CUBA: GROWTH MODEL ANALYSIS

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ABSTRACT

Cuba is one of the very few countries which are centrally planned to this day and is mostly controlled by the state and its enterprises. Because of this, its economy makes for an extremely intriguing case to analyze specially when it comes to looking into the efficacy in terms of economic output and growth of such economic systems. In this paper, we have looked into Cuba's economy in depth through the lens of the Solow Model , one of the most pivotal concepts in the field of development economics, which looks at economic growth and its relation with capital accumulation, labor, population growth and changes in productivity, ultimately comparing its performance to other economies in the Caribbean, US and Canada .

Key Words: Cuba, Solow Model, Development Economics

Introduction

Cuba, the biggest country in the Caribbean in terms of both landmass and size, is one of the few economies today which still dominantly consists of state-run enterprises. Its former longtime leader, Fidel Castro, overthrew US backed democratic regime in 1959 and rebuilt the country on Marxist/Leninist principles which laid emphasis on health, education and welfare. Because of ideological similarities and their strategic location, they were heavily backed by Soviet Union and other communist states from early, both in the form of both economic and military aid. This economic backing led to Cuba getting excessively dependent of them which thus led to a disastrous economic crisis following the collapse of Soviet Union in 1991. Since then, Cuban government has tried to liberalize the economy which has had mixed results.

The growth model it seems to have followed to a certain extent is that of the Solow model. As a result of the Soviet Union Investment there was a great amount of capital accumulation, both physical and human. Cuba which predominantly relied on the Sugar Industry, had become a massive exporter of the same, after having this labor-intensive sector become relatively capital intensive via Soviet investment in the same. During the initial phase of development, Cuba

initially showed some evidence of structural change, as the economy transited form a labor intensive to a relatively capital intensive one, with very high levels of literacy and health standards. The Solow model seems to work well initially , especially with a centrally planned closed economy , and most of the savings being channeled into investment , in order to boost economic growth ; the only catch here being that , Cuba may not have necessarily have had high domestic savings (data unavailable) , and even if it did , it was likely to be overshadowed by the massive inflow if FDI from Soviet Union.

High per capita income growth till the collapse of Soviet Bloc, can be attributed to high capital investment/accumulation and a moderating population growth rate. Technical progress did play an important role, however as data available indicates, it did not have a major influence. In relation to the new growth theories, we see how Cuba (or rather Soviet-led Cuba) invested heavily in physical capital, via education and health reforms,however, still seem to have been left behind (in per capita income terms) relative to other countries with similar literacy and health parameters. This choking of the economy is largely attributed to the absence of a free-market system in Cuba, which in the current absence of direct Soviet investments, seems to have suffered a lack of resources to carry on with its capital growth. In fact, narrowing employment opportunities, coupled with high literacy rates, is driving many Cubans elsewhere. In our report, we have tried have taken 6 macroeconomic variables: population growth rate, technical progress, human capital, physical capital, savingsrate, and FDI and analyzed them with respect to the Solow model of growth and other growth theories that we have studied for far.

(Note: Even though the Solow model studied is a closed economic model, in our case we need to account to FDI due to its major importance to the Cuban growth trajectory. At the same time, we have not taken the depreciation rate as a variable, due to lack of data on the same, and also because the other variables we have considered seemed to have greater significance to the country of our choice. Data for Cuba is difficult to find;thus, we have made use of all available)

Growth Model Analysis

a) Savings and Growth

The Savings rate here is the GDP minus the final consumption expenditure taken as a percentage of GDP. According to the Solow model, savings rate has a significant impact on the long run level of income and short run growth even though it does not affect the long run growth.

For further analysis, GDP per capita is taken as the measure of income per capita and data is derived from the World Bank database.

Cuba's savings rate remains fairly constant within the range of 10% to 15% except for the period between 1990- 1995. Savings was impacted by economic reforms like liberalization. Till end of 1993, the socialist government had criminalized the possession of hard currency. So, the savings were forced upon the population of Cuba which lead to domestic national savings being constant. In 1994, liberalization was implemented which decriminalized possession of hard currency which is why we later see a slightly more fluctuating trend than before.
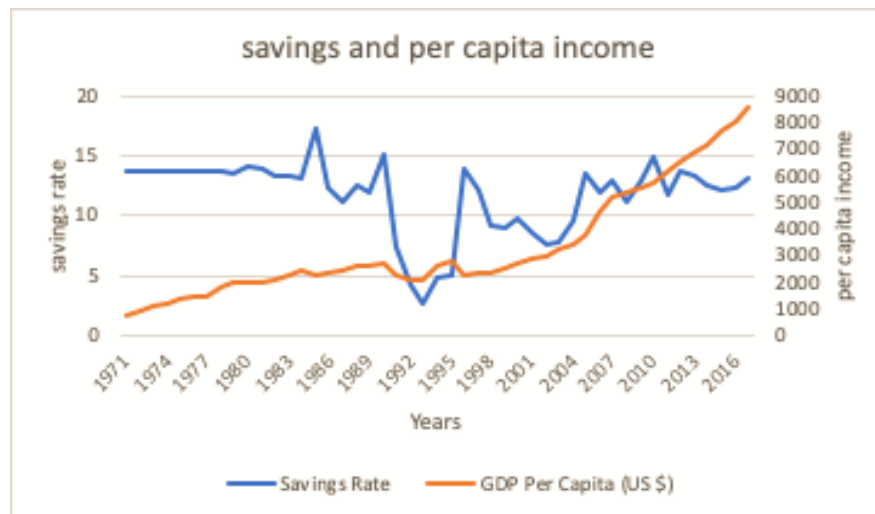
Till 1985 Cuba received great assistance from the Soviet Union in the form of cheap oil imports which it would sell at world market prices, in barter for sugarcane exports. The total national savings fell because the country began to consume its stock of fixed capital and run down its inventories after assistance from soviet stopped. These were saving of the state which fell, the household saving however surged in lieu of contingency. The recovery from this economic shock was quick though. The savings rate is also influenced by the monetary policy. The government of Cuba implemented contractionary fiscal policy where it reduced its expenditure and increased the tax rates. Even though it could not offset the fiscal deficit, but the money supply still reduced. This caused deflation which caused a higher purchasing power of Peso. The savings rate also increased as a result of higher real income. And hence the economy stabilized in 1996.

According to the Solow model, the savings rate has a level effect on the per capita income in steady state and has a positive relationship with it. To test this for Cuba, we run correlation. The correlation between per capita income and savings rate over 1971 to 2017 is 0.08 which is positive but, to get a clearer idea, we divide the data into two time periods: when Cuba was assisted by Soviet Union (1970 to 1990) and when it did not (1990 to 2017). The correlation in the first period is -0.170. It is an anomaly as the savings were forced on the population by the

government. But, in the second period, the correlation is 0.583 which shows a positive relationship between savings rate and per capita income. Hence, we can say that the Solow model holds. However, we can't comment on the level effect as the country is not in the steady state.

The Solow model says that in the short run, the savings rate affects the growth. For Cuba, the correlation for the whole time period is 0.480 but when we dig deeper the correlation in the first period, the correlation is 0.051 which is explained by the forced savings. However, in the second the correlation is positive 0.561 which says they have a positive relationship in the short run hence the Solow model holds.

b) ForeignDirect Investment

Foreign Direct Investment is an investment in the form of ownership in a business in one country by an entity based in another country. FDI is not a part of the Solow Model but since Cuba is very dependent on the FDI, to have a full picture, it is important to know about the inflows of FDI since it has been a major source of growth in the Cuban Economy.

In Cuba, foreign investment has been more about cultural identity and national sovereignty rather than money. In early 1960s, most of the state and foreign owned property were nationalized which led exiting of the educated middle class from the country. Soviet-style planning dominated the economy in Cuba. Soviet Union was a major importer and financial aid provider to Cuba so after sudden loss of soviet subsidies in 1990s, Cuba moved towards a more liberalized policy andwelcomed investors from all over the world. As we can see from the below table, a difference in the inflows of FDIs from Soviet Union when it existed and after it collapsed, we can see a

Year	GDP	Annual flow from Soviet Union	Annual Flow/GDP*100
1976	14206158675	1569000000	11.04450567
1977	17844705325	2270000000	12.7208601
1978	19584443288	2946000000	15.04255167
1979	19912889861	3178000000	15.95951176
1980	20150254096	3463000000	17.1858875
1981	20953510235	4555000000	21.73860107
1982	22204940512	4666000000	21.01334159
1983	24039383608	4260000000	17.72092026
1984	22920490774	4620000000	20.15663646
		Average of Annual flow/GDP*100	16.95364623

Year	GDP	Annual Flow	Annual flow/GDP*100
1993	2.8448E+10	54000000	0.189817842
1994*	3.043E+10	563400000	1.851474319
1995	2.5017E+10	4700000	0.018786948
1996	2.5366E+10	82100000	0.323662767
1997	2.5736E+10	442000000	1.717416503
1998	2.8365E+10	206600000	0.728372299
1999	3.0565E+10	178200000	0.583012164
2000	3.1682E+10	448100000	1.414349923
2001	3.3591E+10	38900000	0.115806552
		Average of Annual flow/GDP*100	0.771411035

*The reported flow jump in 1994 when the government decided to fold in flows from years prior to 1993.

difference:

When the economy started recovering, government revaluated the opening to foreign capital and ordered closure of many Joint Ventures (JVs). It was more interested in the state-backed projects involving Venezuela and China who were willing to offer capital on subsidized terms, on a non-transparent basis which was not reported to the international agencies that track FDI. This leads

to the limitation of lack of data on FDI from 2001 due to the same. It can be also said that the capital flows might also be state-banking loans, in the name of "Investments".

Cuban Economy has become a low-productivity economy and even the merchandise exports were reported at $4.6 billion in 2010 which was less than the 10 percent of the national output reflecting the low international competitiveness. There have been some positive developments in international tourism, nickel and cobalt and high value-added agriculture (due to higher FDIs and foreign partnerships in these sectors) but these have not been enough to lift Cuba to a strong sustainable growth. Reforms were made in 2011 that directly addressed to FDI but they never recognized the critical role of the FDI in economy growth. Cuban Economic planners believe that FDI at its best a secondary supplement for economy growth.

Legally, Law 77(1995) authorized for 100 percent foreign ownership in Cuba but one Interesting feature that was also noticed that it only allowed FDI ventures for a fixed period of time, and after that the contract should be renewed which could also lead to the government altering the contracts fundamentally. Previously government allowed foreign partners majority control, but now it asked 51% or more voting shares to the state-owned enterprise partner. It also excludes FDI in health, education and armed forces foreign institutions with an exception of commercial system. In reality, JVs have also been excluded from: Sugar and Biotechnology.

Cuba's other drawbacks includes world's heaviest tax on labor and shifting standards for JVs. On the basis of Foreign Investment Act 1995, Cuba also created industrial free trade zones to attract FDI which failed due to two factors: High cost of labor and lack of free trade agreements. Also, closed US markets for trade due to US sanctions.

Inflows of FDI, by Country, 1990-2009			
Country	Cumulative FDI (US$ billions)	Inflows/GDP (percentage)	Per Capita FDI inflows
Chile	110	5.7	6,532
Costa Rica	14	3.9	3,057
Croatia(d)	30	4.2	6,863
Dominican Republic	17	3.1	1,755
Ireland	113	5.8	25,013
Jamaica	10	4.9	3,528
Malaysia	90	4.4	3,231
Nicaragua	4	4.8	710
Vietnam	48	6.1	563

In countries which are comparable to Cuba in size or those who share the same characteristics, FDI has helped and made a substantial contribution to their growth. Jamaica, with a population of under 3 million, and persistent political unrest and criminal violence attracted nearly $10 billion. Two Asian countries, Vietnam and Taiwan, attracted about $50 Billion each. Vietnam has a strong state presence and is one-party state and Taiwan with a population of 23 million is

an island economy with a tense political relationship with its neighbor, Ireland who also took advantage of its educated workforce and gained access to European markets to attract over $110 billion in FDI.

Reforms have taken place such as some workers are permitted to hold two jobs, employers can hire part time workers, government has also permitted some firms to reduce staff, giving greater weight to labor productivity over employment security. At the same time new rule abolish the flexibility of JVs to grant small perks to employees, and there is a delay in approval for new projects.

Unless and until Cuba doesn't recognize FDI as an important source of growth, and only changes in the legal system won't help Cuba to bring in large amount of FDI, it is also the implementation of the laws that will bring the change.

c) Human Capital

Human Capital, in the given context, is defined by skills, knowledge or experience possessed by the population as a whole which is viewed as value or cost to an economy. According to the human capital augmented Solow Model, human capital is an important component for long term growth of an economy as it increases the rate of return from physical capital.

To study the condition of human capital and its contribution to the growth of Cuban economy from a quantitative perspective, Human Development Index has been taken as a proxy since it paints a holistic picture of the quality of human capital present in an economy.

Human Development Index (HDI) is a measurement developed to assess overall progress in living standards in a nation in comparison to the rest of the world. It takes 3 basic aspects of human development into consideration: income (GNI per capita), health (life expectancy) and education (mean and expected years of schooling).

Cuba's HDI value from 1990 to 2017 has ranged from .652 to .782 which, according to UNDP, is an indication of high availability of human capital and extremely favorable conditions to in. In 2017, Cuba was ranked 73 out of 189 countries.
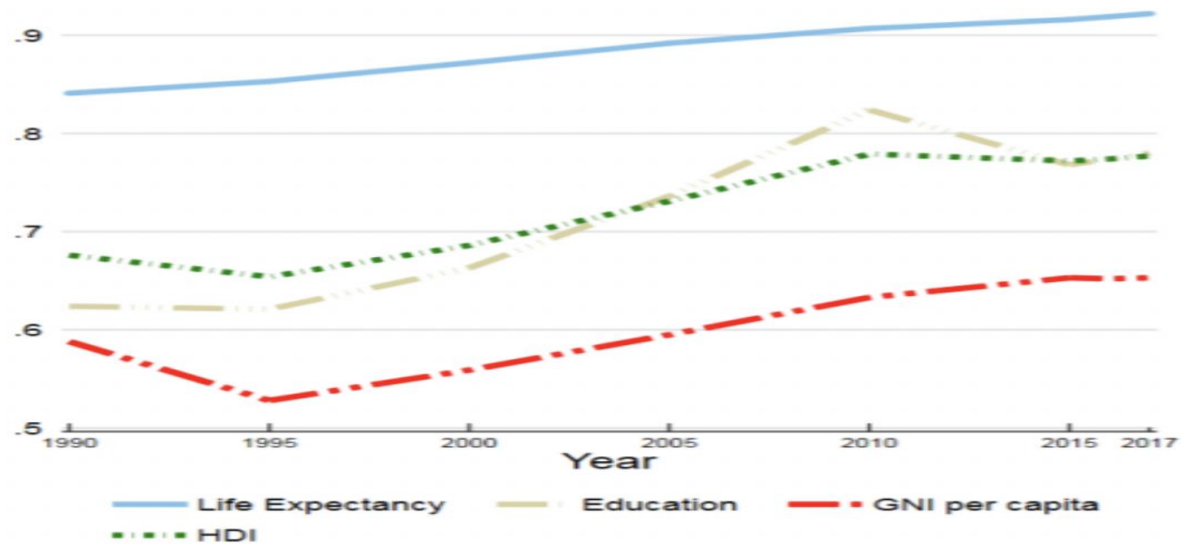
The graph above is the trend in Cuba's HDI component indices from 1990-2017 and it is taken from a UNDP report on Cuba which was published in 2018. According to the graph, Cuba's HDI is relatively high despite of relatively low-income per capita levels. This is because they have an extremely high life expectancy and education level which pulls up their index number.

High level of education and life expectancy levels suggests that Cuba is abundant in human capital. However, her income per capita (PPP) is still low with their global ranking being 128 out of 193 countries in 2017 which could mean that either:

•Cuba is still going through initial stages of growth and with her their per capita growth rate will converge to a steady level or,

•There isn't just enough physical capital on a macro level (infrastructure, roadways, etc) with which human capital could work.

In Cuba, majority of the economic activities is controlled by the state. The government decides all the prevailing wages and prices with supply and demand conditions having little to no influence on it. What it means is that most of the domestic investment is also left to the state. Cuba has done a commendable job of maintaining human capital. the Cuban government spends more than half its GDP on education, healthcare and other welfare programmes. It also has the highest investment in education in the world which is about 13 percent of its GDP.

However, investment in physical capital has been inadequate to the least. Since 1991, the Gross Capital Formation (% of GDP) in Cuba has averaged at 10.2 percent approx. which is way lower than world average of 24.5 percent. Moreover, more has half of their infrastructure is more than 40 years old and it has an extremely low rate of cellular subscription and internet penetration rate.

In conclusion, it could be said that Cuba, while having abundance of human capital owning to prioritization of welfare programmes by its government, has a low income per capita due to lack of investment in physical capital.

d) Population Trends in Cuba and economic growth:

Population growth as a macroeconomic variable in most of the models we have studied is a deterrent to per capita income. In the Harrod-Domar model we have studied population growth rates has a deterring impact on per capita income growth. In fact, as the equation of HD model points: growth of per capita income = growth of income - population growth rate. We used data available from 1972 - 2016 (obtained from World Development Indicators - World Bank) to simply check the relevance of this equation. And it fits almost perfectly, with a little margin for error. This shows clearly how increasing population growth rate eats into a Cuban per capita GDP growth rate and lowers its per capita income income growth rate.

We now look at the relevance of the Solow model (endogenous capital-growth), where changes in population growth rates can have level and growth effects to the steady state (with the level suffering a negative impact and growth having a positive impact). However, since we are unable to approximate the steady state, we simply check the direction of relation between [ln (per capita income)] and population growth rates see fig. 1.1.Furthermore, a correlation test is done for per capita income growth rates and population growth rates as well. Both the relation tests give correlation values of -0.66637 (considerably significant) and -0.173007 (negative though not so significant) respectively, which is largely in alignment with both model predictions.

To get a better idea we need to look closer at figure 1.1, which clearly shows a largely negative relation between the two variables. However, a closer look highlights a few interesting cases:

1) Post the 1980s to 1988 we see a positive relation between the two variables, which is in contradiction to the what is expected. An explanation for the same could lie in the analysis of the composition of population, the quality of workforces and technological progress. Since the 1960s to 1990 Cuba had seen rising levels of Urban population as a percent of total population in combination with increased labour force participation rates (with women also entering the workforce); furthermore, increased human capital in the form of high literacy rates (97.846% as

of 1981) could have made the workforce more productive. Hence the effect of an increase in population growth rate, instead of having a negative effect on per capita income (by eating into total income) has actually increased it by increasing output in a greater proportion. We also need to account for the massive increase in physical capital which automatically increases returns to labour (relatively skilled). Furthermore, technical process could also serve as a potential explanation.

2) Approx. from 1989 to 1992 we see both these variables reducing together. This is explained primarily by the collapse of the Soviet Union, which was a major source of growth for Cuba!! As a result, income levels fell, and Cuba also saw a significant amount of out-migration. Furthermore, clearly the fall in income was more than the fall in population, as a result of which per capita income levels also dropped (with per capita growth rates becoming negative).

An analysis of the more recent time period shows there exists a largely negative relation between the variables discussed above. It is important to discuss trends of the population growth rate itself: note however that as of recent (2006-2010) the population growths had turned negative and the population growth rates have been moderating largely since the 1960s itself. The primary reasons:

1) The decline of fertility- In Cuba, the global fertility rate has dropped from 4.7 children per woman (15 to 49) in 1960-65 to 1.63 in 2016 (ONEI, 2016), and is the lowest of all Latin America. This is so because, firstly ,women have been granted equal social rights & have entered the labor market at all occupational/professional levels after education ; secondly birth reduction is also the result of self-limited child conception because of economic difficulties and housing shortages ; thirdly the 1960-70 baby-boomers came to fertile age in the midst of the 1990s economic crisis when having child would be "expensive".

2) Outmigration combined with declining fertility resulted in reducing population growth during 2006-2010 (ONEI, 2016). As illustrated in fig 1.2 , emigration has been continuous, although its rates vary from year to year depending upon the severity of restrictions imposed by domestic policies and the relationship between Cuba and the United States.
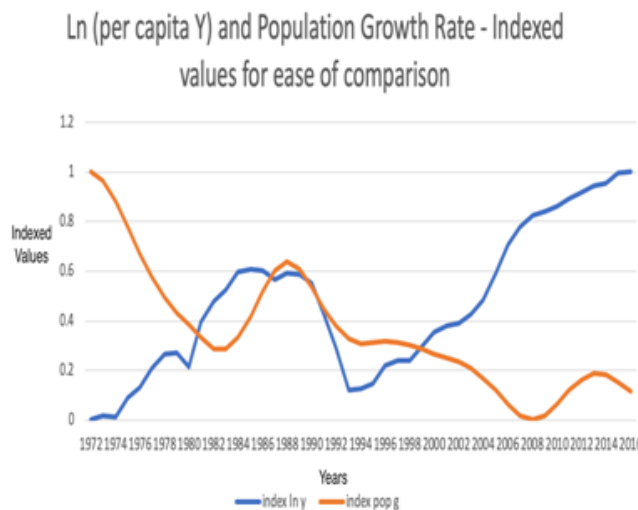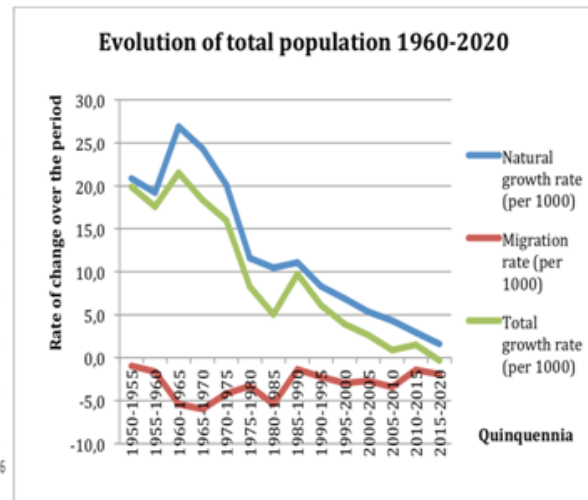
Fig. 1.1

Computed from ECLAC, 2017

Fig 1.2

e) Capital Formation

Gross fixed capital formation (GFCF), also called "investment", is defined as the acquisition of produced assets (including purchases of second-hand assets), including the production of such assets by producers for their own use, minus disposals. It therefore does not include, for example, the purchase of land and natural resources. Gross capital in a particular country is affected by its savings rate and re investment of those savings in the next year for production, manufacturing, and construction hence further increasing the level of consumption and savings. This is negatively affected by the growth of population as capital formed in a country has to be distributed among the people of country and everything else remaining the same as population increase capital formed and saved and re invested Per capital decreases.

The Cuban state claims to adhere to Socialist principles in organizing its largely state- controlled planned economy. Most of the means of production are owned and run by the government and most of the labour force is employed by the state.

Cuba's, infrastructure, power system, and communications are all in need of improvement.1959 Cuba was one of the most exceptional nations in Latin America, however a great part of the foundation has not been refreshed since the insurgency.

For instance, a large number of the 29,800 kilometers of streets that were recorded as cleared in 1996 were done as such before 1959, and have not been kept up.The first pre-Revolutionary

water and sewerage frameworks were introduced utilizing U.S.- made gear, for which new parts are inaccessible because of the U.S. exchange ban. Of the 170 air terminals in Cuba, just 77 had cleared runways. The travel industry has consistently been a gigantic piece of the Cuban economy, yet expanded the travel industry has placed a strain on foundation in Cuba

	Gross fixed capital formation (% of GDP)	Exports of goods and services (annual % gdp)	Manufacturing, value added (% of GDP)	Industry (including construction), value added (% of GDP)	population	gdp
Gross fixed capital formatic	1					
Exports of goods and servic	0.845802471	1				
Manufacturing, value adde	-0.827988974	-0.615746913	1			
Industry (including construc	-0.62586936	-0.419462836	0.94778761	1		
population	-0.876098059	-0.775020077	0.73839708	0.58134614	1	
gdp	0.046273555	0.131751829	-0.1510239	-0.2141738	0.31909061	1
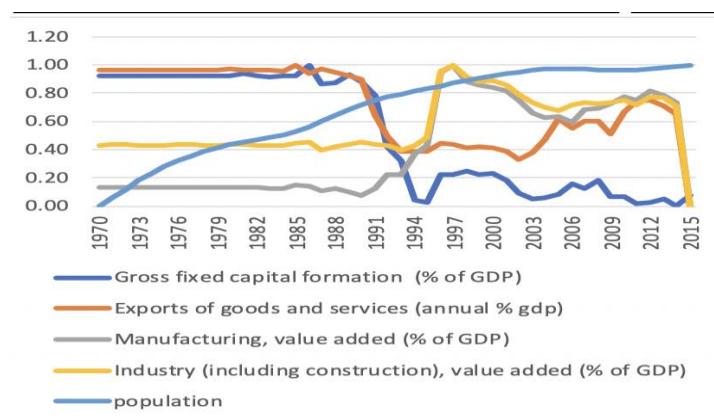
(indexed values,formula: (actual-minimum/max-min))
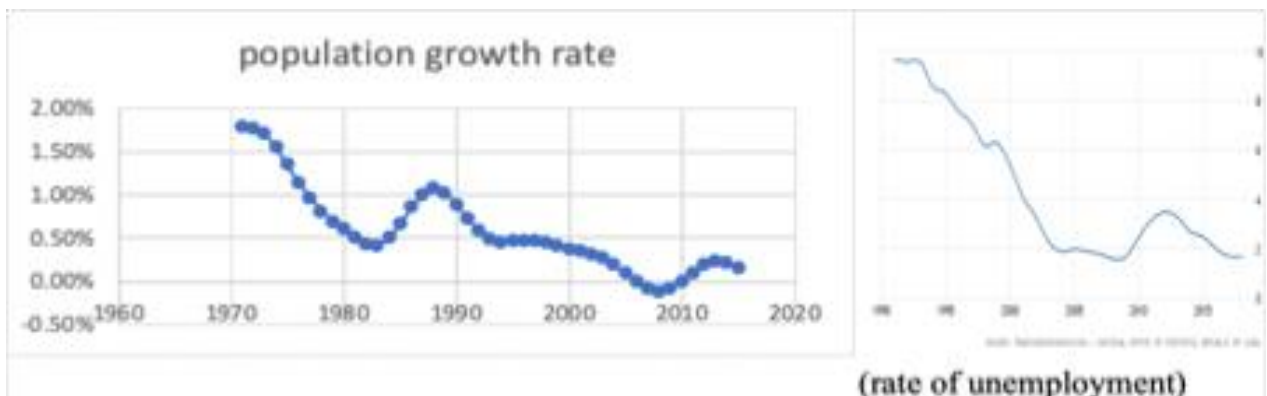
(rate of unemployment)

With resect the above graphs, though the unemployment and rate of population growth have been low and stagnant respectively the productivity of capital formed is low due to less population. Hence the conversion of this capital formed into manufacturing,industrialization and

exports hasn't been much causing the incremental of capital formation stagnant or fall. This result is less infrastructure, less attractions and hence less tourism which one of the biggest revenue generators for Cuba.

In Cuba's case we also see that the capital formed doesn't correlates with any variable but exports. In 1994 when manufacturing and industry performed well, the capital formed has fallen down which tells us two things, the country is unable to capitalize and optimize the resources and the length gestation period between capital forming and creating more capital has caused further capital depletion and hence less capital formation. Cuba was one of the riches countries in the Latin America right now is at its worst position of capital formed went to almost zero in 2016, affecting all the sectors as seen in the graph above. For a country like Cuba acceptance of FDI, debt, and grants and increase in population can be the only way to grow. Technological growth has been low / stagnant since 1970 due to the same infrastructure and bad governance.

f) Technical Progress

Technical progress explains why despite having similar economic and population growth, savings rate and rate of capital formation, countries don't necessarily converge. The following section assess the role of technological process in Cuba's growth story.

Consider the production functions –

$$Yt = F(Kt, Lt, t) \qquad (1) \quad \& \quad Yt = A(t)G(Kt, Lt) \qquad (1')$$

Where Yt, Kt, and Lt are the quantities of aggregate real output, physical capital and labour, respectively, at time t, in the second equation technological change is disembodied as A varies independently with time, to obtain the growth rate of capital, output and labor and the respective elasticities w.r.t labour and capital, we take natural log of (1') and differentiate it totally w.r.t t we get –

$$\frac{\Delta Y}{Y} = \frac{\Delta A}{A} + \alpha \frac{\Delta K}{K} + \beta \frac{\Delta L}{L} \qquad (4)$$

Where, $\frac{\Delta Y}{Y}$, $\frac{\Delta K}{K}$, $\frac{\Delta L}{L}$ are the rate of growth of output, capital and labor respectively in annual basis. The constants α and β are the elasticities of output with respect to capital and labor respectively. The factor $\frac{\Delta A}{A}$ represents the rate of technical progress or TFP.

Using the above equation estimates of total factor productivity could be found –

Table 6. TFP Estimates for the Cuban Economy

	TFP (%)	Output Rate of Growth (%)	Investment Rate of Growth (%)	Investment/ GMP
1963-1970	1.0	4.4	3.2	0.18
1971-1980	0.8	5.9	18.3	0.26
1981-1988	-1.7	3.8	4.9	0.31
Average (63-88)	0.22	4.5	9.3	0.25

This showed that total factor productivity reduced as time went on but investment increased ,this is contrary to what the theory suggests and this could be attributed to inefficient allocation of resources and no economic incentive for privately run firms , increase in investments byproduct of the political support showed by the Soviet Russia during that period , furthermore sectoral analysis suggests that agricultural TFP have been completely stagnant , the agricultural sector by dependent by large amount of investments (and the returns from the investment were planned to be invested to blossom the industrial sector)however, the investments turned out to be unproductive, at the same time, the TFP in industrial sector was found out to be moderate to low (taking the low investment-output ratio into account) which indicated that the investment among different sector needs to be balanced with regards to their output generation , also decreasing TFP growth with incremental subsidies from the soviet Russia also indicates how over dependence on them led to Cuba's economy getting inefficient. This also resulted in further slowdown once the Soviet Union collapsed and they stopped receiving subsidies. In all, the reasons (which also contradicts our theoretical understanding) why there was no increase in TFG despite investments in human and physical capital can be panned out as follows –

1) TFP and investment evidence from the analysis done above indicates that there is an optimal level of investment that maximizes technological change.

2) It seems that TFP should be positively related to the country's technical capacity, human capital, quality of its institutions and markets.

3) Investment over the aforementioned optimum level, lead to investment becoming inefficient, resulting in the reduction of rate of technological change .

Conclusion:

We plot the ln (per capita incomes) of Cuba (CU), North American Continent avg. (NA) and Caribbean and Latin American Countries (CLA) average over a period of 1970 - 2017 to see of convergence has taken place. The reason we have also brought in CLA into the picture, is because CU is often compared to CLA countries, due to similarity of parameters.

As is evident from the graphs below , the growth rate of per capita incomes (slope of curve) was initially higher for CU and CLA when compared to NA , because the former two were had lower incomes and lower capital stocks to begin with in comparison to United States and Canada (whose large per capita income and capital abundance pull up the continents average massively)

However, with time, the sloped has more or less become same, which could imply unconditional convergence to a certain extent (sinceUS, Canada and Cuba are quite different countries in terms of political structure and ideologies and thus considering them to be homogenous could be a mistake).

A major reason why this trend could be observed is because in initially Cuba received massive investments from the Soviet , however as of recent its growth has slowed not necessarily because it has converged (or reached a steady state) but simply because it has been suffering for stagnation for quite some time now , given the absence of free market system and other inclusive institutions in Cuba. This could also be the reason why if we closely observe CLA, the slope seems to be more CU for most of the period between 2000 and 2010.
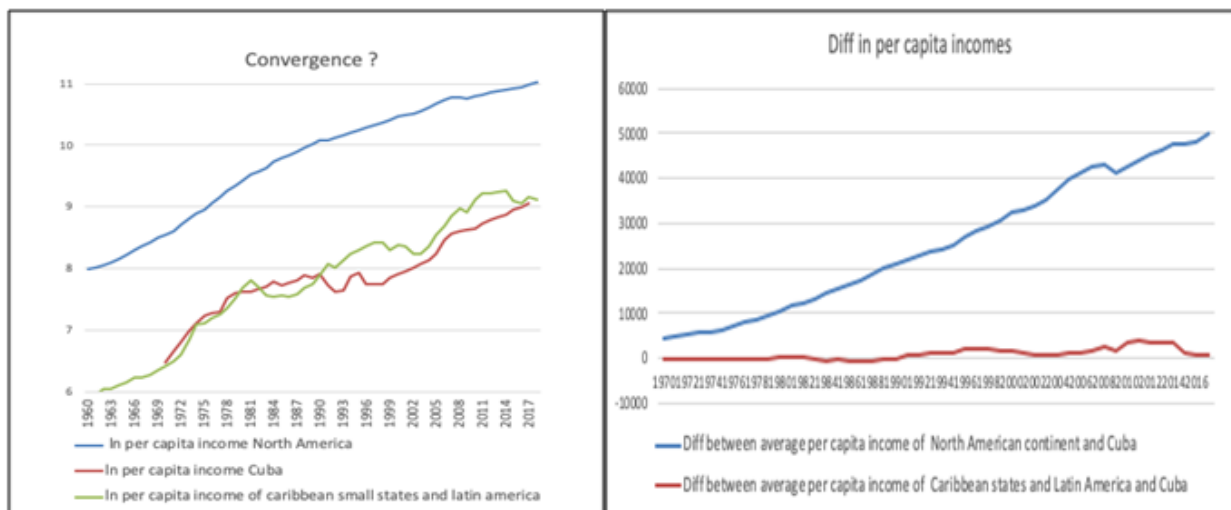
Furthermore, if we look at the difference between just per capita incomes, we clearly see how the diff between pci of NA and CU have increased massively over time, whereas the diff of pci of CLA and CU started off as negative but has become positive (the absolute values remain small however).

The rising difference could be clearly attributed to the difference in the bases of per capita income as the start of the time period considered itself ; furthermore as is evident CU did not grow at incredibly high rates compared to NA primarily due to the collapse of Soviet Union and a growth slump thereafter given the absence of FDI (which fueled Cuban growth for quite some time).

(CLA avg and CU started with similar bases). The diff between CLA and CU started off negative given CU's great growth initially (Soviet investment), however as Cuba succumbed to a socialist slowdown, the CLA countries picked up growth and the diff between pci became positive (though not so high).

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