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Wagner's Law in Brunei: New Findings

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Abstract

Despite numerous research efforts to examine the Wagner's Law, there is still lacking of systematically analysis on this important topic in Asia. Thus, the current paper aims to fill this research gap and chooses Brunei as a case study to examine the validity of the Wagner's Law. It is a well-known fact that the Bruneian government has been playing an important role to simulate economic development in the country. It means that Brunei could be interesting example of Asian country where the government expenditure would stimulate economic development. The empirical findings indicate that there is a long-run relationship between economic development, population and government expenditure and there exists a short-run causality between population and government expenditure. These findings seem to empirical evidence to support the Wagner's Law in Brunei.

Keywords: economic development, government expenditure, Brunei, Wagner's Law

1 Introduction

There is a well-known fact that the Bruneian government has been playing important role in industrialization process in the country. The Bruneian government has made serious effects to launch various development projects and plans in order to sustain its economic development and to provide valuable job opportunities for its citizens in the country. The designs of the new economic plans, their implementation processes to oversee these government-initiated development projects could induce the Bruneian government to set up new government offices and agencies. This would inevitably results in the expansion of bureaucratic system in its government sector. In other words, Brunei could be one of interesting examples in Asia where government expenditure would grow as the country becomes wealthier (Bird, 1971; Oxley, 1994; Furuoka, 2008).

More generally, any governments would make serious attempts to diversify their activities by substituting the private sector activities in the early stages of the industrialisation process. As a result, the size of government expenditure would tend to expand during the process of economic development. This inevitable expansion of

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the government expenditure during the industrialisation process is first detected by a famous German economist, Adolph Wagner in 1883. Wagner argued that the public sector expenditure grows as a country develops economically and its national income increases. This positive relationship between economic development and government expenditure is known as the Wagner's Law. In other words, the Wagner's Law has recognised as an important social regularity to describe the relationship between economic development and government expenditure. He predicts, as a country would become wealthier, the size of the bureaucracy mechanism and the government expenditure would tend to increase (Wagner, 1883; Oxley, 1994).

More precisely, Wagner gave the following three reasons to explain why government expenditure would tend to increase when a country would implement the industrialisation programs. Firstly, the administrative mechanism and protective functions of the government offices and agencies would replace the private activities. Secondly, the economic development would lead to the creation of middle and upper classes which results in an increase in the government expenditure on the culture and welfare. Finally, the government would increase efforts to manage the financial sectors and to regulate the industrial monopolies in the economic transaction (Wagner, 1883; Bird, 1971).

Despite numerous empirical inquiries to examine the Wagner's Law, the empirical findings are contradictory and inconclusive (Kolluri *et al.,* 2000; Furuoka, 2008). Kolluri *et al.* (2000) commented that a number of researchers have tested the Wagner's Law of the government expenditure and they reported the conflicting results. Some researcher provided evidence to support the Wagner's Law (Kyzyzaniak 1974; Vatter and Walker 1986; Nagarajan and Spears 1990; Ram 1987; Lin 1995; Ahsan *et al.* 1996; Kolluri *et al.* 2000; Furuoka, 2008; Richter and Paparas, 2012; Kumar *et al.* 2012; Bashirli and Sabiroglu, 2013; Permana and Wika, 2014). On the other hand, other researcher denied the existence of Wagner's Law as their empirical findings did not support the positive relationship between economic development and government expenditure (Diamond 1977; Wagner and Weber 1977; Afxentiou and Serletis 1991; Ashworth 1994; Hondroyiannis and Papapetrou 1995; Chang *et al*. 2004; Ighodaro and Oriakhi, 2010; Bojanic, 2013; Emerenini and Ihugba, 2014).

Furthermore, Wagner's Law has been a much discussed topic in the field of the applied macroeconomics. Despite numerous empirical studies to test the existence of the Wagner's Law in the developed countries in North America and Europe, there is still a lack of systematic research in Asia, such as Brunei. Thus, current paper chooses Brunei as a case study to test the Wagner's Law. For the purpose of empirical analysis, it employs a three-stage procedure proposed by Oxley (1994). Firstly, the unit root test is used to examine the stationarity of data on economic development, population and government expenditure. Secondly, the cointegration test is employed to examine the long-run movement of these variables. Finally, the paper used the Granger-causality test based on the Vector Error Correction Model (VECM) to examine the causality among these variables.

The empirical analysis of the Wagner's Law in Brunei could be interesting case study because the findings could offer interesting insights as the economic development in Brunei in recent years can closely resemble the economic development in Germany in the 19th century. During the period, the German economy were in the process of the rapid industrialisation in which the German government had implemented various development projects in order to catch up with its more economically advanced European neighbours (Bird, 1971; Oxley, 1994; Furuoka, 2008).

This paper consists of four sections. Following this introductory section, second section discusses data and research methods. The next section reports the empirical findings. The final section is conclusion.

2. Data and Methods

The current paper aims to test the validity of the Wagner's Law by examining the relationship between economic development and government expenditure. For the purpose of empirical analysis, this study uses time-series data sets for the period 1970-2009. The main source of the data is *Penn World Table* published by the Centre for International Comparisons of Production, Income and Prices at the University of Pennsylvania (Heston *et al*, 2013).

In this paper, the Wagner's Law could be estimated using the following equation (Oxley, 1994; Thornton, 1999):

$$\ln (GE_t) = \alpha + \beta \ln (GDP_t) + (1-\beta) \ln (POP_t) + \mu \quad (1)$$

where *ln* is natural log, GDP_t is real Gross Domestic Product (GDP) in year *t;* GE_t, is real Government Expenditure in year *t;* POP_t is population size in year *t;* μ is a random disturbance term. Real government expenditure could be estimated using the GDP deflator (Oxley, 1994; Thornton 1999). Support for Wagner's Law would require that elasticity of government expenditure with respect to domestic product exceed unity, i.e. $\beta > 0$ (Oxley 1994).

Following the three-stage procedure suggested by Oxley (1994), the present study examined the Wagner's Law in Brunei in three stages. In the first stage of empirical analysis, the unit root test could be used to examine the stationarity of data sets (Oxley, 1994). The current study uses the augmented Dickey-Fuller (ADF) unit root test to investigate the stationarity (Dickey and Fuller 1979, 1981). The ADF test could be based on the following equation:

$$\Delta y_t = \mu + \beta_{t-1} t + \sum_{i=1}^{n} g_i \Delta y_{t-i} + \varepsilon_t \quad (2)$$

where t is a linear time trend, Δ is the difference operator, and ε_t is the error term. The ADF tests tend to be sensitive to the choice of lag length n which is determined by minimising the Akaike information criterion (AIC) (Akaike 1974). The AIC criterion is defined as:

$$AIC(q) = T \ln(\frac{RRS}{n-q}) + 2q$$

where T is the sample size, RRS is the residual sum of squares, n is lag length, q is the total number of parameters estimated.

This paper also used Phillips-Perron (PP) unit root test to analyse the stationarity of time-series data (Phillips and Perron, 1988). The PP test is basically based on the equation (2) but it uses the modified Dickey-Fuller statistics. The nonparametric PP test could be more robust than the parametric ADF test if there would be the autocorrelation and heteroscedasticity in the data sets. In other words, to overcome the autocorrelation problem in the data, the PP test made a non-parametric correction to the ADF statistic (Phillips and Perron, 1988). The modified ADF-statistic (Z_δ) can be expressed as (Greene: 2003):

$$Z_\delta = t_\delta \sqrt{\frac{c_0}{a}} - \frac{(a - c_0)Tv}{2\sqrt{as^2}} \quad (6)$$

where Z_δ is the PP statistics, t_δ is ADF statistics, C_0 is an estimate of the error variance, a is an estimate of the residual spectrum, T is the number of observation, v is the standard error of the coefficient (δ), s is the standard error of the test regression.

In the second stage of empirical analysis, current study employs the Ordinary Least Squares (OLS) regression model if the variables are integrated of order zero. On the other hand, if the variables are integrated of order one, the Johansen cointegration test would be used to examine the long-run co-movement of the variables (Johansen 1988, 1991). The Johansen cointegration test is based on maximum likelihood (ML) estimation of the K-dimensional Vector Autoregressive (VAR) model of order p:

$$Z_t = \mu + A_1 \Delta Z_{t-1} + A_2 \Delta Z_{t-2} + \ldots A_{k+1} \Delta Z_{t-p+1} + \varepsilon_t$$

where Z_t is a $k \times 1$ vector of stochastic variables, μ is a $k \times 1$ vector of constants, A_t is $k \times k$ matrices of parameters, and ε_t is a $k \times 1$ vector of error terms. The estimation model is transformed into an error correction model (ECM) form:

$$\Delta Z_t = \mu + \Gamma_1 \Delta Z_{t-1} + \Gamma_2 \Delta Z_{t-2} + \ldots \Gamma_{k+1} \Delta Z_{t-p+1} + \pi Z_{t-1} + \varepsilon_t$$

where π and $\Gamma_1, \ldots, \Gamma_{k+1}$ are $k \times k$ matrices of parameters. If the coefficient matrix π has reduced rank, $r < k$, then the matrix can be decomposed into $\pi = \alpha\beta'$. The Johansen cointegration test involves testing for rank of π matrix by examining whether the eigenvalue of π would be significantly different from zero. There are three conditions: 1) $r = k$, which means that the Z_t is stationary at levels, 2) $r=0$, which means that the Z_t is the first differenced Vector Autoregressive, and 3) $0<r<k$, which means there exists r linear combinations of Z_t that are stationary or cointegrated.

For example, if r is equal to 1, then the relationship between these three variables could be written as:

$$\begin{bmatrix} \Delta \ln GE_t \\ \Delta \ln GDP_t \\ \Delta \ln POP_t \end{bmatrix} = \begin{bmatrix} \mu_1 \\ \mu_2 \\ \mu_3 \end{bmatrix} + \sum_{i=1}^{k-1} \begin{bmatrix} \Gamma_{i,11} \Gamma_{i,12} \Gamma_{i,13} \\ \Gamma_{i,21} \Gamma_{i,22} \Gamma_{i,23} \\ \Gamma_{i,31} \Gamma_{i,32} \Gamma_{i,33} \end{bmatrix} \begin{bmatrix} \Delta \ln GE_{t-i} \\ \Delta \ln GDP_{t-i} \\ \Delta \ln POP_{t-i} \end{bmatrix} + \begin{bmatrix} \alpha_1 \\ \alpha_2 \\ \alpha_3 \end{bmatrix} \begin{bmatrix} \beta_1 \beta_2 \beta_3 \end{bmatrix} \begin{bmatrix} \Delta \ln GE_{t-1} \\ \Delta \ln GDP_{t-1} \\ \Delta \ln POP_{t-1} \end{bmatrix} + \begin{bmatrix} \varepsilon_1 \\ \varepsilon_2 \\ \varepsilon_3 \end{bmatrix}$$

The vector β represent the r linear cointegrating relationship between the variables. This paper employs the Trace (Tr) eigenvalue statistics and Maximum (L-max) eigenvalue statistics (Johansen 1988; Johansen and Juselius 1990). The likelihood ratio statistic for the trace test can be expressed as:

$$Tr = -T \sum_{i=r+1}^{p-2} \ln(1 - \hat{\lambda}_i)$$

where $\hat{\lambda}_{r+1}, \ldots\ldots\ldots, \hat{\lambda}_p$ are the smallest eigenvalue of estimated $p - r$. The null hypothesis for the trace eigenvalue test is that there are at most r cointegrating vectors. On the other hand, the L-max could be expressed as:

$$L - \max = -T \ln(1 - \hat{\lambda}_{r+1})$$

The null hypothesis for the maximum eigenvalue test is that r cointegrating vectors are tested against the alternative hypothesis of $r+1$ cointegrating vectors. If trace eigenvalue test and maximum eigenvalue test would yield different results, the results of maximum eigenvalue test should be used because the power of the maximum eigenvalue test is considered greater than the one of trace eigenvalue test (Johansen and Juselius 1990).

In the third stage of empirical analysis, this paper uses the Granger-causality test based on the following Vector Error Correction Model (VECM):

$$\Delta \ln GE_t = b_1 + \sum_{i=1}^{n} b_{2i} \Delta \ln GDP_{t-i} + \sum_{i=1}^{n} b_{3i} \ln POP_{t-i} + \sum_{i=1}^{n} b_{4i} \ln GE_{t-i} + b_5 u_{t-1} + \varepsilon_t$$

where u_{t-1} is the lagged error correction term. There are two advantages to using VECM method rather than the standard Granger causality test, i.e., 1) the *F*-test of the independent variables indicates the short-run causal effect, and 2) significant and negative error correction term indicates the long-run causal effects.

Finally, this paper also estimates the impulse response function (IRF) and generates the variance decomposition in order to analyse the relationship between economic development and government expenditure. On the one hand, the impulse response function could be used to analyse the patterns and the directions of the various shocks. On the other hand, the variance decomposition could be used to analyse the relative importance of various shocks. This paper uses the Choleski factorization method which is suggested by Sims (1980). This method is based on the following vector autoregressive process of order *P*,

$$X_t = \mathrm{d} + \sum_{k=o}^{P} A_k X_{t-k} + e_{t-k}$$

where X_t is an *n x 1* vector of *n* variables, δ is an *n x 1* vector constant terms. A_k is an *n x n* matrix of coefficients, e_t is an *n x 1* vector of error terms. Every vector autoregressive process has an infinite order vector moving average (UMA) representation. The VAR(1) of the moving average representation could be expressed as:

$$X_t = \mathrm{m} + \sum_{k=o}^{P} B_k e_{t-k}$$

where μ is the mean value of univariate AR(P) process or $(I_k - A_1 - A_2 - .... - A_p)^{-1}\delta$. On the other hand, the *ij* th element if the matrix B_k could capture the response of the *i* th
variable to a shock in the *j* th variable in period *k*.

3 Empirical Results

First of all, the ADF root test was done to examine the stationarity of the variables. The results from the ADF are shown in Table 1(a). On the other hand, the PP root test was done to investigate the stationarity of the variables. The results from the PP are shown in Table 1(b).

Table 1(a) ADF unit root test

	Levels		First Difference	
	Constant without trend	Constant with trend	Constant without trend	Constant with trend
ln*(GDP)*	-1.674(0)	-1.927(0)	-4.631(0)**	-3.305(1)
ln*(GE)*	-2.231(0)	-2.134(0)	-6.675(0)**	-4.266(0)**
ln*(POP)*	-7.595(1)**	-1.664(0)	-1.713(1)	-13.580(0)**

Notes: Figures in parentheses indicate number of lag structures
Maximum lag length is set as four
** indicates significance at 1% level
* indicates significance at 5% level

Table 2(b) PP unit root test

	Levels		First Difference	
	Constant without trend	Constant with trend	Constant without trend	Constant with trend
ln*(GDP)*	-1.634(3)	-2.082(3)	-4.707(3)**	-4.703(3)**
ln*(GE)*	-4.303(6)**	-1.968(3)	-6.679(1)**	-9.233(7)**
ln*(POP)*	-10.043(4)**	-1.701(2)	-5.552 (4)**	-13.580(6)**

Notes: Figures in parentheses in the PP test results indicate number of bandwidth
** indicates significance at the 1% level,
* indicates significance at the 5% level

Despite minor differences in the findings from the ADF test and the PP test in the tables, the obtained results indicate that the three variables -- ln*GDP,* ln*POP* and ln*GE* -- are integrated of order one, I(1).

In the second stage, the Johansen cointegration test was used to test the long-run movement of the variables. As Engle and Granger (1987) pointed out, only variables with the same order of integration could be tested for cointegration. As such, in the present study, all three variables could be examined for cointegration.

First of all, the Akaike Information Criterion (AIC) is used to determine optimal lag length selection while maximum lag length is set for six. Table 2 shows that optimal lag length for the Johansen cointegration test is three (3), which minimises the AIC.

Table 2 Optimal Lag Length Selection for the Johansen Test
(Maximum Lag Length=3)

Lag Length	AIC
0	-0.704
1	-12.006
2	-12.462
3	-12.910*

AIC denotes the Akaike Information Criterion
*indicates optimal lag length selected by AIC

Secondly, results of the cointegration tests are reported in Table 3(a) and Table 3(b). Trace Eigenvalue test indicates that there is one cointegrating equation while Maximum Eigenvalue Statistic indicates one cointegrating equation. Following Johansen and Juselius's (1990) suggestion, if there is discrepany in the findings between two different methods, this paper would use empirical results from Maximum Eigenvalue Statistic.

Table 3(a) The Johansen Cointegration Test (Trace Eigenvalue Statistic)

Eigenvalue	Trace statistic	5 percent critical value	Significance	Number of co-integrating equations
0.461	32.701	24.273	0.003	None*
0.220	10.441	12.323	0.101	At most 1
0.039	1.467	4.129	0.264	At most 2

The results are based on a VAR with three lags, no intercept in the cointegration equation and no intercept in the VAR

Table 3(b) The Johansen Cointegration Test (Maximum Eigenvalue Statistic)

Eigenvalue	Max statistic	5 percent critical value	Significance	Number of co-integrating equations
0.461	22.260	17.797	0.001	None*
0.220	8.973	11.224	0.121	At most 1
0.039	1.467	4.129	0.264	At most 2

The results are based on a VAR with three lags, no intercept in the cointegration equation and no intercept in the VAR

The findings indicate that there exists long-run relationship between the three variables (i.e., ln*GDP,* ln*POP* and ln*GE*), which means that these variables are cointegrated. In other words, although the variables are not stationary at levels, in the long run, they closely move with each other. Long-run cointegration when the variables are normalised by cointegrating coefficients could be expressed as:

$$\ln GE = -0.039 \ln GDP + 1.718 \ln POP$$

This cointegrating vector equation indicates that there exists a positive long-run relationship between population growth and government expenditure. On the other hand, there is a negative long-run relationship between economic development and government expenditure. This means that in Brunei, government expenditure may decrease as the size of national income grows. In other words, Brunei does not represent a typical example of a Asian country where the size of government expands as the country pursues economic development and industrialisation.

In the third stage of analysis, the Granger-causality method based on the VECM is employed to examine long-run and short-run casual relationships between the three variables.

Table 4 Optimal Lag Length Selection for Causality Test
(Maximum Lag Length = 3)

Lag Length	AIC
1	-11.468
2	-11.826
3	-11.983*

AIC denotes the Akaike Information Criterion
*indicates optimal lag length selected by AIC

Firstly, the Akaike Information Criterion is used to determine the optimal length for the causality test. As Table 4 shows, optimal lag length for causality test is three (3) which minimises the AIC.

Next, results of the chi-square test and t-tests are reported in Table 5. The findings show that the error correction term is statistically significant and negative. This means that there is long-run Granger causality between the three variables. In other words, the long-run Granger causality did confirm that there exists the long-run equilibrium relationship between Brunei's GDP and government expenditure as indicated by the results of the Johansen cointegration test.

Table 5 Granger-Causality Test based on VECM Dependent Variable: Δln*GE*

Variable	Chi-square statistics	P-value
Δln*GDP*	5.716	0.123
Δln*POP*	17.704	0.005
	Coefficient	**t-statistic**
U_{t-1}	-0.426	-3.663**

Note: To test for causality when variables are co-integrated, the following Granger causality test based on the VECM could be used:

$$\Delta ln(GE)_t = b_1 + \sum_{i=1}^{n} b_{2i}\Delta \ln(GDPt-i) + \sum_{i=1}^{n} b_{3i}\Delta \ln(POPt-i) + \sum_{i=1}^{n} b_{4i}\Delta \ln(GEt-i) + b_5 u_{t-1} + \varepsilon_t$$

Short-run causality: the joint significance of the coefficients is determined by the F-test

Long-run causality: the level of significance for error correction term is determined by the t-statistics.

The results are based on a VECM with six lags

More importantly, as the results of the chi-square tests indicate, the Granger causality between the population growth and government expenditure has been detected in short-run. This means that in Brunei, the size of population influences the size of government expenditure over a short period of time. In other words, Brunei's population growth does "Granger cause" the size of public spending in short-run.

Finally, the impulse response function (IRF) and the variance decomposition is use to examine the pattern and relative importance of population growth and economic development in the expansion of government expenditure in Brunei.[1] The results from IRF analysis and variance decomposition analysis are reported in Figure 1 and Figure 2.

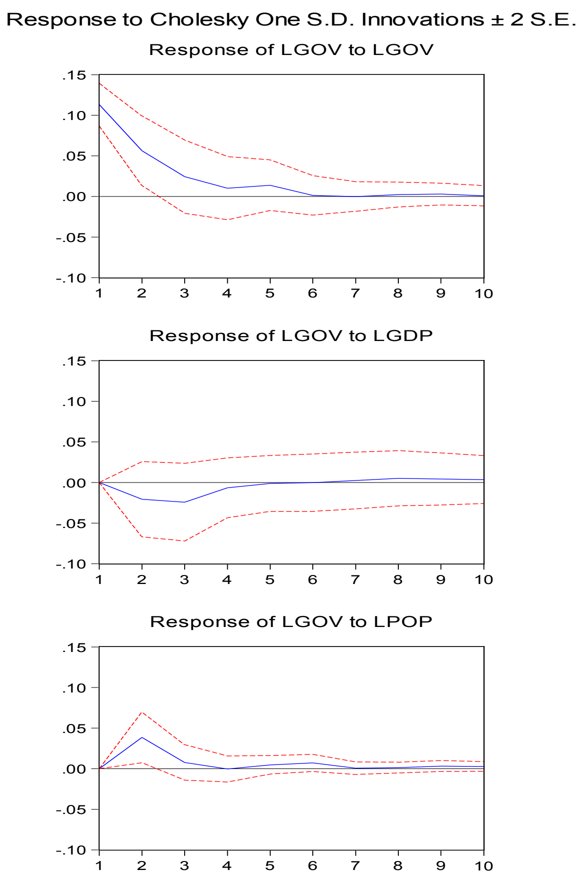

Figure 1 Impulse Response Functions of GDP

[1] The Cholesky Ordering is GE, GDP, POP. Although the pattern of response in the VAR model are sensitive to the ordering, the changing the ordering seems to have a minor impact on the results.

As impulse response functions of GE shows, Brunei's government expenditure seems to be driven by economic development as well as population growth. In other word, the government expenditure growth is positively response to income innovation, but these responses are not statistically significant. On the other hand, the government expenditure growth also is positively response to the population innovation. However, these responses also are not statistically significant.

The results from Variance Decomposition indicate that the effects of innovation in population are higher than ones in incomes. The effects of innovation in population accounted for 8.233 percent of the variation in forecast error of the government expenditure expansion in the tenth period in Brunei. The innovation in income accounted for only 5.718 percent of the forecast error.

Period	S.E.	LGOV	LGDP	LPOP
1	0.113114	100.0000	0.000000	0.000000
2	0.133710	89.32837	2.379786	8.291848
3	0.138274	86.62764	5.309088	8.063274
4	0.138802	86.50570	5.491430	8.002869
5	0.139576	86.53394	5.437994	8.028066
6	0.139763	86.31166	5.423822	8.264516
7	0.139784	86.28487	5.451505	8.263629
8	0.139906	86.16250	5.579675	8.257827
9	0.140039	86.04298	5.662195	8.294829
10	0.140111	85.95829	5.718551	8.323159

Figure 2 Variance Decomposition of GDP

In a nutshell, empirical findings of the present study imply that there is long-run cointegration and causality relationship between Brunei's GDP, population and the country's government expenditure. On the other hand, in the present inquiry, the short-run causality has been detected between Brunei's population growth and the amount of government expenditure.

4 Conclusion

This paper used the three-stage procedure to examine the relationship between Brunei's economic development and government expenditure. The findings of the current study offer some interesting insights. The results of the Johansen cointegration test indicate that there exists long-run relationship between Brunei's economic development and government expenditure. On the other hand, the empirical findings from Granger causality pointed out that a long-run causality between the variables could be established. On the other hand, empirical findings of the current research provide an additional evidence in support of the proposition that population growth in Brunei "Granger causes" expansion of the government expenditure in short-run.

As a conclusion, the empirical findings of the present study indicate that there is a long-run relationship between Brunei's GDP, population and government expenditure and a short-run causality between population and expansion of government expenditure. These findings confirm that Wagner's hypothesis may be valid in the context of an Asian country, such as Brunei. In other words, the current study provides an additional empirical evidence to support the existence of Wagner's Law.

There have transpired some contradictions in the course of the current research. To address this issue, future research studies may choose employing different model specifications which would incorporate such variables as GDP per capita or government expenditure per person.

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