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The Integrated Properties of Gross Domestic Products in Current Values and in Accumulated Statistics in China

Gaolu Zou

School of Tourism and Economic Management, Chengdu University, Chengdu, China

Abstract: **Inferences based on time series heavily depend on the integration of variables of interest. This paper aims to examine the integrated property of gross domestic products (GDP) in China. Data were quarterly time series and covered the period from 1993 to 2016. Data were seasonally adjusted and in logarithms. Nominal GDP comprised two types: one was measured in current values. The other was measured in accumulated statistics. Alternative unit root techniques have the dissimilar power, size, and finite-sample property; hence, differing inferences often arise. The Phillips-Perron test indicated one unit root for the two series. However, the augmented Dickey-Fuller test and the Elliott-Rothenberg-Stock point-optimal test suggested two unit roots. The Perron test suggested that these two series variables were trend-stationary, with a break date occurred around Quarter 1, 2008, which might have increased the order of series variables suggested by two conventional tests. Overall, two quarterly GDP series in nominal terms contained a unit root. Tests indicated consistent results for GDP in current values and in accumulated statistics, which implies that they could substitute each other in future analyses. The paper suggests that at least two conventional unit root tests along with break-date tests might lead to right unit root inferences.**

Keywords: **Unit root, structural break, trend, time series stationarity.**

I. INTRODUCTION

Most macroeconomic time series contained a unit root [1]. A huge literature has examined the unit root of China's gross domestic products (GDP) for different purposes [2-7]. The integrated properties that have found from previous studies were not consistent because GDP data applied were measured in real terms or nominal terms, had unlike periods or sourced from different geographic regions. Also, literature applied various methods. This paper aims to contribute to the literature in that it examines the unit root of China's quarterly nominal GDP from 1993 to 2016, particularly the differences of unit root property between GDP in current values and in accumulated statistics, using three alternative techniques while introducing a break-date test.

II. METHODOLOGY

Unit root tests used three alternative techniques: the augmented Dickey-Fuller (ADF) test [8, 9], the Phillips-Perron test (PP) [10, 11] and the Elliott-Rothenberg-Stock (ERS) point-optimal test [12]. These tests have their respective merits and limitations [7, 13]. A structural break may occur in a time series variable, which may lead to inexact inferences of a unit root [14-17]. This study used the Perron test Model C to detect the possible break date [15]. Results of these tests were put together to evaluate the integrated property of a variable.

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III. DATA

GDP has two types: GDP measured in current statistics (*Current GDP*) and GDP measured in accumulated values onwards from January (*Accumulated GDP*). GDP was at current prices. Data were quarterly time series and covered the period from 1993 to 2016. Data were collected from the National Bureau of Statistics of China [18]. Major details of the data were given in TABLE I. Fig. 1. Plotted changes in GDP from 1993-2016, which shows that two series were mean nonzero and may contain a trend.

TABLE I: DESCRIPTIVE STATISTICS

Description	GDP (current statistics, current price, RMB 100 million)	GDP (current price, statistics accumulated from January onwards, RMB 100 million)
Mean	10.75	11.60
Median	10.68	11.53
Maximum	12.17	13.03
Minimum	8.97	9.79
Std. Dev.	0.91	0.92
Skewness	-0.02	-0.03
Kurtosis	1.78	1.81
Jarque-Bera	5.93	5.68
Probability	0.05	0.06
Observations	96	96

Notes: Series were seasonally adjusted using the X13-multiplicative method. Logarithmic transformation.

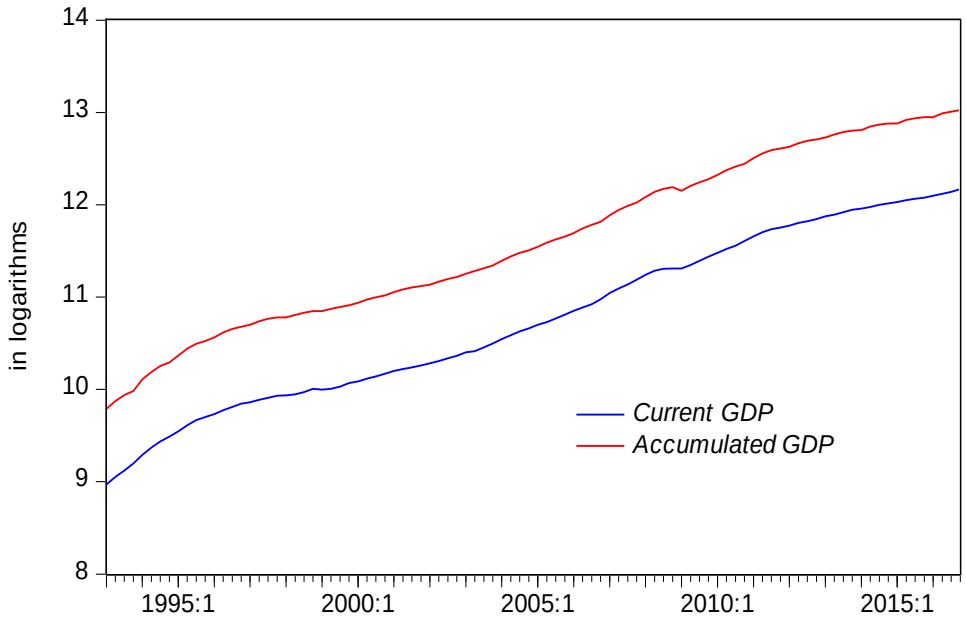

Fig. 1. CHANGES IN GDP, CHINA

IV. EMPIRICAL RESULTS

For both *Current GDP* and *Accumulated GDP*, the ADF and ERS tests indicated two unit roots (TABLE II); however, the PP test showed one unit root. These two variables contained a shift occurred in the first quarter of 2008; hence, they were trend-stationary. However, estimated $\alpha \approx 1$ implied a unit root (TABLE III, TABLE IV). The structural break that occurred might have increased the order of variables suggested by the ADF and ERS tests. Thus, the study suggests these two variables are integrated of order one. They have similar unit root properties.

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TABLE II: ALTERNATIVE UNIT ROOT TESTS

Variable	Method	*k*	Level	*k*	First difference	*k*	Second difference
Current GDP	ADF	4	-2.85	6	-3.23	2	-9.45***
	PP	6	-2.64	12	-3.81**		
	ERS	1	24.68	3	22.46	0	2.11***
Accumulated GDP	ADF	4	-2.68	11	-2.22	10	-4.55***
	PP	6	-2.72	2	-6.19***		
	ERS	4	15.46	3	27.77	0	2.34***

Notes: For ADF tests, the lag length *k* was selected using *t*-statistics. For ERS tests, *k* was selected using the modified AIC [13]. For PP tests, *k* was selected using the Newey-West method [19]. Test equations contained the trend and intercept as Fig. 1. Suggested [20]. **, ***indicated the 5% and 1% levels, respectively.

TABLE III: THE STRUCTURAL BREAK TEST FOR CURRENT GDP (PERRON MODEL C)

Log variable	Parameter & variable	Coefficient	Std. Error	*t*-Statistic	*P*-value	T_b
Current GDP	θ	0.06	0.02	3.00	0.00	2008Q2
	β	0.00	0.00	2.64	0.01	
	γ	0.00	0.00	-2.98	0.00	
	δ	0.01	0.01	0.46	0.64	
	α	0.94	0.03	29.14	0.00	
	Δ, t-1	0.43	0.12	3.57	0.00	
	Δ, t-2	-0.08	0.14	-0.57	0.57	
	Δ, t-3	-0.11	0.13	-0.81	0.42	
	Δ, t-4	0.25	0.13	1.93	0.06	
	Δ, t-5	-0.10	0.13	-0.79	0.43	
	Δ, t-6	0.19	0.13	1.44	0.15	
	Δ, t-7	-0.27	0.13	-2.05	0.04	
	Δ, t-8	0.01	0.13	0.09	0.93	
	Δ, t-9	0.02	0.13	0.14	0.89	
	Δ, t-10	-0.03	0.13	-0.24	0.81	
	Δ, t-11	0.10	0.12	0.77	0.44	
	Δ, t-12	0.05	0.13	0.37	0.71	
	Δ, t-13	0.24	0.11	2.14	0.04	
	Intercept	0.55	0.29	1.87	0.07	
	R-squared	1.00	Mean dependent var	10.98		
	Adjusted R-squared	1.00	S.D. dependent var	0.78		
	S.E. of regression	0.01	Akaike info criterion	-6.20		
	Sum squared resid	0.01	Schwarz criterion	-5.64		
	Log likelihood	273.11	Hannan-Quinn criter.	-5.97		
	F-statistic	27740.25	Durbin-Watson stat	1.98		
	Prob(F-statistic)	0.00				

Notes: Parameters were the same as Perron [15]. Δ indicated the first difference. t-1, t-2, ..., t-*k* were lagged terms where *k* was set between 2 and 14 and selected using the method suggested by Ng and Perron [21]. Trimming fraction was 0.20. T_b indicated the break date detected.

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TABLE IV: THE STRUCTURAL BREAK TEST FOR ACCUMULATED GDP (PERRON MODEL C)

Log variable	Parameter & variable	Coefficient	Std. Error	*t*-Statistic	*P*-value	T_b
Accumulated GDP	θ	0.06	0.02	2.56	0.01	2008Q1
	β	0.00	0.00	2.20	0.03	
	γ	0.00	0.00	-2.56	0.01	
	δ	0.00	0.02	-0.03	0.97	
	α	0.93	0.04	21.82	0.00	
	Δ, t-1	0.16	0.12	1.36	0.18	
	Δ, t-2	0.01	0.11	0.08	0.94	
	Δ, t-3	-0.06	0.11	-0.52	0.61	
	Δ, t-4	0.36	0.11	3.21	0.00	
	Δ, t-5	0.01	0.12	0.07	0.94	
	Δ, t-6	-0.04	0.12	-0.31	0.76	
	Δ, t-7	-0.02	0.12	-0.17	0.87	
	Δ, t-8	-0.18	0.12	-1.50	0.14	
	Δ, t-9	0.12	0.10	1.22	0.23	
	Δ, t-10	-0.06	0.10	-0.63	0.53	
	Δ, t-11	0.03	0.10	0.34	0.74	
	Δ, t-12	0.38	0.10	3.79	0.00	
	Intercept	0.67	0.43	1.57	0.12	
	R-squared	1.00	Mean dependent var	11.82		
	Adjusted R-squared	1.00	S.D. dependent var	0.79		
	S.E. of regression	0.01	Akaike info criterion	-5.57		
	Sum squared resid	0.01	Schwarz criterion	-5.04		
	Log likelihood	249.04	Hannan-Quinn criter.	-5.36		
	F-statistic	16076.47	Durbin-Watson stat	2.09		
	Prob(F-statistic)	0.00				

V. CONCLUSION

The unit root of China's GDP has been widely investigated in various applications. The integrated properties that have showed in prior studies were not constant. GDP variables applied were in real terms or nominal terms had unlike lengths or sourced from national accounts or different provinces or cities. Tests used various methods.

Using quarterly China's GDP in nominal terms, this study conducted the ADF, PP and ERS tests. also, it conducted the Perron break-point test. As suggested in the past, two variables were not stationary. The study suggests that these two variables contain a unit root. Particularly, the unit root property between GDP in current values and in accumulated statistics is similar. This result is implicative for the future study; these two statistical indicators that are simultaneously published the National Bureau of Statistics of China are a substitute for each other. Either of them may be not available in a province, a county or a city. A researcher would still be confident that one type of GDP statistics (for example GDP in current values) is useful although the other is missed.

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