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DETERMINING THE OPTIMAL ALLOCATIONS OF GOVERNMENT'S HEALTHCARE EXPENDITURE BUDGETS

BY

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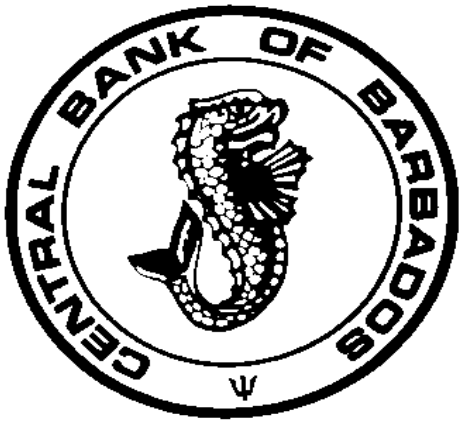

CENTRAL BANK OF BARBADOS

Determining the Optimal Allocations of Government's Healthcare Expenditure Budgets

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ABSTRACT

Traditionally, successive governments in Barbados have heavily subsidized the public provision of healthcare services, but now depressed tax revenues and rising debt burdens have diminished the current administration's ability to fully fund these programmes. Policymakers must now determine how best to allocate scarce resources to effectively fund these initiatives, while not compromising the quality of public services. However, while substantial research has been conducted on the social and economic benefits of public spending on healthcare in small, developing states in the Caribbean, academics have placed less focus on the effects which individual components of expenditure have on long-term labour productivity and economic growth. This study seeks to fill that gap in the literature by evaluating the impacts of individual public spending on Primary healthcare, Hospital services and the Pharmaceutical programme on labour productivity and determines the most effective allocations of government healthcare budgets. The results suggest that only government's spending on Primary healthcare positively influences labour productivity, and a reallocation of finances from the Hospital services to fund the Primary healthcare system while simultaneously cutting total spending can yield long-term benefits to both productivity and overall economic growth.

KEYWORDS: Government healthcare expenditure, Labour productivity, Non-linear programming

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INTRODUCTION

The economic and social benefits of a healthy population and access to the provision of quality healthcare services have been well articulated globally. Balaji (2011) says it best when he states, "Health is a primary and most essential input for human resources development of a country and the economic performance of any nation is interlinked with the health status of the population." Schultz (1961) contends that investment in human capital, particularly via health facilities and services, on-the-job training, formally organized school education, adult study programmes and individual migration accounted for the largest share of the increase in per worker real incomes of his time. Further, Bloom and Canning (2000) posit that improved healthcare drives economic growth higher via positive impacts on labour productivity, incentives to invest in lifelong higher education, investment in physical capital via higher incentives to save for old-age, and declining trends in infant mortality, while Umoru and Yaqub (2013) confirm the health capital-labour productivity nexus for Nigeria.

These theories suggest that national authorities' effective spending on public healthcare systems should boost their citizens' quality of living and overall life expectancy. In fact, Gupta, Verhoeven and Tiongson (2002) provided evidence that governments' spending on healthcare lowers infant and child mortality rates for 50 developing states. Closer to home, Greenidge and Stanford (2007) and Bynoe, Craigwell and Lowe (2012) highlight that Caribbean governments' public expenditure on healthcare directly drives higher life expectancy at birth, while the latter study suggests that public healthcare spending also indirectly boosts school enrollment by lowering infant mortality rates.

Traditionally, successive governments in Barbados have heavily subsidized the public provision of healthcare services, but now depressed tax revenues and rising debt burdens have diminished the current administration's ability to fully fund these programmes. In 2013/2014, the government of Barbados' fiscal deficit ballooned to approximately 11.8% of GDP, as despite additional taxes being instituted over the previous three years, government's revenue remained significantly below pre-crisis levels, and a bloated public sector and accounting for previously excluded expenditures drove current spending higher. Government initiated a number of spending cuts including a 10% reduction in the size of the public sector workforce and greater restraint on transfers and subsidies to public corporations including the Queen Elizabeth Hospital. While these measures brought the deficit down to 6.8% of GDP during 2014/2015, further fiscal consolidation is required as arrears to private suppliers continue to accumulate amid reports of worsening cash flows including at the state-run general hospital (Ministry of Finance and Economic Affairs, 2015). As such, there have been calls for a public debate on the future of healthcare financing, including the possibility of introducing user fees for the consumption of public services (Ministry of Finance and Economic Affairs, 2015). Policymakers must now determine how best to allocate scarce resources to effectively fund these initiatives, while not compromising the quality of public services.

In light of this, this paper aims to evaluate the relative long-run contributions of public spending on Primary healthcare, Hospital services, and the Pharmaceutical programme to labour productivity by employing the Dynamic Ordinary Least Squares (DOLS) technique to data

spanning the period 1982 – 2013[1]. Further, the study proposes to determine an optimal allocation of government's 2015/2016 healthcare budget to maximize the long-term benefits of public spending or minimize total healthcare spend while maintaining current levels of output per worker. These three components of the public healthcare system were chosen as they account for almost 80% of the public healthcare budget and represent key constituents of the overall healthcare system.

While substantial research has been conducted on the economic benefits of public spending on healthcare in small, developing states in the Caribbean, to the best of this author's knowledge, academics have placed no focus on the effects which individual components of health expenditure have on economic growth and national development. Further, empirical results concerning the effects of healthcare expenditure on growth have proven inconclusive thus far. For example, Acosta-Ormaechea and Morozumi (2013) show that in the case of fifty-six countries, increasing the share of government's health budget relative to other areas of spending has no significant impact on GDP per capita, while Mishra and Mohapatra (2011) find little evidence of a causal relationship from healthcare spending to economic growth for four Indian states. However, Balaji (2011), whose results corroborated those of Mishra and Mohapatra (2011) for four southern Indian states posits that a significant share of funds allocated to healthcare either go toward spending on salaries and other administrative costs or are leaked out of the system via corruption and inefficiencies. Hence, higher spending on inefficiently allocated capital will likely not improve economic prospects. Nonetheless, Colombier (2011) adds support to Bloom and Canning (2000) and Umoru and Yaqub (2013) and finds a weak, though significant long-run relationship between output per worker (a proxy for labour productivity) and healthcare expenditure. The authors suggest conducting further research to better understand the link between healthcare expenditure and economic growth.

Carter, Craigwell and Lowe (2013) are the latest authors to tackle the issue of the effects of public spending on social services on economic growth in the Caribbean. They employed both the DOLS and Unrestricted Error Correction Model techniques to determine the existence of a long-run relationship between GDP per capita and spending on healthcare, education and social security in Barbados between 1976 and 2011 and found that healthcare expenditure had negative, though at times insignificant, effects on output per person in both the short- and long-runs. However, Belgrave and Craigwell (1995), who were among the first to investigate the effects of public spending on healthcare and other functional and economic categories on Barbadian economic growth between 1969 and 1992, determined that while spending a greater share of the public budget on healthcare had positive long-term effects on growth, future research should focus on disaggregating the effects of spending on hospital and polytechnic services on economic prosperity to better understand the sources of this positive relationship. Further, their Engle-Granger approach to determining the extent of the long-run relationship between GDP and public spending failed to appropriately account for potential endogeneity and reverse causality.

[1] For the purposes of this paper, spending on Primary healthcare includes funds allocated for Dental and Nutrition services, HIV/AIDS Prevention and Control, Health promotion and spending on maternal healthcare at the Polyclinics (including preventative healthcare, immunization, Fast Track and laboratory services); Hospital services include spending on the state-run Queen Elizabeth Hospital, Psychiatric Hospital and the Emergency Ambulance Service while the Pharmaceutical Programme includes funds allocated to the national drug service

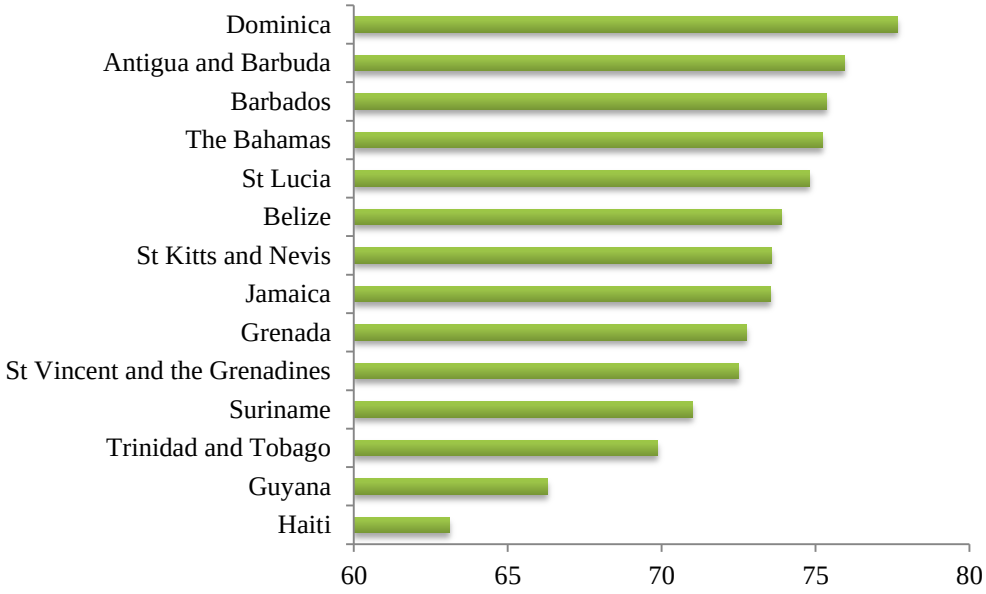
Hence, this current study contributes to the literature by heeding Belgrave and Craigwell's (1995) advice to disaggregate the effects of spending on various health services on economic activity in an attempt to further clarify the relationship and reconcile the seemingly contradictory results derived from the aforementioned studies. Further, simulations conducted by the Canadian Health Services Research Foundation (2012) have indicated that increased immunization of the elderly could significantly reduce the number of visits made to medical doctors and in fact would save the public health system millions of Canadian dollars annually. In this light, a reallocation of public spending may not only increase health and life expectancy outcomes, but reduce government's healthcare budget requirements. Thus, the results of this study's optimization exercise are sure to provide guidance to policymakers on the ideal allocation of spending given current budgetary constraints.

The rest of the paper is structured as follows: Section 2 provides a brief overview of the structure of the Barbadian healthcare system, while Section 3 presents the methodology and data used in the study. Section 4 presents and discusses the results, and Section 5 concludes with policy implications and considerations.

OVERVIEW OF THE BARBADIAN HEALTHCARE SYSTEM

Barbados' national healthcare system has put the country among the leaders of the pack in terms of life expectancy and overall quality of healthcare in CARICOM (see Figure 1) and has contributed to its high ranking in the UNDP's Human Development Index (HDI). The island's population benefits from low rates of infant mortality (7.3 deaths per 1,000 births), while the Ministry of Health has eradicated the presence of several diseases via widespread vaccination (Ministry of Finance and Economic Affairs, 2014).

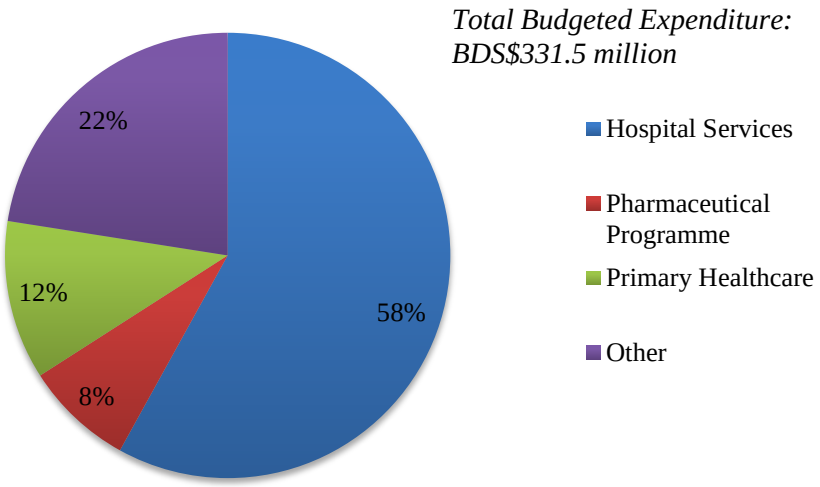
Figure 1: 2013 Life Expectancy at Birth in Selected CARICOM Countries (Years)



Source: UNDP 2014 Human Development Report

All toll, the healthcare system offers primary, secondary and tertiary healthcare services, delivered by both the public and private sectors (Rodney and Copeland, 2009), and Figure 2 illustrates the distribution of the public healthcare budget by major segment. In sum, of a total healthcare budget of $331.5 million, spending on the Pharmaceutical programme, Hospital services and Primary healthcare are expected to account for the lion share of spending during government's current fiscal year 2015/2016. Thus, as a result of the major roles that these segments play in the provision of healthcare and the significant share of the public healthcare budget which they account for, this paper chooses to focus on public spending for Primary healthcare, Hospital services and the Pharmaceutical programme. This section delves deeper into the respective roles these services play in maintaining a healthy population.

Figure 2: 2015/2016 Budgeted Public Health Expenditure by Major Segment



Source: 2015/2016 Draft Estimates of Revenue and Expenditure of Barbados

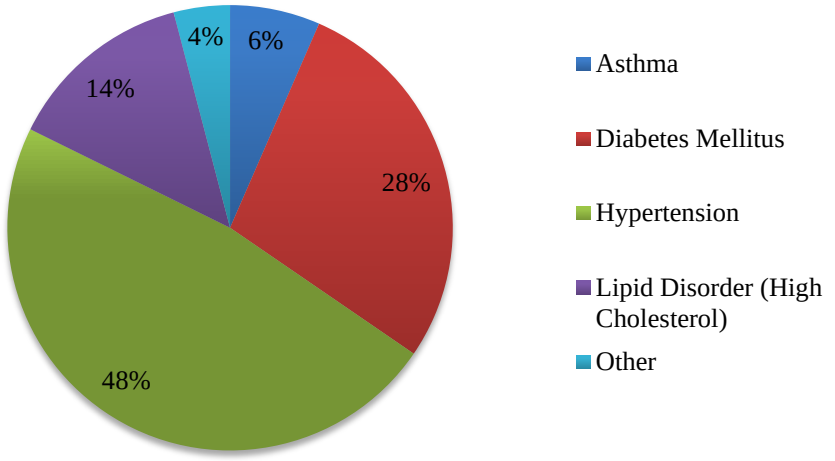
Primary Healthcare

Since 1976, the Barbadian government has committed to developing a primary healthcare service driven by the provision of decentralized medical care via an expansive network of polyclinics and other satellite clinics (Rodney and Copeland, 2009). These eight polyclinics, located in/near the capital city and other easily accessible and densely populated catchment areas "…provide care through comprehensive clinical and community services…" (Ministry of Finance and Economic Affairs, 2014), and these services are supported by the provision of private care by doctors who are the first points of contact for at least half of the general populous (Rodney and Copeland, 2009). Specifically, these services include "…maternal and child health, adolescent health, community mental health, dental health, nutrition, general practice clinics, and environmental health services" (Pan American Health Organisation, 2007). To date, the polyclinics have been successful in mitigating the presence of many chronic and sometimes fatal diseases which have the potential to significantly reduce labour productivity. In fact, in 2013 Barbados recorded no cases of measles, yellow fever, polio, rubella, neonatal tetanus or

congenital rubella syndrome and received the Caribbean Public Health Agency shield for "…excellent surveillance for immunization diseases…" (Ministry of Finance and Economic Affairs, 2014).

However, the proliferation of non-communicable diseases (NCDs) in Barbados has placed additional burdens on primary healthcare centres and by extension, the public healthcare budget. In fact, the Prime Minister, the Rt. Honourable Freundel Stuart opined that by 2011, the economic burden of NCDs accounted for over 5.3% of GDP (Ministry of Finance and Economic Affairs, 2012). Figure 3 shows that in 2012, cases of Hypertension, Diabetes Mellitus, and Lipid Disorder accounted for 89% of public attendances across polyclinics.

Figure 3: 2012 Distribution of Public Attendances at Polyclinics (%)



Source: Barbados Economic and Social Report, 2013

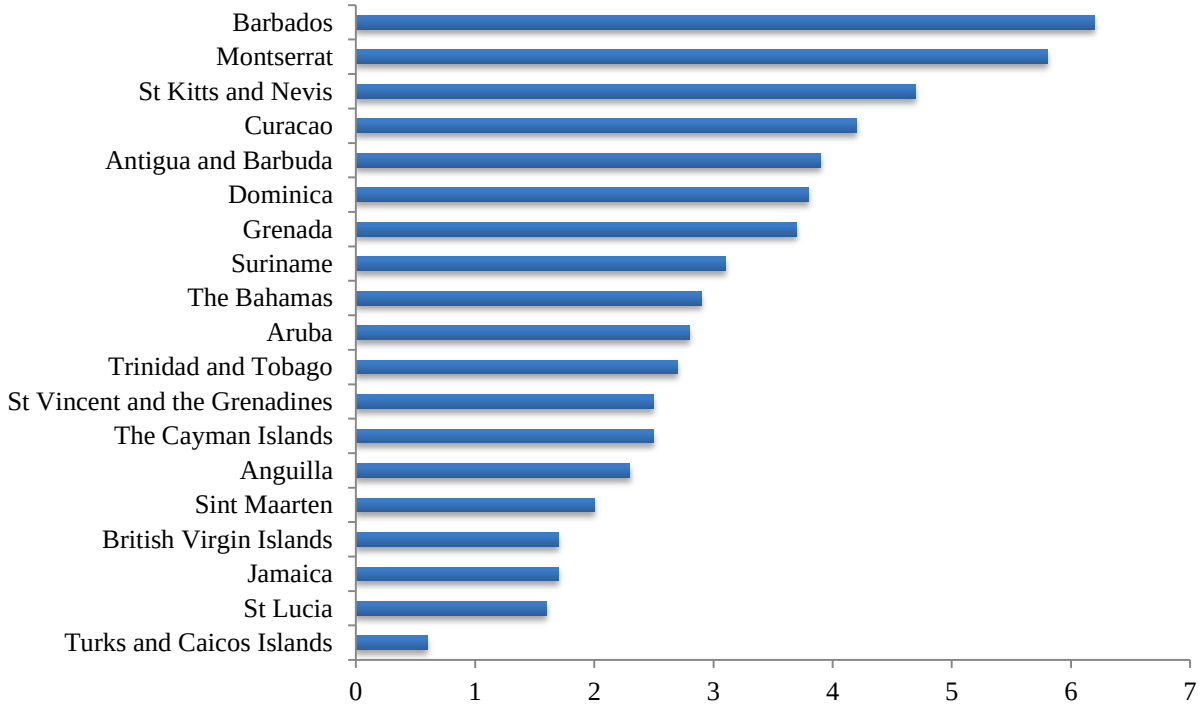
As such, the government of Barbados has placed additional emphasis on combating the propagation of NCDs including training for clinic staff at the polyclinics and community outreach intended to educate citizens on the benefits of healthy lifestyles (Ministry of Finance and Economic Affairs, 2013). Most recently, the Minister of Finance has gone one step further and instituted a 10% excise tax on the pre-Value Added Tax price of sweetened drinks and juices in an effort to reduce domestic consumption (Ministry of Finance and Economic Affairs, 2015).

Hospital Services

The state-run Queen Elizabeth Hospital (QEH) offers services not provided by the polyclinics, while the Psychiatric and Geriatric hospitals cater to those with mental illnesses and the elderly respectively. The QEH delivers medicine, surgery, pediatrics, obstetrics and gynecology, accident and emergency, psychiatry, and oncology services and includes a capacity of approximately 510 beds (Pan American Health Organisation, 2007; Ministry of Finance and Economic Affairs, 2011). Additionally, several private healthcare centres, including the Bayview Hospital, the Sandy Crest Medical Centre and the FMH Emergency Medical Clinic

augment many of these services. In fact, relative to several other Caribbean countries, Barbados boasts the largest number of hospital beds per capita (see Figure 4).

Figure 4: Hospital Beds per 1,000 Persons in the Non-Latin Caribbean: 2010 – 2013 (%)



Source: Pan American Health Organisation

In response to rising usage of the QEH's Accident and Emergency (A&E) department for non-critical queries and complaints about the length of time patients must wait to be attended to upon arrival, the Ministry of Health has instituted measures to improve the delivery of service in this unit. In 1999, efforts were made to refer non-emergency patients to the nearby polyclinic, while the recently implemented Rapid Improvement Project has successfully reduced visits to the QEH (Pan American Health Organisation, 2007; Ministry of Finance and Economic Affairs, 2014). Like the polyclinics, the QEH has also felt the burden of the rising incidence of NCDs. In 2012, medicine, obstetrics, gynaecology, surgery and pediatrics were the hospital's most utilized in-patient services, with the high usage attributed primarily to the rise in these diseases and an increasingly aging population (Ministry of Finance and Economic Affairs, 2013).

The free, public emergency ambulance service, which covers all parishes on the island, also operates primarily from the QEH, with a smaller, satellite station catering mainly to the northern and central parishes (Brathwaite et al, 2012). Once again, private ambulance services supplement the public service. Nonetheless, significant inefficiencies remain present in the public system as Brathwaite et al. (2012) submit that almost one-fifth of calls to the emergency ambulance system between January and September 2005 resulted in no patients being transported. The primary reasons cited included cancelled calls, (particularly by patients who waited longer for the service to arrive), services refused, and patients who were eventually

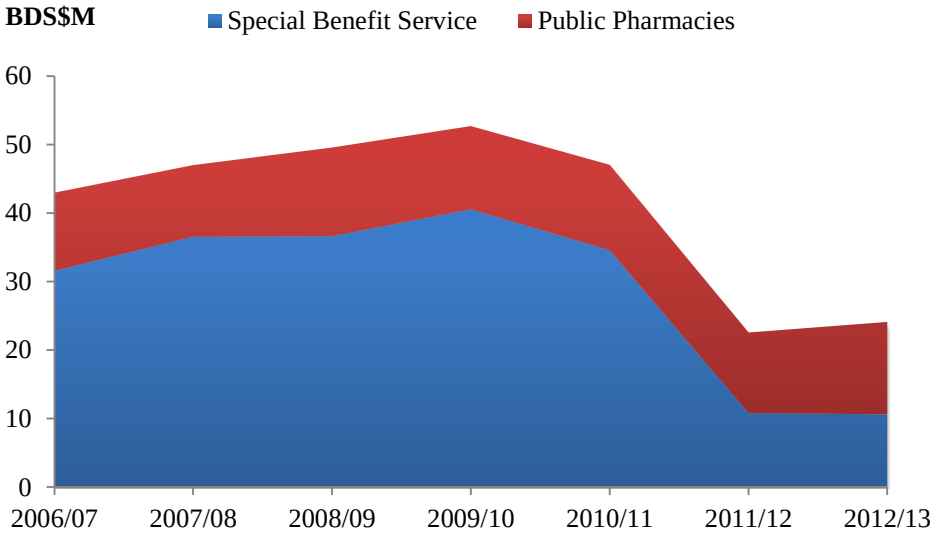
transported by other means. These non-transported calls incur a public cost with no corresponding benefit.

Pharmaceutical Programme/Barbados Drug Service

Up until recently, government, in addition to distributing drugs free of cost at public pharmacies and outpatient clinics, has leveraged the island-wide network of private pharmacies by subsidizing the provision of pharmaceuticals to children, the elderly and citizens suffering from hypertension, cancer, diabetes, glaucoma, asthma, and epilepsy (Pan American Health Organisation, 2007). Again, NCDs continue to pose a threat to the sustainability of this programme in its current form and were cited as a major strategic issue facing the Barbados Drug Service as early as 2006 (Ministry of Economic Affairs and Development, 2007).

The free provision of drugs has also encouraged increased usage of the system, evidenced by the escalating volume and value of subscriptions filled under the Special Benefit Service administered via the private pharmacies. Between 1992/93 and 2010/11, the total value of prescriptions filled via the Special Benefits Service increased from BDS$6.3 million to BDS$34.6 million, as both the volume and cost per prescription increased over that period. However in April 2011, to combat the rising cost of providing quality drugs to citizens, government introduced a dispensing fee for all citizens accessing drugs from private pharmacies. As a result, expenditure on private sector-filled prescriptions declined to BDS$10.6 million by 2012/13 without a corresponding increase in drugs issued via the public pharmacy network (see Figure 5).

Figure 5: Value of Prescriptions Filled by the Barbados Drug Service



Source: Barbados Economic and Social Reports: 2009, 2013

METHODOLOGY AND DATA

Methodology

This study seeks to uncover the existence and nature of a long-run relationship between worker productivity and healthcare expenditures to determine an optimal allocation of government's healthcare budget. To do that, it leverages the Dynamic Ordinary Least Squares (DOLS) approach to ascertain the presence of cointegration among the relevant variables and applies these estimates within a non-linear optimization framework.

The DOLS framework permits the derivation of both long- and short-run parameter estimates within small samples such as that used in this paper, and is appropriate in cases where regressors are integrated of different orders. Within the long-run equation, it corrects for potential endogeneity between regressand and regressors and serial correlation of the residuals by applying leads and lags of the first differences of all non-stationary variables within the long-run model.

Equations (1) and (2) below outline the long- and short-run model specifications respectively of the DOLS framework. y_t and x_t denote the regressand and regressors respectively at time *t*, while $k_1$and k_2 represent the number of lead and lag lengths chosen. Further, β and δ_j capture the long- and short-run effects respectively of the independent variables on the respective dependent variables, while γ_j contains the coefficients on the lead and lagged variables in the long-run equation, and Δ is the first difference operator. Finally, u_t and v_t capture the white noise errors in equations (1) and (2) respective which are assumed to be identically and independently normally distributed with zero means and constant variances. u_{t-1} enters the short-run regression as an error correction term and ρ captures the speed of adjustment back to long-run equilibrium after a temporary shock. A condition of cointegration and the existence of a valid long-run relationship is that the linear combination of non-stationary regressors and regressand u_t is stationary and ρ is statistically significant and lies between 0 and -1.

$$y_t = \beta' x_t + \sum_{j=-k_1}^{+k_2} \gamma_j \Delta x_{t-j} + u_t \quad (1)$$

$$\Delta y_t = \alpha_0 + \sum_{j=1}^{k_2} \alpha_j \Delta y_{t-j} + \sum_{j=0}^{k_2} \delta_j \Delta x_{t-j} + \rho u_{t-1} + v_t \quad (2)$$

Having estimated the value of the long-run multipliers, the study then seeks to determine the optimal allocations of spending on Primary healthcare, Hospital services and the Pharmaceutical programme which will maximize national output per worker or minimize public spending while maintaining a specified level of labour productivity. The non-linear programming problem framework is defined as:

$$Min\ f(x) or\ Max - f(x)$$

subject to: $g_i(x) = c_1$

$$h_i(x) \leq c_2 or - h_i(x) \geq -c_2 \qquad with\ i = 1,2,\ldots,m$$

where $f(x)$represents the non-linear objective function to be minimized or maximized, $g_i(x) = c_1$ and $h_i(x) \leq c_2$are equality and inequality constraints with $c_1$and $c_2$as constant parameters and m measures the number of constraints in the problem. In this paper, each maximization and minimization problem is solved using the GRG non-linear engine available as part of the Solver add-in in Microsoft Office Excel 2010.

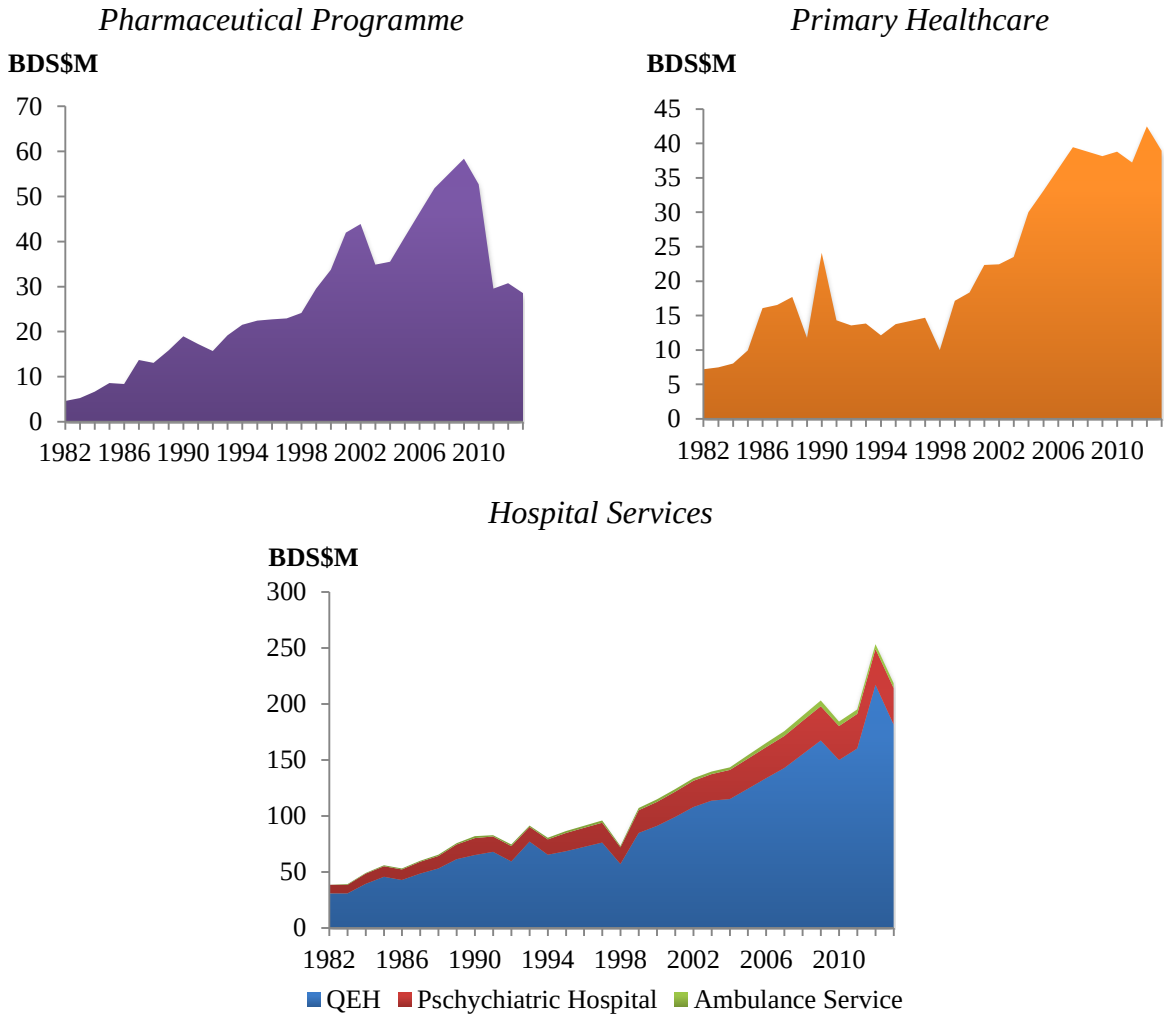
Data

The data used for this paper span the period 1982 – 2013 and comprise annual series of public health expenditures by category, Real Gross Domestic Product (GDP) per employed worker ($\frac{Y}{L}$), capital per employed worker ($\frac{K}{L}$) and public expenditure on education (*EDUCATION*). Government spending on Primary healthcare (*PRIMARY*), Hospital services (*HOSPITAL*) and the Pharmaceutical programme (*DRUG*) capture government's contribution to these areas of public healthcare over the period and are the main regressors of interest. At the same time, capital per employed worker captures the country's physical productive capacity as per the standard Cobb-Douglas production function while, in the absence of a long enough series on the literacy rate or the number of tertiary graduates, public spending on education proxies the knowledge component of human capital and is included in line with previous research in this area (see Carter, Craigwell and Lowe, 2013). The latter two series are included as control variables and each is expected to positively drive labour productivity.

Data on healthcare spending was sourced from the annual publications of the Barbados Estimates of Revenue and Expenditure, Real GDP per employed worker is calculated based on real GDP and total employed workforce from the Central Bank of Barbados' Online Statistics, while total capital is estimated from the capital accumulation equation $K_t = K_{t-1}(1-\delta) + I_t$ where K_t and K_{t-1} denote the capital stocks at time *t* and *t-1* respectively, I_t proxies annual investment and is proxied by real gross fixed capital formation sourced from the United Nations Statistics Division National Accounts Main Aggregates Database, and δ captures the annual average rate of capital depreciation, assumed to be 5% per annum. For the purposes of this paper, the initial stock of capital (K_0) was assumed to equal the level of real gross fixed capital formation in 1970.

Figure 6 confirms successive governments' continued commitment to funding healthcare services, as spending on the Pharmaceutical Programme, Hospital services and Primary healthcare increased from BDS$50.5 million during 1982/1983 to BDS$286.0 million by 2013/2014. Of note is the sharp rise in spending on primary healthcare, driven by additional funds allocated to expand the capacity of the island's polyclinics. Today, polyclinics account for 64% of government's Primary healthcare budget. However, despite the rising incidence of NCDs and large accumulated debts owed by the QEH (Ministry of Finance and Economic Affairs, 2015), the graph emphasizes that government has steadily made cuts to spending on the Pharmaceuticals programme and Hospital services (the single largest component of the healthcare budget) over the latter two to four years of the sample as it struggles to fund key social services via ever-depressed tax revenues.

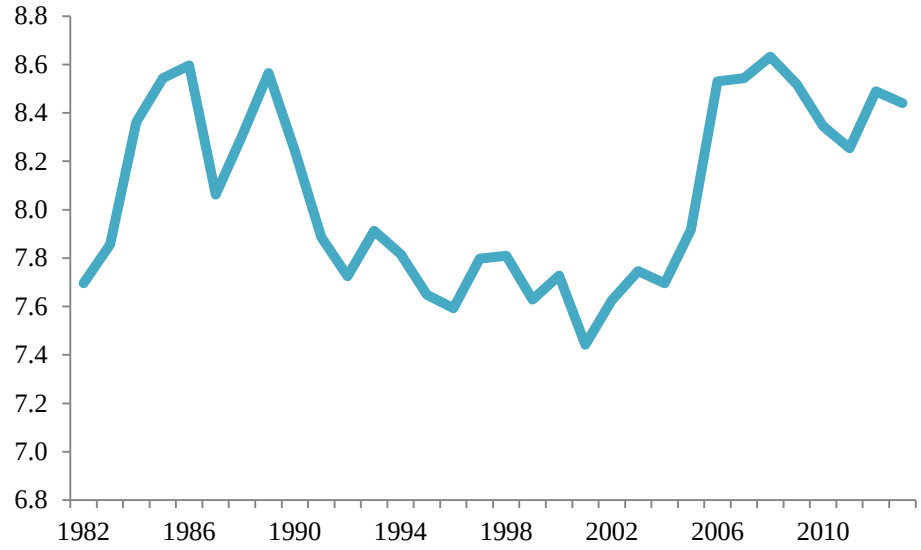
Figure 6: Public Health Expenditure by Selected Segments: Fiscal Years 1982 – 2013



Sources: Estimates of Revenue and Expenditure of Barbados(various years)

On the other hand, labour productivity has fluctuated over the period, falling steadily during the late 1980s, before remaining relatively flat during the decade that followed (see Figure 7). However, the advent of the 21st century and the rapid growth in economic activity associated with fiscal stimulus and preparation for the 2007 International Cricket Council Cricket World Cup boosted growth in output per worker, coinciding with the aforementioned surge in spending on primary healthcare. Further, after an initial decline in productivity after the 2008/2009 global financial meltdown, output per worker recovered marginally as the gradual decline in employment coincided with a virtually flat economic performance.

Figure 7: Real Gross Domestic Product by Employed Worker: 1982 – 2013



Sources: Central Bank of Barbados, Author's Calculations

For the purposes of the regression analysis, spending on the Pharmaceutical programme, Hospital services, Primary healthcare, and Education are deflated to real variables using the GDP deflator sourced from the United Nations Statistics Division National Accounts Main Aggregates Database. Additionally, all variables (regressand and regressors) enter equations (1) and (2) in logged form.

ESTIMATION & ANALYSIS OF RESULTS

Regression and Optimization Outcomes

To determine the presence or nature of any long-run relationship which may exist between two or more variables, at least two of those series must be non-stationary and integrated of the same order. Thus, formal Augmented Dickey Fuller (ADF) tests were conducted on all relevant variables and the results suggest that all series except $\log(DRUG)_t$ possessed unit roots and were integrated of order 1 (see Table 1 below). This latter finding, significant only at the 10% level, appeared unusual given the significant upward trend observed throughout most of the series in Figure 6 earlier. As a result, the baseline regression assumed that the series possesses a unit root and is integrated of order 1, and robustness checks conducted suggested that regression coefficient estimates were quantitatively similar to if treated as a stationary variable.

Table 1: Results of Augmented Dickey Fuller Unit Root Tests

Series	Levels	1st Difference
$\log(\frac{Y}{L})_t$	-1.747 (0.399)	-5.023 (0.000)***
$\log(\frac{K}{L})_t$	-1.196 (0.663)	-4.005 (0.004)***
$\log(EDUCATION)_t$	-1.583 (0.479)	-7.199 (0.000)***
$\log(DRUG)_t$	-2.691 (0.087)*	
$\log(HOSPITAL)_t$	-0.860 (0.787)	-8.036 (0.000)***
$\log(PRIMARY)_t$	-1.478 (0.531)	-8.767 (0.000)***

N.B. *,**,*** indicate statistical significance at the 10%, 5% and 1% levels respectively; p-values are in parentheses

Next equations (1) and (2) were estimated and results illustrated in Table 2. Overall, the long- and short-run regressions capture significant variations in GDP per worker and productivity growth, with adjusted R^2 of 80.0% and 62.4% respectively. Also important, the models' residuals exhibit no presence of serial correlation and non-normality. Finally, the negative and statistically significant coefficient on the lagged error correction term confirms the presence of cointegration and validates the existence of a long-run relationship between GDP per worker and the regressors.

In the long-run, the results suggest that capital per worker positively affects worker productivity, with a 1% increase prompting a 0.422% rise in GDP per worker, while public spending on education has no statistically significant impact on output per worker, but carries an unintuitive negative coefficient – a result also found by Carter, Craigwell and Lowe (2013) when modeling real output per capita. In the short-run, both variables maintain their respective signs, but spending on education now creates a near-term, significant drag on labour productivity.

The respective effects of the highlighted health expenditure variables on per worker output (assuming that $\log(DRUG)_t$ is integrated of order 1) provide some explanation for the inconclusive results reported by Belgrave and Craigwell (1995) and Carter, Craigwell and Lowe (2013). In the long-run, a 1% rise in spending on primary healthcare significantly boosts real GDP per worker by 0.18% as public immunizations and basic health services improve worker efficiency and effectiveness. However, while spending on both the Pharmaceutical programme and Hospital services create drags on national output per worker, only the former result appears statistically significant in this instance. In the short-term, none of the three health expenditure variables is effective in driving higher productivity implied by very small coefficients insignificantly different from zero. This suggests that the effects of these expenditures only yield material results over time. Finally, as a test of robustness, the regression is rerun with $\log(DRUG)_t$ treated as a stationary variable. The results appear quantitatively similar to the non-stationary case except that now the coefficient on real spending on Hospital services becomes statistically significant only at the 10% level.

Table 2: DOLS Results: Regressand – GDP per Worker

Regressors	Baseline: Assuming $\log(DRUG)_t$ is I(1)		Robustness Check: Assuming $\log(DRUG)_t$ is I(0)	
	Long-run	*Short-run*	*Long-run*	*Short-run*
CONSTANT	1.506 (0.000)***	-0.002 (0.713)	1.545 (0.000)***	-0.002 (0.703)
$\log(\frac{K}{L})_t$	0.422 (0.009)***	0.780 (0.000)***	0.427 (0.004)***	0.774 (0.000)***
$\log(EDUCATION)_t$	-0.145 (0.162)	-0.133 (0.011)**	-0.152 (0.124)	-0.136 (0.009)***
$\log(DRUG)_t$	-0.053 (0.048)**	-0.037 (0.149)	-0.050 (0.022)**	-0.037 (0.149)
$\log(HOSPITAL)_t$	-0.196 (0.130)	0.009 (0.855)	-0.202 (0.068)*	0.011 (0.829)
$\log(PRIMARY)_t$	0.181 (0.000)***	-0.007 (0.755)	0.183 (0.000)***	-0.008 (0.724)
ECM_{t-1}		-0.793 (0.001)***		-0.807 (0.001)***
Adjusted R^2	0.800	0.624	0.824	0.633
Jarque Bera Statistic	0.358	0.502	0.313	0.512
Breusch-Godfrey Serial Correlation LM Test F-statistic (1st lag)	0.619	0.158	0.686	0.128
Number of Leads per variable	1	0	1	0
Number of Lags per variable	0	1	0	1
Number of Observations	30	30	30	30

N.B. *,**,*** indicate statistical significance at the 10%, 5% and 1% levels respectively; p-values are in parentheses and standard errors are corrected for serial correlation using the Newey-West Heteroskedasticity and Autocorrelation Consistent Covariance (HAC) procedure

The estimated long-run coefficients were then applied to the non-linear programming framework to determine the most optimal allocations of the public healthcare budget under various scenarios. Scenarios 1, 2 and 3 hold the common assumption that government seeks to maximize national labour productivity subject to constraints on budgetary spend, while Scenario 4 assumes that government seeks to minimize the total amount spent on Primary healthcare, Hospital services and the Pharmaceutical programme while maintaining the current level of output per worker. The respective maximization and minimization frameworks are outlined below:

Maximize Real Output per Employed Worker

$$Max: e^{-0.053\times\log(DRUG)_t - 0.196\times\log(HOSPITAL)_t + 0.181\times\log(PRIMARY)_t + 2.719}$$

$$\text{subject to: } \ln\left(e^{\log(DRUG)_t} + e^{\log(HOSPITAL)_t} + e^{\log(PRIMARY)_t}\right) \leq \ln\frac{C_1}{Deflator} \quad \text{(a)}$$

$$\log(DRUG)_t \geq \ln\frac{C_2}{Deflator} \quad \text{(b)}$$

$$\log(HOSPITAL)_t \geq \ln\frac{C_3}{Deflator} \quad \text{(c)}$$

$$\log(PRIMARY)_t \geq \ln\frac{C_4}{Deflator} \quad \text{(d)}$$

Minimize Nominal Healthcare Expenditure

$$Min: Deflator \times e^{\ln(e^{\log(DRUG)_t} + e^{\log(HOSPITAL)_t} + e^{\log(PRIMARY)_t})}$$

$$\text{subject to: } \log(DRUG)_t \geq \ln \frac{C_2}{Deflator}$$

$$\log(HOSPITAL)_t \geq \ln \frac{C_3}{Deflator}$$

$$\log(PRIMARY)_t \geq \ln \frac{C_4}{Deflator}$$

$$-0.053 \times \log(DRUG)_t - 0.196 \times \log(HOSPITAL)_t + 0.181 \times \log(PRIMARY)_t + 2.719 = \ln C_5 \quad \text{(e)}$$

where C_1 represents the total, nominal budgeted expenditure for the Pharmaceutical programme, Hospital services and Primary healthcare, while C_2, C_3 and C_4 capture assumed minimum budgetary requirements for each of these segments respectively in millions of Barbados dollars. C_5 is the 2014 level of GDP per worker employed. The value 2.719 encompasses the value of the constant term from equation (1) and the result of $0.422 \times \log(\frac{K}{L})_t - 0.145 \times \log(EDUCATION)_t$ where capital per worker is assumed to remain constant at its 2013 level, and the nominal value of education, prior to deflating to real terms, is government's 2015/2016 budgeted expenditure of BDS$489.0 million. Table 3 below describes the four scenarios and the assumed values of each unknown, constant parameter.

Table 3: Non-linear Optimization Scenarios

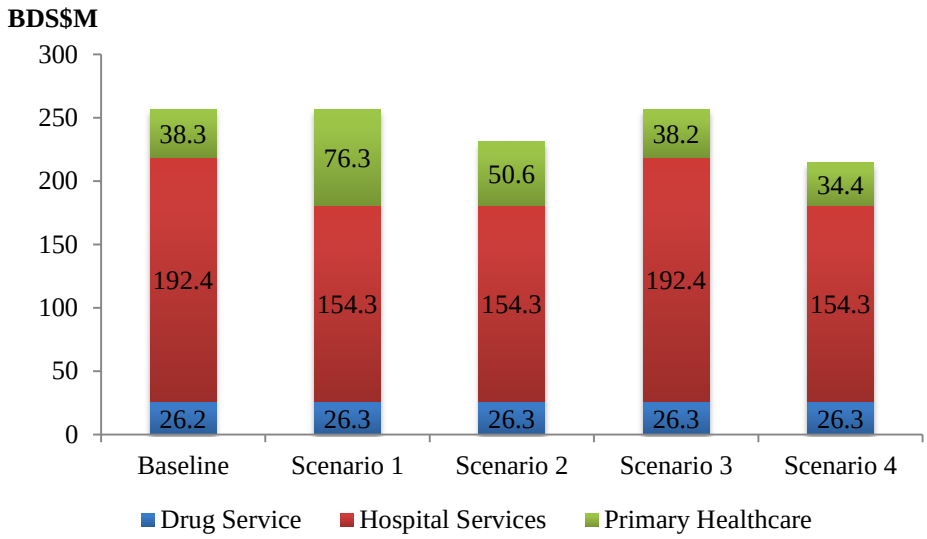
Scenario	Description	C_1	C_2	C_3	C_4	C_5
Baseline	Current budget allocations and GDP per worker projections based on regression model estimates	26.2	192.4	38.3	256.8	8.7
1	Minimum budgetary constraints for each segment based on minimum levels spent between 2005 and 2014	26.3	154.3	33.2	256.8	
2	Minimum budgetary constraints and a 10% reduction in the total healthcare budget	26.3	154.3	33.2	231.1	
3	Minimum budgetary constraints, but hospital services' outlay maintained at 2015/2016 budgetary levels	26.3	192.4	33.2	256.8	
4	GDP per worker fixed at 2014 level, minimum budgetary constraints for each segment remain	26.3	154.3	33.2		8.9

Figures 8 and 9 graphically illustrate the results of the non-linear optimization problems. The results suggest that under Scenarios 1 and 2, government is able to increase output per worker by approximately 18% and 10% by maintaining current expected expenditure to the pharmaceutical programme, reducing the budgeted allocation to Hospital services to the minimum level assumed under constraint (c), and reallocating those funds to Primary healthcare. Of note, under Scenario 2, government was able to cut its total budget by 10% and still enhance labour productivity by a similar factor. However, under Scenario 3, where government maintains current budgetary

allocations to the hospital, there is no scope for reallocation of resources and hence no opportunities to increase output per worker. Further, as under Scenarios 1 and 2, government's total healthcare budget constraint is binding as it uses all available resources.

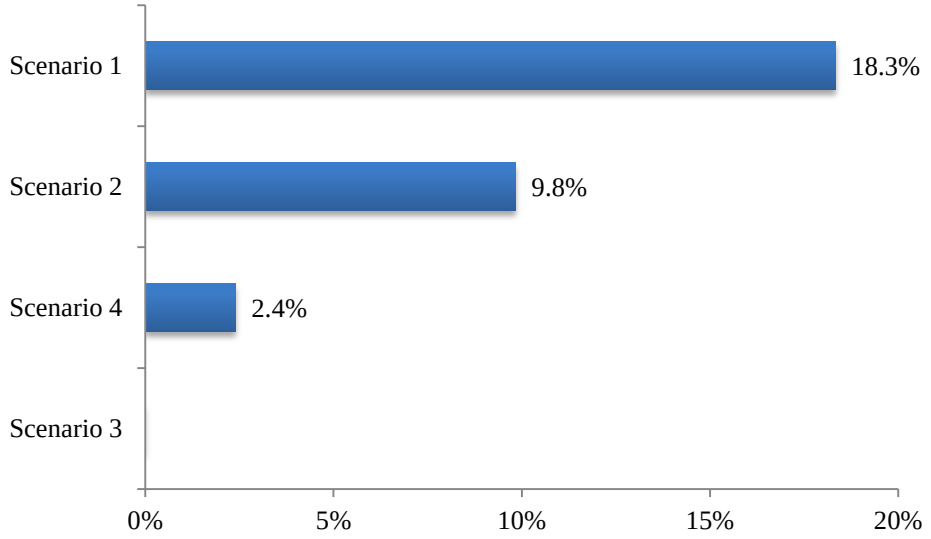
Finally, under Scenario 4, government can reduce its budget by 16% to BDS$215 million without compromising the current level of GDP per worker by cutting public funding for Hospital services by 20%, Primary healthcare by 10% and maintaining spending on the Pharmaceutical programme. However, it must be noted that while this scenario assumes that national output per worker remains stable, it does not speak to the effects on the overall quality of the provision of healthcare from this reduction, nor does it address the issues related to alternative funding of healthcare services.

Figure 8: Simulated Distributions of 2015/2016 Public Healthcare Expenditures by Category



Sources: Draft Estimates of Revenue and Expenditure 2015/2016, Author's Calculations

Figure 9: Percentage Change in GDP per Worker Employed Relative to Baseline



Sources: Author's Calculations

Discussion of Results

The results suggest that government is effective at stimulating improved worker productivity only through its spending on Primary healthcare services including the maternal and basic healthcare provided at the polyclinics and its nutritional and dental health programmes. These programmes ensure that children and adults alike have access to basic healthcare services and are immunized against the contraction of certain diseases which may have material effects on persons' abilities to work. To date, several of these diseases have been eradicated from the workforce and have likely played a great role in improving labour productivity in the process.

At the same time, spending on the QEH, psychiatric hospital and emergency ambulance services, which together account for 58% of the total budgeted healthcare spend for 2015/2016, has no positive effect on labour productivity. In fact, a 1% rise in spending on Hospital services potentially reduces output per worker by 0.20% over time. The QEH in particular, which alone accounts for 82% of this spending, has struggled to pay external suppliers, is saddled with large, outstanding payables (Ministry of Finance and Economic Affairs, 2015), and as mentioned in Section 2, now carries the additional burden of treating more patients for lifestyle-related, non-communicable diseases and providing free, yet expensive services to an increasingly aging population. Further, the aforementioned inefficiencies associated with the emergency ambulance service and the aging physical plant at the QEH (Ministry of Finance and Economic Affairs, 2015) suggest that public finances spent in these areas may not be as effective in generating the expected outcomes as previously hoped. This latter result is consistent with the findings of Balaji (2011) who found that corruption and inefficiencies limited the effectiveness of public healthcare spending in India.

Further, the negative effect of spending on the Pharmaceutical programme implies that inefficiencies may exist in this system, creating a drag on overall productivity. However, the size of the coefficient remains very small, as a 1% increase in real expenditure reduces output

per worker by just 0.05% over the long-run. Nonetheless, while government has already started to reduce its budgetary support to this area, these results suggest that the effect on overall economic activity should be negligible.

Finally, the results suggest that significant gains may accrue to the public healthcare system and national productivity by simply rebalancing the current distribution of expenditure with a larger percentage focused on the provision of Primary healthcare services and less allocated to the larger state-run hospitals. Given the QEH's current indebtedness and its role as the sole public provider of surgeries and other essential services, this reallocation may require some consideration and wider discussion about private healthcare financing and the role of national or private health insurance. Whatever the financing model chosen, the importance of public healthcare spending to overall quality of life should dictate that care should be taken not to compromise the quality of healthcare provided to Barbadians.

CONCLUSION

Over the past seven years, the government of Barbados has run persistently high fiscal deficits due to depressed revenues and stubbornly high expenditures. As a result, the provision of key social services such as free public healthcare has come under increased scrutiny. Thus, this paper estimated the relative long-run contributions of government's spending on Primary healthcare, Hospital services and the Pharmaceutical programme to real GDP per worker in Barbados over the period 1982 – 2013. In addition, the study determined optimal allocations of government's 2015/2016 healthcare budget to maximize GDP per worker over the long-run and minimize total healthcare spending.

The results suggest that government's spending on Primary healthcare positively influences labour productivity, but expenditure on Hospital services and the Pharmaceutical programme are potential drags on output per worker. As a result, a reallocation of finances from the Hospital services to fund the Primary healthcare system while simultaneously cutting total spending can yield long-term benefits to both productivity and overall economic growth. Hence, based on this analysis, recent budgetary cuts to both the QEH and the drug service should have no negative effects on overall labour productivity.

The implications of these results are clear: just improving the efficiency of government spending, particularly at the hospital and within the drug service can reduce government's fiscal burden and provide space to fund more productive projects without jeopardizing overall labour productivity. Further, this framework can prove a useful tool in determining future budgetary allocations given certain constraints and requirements.

Unfortunately, the study did suffer from one major limitation and surpassing this in future research may yield even more insightful results. The relatively short data set limited the number of variables which could practically be included in each regression and did not permit an investigation of the effects of each segment of expenditure on output per worker over a considerably longer time period. In fact, if possible, this research should be extended to understand whether the relative contributions of each expenditure item have indeed evolved over

time, particularly given a major policy shift in 1976 when government committed to providing island-wide primary healthcare.

Notwithstanding these limitations, the findings that spending on the hospital and drug service, two key components of the healthcare system, do not add to labour productivity require additional research to better understand the underlying reasons behind this before government goes about cutting budgetary support to both services. Further, if cuts are to be made, government needs to carefully determine which specific services will be affected, whether they will be provided in future and if so, under what financing arrangements. These are issues which require more than an economic view of the problem and thus later studies should account for the social impacts which these cuts may have on the population, particularly the most vulnerable in society. Finally, while not a major focus in this study, the finding that real education expenditure, though not statistically significant, negatively impacts output per worker is worthy of further investigation and perhaps greater insight can be had if the quality and level of education spending is accounted for.

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