.26	437.17	564.81	4841.23	648.66	15974.95
2010	8987.42	575.47	1481.85	767.51	958.50	2387.63	732.73	15891.11
2011	10924.78	—	1805.46	1022.27	1118.25	2869.14	920.48	18660.38
2012	12595.30	—	2218.16	765.09	954.95	3416.21	1042.90	20992.61

Notes: "—" means that they are 0 because off-budget expenditures were included in budget expenditures since 2011.

Source: (1) Data of budget expenditures, off-budget expenditures, and export tax rebates are from *China Finance Yearbook 2013*; (2) data of social insurance fund expenditures are from *China Labor Statistical Yearbook 2013*; (3) data of government-managed fund expenditures without land sale revenues from 2003 to 2012 are from Gao et al.; (2014) and data of 1989-2002 are estimated by using the average growth rate.

[1] More details can be seen in *China finance Yearbook 2013*.

Two main methods are used to measure investments from budget and off-budget expenditures: one-by-one removal and gradual accumulation (Zhang et al., 2011). Here, we select the accumulation method for our measurements. The measurement process for off-budget fund expenditures is fairly easy and only calculation of the total amount of public affairs and transportation is necessary. Unfortunately, itemized expenditures of off-budget fund expenditures were not published in the *China Statistical Yearbook* before 2007. Thus, we calculate an average investment ratio according to the data of 2007-2009[1] and then use this unchangeable ratio to estimate the amount of investment. Measurement of the investment component in budget expenditures is difficult, especially since the statistical caliber of itemized expenditures has been changed since 2007. Budget expenditures were divided into 11 classes before 2007; since 2007, however, these classes have been further subdivided into 23 categories. We select expenditures of basic construction, potentiality exploration and technical innovation, science and technology charges, supporting agriculture, science, education, culture, and health[2] to estimate government investments before 2007 (Zhang, 2012). We also select expenditures of general public affairs, forestry and water management, transportation, post-disaster reconstruction, and housing security to estimate government investments after 2007. Finally, results of the non-investment scale of full-caliber government expenditures from 1989 to 2012 may be obtained (Table 4).

Table 4

Results of China's government expenses from 1989 to 2012 (unit: billion yuan, current prices)

Year	Non-investment scale of full-caliber government expenditures	Depreciation of government fixed capital stock	Government expense	Year	Non-investment scale of full-caliber government expenditures	Depreciation of government fixed capital stock	Government expense
1989	357.86	26.12	383.98	2001	1780.91	293.32	2074.23
1990	389.15	30.17	419.32	2002	2032.71	335.05	2367.76
1991	442.22	34.72	476.94	2003	2357.96	386.94	2744.90
1992	520.47	41.06	561.53	2004	2831.19	447.00	3278.19
1993	410.59	49.98	460.57	2005	3384.15	524.06	3908.21
1994	546.04	63.34	609.38	2006	4041.29	616.47	4657.76
1995	680.14	81.48	761.62	2007	5401.01	722.02	6123.03
1996	905.39	105.42	1010.81	2008	6560.54	1024.07	7584.61
1997	899.54	134.70	1034.24	2009	7728.27	1341.61	9069.88
1998	1022.97	171.32	1194.29	2010	8982.99	1785.66	10768.65
1999	1228.60	210.91	1439.51	2011	10408.89	2264.28	12673.17
2000	1547.95	256.35	1804.30	2012	12110.97	2710.03	14821.00

Source: *China Statistical Yearbook 2013*.

2.2.2. Estimation of depreciation of government fixed capital stock

The key to accurate measurement of the depreciation of government fixed capital stock is to

[1] Here, we simply used the period of 2007-2009 because the proportion of investment was very small in 2010.

[2] More details can be seen in *China Statistical Yearbook 2013*.

calculate the fixed capital stock. The perpetual inventory method is usually applied to measure fixed capital stock. To ensure the results of the fixed asset data can be additive, it is necessary to use the price index to remove the impact of the price factor. We estimate the deflator index of fixed-asset investments, initial stock of fixed capital, and public investments of fixed capital according to Zhang (2010). We note here that public investments of fixed capital stock do not only come from the government sector; this parameter also includes some investments from enterprises and individuals. However, government expenditures remain the absolute source of public investment. Because Zhang (2010) only estimated the data before 2008, we must further estimate China's fixed capital stock from public investments in the period of 2008-2012. We can calculate the depreciation of government fixed-capital stock according to the fixed capital stock and a constant depreciation rate (5%). Calculation of the depreciation in current prices using the deflator index is also necessary to ensure data comparability. The final measurement results are shown in Table 4.

3. Applicability test of Wagner's Law in China

The two new indicators of China's government expenditures are reconstructed and estimated through the known data. In this section, we use these data to test the applicability of Wagner's Law in China.

3.1. Model setting and data sources

Table 1 lists six test models based on Wagner's Law; here, models 1 and 4 are often applied in practice. Model 1 considers time-series data of numerical increases, while model 4 is a time-series model considering proportional increases in expenditures. In this paper, we combine these models to test whether or not economic growth causes increases in government expenditures as well as prove whether or not a positive correlation exists between the two if the first statement holds.

Besides the indicator of fiscal government expenditures, E1, and the two new government-expenditure indicators (i.e., full-caliber government expenditure, E2, and government expense, E3, other indicators are described in the empirical tests performed in this study; these indicators include gross national income (GNI) and national population (P). All of the data can be found in *China Statistical Yearbook 2013*. To eliminate the influence of price, we use the GDP deflator to calculate government expenditures and GPD at a fixed price. Data of GDP deflator may be obtained from the United Nations statistical database; the deflator index in 2000 was 100. Government expenditure will be multiplied by 100, which may reduce the trouble when the numerical value is too small (Wu, 2006).

3.2. Applicability testing

3.2.1. Stationarity and unit root tests

The test of stationarity is the first step of time-series analysis that aims to avoid spurious

regression; this test is also the premise of cointegration and causality testing. The most-used stationarity test is the Augmented Dickey-Fuller (ADF) test, which is performed by adding y_t to the right-hand side of the regression function to control higher-order serial correlation. Three models are available in the ADF test: intercept, trend and intercept, and none.

$$\Delta y_t = \gamma y_{t-1} + \sum_{i=1}^{p} \beta_i \Delta y_{t-i} + \mu_t \tag{1}$$

$$\Delta y_t = \gamma y_{t-1} + a + \sum_{i=1}^{p} \beta_i \Delta y_{t-i} + \mu_t \tag{2}$$

$$\Delta y_t = \gamma y_{t-1} + a + \sigma t + \sum_{i=1}^{p} \beta_i \Delta y_{t-i} + \mu_t \tag{3}$$

Where a is a constant, σt is the linear drift, $\mu_t \square i.i.d.$, $N(0,\delta^2)$, and t=1, 2, …, T.

The results above demonstrate that the original-series data are unstable in all three ADF tests, whereas the first-order difference series data are all stable at the 95% level; this result means the series are all integrated of one order, (I (1)).

3.2.2. Cointegration test

When the series are all I (1), it is possible that there is a long term relationship of cointegration. Since Wagner's Law requires regression results, we select the Engle-Granger two-step method to do the cointegration test. Linear regression is performed using two factors, followed by the ADF test on residual series. If the residual series is stable, the two factors are cointegrated and the regression result is not spurious.

Table 5
ADF test results

Factor	Test value and significance of original factor	Conclusion	Test value and significance of first-order difference	Conclusion
LE1	1.26	Unstable	-3.41**	Stable
LE2	0.92	Unstable	-4.29***	Stable
LE3	1.41	Unstable	-6.80***	Stable
LGNI	-0.87	Unstable	-3.53**	Stable
L(100*E1/GNI)	-2.51	Unstable	-3.37**	Stable
L(100*E2/GNI)	-1.01	Unstable	-4.21***	Stable
L(100*E3/GNI)	-0.62	Unstable	-5.39***	Stable
L(GNI/P)	1.37	Unstable	-3.18**	Stable

Notes: (1) During testing of the original-series data, the results of all three ADF tests are insignificant at the 10% level.; (2) we provide only the test results of the intercept and m-lagged first-differences data of the dependent variable (m=3); (3) ***, **, and * reflect significance at the 1%, 5%, and 10% level; (4) a series is considered stable if the test value is significant at the 5% level.

Table 6
Engle-Granger two-step method results

Model 1, dependent factor LGNI						
Explanatory factor	Constant (a)	Coefficient (b)	$\overline{R}^2$	D.W.	Residual ADF test value	Cointegrated
LE1	-1.504*	0.996***	0.907	0.303	-2.483**	Yes
LE2	-3.493***	1.199***	0.938	0.387	-2.109**	Yes
LE3	-4.176***	1.220***	0.939	0.320	-2.017**	Yes
Model 4, dependent factor L (GNI/P)						
L(100*E1/GNI)	3.061***	-0.001	-0.045	0.303	-2.504**	Yes
L(100*E2/GNI)	1.433**	0.220***	0.283	0.392	-2.119**	Yes
L(100*E3/GNI)	—	0.329***	0.310	0.312	-2.867***	Yes

Notes: (1) "—"means the constant is not significant and no intercept regression is used; (2) ***, **, and * indicate significance at the 1%, 5%, and 10% levels; (3) cointegration is indicated if the test value is significant at the 5% level.

3.2.3. Granger causality test

The Granger causality test is a statistical hypothesis test for determining whether one time series is useful in forecasting another (Granger, 1969). The cointegration test results described in Table 4 indicate that cointegration exists in each of the two factors we tested. Moreover, through Granger causality, we can test whether or not LGNI and L (GNI/P) are the Granger causalities of their counterparts. A time series X is said to Granger-cause Y if it can be shown, usually through a series of t-tests and F-tests on lagged values of X (and with lagged values of Y also included), that those X values provide statistically significant information about future values of Y. Here, test results are relevant to the lag's length, which is denoted as K. In this paper, K can range from 1 to 3.

Table 7
Granger causality test results

H_0 hypothesis	Statistic value at each lag value		
	K=1	K=2	K=3
LGNI does not cause LE1	12.220***	12.018***	12.781***
LGNI does not cause LE2	10.833***	10.932***	12.594***
LGNI does not cause LE3	12.853***	10.681***	9.418***
L(GNI/P) does not cause L(100*E1/GNI)	3.560*	6.719***	8.875***
L(GNI/P) does not cause L(100*E2/GNI)	5.994**	10.372***	14.053***
L(GNI/P) does not cause L(100*E3/GNI)	8.596***	10.033***	10.507***

Notes: ***, **, and * are indicate significance at the 1%, 5%, and 10% levels.

3.3. Empirical analysis results

According to test results we can get that all the variables are I (1), further it can be proved that all the variables in model 1 or 4 can meet requirements of cointegration through the Engle-Granger two-step method. The cointegration results may be used not only to determine whether a regression equation is spurious or not but also as preconditions for Granger causality analysis.

The test results of model 1 (Table 7) show that here is a single Granger causality between economic growth and government expenditures in all three cases. The results also prove that economic growth can cause expansion of government expenditures. However, regression results in Table 6 demonstrate that the regression coefficient of LE10.996 is slightly less than 1 while those of LE2 and LE3 are greater than 1. These values indicate that increases in government expenditures are fully elastic when LE2 or LE3 are used but that LE1 cannot yield the same results. In other words, economic growth can cause expansion of government expenditures, and the expansion speed is faster than the economic growth rate. This analysis supports the applicability of Wagner's Law in China when E2 or E3 is used to measure government expenditures with model 1.

Model 4 is used to test the applicability of Wagner's law from the perspective of proportional increase. The results also show that the growth of per capita income (L (GNI/P)) causes the ratio of government expenditure to GDP in all three cases (Table 7). We can conclude from the regression results in Table 6 that the regression coefficient b is not significant and negative; even the adjusted R2 is also negative when the fiscal expenditure E1 is used to measure the relative scale of government. This result indicates that evidence supporting the applicability of Wagner's Law in China cannot be obtained using fiscal expenditure E1 to measure the relative scale of government. By contrast, the use of full-caliber government expenditure E2 and government expense E3 to measure relative changes in government scale can support the feasibility of Wagner's Law in China. The regression coefficients obtained, which are less than 1, indicate that the growth of per capita income can lead to expansion of the relative scale of government; however, the growth rate of expansion of the relative government scale is slower than the growth rate of per capita income. In terms of Wagner's Law, the growth rate of the relative scale of government is inelastic.

4. Conclusions

In this paper, we reconstructed two new government expenditure indicators and estimated the scale of the indicators. We then used these indicators to test the applicability of Wagner's law in China with models 1 and 4. The test results of model 1 showed that both the budget expenditure (including off-budget expenditures) indicator and the two new indicators can effectively support the applicability of Wagner's Law in China. However, from the perspective of proportional expenditure increases with model 4, the current budget expenditures cannot support the applicability of the law. The new government-expenditure indicators can support the law when they are applied to a test at the same time. Results reveal that the new expenditure indicators developed in this work can make up for the deficiency of current expenditure indicators used to

describe the scale of government to a certain extent.

The expansion of China's government scale in recent years may be partly explained by Wagner's Law. However, changes in government expenditures are not entirely determined by economic growth. More factors need to be considered when analyzing this problem. The applicability of Wagner's Law requires fulfillment of several conditions. The law may only apply to certain stages of development, and the scale of public government expenditures can not rise forever (Guo, 2005). In the future, application of Wagner's Law will face more challenges in China because the scope through which government expenditures will be increased will become narrower. On the one hand, as government organizations reform, streamlining of government bodies will be necessary to improve efficiency. On the other hand, the government must reduce future expenditures by reducing land sale revenues and raising government debt risks.

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