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# The Productivity of Government Spending in Asia: 1983–2000

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*Abstract*

Leightner [The Changing Effectiveness of Key Policy Tools in Thailand. Institute of Southeast Asian Studies for East Asian Development Network, EADN Working Paper 19(2002)x0219-6417] develops a new analytical technique, named "Reiterative Truncated Projected Least Squares" (RTPLS), which produces 1/2 the error of OLS when omitted variables interact with the included independent variable. In this paper, RTPLS is applied to annual panel data on government spending and GDP from 1983 to 2000 for 23 developing Asian and Pacific countries. RTPLS produces estimates for the government spending multiplier for these countries and shows how omitted variables have affected these multipliers across countries and over time.

**JEL Classification:** C13, E62, O23

**Keywords:** omitted variables, government spending multipliers, fiscal policy

The purpose of this study is to measure the productivity of government spending in Asia between 1983 and 2000 and to show how that productivity has changed over time, especially in the wake of Asia's financial crisis. The productivity of government spending will be measured as the change in Gross Domestic Product (GDP), as measured in billions of U.S. dollars, that results from a 1 billion US $ increase in government purchases of final goods and services (G).

In order to correctly estimate these government spending multipliers, the influence of numerous variables that interact with government policy must be incorporated into the estimation procedure. Incorporating these variables into the model is particularly difficult for Asia because these variables include some immeasurable forces, like (1) rising international expectations during the "Asian Miracle", then plummeting international expectations during the "Asian Crisis," (2) community effects, where what is happening in one Asian country affects what is happening in other Asian countries, and (3) differences in what governments purchase across countries and time. Thus, any attempt to estimate government spending multipliers in Asia faces the serious econometric problem of accounting for an almost infinite number of variables, many of which cannot be measured, with a finite amount of data. These econometric problems are not unique to this study—the problem of omitted variables plagues most empirical studies.

Building on Branson and Lovell (2000), Leightner (2002) created a new analytical technique named Reiterative Truncated Projected Least Squares (RTPLS) that produces reduced form estimations while greatly reducing the influence of omitted, unknown, and immeasurable variables. This new technique makes it possible to estimate government policy multipliers that reflect the influence of the numerous variables that interact with government policy without having to measure these variables and without having to even know what these variables are. Furthermore, RTPLS can be used to generate government spending multipliers without having to construct complex systems of simultaneous equations where error in the estimation of one equation can be multiplied many fold when the entire system is solved. Moreover, to the extent that autocorrelation and heteroscedasticity are due to omitted variables, RTPLS also solves these problems.

The first stage of RTPLS is Two Stage Least Squares (2SLS), where the first stage is replaced by an output oriented frontier analysis (or data envelopment analysis—DEA).[1] By projecting all data to this frontier, the influence of unfavorable omitted variables is eliminated. The second stage regression then estimates the relationship between the dependant variable and the included independent variable when the omitted variables are at their most favorable level. Before the next RTPLS iteration is conducted, the observations that determined the frontier in the previous iteration are eliminated. Additional iterations are conducted until the sample size is too small to support an additional iteration. Each iteration produces a slope estimate of the relationship between the dependant and included independent variable under progressively less favorable levels of omitted variables. A given iteration's slope estimate is entered into the data for the observations that determined the frontier in that iteration. A final regression is then conducted between these slope estimates and a constant, the inverse of the included independent variable, and the ratio of the dependant variable to the included independent variable. The data is then plugged back into the equation estimated in this final regression in order to determine a slope estimate for each observation.[2] These slope estimates are reduced form estimates that capture the influence on the dependent variable of everything that is correlated with the included independent variable.

The results of the first 30 simulation tests of RTPLS indicate that OLS produces an average of 125% more error than RTPLS when omitted variables cause the true coefficient for the included variable to vary by 10%. When the omitted variables cause the true coefficient to vary by a 100 and a 1000%, then OLS produces an average of 112 and 401%, respectively more error than RTPLS. RTPLS produces reduced form coefficients that capture all the forces correlated with the included independent variable without having to construct complicated systems of hundreds or thousands of equations.

The remainder of this paper is organized as follows. Section 2 presents the Asian data and explains how RTPLS is applied to it. Section 3 presents the results. Section 4 concludes.

## 1. The Data and the Application of RTPLS

All the data was down loaded from http://www.adb.org/documents/Books/Key_Indicators/2000/default.asp?p= ecnm. All data was converted to billions of U.S. dollars. The four Asian countries hardest hit by the crisis were Thailand, South Korea, Indonesia, and Malaysia. The first three of these countries agreed to IMF conditions in order to receive large IMF loans and remained relatively open to foreign capital flows. Malaysia did not agree to IMF conditions, did not receive an IMF loan, and imposed relatively strong controls on foreign capital flows.

Figure 1 shows what happened to GDP from 1983 to 2000 for these four crisis countries. The 1997–1998 fall in GDP, due to the crisis, appears to be related to the 1985–1996 growth in GDP. South Korea, with the greatest growth between 1985 and 1996, experienced the greatest fall from 1997 to 1998 and Malaysia, with the smallest growth, experienced the smallest fall. Only 8 out of 23 Asian and Pacific countries examined in this paper did not suffer a 1% or greater annual fall in GDP between 1997 and 1999 (Azerbaijan, Bangladesh, Bhutan, China, India, Pakistan, Sri Lanka, and Uzbekistan). For some of the countries, all (or a major part of) the fall in GDP (as measured in U.S. dollars) could be due to devaluations and depreciations of the national currencies of these Asian countries.

The steps of the RTPLS procedure are presented below; these steps were used to show how the relationship between GDP and government spending ($d$GDP/$d$G) changed over time in the 23 Asian countries analyzed.

*Step 1*. The data was arranged in three columns. The first column contained the observation number, which was used to identify each observation with its corresponding country and year after the RTPLS procedure was completed. The second and third columns contained GDP and government expenditures on final goods and services (G) respectively. GDP and G were measured in billions of U.S. dollars.

*Step 2*. The data was sorted by increasing value for G.

*Step 3*. The ratio of maximally expanded GDP to actual GDP ($\Phi$) was calculated for each observation by using the DEA problem given in equation (1) below. $\Phi$ provides a measure of the influence of unfavorable omitted variables on each observation.

$$\begin{aligned} &\max \Phi \\ &\text{subject to} \quad \Sigma_i \lambda_i \mathrm{G}_i \leq \mathrm{G}^\circ, \\ &\qquad\qquad\quad \Phi\mathrm{GDP}^\circ \leq \Sigma_i \lambda_i \mathrm{GDP}_i, \quad \Sigma_i \lambda_i = 1, \lambda_i \geq 0, i = 1, \ldots, \mathrm{I}. \end{aligned} \tag{1}$$

This problem is solved I times, once for each observation in the sample. For observation "o" under evaluation, the problem seeks the maximum expansion in GDP$^\circ$ consistent with best practice observed in the sample, i.e., subject to the constraints in the problem.

*Step 4*. All of the data is projected to the frontier by multiplying each observation's GDP by that observation's $\Phi$. By projecting the data to the frontier, the influence of unfavorable omitted variables is eliminated.

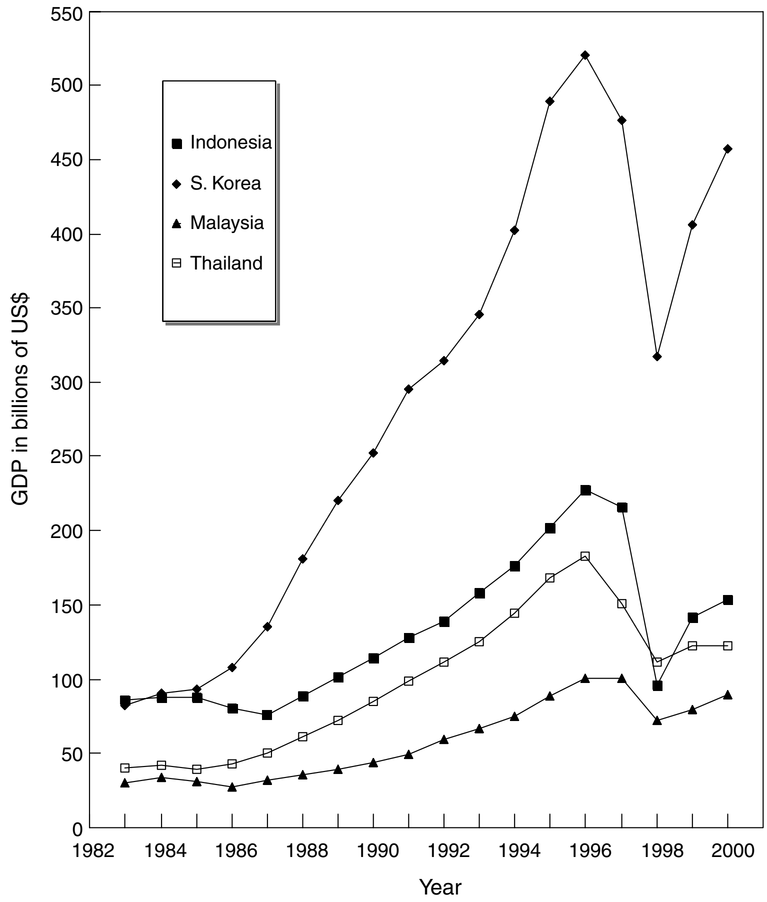


*Figure 1.* GDP for crisis countries in US $.

*Step 5*. The upper right hand section of this frontier will be horizontal if the observation with the greatest amount of GDP does not correspond to the observation with the greatest amount of G. When this happens, the DEA program draws a horizontal line to the right from the observation with the greatest GDP. This horizontal section of the frontier needs to be truncated off because it has nothing to do with the real relationship between GDP and G.[3] Furthermore, the frontier perfectly shows the relationship between GDP and G if all of the efficient points on the frontier have the same omitted variable value. This is rarely true in reality but DEA does find the points that are associated with the relatively largest omitted variables. However, the point with the smallest value for G will always be on the frontier no matter what omitted variable value is associated with it. The simulation tests conducted to date indicate that eliminating the first 3% of the observations noticeably increases the accuracy of RTPLS because doing so eliminates the points that are on the frontier solely because they have relatively small values for the known independent variable (in this case, G). Therefore, RTPLS truncates off any upper-right hand horizontal region of the frontier and the lower-left hand 3% of the frontier. When applying all the rules, the number of observations not used is always rounded up to the next integer.[4] The reason the data was sorted in step 2 was to make these truncations occur at the ends of the data series.

*Step 6*. An OLS regression is run that explains the projected, truncated GDP data as a linear function of a constant and G. Since projecting GDP to the frontier tremendously reduces the amount of variation in the data, the OLS regression used in this step produces much higher adjusted $R^2$s and $F$-statistics and much lower standard errors (in comparison to the same data that has not been projected to the frontier). However, drawing conclusions from these "improved" statistics would be inappropriate (at best) since the econometric properties and validity of these statistics have not been demonstrated when using a RTPLS procedure. It is important to realize that all estimations conducted in the RTPLS procedure use OLS, which considers stochastic error. Non-parametric techniques are used solely for the elimination of the influence of omitted variables, prior to estimation.

*Step 7*. The efficient observations (observations where $\Phi = 1$) are deleted and steps 3–7 are reiterated until the sample size is too small. Specifically, an additional iteration was not conducted if that iteration's second stage regression would use fewer than 10 observations.

*Step 8*. The slope estimate, from each iteration (step 6), is entered into the data for the observations that were efficient in that iteration. The observations that were truncated off due to their being in the first 3% of a given iteration and the observations that were left over when the sample size became too small will not have slope estimates associated with them in step 8. The observations without slope estimates are not used in step 9; however RTPLS estimates are generated for them in step 10.

*Step 9*. A final regression (OLS) is run which makes these slope estimates a linear function of a constant, the inverse of the independent variable (1/G), and the ratio of the dependent to independent variable (GDP/G).

*Step 10*. The data is plugged back into this final regression to obtain a $d$GDP/$d$G estimate for each observation.

## 2. The *d*GDP/*d*G Results

The empirical results[5] from using RTPLS to estimate government spending multipliers for developing Asian countries are presented in Table 1. On average, $d$GDP/$d$G was 7.96 in 1983, slowly grew to 8.20 in 1997, fell to 8.16 by 1999, but more than rebounded to 8.23 in 2000. The mean value of 7.96 for $d$GDP/$d$G in 1983 means that, on average, an increase in government spending of 1 billion US $ in 1983 would have caused GDP to rise by 7.96 billion US $. In a simple macroeconomic model (where only consumption and investment are related to income) the value for the government spending multiplier is $1/[1 - (\mathrm{MPC} + \mathrm{MPI})]$ where

MPC is the marginal propensity to consume and MPI is the marginal propensity to invest. If MPC+MPI is 0.875 then this simple model produces a *d*GDP/*d*G multiplier of 8. More complex macroeconomic models would include the effects of income on imports, on interest rates, on the exchange rate, and on etc. It is important to realize that RTPLS produces reduced form estimates for *d*GDP/*d*G that capture all the ways that GDP and government purchases are correlated without having to construct complicated macroeconomic models. Furthermore, RTPLS traces out how *d*GDP/*d*G changes due to forces that interact with government spending.

Figure 2 graphically depicts *d*GDP/*d*G over time for the crisis countries. Both G (Figure 3) and *d*GDP/*d*G (Figure 2) fell for South Korea and Thailand between 1997 and 1998. This implies that omitted variables lessened the negative impact on GDP of the 1997–1998 fall in G in South Korea and Thailand. In contrast, *d*GDP/*d*G was rising in Indonesia and Malaysia between 1997 and 1998 while G was falling; implying that omitted variables increased the negative impact on GDP of the fall in G for Indonesia and Malaysia. To add insult to injury, *d*GDP/*d*G fell between 1998 and 1999 for Indonesia and Malaysia (Figure 2) while G was rising (Figure 3). This implies that omitted variables reduced the positive effect of an increase in G on GDP between 1998 and 1999 for Indonesia and Malaysia.

Thailand's and Indonesia's *d*GDP/*d*G appear to track each other's *d*GDP/*d*G for 1985–1993 and Malaysia's and Indonesia's *d*GDP/*d*G appear to track each other's *d*GDP/*d*G between 1993 and 1999 (Figure 2). This apparent tracking effect is probably due to these countries facing similar forces that interact with government spending to affect GDP. Although government spending in South Korea increased dramatically between 1985 and 1996 (Figure 3), *d*GDP/*d*G stayed remarkably constant for South Korea during the same time (Figure 2). This indicates that government spending did not face diminishing returns in South Korea. As Malaysia's government spending steadily increased from 1986 to 1996 (Figure 3), its *d*GDP/*d*G also steady increased (Figure 2). This implies that omitted variables caused increasing returns to government spending in Malaysia during that time. Thailand's *d*GDP/*d*G also increased from 1985 to 1991 and then fell during 2000. It is interesting that the turning point of Thailand's *d*GDP/*d*G was 1991 when Japan fell into its worse recession since the 1940s (a recession that continued to 2001). Throughout the 1980s, Thailand was a major beneficiary of Japanese aid and investment—aid and investment that could make government expenditures more productive.

The *d*GDP/*d*G results found for Thailand in this study, which used annual panel data from 23 developing Asian and Pacific countries between 1983 and 2000, appear to conflict with the *d*GDP/*d*G results found using monthly data for just Thailand between January 1993 and December 2000. Leightner (2002) found a January 1993 to June 1997 average monthly *d*GDP/*d*G of 2.95 and a July 1997 to December 2000 average monthly *d*GDP/*d*G of 0.76. In this present study Thailand's average annual *d*GDP/*d*G was 8.27 for 1993–1996 and 8.14 for 1998–2000. There are several possible explanations for this apparent discrepancy.

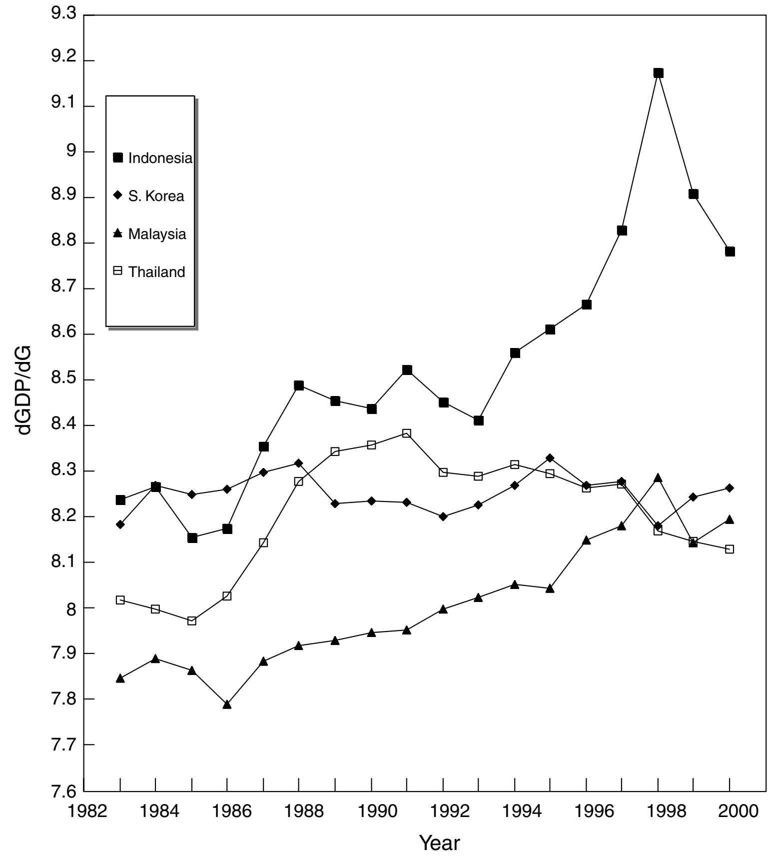


*Figure 2.* *d*GDP/*dG* for crisis countries.

First, the difference in the Thai results found in this study versus those found in Leightner (2002) could be due to the base currency used. In this study, GDP and government purchases were translated into U.S. dollars; whereas, Leightner (2002) used the Thai data as expressed in Thai baht, without converting it to U.S. dollars. To test the effects of using data in baht versus dollars, the monthy data used in Leightner (2002) was translated into U.S. dollars and the analysis that Leightner conducted was re-done. When this was done, the average *d*GDP/*d*G for January 1993 to June 1997 was 2.85 [Leightner (2002) found 2.95] and for July 1997 to December 2000 it was 0.70.[6] Therefore, using dollars instead of Thai baht cannot explain the differences between this current study and Leightner (2002).

The apparent discrepancy between this paper's results and Leightner (2002) could be due to differences in what is included in government spending. This current study used only government spending on final goods and services (which is what is included when calculating GDP using the expenditures approach); in contrast, Leightner (2002) used all government expenses (which is what is used

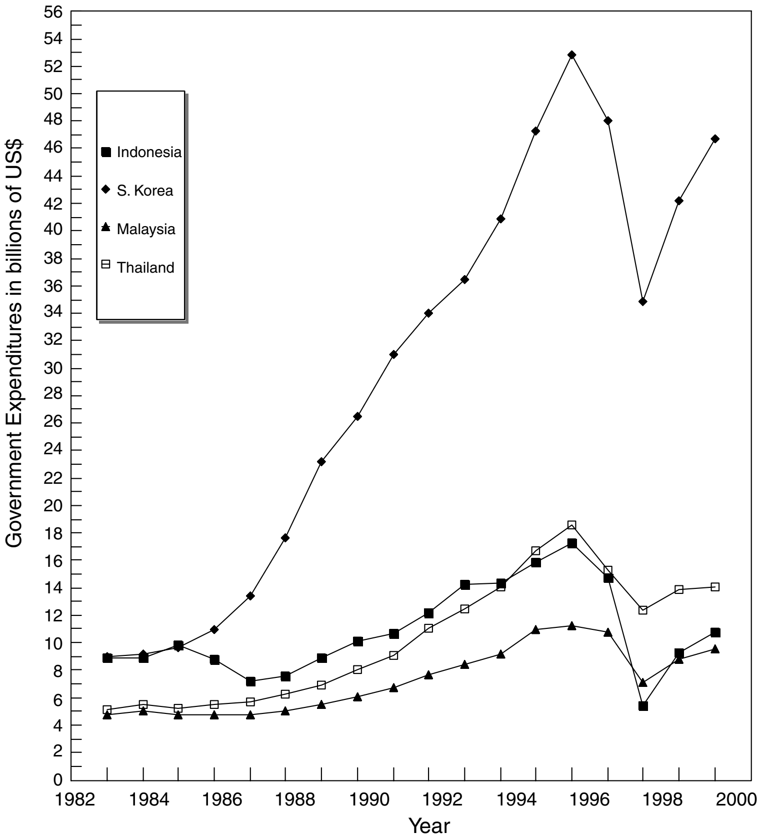


*Figure 3.* Government expenditures for crisis countries.

to calculate a government surplus or deficit). All government expenses would include transfer payments; whereas, government spending on final goods and services would not. Leightner (2002) used all government expenses because monthly data on government purchases of final goods and services is not available. However, quarterly data on government purchases of final goods and services (from 1993, first quarter to 2001, third quarter) is available through the Bank of Thailand's web page. When RTPLS is used with this quarterly Thai data, average $d$GDP/$d$G for 1993–1996 is 8.23 (in this study it was 8.27) and average $d$GDP/$d$G for 1998–2000 is 7.89 (in this study it was 8.14). Therefore the panel data for 23 different countries produced average RTPLS estimates for Thailand that are within 3% of the average RTPLS results from using quarterly time series data on just Thailand. For the case of Thailand, RTPLS produced extremely robust results.

The differences between the results obtained in this study and Leightner (2002) are due to differences in what was included in government spending. It makes sense that government purchases of final goods and services (which was used in this study) would have a much bigger multiplier effect than total government expenses. The RTPLS reduced form estimates of *d*GDP/*d*G produced when G includes transfer payments would include the fact that when GDP falls, then transfer payments increase. In contrast, when G does not include transfer payments, then RTPLS estimates of *d*GDP/*d*G would not include this negative correlation between GDP and transfer payments.

In addition to the four countries discussed above, Hong Kong, the Philippines, Singapore, and Taiwan also suffered noticeable declines in GDP in 1998. All of these countries experienced between four-fold and five-fold increases in G between 1983 and 1997. For example, G in Taiwan increased from 8.5 billion US$ in 1983 to 41.7 billion US$ in 1997. In spite of this almost five-fold increase in government spending, Taiwan's *d*GDP/*d*G multiplier stayed relatively constant at approximately 7.85 (see Table 1 and Figure 4). In contrast, *d*GDP/*d*G fell for the Philippines from 1984 to 1997 and for Hong Kong from 1988 to 1999 (Table 1 and Figure 4). Meanwhile, in Singapore, *d*GDP/*d*G rose between 1985 and 1994. *d*GDP/*d*G rising in Singapore while it fell in the Philippines is especially intriguing because both the level and changes in G were similar for Singapore and the Philippines between 1983 and 1997.

This current study also produced some interesting results for Asian countries which were not primary sufferers from 1997 to 1998 crisis. Bangladesh has the highest *d*GDP/*d*G of all the countries analyzed between 1990 and 2000 (Table 1). Prior to 1990, Bangladesh's *d*GDP/*d*G was very similar to that of India and most of India's other neighbors. Although *d*GDP/*d*G changes over time for most of the countries analyzed, these changes appear to be relatively smooth in comparison to Bangladesh's change in *d*GDP/*d*G between 1989 and 1990.[7] Mainland China's and Taiwan's *d*GDP/*d*Gs appear to track each other for 1983–1998 and then converge. While Pakistan's G almost doubled between 1983 and 1989, its *d*GDP/*d*G steadily fell from 8.11 to 7.80. While Pakistan's G grew relatively slowly between 1990 and 1994, its *d*GDP/*d*G increased from 7.87 to 8.07. After 1995 increases in Pakistan's G corresponded to falls in Pakistan's *d*GDP/*d*G and decreases in Pakistan's G correspond to increases in Pakistan's *d*GDP/*d*G. This implies an asymmetric directional effect from omitted variables—falls in G cause a bigger negative effect on GDP than equal rises in G cause GDP to increase.

## 3. Conclusion

Governments need to know how productive changes in government spending are in producing desired changes in gross domestic product. Applying the most basic traditional econometric method (OLS) to the data used in this paper produces equation (2) ($t$-statistics are given in parentheses).

$$\begin{array}{lll} \mathrm{GDP} = & 6.079 + 8.167\mathrm{G} & \text{R Bar Squared} = 0.9787 \\ & (4.504)(131.239) & F - \text{Statistic} = 17224 \end{array} \tag{2}$$

*Table 1.* $d$GDP/$d$G for developing Asian and Pacific countries.

| | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Azerbaijan | | | | | | | | | | 7.18 | 7.41 | 7.45 | 7.87 | 7.95 | 8.73 | 8.50 | 7.68 | 7.92 |
| Bangladesh | 8.01 | 8.02 | 8.03 | 8.01 | 8.11 | 8.08 | 7.94 | 9.80 | 9.84 | 9.65 | 9.40 | 9.43 | 9.56 | 9.69 | 9.71 | 9.51 | 9.59 | 9.60 |
| Bhutan | 6.53 | 6.57 | 6.59 | 6.67 | 6.83 | 6.82 | 6.84 | 6.82 | 6.71 | 6.74 | 6.65 | 6.82 | 6.98 | 7.01 | 7.12 | 7.12 | 7.17 | |
| Cambodia | | | | | | 8.77 | 8.19 | 8.26 | 7.63 | 8.02 | 8.94 | 8.32 | 8.95 | 8.69 | 8.77 | 8.87 | 8.73 | 8.62 |
| China | 7.93 | 7.93 | 7.99 | 7.98 | 8.04 | 8.11 | 8.07 | 7.95 | 8.00 | 8.00 | 8.00 | 8.02 | 8.12 | 8.11 | 8.10 | 8.07 | 8.03 | 8.00 |
| Fiji | 7.49 | 7.52 | 7.51 | 7.58 | 7.56 | 7.56 | 7.60 | 7.59 | 7.59 | 7.59 | 7.59 | 7.67 | 7.70 | 7.70 | 7.68 | 7.62 | 7.68 | 7.60 |
| Hongkong | 8.57 | 8.68 | 8.64 | 8.66 | 8.83 | 8.86 | 8.77 | 8.67 | 8.60 | 8.51 | 8.51 | 8.49 | 8.42 | 8.43 | 8.44 | 8.32 | 8.25 | 8.31 |
| India | 8.24 | 8.21 | 8.15 | 8.09 | 8.06 | 8.08 | 8.09 | 8.11 | 8.14 | 8.15 | 8.16 | 8.23 | 8.17 | 8.20 | 8.13 | 8.07 | 8.01 | |
| Indonesia | 8.22 | 8.24 | 8.14 | 8.15 | 8.33 | 8.46 | 8.43 | 8.41 | 8.49 | 8.42 | 8.39 | 8.53 | 8.58 | 8.63 | 8.79 | 9.12 | 8.86 | 8.74 |
| Kazakhstan | | | | | | | | | | | 7.92 | 8.16 | 7.95 | 7.99 | 8.03 | 8.16 | 8.17 | 8.12 |
| Korea | 8.17 | 8.25 | 8.23 | 8.24 | 8.28 | 8.29 | 8.21 | 8.21 | 8.21 | 8.18 | 8.21 | 8.25 | 8.31 | 8.25 | 8.26 | 8.16 | 8.22 | 8.24 |
| Kyrgyz | | | | | | | | | | | 7.43 | 7.51 | 7.55 | 7.61 | 7.64 | 7.61 | 7.53 | 7.55 |
| Malaysia | 7.85 | 7.89 | 7.86 | 7.79 | 7.88 | 7.92 | 7.93 | 7.95 | 7.95 | 8.00 | 8.02 | 8.05 | 8.04 | 8.15 | 8.18 | 8.29 | 8.14 | 8.19 |
| Nepal | 8.06 | 8.15 | 8.15 | 8.19 | 8.21 | 8.24 | 8.12 | 8.29 | 8.21 | 8.39 | 8.29 | 8.40 | 8.24 | 8.25 | 8.30 | 8.24 | 8.30 | 8.30 |
| Newguinea | 7.54 | 7.54 | 7.53 | 7.55 | 7.57 | 7.61 | 7.54 | 7.53 | 7.56 | 7.56 | 7.55 | 7.69 | 7.74 | 7.66 | 7.67 | 7.69 | 7.72 | |
| Pakistan | 8.11 | 8.06 | 8.06 | 8.01 | 7.96 | 7.85 | 7.80 | 7.87 | 7.92 | 8.01 | 8.00 | 8.07 | 8.10 | 8.03 | 8.09 | 8.13 | 8.22 | 8.15 |
| Philippines | 8.48 | 8.73 | 8.61 | 8.54 | 8.47 | 8.38 | 8.31 | 8.25 | 8.26 | 8.30 | 8.25 | 8.18 | 8.12 | 8.08 | 7.99 | 7.98 | 7.99 | 8.01 |
| Singapore | 8.15 | 8.16 | 7.91 | 7.95 | 8.03 | 8.19 | 8.21 | 8.23 | 8.26 | 8.34 | 8.34 | 8.47 | 8.45 | 8.32 | 8.33 | 8.25 | 8.28 | 8.21 |
| Srilanka | 8.11 | 8.14 | 8.00 | 7.93 | 7.90 | 7.90 | 7.94 | 7.95 | 7.92 | 7.98 | 7.96 | 7.97 | 7.88 | 8.18 | 8.20 | 8.26 | 8.36 | 8.19 |
| Taipei | 7.83 | 7.84 | 7.83 | 7.89 | 7.92 | 7.88 | 7.85 | 7.79 | 7.78 | 7.81 | 7.86 | 7.91 | 7.93 | 7.92 | 7.92 | 7.92 | 7.99 | 8.00 |
| Thailand | 8.00 | 7.98 | 7.96 | 8.01 | 8.13 | 8.25 | 8.32 | 8.33 | 8.36 | 8.27 | 8.27 | 8.29 | 8.27 | 8.24 | 8.25 | 8.15 | 8.13 | |
| Vietnam | | | | | | | | 7.99 | 8.46 | 9.02 | 8.63 | 8.47 | 8.49 | 8.47 | 8.51 | 8.60 | 8.89 | 8.89 |
| Uzbekistan | | | | | | | | | | | | 7.63 | 7.62 | 7.63 | 7.67 | 7.67 | 7.67 | 7.69 |
| MEAN | 7.96 | 7.99 | 7.95 | 7.96 | 8.00 | 8.07 | 8.01 | 8.11 | 8.10 | 8.11 | 8.08 | 8.09 | 8.13 | 8.14 | 8.20 | 8.19 | 8.16 | 8.23 |

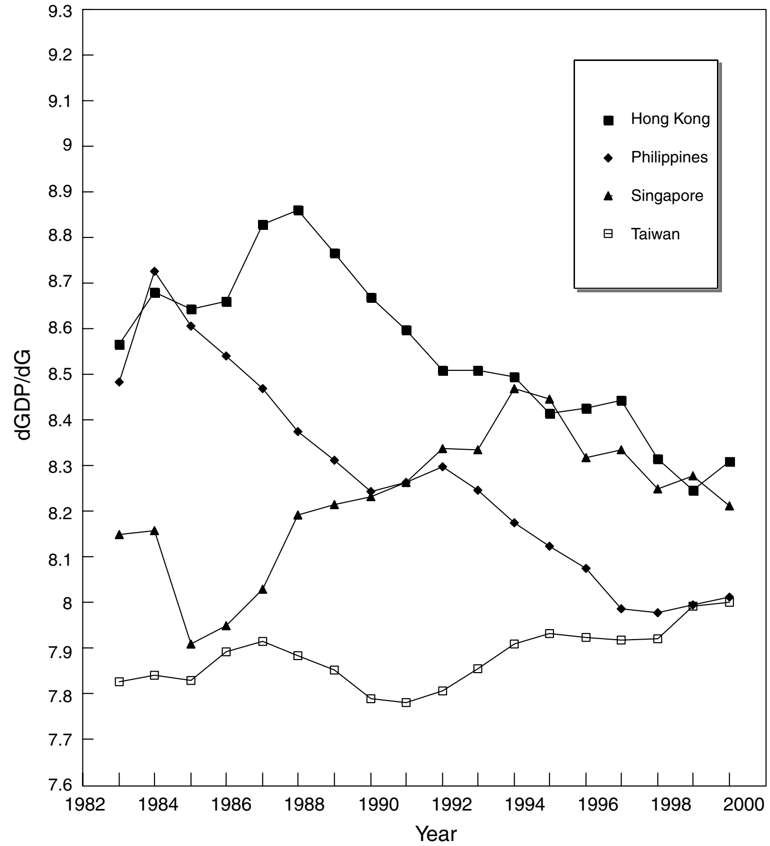


*Figure 4.* *d*GDP/*dG* for seclect countries.

(With 376 observations and a Durbin–Watson Statistic of 0.27906, the possibility of autocorrelation can not be rejected at a 95% confidence level). Traditional estimates, like the one given in equation (2), and their more sophisticated counterparts that correct for simultaneous equation bias, autocorrelation, and heteroscedasticity, produce only one *d*GDP/*d*G estimate for all countries and years.[8] In contrast to traditional econometric methods, this paper uses a new statistical method, named RTPLS, to estimate *d*GDP/*d*G for 23 Asian and Pacific developing countries between 1983 and 2000. RTPLS produces reduced form estimates without having to construct complex systems of equations and these estimates show how forces that are not explicitly modeled affect the estimate. Whereas traditional regression techniques produce one value for *d*GDP/*d*G for all 23 countries studied for all the years studied, RTPLS produces a separate multiplier for each country and year in the data. This makes it possible to see how the multiplier is changing over time and, thus, to design more appropriate responses to any given set of circumstances. For example, the Philippines government knowing the traditionally generated $d$GDP/$d$G estimate of 8.167 given in equation (2) above is no where near as helpful as Figure 4 and Table 1, which shows that omitted variables caused $d$GDP/$d$G in the Philippines to fall from 8.73 in 1984 to 7.98 in 1998. RTPLS shows how multipliers differ between countries and over time due to the influence of omitted variables.

Although adding dummy variables to traditional methods can show how $d$GDP/$d$G differs for different countries or for different years, dummying both years and countries when using traditional methods is impossible because the number of right hand variables would then exceed the number of observations. There is no way for traditional statistically methods to show the depth of information provided by Table 1 and Figures 2 and 4. RTPLS holds great promise. It is a powerful tool for analyzing the productivity of all things (not just government spending) and it analyzes productivity while minimizing the influence of un-modeled forces that interact with the included variables. RTPLS captures the influence of omitted variables without having to know what those omitted variables are and without having to proxy these omitted variables. Furthermore, to the extent that autocorrelation and heteroscedasticity are caused by omitted variables, RTPLS solves these problems also.

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## Notes

1. DEA techniques are based upon Shephard (1970), Debreu (1951), Farrell (1957), Charnes, Cooper, and Rhodes (1978), and Banker, Charnes, and Cooper (1984).
2. This is not the first time a reiterative procedure has been used to eliminate the influence of omitted variables. Leightner and Lovell (1998) and Leightner (1999) use a different type of reiterative process to eliminate the influence of climate on pollution concentrations in the Mae Moh valley of Northern Thailand. Furthermore, this is not the first time parametric and non-parametric techniques have been combined. Thiry and Tulkens (1992) use FDH, instead of DEA, to eliminate technical inefficiency before parametrically estimating a production function. Even though what Thiry and Tulkens (1992) do is very similar to what Branson and Lovell (2000) do, Thiry and Tulkens do not connect their procedure with the elimination of the influence of omitted variables.
3. If there is no relationship between GDP and G, then the horizontal section of the frontier would be most of the frontier and would represent the true relationship between GDP and G. To incorporate this possibility, Leightner (2002) recommends that the entire horizontal section be eliminated if it contains less than 33% of the remaining observations and that only the last 10% of the observations be eliminated if the horizontal region contains 33% of the remaining observations or more. It is not known if this 33% rule is optimal. All that is known is that in the simulation tests conducted to date a 33% rule appears to work best.

4. I do not know if these are the optimal rules to use. These rules were developed by a trial and error method of seeing which rules appear to work best. Additional research needs to be conducted to determine what rules make RTPLS perform optimally and how the sample size affects the optimal rule. Such tests are beyond the scope of this paper. However, when this author developed RTPLS to conduct a study of Thai fiscal and monetary policy both before and after the Thai crisis, he found that using different truncation rules did not affect the basic shape of the line drawn between RTPLS estimates and time; however, different truncation rules did affect the amplitude and average height of that line.
5. Leightner (2002) found that the RTPLS estimates for the 3% of the observations that have the smallest values for the included independent variable are more suspect than the RTPLS estimates for other observations. These more suspect estimates are for Bhutan in 1983–1988 and 1990–1993.
6. Some researchers now use purchasing power parity (ppp) for cross country studies. However, the similarity between the results when Thai baht and when U.S. dollars are used indicates that using ppp was not necessary. Furthermore, using ppp in the wake of major devaluations, and before prices have had adequate time to adjust, would (apparently unnecessarily) open the analysis to additional questions.
7. Between 1989 and 1990, Bangladesh's *d*GDP/*d*G changed much more than any other country's (in a distant second and third, Bangladesh, Vietnam and Cambodia's estimates of *d*GDP/*d*G varied the most between 1990 and 1993). Furthermore, after 1990, Bangladesh enjoyed the highest estimated multipliers for *d*GDP/*d*G. To test the robustness of my estimates, I redid the analysis after eliminating Bangladesh. On average, the *d*GDP/*d*G estimates were 0.105 lower when Bangladesh was not included. Thus including Bangladesh only changed the results on average by 1.3% (0.105/8.074). The country who had *d*GDP/*d*G most affected by omitting Bangladesh was Bhutan. It is interesting to note that the country most affected by omitting Bangladesh was the country that contained the 3% of the observations with the smallest values for the independent variable—Bhutan. Remember Leightner (2002) warns that the estimates for the three percent of the observations with the smallest values for the independent variable are more suspect.
8. Traditional methods that use dummy variables and/or that modeled interactions can produce varying estimates for *d*GDP/*d*G, but this is not normally done. Furthermore, it is almost impossible to know how to perfectly specify a model of the whole economy when data is not infinite. When using traditional methods, it is possible that one mis-specified equation can drastically bias the resulting estimates of *d*GDP/*d*G. RTPLS does not carry these same problems since a system of equations does not have to be constructed to use RTPLS.

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