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# An Empirical Study on the Economic Growth of Ethiopia and South Africa---From the Perspective of Convergence Theory

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***Abstract:*** Ethiopia and South Africa are representative economies in Africa. But during the 2000-2019 period, the two countries were significantly different in economic performance because they chose different development models. Specifically, Ethiopia chose Chinese model to develop its economy since 2000s while South Africa has been using Western model. Based on convergence theory, this paper reveals the followings by econometric method: During the 1960-2019 period, measured by the steady state of per-capita output, the relative position of South Africa in a test sample generally remains slightly lower than the average level of all sample countries and shows a slight downward trend; the relative position of Ethiopia is much lower than the average level of all sample countries and continuously declined from 1960s to 1990s, but began and kept rising rapidly since 2000s. The paper gives explanations for the above empirical study results and also provides some suggestions for the future growth of the steady states of per-capita output of the above two countries.

***Keywords:*** Ethiopia and South Africa; steady state of per-capita output; β-convergence

## 1. Introduction

In Africa, Ethiopia and South Africa are two representative countries in economic development. The reason for that the two countries chose different economic development models, which have brought about different effects in economic

development. Specifically, Ethiopia chose Chinese model to develop its economy since 2000s while South Africa has been using Western model. In recent years, some economists have put their research work on the economic growths of the Ethiopia and South Africa and the comparison between the two countries, they have achieved many research results with important reference value. Examples are as follows: Seid Nuru (2019), Endaylalu Solomon (2019), Johanna A. Badenhorst-Weiss and Beverley J. Waugh (2019), Solomon Tilahun Mengistu (2022), Molobe Joyce Ramakgasha, Lungile Gidi and Tshephi Kingsley Thaba. (2023), Girma Mulugeta Emeru (2023), Melkamu Wondimu (2023), Dikeledi Semenya and Kanayo Ogujiuba (2024), Addis Yimer and Alemayehu Geda (2024), Gisele Mah. (2025), Nomfundo Portia Vacu-Ngqila (2025) and others have published the concerned research results. Specifically, the above economists have studied the influences of investment, exports, infrastructure, public expenditure and debt, foreign and domestic debt, business environment and other factors on the growths of Ethiopia and South Africa.

These scholars' research work is generally valuable. However, there is a deficiency in their research work, which is reflected in the fact that these scholars are accustomed to using total output (i.e., GDP) or per-capita output (i.e., per-capita GDP) as a measure of economic growth, while ignoring investigation on the changes in the steady state of per-capita output of both Ethiopia and South Africa.

This paper will use the econometric method to investigate the changes in the steady states of per-capita output of Ethiopia and South Africa. According to the theory of convergence, an economy's per-capita output always converges to its steady state of per-capita output for a given period, therefore, the steady state of per capita output can indicate the degree of affluence that an economy can achieve for that given period. From the perspective of economic convergence, it can be considered that developed economies are obviously richer than developing economies and the reason for that is they enjoy much higher steady states of per-capita output than developing economies, this is to imply, if developing countries want to become developed ones, they need to catch up with developed countries in the steady state of per-capita output. In addition, developing countries are also different in the steady state of per-capita output. On the other hand, due to the existence of capital accumulation and technological innovation, the steady state of per-capita output is constantly improving over time for most countries, but the growth rate is usually

different among countries, so it is necessary to investigate whether the steady state of per-capita output of a country (especially for those noticeable developing countries) obtains a relative change in a test sample of many countries.

To carry out such a study, this paper establishes an important concept: ***the relative steady state of per-capita output,*** which is the ratio of the steady state of per-capita output of a country to the average level of a set of countries. Based on this definition, to judge whether there is a relative change in the steady state of per-capita output of a country in a set of countries, one just needs to investigate whether there is a change in the relative steady state of per-capita output of the country.

This paper will use econometric methods to obtain the estimates of the relative steady states of per-capita output of Ethiopia and South Africa in the 1960s, 1970s, 1980s, 1990s, 2000s and 2010s to show the relative changes in the steady states of per-capita output of the two countries in a test sample of 110 countries during the 1960-2019 period, and will also make a corresponding description. Conclusions and suggestions will be finally given for the two countries.

This paper consists of seven sections. Section 1 is introduction. Section 2 will give the explanations of some concerned concepts on convergence. Section 3 introduces the regression equation used in this paper. Next, the data, the empirical method and the details of both results and analyses are shown in Section 4. After Section 5 using paths to show the relative changes in the steady states of per-capita output of both Ethiopia and South Africa, Section 6 makes an explanation of the research results. Finally, conclusions and suggestions are provided in Section 7.

## 2. The explanations of some concerned concepts on convergence

This paper makes a study on convergence based on the Solow model[1] which is shown in Figure 1[2]. Several concepts on convergence are involved: the steady state, social infrastructure, the speed of convergence β and β-convergence.

The steady state is shown in Figure 1. Figure 1 shows, for an economy for a given period, the capital per unit of effective labor $k$ converges to its steady state $k^*$, so the output per unit of effective labor $f(k)$ converges to its steady state $f(k^*)$. Further, the output per unit of labor (i.e., per-capita output) $Af(k)$ converges to its steady state $Af(k^*)$, where $A$ denotes the effectiveness of labor for the given period.

The model can show the effects of some economic parameters on the steady state. For example, for an economy, if the saving rate $s$ rises or the population growth

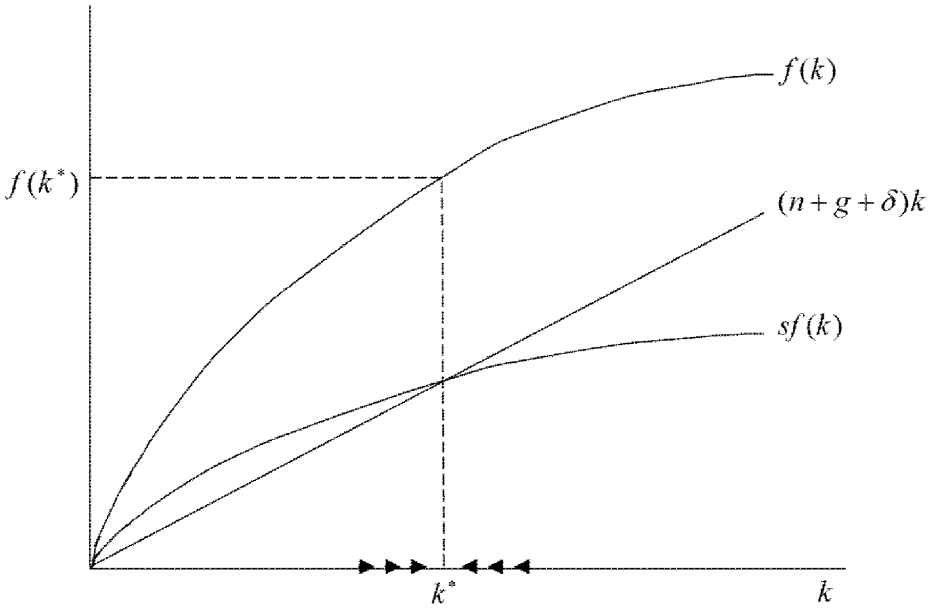


Figure 1: An economy's steady state for a given period

rate $n$ declines, $k^*$ and $f(k^*)$ will increase, resulting in an increase in the steady state of per-capita output $Af(k^*)$ with a given $A$. In addition, if the effectiveness of labor $A$ improves and $k^*$ is given, $Af(k^*)$ will also increase.

According to what Romer described, social infrastructure[3] refers to the institutions, policies, traditions and cultures, which can influence economic growth. In fact, a country's social infrastructure can also influence its steady state of per-capita output. Developed countries can enjoy high steady states of per-capita output mainly because of their superior social infrastructures, so a developing country wants to be a developed one, it should improve its social infrastructure at first.

The speed of convergence β can be explained by the following equation[4].

$$k(t) - k^* = e^{-\beta t}\left(k(0) - k^*\right) \tag{1}$$

In equation (1), only a positive value of β let $k$ converge to $k^*$, and a larger value of β means a faster convergence. β in equation (1) is deemed as a small constant when $k$ is close to $k^*$; otherwise, β is changeable.

β-convergence consists of absolute convergence and conditional convergence. Absolute convergence means all selected economies can enjoy the similar steady state of per-capita output to converge because they enjoy similar social infrastructure,

while conditional convergence means the situation is opposite because the selected economies might have different social infrastructures.

## 3. The regression equation to test the hypothesis of β-convergence

The hypothesis of β-convergence is tested by the following equation[5].

$$(1/T)\log\left(Y_{i,t}/Y_{i,t-T}\right)=\alpha_i-(1/T)\left(1-e^{-\beta T}\right)\log Y_{i,t-T}+u_{i,t} \tag{2}$$

where the subscript $t$ denotes year $t$; the subscript $i$ denotes economy $i$; $T$ denotes the length of the time interval of observations used; $Y^{i,t}$ denotes per-capita output of economy $i$ for all $i$ in year $t$, as shown in Section 3, $Y_i=A_i f(k_i)$ holds for economy $i$ for all $i$; β denotes the average speed of convergence for all economies in a sample for a given period; $\alpha_i=x_i+(1/T)(1-e^{-\beta T})\log Y_i^*$, $Y_i^*$ denotes the technological progress rate of economy $i$ for all $i$ ($x_i=g_i$ holds for all i), $Y_i^*$ denotes the steady state of per-capita output of economy $i$ for all $i$ for a given period, and as shown in Section 3, $Y_i^*=A_i f(k_i^*)$ holds for economy $i$ for all $i$ for a given period. Equation (2) implies the average annual growth rate (between year $t$-$T$ and year $t$) of per-capita output of economy $i$ for all $i$ depends positively on $Y_i^*$ and negatively on $Y^{i,t-T}$.

To remove the time trend associated with the growth of technological progress ($x_i$), Coulombe (2004) defines $y_{i,t}=\log(Y_{i,t}/\bar{Y}_t)$, where $\bar{Y}_t$ is the cross section mean of $Y^{i,t}$ in year $t$ for all $t$. The equation (3) is gained by converting the equation (2), the details for that are shown in *Appendix A*.

$$(1/T)\Delta y_{i,t}=c_i-(1/T)\left(1-e^{-\beta T}\right)y_{i,t-T}+\varepsilon_{i,t} \tag{3}$$

where $\Delta y_{i,t}=y_{i,t}-y_{i,t-T}=\log(Y_{i,t}/\bar{Y}_t)-\log(Y_{i,t-T}/\bar{Y}_{t-T})$;

$c_i=\alpha_i-\bar{\alpha}=(1/T)\left(1-e^{-\beta T}\right)y_i^*$ almost holds because both $x_i$ and $\bar{x}$ are positive and little enough so that the gap $x_i-\bar{x}$ can be ignored, $y_i^*=\log(Y_i^*/\bar{Y}^*)$, which denotes ***the relative steady state of per-capita output*** **(*log version*)** of economy $i$ for all $i$; and $\varepsilon_{i,t}=u_{i,t}-\bar{u}_t$.

Equation (3) can be used to test the hypothesis of β convergence. In equation (3), $c_i$ is the constant term (= the fixed effect) of economy $i$ for all $i$. In the case of

conditional convergence, $Y_i^*$ varies with *i*, then $Y_i^*$ does not equal $\bar{Y}^*$ for most *i* and $y_i^*$ does not equal zero for most *i*, thus $c_i$ does not equal zero for most *i* , i.e., $c_i$ is significant for most *i*. But for absolute convergence, the situation is just the opposite, $c_i$ is not significant for most *i*.

## 4. The data, the empirical method, the results and analyses

### *4.1. The data*

Data on GDP per-capita (constant 2015 US$) for countries and regions can be found in World Bank database. The downloaded data on GDP per-capita cover the years from 1960 to 2019 and contain 110 countries and regions[6], which are listed in *Appendix B* and whose data on GDP per-capita are available in each year from 1960 to 2019.

### *4.2. The empirical method*

Firstly, the above data is divided into the six sub-samples: the 1960-1969 sub-sample, the 1970-1979 sub-sample, the 1980-1989 sub-sample, the 1990-1999 sub-sample, the 2000-2009 sub-sample and the 2010-2019 sub-sample. Each above sub-sample contains both developed and developing countries, thus conditional convergence should exist in each sub-sample. Secondly, the hypothesis test of conditional convergence should be completed in each above sub-sample to confirm whether conditional convergence exists in each one. Thirdly, after all hypothesis tests are completed, according to the regression results obtained, the estimates of the relative steady states of per-capita output of Ethiopia and South Africa in the 1960s, 1970s, 1980s, 1990s, 2000s and 2010s will be calculated, respectively, which can show the relative positions of the steady states of per-capita output of the two countries in the test sample in each sub-period.

In addition, $(1/T)\left(1-e^{-\beta T}\right) \cong \beta$ holds when β is a very small positive number[7], so the constant term $c_i = \beta y_i^*$ holds for country *i* for all *i*. Now take one year as the time interval of observations, i.e., $T = 1$ year, equation (3) is rewritten as

$$\Delta y_{i,t} = c_i - \beta y_{i,t-1} + \varepsilon_{i,t} \tag{4}$$

It is equation (4) that is used to test the hypothesis of conditional convergence.

### *4.3. The results and analyses*

According to the aforementioned related definition, if β in equation (4) is positive; $c_i$ in equation (4) is significant for most *i*, the hypothesis of conditional convergence cannot be rejected, respectively, in each of the above six sub-samples.

First, the data of the 1960-1969 sub-sample is used to estimate equation (4). Now make two null hypotheses for the above sub-sample: $H_0$ : β = 0, $H_0$: $c_i$ = 0.

The regression results from estimating equation (4) by using data in the 1960-1969 sub-sample are shown in the part 1 of *Appendix C*, but the results about Ethiopia and South Africa are chosen and given in Table 1.

**Table 1: The selected regression results from using the 1960-1969 sub-sample**

| *Variable* | *Coefficient* | *Estimates* | *Std. Error* | *t-statistic* | *p value* |
|---|---|---|---|---|---|
| $y_{i,t-1}$ | -β | -0.131739 | 0.026188 | -5.030469 | 0.0000 |
| $c$ (*ETH*) | $c$ (*ETH*) | -0.437378 | 0.080674 | -5.421552 | 0.0000 |
| $c$ (*ZAF*) | $\beta$ (*ZAF*) | -0.050454 | 0.007361 | -6.854319 | 0.0000 |

In Table 1, the p value for the estimate of β shows $H_0$: β= 0 is rejected at the 1% significance level, and the estimate of β shows β is positive. In the part 1 of *Appendix C*, p values for most estimates of $c_i$ show $H_0$: $c_i$= 0 is rejected at the 1% significance level. Therefore, the regression results of β and $c_i$ show the hypothesis of conditional convergence is not rejected in the 1960-1969 sub-sample.

Then, the data of the other five sub-samples are used to estimate equation (4), respectively. Similarly, for each sub-sample, make two null hypotheses: $H_0$: β = 0, $H_0$: $c_i$ = 0. Their regression results from equation (4) are shown, respectively, in the parts 2, 3, 4, 5 and 6 of *Appendix C*, and the results about Ethiopia and South Africa are chosen and displayed in the five following Tables, respectively.

**Table 2: The selected regression results from using the 1970-1979 sub-sample**

| *Variable* | *Coefficient* | *Estimates* | *Std. Error* | *t-statistic* | *p value* |
|---|---|---|---|---|---|
| $y_{i,t-1}$ | –β | -0.193205 | 0.031945 | -6.048017 | 0.0000 |
| $c$ (ETH) | $c$ (ETH) | -0.677664 | 0.107481 | -6.304994 | 0.0000 |
| $c$ (ZAF) | $c$ (ZAF) | -0.119785 | 0.016216 | -7.386909 | 0.0000 |

**Table 3: The selected regression results from using the 1980-1989 sub-sample**

| *Variable* | *Coefficient* | *Estimates* | *Std. Error* | *t-statistic* | *p value* |
|---|---|---|---|---|---|
| $y_{i,t-1}$ | $-\beta$ | -0.121608 | 0.032093 | -3.789291 | 0.0002 |
| *c* (ETH) | *c*(ETH) | -0.453641 | 0.113587 | -3.993767 | 0.0001 |
| *c*(ZAF) | *c*(ZAF) | -0.109629 | 0.027074 | -4.049307 | 0.0001 |

**Table 4: The selected regression results from using the 1990-1999 sub-sample**

| *Variable* | *Coefficient* | *Estimates* | *Std. Error* | *t-statistic* | *p value* |
|---|---|---|---|---|---|
| $y_{i,t-1}$ | $-\beta$ | -0.240357 | 0.033010 | -7.281326 | 0.0000 |
| *c* (ETH) | *c* (ETH) | -0.964237 | 0.125359 | -7.691800 | 0.0000 |
| *c*(ZAF) | *c*(ZAF) | -0.259912 | 0.032345 | -8.035681 | 0.0000 |

**Table 5: The selected regression results from using the 2000-2009 sub-sample**

| *Variable* | *Coefficient* | *Estimates* | *Std. Error* | *t-statistic* | *p value* |
|---|---|---|---|---|---|
| $y_{i,t-1}$ | $-\beta$ | -0.072642 | 0.036595 | -1.985001 | 0.0475 |
| *c*(ETH) | *c*(ETH) | -0.246978 | 0.154170 | -1.601984 | 0.1095 |
| *c*(ZAF) | *c*(ZAF) | -0.063451 | 0.038221 | -1.660099 | 0.0973 |

**Table 6: The selected regression results from using the 2010-2019 sub-sample**

| *Variable* | *Coefficient* | *Estimates* | *Std. Error* | *t-statistic* | *p value* |
|---|---|---|---|---|---|
| $y_{i,t-1}$ | $-\beta$ | -0.218913 | 0.018160 | -12.05489 | 0.0000 |
| *c*(ETH) | *c*(ETH) | -0.683519 | 0.064939 | -10.52549 | 0.0000 |
| *c*(ZAF) | *c*(ZAF) | -0.226494 | 0.016783 | -13.49508 | 0.0000 |

Similarly, using the previous method, one can know that for each sub-sample, $\beta$ is positive and $H_0$: $c_i = 0$ is rejected at the 5% or 10% significance level. According to the information about $\beta$ and $c_i$, the hypothesis of conditional convergence is not rejected, respectively, in each of the other five sub-samples.

In explaining equation (3) in Section 3, it is shown $y_i^* = \log(Y_i^* / \bar{Y}^*)$ denotes the relative steady state of per-capita output (log version) of country *i* for all *i*. Let $y_{i,0}^*$, $y_{i,2}^*$, $y_{i,2}^*$, $y_{i,4}^*$, $y_{i,4}^*$ and $y_{i,5}^*$ denote, respectively, the relative steady state of per-capita output of country *i* for all *i* in the 1960s, 1970s, 1980s, 1990s, 2000s and 2010s. In addition, as shown in Section 4.2, $c_i = \beta y_i^*$ holds for country *i* for all *i*, so the estimates of $y_i^*$ can be computed using the estimates of $c_i$ and $\beta$ in each sub-

sample. Take the estimates of $c_i$ and β in Table 1 as an example, the estimates of $y_i^*$ of Ethiopia and South Africa in the 1960s are computed as follows.

$$\hat{c}_0\ (ETH) = \hat{c}_0\ (ETH)\,\hat{y}_0^* = -0.437378/0.131739 = -3.3200$$

$$\hat{y}_0^*\ (ZAF) = \hat{c}_0\ (ZAF) / \beta_0 = -0.050454/0.131739 = -0.3830$$

Similarly, using the estimates in Tables 2, 3, 4, 5 and 6, one can compute the estimates of $y_i^*$ of the two countries, respectively, in the 1970s, 1980s, 1990s, 2000s and 2010s by using the above method. All estimates are given in Table 7.

**Table 7: Estimates of relative steady states of per-capita output of the two countries**

| *Names of countries* | *Estimates in 1960s* | *Estimates in 1970s* | *Estimates in 1980s* | *Estimates in 1990s* | *Estimates in 2000s* | *Estimates in 2010s* |
|---|---|---|---|---|---|---|
| Ethiopia | -3.3200 | -3.5075 | -3.7304 | -4.0116 | -3.3999 | -3.1223 |
| South Africa | -0.3830 | -0.6200 | -0.9015 | -1.0813 | -0.8735 | -1.0346 |

In Table 7, the estimates of Ethiopia and South Africa are all negative because both of them are developing countries. The estimates of all developing countries in the test sample will be significantly negative or near to zero. But for all developed countries in the test sample, their estimates will be positive.

## 5. The paths of relative steady states of per-capita output of Ethiopia and South Africa

The path of a country's relative steady state of per-capita output shows how its steady state of per-capita output changes relatively in a set of countries over time, i.e., measured by steady state of per-capita output, the path shows how a country's relative position changes in a set of countries over time. The path can be drawn by using the estimates of a country's relative steady state of per-capita output in the successive sub-periods. Thus, the paths of Ethiopia and South Africa are drawn by using their estimates in Table 7 and displayed in Figure 2.

As to the horizontal axis with a scale of 0 in Figure 2, as shown earlier, $y_i^* = \log(Y_i^* / \bar{Y}^*)$ signifies the relative steady state of per-capita output (log version) of country *i* for all *i*. so the horizontal axis is for such a hypothetical country: its relative steady state of per-capita output equals 0 in each subperiod,

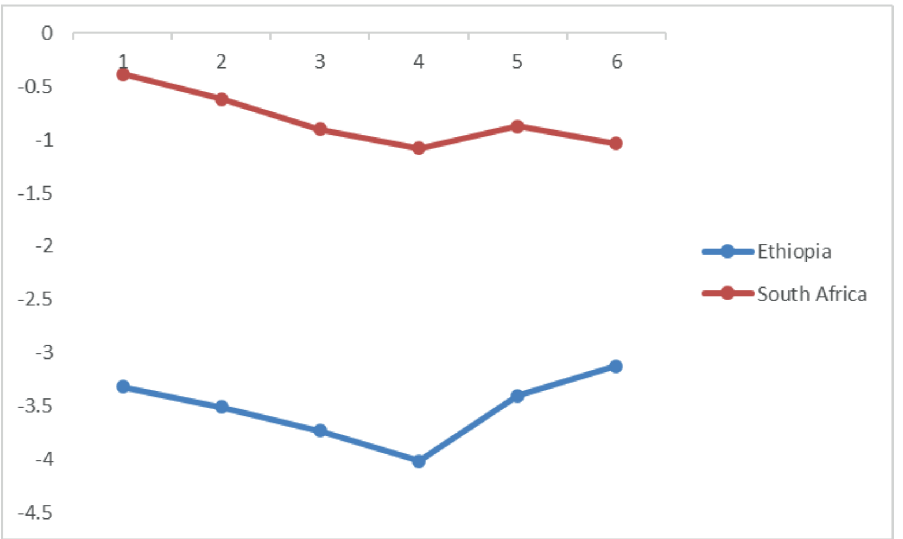


Figure 2: The paths of relative steady states of per-capita output of Ethiopia and South Africa (1960-2019)

*Note:* 1. The numbers 1, 2, 3, 4, 5 and 6 below the horizontal axis denote 1960s, 1970s, 1980s, 1990s, 2000s and 2010s, respectively. 2. The numbers arranged vertically denote the measures of relative steady state of per-capita output.

i.e., its steady state of per-capita output equals the average of all sample countries in each subperiod.

South Africa's path is roughly between 0 and -1, i.e., its relative position of the steady state of per-capita output generally remains slightly lower than the average of all sample countries (horizontal axis with a scale of 0), but the path shows a slight downward trend, i.e., the growth of South Africa's steady state of per-capita output is relatively slow among all sample countries. South Africa has been using Western model to develop its economy, but the results of the empirical study of this paper show that South Africa's economic performance was relatively poor during the 1960-2019 period, maybe not worth imitating.

Ethiopia's path is much lower than the horizontal axis. What is striking is that the path continuously declined from 1960s to 1990s, but kept rising rapidly since 2000s, i.e., measured by the steady state of per-capita output, the relative position of Ethiopia in the sample countries continuously declined first, but begun to rise rapidly since 2000s. This situation is consistent with the rapid growth of per-capita output of Ethiopia in 2000s and 2010s, which is also remarkable.

## 6. An explanation of the above empirical research results

As shown earlier in Section 2, the social infrastructure mentioned in convergence theory refers to the system, policy, tradition and culture, which are related to economic growth. In fact, a country's social infrastructure can affect its steady state of per-capita output by affecting its economic parameters and labor efficiency. For example, if a country's social infrastructure has been significantly improved, it will lead to favorable changes in both its saving rate (almost referred to as investment rate) and labor efficiency, which can cause a rapid and relative growth of its steady state of per-capita output. On the contrary, the situation is the opposite.

One explanation for the above different growth performance of the steady state of per-capita output between Ethiopia and South Africa should be the difference in their development models. During the 1960-2019 period, South Africa has always followed the Western development model, even after Mandela became South Africa's president in 1994, only the personnel of South Africa's management have undergone major changes, but its development model is still the Western development model as a whole, i.e., South Africa's the social infrastructure did not improve significantly during the 1960-2019 period.

Ethiopia also experienced a similar relative decline from 1960s to 1990s, but at the end of 1990s it began to learn from China's model, focusing on imitating China's "state-led economic development" model. Meles Zenawi, the Prime Minister of Ethiopia publicly stated in 2006 Ethiopia should learn from the experience of the East, especially the development model of China, and pull the economy out of the quagmire with state-led forces. Mulatu Teshome, the next Prime Minister of Ethiopia, continued to carry out China's development model. Specifically, during the 2000-2019 period, Ethiopia mainly promoted its economic growth through infrastructure construction (such as roads and power stations, etc.) and industrialization policies (especially the establishment of export-oriented enterprises). In view of this, many people who have been to Ethiopia call it "Little China" in Africa. In short, after the end of 1990s, by learning from China's model, Ethiopia 's social infrastructure was continuously and significantly improved and relatively improved in sample countries, which led to its steady state of per-capita output obtained a rapid and relative growth.

## 7. Conclusions and suggestions

According to the theory of economic convergence, the steady state of per-capita output indicates the degree of wealth that a country can achieve. This paper puts

forward three propositions: (1) For most countries, their steady states of per-capita output will be impossible to remain unchanged for a long time because their economic parameters and labor efficiency will change at times. It is further inferred that the steady state of per-capita output of a country will change relatively in a group of countries because the involved countries will experience the different speeds of change. (2) The steady-states of per-capita output of developed countries are much higher than those of developing countries mainly due to the difference in social infrastructure. Therefore, if a developing country wants to become a developed one, it must improve its social infrastructure to let its steady state of per-capita output rise relatively until close to the overall level of developed countries. (3) For some important developing countries, it is worth to study how their steady states of per-capita output changed relatively among many countries.

Using econometric method, this paper makes a study on the steady states of per-capita output of Ethiopia and South Africa (as two representatives of African countries). The paper reveals the followings: During the 1960-2019 period, measured by the steady state of per-capita output, in the early stage, both experienced a similar relative decline, but in the later stage, Ethiopia had a sustained and significant relative increase while South Africa did not. Therefore, in the growth performance of the steady state of per-capita output, Ethiopia was better than South Africa.

As for South Africa, this paper gives the following suggestions: on the premise of maintaining national sovereignty and independence, South Africa should establish strong and stable government to improve the execution of government policies. Then a strong South Africa government should formulate practical and effective policies to improve its social infrastructures to attract more investments and at the same time realize faster growth of labor efficiency. Specifically, at present, South Africa's transportation network mainly serves mineral transportation and lacks comprehensive infrastructure (such as electricity and logistics), which restricts the development of other industrial fields and the labor efficiency of the whole economy. Only after South Africa eliminate the above shortcomings, the country can obtain a rapid and relative rise in its steady state of per-capita output in the future.

As for Ethiopia, this paper makes the following suggestions: Ethiopia government still need to make more good policy to improving the labor efficiency of the whole economy. Although Ethiopia began to learn China's development model systematically after the end of 1990s, Ethiopia's economic level was far lower

than that of South Africa's for a long time, and its economic foundation is still weak. Specifically, Ethiopia has attracted foreign investment to build some industrial parks, but most of them are full of the labor-intensive enterprises such as textile and shoemaking, so the industrial base of the country is still weak, especially the country is lack of core technology and industry consolidation capacity. In addition, the product supply chain needs to be improved and the logistics is still inefficient in Ethiopia. If Ethiopia can eliminate these shortcomings, the country is possible to catch up with even exceed South Africa in the steady state of per-capita output in the future.

## Notes

1. For details of Solow model, see Romer (2001, Chapter 1).
2. See Romer (2001, p.21)
3. See Romer (2001, p.143)
4. See Romer (2001, p.24)
5. Barro and Sala-I-Martin (2004. p.466), the equation on page 466 shows the time interval ($T$) of observations is from year 0 to year $T$.
6. World Bank provides data on GDP per-capita, but data in both 1960s and 1970s are not available for many countries and regions, this paper can only choose the 110 countries and regions to form a test sample.
7. The natural number $e \approx 2.718$, the time interval $T \geq 1$, and $\beta$ is no more than 30% (= 0.3).

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## Appendix A The Transformation of Equation (2)

Firstly, equation (2) shown in the paper's Section 4 can be rewritten as

$$(1/T)\left(\log Y_{i,t} - \log Y_{i,t-T}\right) = \alpha_i - (1/T)\left(1 - e^{-\beta T}\right)\log Y_{i,t-T} + u_{i,t} \qquad (2)^*$$

Then one takes the mean over the number of economies $N$ of this equation and obtains

$$(1/T)\left(\frac{1}{N}\sum_{i=1}^{N}\log Y_{i,t} - \frac{1}{N}\sum_{i=1}^{N}\log Y_{i,t-T}\right) = \frac{1}{N}\sum_{i=1}^{N}\alpha_i - (1/T)\left(1 - e^{-\beta T}\right)\frac{1}{N}\sum_{i=1}^{N}\log Y_{i,t-T} + \frac{1}{N}\sum_{i=1}^{N}u_{i,t}$$

or $$(1/T)(\log \bar{Y}_t - \log \bar{Y}_{t-T}) = \bar{\alpha} - (1/T)\left(1 - e^{-\beta T}\right)\log \bar{Y}_{t-T} + \bar{u}_t, \qquad (5)$$

where $\bar{Y}_t = \sqrt[N]{Y_{1,t}Y_{2,t}\cdots Y_{N,t}}$; $\bar{Y}_{t-T} = \sqrt[N]{Y_{1,t-T}Y_{2,t-T}\cdots Y_{N,t-T}}$; $\bar{\alpha} = \bar{x} + (1/T)\left(1 - e^{-\beta T}\right)\log \bar{Y}^*$

$\bar{x} = (1/N)\sum_{i=1}^{N} x_i$ and $\bar{Y}^* = \sqrt[N]{Y_1^* Y_2^* \cdots Y_N^*}$; and $\bar{u}_t = (1/N)\sum_{i=1}^{N} u_{i,t}$

Finally, one can obtain the following equation through equation (2)* minus equation (5).

$$(1/T)\Delta y_{i,t} = c_i - (1/T)\left(1 - e^{-\beta T}\right)y_{i,t-T} + \varepsilon_{i,t} \qquad (6)$$

where $\Delta y_{i,t} = y_{i,t} - y_{i,t-T} = \log(Y_{i,t}/\bar{Y}_t) - \log(Y_{i,t-T}/\bar{Y}_{t-T})$;

$c_i = \alpha_i - \bar{\alpha} = (1/T)\left(1 - e^{-\beta T}\right)y_i^*$ almost holds because both $x_i$ and $\bar{x}$ are positive and small enough so that the difference $x_i - \bar{x}$ can be neglected, $y_i^* = \log(Y_i^*/\bar{Y}^*)$, so $y_i^*$ denotes ***the relative steady state of per-capita output*** (***log version***) of economy $i$ for all $i$; and $\varepsilon_{i,t} = u_{i,t} - \bar{u}_t$.

Equation (6) is the equation (3) shown in the paper's Section 3.

## Appendix B The 110 Countries and Regions (with Codes) in the Test Sample

Argentina---ARG, Australia---AUS, Austria---AUT, Burundi---BDI, Belgium---BEL, Benin---BEN, Burkina Faso---BFA, Bangladesh---BGD, Bahamas---BHS, Belize---BLZ, Bermuda---BMU, Bolivia---BOL, Brazil---BRA, Barbados---BRB, Botswana---BWA, Central African Republic---CAF, Canada---CAN, Switzerland-

--CHE, Chile---CHL, China---CHN, Cote d'Ivoire---CIV, Cameroon---CMR, Congo, Dem. Rep.---COD, Congo, Rep.---COG, Colombia---COL, Costa Rica---CRI, Germany---DEU, Denmark ---DNK, Dominican Republic ---DOM, Algeria---DZA, Ecuador---ECU, Egypt---EGY, Spain---ESP, Ethiopia---ETH, Finland---FIN, Fiji---FJI, France---FRA, Gabon---GAB, United Kingdom---GBR, Ghana---GHA, Greece---GRC, Guatemala---GTM, Guyana---GUY, Hong Kong---HKG, Honduras---HND, Haiti---HTI, Hungary---HUN, Indonesia---IDN, India---IND, Ireland---IRL, Iran---IRN, Iraq---IRQ, Iceland---ISL, Israel---ISR, Italy---ITA, Japan---JPN, Kenya---KEN, Korea, Rep.---KOR, Liberia---LBR, Libya---LBY, Sri Lanka---LKA, Lesotho---LSO, Luxembourg---LUX, Madagascar---MDG, Mexico---MEX, Myanmar---MMR, Mauritania---MRT, Mauritius---MUS, Malawi---MWI, Malaysia---MYS, Niger---NER, Nigeria---NGA, Nicaragua---NIC, Netherlands---NLD, Norway---NOR, Nepal---NPL, New Zealand---NZL, Pakistan---PAK, Panama---PAN, Peru---PER, Philippines---PHL, Papua New Guinea---PNG, Puerto Rico---PRI, Portugal---PRT, Paraguay---PRY, Rwanda---RWA, Saudi Arabia---SAU, Sudan---SDN, Senegal---SEN, Singapore---SGP, Sierra Leone---SLE, Somalia---SOM, Suriname---SUR, Sweden---SWE, Seychelles---SYC, Syrian Arab Republic---SYR, Chad---TCD, Togo---TGO, Thailand---THA, Trinidad and Tobago---TTO, Tunisia---TUN, Turkiye---TUR, Tanzania---TZA, Uruguay---URY, United States---USA, St. Vincent and the Grenadines---VCT, South Africa---ZAF, Zambia---ZMB, Zimbabwe---ZWE

## Appendix C The Regression Results from the Equation (4) (Outputs of Eviews)

### *1. The Regression Results by Using the 1960-1969 Sub-sample*

Dependent Variable: D(Y?)
Method: Pooled EGLS (Cross-section weights)
Date: 07/18/25 Time: 22:08
Sample (adjusted): 1961 1969
Included observations: 9 after adjustments
Cross-sections included: 110
Total pool (balanced) observations: 990
Linear estimation after one-step weighting matrix
White cross-section standard errors & covariance (d.f. corrected)

| *Variable* | *Coefficient* | *Std. Error* | *t-Statistic* | *Prob.* |
|---|---|---|---|---|
| Y?(-1) | -0.131739 | 0.026188 | -5.030469 | 0.0000 |
| ARG--C | 0.020733 | 0.014872 | 1.394083 | 0.1636 |
| AUS--C | 0.159734 | 0.036589 | 4.365692 | 0.0000 |
| AUT--C | 0.112635 | 0.021669 | 5.197920 | 0.0000 |
| BDI--C | -0.439172 | 0.069963 | -6.277172 | 0.0000 |
| BEL--C | 0.113023 | 0.020085 | 5.627322 | 0.0000 |
| BEN--C | -0.310966 | 0.052917 | -5.876437 | 0.0000 |
| BFA--C | -0.433939 | 0.085703 | -5.063303 | 0.0000 |
| BGD--C | -0.365982 | 0.068954 | -5.307651 | 0.0000 |
| BHS--C | 0.191002 | 0.036712 | 5.202741 | 0.0000 |
| BLZ--C | -0.180853 | 0.033616 | -5.379923 | 0.0000 |
| BMU--C | 0.266292 | 0.059063 | 4.508643 | 0.0000 |
| BOL--C | -0.193607 | 0.035225 | -5.496328 | 0.0000 |
| BRA--C | -0.109539 | 0.027853 | -3.932685 | 0.0001 |
| BRB--C | 0.054806 | 0.014660 | 3.738359 | 0.0002 |
| BWA--C | -0.312730 | 0.071503 | -4.373673 | 0.0000 |
| CAF--C | -0.350662 | 0.067085 | -5.227155 | 0.0000 |
| CAN--C | 0.141125 | 0.030445 | 4.635464 | 0.0000 |
| CHE--C | 0.256436 | 0.049880 | 5.141094 | 0.0000 |
| CHL--C | -0.077257 | 0.015828 | -4.881050 | 0.0000 |
| CHN--C | -0.477093 | 0.072825 | -6.551203 | 0.0000 |
| CIV--C | -0.155826 | 0.033382 | -4.667963 | 0.0000 |
| CMR--C | -0.284278 | 0.052942 | -5.369647 | 0.0000 |
| COD--C | -0.238279 | 0.050869 | -4.684183 | 0.0000 |
| COG--C | -0.234914 | 0.050897 | -4.615494 | 0.0000 |
| COL--C | -0.156151 | 0.029231 | -5.341972 | 0.0000 |
| CRI--C | -0.073003 | 0.011004 | -6.634506 | 0.0000 |
| DEU--C | 0.112107 | 0.021517 | 5.210121 | 0.0000 |
| DNK--C | 0.174206 | 0.031751 | 5.486576 | 0.0000 |
| DOM--C | -0.212110 | 0.050216 | -4.223908 | 0.0000 |
| DZA--C | -0.159312 | 0.037863 | -4.207532 | 0.0000 |
| ECU--C | -0.145070 | 0.026746 | -5.424005 | 0.0000 |
| EGY--C | -0.269365 | 0.048627 | -5.539450 | 0.0000 |
| EMU--C | 0.096805 | 0.016536 | 5.854124 | 0.0000 |
| ESP--C | 0.070760 | 0.007010 | 10.09380 | 0.0000 |
| ETH--C | **-0.437378** | **0.080674** | **-5.421552** | **0.0000** |
| FIN--C | 0.104396 | 0.016305 | 6.402770 | 0.0000 |
| FJI--C | -0.153714 | 0.030036 | -5.117593 | 0.0000 |
| FRA--C | 0.114108 | 0.020955 | 5.445389 | 0.0000 |

| | | | | |
|---|---|---|---|---|
| GAB--C | -0.031907 | 0.017030 | -1.873586 | 0.0613 |
| GBR--C | 0.121884 | 0.029684 | 4.106121 | 0.0000 |
| GHA--C | -0.261274 | 0.050232 | -5.201385 | 0.0000 |
| GRC--C | 0.054676 | 0.012245 | 4.465215 | 0.0000 |
| GTM--C | -0.154173 | 0.026763 | -5.760608 | 0.0000 |
| GUY--C | -0.129465 | 0.031323 | -4.133227 | 0.0000 |
| HKG--C | -0.000615 | 0.014810 | -0.041535 | 0.9669 |
| HND--C | -0.220737 | 0.036196 | -6.098393 | 0.0000 |
| HTI--C | -0.218943 | 0.040422 | -5.416386 | 0.0000 |
| HUN--C | -0.044361 | 0.032304 | -1.373247 | 0.1700 |
| IDN--C | -0.334169 | 0.066751 | -5.006177 | 0.0000 |
| IND--C | -0.406483 | 0.078880 | -5.153159 | 0.0000 |
| IRL--C | 0.064685 | 0.012255 | 5.278329 | 0.0000 |
| IRN--C | -0.044764 | 0.022317 | -2.005827 | 0.0452 |
| IRQ--C | -0.228782 | 0.046872 | -4.881011 | 0.0000 |
| ISL--C | 0.116905 | 0.036456 | 3.206701 | 0.0014 |
| ISR--C | 0.089830 | 0.016518 | 5.438327 | 0.0000 |
| ITA--C | 0.101045 | 0.015918 | 6.347822 | 0.0000 |
| JPN--C | 0.105364 | 0.013045 | 8.076756 | 0.0000 |
| KEN--C | -0.289940 | 0.049171 | -5.896545 | 0.0000 |
| KOR--C | -0.179433 | 0.041582 | -4.315199 | 0.0000 |
| LBR--C | -0.128444 | 0.021832 | -5.883311 | 0.0000 |
| LBY--C | 0.166239 | 0.035545 | 4.676824 | 0.0000 |
| LKA--C | -0.303547 | 0.059133 | -5.133309 | 0.0000 |
| LSO--C | -0.409626 | 0.078387 | -5.225677 | 0.0000 |
| LUX--C | 0.201143 | 0.039452 | 5.098478 | 0.0000 |
| MDG--C | -0.302458 | 0.055254 | -5.473969 | 0.0000 |
| MEX--C | -0.032677 | 0.004603 | -7.098350 | 0.0000 |
| MMR--C | -0.533900 | 0.103023 | -5.182320 | 0.0000 |
| MRT--C | -0.194834 | 0.035060 | -5.557093 | 0.0000 |
| MUS--C | -0.194508 | 0.056193 | -3.461402 | 0.0006 |
| MWI--C | -0.411893 | 0.081351 | -5.063163 | 0.0000 |
| MYS--C | -0.184486 | 0.036000 | -5.124532 | 0.0000 |
| NER--C | -0.301765 | 0.054254 | -5.562094 | 0.0000 |
| NGA--C | -0.220987 | 0.056574 | -3.906131 | 0.0001 |
| NIC--C | -0.134747 | 0.027800 | -4.847026 | 0.0000 |
| NLD--C | 0.134691 | 0.029814 | 4.517681 | 0.0000 |
| NOR--C | 0.171562 | 0.034578 | 4.961648 | 0.0000 |
| NPL--C | -0.414007 | 0.075962 | -5.450177 | 0.0000 |
| NZL--C | 0.138764 | 0.031667 | 4.382038 | 0.0000 |
| PAK--C | -0.327246 | 0.062171 | -5.263671 | 0.0000 |

| | | | | |
|---|---|---|---|---|
| PAN--C | -0.066204 | 0.018766 | -3.527874 | 0.0004 |
| PER--C | -0.098413 | 0.020794 | -4.732843 | 0.0000 |
| PHL--C | -0.225904 | 0.042434 | -5.323708 | 0.0000 |
| PNG--C | -0.175450 | 0.035592 | -4.929465 | 0.0000 |
| PRI--C | 0.058956 | 0.008537 | 6.906227 | 0.0000 |
| PRT--C | 0.002291 | 0.006891 | 0.332533 | 0.7396 |
| PRY--C | -0.181221 | 0.035498 | -5.105162 | 0.0000 |
| RWA--C | -0.434874 | 0.093360 | -4.658040 | 0.0000 |
| SAU--C | 0.099442 | 0.018439 | 5.393142 | 0.0000 |
| SDN--C | -0.315653 | 0.058494 | -5.396357 | 0.0000 |
| SEN--C | -0.272945 | 0.041235 | -6.619285 | 0.0000 |
| SGP--C | -0.020277 | 0.022514 | -0.900647 | 0.3680 |
| SLE--C | -0.338101 | 0.065636 | -5.151127 | 0.0000 |
| SOM--C | -0.413329 | 0.074676 | -5.534963 | 0.0000 |
| SUR--C | -0.029970 | 0.013579 | -2.207047 | 0.0276 |
| SWE--C | 0.155681 | 0.030723 | 5.067303 | 0.0000 |
| SYC--C | -0.095781 | 0.017043 | -5.619887 | 0.0000 |
| SYR--C | -0.310121 | 0.086323 | -3.592584 | 0.0003 |
| TCD--C | -0.365575 | 0.072804 | -5.021384 | 0.0000 |
| TGO--C | -0.283588 | 0.060180 | -4.712363 | 0.0000 |
| THA--C | -0.272877 | 0.053095 | -5.139380 | 0.0000 |
| TTO--C | -0.026832 | 0.013315 | -2.015124 | 0.0442 |
| TUN--C | -0.274135 | 0.048386 | -5.665531 | 0.0000 |
| TUR--C | -0.109651 | 0.016992 | -6.452959 | 0.0000 |
| TZA--C | -0.257666 | 0.045788 | -5.627325 | 0.0000 |
| URY--C | -0.022633 | 0.006904 | -3.278190 | 0.0011 |
| USA--C | 0.164803 | 0.037017 | 4.452069 | 0.0000 |
| VCT--C | -0.203218 | 0.041593 | -4.885887 | 0.0000 |
| ZAF--C | -0.050454 | 0.007361 | -6.854319 | 0.0000 |
| ZMB--C | -0.242897 | 0.037722 | -6.439182 | 0.0000 |
| ZWE--C | -0.239086 | 0.050742 | -4.711852 | 0.0000 |

Weighted Statistics

| | | | |
|---|---|---|---|
| R-squared | 0.411059 | Mean dependent var | -0.012160 |
| Adjusted R-squared | 0.337358 | S.D. dependent var | 0.056350 |
| S.E. of regression | 0.045870 | Sum squared resid | 1.849491 |
| F-statistic | 5.577364 | Durbin-Watson stat | 1.997058 |
| Prob(F-statistic) | 0.000000 | | |

Unweighted Statistics

| | | | |
|---|---|---|---|
| R-squared | 0.331037 | Mean dependent var | -0.009737 |
| Sum squared resid | 1.854837 | Durbin-Watson stat | 2.035115 |

## 2. The Regression Results by Using the 1970-1979 Sub-sample

Dependent Variable: D(Y?)
Method: Pooled EGLS (Cross-section weights)
Date: 07/18/25 Time: 22:28
Sample (adjusted): 1971 1979
Included observations: 9 after adjustments
Cross-sections included: 110
Total pool (balanced) observations: 990
Linear estimation after one-step weighting matrix
White cross-section standard errors & covariance (d.f. corrected)

| *Variable* | *Coefficient* | *Std. Error* | *t-Statistic* | *Prob.* |
|---|---|---|---|---|
| Y?(-1) | **-0.19320**5 | **0.031945** | **-6.048017** | **0.0000** |
| ARG--C | 0.010234 | 0.013861 | 0.738335 | 0.4605 |
| AUS--C | 0.216963 | 0.039751 | 5.457983 | 0.0000 |
| AUT--C | 0.185548 | 0.029641 | 6.259899 | 0.0000 |
| BDI--C | -0.636301 | 0.098691 | -6.447383 | 0.0000 |
| BEL--C | 0.174049 | 0.029956 | 5.810124 | 0.0000 |
| BEN--C | -0.506263 | 0.080142 | -6.317104 | 0.0000 |
| BFA--C | -0.664220 | 0.103846 | -6.396226 | 0.0000 |
| BGD--C | -0.623777 | 0.097363 | -6.406732 | 0.0000 |
| BHS--C | 0.160555 | 0.024395 | 6.581402 | 0.0000 |
| BLZ--C | -0.230763 | 0.041837 | -5.515810 | 0.0000 |
| BMU--C | 0.403408 | 0.069322 | 5.819351 | 0.0000 |
| BOL--C | -0.285245 | 0.040829 | -6.986333 | 0.0000 |
| BRA--C | -0.081249 | 0.015853 | -5.125264 | 0.0000 |
| BRB--C | 0.055730 | 0.006873 | 8.108697 | 0.0000 |
| BWA--C | -0.292544 | 0.066718 | -4.384772 | 0.0000 |
| CAF--C | -0.542732 | 0.080616 | -6.732307 | 0.0000 |
| CAN--C | 0.200119 | 0.035531 | 5.632187 | 0.0000 |
| CHE--C | 0.344494 | 0.056892 | 6.055194 | 0.0000 |
| CHL--C | -0.165345 | 0.043312 | -3.817550 | 0.0001 |
| CHN--C | -0.620553 | 0.109099 | -5.687998 | 0.0000 |
| CIV--C | -0.230873 | 0.038936 | -5.929503 | 0.0000 |
| CMR--C | -0.390526 | 0.074927 | -5.212099 | 0.0000 |

| | | | | |
|---|---|---|---|---|
| COD--C | -0.424194 | 0.063180 | -6.714096 | 0.0000 |
| COG--C | -0.333535 | 0.057356 | -5.815207 | 0.0000 |
| COL--C | -0.211481 | 0.036649 | -5.770465 | 0.0000 |
| CRI--C | -0.082311 | 0.015153 | -5.431964 | 0.0000 |
| DEU--C | 0.169124 | 0.027217 | 6.213894 | 0.0000 |
| DNK--C | 0.230355 | 0.038558 | 5.974310 | 0.0000 |
| DOM--C | -0.241951 | 0.039346 | -6.149245 | 0.0000 |
| DZA--C | -0.186651 | 0.034284 | -5.444238 | 0.0000 |
| ECU--C | -0.170883 | 0.023679 | -7.216554 | 0.0000 |
| EGY--C | -0.390418 | 0.065133 | -5.994153 | 0.0000 |
| EMU--C | 0.143911 | 0.023813 | 6.043347 | 0.0000 |
| ESP--C | 0.087349 | 0.020098 | 4.346153 | 0.0000 |
| ETH--C | **-0.677664** | **0.107481** | **-6.304994** | **0.0000** |
| FIN--C | 0.166493 | 0.027999 | 5.946309 | 0.0000 |
| FJI--C | -0.182878 | 0.035216 | -5.193083 | 0.0000 |
| FRA--C | 0.171589 | 0.027557 | 6.226660 | 0.0000 |
| GAB--C | 0.033537 | 0.059324 | 0.565316 | 0.5720 |
| GBR--C | 0.174344 | 0.027818 | 6.267191 | 0.0000 |
| GHA--C | -0.454986 | 0.075395 | -6.034678 | 0.0000 |
| GRC--C | 0.095207 | 0.018958 | 5.021935 | 0.0000 |
| GTM--C | -0.210198 | 0.034357 | -6.117992 | 0.0000 |
| GUY--C | -0.210652 | 0.026475 | -7.956674 | 0.0000 |
| HKG--C | 0.034128 | 0.013922 | 2.451414 | 0.0144 |
| HND--C | -0.334342 | 0.055480 | -6.026387 | 0.0000 |
| HTI--C | -0.306977 | 0.053681 | -5.718525 | 0.0000 |
| HUN--C | -0.047062 | 0.011445 | -4.112064 | 0.0000 |
| IDN--C | -0.440843 | 0.074881 | -5.887272 | 0.0000 |
| IND--C | -0.630891 | 0.093846 | -6.722649 | 0.0000 |
| IRL--C | 0.099360 | 0.019365 | 5.130831 | 0.0000 |
| IRN--C | -0.081078 | 0.033331 | -2.432506 | 0.0152 |
| IRQ--C | -0.287571 | 0.062554 | -4.597172 | 0.0000 |
| ISL--C | 0.215728 | 0.028007 | 7.702594 | 0.0000 |
| ISR--C | 0.134306 | 0.022385 | 5.999860 | 0.0000 |
| ITA--C | 0.147749 | 0.024859 | 5.943591 | 0.0000 |
| JPN--C | 0.128815 | 0.021300 | 6.047514 | 0.0000 |
| KEN--C | -0.382315 | 0.076876 | -4.973116 | 0.0000 |
| KOR--C | -0.162229 | 0.037341 | -4.344567 | 0.0000 |
| LBR--C | -0.228971 | 0.037197 | -6.155636 | 0.0000 |
| LBY--C | 0.159991 | 0.042988 | 3.721802 | 0.0002 |
| LKA--C | -0.453371 | 0.072550 | -6.249073 | 0.0000 |
| LSO--C | -0.587064 | 0.110188 | -5.327831 | 0.0000 |

| | | | | |
|---|---|---|---|---|
| LUX--C | 0.287556 | 0.048156 | 5.971331 | 0.0000 |
| MDG--C | -0.514351 | 0.083129 | -6.187374 | 0.0000 |
| MEX--C | -0.046825 | 0.012038 | -3.889787 | 0.0001 |
| MMR--C | -0.790999 | 0.130964 | -6.039829 | 0.0000 |
| MRT--C | -0.356675 | 0.054121 | -6.590304 | 0.0000 |
| MUS--C | -0.248791 | 0.041170 | -6.042941 | 0.0000 |
| MWI--C | -0.585859 | 0.102812 | -5.698340 | 0.0000 |
| MYS--C | -0.221703 | 0.042692 | -5.193051 | 0.0000 |
| NER--C | -0.541971 | 0.100759 | -5.378875 | 0.0000 |
| NGA--C | -0.276162 | 0.049403 | -5.590022 | 0.0000 |
| NIC--C | -0.292944 | 0.036466 | -8.033309 | 0.0000 |
| NLD--C | 0.193951 | 0.034481 | 5.624903 | 0.0000 |
| NOR--C | 0.267551 | 0.043797 | 6.108829 | 0.0000 |
| NPL--C | -0.648418 | 0.100008 | -6.483641 | 0.0000 |
| NZL--C | 0.173249 | 0.033902 | 5.110236 | 0.0000 |
| PAK--C | -0.513184 | 0.078983 | -6.497382 | 0.0000 |
| PAN--C | -0.121879 | 0.025149 | -4.846260 | 0.0000 |
| PER--C | -0.182128 | 0.023924 | -7.612755 | 0.0000 |
| PHL--C | -0.324516 | 0.051696 | -6.277448 | 0.0000 |
| PNG--C | -0.283929 | 0.048472 | -5.857630 | 0.0000 |
| PRI--C | 0.091728 | 0.009717 | 9.439472 | 0.0000 |
| PRT--C | 0.021870 | 0.010767 | 2.031264 | 0.0425 |
| PRY--C | -0.218791 | 0.045430 | -4.816006 | 0.0000 |
| RWA--C | -0.633213 | 0.108452 | -5.838640 | 0.0000 |
| SAU--C | 0.271186 | 0.048703 | 5.568119 | 0.0000 |
| SDN--C | -0.481704 | 0.059626 | -8.078775 | 0.0000 |
| SEN--C | -0.439225 | 0.064515 | -6.808094 | 0.0000 |
| SGP--C | 0.060236 | 0.004558 | 13.21417 | 0.0000 |
| SLE--C | -0.530120 | 0.084041 | -6.307838 | 0.0000 |
| SOM--C | -0.636753 | 0.093795 | -6.788741 | 0.0000 |
| SUR--C | -0.056711 | 0.019642 | -2.887252 | 0.0040 |
| SWE--C | 0.205754 | 0.039246 | 5.242632 | 0.0000 |
| SYC--C | -0.062960 | 0.038200 | -1.648170 | 0.0997 |
| SYR--C | -0.415549 | 0.071951 | -5.775413 | 0.0000 |
| TCD--C | -0.622378 | 0.077025 | -8.080256 | 0.0000 |
| TGO--C | -0.481505 | 0.072716 | -6.621721 | 0.0000 |
| THA--C | -0.375029 | 0.064400 | -5.823429 | 0.0000 |
| TTO--C | -0.048915 | 0.014732 | -3.320430 | 0.0009 |
| TUN--C | -0.317669 | 0.057693 | -5.506228 | 0.0000 |
| TUR--C | -0.158921 | 0.019932 | -7.973074 | 0.0000 |
| TZA--C | -0.554469 | 0.083718 | -6.623020 | 0.0000 |

| | | | | |
|---|---|---|---|---|
| URY--C | -0.040870 | 0.012454 | -3.281579 | 0.0011 |
| USA--C | 0.225539 | 0.037646 | 5.991050 | 0.0000 |
| VCT--C | -0.278362 | 0.066036 | -4.215320 | 0.0000 |
| ZAF--C | **-0.119785** | **0.016216** | **-7.386909** | **0.0000** |
| ZMB--C | -0.416758 | 0.056849 | -7.331028 | 0.0000 |
| ZWE--C | -0.358407 | 0.057838 | -6.196794 | 0.0000 |

| Weighted Statistics | | | |
|---|---|---|---|
| R-squared | 0.404075 | Mean dependent var | -0.000476 |
| Adjusted R-squared | 0.329499 | S.D. dependent var | 0.063215 |
| S.E. of regression | 0.051763 | Sum squared resid | 2.355182 |
| F-statistic | 5.418335 | Durbin-Watson stat | 1.913778 |
| Prob(F-statistic) | 0.000000 | | |

| Unweighted Statistics | | | |
|---|---|---|---|
| R-squared | 0.267984 | Mean dependent var | -0.003325 |
| Sum squared resid | 2.367822 | Durbin-Watson stat | 1.765631 |

## 3. The Regression Results by Using the 1980-1989 Sub-sample

Dependent Variable: D(Y?)
Method: Pooled EGLS (Cross-section weights)
Date: 07/18/25 Time: 22:39
Sample (adjusted): 1981 1989
Included observations: 9 after adjustments
Cross-sections included: 110
Total pool (balanced) observations: 990
Linear estimation after one-step weighting matrix
White cross-section standard errors & covariance (d.f. corrected)

| *Variable* | *Coefficient* | *Std. Error* | *t-Statistic* | *Prob.* |
|---|---|---|---|---|
| Y?(-1) | **-0.121608** | **0.032093** | **-3.789291** | **0.0002** |
| ARG--C | -0.043193 | 0.014928 | -2.893320 | 0.0039 |
| AUS--C | 0.145333 | 0.036525 | 3.979046 | 0.0001 |
| AUT--C | 0.124101 | 0.033045 | 3.755502 | 0.0002 |
| BDI--C | -0.389952 | 0.109180 | -3.571658 | 0.0004 |
| BEL--C | 0.115514 | 0.029488 | 3.917317 | 0.0001 |
| BEN--C | -0.328900 | 0.084741 | -3.881247 | 0.0001 |
| BFA--C | -0.419654 | 0.109549 | -3.830750 | 0.0001 |

| | | | | |
|---|---|---|---|---|
| BGD--C | -0.379096 | 0.100637 | -3.766945 | 0.0002 |
| BHS--C | 0.129742 | 0.046875 | 2.767831 | 0.0058 |
| BLZ--C | -0.138408 | 0.047865 | -2.891622 | 0.0039 |
| BMU--C | 0.245645 | 0.067080 | 3.661971 | 0.0003 |
| BOL--C | -0.251011 | 0.061723 | -4.066705 | 0.0001 |
| BRA--C | -0.074177 | 0.014365 | -5.163702 | 0.0000 |
| BRB--C | 0.036171 | 0.011976 | 3.020398 | 0.0026 |
| BWA--C | -0.110905 | 0.048883 | -2.268779 | 0.0235 |
| CAF--C | -0.364769 | 0.089712 | -4.065985 | 0.0001 |
| CAN--C | 0.130828 | 0.034372 | 3.806216 | 0.0002 |
| CHE--C | 0.220627 | 0.056786 | 3.885215 | 0.0001 |
| CHL--C | -0.100195 | 0.040833 | -2.453813 | 0.0143 |
| CHN--C | -0.278980 | 0.084607 | -3.297356 | 0.0010 |
| CIV--C | -0.223550 | 0.052453 | -4.261899 | 0.0000 |
| CMR--C | -0.223956 | 0.058745 | -3.812331 | 0.0001 |
| COD--C | -0.311003 | 0.071323 | -4.360506 | 0.0000 |
| COG--C | -0.159822 | 0.056854 | -2.811100 | 0.0050 |
| COL--C | -0.138515 | 0.035246 | -3.929950 | 0.0001 |
| CRI--C | -0.090394 | 0.020457 | -4.418627 | 0.0000 |
| DEU--C | 0.115571 | 0.029772 | 3.881918 | 0.0001 |
| DNK--C | 0.158904 | 0.046631 | 3.407712 | 0.0007 |
| DOM--C | -0.158779 | 0.043777 | -3.626965 | 0.0003 |
| DZA--C | -0.135312 | 0.031289 | -4.324622 | 0.0000 |
| ECU--C | -0.131171 | 0.033487 | -3.917068 | 0.0001 |
| EGY--C | -0.196894 | 0.055871 | -3.524093 | 0.0004 |
| EMU--C | 0.098776 | 0.024409 | 4.046746 | 0.0001 |
| ESP--C | 0.061400 | 0.013971 | 4.394875 | 0.0000 |
| ETH--C | **-0.453641** | **0.113587** | **-3.993767** | **0.0001** |
| FIN--C | 0.131200 | 0.030590 | 4.288989 | 0.0000 |
| FJI--C | -0.161598 | 0.046229 | -3.495571 | 0.0005 |
| FRA--C | 0.113465 | 0.028130 | 4.033622 | 0.0001 |
| GAB--C | -0.045470 | 0.030627 | -1.484622 | 0.1380 |
| GBR--C | 0.129146 | 0.032991 | 3.914559 | 0.0001 |
| GHA--C | -0.330916 | 0.083450 | -3.965433 | 0.0001 |
| GRC--C | 0.035212 | 0.012953 | 2.718477 | 0.0067 |
| GTM--C | -0.188204 | 0.044893 | -4.192291 | 0.0000 |
| GUY--C | -0.203613 | 0.048300 | -4.215605 | 0.0000 |
| HKG--C | 0.092438 | 0.018759 | 4.927579 | 0.0000 |
| HND--C | -0.236541 | 0.055194 | -4.285620 | 0.0000 |
| HTI--C | -0.249158 | 0.050189 | -4.964396 | 0.0000 |
| HUN--C | -0.022398 | 0.009484 | -2.361635 | 0.0184 |

| | | | | |
|---|---|---|---|---|
| IDN--C | -0.243813 | 0.072418 | -3.366758 | 0.0008 |
| IND--C | -0.365067 | 0.102761 | -3.552596 | 0.0004 |
| IRL--C | 0.082231 | 0.014819 | 5.548910 | 0.0000 |
| IRN--C | -0.163406 | 0.042355 | -3.858037 | 0.0001 |
| IRQ--C | -0.212970 | 0.049187 | -4.329836 | 0.0000 |
| ISL--C | 0.144405 | 0.040132 | 3.598295 | 0.0003 |
| ISR--C | 0.083580 | 0.023501 | 3.556498 | 0.0004 |
| ITA--C | 0.110923 | 0.026776 | 4.142669 | 0.0000 |
| JPN--C | 0.118738 | 0.023877 | 4.972942 | 0.0000 |
| KEN--C | -0.266355 | 0.069183 | -3.850008 | 0.0001 |
| KOR--C | -0.003012 | 0.018345 | -0.164162 | 0.8696 |
| LBR--C | -0.273926 | 0.043097 | -6.355993 | 0.0000 |
| LBY--C | -0.042240 | 0.035880 | -1.177260 | 0.2394 |
| LKA--C | -0.255292 | 0.068229 | -3.741706 | 0.0002 |
| LSO--C | -0.376015 | 0.099133 | -3.793052 | 0.0002 |
| LUX--C | 0.218265 | 0.051114 | 4.270173 | 0.0000 |
| MDG--C | -0.389468 | 0.086735 | -4.490328 | 0.0000 |
| MEX--C | -0.045388 | 0.019671 | -2.307367 | 0.0213 |
| MMR--C | -0.505059 | 0.126470 | -3.993522 | 0.0001 |
| MRT--C | -0.256295 | 0.064640 | -3.964962 | 0.0001 |
| MUS--C | -0.125118 | 0.043260 | -2.892240 | 0.0039 |
| MWI--C | -0.434979 | 0.096466 | -4.509142 | 0.0000 |
| MYS--C | -0.116875 | 0.039720 | -2.942514 | 0.0033 |
| NER--C | -0.402841 | 0.101998 | -3.949494 | 0.0001 |
| NGA--C | -0.284377 | 0.060705 | -4.684550 | 0.0000 |
| NIC--C | -0.272486 | 0.059243 | -4.599451 | 0.0000 |
| NLD--C | 0.119445 | 0.032282 | 3.700028 | 0.0002 |
| NOR--C | 0.188216 | 0.052561 | 3.580875 | 0.0004 |
| NPL--C | -0.394585 | 0.110795 | -3.561403 | 0.0004 |
| NZL--C | 0.112189 | 0.032217 | 3.482337 | 0.0005 |
| PAK--C | -0.291563 | 0.080059 | -3.641855 | 0.0003 |
| PAN--C | -0.097963 | 0.031020 | -3.158039 | 0.0016 |
| PER--C | -0.170134 | 0.038338 | -4.437798 | 0.0000 |
| PHL--C | -0.237175 | 0.065149 | -3.640501 | 0.0003 |
| PNG--C | -0.212567 | 0.047025 | -4.520298 | 0.0000 |
| PRI--C | 0.065999 | 0.015461 | 4.268678 | 0.0000 |
| PRT--C | 0.028219 | 0.008996 | 3.136747 | 0.0018 |
| PRY--C | -0.127631 | 0.042527 | -3.001184 | 0.0028 |
| RWA--C | -0.412569 | 0.103251 | -3.995802 | 0.0001 |
| SAU--C | -0.008897 | 0.032645 | -0.272521 | 0.7853 |
| SDN--C | -0.316974 | 0.093036 | -3.406990 | 0.0007 |

| | | | | |
|---|---|---|---|---|
| SEN--C | -0.287483 | 0.075609 | -3.802213 | 0.0002 |
| SGP--C | 0.097477 | 0.016104 | 6.053152 | 0.0000 |
| SLE--C | -0.369907 | 0.088740 | -4.168458 | 0.0000 |
| SOM--C | -0.431155 | 0.126594 | -3.405796 | 0.0007 |
| SUR--C | -0.065062 | 0.025305 | -2.571144 | 0.0103 |
| SWE--C | 0.142054 | 0.037948 | 3.743417 | 0.0002 |
| SYC--C | -0.042016 | 0.019833 | -2.118505 | 0.0344 |
| SYR--C | -0.306176 | 0.079007 | -3.875314 | 0.0001 |
| TCD--C | -0.376218 | 0.106744 | -3.524482 | 0.0004 |
| TGO--C | -0.347856 | 0.084836 | -4.100313 | 0.0000 |
| THA--C | -0.176628 | 0.063361 | -2.787648 | 0.0054 |
| TTO--C | -0.090918 | 0.025638 | -3.546185 | 0.0004 |
| TUN--C | -0.208860 | 0.053961 | -3.870553 | 0.0001 |
| TUR--C | -0.089387 | 0.023587 | -3.789664 | 0.0002 |
| TZA--C | -0.384299 | 0.096627 | -3.977150 | 0.0001 |
| URY--C | -0.051046 | 0.021527 | -2.371259 | 0.0179 |
| USA--C | 0.157085 | 0.039921 | 3.934890 | 0.0001 |
| VCT--C | -0.124085 | 0.042137 | -2.944800 | 0.0033 |
| ZAF--C | **-0.10962**9 | **0.027074** | **-4.049307** | **0.0001** |
| ZMB--C | -0.314895 | 0.080189 | -3.926905 | 0.0001 |
| ZWE--C | -0.239620 | 0.068641 | -3.490894 | 0.0005 |

Weighted Statistics

| | | | |
|---|---|---|---|
| R-squared | 0.467442 | Mean dependent var | -0.002061 |
| Adjusted R-squared | 0.400797 | S.D. dependent var | 0.058520 |
| S.E. of regression | 0.045300 | Sum squared resid | 1.803750 |
| F-statistic | 7.013860 | Durbin-Watson stat | 1.760473 |
| Prob(F-statistic) | 0.000000 | | |

Unweighted Statistics

| | | | |
|---|---|---|---|
| R-squared | 0.330987 | Mean dependent var | -0.008081 |
| Sum squared resid | 1.803904 | Durbin-Watson stat | 1.784610 |

## 4. The Regression Results by Using the 1990-1999 Sub-sample

Dependent Variable: D(Y?)
Method: Pooled EGLS (Cross-section weights)
Date: 07/18/25 Time: 22:53
Sample (adjusted): 1991 1999
Included observations: 9 after adjustments
Cross-sections included: 110
Total pool (balanced) observations: 990
Linear estimation after one-step weighting matrix
White cross-section standard errors & covariance (d.f. corrected)

| *Variable* | *Coefficient* | *Std. Error* | *t-Statistic* | *Prob.* |
|---|---|---|---|---|
| Y?(-1) | **-0.240357** | **0.033010** | **-7.281326** | **0.0000** |
| ARG--C | -0.034273 | 0.013222 | -2.592182 | 0.0097 |
| AUS--C | 0.282598 | 0.040105 | 7.046427 | 0.0000 |
| AUT--C | 0.246730 | 0.032454 | 7.602357 | 0.0000 |
| BDI--C | -0.881397 | 0.118378 | -7.445619 | 0.0000 |
| BEL--C | 0.225721 | 0.029989 | 7.526731 | 0.0000 |
| BEN--C | -0.658090 | 0.090610 | -7.262863 | 0.0000 |
| BFA--C | -0.830376 | 0.122294 | -6.790007 | 0.0000 |
| BGD--C | -0.736390 | 0.100697 | -7.312895 | 0.0000 |
| BHS--C | 0.191464 | 0.029062 | 6.588159 | 0.0000 |
| BLZ--C | -0.212796 | 0.036363 | -5.851973 | 0.0000 |
| BMU--C | 0.478263 | 0.068070 | 7.026033 | 0.0000 |
| BOL--C | -0.452371 | 0.060887 | -7.429654 | 0.0000 |
| BRA--C | -0.165964 | 0.018696 | -8.877131 | 0.0000 |
| BRB--C | 0.033203 | 0.009946 | 3.338308 | 0.0009 |
| BWA--C | -0.244835 | 0.041557 | -5.891560 | 0.0000 |
| CAF--C | -0.810438 | 0.108018 | -7.502811 | 0.0000 |
| CAN--C | 0.232794 | 0.034322 | 6.782589 | 0.0000 |
| CHE--C | 0.400018 | 0.058055 | 6.890293 | 0.0000 |
| CHL--C | -0.108081 | 0.015794 | -6.843045 | 0.0000 |
| CHN--C | -0.455884 | 0.068737 | -6.632287 | 0.0000 |
| CIV--C | -0.479543 | 0.064215 | -7.467732 | 0.0000 |
| CMR--C | -0.608035 | 0.081899 | -7.424178 | 0.0000 |
| COD--C | -0.855242 | 0.105330 | -8.119621 | 0.0000 |
| COG--C | -0.446573 | 0.056956 | -7.840669 | 0.0000 |
| COL--C | -0.277581 | 0.029793 | -9.317034 | 0.0000 |
| CRI--C | -0.137545 | 0.016339 | -8.418065 | 0.0000 |
| DEU--C | 0.225001 | 0.030225 | 7.444122 | 0.0000 |

| | | | | |
|---|---|---|---|---|
| DNK--C | 0.304406 | 0.042184 | 7.216111 | 0.0000 |
| DOM--C | -0.293725 | 0.041183 | -7.132190 | 0.0000 |
| DZA--C | -0.328700 | 0.042845 | -7.671806 | 0.0000 |
| ECU--C | -0.277203 | 0.033165 | -8.358351 | 0.0000 |
| EGY--C | -0.417261 | 0.056953 | -7.326422 | 0.0000 |
| EMU--C | 0.189832 | 0.025363 | 7.484565 | 0.0000 |
| ESP--C | 0.123464 | 0.014195 | 8.697979 | 0.0000 |
| ETH--C | **-0.964237** | **0.125359** | **-7.691800** | **0.0000** |
| FIN--C | 0.218102 | 0.032452 | 6.720717 | 0.0000 |
| FJI--C | -0.285530 | 0.037196 | -7.676434 | 0.0000 |
| FRA--C | 0.211160 | 0.029659 | 7.119684 | 0.0000 |
| GAB--C | -0.107718 | 0.018576 | -5.798822 | 0.0000 |
| GBR--C | 0.241627 | 0.034490 | 7.005758 | 0.0000 |
| GHA--C | -0.618769 | 0.084902 | -7.288046 | 0.0000 |
| GRC--C | 0.067403 | 0.007515 | 8.969358 | 0.0000 |
| GTM--C | -0.344783 | 0.045438 | -7.587964 | 0.0000 |
| GUY--C | -0.291825 | 0.042747 | -6.826870 | 0.0000 |
| HKG--C | 0.169293 | 0.027942 | 6.058766 | 0.0000 |
| HND--C | -0.491081 | 0.056588 | -8.678266 | 0.0000 |
| HTI--C | -0.557830 | 0.081730 | -6.825274 | 0.0000 |
| HUN--C | -0.124945 | 0.012369 | -10.10149 | 0.0000 |
| IDN--C | -0.459211 | 0.063744 | -7.203953 | 0.0000 |
| IND--C | -0.705381 | 0.098171 | -7.185253 | 0.0000 |
| IRL--C | 0.234663 | 0.027830 | 8.431958 | 0.0000 |
| IRN--C | -0.294999 | 0.045801 | -6.440822 | 0.0000 |
| IRQ--C | -0.430927 | 0.097708 | -4.410335 | 0.0000 |
| ISL--C | 0.254949 | 0.034408 | 7.409627 | 0.0000 |
| ISR--C | 0.179318 | 0.027676 | 6.479272 | 0.0000 |
| ITA--C | 0.204686 | 0.029079 | 7.039006 | 0.0000 |
| JPN--C | 0.207845 | 0.031043 | 6.695367 | 0.0000 |
| KEN--C | -0.574067 | 0.074489 | -7.706723 | 0.0000 |
| KOR--C | 0.041792 | 0.012996 | 3.215806 | 0.0013 |
| LBR--C | -0.865276 | 0.195513 | -4.425672 | 0.0000 |
| LBY--C | -0.031265 | 0.021475 | -1.455868 | 0.1458 |
| LKA--C | -0.470685 | 0.066698 | -7.056952 | 0.0000 |
| LSO--C | -0.699905 | 0.095971 | -7.292901 | 0.0000 |
| LUX--C | 0.448448 | 0.054925 | 8.164679 | 0.0000 |
| MDG--C | -0.811392 | 0.103117 | -7.868696 | 0.0000 |
| MEX--C | -0.087300 | 0.017340 | -5.034738 | 0.0000 |
| MMR--C | -0.956244 | 0.133271 | -7.175175 | 0.0000 |
| MRT--C | -0.545910 | 0.071556 | -7.629171 | 0.0000 |

| | | | | |
|---|---|---|---|---|
| MUS--C | -0.222530 | 0.031184 | -7.136113 | 0.0000 |
| MWI--C | -0.832512 | 0.121241 | -6.866581 | 0.0000 |
| MYS--C | -0.174097 | 0.029923 | -5.818116 | 0.0000 |
| NER--C | -0.835878 | 0.106283 | -7.864675 | 0.0000 |
| NGA--C | -0.531573 | 0.068847 | -7.721081 | 0.0000 |
| NIC--C | -0.554907 | 0.077794 | -7.133080 | 0.0000 |
| NLD--C | 0.251854 | 0.032163 | 7.830579 | 0.0000 |
| NOR--C | 0.384628 | 0.052534 | 7.321492 | 0.0000 |
| NPL--C | -0.776458 | 0.107887 | -7.196938 | 0.0000 |
| NZL--C | 0.190105 | 0.032633 | 5.825532 | 0.0000 |
| PAK--C | -0.603740 | 0.079814 | -7.564362 | 0.0000 |
| PAN--C | -0.151913 | 0.024974 | -6.082872 | 0.0000 |
| PER--C | -0.337015 | 0.043721 | -7.708332 | 0.0000 |
| PHL--C | -0.482434 | 0.063070 | -7.649156 | 0.0000 |
| PNG--C | -0.406528 | 0.052473 | -7.747346 | 0.0000 |
| PRI--C | 0.149570 | 0.019980 | 7.486004 | 0.0000 |
| PRT--C | 0.070656 | 0.006693 | 10.55607 | 0.0000 |
| PRY--C | -0.264796 | 0.031377 | -8.439295 | 0.0000 |
| RWA--C | -0.919897 | 0.151488 | -6.072404 | 0.0000 |
| SAU--C | 0.075692 | 0.023360 | 3.240252 | 0.0012 |
| SDN--C | -0.597071 | 0.088997 | -6.708873 | 0.0000 |
| SEN--C | -0.613798 | 0.084886 | -7.230853 | 0.0000 |
| SGP--C | 0.221619 | 0.032083 | 6.907715 | 0.0000 |
| SLE--C | -0.847119 | 0.114673 | -7.387227 | 0.0000 |
| SOM--C | -0.908837 | 0.135595 | -6.702582 | 0.0000 |
| SUR--C | -0.181993 | 0.025894 | -7.028373 | 0.0000 |
| SWE--C | 0.248826 | 0.034032 | 7.311550 | 0.0000 |
| SYC--C | -0.039461 | 0.016418 | -2.403579 | 0.0164 |
| SYR--C | -0.546283 | 0.069851 | -7.820700 | 0.0000 |
| TCD--C | -0.837413 | 0.117347 | -7.136191 | 0.0000 |
| TGO--C | -0.711107 | 0.101937 | -6.975932 | 0.0000 |
| THA--C | -0.307157 | 0.043360 | -7.083843 | 0.0000 |
| TTO--C | -0.099977 | 0.023589 | -4.238341 | 0.0000 |
| TUN--C | -0.386612 | 0.056279 | -6.869603 | 0.0000 |
| TUR--C | -0.182110 | 0.024093 | -7.558695 | 0.0000 |
| TZA--C | -0.772246 | 0.106034 | -7.282993 | 0.0000 |
| URY--C | -0.036608 | 0.010148 | -3.607583 | 0.0003 |
| USA--C | 0.298158 | 0.042214 | 7.062942 | 0.0000 |
| VCT--C | -0.239668 | 0.033056 | -7.250418 | 0.0000 |
| ZAF--C | **-0.25991**2 | **0.032345** | **-8.035681** | **0.0000** |
| ZMB--C | -0.674842 | 0.092294 | -7.311892 | 0.0000 |

| | | | | |
|---|---|---|---|---|
| ZWE--C | -0.490242 | 0.069660 | -7.037585 | 0.0000 |
| | Weighted Statistics | | | |
| R-squared | 0.441263 | Mean dependent var | | -0.005120 |
| Adjusted R-squared | 0.371341 | S.D. dependent var | | 0.074477 |
| S.E. of regression | 0.059051 | Sum squared resid | | 3.065139 |
| F-statistic | 6.310825 | Durbin-Watson stat | | 1.701596 |
| Prob(F-statistic) | 0.000000 | | | |
| | Unweighted Statistics | | | |
| R-squared | 0.284435 | Mean dependent var | | -0.005458 |
| Sum squared resid | 3.202617 | Durbin-Watson stat | | 1.665214 |

## 5. The Regression Results by Using the 2000-2009 Sub-sample

Dependent Variable: D(Y?)
Method: Pooled EGLS (Cross-section weights)
Date: 07/18/25 Time: 23:05
Sample (adjusted): 2001 2009
Included observations: 9 after adjustments
Cross-sections included: 110
Total pool (balanced) observations: 990
Linear estimation after one-step weighting matrix
White cross-section standard errors & covariance (d.f. corrected)

| *Variable* | *Coefficient* | *Std. Error* | *t-Statistic* | *Prob.* |
|---|---|---|---|---|
| Y?(-1) | **-0.072642** | **0.036595** | **-1.985001** | **0.0475** |
| ARG--C | -0.019870 | 0.019565 | -1.015552 | 0.3101 |
| AUS--C | 0.090623 | 0.042217 | 2.146617 | 0.0321 |
| AUT--C | 0.070939 | 0.036195 | 1.959917 | 0.0503 |
| BDI--C | -0.300895 | 0.148201 | -2.030320 | 0.0426 |
| BEL--C | 0.064407 | 0.032657 | 1.972207 | 0.0489 |
| BEN--C | -0.204806 | 0.106540 | -1.922339 | 0.0549 |
| BFA--C | -0.238073 | 0.128366 | -1.854634 | 0.0640 |
| BGD--C | -0.190994 | 0.114881 | -1.662541 | 0.0968 |
| BHS--C | 0.036078 | 0.026672 | 1.352617 | 0.1765 |
| BLZ--C | -0.072067 | 0.033030 | -2.181879 | 0.0294 |
| BMU--C | 0.146400 | 0.074021 | 1.977810 | 0.0483 |
| BOL--C | -0.134408 | 0.074905 | -1.794382 | 0.0731 |

| | | | | |
|---|---|---|---|---|
| BRA--C | -0.044575 | 0.029030 | -1.535485 | 0.1250 |
| BRB--C | 0.004133 | 0.009968 | 0.414610 | 0.6785 |
| BWA--C | -0.085244 | 0.029193 | -2.919959 | 0.0036 |
| CAF--C | -0.257575 | 0.141553 | -1.819640 | 0.0692 |
| CAN--C | 0.065780 | 0.035742 | 1.840430 | 0.0660 |
| CHE--C | 0.114109 | 0.057613 | 1.980600 | 0.0479 |
| CHL--C | -0.013226 | 0.015200 | -0.870092 | 0.3845 |
| CHN--C | -0.031903 | 0.060992 | -0.523069 | 0.6011 |
| CIV--C | -0.191755 | 0.089655 | -2.138811 | 0.0327 |
| CMR--C | -0.181975 | 0.094373 | -1.928257 | 0.0541 |
| COD--C | -0.274362 | 0.135715 | -2.021598 | 0.0435 |
| COG--C | -0.147575 | 0.082334 | -1.792388 | 0.0734 |
| COL--C | -0.076394 | 0.046016 | -1.660181 | 0.0972 |
| CRI--C | -0.026826 | 0.021736 | -1.234207 | 0.2175 |
| DEU--C | 0.055800 | 0.030603 | 1.823326 | 0.0686 |
| DNK--C | 0.079266 | 0.045278 | 1.750654 | 0.0804 |
| DOM--C | -0.071157 | 0.047639 | -1.493668 | 0.1356 |
| DZA--C | -0.085686 | 0.048524 | -1.765844 | 0.0778 |
| ECU--C | -0.077111 | 0.047677 | -1.617361 | 0.1062 |
| EGY--C | -0.109911 | 0.067734 | -1.622688 | 0.1050 |
| EMU--C | 0.049180 | 0.026755 | 1.838140 | 0.0664 |
| ESP--C | 0.034758 | 0.018293 | 1.900085 | 0.0577 |
| ETH--C | **-0.246978** | **0.154170** | **-1.601984** | **0.1095** |
| FIN--C | 0.074238 | 0.040246 | 1.844587 | 0.0654 |
| FJI--C | -0.100116 | 0.049502 | -2.022454 | 0.0434 |
| FRA--C | 0.053736 | 0.028978 | 1.854350 | 0.0640 |
| GAB--C | -0.087661 | 0.032448 | -2.701598 | 0.0070 |
| GBR--C | 0.069701 | 0.038101 | 1.829372 | 0.0677 |
| GHA--C | -0.173854 | 0.098692 | -1.761585 | 0.0785 |
| GRC--C | 0.036209 | 0.015841 | 2.285777 | 0.0225 |
| GTM--C | -0.109436 | 0.057081 | -1.917200 | 0.0555 |
| GUY--C | -0.085489 | 0.056434 | -1.514837 | 0.1302 |
| HKG--C | 0.071702 | 0.029991 | 2.390747 | 0.0170 |
| HND--C | -0.145540 | 0.073702 | -1.974701 | 0.0486 |
| HTI--C | -0.183694 | 0.094457 | -1.944749 | 0.0521 |
| HUN--C | -0.013528 | 0.012100 | -1.118010 | 0.2639 |
| IDN--C | -0.118389 | 0.075394 | -1.570277 | 0.1167 |
| IND--C | -0.169669 | 0.106515 | -1.592918 | 0.1115 |
| IRL--C | 0.080253 | 0.043434 | 1.847699 | 0.0650 |
| IRN--C | -0.068660 | 0.041960 | -1.636344 | 0.1021 |
| IRQ--C | -0.130895 | 0.103961 | -1.259079 | 0.2083 |

| | | | | |
|---|---|---|---|---|
| ISL--C | 0.088385 | 0.044712 | 1.976779 | 0.0484 |
| ISR--C | 0.046068 | 0.024774 | 1.859564 | 0.0633 |
| ITA--C | 0.042515 | 0.027624 | 1.539050 | 0.1242 |
| JPN--C | 0.044316 | 0.029261 | 1.514488 | 0.1303 |
| KEN--C | -0.186876 | 0.096003 | -1.946568 | 0.0519 |
| KOR--C | 0.047511 | 0.010259 | 4.631312 | 0.0000 |
| LBR--C | -0.269118 | 0.145908 | -1.844437 | 0.0655 |
| LBY--C | -0.015970 | 0.010863 | -1.470118 | 0.1419 |
| LKA--C | -0.112184 | 0.068123 | -1.646789 | 0.1000 |
| LSO--C | -0.195063 | 0.107394 | -1.816329 | 0.0697 |
| LUX--C | 0.139404 | 0.070139 | 1.987538 | 0.0472 |
| MDG--C | -0.266786 | 0.129096 | -2.066563 | 0.0391 |
| MEX--C | -0.051129 | 0.014372 | -3.557581 | 0.0004 |
| MMR--C | -0.158507 | 0.129888 | -1.220342 | 0.2227 |
| MRT--C | -0.171796 | 0.083841 | -2.049068 | 0.0408 |
| MUS--C | -0.040785 | 0.035496 | -1.148987 | 0.2509 |
| MWI--C | -0.255552 | 0.131576 | -1.942233 | 0.0524 |
| MYS--C | -0.048726 | 0.024772 | -1.966968 | 0.0495 |
| NER--C | -0.266721 | 0.138424 | -1.926843 | 0.0543 |
| NGA--C | -0.116406 | 0.080490 | -1.446213 | 0.1485 |
| NIC--C | -0.164055 | 0.083569 | -1.963104 | 0.0499 |
| NLD--C | 0.072121 | 0.036235 | 1.990370 | 0.0469 |
| NOR--C | 0.109549 | 0.055671 | 1.967790 | 0.0494 |
| NPL--C | -0.220464 | 0.124682 | -1.768209 | 0.0774 |
| NZL--C | 0.061546 | 0.028040 | 2.194928 | 0.0284 |
| PAK--C | -0.175637 | 0.095099 | -1.846873 | 0.0651 |
| PAN--C | -0.021911 | 0.025640 | -0.854578 | 0.3930 |
| PER--C | -0.071230 | 0.050697 | -1.405025 | 0.1604 |
| PHL--C | -0.133240 | 0.074184 | -1.796061 | 0.0728 |
| PNG--C | -0.161310 | 0.080475 | -2.004457 | 0.0453 |
| PRI--C | 0.044129 | 0.020275 | 2.176533 | 0.0298 |
| PRT--C | 0.008716 | 0.006381 | 1.365921 | 0.1723 |
| PRY--C | -0.088831 | 0.046508 | -1.910015 | 0.0565 |
| RWA--C | -0.215314 | 0.137042 | -1.571160 | 0.1165 |
| SAU--C | -0.001442 | 0.017436 | -0.082687 | 0.9341 |
| SDN--C | -0.172958 | 0.088584 | -1.952482 | 0.0512 |
| SEN--C | -0.193434 | 0.098878 | -1.956291 | 0.0507 |
| SGP--C | 0.081434 | 0.043362 | 1.878018 | 0.0607 |
| SLE--C | -0.239408 | 0.119161 | -2.009116 | 0.0448 |
| SOM--C | -0.249405 | 0.141209 | -1.766208 | 0.0777 |
| SUR--C | -0.033301 | 0.030231 | -1.101565 | 0.2710 |

| | | | | |
|---|---|---|---|---|
| SWE--C | 0.079499 | 0.041515 | 1.914940 | 0.0558 |
| SYC--C | -0.027655 | 0.018994 | -1.455953 | 0.1458 |
| SYR--C | -0.169433 | 0.090108 | -1.880321 | 0.0604 |
| TCD--C | -0.192414 | 0.121628 | -1.581991 | 0.1140 |
| TGO--C | -0.248140 | 0.118724 | -2.090058 | 0.0369 |
| THA--C | -0.071972 | 0.045487 | -1.582264 | 0.1139 |
| TTO--C | 0.033594 | 0.008278 | 4.058276 | 0.0001 |
| TUN--C | -0.092693 | 0.060165 | -1.540656 | 0.1238 |
| TUR--C | -0.044467 | 0.017154 | -2.592176 | 0.0097 |
| TZA--C | -0.204744 | 0.118250 | -1.731452 | 0.0837 |
| URY--C | -0.012381 | 0.022980 | -0.538763 | 0.5902 |
| USA--C | 0.083736 | 0.045455 | 1.842166 | 0.0658 |
| VCT--C | -0.042878 | 0.031463 | -1.362776 | 0.1733 |
| ZAF--C | **-0.063451** | **0.038221** | **-1.660099** | **0.0973** |
| ZMB--C | -0.179800 | 0.107280 | -1.675992 | 0.0941 |
| ZWE--C | -0.261915 | 0.119774 | -2.186745 | 0.0290 |

Weighted Statistics

| | | | |
|---|---|---|---|
| R-squared | 0.357238 | Mean dependent var | 0.007357 |
| Adjusted R-squared | 0.276801 | S.D. dependent var | 0.045212 |
| S.E. of regression | 0.038449 | Sum squared resid | 1.299416 |
| F-statistic | 4.441234 | Durbin-Watson stat | 1.496846 |
| Prob(F-statistic) | 0.000000 | | |

Unweighted Statistics

| | | | |
|---|---|---|---|
| R-squared | 0.273552 | Mean dependent var | 0.006104 |
| Sum squared resid | 1.361555 | Durbin-Watson stat | 2.068220 |

## 6. The Regression Results by Using the 2010-2019 Sub-sample

Dependent Variable: D(Y?)
Method: Pooled EGLS (Cross-section weights)
Date: 07/18/25 Time: 23:19
Sample (adjusted): 2011 2019
Included observations: 9 after adjustments
Cross-sections included: 110
Total pool (balanced) observations: 990
Linear estimation after one-step weighting matrix
White cross-section standard errors & covariance (d.f. corrected)

| *Variable* | *Coefficient* | *Std. Error* | *t-Statistic* | *Prob.* |
|---|---|---|---|---|
| Y?(-1) | **-0.218913** | **0.018160** | **-12.05489** | **0.0000** |
| ARG--C | -0.063188 | 0.011143 | -5.670442 | 0.0000 |
| AUS--C | 0.263777 | 0.023240 | 11.35035 | 0.0000 |
| AUT--C | 0.210543 | 0.017154 | 12.27337 | 0.0000 |
| BDI--C | -0.908587 | 0.071794 | -12.65550 | 0.0000 |
| BEL--C | 0.191632 | 0.015715 | 12.19412 | 0.0000 |
| BEN--C | -0.602879 | 0.054422 | -11.07784 | 0.0000 |
| BFA--C | -0.704523 | 0.061960 | -11.37057 | 0.0000 |
| BGD--C | -0.539128 | 0.053751 | -10.03013 | 0.0000 |
| BHS--C | 0.113224 | 0.014221 | 7.961974 | 0.0000 |
| BLZ--C | -0.241937 | 0.018578 | -13.02298 | 0.0000 |
| BMU--C | 0.384450 | 0.033130 | 11.60414 | 0.0000 |
| BOL--C | -0.369554 | 0.031869 | -11.59608 | 0.0000 |
| BRA--C | -0.153641 | 0.016053 | -9.570595 | 0.0000 |
| BRB--C | -0.006356 | 0.003970 | -1.601189 | 0.1097 |
| BWA--C | -0.217973 | 0.026655 | -8.177674 | 0.0000 |
| CAF--C | -0.857747 | 0.082494 | -10.39773 | 0.0000 |
| CAN--C | 0.205498 | 0.017329 | 11.85892 | 0.0000 |
| CHE--C | 0.347433 | 0.029151 | 11.91822 | 0.0000 |
| CHL--C | -0.047284 | 0.006089 | -7.765108 | 0.0000 |
| CHN--C | -0.123346 | 0.019896 | -6.199649 | 0.0000 |
| CIV--C | -0.460583 | 0.042166 | -10.92299 | 0.0000 |
| CMR--C | -0.546850 | 0.044257 | -12.35633 | 0.0000 |
| COD--C | -0.778425 | 0.065422 | -11.89853 | 0.0000 |
| COG--C | -0.471180 | 0.034190 | -13.78121 | 0.0000 |
| COL--C | -0.216003 | 0.018787 | -11.49761 | 0.0000 |
| CRI--C | -0.073487 | 0.006996 | -10.50462 | 0.0000 |
| DEU--C | 0.198142 | 0.015905 | 12.45789 | 0.0000 |

| | | | | |
|---|---|---|---|---|
| DNK--C | 0.253435 | 0.020489 | 12.36942 | 0.0000 |
| DOM--C | -0.176767 | 0.022576 | -7.829976 | 0.0000 |
| DZA--C | -0.285587 | 0.020877 | -13.67933 | 0.0000 |
| ECU--C | -0.226031 | 0.019243 | -11.74601 | 0.0000 |
| EGY--C | -0.347574 | 0.032109 | -10.82495 | 0.0000 |
| EMU--C | 0.155172 | 0.011512 | 13.47934 | 0.0000 |
| ESP--C | 0.092406 | 0.008011 | 11.53553 | 0.0000 |
| ETH--C | **-0.68351**9 | **0.064939** | **-10.52549** | **0.0000** |
| FIN--C | 0.205374 | 0.016333 | 12.57408 | 0.0000 |
| FJI--C | -0.250303 | 0.023961 | -10.44626 | 0.0000 |
| FRA--C | 0.169373 | 0.013277 | 12.75650 | 0.0000 |
| GAB--C | -0.200353 | 0.015950 | -12.56102 | 0.0000 |
| GBR--C | 0.213284 | 0.018069 | 11.80397 | 0.0000 |
| GHA--C | -0.475324 | 0.046084 | -10.31437 | 0.0000 |
| GRC--C | -0.002372 | 0.007550 | -0.314209 | 0.7534 |
| GTM--C | -0.312982 | 0.027655 | -11.31738 | 0.0000 |
| GUY--C | -0.222753 | 0.021362 | -10.42760 | 0.0000 |
| HKG--C | 0.204278 | 0.018332 | 11.14298 | 0.0000 |
| HND--C | -0.435136 | 0.036363 | -11.96655 | 0.0000 |
| HTI--C | -0.550835 | 0.043818 | -12.57102 | 0.0000 |
| HUN--C | -0.045458 | 0.012901 | -3.523700 | 0.0004 |
| IDN--C | -0.333875 | 0.032769 | -10.18863 | 0.0000 |
| IND--C | -0.488314 | 0.046740 | -10.44745 | 0.0000 |
| IRL--C | 0.302035 | 0.029569 | 10.21446 | 0.0000 |
| IRN--C | -0.273923 | 0.022847 | -11.98963 | 0.0000 |
| IRQ--C | -0.278447 | 0.023408 | -11.89542 | 0.0000 |
| ISL--C | 0.256876 | 0.022264 | 11.53749 | 0.0000 |
| ISR--C | 0.174992 | 0.012006 | 14.57530 | 0.0000 |
| ITA--C | 0.123494 | 0.009709 | 12.72005 | 0.0000 |
| JPN--C | 0.156158 | 0.015361 | 10.16588 | 0.0000 |
| KEN--C | -0.522535 | 0.046424 | -11.25570 | 0.0000 |
| KOR--C | 0.125670 | 0.008379 | 14.99738 | 0.0000 |
| LBR--C | -0.710270 | 0.053160 | -13.36102 | 0.0000 |
| LBY--C | -0.166440 | 0.103660 | -1.605635 | 0.1087 |
| LKA--C | -0.294124 | 0.024690 | -11.91276 | 0.0000 |
| LSO--C | -0.607781 | 0.042272 | -14.37781 | 0.0000 |
| LUX--C | 0.393096 | 0.035242 | 11.15430 | 0.0000 |
| MDG--C | -0.794591 | 0.065329 | -12.16295 | 0.0000 |
| MEX--C | -0.117198 | 0.007678 | -15.26333 | 0.0000 |
| MMR--C | -0.554782 | 0.054108 | -10.25322 | 0.0000 |
| MRT--C | -0.522686 | 0.043481 | -12.02108 | 0.0000 |

| | | | | |
|---|---|---|---|---|
| MUS--C | -0.107880 | 0.013341 | -8.086349 | 0.0000 |
| MWI--C | -0.752907 | 0.065338 | -11.52321 | 0.0000 |
| MYS--C | -0.104463 | 0.012958 | -8.061898 | 0.0000 |
| NER--C | -0.774055 | 0.063812 | -12.13020 | 0.0000 |
| NGA--C | -0.419576 | 0.033412 | -12.55761 | 0.0000 |
| NIC--C | -0.466616 | 0.030963 | -15.07026 | 0.0000 |
| NLD--C | 0.215840 | 0.016555 | 13.03755 | 0.0000 |
| NOR--C | 0.320316 | 0.028786 | 11.12734 | 0.0000 |
| NPL--C | -0.623878 | 0.060478 | -10.31580 | 0.0000 |
| NZL--C | 0.182103 | 0.015509 | 11.74187 | 0.0000 |
| PAK--C | -0.528123 | 0.046634 | -11.32483 | 0.0000 |
| PAN--C | -0.025772 | 0.004198 | -6.139405 | 0.0000 |
| PER--C | -0.211259 | 0.017151 | -12.31791 | 0.0000 |
| PHL--C | -0.355191 | 0.035212 | -10.08711 | 0.0000 |
| PNG--C | -0.421192 | 0.035501 | -11.86431 | 0.0000 |
| PRI--C | 0.117540 | 0.012310 | 9.548574 | 0.0000 |
| PRT--C | 0.031900 | 0.004611 | 6.917644 | 0.0000 |
| PRY--C | -0.226716 | 0.021492 | -10.54897 | 0.0000 |
| RWA--C | -0.664232 | 0.061959 | -10.72055 | 0.0000 |
| SAU--C | 0.037997 | 0.010110 | 3.758473 | 0.0002 |
| SDN--C | -0.578140 | 0.044826 | -12.89743 | 0.0000 |
| SEN--C | -0.562568 | 0.049225 | -11.42851 | 0.0000 |
| SGP--C | 0.272282 | 0.020780 | 13.10329 | 0.0000 |
| SLE--C | -0.714924 | 0.070899 | -10.08374 | 0.0000 |
| SOM--C | -0.760696 | 0.061840 | -12.30106 | 0.0000 |
| SUR--C | -0.149134 | 0.018354 | -8.125379 | 0.0000 |
| SWE--C | 0.241012 | 0.019924 | 12.09634 | 0.0000 |
| SYC--C | 0.017387 | 0.013287 | 1.308589 | 0.1910 |
| SYR--C | -0.705289 | 0.069978 | -10.07866 | 0.0000 |
| TCD--C | -0.712659 | 0.053536 | -13.31185 | 0.0000 |
| TGO--C | -0.668773 | 0.056838 | -11.76633 | 0.0000 |
| THA--C | -0.224217 | 0.019604 | -11.43710 | 0.0000 |
| TTO--C | -0.013430 | 0.018178 | -0.738792 | 0.4602 |
| TUN--C | -0.323113 | 0.025071 | -12.88809 | 0.0000 |
| TUR--C | -0.075615 | 0.009742 | -7.762007 | 0.0000 |
| TZA--C | -0.621468 | 0.055154 | -11.26783 | 0.0000 |
| URY--C | 0.004852 | 0.005118 | 0.948063 | 0.3434 |
| USA--C | 0.269005 | 0.021328 | 12.61283 | 0.0000 |
| VCT--C | -0.171904 | 0.015863 | -10.83654 | 0.0000 |
| ZAF--C | **-0.22649**4 | **0.016783** | **-13.49508** | **0.0000** |
| ZMB--C | -0.563839 | 0.043308 | -13.01933 | 0.0000 |

| | | | | |
|---|---|---|---|---|
| ZWE--C | -0.539256 | 0.039125 | -13.78279 | 0.0000 |
| | Weighted Statistics | | | |
| R-squared | 0.622540 | Mean dependent var | | 0.015035 |
| Adjusted R-squared | 0.575304 | S.D. dependent var | | 0.065164 |
| S.E. of regression | 0.042467 | Sum squared resid | | 1.585208 |
| F-statistic | 13.17933 | Durbin-Watson stat | | 1.466764 |
| Prob(F-statistic) | 0.000000 | | | |
| | Unweighted Statistics | | | |
| R-squared | 0.308769 | Mean dependent var | | 0.004161 |
| Sum squared resid | 1.677889 | Durbin-Watson stat | | 2.248145 |