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AN ANALYSIS OF ECONOMIC GROWTH IN LOW INCOME COUNTRIES

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Abstract. *Most work on growth accounting is focused on developing or developed countries and groups, but little is conducted on low-income countries (LICs). This paper adopts Cobb-Douglas approach to estimate factor share in LICs, and then growth rate of capital, labor, and total productivity. Sensitivity analysis by using alternative factor share is to test the effect of structural change on economic growth. This analysis shows that factor share at 0.5 is available for LICs. Output growth in this group of countries is mainly from slow growth in physical capital, while human capital and total factor productivity (TFP) fail to play important roles in the determination of economic growth. The empirical finding of structural specification reported an insignificant determination of human capital on economic growth, even plays a negative role in the development of economy, which is not consistent with early work considering human capital as an important factor in economic development.*
Keywords: Economic growth, Cobb-Douglas approach, Total factor productivity, Low income countries

1. **Introduction.** How does economic growth be measured associated with the growth of physical capital, human capital, labor, and total productivity? A traditional methodology is to take output as the components of ordinary inputs by using standard Cobb-Douglas production function.

Most work on growth accounting is focused on developing or developed countries and groups, but little work is conducted on low-income countries (LICs). Unlike US, Euro, China and big economic groups like Organization for Economic Co-operation and Development (OECD) and BRICS (BRICS is the acronym coined to associate five major emerging economies: Brazil, Russia, India, China, and South Africa), which play important roles in the world, LICs may not be so powerful and dominant. However, understanding what determines growth in low-income countries is crucial to figure out how LICs can become middle-income countries, thus promoting economy in the whole world.

Hall and Jones [1] believe that differences in physical capital and education attainment can only partially explain the variation in output per worker. A country's long-run economic performance is determined primarily by the institutions and government policies that make up the economic environment within which individuals and firms make investments, create and transfer ideas, and produce goods and services.

Baier et al.'s [2] work shows that little of the average growth of output per worker is directly due to the growth of total factor productivity: eight percent for all of the countries, even negative in less developed countries in Sub-Saharan. These negative growth rates are consistent with the importance of institutional changes and conflicts.

Gonçalves and Martins's [3] study adopts affixed-effects model though second stage estimation that captures different dimensions of firm level characteristics that impact

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total factor productivity (TFP) growth, their study shows that age and debt influence negatively TFP growth, whereas size, exports and training expenses prompt TFP growth.

Garzarelli and Limam [4] investigated the relative importance of physical capital accumulation and TFP in explaining output growth in Sub-Saharan African countries. They found that a large growth in SSA is explained by factor and not by TFP.

Based on previous study on the factor accumulation and TFP, this study aims to take a step forward to estimate sources of output growth and the role of these factors playing in economic growth in low-income countries, a standard Cobb-Douglas aggregate production function is used to estimate factor share in LICs, and then growth rate of capital, labor, and total productivity can be estimated. Sensitivity analysis by using alternative factor share is to test the effect of structural change on economic growth, and factor share in different countries may not be constant, but varies over time.

Low-income countries had experienced long-term government instability and policy changes. Countries affected by conflict and weak states usually reflected flawed economic policies. In this project, WGI (from the World Bank) serves as a proxy of institutions and government policies that provide the incentives for both individuals and firms in an economy.

In the long run, structural changes may challenge the fitfulness of standard Cobb-Douglas approach, and a more structural specification is used to reallocate the contribution of factors.

2. **Model Specification.** Output growth comes from different input growth and an unobservable residual. Growth accounting is a process of finding out by how much each input factor contributes to the total growth of output. Consider the standard growth accounting methodology uses aggregate production function in the Cobb-Douglas form used by Wang and Yao [5] in low-income countries. It is assumed that the relationship between output and resources can be summarized by this aggregate production function which can be written as

$$Y_t = A_t K_t^{\alpha} (L_t H_t)^{\beta} \tag{1}$$

where Y_t is the total output measured by real GDP, A_t is total factor productivity (TFP), K_t is the physical capital stock, L_t is number of workers participated in the production, and H_t is human capital stock, which is measured by the ratio of employees with education to the total employment aged over 15 years old. L_tH_t is the number of effective labors, which it is an adjusted measurement of labor force input. α and β are factor shares of physical capital stock and skill-augmented labor which required $\alpha + \beta = 1$ (constant return to scale).

Taking logs to linearize the above equation, we get the following:

$$\log(Y_t) = \log(A_t) + \alpha \log(K_t) + \beta(\log(L_t) + \log(H_t)) \tag{2}$$

According to equation above, the estimates of the magnitudes of α, β and TFP can be provided.

Differentiating both side, we get the relationship of percentage change between output growth and input growth:

$$a_t = g_t - \alpha \hat{k}_t - \beta \left(\hat{l}_t + \hat{h}_t \right) \tag{3}$$

where a_t is growth in TFP, g_t is the growth rate of real GDP (total output), $\hat{k}_t$ is the growth rate of physical capital stock, $\hat{l}_t$ and $\hat{h}_t$ are the growth rate of labor force and human capital stock. TFP is the so-called 'ancillary variables', which include factors that we cannot observe but do have effects on output growth, such as technological progress, institutional change, proxies for political stability, efficiency and other omitted variables. The change of TFP is the remaining part of output growth apart from the growth of physical stock, human capital and labor force. The TFP residual plays a very important role in economic growth. The measurement of TFP makes it possible to estimate residual part of this model, so as to lessen the probability of biasedness. The next part will describe the data series Y_t, K_t, L_t, and H_t.

3. **Data Collection and Measurement.** Data used for measurement of economic growth cover 28 years from 1992 through 2019, available for 28 low-income countries and are taken from World Bank Indicators (WDI). According to The World Bank, 36 countries are classified into low-income countries, and this group of fragile states is characterized by low socio-economic indicators and weak institutions, internal governance, and political instability and violence conflict. Countries selected by The World Bank for study include Burundi, Central African Republic, Comoros, Guinea, Haiti, Tajikistan, Togo, and Zimbabwe and so on. Because of missing data for some countries, 24 countries are chosen for analysis.

3.1. **Factor shares.** Regarding to the parameter of the standard production function, Baier et al. [2] used "one third" natural neoclassical approach, the same as was used by Hall and Jones. While a value of $\alpha = 1/3$ is usually used in developed countries, which shows consistent with data accounted. This approach may be not so valid when focused on LICs which is lack of human resources, technology and complete education system. Benhabib and Spiegel [6] did not assume C.R.S assumption.

The factor shares generally vary over time and are different from various groups of countries. Although the common factor share of physical capital, human capital and labor force is 0.5, the estimation of factor share in LICs is still necessary.

3.2. **Output.** The value of total output of society is measured by using GDP based on constant 2005 US$, which means that the year 2005 serves as the base year, and the GDP collected is used to measure real GDP of these countries. At the meantime, GDP in current US dollar and implicit GDP deflator are also used to get another measurement of real GDP. Both regressions by using different real GDP show almost the same results.

3.3. **Physical capital stock.** As for physical capital stock, following the method used by Wang and Yao [5], which was estimated in the standard perpetual inventory approach, gross fixed capital formation at constant 2005 US dollar is used to represent physical capital stock.

3.4. **Labor force.** In Cobb-Douglas production function form, labor force is the total number of workers in a country of a period. Original data from The World Bank represents the total labor force, but real labor force used in production is the labor force employed for production, so the real labor force is calculated as the following:

$$rlf = lf * (1 - unemrt) \tag{4}$$

where rlf: real labor force, lf: labor force, $unemrt$: unemployment rate.

Using real labor force thus would be a superior measure for workers input into production, but the accuracy of this measure may be different broadly depending on which group of countries or what kind of countries and states is analyzed. Benhabib and Spiegel [6] figured out that workers in traditional agriculture may count a large number, this group of workers may not be counted as members of the labor force, and this case may be more evident in LICs. It is assumed that the unemployment remains the same in both agriculture and manufacture in one period of time, thus making rlf available for unemployment rate estimation.

3.5. **Human capital stock.** Human capital stock represents the degree of the quality of labor force. Traditionally, it is measured by the ratio of workers with secondary education to the total labor force. In LICs, most of them fail to record the degree of people's education. Because of lacking data, labor participation rate is used instead of secondary education. Data shortcomings set a severe impediment to empirical work on the growth accounting in LICs. Labor force participation rate is the percentage of labor input to real labor force. An assumption is that only the workers with higher level of education would serve as labor force and participate in the production, which makes labor force participation rate a substitution of education level to measure human capital stock.

It seems that the labor participation rate can be used to replace educational institution, but the accuracy of result by using this term may not be very convincing. Commonly, secondary attainment rate and year of school are good measures of human capital stock, and data are taken from Barro and Lee [9] data set. One disadvantage of this data set measured the human capital stock in Sub-Saharan Africa rather than LICs. However, one thing is that most LICs are located in sub-Saharan Africa, so the data are used to roughly estimate human capital in LICs, although it may cause critiques.

3.6. **Total factor productivity.** Total factor productivity includes the effects of other factors on output except physical capital and effective labor, such as technology, efficiency, political changes, institution, and accumulation of skills.

One should note that it is impossible to take only one framework or a few countries to get an accurate empirical assessment of the long term growth effects from change of government policy, institutions, efficiency and other variables. It should be noticed that TFP is the total residual of economic growth when we only consider physical capital, human capital and labor. The errors of these three factors may also appear in TFP.

4. **Empirical Results.** The log difference of labor and human capital stock are indicated to have positive relationship with log difference of real GDP, accumulation of labor and human capital stock speed up the growth of output. While log difference of physical capital stock is shown to be negatively related to log difference of real GDP.

This result for the relationship between factors and output growth shows a dramatic variance to previous results. Regression on log difference in real GDP and log difference in human capital stock reports a significant negative relation by using secondary education and years of school, which is consistent with the results of Barro and Lee [10] estimate of human capital and literary.

Bangladesh and Kenya yield higher level of incomes among LICs in the period 1992-2019, Chad and Benin are in middle, and Gambia and Comoros have low level of output. About one-half of LIDCs are classified as being at medium/high vulnerability to a growth shock according to IMF Policy Paper in 2014. The similar results have shown that all these countries had experienced vulnerable growth shock, and the most obvious vulnerability of GDP growth rate is Chad, whose income is in the middle position. Bangladesh maintained relatively smooth growth rate compared with other countries.

4.1. **Estimation of factor share.** The coefficients on log physical capital stock, the sum of log labor force and log human capital stock are very significant at 95% confidence interval. Under the CRS assumption, factor shares of these items can be normalized; thus it is estimated a value of $\alpha = 0.4573$, $\beta = 0.5427$. This result is much the same like overall economy-wide share at 0.5. The factor share of 0.5 may be more close to the real factor share of low income countries. In order to find the sensitivity of TFP growth, using alternative values of factor share becomes reasonable.

Estimated equation:

$$\begin{aligned} &\log(Y_t) = 8.43 + 0.41\log(K_t) + 0.48(\log(L_t) + \log(H_t)) \\ &\qquad\qquad\qquad\quad (1.28) \qquad\qquad (0.13) \quad (0.11) \\ &R^2 = 0.91 \end{aligned} \tag{5}$$

Table 1. Factor share estimation

Variable	Coefficient	Std. Error	T-Statistic	Prob.
C	8.43	1.28	6.58	0.00
LOG(PC)	0.41	0.13	3.11	0.00
LOG(LF)+LOG(HCS)	0.48	0.11	4.26	0.00

4.2. **Sources of economic growth.** From the relationship between log of human capital stock and TFP at the factor share of 0.5, we can see that apparently, the results based on different measure of human capital stock are almost the same. Before 1995, the growth rate of human capital is much higher than the following years. The path slows down since the year 1995 and remains almost the same growth rate from then on. The similar results by using different measure of human capital indicate that labor participate rate, secondary attainment rate and year of school are available for estimating human capital stock, and it makes this paper more convincing at the same time.

Although TFP is regarded as an important part of economic growth besides human capital labor and physical capital's contribution, the results seem to tell a totally different story from the common views. Log TFP decreases over this period, TFP does not encourage the economic growth, and it sets impediment to GDP instead. Many previous work reported a robust TFP growth over time may be explained that they mainly focus on developed countries and developing countries like OECD, NICS and BRICS. While when considering LICs and least developing countries, the shortage of advanced technology progress and low educational levels lead to non-growth even negative relation between TFP and real GDP. The downward curve may be explained by that the adoption and implementation of new technologies of an economy cost more than it produces in the same period. The cost of technology improvement is really high in poor and less developed countries. Meanwhile, government instability, political changes may be another reason of the negative growth of TFP.

To find out the accumulation of each variable, Table 2 shows the growth rate of these variables. LICs have a lower capability of economic development than developed countries. The average growth rate of output over 28 years is 3.88%, the accumulation of physical capital is relatively high compared with other factors, even close to 2 times of the growth rate of GDP, which means that physical capital stock contributes most of output in poor countries. There exists a surprising concern of the negative growth rate of TFP of $-.17\%$, and .05% growth rate of human capital stock, and both of these two numbers indicate that education enrollment, institution, technology progress and other factors that are related to TFP did not help to increase the output of poor countries. This result comes out based on the assumption of 0.5 values of factor share. Alternative factor shares lead to various growth rates of these factors. The results will be shown in sensitivity analysis.

Table 2. Growth rate of variables (%)

	All years (1992-2019)
Growth rate (% per year)	
Output	3.88
Physical capital stock	5.80
Labor	2.35
Human capital stock	0.05
TFP	-0.17

Note: Factor shares are at 0.5 for labor, human capital stock and physical capital

4.3. **Sensitivity analysis.** As per capita income rises, countries will typically experience structural changes. In particular, income growth typically leads to a shift in the composition of production between agriculture, manufacturing and services. So, the factor share may also change over time.

The small role of human capital stock and even negative growth of TFP in the standard Cobb-Douglas production function may face suspects. One may argue if the accumulation factors really push the economic growth. In addition to the analysis at 0.5 factor share, alternative values of factor share can test the accuracy of the results, thus find out better explanations of economic growth in low-income countries and give proper policy suggestion.

The alternative values factor shares report the different growth rate of TFP. See Table 3. Different values factor shares only have effects on the growth rate of TFP. The larger proportion of physical capital stock makes even larger negative impact on the growth rate of TFP. It is estimated that when $\alpha = 0.3$, which is close to "one third" standard capital share, TFP growth is positively at the rate of .13%. An evident negative correlation exists between the growth rate of TFP and α. One explanation for the negative coefficient of TFP growth rate is that LICs rely more on physical capital input in the production, note that the growth rate of physical capital is negative, which makes the negative effect on the shortage of education, technology and factor like that more severe. The result gives us a hint that one country may reduce the proportion of physical capital and enhance the technology, efficiency to catch up with developing even developed countries.

Table 3. Growth rate of variables at alternative factor share values

Factor		Constant	Coefficient
GDP (constant 2005 US$)		24.73	0.0388
Physical capital stock		10.00	0.0580
Labor input		18.09	0.0235
Human capital stock (%)		4.32	0.0005
TFP	$\alpha = 0.6$, $\beta = 0.4$	9.7609	-0.0052
	$\alpha = 0.5$, $\beta = 0.5$	8.5199	-0.0017
	$\alpha = 0.4$, $\beta = 0.6$	7.2788	0.0018
	$\alpha = 0.3$, $\beta = 0.7$	6.0378	0.0053

Source of economic growth could also be estimated by the contribution to GDP growth. Table 4 shows the ratios of growth rate of each factor to total GDP growth at alternative factor shares. A similar positive relation can be found between factor share α and the contribution of physical capital stock. Opposite to physical capital stock, labor, human capital stock and TFP are negative related to α.

There are many possible explanations of changes in TFP per worker. Based on the estimation of factor share in the previous sector which is similar to 0.5, physical capital stock is a dominant factor in the production of low-income countries, counted for 74.70% to GDP growth; however, TFP counted for -4.40%, which indicated that TFP plays an important role and the negative effects of it on GDP growth need to be taken into consideration.

4.4. **Measure of economic performance.** As is known, the source of economic growth is the sum of the growth of physical capital, the growth of human capital, the growth of labor and the growth of TFP. The growth accounting approach may not always explain

TABLE 4. Contribution to GDP growth from factors (%)

	All years (1992-2019)			
	$\alpha = 0.6$	$\alpha = 0.5$	$\alpha = 0.4$	$\alpha = 0.3$
	$\beta = 0.4$	$\beta = 0.5$	$\beta = 0.6$	$\beta = 0.7$
Contribution to GDP growth (%)				
Physical capital stock[a]	89.60%	74.70%	59.70%	44.80%
Labor[a]	24.20%	30.30%	36.40%	42.40%
Human capital stock[a]	−0.50%	−0.60%	−0.70%	−0.80%
TFP[b]	−13.40%	−4.40%	4.60%	13.60%

α is the factor share of physical capital stock.

β is the factor share of human capital stock and labor.

OLS over logs of the variables was used to regress the growth rates on time.

a: Ratio of factor input to production, weighted by factor share, to output growth.

b: Ratio of TFP growth to GDP growth.

the gap between two countries or among a group of countries, because even similar factor inputs can yield much different output due to economic performance determinants. Hall and Jones [1] believe primary, fundamental determinant of a country's long-run economic performance is its social infrastructure. Institutions and government policy can be included in social infrastructure. WGI data set from The World Bank is used for the measures of economic performance which include Government Effectiveness, Control of Corruption, Political Stability and Absence of Violence/Terrorism, Regulatory Quality, Rule of Law, Voice and Accountability. To estimate the effect of these indicators to economy, a simple model is like the following:

$$\log\left(\frac{Y}{L}\right) = \alpha + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_5 + \beta_6 x_6 + \varepsilon \tag{6}$$

where Y is the real GDP, L is population, $\frac{Y}{L}$ is GDP per capita, $x_1, \ldots, x_6$ are the values of WGI of the following order: Control of Corruption, Government Effectiveness, Political Stability and Absence of Violence/Terrorism, Regulatory Quality, Rule of Law, Voice and Accountability, and ε is a random error term.

For the limit sample of countries, WGI data was available in the period of 1996 to 2010. Relative results were

$$\log\left(\frac{Y}{L}\right) = \underset{(0.31)}{6.38} - \underset{(0.46)}{1.22x_1} + \underset{(0.49)}{0.98x_2} + \underset{(0.24)}{0.49x_3} + \underset{(0.40)}{0.19x_4} - \underset{(0.64)}{0.73x_5} - \underset{(0.33)}{0.37x_6} \tag{7}$$

$R^2 = 0.436$

Note: the number in parenthesis is the standard error of each variable.

R-squared for the regression is 0.436, which is considering that WGI can explain 43.6% of the change in GDP per capita. Only the estimate of control of corruption and political stability and absence of violence/terrorism are significant statistically.

The countries with high GDP per capita have a low value of regulation efficiency. This result may be somewhat confusing and misleading. Zimbabwe has lowest regulation efficiency, which means equally weak social infrastructure in this country is in accordance with the lowest real GDP position among LICs. GDP per capita of Zimbabwe is dramatically high compared with other LICs. To avoid data error, when ignoring this data, a strong opposite result appears. It is indicated a fairly significant positive correlation between regulation efficiency and GDP per capita. So the previous result may not be correct. With this result, a hypothesis is made that efficient political regulation is a powerful factor promoting higher GDP per capita, thus pushing the development of low-income countries.

5. **Conclusions.** Using standard Cobb-Douglas approach as a guide, which satisfies C.R.S assumption, this project analyzes the economic growth in LICs. Growth of production is attributed to the growth of physical capital, human capital, labor and TFP. In this project, it is found that factor share at 0.5 is available for LICs. Output growth in this group of countries is mainly from slow growth in physical capital, while human capital and TFP fail to play important roles in the determination of economic growth.

When estimating the growth of TFP, and negative results are obtained, and negative growth rate of TFP indicates a weak performance of productivity, including incomplete technology, poor institutional education, and inefficient governance and so on. Another finding is that negative correlation in TFP and factor share α, which makes us consider encouraging technology progress and investment in education is an effective way for output growth, thus helping LICs to go out of poverty.

To explain the difference of capital and productivity across countries, social infrastructure is estimated by using WGI in finding out this variance. Countries with high social infrastructure level induce high GDP per capita, which means that infrastructure is a powerful factor promoting economic performance. One country may enhance its governance efficiency, property rights, policy, and regulation efficiency to reach a promotion of development in LICs with weak government stability. The government could take an active role in promoting economic performance, for example, investing in training more workers with skills suitable for the service sector or by identifying and addressing potential bottlenecks. Thus, the innovation and education should be included to investigate if these factors can serve as an engine for the economic growth in low income countries in the future study.

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