GROWTH AND POLICY-INDUCED DISTORTIONS IN THE CUBAN ECONOMY: AN ECONOMETRIC APPROACH

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The objective of this article is to evaluate the role played by economic policies in Cuba during the period 1990–2016, using a production function-based empirical model. In particular, the article is concerned with several policies that have severely distorted the Cuban economy and stifled economic activity for decades.

- The subsidization of employment to state enterprises, aimed at concealing open unemployment.
- The administrative restrictions on the size of the private sector.
- Price controls.
- Restrictions on the use of technology.
- The low level of government investment—the predominant source of capital formation in Cuba.

The effects of these policies on real gross domestic product (GDP) are evaluated by estimating a production function featuring specific policy variables that affect total factor productivity (TFP). The model differs from previous studies involving production functions, including the recent seminal article by Pavel Vidal (2018), by recognizing that hidden unemployment of labor and capital has been an important aspect of Cuba's economic history in recent decades.

The first section of this article provides a brief history of policy-induced distortions since the early 1990s; the second section describes the production function-based model used to explain the evolution of real GDP; the third section presents the regression results; the fourth section accounts for the role of key variables in explaining the evolution of real GDP; and the final section provides an example of how policy changes could help to increase the level and the growth of real GDP. Annex I explains how the main variables are calculated; and Annex II deals with the construction of the capital utilization variable.

A BRIEF HISTORY OF POLICY-INDUCED DISTORTIONS

The empirical findings of this paper confirm that government policies have had a significant adverse effect on Cuba's economic performance. Price controls, limitations on the size of the private sector, and employment subsidies have introduced distortions and perverse incentives that have severely lowered productivity and output, particularly in the immediate post-Soviet period of the early 1990s. Beginning in 1994, however, policy changes helped to reduce, albeit slowly and unevenly, the damage inflicted by these distortions. The process was accelerated after 2011, as Raúl Castro took over the reins of economic policy, although it appears to have slowed, or even stopped, in recent years.

The **subsidization of employment** to state enterprises caused hidden unemployment to surge after the

1. I would like to thank Roger Betancourt for his comments on a previous draft of this paper, and particularly for encouraging me to explore more thoroughly the issue of capital utilization.

elimination of Soviet/Russian assistance in 1989–2000. Subsidies to cover enterprise losses increased sharply, peaking at CUP 5.4 billion in 1993, equivalent to 60% of the annual average wage rate in the public sector. As a result, hidden unemployment is estimated to have reached almost half of the nation's labor force in 1993. However, disguised unemployment (and the associated number of unproductive workers) fell sharply beginning in 1994, as subsidies were slashed in the context of an aggressive program of fiscal adjustment. Hidden unemployment continued to decline in the mid- and late-1990s. By 2001 subsidies for enterprise losses had declined to less than 3% of the public sector wage rate, and disguised unemployment in the public sector is estimated to have fallen to 7.5% of the labor force. Hidden unemployment then increased to almost 22% in 2011—the last year for which the required data are available—but then fell through 2016 (to perhaps 15%), owing to the massive transfer of employees from the state to the private sector that began in 2011.

The fiscal cost of the subsidies in the immediate post-Soviet period was substantial. In 1993 the government paid inactive employees the equivalent of 32.7% of nominal GDP. By 2011, however, the cost of the subsidies had dropped to the equivalent of 2.2% of GDP.

It could be argued that, in the absence of the wage subsidies, Cuba would have suffered an intolerable rise in uncompensated, open unemployment; or, alternatively, that the government would have had to pay a comparable sum in the form of unemployment compensation. This is not correct. First, a well-designed unemployment compensation program would have been less onerous, would have maintained incentives for job search, and would have been less distortionary. Second, the government could have lowered the barriers to private sector entry, so that many effectively unemployed workers could have found a job outside the state sector. Third, the demoralizing effect on active workers of seeing their inactive colleagues goof off (or even sometimes work at extraneous jobs while receiving a government salary) would have been avoided.

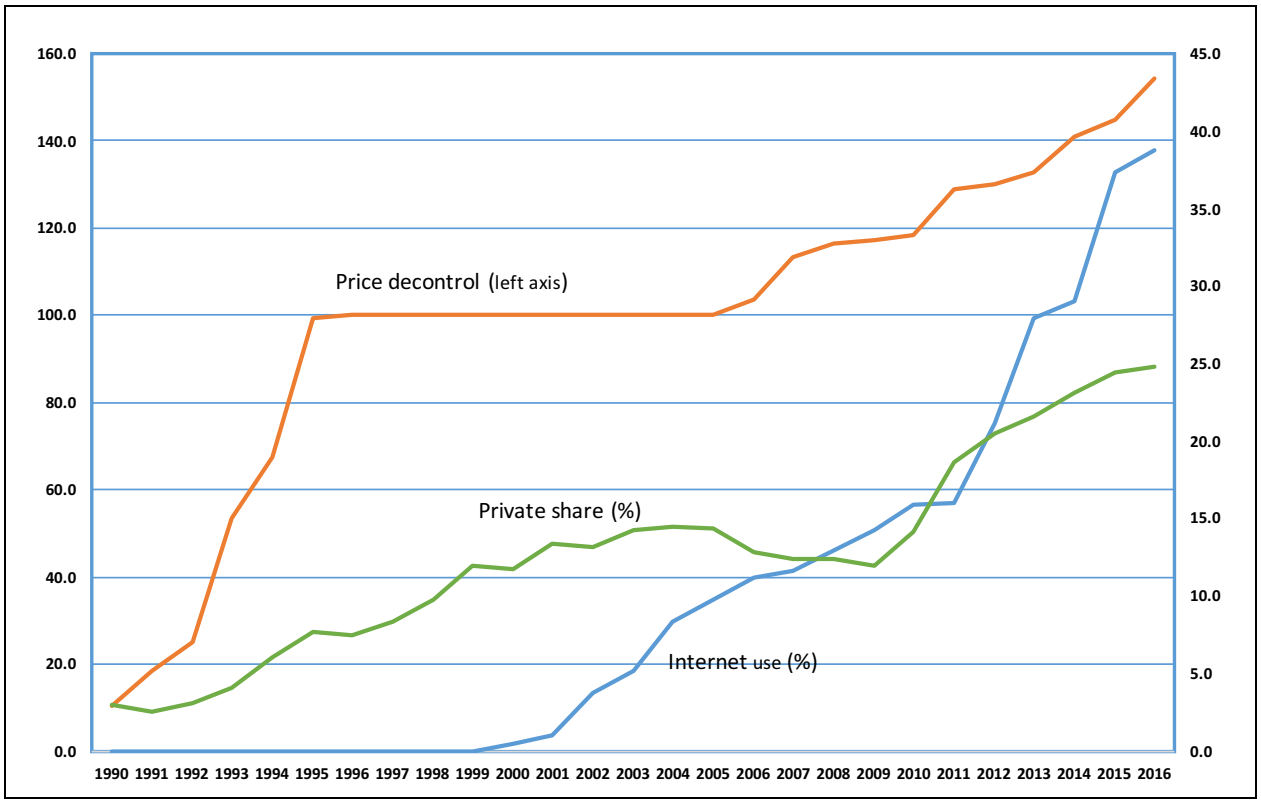
There is another type of government transfer which represents a subsidy to enterprises related to the use of oil and products imported from Venezuela.[2] These subsidies started in 2001 with the Accord between the two countries, increased rapidly during the 2000s reaching peaks of just over $6 billion in 2011 and 2012, before falling to $1.6 billion in 2016 as the world price of oil collapsed and Venezuela, facing a severe economic crisis, cut its oil deliveries to Cuba.

Aside from the issues of subsidies and hidden unemployment, **labor market arrangements** in Cuba's state sector are rigid, unfair and unimaginative. In spite of recent attempts to introduce flexibility, salaries are still insufficiently linked to skills and effort; the wages of Cubans who work for foreign companies and governments remain subject to discrimination in the form of huge confiscatory taxes; and collective bargaining and free trade unions are inexistent. Allowing enterprises to set wages freely as part of agreements with their employees would improve the functioning of the labor market substantially. For example, the German metal workers union *IG Metall* recently signed a contract that allows for a choice between wage awards and additional leisure time. No one in Cuba seems to have paid any attention to this innovative arrangement, even though if implemented in Cuba it could help households deal with the time-consuming chores imposed by the rationing system and therefore help to resolve the problem of the falling participation rate.

The **private sector share of employment,** which is determined primarily by an official list of authorized occupations, was minuscule in 1989 and remained quite low during the immediate post-Soviet depression. It increased modestly during most of the following expansion but it declined in 2006–2010. It

2. These subsidies are labeled *"other"* transfers to enterprises in ONEI's fiscal tables. They are financed by Cuban exports of professional services (mainly medical personnel) sold at prices that probably involve a substantial Venezuelan subsidy. Since publication of these subsidies was discontinued after 2011, data for subsequent years refer to products imported directly from Venezuela, or indirectly through the Netherlands Antilles.

Figure 1. Policy Variables affecting Total Factor Productivity



then surged from 2011–2016, as part of the large scale program launched by Raúl Castro's administration to reduce the number of unproductive employees by transferring them from the state to the private sector. The private employment share of the labor force jumped from 18.6% in 2011 to 20.5% in 2012 and to 24.8% in 2016.[3] Nevertheless, Cuba's share remains quite low by international standards. The European Bank for Reconstruction and Development estimated that in 2010 most of the countries that had evolved from a centrally planned to a market economy (with the exception of Belarus and Turkmenistan) had reached private shares of 60% or more. The most advanced, Estonia, the Czech and Slovak Republics and Hungary, had reached 80% or more. So Cuba has a long way to go.

Lack of data complicates judgments about the effects of **price liberalization**. Prices in Cuba are known to be subject to pervasive ceilings, but data on the number of goods subject to ceilings and on the intensity of controls is not publicly available. In fact, the annual reports published by the National Office of Statistics and Information (ONEI) are silent on this subject. A proxy for price decontrol (described in detail in Annex I) suggests that there have been a few instances of price liberalization since 1990. Apparently some ceilings were lifted in 1993–95, when the authorities sought to reduce the monetary overhang and the severity of rationing, but this was followed by a lengthy period of inaction through the mid-2000s (see Figure 1). Beginning in 2007, there was a new period of price liberalization that extended through 2016. How much scope remains for further liberalization remains uncertain. It should be stressed that the proxy used in this article reflects the degree of control over *absolute* level of prices, but does not capture the (probably severe) inefficiencies caused by distorted *relative* prices.

3. An increase in the private share has a temporary effect on the rate of *growth* of the economy, but it raises permanently the *lev*el of GDP.

Several indicators suggest that Cuba has lagged substantially in the area of **communications technology**. For example, as late as 2000, the number of fixed telephone lines per hundred inhabitants was only 4.4 in Cuba, compared with 22.9 in Costa Rica. By 2016, Cuba's ratio had increased to 11.6—still below Costa Rica's 17.5. Even more striking are the figures for Internet use, which are of particular interest because, in the case of Cuba, they are mostly determined by government-imposed restrictions rather than by technological progress or income. According to the International Telecommunications Union (ITU), the percentage of the Cuban population using the internet as late as 2000 was a measly 0.5%, compared with 5.8% in Costa Rica. Cuba's share surged to 38.8% in 2016, but it was still well below Costa Rica's 66%.[4] (Iceland ranks first among all countries at 98%.) So there was a considerable improvement in Cuba's performance since the beginning of the 21st century, but the country's initial deficiency was abysmal, and therefore there is still a great deal of catching up to do.

Cuba's ratio of **investment** to GDP is one of the lowest in the world. Data from the International Monetary Fund's World Economic Outlook in 2012 shows investment-to-GDP ratios of 24.9% for the world average, 31.6% for emerging markets and developing economies, and 20.3% for Latin America and the Caribbean. In that year Cuba's investment rate was only 9.9%.[5] A once-and-for all increase in the investment ratio would not only raise the *level* of Cuba's GDP but also its rate of growth, since a permanently higher investment rate would raise the capital stock in every subsequent year, so that the effects on output would cumulate over time.

This brief outline does not exhaust the list of policies that have hindered economic activity in Cuba. Others injurious practices that are important, albeit hard to quantify, include:

- government interference with state enterprises and cooperatives, particularly in the agricultural sector;
- the practice of using administrative import controls to deal with balance of payments pressures;
- the "*secretismo*" of senior government officials that conceals information from private investors, researchers, the press and market participants in general;
- last but not least, Cuba's dual (now multiple) exchange rate system continues to be a major source of discrimination against the export sector and of statistical distortion. Hopefully that system is now on its death bed.

Progress has been made in other areas since Raúl Castro became President. For example residents have been authorized to buy and sell houses and automobiles, and private farmers have been authorized to hold land in usufruct, although reforms in the agricultural sector have since been partially reversed.

THE MODEL

The model used to explain the evolution of aggregate production relies on a linear-homogeneous Cobb-Douglas production function relating output to *utilized* levels of employment and capital, and to total factor productivity:

$$y = \alpha\, e^* + (1-\alpha)\, k^* + x \qquad (1)$$

where lower case letters indicate natural logarithms; y is output; e^* is *active* employment; k^* is the *utilized* capital stock; x is a vector of variables that influence TFP; and α is the elasticity of output with respect to the effective labor input.

The approach differs from that of previous studies in several important ways. First, the labor input (e^*) is defined as *active* employment. i.e., total employment minus hidden unemployment in the state sector. Second, the *utilized* capital stock is endogenously determined within the model on the basis of estimates of

4. Recently there has been a controversy in this area as ONEI revised the share of internet users upward, while the ITU kept publishing numbers on the old basis. In 2016 the internet share was 38.8% according to the ITU and 40.3% according to ONEI.

5. This comparison is based on data for total fixed investment in percent of GDP, with both numerator and denominator expressed in current units of domestic currency. By contrast, the data used in this article to construct Cuba's capital stock involve domestic *non-residential* fixed investment at constant 1997 prices.

the gap between actual and potential GDP and labor utilization. Third, TFP is a function of several policy variables, rather than simply a time trend as is conventionally assumed.

Subtracting e^* from both sides of equation (1) yields the intensive form:

$$y - e^* = (1-\alpha)(k^* - e^*) + x \quad (2)$$

In words, labor productivity is a function of the capital/labor ratio and TFP, where both capital and labor are evaluated in effectively utilized terms.

The unobservable *utilized* capital stock (k^*) is defined as the total (outstanding) capital stock (k) multiplied by the capital utilization ratio $\rho = k^*-k$. Substituting into equation (2) yields:

$$y - e^* = (1-\alpha)(k - e^*) + (1-\alpha)\rho + x \quad (3)$$

which provides the general model for the regression results reported in the next section. Data for all the variables on the right hand side of (3) are either published or can be constructed as explained in detail in Annexes I and II.

REGRESSION RESULTS

Estimation results using ordinary least square (OLS) are presented in Table 1. In all the equations listed in the table the dependent variable is the (logarithm of) real GDP divided by *active* employment. OLS estimates are efficient in the sense that they minimize the sum of squared residuals of the regression. However they can be biased in the presence of serial correlation. Since the Durbin-Watson statistics associated with all the OLS regressions indicate the presence of auto-correlated residuals, the equations were also estimated using a maximum likelihood method by imposing a first order autoregressive transformation (AR1). The results are reported in Tables 1 and 2.

- Lines 1.1 and 2.1 include the **capital/labor** ratio as the only explanatory variable. The estimated coefficient is not significantly larger than zero in the AR1 regression but not in the OLS regression. (Throughout this article statistical significance is evaluated at the 99% confidence level based on a one-tailed t test). In both equations the F statistics are very low and there is considerable evidence of serial correlation. These results clearly suggest a problem of omitted variables.
- Lines 1.2 and 2.2 correspond to the basic model of equation (3) without TFP variables. The addition of the **capital utilization** ratio ? raised the adjusted R^2 sharply. It also raised the t statistics, albeit marginally for the OLS equation. The Durbin-Watson statistics were higher but autocorrelation remained a problem, even in the AR1 regression. The coefficient of the capital utilization variable were significantly positive in both regressions, and they were quite robust with respect to changes in specification.
- In lines 1.3 and 2.3 the **private employment share** turned out to be significantly positive. Its inclusion raised the DurbinWatson statistics considerably and the serial correlation coefficient in the AR1 equation became insignificant. Thus serial correlation ceases to be a problem.
- In lines 1.4 and 2.4 the coefficient of the **price decontrol** variable was significant and correctly signed. The coefficient of the private share variable dropped significantly, probably because of multicollinearity, but the Akaike test suggested that the inclusion of both policy variables was appropriate.
- The estimated coefficients of the technology variables (not shown) were small and insignificantly different from zero. For the internet variable this was perhaps because it is strongly correlated with the private share and the price liberalization variables. (See Figure 1). This appeared to be confirmed when equation 1.2 was re-estimated by adding the internet variable, yielding a significant coefficient (with a t ratio of 7.2) and a higher Akaike test value, but with a clear indication of serial correlation. In the AR1 version of the equation the internet coefficient became insignificant. All things considered, the internet variable should, in theory, affect TFP and output; but we are unable to confirm that hypothesis on the basis of the regression results.
- There is an important accounting issue that affects the measurement of key variables in the equations. Variables that are originally expressed in foreign currency units should, in principle, be

Table 1. Equations for the Ratio of GDP to Active Employment Ordinary Least Squares Estimates

	Constant term c	Capital / labor k - e*	Capital utilization k*- k	Private employment ratio e^{pr}- e	Price decontrol p_d	Exchange rate r	Human capital h	Adjusted R^2 F statistic	Durbin-Watson	Degrees of freedom
1.1	1.09	0.42						0.122	0.07	25
	(2.0)	(2.1)						5		
1.2	2.61	0.17	1.41					0.918	0.36	24
	(13.0)	(2.6)	(14.9)					134		
1.3	2.22	0.39	1.28	0.17				0.992	1.20	23
	(34.7)	(16.7)	(39.1)	(15.9)				1116		
1.4	1.78	0.42	1.28	0.11	0.06			0.995	1.33	22
	(14.7)	(21.6)	(40.7)	(5.5)	(3.9)			1372		
1.5	1.79	0.33	1.30	0.10	0.08	0.05		0.997	1.20	20
	(17.2)	(10.1)	(47.4)	(6.2)	(5.4)	(3.0)		1498		
1.6	0.68	0.30	1.13	0.06	0.06	0.07	0.83	0.998	1.25	19
	(2.4)	(10.3)	(25.6)	(3.1)	(5.0)	(4.9)	(4.1)	1773		

Note: Note: All lower case letter denote natural logarithms

Numbers in parenthesis under the coefficients are t statistics

The dependent variable in all equations is the (log) ratio of real GDP to active employment (y - e*).

Y is real GDP, *K* is the total (observed) capital stock; *K** is the utilized capital stock; *E* is the total (published) level of employment; *E** is the level of active employment; E_{pr} is private employment; P_d is a price decontrol variable, and h is a measure of human capital.

Table 2. Equations for the Ratio of Real GDP to Active Employment Maximum likelihood estimates—first order serial correlation

	Constant term Cst.	Capital/ labor k - e*	Capital utilization k* - k	Private employment ratio e_{pr}- e	Price liberalization p_d	Exchange rate r	Human capital h	Serial correlation coefficient	Adjusted R^2 F statistic	Durbin-Watson	Degrees of freedom
2.1	0.32	0.72						0.973	0.955	0.516	24
	(0.8)	(7.7)						(22.8)	183		
2.2	1.23	0.54	0.88					0.996	0.995	0.41	23
	(5.7)	(14.1)	(12.1)					(24.0))	1210		
2.3	2.2	0.40	1.17	0.18				0.410	0.992	1.79	22
	(34.7)	(16.7)	(39.1)	(18.7)				(1.6)	1116		
2.4	1.70	0.42	1.28	0.09	0.07			0.403	0.996	1.66	21
	(11.4)	(17.1)	(21.1)	(2.5)	(3.2)			(1.21)	937		
2.5	1.73	0.31	1.30	0.09	0.09	0.06		0.52	0.997	1.58	20
	(11.4)	(6.4)	(33.7)	(2.7)	(4.7)	(2.5)		(1.6)	1213		
2.6	0.62	0.33	1.14	0.05	0.07	0.05	0.82	0.50	0.999	1.54	18
	(1.6)	(8.0)	(14.5)	(2.1)	(3.1)	(3.5)	(3.0)	(1.4)	1434		

Note: Note: All lower case letter denote natural logarithms

Numbers in parenthesis under the coefficients are t statistics. The dependent variable in all equations is the (log of the) ratio of real GDP to active employment, *(y - e*). Y* is real GDP; *K* is the total (observed) capital stock; *K** is the *utilized* capital stock; E is the total (published) level of employment. *E** is the level of *active* employment; E_{pr} is private employment; d_p is a price decontrol proxy; and *h* is a measure of human capital.

converted into Cuban pesos at a market **exchange rate**, but ONEI converts them at the highly overvalued official rate of 1 peso (CUP) = 1 U.S. dollar. This distortion affects both sides of the equations reported in Tables 1 and 2: the left hand side because the peso value of exports of goods and services and consumption of goods sold in private markets is underestimated; and the right hand side because the capital stock is understated as investment flows include imports of capital goods.

- To obtain a very rough indication of the *net* effect involved, the peso/$ exchange rate in the parallel market (and more recently the CADECA rate) was introduced in lines 1.5 and 2.5. The results suggest that the understatement of the capital stock variable is larger than the underestimation of real GDP. It is noteworthy that the other coefficients are not greatly affected by the introduction of the exchange rate except that the estimate of the labor elasticity ? is a bit lower. Of course, this is a very crude adjustment. A more thorough treatment of the problem would require adjusting each of the variables involved using the market exchange rate and correcting both sides of the equation accordingly. This is not done here and will have to wait for a forthcoming paper. Vidal (2017) and Luis (2017) deal with a similar problem by constructing average exchange rates to convert peso GDP into U.S. dollars.

- Finally, a **human capital** variable *(h)* proposed by Vidal (2017) was introduced in lines 1.6 and 2.6, yielding significantly positive coefficients, although they were quite vulnerable to changes in specification. This does not mean that education is not important: most of the variation in *h* occurs before the beginning of our sample period. The size of the h coefficient in both tables is about 0.8, a little higher than the estimated value of the labor elasticity of output (0.7).

GROWTH ACCOUNTING

The regression results shown in line 2.4 of Table 2 were used together with a growth accounting framework to quantify the role of key variables in explaining the evolution of Cuba's real GDP The analysis was conducted for two time periods with sharply different experiences and policies: the deep recession of the immediate post-Soviet periodand the subsequent period of recovery and expansion.

- **1990–1993.** The abysmal contraction that followed the end of Soviet/Russian assistance (output fell at an average annual average of almost 10 percent in 1990–94[6]) was associated with a large drop in the utilization of the capital stock that reflected the dramatic contraction of aggregate demand and the difficulty in repairing and replacing Soviet equipment. The fall in investment also led to a reduction in the outstanding capital stock and therefore in output. The contribution of total employment during this period was very small because government subsidized state enterprises to keep employees in their payroll in spite of the steep fall in the demand for their products. But *active* employment plunged, accounting for almost 28% of the fall in GDP. Together, the drop in the utilization of capital and labor accounted for a whopping 60% percent of the contraction of output. A minor offset came from a positive contribution of policy changes, and there was a fairly large unexplained residual, suggesting that unidentified factors had contributed to the plunge in production.

- **1994–2016.** Increased utilization of capital and labor contributed just more than 60% to the 4.2% average annual output growth over this period—thus erasing the huge declines that occurred during the post-Soviet period. This reflected the absorption of the massive levels of disguised unemployment and idle capital at the beginning of the recovery. The contribution of factor accumulation was relatively modest because of low investment and slow growth of the

6. To remind, percentage changes are calculated as changes in logarithms.

Table 3. Cuba: Growth Accounting

		1990–1994		1994–2016	
	Contributions to output growth of:	Average annual percentage rate rate (%)	Percent of total contribution	Average annual percentage rate rate (%)	Percent of total contribution
	Real GDP	-9.9	100	4.2	100
1=1a+1b	Utilized Capital	-4.1	42	2.3	54
1a	Accumulation of capital stock	-1.0	10	0.4	9
1b	Capital utilization rate	-3.2	32	1.9	45
2=2a+2b	Active employment	-2.9	29	1.2	29
2a	Employment growth	-0.1	-1	0.3	8
2b	Labor utilization rate	-2.8	-28	0.9	21
3=4+5+6	Total factor productivity	0.6	-6	0.6	15
4	Private share	0.3	-3	0.6	13
5	Price liberalization	0.4	-4	0.1	2
1–2-4–5	Unexplained residual	-3.5	35	0.1	-1
	Change in real GDP due to:				
	Total resource utilization	-5.9	-60	2.7	61
1b	Capital	-3.2	-32	1.9	42
2b	Labor	-2.8	-28	0.9	19
1a+2a	Input growth	-1.1	-26	0.7	17

Note: The contribution of the annual percentage change in variable Z to the total change in real GDP is calculated by multiplying the annual average percentage change in Z during the relevant period by the corresponding regression coefficient (taken from Table 1). Percentage changes are calculated as differences in natural logarithms.

labor force. The contribution of TFP was modest and the unexplained residual was negligible.

QUO VADIMUS?

An important conclusion emerges from this paper: near full utilization of resources at present means that Cuba will no longer be able to count on increased utilization of factors of production to grow at a satisfactory rate. To make things worse, employment growth cannot be counted upon to fuel growth since both population and the labor force are expected to be stagnant over the medium to long term—or even to decline, if the current downward trend in labor participation persists. So, from now on, the only way to improve living standards will be to boost investment and TFP growth.

The Cuban authorities themselves have stressed the need to increase growth. Indeed, they have mentioned a target of 5% annual GDP growth, which, *prima facie* seems like pie in the sky. The empirical results presented in this article provide a more rigorous way to determine how policy changes can help to achieve higher growth. This was done by combining the regression results reported in Table 2 together with assumptions about policies and labor market developments, in order to simulate an alternative path for growth over the next 10 years. Specifically, it was assumed that employment would remain unchanged over the simulation period—as population and the labor force would remain constant and disguised unemployment is assumed to have been virtually eliminated. In the alternative scenario, the government is assumed to adopt two key policy measures: (i) the ratio of real fixed non-residential investment to real GDP is raised gradually from the current 11.6% to 14% in 2022 and is then held at that rate indefinitely; and (ii) the share of private employment is raised from 24.8% in 2016 to 35% in 2022 and then kept at that rate.[7]

These are admittedly ambitious goals, but they are certainly not extreme: the programmed ratio of investment to GDP and the planned share of the pri-

7. The 10 percentage point increase in the private share of employment could be achieved in various ways. One possibility would be to privatize culture and sports (which would raise the private share by 3.9 percentage points), to cease government interference with the UBPCs and other agricultural cooperatives, making them truly private (4.4 percentage points), and to raise the private participation in construction by 1.8 percentage points.

vate sector are both modest by the standards of other countries, particularly those that have evolved from a planned to a market economy.

Table 4. Effects of Raising the Investment Ratio and the Share of Private Employment on the Growth and Level of Real GDP

	(average annual percentage changes)	
Real GDP growth	**2017–2022**	**2022–2027**
Baseline scenario	2.5%	1.0%
Program scenario	4.1%	2.0%
Total effect of policies	1.6%	1.0%
Effect of higher investment	0.7%	0.9%
Effect of higher private share	0.9%	0.1%

	(million CUP pesos)	
Level of real GDP	**2022**	**2027**
Baseline scenario	59558	62557
Program scenario	64470	70266
Program / baseline (%)	8.2%	12.3%

Note: Author's estimates

As shown in Table 4, the program would achieve an annual GDP growth rate of 4.1% over the medium term (2017–2022), compared to 2.5% in the baseline (current policies) projection, with roughly equal contributions from both policies. In the following period (1922–2027), growth would slow to 2%, still double the baseline growth rate of 1%. The private share would cease to fuel additional growth. But even though the investment/GDP ratio would remain unchanged after 2022, its *level* would remain above baseline and therefore would continue to generate higher growth through its lasting effect on the capital stock.

A long term annual growth rate of 2% may seem disappointing, but it is to a large extent the inevitable result of demographic stagnation and a still seriously distorted economy. A more ambitious goal would require even higher investment ratios and private shares and/or changes in other distorting policies like price controls. Still, it should be noted that the program succeeds in raising real GDP above its baseline level by 8% in 2022, and more than 12% in 2027. These are not minor improvements.

The success of the program would hinge on the ability to finance the increase in investment. It would not be desirable to rely on private saving given the need to raise household consumption. Therefore additional financing would have to come from foreign saving (presumably private direct investment inflows), or from a reduction in government dissaving, which could be achieved by lowering subsidies and by privatizing part of the category labeled "entrepreneurial services, real estate activities, and rentals," and—why not?—parts of the health sector.

All this would require dealing with the ideological hang-ups of many officials. But the payoff would be substantial. Inaction would not kill the economy, but it would condemn the country to a long period of very slow growth.

ANNEX I. CONSTRUCTION OF KEY VARIABLES

Because many of the relevant variables used in this article are unpublished, the analysis requires the careful construction of several policy-related proxies.

Active employment in the state sector *(E_s^*)* is equal to total state employment minus disguised unemployment. In turn, disguised unemployment is estimated in two ways. From 1990 to 2011 it is a function of the wage rate in the state sector *(w),* the tax on labor paid by enterprises *(t),* and the subsidy per employee paid by the government to the state enterprises *(s)* on condition that they refrain from laying off redundant workers:

$$E_s^* - (w - t - s)/(w - t)\, E_s \qquad (4)$$

Where E_s is the level of total employment in the state sector.[8] For two reasons, the model of equation (4) cannot be used after 2011. First, because in 2012 the official statistical agency ONEI discontinued publication of the structure of state subsidies to enterprises, making it impossible to measure the variable *s*. Second, because the government's strategy to reduce disguised unemployment changed radically in 2011, from an indirect method based on subsidy reduction to a direct method involving transfers of employees from the state to the private sector coupled with an expansion of the list of private activities allowed to operate legally. Therefore, beginning in 2012 active employment was calculated using the identity $E_s^* = E_s - \hat{U}_s$ where $\hat{U}_s$ is the level of hidden unemployment, and assuming that in every year the entire reduction in state employment involved in a fall in disguised unemployment.

Economy-wide active employment *(E^*)* is the sum of active state employment and private employment, $E_s^* + E_{pr}$. This implies that all private employment is active because the government generally does not provide subsidies to private producers. (The government may have provided transitional subsidies to firms that were privatized as part of the large-scale reduction of state sector employment starting in 2011. But this hypothesis cannot be tested since, as noted above, ONEI stopped publishing the breakdown of state subsidies to enterprises.)

There are four possible problems with this estimate of active employment. First, some of the redundant state employees reportedly take advantage of their free time to perform informal work for their own account at their workplace. This would imply a downward bias in the estimates of active employment. Second, the E^* does not include people working in the underground economy—probably a substantial number—another source of downward bias. Third, a number of self-employed enterprises are said to be unregistered and are not included in the official data. According to Ritter (2016) these enterprises employed 450 thousand workers *circa* 2015, or almost one third of the total private workforce. Finally, while the model underlying equation (4) is based on the assumed behavior of state enterprises, but it is applied to the entire public sector. Whether the behavior of government ministries and agencies can be modeled like that of state enterprises, is of course, debatable.

8. The methodology underlying equation (4) is explained in "Estimating Disguised Unemployment in Cuba" (Hernández-Catá 2015). The formulation used in this article is more complete as it includes tax rates on employed labor. Unfortunately, this variable cannot be updated because in 2012, Cuba's statistical office discontinued, without explanation, the publication of data on subsidies for enterprise losses.

The outstanding capital stock *(K)*, which includes utilized as well as idle capital, is constructed using the Perpetual Inventory model. This involves accumulating over time real non-residential fixed investment *(I)* plus the capital stock at the end of the previous year (K_0) minus depreciation (δK_0):

$$K = I + (1- \delta) K_0 \quad (5)$$

Where K_0 is the capital stock in t previous period. Following Vidal Alejandro (2017) the annual rate of depreciation δ is calculated as a weighted average of depreciation rates for each of the 3 categories of real fixed investment: construction, machinery and equipment, and other investment. Unlike Vidal Alejandro, however, we use *non-residential* rather than total fixed investment. Thus the average depreciation rate δ varies over time as the share of each category of investment evolves. The individual depreciation rates, taken from a study for Colombia, are 3% for construction and 8% each for the other two categories. The Colombian data are chosen in preference to those published by the United States (and adopted by Vidal Alejandro) because asset lives in developing countries tend to be significantly longer (and depreciation rates lower) than those in industrial countries.[9] Depreciation rates for Costa-Rica were also used with similar results to those obtained using Colombian data.

The **potential labor force** is defined as the conventionally defined labor force (employment plus open unemployment) plus the estimated number of discouraged workers.

The **private share** in the economy is approximated by the ratio of private to total employment (E_p/E).[10] This ratio probably underestimates the true importance of the private sector in the economy to the extent that E^* fails to include the informal sector. In addition, the private employment share does not capture the productivity differential between the private and public sectors, which is most probably positive and substantial, and it is therefore an imperfect proxy for the private share of GDP.[11]

Price controls. Information on regulated and unregulated prices is available to the authorities, but it is not made public. A proxy for price decontrol was constructed by selecting, for each of the economic sectors for which data is available, *large* annual increases in GDP deflators (*large* being arbitrarily set at 8% or more; the observations corresponding to price increases of less than 8% were set at zero). The logic behind this variable is that, in a country like Cuba, where general inflation is typically quite low, large price increases are probably associated with episodes of price liberalization. The sectoral variables were aggregated into an economy-wide index of large price increases.[12]

Communications Technology. Telephone density and the share of Internet users in the population were taken from the International Telecommunications Union website.

Subsidies to states enterprises *(S).* This is the sum of subsidies for enterprise losses and what ONEI labels "other" subsidies. The latter is believed to cover the

9. It should be noted that official data may underestimate investment inasmuch as some of the remittances received by Cuban residents from their relatives abroad may be used to finance private capital formation—a recent development that may become increasingly important in the future. This point was made by Roger Betancourt.

10. The share of non-state employment was also used, but did not perform as well as the private share in the regressions. The non-state sector includes the Basic Units of Cooperative Production (UBPCs) and other cooperatives in addition to the private sector. These cooperatives have suffered from considerable interference by the authorities and therefore do not qualify as truly "private. By contrast "private employment," as defined by ONEI, *excludes* the UBPCs. It does include the considerably more independent Cooperatives of Credit and Services (CCS) and the highly successful independent private farmers, in addition to the private non-agricultural sector which consists primarily of the self-employed.

11. This is a problem only to the extent that the productivity differential varies over time. If it were constant, its effect would be captured by the regression coefficient of the employment share.

12. Two other proxies for the effect of price controls were specified as the ratio of two consumption deflators: one for household purchases of goods and services in the market, and the other for household purchases from state stores. The two proxies are based on data published by ONEI in Tables 5.14 ("Final Consumption by Sources of Supply"), and 5.15 ("Total Final Consumption Expenditure"). None of these variables performed satisfactorily in the regressions.

pass-through of Venezuelan subsidies for petroleum exports to Cuba. The subsidy rate *(s)* used in equation (4) is equal to the value of subsidies divided by employment in the state sector.

ANNEX II. CONSTRUCTING THE CAPITAL UTILIZATION VARIABLE

Capital stock figures are typically generated by accumulating real fixed investment net of depreciation over time. However, data on that fraction of the capital stock that is effectively utilized at any point in time, is generally unavailable. Yet this is the variable that is relevant in estimating a production function. This annex describes a consistent way to construct a capital utilization variable.

Consider a linear-homogeneous Cobb-Douglass production function relating actual output (y) to utilized labor (e^*), utilized capital (k^*), and total factor productivity (x):

$$y = \alpha\, e^* + (1\ \alpha)\, k^* + x \qquad \text{(A1)}$$

where lower case letters represent natural logarithms and a is the elasticity of output with respect to the effective labor input. Consider next a production function with identical technology but evaluated at full employment of resources.

$$\bar{y} = \alpha\, f + (1 - \alpha)\, k + x \qquad \text{(A2)}$$

where $\bar{y}$ is potential GDP, k is the total outstanding capital stock, f is the potential labor force and x is total factor productivity. Subtracting (A2) from (A1) yields:

$$y - \bar{y} = \alpha\,(e^* - f) + (1 - \alpha)\,(k^* - k) \qquad \text{(A3)}$$

In words, the gap between actual and potential output is equal to a weighted sum of the labor utilization and the capital utilization rates, each weighted by its relevant elasticity.

The capital utilization variable can then be calculated as:

$$k^* - k = [(y - \bar{y}) - \alpha\,(e^* - f)] / (1 - \alpha) \qquad \text{(A4)}$$

In this paper, the potential GDP variable $\bar{y}$ is calculated on the basis of equation *(A2),* where the TFP variable X is assumed to grow at a constant rate, as derived in a previous growth exercise. This estimate of potential output is then used together with equation (A4) to calculate the capital utilization rate. In the equations estimated in Tables 1 and 2 of this paper, however, TFP is not assumed to grow at a constant rate but is a function of several policy-related variables. In principle, it should be possible to re-calculate $\bar{y}$ using this (presumably improved) estimate of TFP, but this is not done in this paper.

REFERENCES

Berlemann, Michael, and Jan-Erik Wesselhöft (2014) "Estimating Aggregate Capital Stocks. A Survey of Previous Implementations and Evidence for 103 Countries." *Journal of Economic Literature,* 65. pp. 1–34.

Hernández-Catá, Ernesto. (2013). "Accounting for the Growth of Real GDP in Cuba. An Experimental Empirical Study". *Economic Behavior, Game Theory and Technology in Emerging Markets,* Bryan Christensen and Basilgam Muslum, eds. (London: IGI Editions).

Hernández-Catá, Ernesto (2015). "Estimating Disguised Unemployment in Cuba". *Cuba in Transition—Volume 25.* Washington: Association for the Study of the Cuban Economy.

Hernández-Catá, Ernesto (2016). "Why Has the Cuban Economy Grown So Fast Since the Mid-1990s?" Paper presented at the Annual Conference of the American Economic Association. San Francisco (January).

Luis, Luis R. (2018) "Unifying the Cuban Peso. Tentative Numbers". Ascecuba.org//Blog (July 27).

Ritter Archibald (2016). "Alternative Institutional Futures for Cuba's Mixed Economy." The Cuban Economy Blog (February).

Tribun Uribe, Ana María. "Tasa de rendimiento del capital de Colombia para el periodo entre 1990 y 2000". Departamento de Modelos Macroeconómicos. Bogotá, Colombia.

Vidal Alejandro, Pavel (2017) "¿Qué lugar ocupa la economía cubana en la región? Una medición a la tasa PPA de las brechas de ingreso y productividad". Resumen de Políticas Nº IDB-PB-269. Banco Interamericano de Desarrollo. Washington D.C.