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Health care expenditures in Asia countries: Panel data analysis

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Abstract

Most studies on the link between health care expenditure (HCE) and GDP have been analyzed using data intensively from OECD countries, but little is known for other regions. The contribution of this paper is to present new results of several panel unit root and cointegration tests from 11 Asian countries using balanced panel data for the period of 1975 －2006. The findings suggest the presence of unit-roots and cointegration in HCE and GDP in Asian data for both cases of with and without time trend in the regressions. This study also finds that the income elasticity varies largely from country to country either the short-run or the long-run. Moreover, the Granger causality tests suggest that only uni-directional causality (GDP cause HCE) does exist.

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1. Introduction

A majority of studies have found that there is a strong and positive link between national expenditure on health care and national income. Real per capita health care expenditure (HCE) solely or a combination with non-income variables (e.g. demography, relative price, and fiscal constraints) are hypothesized to be a log-form function of real per capita GDP. In pioneering works, Newhouse (1977) and others analyzed HCE on GDP in OECD countries by using cross-section data. The research interest was to find the determinants of HCE and to check whether health care is a luxury or a necessary good. Following the publication of annual health care statistics by OECD (1990), the research interest has shifted to detect the issues of unit root and cointegration between HCE and GDP.

Existing studies on the relationship between HCE and GDP have been derived intensively from OECD countries data. Some researches use states level data of Canada and USA due to data availability. But little is known for other regions. For instance, Gbesemete and Gerdtham (1992) and Jaunky and Khadaroo (2008) provide some lessons from African nations. To our knowledge, a panel analysis on the link between HCE and GDP across Asian countries is still very scarce, if any exists. This paper, therefore, revisits this topic again by using new data set from Asian countries. The rest of the paper is structured as follows: Section 2 reviews the literature and Section 3 describes the methodology of panel unit root and cointegration tests. Section 4 briefly presents the data sources. Section 5 shows the test results and discussions. Section 6 concludes the paper.

2. Literature Review

Many recent studies have tested the hypotheses of unit root and cointegration in HCE and GDP, but reached different conclusions. Examples of the studies that supports on the existences of unit root and cointegration include Hansen and King (1996), Blomqvist and Carter (1997), Gerdtham and Lothgren (2000) and Westerlund (2007) for OECD countries, Dritsakis (2005) for EU members, Bilgel (2004) for Canada provinces and Tosetti and Moscone (2007) and Wang and Rettenmaier (2007) for USA states. In contrast, some scholars used the same data with a previous study to re-examine the hypotheses of unit root in HCE and GDP by applying different techniques and the results suggest that HCE and GDP are stationary. For instance, McCoskey and Selden (1998) revisit Hansen and King (1996), and Jewell, Lee, Tieslau and Strazicich (2003) and Carrion-i-Silvestre (2005) revisit Gerdtham and Lothgren (2000).

On the other hand, some studies using data from OECD countries have found mixed results. For examples, Roberts (1999) found no evidence to reject the null hypothesis of a unit root for any variable and country in case with a time trend, but only about half of the countries in case without a time trend. The results for cointegration were also not conclusive. The findings from Okunade and Karakus (2001) suggest that the unit root hypothesis is rejected for HCE but not for GDP. Dreger and Reimers (2005) found evidence to detect a unit root for HCE, but inconclusive results for GDP by different methods of panel tests.

3. Panel Unit Root and Cointegration Tests

3.1 Panel Unit Root Tests

Baltagi and Kao (2000) provide a survey of development in nonstationary panels including the earlier manuscripts of the methods employed in this paper [*]. The characteristics of these methods are as follows: (a) Levin, Lin and Chu (2002) tests and Breitung (2002) tests assume common unit root process. (b) Im, Pesaran and Shin (2003) tests allow for a heterogeneous coefficient based on averaging individual unit root ADF test statistic. (c) Maddala and Wu (1999) and Choi (2001) proposed two Fisher type tests (ADF and PP) which combining the p-values from unit root tests for each cross-section to test for unit root in panel data. (d) Hadri (2000) proposed a residual based Lagrange Multiplier (LM) test for the null that the time series for each are stationary around a deterministic trend against the alternative of a unit root in panel data.

3.2 Panel Cointegration Tests

The most influential theoretical contributions on panel cointegration tests are, perhaps, Pedroni (1999, 2004). Together this study also performs the tests proposed by Maddala and Wu (1999) and newly developed tests by Westerlund (2007)[†].

(a) Pedroni (1999, 2004)

Following the introduction of the residual-based panel cointegration tests in 1995, Pedroni (1999, 2004) extended his panel cointegration testing procedure to allow for heterogeneous slope coefficients across cross-sections. He derived the asymptotic distributions and explores the small sample performances of seven statistics. For the first four tests, it is assumed that the residuals of the alternative hypothesis have common autoregressive coefficients referred to as the within-dimension based statistics or the so called panel statistics; For the remaining three tests, it is assumed that the residuals of the alternative hypothesis have individual autoregressive coefficients referred to as the between-dimension based statistics or group mean statistics.

(b) Maddala and Wu (1999)

Maddala and Wu (1999) proposed a simple test of unit root with panel data (known as Johansen Fisher Type). The procedure to test panel cointegration does not require for a separate theory for each type of test. Unlike Pedroni tests that either all the relationships are cointegrated or all are not, the proposed tests allow for some relationships to be

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[*] A number of alternative panel unit root tests have been developed in recent years. Not covered tests in this paper include Harris and Tzavalis (1999), Phillips and Sul (2003), Bai and Ng (2004), and Moon and Perron (2004).

[†] Examples of the alternative panel cointegration tests not covered in this paper include McCoskey and Kao (1998), Larsson et al. (2001), Groen and Kleibergen (2003) and Westerlund (2005).

cointegrated and others not.

(c) Westerlund (2007)

Westerlund (2007) proposed new error correction-based cointegration tests for panel data, which do not impose any common factor restriction. If the null hypothesis of no error correction is rejected, then the null hypothesis of no cointegration is also rejected. He proposed four panel statistics. Two of the statistics are based on pooling the information regarding the error correction along the cross-sectional dimension of the panel or the so-called panel statistics. The second pair does not exploit this information which referred to as group mean statistics.

4 Data

The data set contains observations on 11 Asian countries covering the period of 1975-2006 that are gathered from two main sources of Asian Development Bank (ADB) for 8 non-OECD members (Bangladesh, Hong Kong, Indonesia, Malaysia, Nepal, Philippines, Singapore and Sri Lanka) and 3 for OECD members (Australia, Japan and New Zealand)[‡]. This balanced panel data set has a total of 11×32 = 352 observations. All HCE and GDP variables are measured in per capita U.S. dollar terms at constant prices of year 2000 and transformed in natural logarithms.

5 Empirical Results and Discussion

5.1 Panel Unit Root and Cointegration Tests

Consider a simple model of the form:

$$h_{it} = \alpha_o + \alpha_1 y_{it} + \varepsilon_{it},\ i = 1,2,...,N; \quad t = 1,2,...,T. \qquad (1)$$

where h_{it} is total public expenditure per capita for country i in time t, y_{it} is GDP per capita for country i in time t, and ε_{it} is the residuals.

This study has applied several panel unit root and cointegration tests for both with and without a time trend variable. Due to a limited space, the results of ADF and PP unit root tests, Eagle-Granger and Johansen cointegration tests, and panel unit root and cointegration tests in case without trend are omitted. They are available from the author upon the request.

‡ The starting data set was the list of 48 Asia and the Pacific countries stated in ADB. However, data especially for government expenditures on health are not available for 27 countries. Another 10 countries including Brunei, Cambodia, Kiribati, Korea, Kyrgyz, Mongolia, Maldives, Taiwan, Tonga and Vanuatu are also excluded due to insufficient samples (short term and/or discontinuous).

Table 1 presents the results of panel unit root tests in case with a time trend[§]. Firstly, for both HCE and GDP, the LLC and Breitung test statistics suggest that the null hypothesis of unit root cannot be rejected. Secondly, the results of IPS, PP Fisher and ADF Fisher test statistics also indicate that these two series have unit roots. And finally, Hadri test statistics show that the null hypothesis of no unit root can be rejected for both HCE and GDP. Therefore, the results of all six panel tests report a rejection of the stationary hypothesis for both HCE and GDP. In the case of the limited country by country sample size like in this study, Hadri tests are probably the most appropriated because they apply a residual based Lagrange Multiplier test and do not require a number of samples for calculating lags as in the other test methods.

It is worth noting that the omitted results of the panel unit root tests in case without a trend show that unit roots are generally detected. Unlike some studies in OECD, for instance Hansen and King (1996) vs. McCoskey and Selden (1998) and Roberts (1999), the presence of time trending variables may not give conflicting results or a particular concern in the case of Asian countries.

Table 1: Summary the results of panel unit root tests "with trend"

Study of unit root testing	HCE	*p* -value	GDP	*p* -value
Null: common unit root				
Levin, Lin & Chu t-stat	-0.651	0.258	-0.324	0.373
Breitung t-stat	1.435	0.924	1.557	0.940
Null: individual unit root				
Im, Pesaran and Shin W-stat	-0.963	0.168	-0.004	0.498
ADF - Fisher Chi-square	30.617	0.104	21.921	0.465
PP - Fisher Chi-square	23.708	0.363	19.680	0.603
Null: no common unit root				
Hadri Z-stat	2.944	0.002	5.008	0.000

Next, this study has further examined the long-run relationship between HCE and GDP, see Table 2[**]. Firstly, the Pedroni test statistics show that the null hypothesis (in which there is no cointegrating relationship) is rejected in five out of the seven tests at the 5% significant level. Thus, the cointegrating relationship between HCE and GDP exists. Secondly, the Johansen Fisher type test proposed by Maddala and Wu (1999) reaches to

[§] The omitted regressions using the popular ADF and PP unit root test statistics of HCE and GDP show the very similar results. Unit roots are not detected for only 3 out of 44 cases at the 5% significantly level with and without trend for the level variables. Using the first difference models, 38 out of 44 cases appear to be stationary at the 5% significantly level.

[**] The omitted regressions using the popular Engle-Granger and Johansen test statistics between HCE and GDP show the very similar results. Engle-Granger test statistics show that the null hypothesis of no cointegration among two series cannot be rejected for two countries without a time trend case and only one country with a time trend case at the 5% significantly level. Similarly, Johansen test statistics also find that the null hypothesis of no cointegration among HCE and GDP generally cannot be rejected at the 5% significantly level (trace statistics seem to have a higher power than maximum Eigenvalue statistics).

the same results by the trace statistics of 36.43 and the maximum Eigenvalue statistic of 35.20 at the 5% significant level. Finally, the Westerlund test statistics report that the null hypothesis of no cointegration is rejected in all four tests at the 1% significant level. As to be noted, the omitted Westerlund test statistics, using 100 bootstrap replications, also reject the null hypothesis in all four tests at the 1% significant level. All Together, the performed test statistics indicate that there is a cointegrating relationship between HCE and GDP for the Asian data[††].

Table 2: Summary the results of panel cointegration tests "with trend"

Study	Test	Statistic	*p* -value
Pedroni (1999, 2004)	Panel v-stat	1.189	0.117
	Panel rho-stat	-1.657	0.049
	Panel PP-stat	-2.745	0.003
	Panel ADF-stat	-5.137	0.000
	Group rho-stat	-0.150	0.440
	Group PP-stat	-3.384	0.000
	Group ADF-stat	-4.939	0.000
Maddala & Wu (1999)	Fisher Stat (Trace test, Rank=0)	36.43	0.027
(Johansen Fisher Type)	Trace test, Rank=1	17.24	0.750
	Fisher Stat (Max-eigen test, Rank=0)	35.20	0.037
	Max-eigen test, Rank=1	17.24	0.750
Westerlund (2007)	Panel statistics P_τ	-9.753	0.000
	Panel statistics P_α	-28.036	0.001
	Group statistics G_τ	-4.283	0.000
	Group statistics G_α	-28.040	0.000

5.2 Long-run and Short-run Income Elasticity

In this subsection, the long-run and short-run elasticity of health care spending against income are examined. First, this study attempts to measure the long-run income elasticity over the period 1975-2006. The method below is obtained from Roberts (1999). Assuming a first order heterogeneous dynamic model for health care spending with one explanatory variable, y ,

[††] As to be note, the omitted results of the panel cointegration test statistics by Pedroni (six out of seven tests), Maddala and Wu, and Westerlund (all four tests) in case without trend also show that HCE and GDP are cointegrated at the 5% significant level.

$$h_{it} = \alpha_{0i} + \alpha_{1i} h_{it-1} + \beta_{0i} y_{it} + \beta_{1i} y_{it-1} + \varepsilon_{it} \quad (2\text{-}1)$$

The long-run elasticity of h_{it} with respect to y_{it} is: $\theta_i = \dfrac{\beta_{0i} + \beta_{1i}}{1 - \alpha_{1i}}$ (2-2)

As shown in Table 3, although some test statistics are insignificant, the results show that income elasticity varies largely from country to country. Health care appears to be a necessary good (elasticity less than one) in Indonesia, Malaysia, Nepal and Sri Lanka. It seems to be a luxury (elasticity larger than one) in Australia, Hong Kong, Japan and Philippines. Thus, whether health care is a necessity or luxury good, yet, remains controversial.

Next, the short-run relationship between HCE and GDP is further investigated. Short-run dynamics can be integrated with long-run equilibrium by using Error Correction Model (ECM).

$$\Delta h_{it} = \gamma_{0i} + \sum_{i=0}^{2} \phi_i \Delta y_{t-i} + EC_{t-i} \quad (3)$$

where EC is the long-run error term and represents the departure from equilibrium at time t.

The test statistics show that short-run income elasticity in most series appears to be largely lower than one, meaning that health spending is a necessity good (Table 4). In fact, many test statistics indicate negative income elasticity (Giffen goods).

In addition, using Granger causality tests, the null hypothesis of D(GDP) does not cause D(HCE) is rejected in series of Hong Kong, Japan, Nepal and Singapore. The reverse causality cannot be rejected in all series. Thus, these results suggest that only uni-directional causality does exist.

Table 3: Long-run GDP elasticity, 1975-2006

	Income elasticity	Standard Error	p-value
Australia	1.6448	0.0925	0.000
Bangladesh	0.7110	0.2410	0.099
Hong Kong	2.1922	0.2064	0.003
Indonesia	0.8168	0.1510	0.000
Japan	2.3278	0.2273	0.023
Malaysia	0.3612	0.3543	0.004
Nepal	0.5797	0.2751	0.033
New Zealand	2.5311	0.2349	0.186
Philippines	1.6184	0.3178	0.000
Singapore	0.9287	0.1887	0.166
Sri Lanka	0.9425	0.2506	0.000

Note: White heteroskedasticity consistent covariance is applied.

Table 4: Error Correction Model (ECM) results 1975-2006, "With Trend"

Country	ΔGDP	Trend	Adjusted R^2
Australia#	-0.0300**	-0.1426	0.594
	(0.0080)	(0.0888)	
Bangladesh	-8.0678**	0.0004	0.175
	(1.4883)	(0.0022)	
Hong Kong#	-2.4765**	-0.1623	0.297
	(0.6137)	(0.1547)	
Indonesia	-12.2098**	-0.0111	0.176
	(2.1079)	(0.0057)	
Japan#	1.6548**	0.0177	0.483
	(0.3302)	(0.0310)	
Malaysia	-16.1590**	-0.0018	0.191
	(3.5390)	(0.0044)	
Nepal	-11.6150**	-0.0009	0.567
	(3.1911)	(0.0032)	
New Zealand	-2.7367**	-0.5840	0.143
	(0.6443)	(0.6948)	
Philippines	-13.2387**	0.2129	0.320
	(2.7816)	(0.4555)	
Singapore	-1.2087**	0.0005	0.712
	(0.3450)	(0.0003)	
Sri Lanka	-1.8273*	-0.0005	0.558
	(0.7087)	(0.0008)	

Note: * and ** represent 5% and 1% levels of significance. Standard errors in parentheses
# denotes second difference variables

6. Concluding remarks

The contribution of this paper is to examine the long-run relationship between health care expenditure (HCE) and GDP, using new data from 11 Asia countries for the period of 1975-2006. The results of six panel unit root tests indicate that the two series of HCE and GDP are non-stationary for both with and without time trend in the regressions. Furthermore, the series are obviously cointegrated by testing three different panel cointegration approaches. Thus, researchers studying national health expenditure need to be concerned about the presence of unit roots and cointegration in the data. This study also finds that the income elasticity varies largely from country to country in either the short-run or the long-run. Moreover, the Granger causality tests suggest that only uni-directional causality (GDP cause HCE) does exist.

It is worth to note that all reported results are somewhat preliminary. The results shown here may be sensitive to inclusions of additional regressors such as the relative price of health care services, medical progress (life expectancy and infant mortality) and the structure of population (for instance, Roberts (1999) and Dreger and Reimers (2005)). It is of interest to examine this study again by applying different techniques (for instance, Jewell, Lee, Tieslau and Strazicich (2003)). The author strongly believes that further analyses, whenever data is available, of the link between HCE and GDP using Asia data are desirable.

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