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Co-integration Analysis and the Long-Run Validity of Wagner's Hypothesis: Evidence from the People's Republic of China*

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Using newly released economic data from the People's Republic of China, the long-run validity of Wagner's hypothesis is tested within the Engle and Granger co-integration framework. Our empirical results lend support to Wagner's hypothesis.

I. Introduction

Over the past three decades Wagner's hypothesis of rising public expenditure for industrializing countries has received considerable attention in the public finance literature. Although there are varying interpretations, the main idea of the "law" is that public spending increases as national income expands.

Empirical investigations of Wagner's hypothesis have been mainly confined to two specific areas, estimation of the impact of economic development on public spending and causality studies which focus on the underlying relationship between these two macro variables.[1,2] Lately,

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1. Impact studies using time series data tend to validate Wagner's hypothesis while cross section studies generate contradictory results depending on the country groupings used (see Nagarajan and Spears (1989, pp. 134)).
2. The causality results range the full continuum from no causal relation to bi-directional causality. Contributions include Afexentiou and Sertletis (1991), Ram (1986) and Sahni and Singh (1984) among others.

these two types of analyses have been criticized for paying insufficient attention to the long-run relationship between economic development and public spending. Many empirical studies such Ahsan, Kwan and Sahni (1996), Murthy (1993) and Oxley (1994) argue that the validity of Wagner's law should be tested on the basis of the co-movement of these two variables over time. Employing co-integration techniques developed by Engle and Granger (1987) and Johansen (1988), the empirical results of these investigations support the long-run validity of the said hypothesis.

Existing co-integration studies on the long-run relationship between public spending and national income focus solely on market economies.[3] To date, no attempt has been made to extend the current empirical work to a transitional economy. In this paper, we consider one such case study: the People's Republic of China, which provides us with the opportunity to investigate the long-run link between public spending and national income in an environment where market mechanisms are not fully developed. In addition, there are other reasons for choosing China as the focus of our study. First, China's pattern of economic development displays many of the conditions necessary for Wagner's hypothesis to operate. These include, a rising per capita income, substantial technological and institutional change following on the "Four Modernizations" (1976-79) and current Economic Reforms (1980-on) and more recently, an implicit democratization of the polity in terms of increasing privatization and a concomitant devolution of decision making power to individuals. Second, to our knowledge no behavioral government expenditure studies exist for the Chinese economy. Lately, recent empirical evidence suggests that the link between income growth and the relative size of the public sector should be particularly strong for a country like China which is in the middle range of industrial development.[4]

In this paper, we directly address the non-stationarity nature of our data by using the Zivot and Andrews (1992) modified unit root test.

3. These include Canada (Ahsan, Kwan and Sahni (1996)). Britain (Oxley (1994)) and Mexico (Lin (1995), Murthy (1993)).

4. See Abizadeh and Gray (1985), Herber (1983) and Ram (1987) for further details on this point.

Our analysis follows the aforementioned co-integration studies in that we employ the Engle and Granger (1987) method to examine the long-run validity of Wagner's hypothesis. Our main empirical findings suggest that Wagner's law holds for China for period 1952-1992.

The remainder of our paper is structured as follows. In section II we give a brief description of the data and the econometric methodology used in our tests. Our empirical results concerning the structure of the co-variance of national income and public expenditure in China are presented in Section III. In Section IV we offer some concluding remarks and indicate possible areas for future research.

II. Methodology and Data

Based on Mann (1980), we employ the following log-linear models to test the long-run validity of Wagner's hypothesis:

$$\ln(GSIZE) = a_0 + a_1\ln(Y) + \varepsilon_{1t}, \quad (1)$$
$$\ln(GSIZE) = b_0 + b_1\ln(YPOP) + \varepsilon_{2t}, \quad (2)$$
$$\ln(G) = c_0 + c_1\ln(Y) + \varepsilon_{3t}, \quad (3)$$
$$\ln(G) = d_0 + d_1\ln(YPOP) + \varepsilon_{4t}, \quad (4)$$
$$\ln(GC) = e_0 + e_1\ln(Y) + \varepsilon_{5t}, \quad (5)$$
and
$$\ln(GPOP) = f_0 + f_1\ln(YPOP) + \varepsilon_{6t}, \quad (6)$$

where G is real government expenditure, Y is real national income, GSIZE is the share of government expenditure in national income, GPOP is real per capita government expenditure, YPOP is real per capita income, GC is real government consumption expenditure, and ε_{it} ($i = 1, \cdots, 6$) are the usual error terms.[5,6]

An important step in understanding the co-movement of income and public expenditure is to examine whether or not each series is stationary.[7] However, it is known that most macro economic time series

5. Equations (1)-(6) are the most commonly-used specifications for the empirical analysis of Wagner's law. See Abizadeh and Yousefi (1988) and Nagarajan and Spears (1990) for further elaborations.

6. We would like to thank an anonymous referee for directing our attention to the six versions of Wagner's law found in Mann (1980).

7. Impact studies, for the most part, confine their attention to OLS coefficient estimates (a_1,

do not possess this property. In order to detect the problem of non-stationarity, we use the unit root test recently proposed by Zivot and Andrews (1992). As indicated by Zivot and Andrew's (1992), their unit root test is more reliable than those of Dickey and Fuller (1979) and Perron (1989), particularly in the case where the time series possesses a "structural break".

The Zivot and Andrews unit root test procedure is performed by estimating the following regression:

$$\triangle X_t = \mu + \theta DU_t(\hat{\lambda}) + \beta(\text{Trend}) + \gamma DT_t(\hat{\lambda}) + \alpha X_{t-1} + \sum_{j=1}^{p} \delta_j \triangle X_{t-j} + \varepsilon_t, \qquad t = 1, \cdots, T \tag{7}$$

where X_t is a potentially non-stationary time series; $DU_t=DT=0$ if $t \leq TB$ (the break point) and $DU_t=1$ and $DT_t=\text{Trend}$ if $t>TB$; the break fraction $\hat{\lambda}=TB/T$; and ε_t is the error term.[8] The break fraction, $\hat{\lambda}$, is estimated directly from the data and can range from $2/T$ to $(T-1)/T$. The terms $\triangle X_{t-j}$ ($j=1, \cdots, p$) are included to purge any serial correlation among residuals. The dummy variables DU and DT are included in equation (7) to account for a potential break in the series. The Zivot and Andrews unit root test chooses $\hat{\lambda}$ so as to minimize the one-sided t-statistic used to test the null hypothesis that $\alpha=1$. The test value is the minimum of all calculated t-values of $\hat{\alpha}$ obtained from (7).

In order to carry out our co-integration analysis, we consider another non-stationary time series, Y. If both X and Y are integrated of order 1 (i.e., I(1)),[9] it is important to examine whether they share a common stochastic trend. If so, then movements in the "trend" of X would appear as shifts in Y (or vice versa), thus indicating X and Y

b_1, c_1, d_1, e_1, f_1) based on equations such as (1)-(6). However, as Granger and Newbold (1976) cogently argue, this may lead to "spurious" regression estimates. As a result, one cannot attach too much credence to the regression results.

8. In performing the Zivot and Andrews test, we assume that the assumptions of error structure such as normality, homoscedasticity, independence are valid.
9. In Box and Jenkin's (1976) terminology, the number of unit roots is equivalent to the order of integration. Thus, if a time series possesses "d" unit roots, it is said to be integrated of order "d".

move together in the long-run. Such behaviour, as suggested by Engle and Granger (1987), is called co-integration.

According to Engle and Granger (1987), the two series X and Y are said to be co-integrated if there exists some linear combination of the two which produces a stationary trend (I(0)). The Engle and Granger (1987) co-integrating regression is carried out as follows:

$$Y_t = \hat{\pi} X_t + \mu_t, \tag{8}$$

where $\hat{\pi}$ is the co-integrating vector. If the residuals μ_t are stationary the two series X and Y are said to be co-integrated. Essentially, this implies that the series converge to a long-run (or stationary) equilibrium condition.

As for the data employed in the present paper, national income, government expenditure and population figures for the period 1952-92 are obtained from the Statistical Yearbook of China and are measured in real terms. The price index used is the implicit national income deflator.

III. Empirical Results

The results of the Zivot and Andrews (1992) unit root test and the Engle and Granger (1987) co-integration analysis are summarized in Table 1. To conserve space, we only report the t-values of $\hat{\alpha}$, the diagnostic results of the Zivot and Andrews regressions, and the Dickey and Fuller tests of co-integration. On the basis of the diagnostic results which include: the Godfrey LM test for first-order serial correlation (LM(1)), the Engle test for first-order autoregressive hetero-scedasticity (ARCH(1)), the White test for heteroscedasticity (WHITE), and the Jacque-Bera test for normality (J-B), the usual assumptions of ε_t appear to be satisfied. As for the t-values of $\hat{\alpha}$, they are statistically insignificant at the 10% level when the series (ln(GSIZE), ln(G), ln(GPOP), ln(GC), ln(Y) and ln(YPOP)) are tested in levels. These findings suggest that the unit root hypothesis cannot be rejected. However, the series are found to be stationary once their first-difference forms are taken. Using Box and Jenkins' (1976) terminology, these variables are said to be integrated of order 1. This evidence is indeed consistent with Nelson and Plosser's (1982) contention that most macroeconomic time series are differenced-stationary.[10] It also highlights the need to properly address the underlying trend properties of the variables considered when testing the secular validity of Wagner's hypothesis.

Since all our time series possess the same degree of integration, we carry out the Engle and Granger co-integration analysis on equations (1)-(6). When we apply the conventional Dickey-Fuller test to the residuals of these six equations, we find that our test values are significant at least at the 5% level, which suggests that the null hypothesis of non-stationarity can be rejected. This evidence points to the existence of a long-run equilibrium condition between the income and public expenditure variables. Our empirical evidence thus provides support for the long-run validity of Wagner's hypothesis for China.

Our focus on long-run equilibrium relationships has enabled us to carry out a properly specified test of Wagner's hypothesis for China's transitional economy. It also allows direct comparisons to be made with existing empirical studies of full-fledged market economies. This underscores a certain measure of uniqueness for our results.

Ⅳ. Conclusion

In this paper we argue that Wagner's hypothesis is a proposition about the long-run co-movement of national income and public spending. Using the Engle and Granger co-integration technique and newly released economic data from the People's Republic of China for 1952-92, we test for the long-run validity of Wagner's hypothesis.

We find that, given the functional forms of equations (1)-(6), the estimated residuals of our co-integrating regressions are stationary. This evidence supports the secular validity of Wagner's hypothesis for the case of China. Also, while addressing the non-stationarity property of our time series, we determined that the relevant variables were

10. See also Zivot and Andrews (1992).

integrated of order one.

As for future research, it would be of considerable interest to extend our analysis to a multi-country framework. As well, the present investigation relates aggregate government spending to economic development. Similar studies undertaken at a more disaggregate level may help to isolate those factors which give rise to growth in public spending.

Table 1 Tests for a Unit Root and Co-integration

Zivot-Andrews Tests:

Series	$t(\hat{\alpha})$	LM(1)	ARCH(1)	WHITE	J-B
Level Data					
ln(GSIZE)	-4.471	0.098	1.185	13.171 (q=9)	1.422
ln(G)	-2.784	0.306	2.566	19.362 (q=13)	1.304
ln(GPOP)	-2.898	2.186	0.333	19.646 (q=13)	1.671
ln(GC)	-3.634	2.631	0.487	18.981 (q=13)	2.155
Ln(Y)	-1.893	0.189	0.004	15.170 (q=9)	4.516
ln(YPOP)	-1.544	1.436	0.001	14.574 (q=9)	2.819
First-Differenced Data					
ln(GSIZE)	-7.306[a]	1.704	0.254	11.916 (q=9)	1.419
ln(G)	-5.616[a]	0.121	0.009	10.260 (q=7)	4.515
ln(GPOP)	-5.710[a]	0.477	0.014	10.250 (q=7)	3.687
ln(GC)	-5.606[a]	0.120	0.018	10.188 (q=7)	4.530
Ln(Y)	-4.975[c]	2.460	0.039	12.012 (q=7)	2.551
ln(YPOP)	-5.780[a]	0.744	0.123	11.389 (q=7)	2.063

Engle and Granger's Co-integration Tests:

	eq. (1)	eq. (2)	eq. (3)	eq. (4)	eq. (5)	eq. (6)
Dickey-Fuller t-statistic:	-4.71[a]	-4.83[a]	-4.71[a]	-3.013[b]	-3.45[b]	-4.83[a]

Notes: Both LM(1) and ARCH(1) are asymptotically distributed as x_1^2. WHITE is asymptotically distributed as x_q^2. J-B is asymptotically distributed as x_2^2. The value of p is determined according to Perron's (1990) procedure. The t statistic for α is for testing $\alpha = 1$. Critical values for the Zivot-Andrews test at the 1%, 5% and 10% significance levels, respectively, are -5.56, -5.08 and -4.82.

a. Significant at the 1% level.

b. Significant at the 5% level.

c. Significant at the 10% level.

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