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Public HEs, diminishing returns, and life expectancy in Latin American and Caribbean countries: a panel data analysis

Gasto público em saúde, retornos decrescentes, e a expectativa de vida nos países da América Latina e do Caribe: uma análise com dados em painel

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ABSTRACT

Introduction: The healthcare literature supposes the health status as a production function composed by economic, demographic and epidemiological factors. According to Grossman' health production model, the health status should experience diminishing returns to increases in those factors. **Objective:** The goal of this study is to examine whether the life expectancy at birth experiences diminishing returns to increases in fiscal healthcare expenditures using Latin American and Caribbean countries data. **Method:** To analyze non-linear specifications between life expectancy at birth and public spending on health, we used different panel data settings with annual data. **Results:** Unlike a previous finding for this region, the main outcome is that life expectancy at birth presents diminishing returns to increases in public spending on health, which is consistent with Grossman's health production framework. **Conclusion:** The evidence indicates that life expectancy at birth is less sensitive to changes of public health expenditures, showing diminishing returns. This found might be used as an input to make better decisions on fiscal sources allocation to health.

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Palavras-chave:
modelos econométricos, financiamento governamental, gastos em saúde

RESUMO

Introdução: A literatura da assistência médica supõe que o estado de saúde é uma função de produção composta por fatores econômicos, demográficos e epidemiológicos. De acordo com o modelo de produção de saúde de Grossman, o estado de saúde deve experimentar retornos decrescentes nos aumentos nesses fatores. **Objetivo:** O objetivo deste estudo é analisar se a expectativa de vida ao nascer experimenta retornos decrescentes à causa dos aumentos nos gastos públicos em saúde utilizando dados de países da América Latina e do Caribe. **Método:** Para analisar especificações não-lineares entre a expectativa de vida ao nascer e gastos públicos em saúde, foram utilizados diferentes configurações de dados de painel e dados anuais. **Resultados:** Ao contrário de um achado anterior para esta região, o principal resultado é que a expectativa de vida ao nascer apresenta rendimentos decrescentes nos gastos públicos em saúde, o que é consistente com o modelo de produção de saúde de Grossman. **Conclusão:** As evidências indicam que a expectativa de vida ao nascer é menos sensível a alterações dos gastos públicos em saúde, mostrando retornos decrescentes. Este achado pode ser usado como um insumo para tomar melhores decisões sobre as alocação de recursos públicos em saúde.

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Introduction

According to the World Health Organization (WHO, 2010), the health care systems of many countries face funding problems and poor allocation of fiscal resources. These problems are present not only in poor countries but also in developed countries, such as Spain, Portugal, and Greece, where recent economic crises have put pressure on their fiscal budgets. In addition, according to the WHO, in many countries between 20 and 40 percent of the fiscal budget for health care is wasted. Such difficulties seem to threaten improvements in the health status of those countries, which, in consequence, will decrease the well-being of the population.

According to Rivera and Currais (2005), life expectancy at birth (LE) is the most commonly used measure of health status. Most of the outcomes indicate that the effect of public health care on LE is small, which means that large increases in the fiscal health care budget do not matter when it comes to increasing the health status. The outcomes of previous literature are consistent with Grossman (1972), who set a non-linear relationship between medical expenses and days of life.

The goal of this study is to examine, using Latin American and Caribbean (LAC) countries, whether the LE experiences diminishing returns due to increases in public HEs. Unlike Meza-Carvajalino and Isaza-Castro (2006), we use non-linear specifications in panel data settings for the annual data of 27 LAC countries. The analysis of this data is interesting because LAC countries have always faced restrictions on fiscal spending due to economic struggles and related inefficiencies in the public sector, which have resulted in poor allocation of fiscal resources.

Our main finding was that LE is not sensitive to changes in public HEs; in other words, LE is inelastic in response to increases in fiscal spending on health. This outcome is consistent with the results obtained by Lichtenberg (2004), Self and Grabowski (2003), Akinkugbe and Mohanoe (2009), Akkoyunlu *et al.* (2009) and Yaqub *et al.* (2012). The evidence found might be used as an input to make better decisions on fiscal sources allocation.

The second section provides a review of the previous empirical literature on this topic. The third section explains the methodology and presents the data. The fourth section presents the results. The last section concludes.

Relevant literature

Grossman (1972) was the first one who used a non-linear model to interpret the relationship between HE and LE using US data. He found a small response of the health. Using US data and non-linear models, as well, Lichtenberg (2004) and Akkoyunlu *et al.* (2009) found similar outcomes. Specifically, the coefficients fluctuated between 0.0052 and 0.011, showing decreasing returns on health care production.

Table 1 summarizes empirical literature that analyzes the effects of fiscal spending on health and LE. Using non-linear specifications, Self and Grabowski (2003), Lichtenberg (2004), Akinkugbe (2005), Akkoyunlu *et al.* (2009), Akinkugbe and Mohanoe (2009) and Yaqub *et al.* (2012) reported an inelastic relationship between public HEs and LE, where the coefficients were between -0.4 and 0.45. Likewise, using OECD data, Frech III and Miller (1999), Shaw *et al.* (2005), Caballer-Tarazona and Barrachina-Martínez (2006), Adams (2008), Joumard *et al.* (2008), Cantarero-Prieto and Pascual-Sáez (2009), Schoder and Zweifel (2011) and Baltagi *et al.* (2012) also reported an inelastic relationship between total HE and LE.

In addition, for Eastern Mediterranean, Sub-Saharan Africa and LAC countries, Iacobuta (2012) and Bayati *et al.* (2013),

Table 1. Studies of the effects of public health spending on life expectancy at birth

Authors	Sample	Period	Specification	Effect
Self and Grabowski (2003)	191 countries	1960-1985 1997	Log-log model	Positive less than 1- bigger for mid and low income countries
Lichtenberg (2004)	US	1960-2001	Log-log model	Positive less than 1
Akinkugbe (2005)	45 SSAC* and 12 MENAC†	1980-2003	Log-log model	Positive less than 1 for SSAC and positive greater than 1 for MENAC
Akinkugbe and Mohanoe (2009)	Lesotho	1980-2001	Log-log model	Positive less than 1
Akkoyunlu, Lichtenberg, Siliverstovs and Zweifel (2009)	US	1960-2001	Log-log model	Positive less than 1
Novignon, Olakojo and Nonvignon (2012)	44 SSAC	1995-2010	Log-log model	Positive greater than 1
Yaqub, Ojapinwa and Yussuff (2012)	Nigeria	1980-2008	Log-log model	Negative less than 1

*Sub-Saharan African countries; †Middle East and North African Countries.

Fayissa and Gutema (2005) and Novignon *et al.* (2012), and Greenidge and Stanford (2009) obtained similar inelastic effect which varied between -0.006 and 0.697. It is important to point out that for private HE, Lichtenberg (2004), Halicioglu (2011) and Novignon *et al.* (2012) found that it is inelastic and positively affected the health status reporting coefficients around 0.0087 and 0.528. However, Akinkugbe (2005) and Novignon *et al.* (2012) found a positive and increasing effect of public HEs on LE, showing elasticities between 0.983 and 1.314.

Finally, using linear specifications, Obrizan and Wehby (2012) obtained a magnitude of 0.351, showing an inelastic outcome of public HE on LE. However, Meza-Carvajalino and Isaza-Castro (2006) and Obrizan and Wehby (2012) reported that public HEs had a positive and increasing relationship on LE, getting coefficients between 1.047 and 1.135.

Methodology and data

Model Specification

Following previous empirical literature, we set the following non linear specification:

$$LE_{it} = \beta_0 PHE_{it} + \sum_j \beta_j X_{jit} + \mu_i + \delta_t + \varepsilon_{it}$$ [A]

Where LEit is the LE for country i (for all, i: 1,2,3,…,N) at time t (for all, t: 1,2,3,…,T) in logs; PHEit is the public HEs-GDP for country i at time t in logs; Xjit is the set of control variables at time t for country i, for all j: 1,2,3,4,5, µi is an unobserved country-specific effect, dt is an unobserved time-specific effect, and eit is the error term at time t for country i. Time dummies are included to control political and/or macroeconomic effects for all countries in a particular year.

Previous empirical literature[B] identifies that the most-used control variables are: real GDP per capita growth rate, literacy rate, urban population, CO_2 emissions and kilocalories. However, for the period of analysis, kilocalories and literacy rate are not available. In addition, school enrollment rate, which in some studies is used instead of literacy rate, is not available either. Instead, we use the food production per capita index as a variable proxy for kilocalories. Fayisa and Gutema (2005) and Halicioglu (2011) indicate that this index captures food availability, and Self and Grabowski (2003) mention that it could determinate the nutrition of a population, factors that affect population health.

Likewise, instead literacy rate, we used the fertility rate.[C] According to Becker, Murphy and Tumura (1994), higher fertility rates increase the discount rate on the per capita future consumption, which discourages investment in the human capital and physical capital, in other words, the degree of altruism per child is negatively related to the number of children[D], so, higher fertility rate should negatively impact the health status of a country. In addition, Parra (2014) mentioned that educational policies adopted in some Latin-American countries have decreased the fertility rate. He mentioned that as women's educational level increases, they are more aware of children health and nutrition. This redounds in a reduction in infant mortality and an increasing of quality of life that eventually increases the national production. Finally, all control variables but real GDP per capita and food production per capita are in logs. Those variables are in first differences.

In [1], b0 represents the elasticity of LEit with respect to PHEit. In other words, this coefficient is the ratio of the percent change in LEit to the percent change in PHEit. When b0 is less than 1, it means that the LE is inelastic to changes in PHE; when b0 is equal to 1 there is a unitary elasticity; and when b0 is greater than 1, it means that LE is elastic to changes in PHE. In our specification, the expected value of b0 is positive and less than 1 because, according to Grossman (1972), LE is less sensitive to changes in PHE. In other words, LE presents diminishing returns due to increases in PHE.[E]

For control variables, the expected effect of real GDP per capita growth on LE is ambiguous because it has seemed that higher incomes allow people to afford better medical services, but, on the other hand, people in high-income countries could also adopt unhealthy lifestyles such as increasing the consumption of alcohol, cigarettes, and fatty foods (Fayissa *et al.* 2005). In addition, food production growth has a positive impact on life expectancy. For CO_2 emissions, the expected sign is mostly negative for developed countries, even though Greenidge and Stanford (2009) found that CO_2 has a negative impact on life expectancy in LAC countries. Likewise, the expected sign of the coefficient of the urban population is ambiguous because the large urban zones not only have large hospitals and good health services but also include criminality, pollution, etc.

Data

The dataset is an unbalanced panel of 838 observations over the period 1970-2010 for the following 27 countries: Antigua and Barbuda, Argentina, The Bahamas, Belize, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, El Salvador, Guatemala, British Guyana, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru, Saint Lucia, Saint Vincent and the Grenadines, Suriname, Trinidad and Tobago, Uruguay

A The magnitudes of the coefficients fluctuated between -0.015 and 0.652.

B Fayissa and Gutema (2005), Shaw *et al.* (2005), Meza-Carvajalino and Isaza-Castro (2006), Greenidge and Stanford (2009) and Halicioglu (2011).

C The fertility rate is not a measure of health status because, according to WHO, some measures of health status are: life expectancy, mortality, maternal and infant mortality, morbidity, infant health, and dental health.

D This notion is based in the dynastic families utility function of Becker and Barro (1988) where parents are altruistic toward their children. Parent altruism determines the discount rate across generations, which declines as the fertility rate increases.

E Some studies report a negative impact of public health care spending on life expectancy.

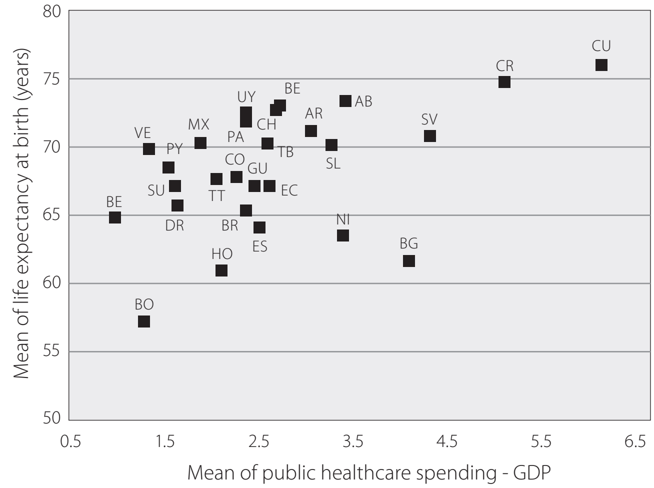
and Venezuela. The World Bank provides LE (years), fiscal health care spending-to-GDP ratio, real GDP per capita (2005 US dollars), fertility rate, urban population (% of total population) and CO_2 emissions (metric tons per capita). The Food and Agriculture Organization (FAO) provides the food production per capita index (2004-2006=100). All variables are converted in logs. The growths of real GDP per capita and the food production per capita are calculated as the first difference in real GDP per capita and food production per capita index, respectively. Table 2 shows the panel unit root tests, which indicates that we are dealing with stationary series.

On average, Figure 1 shows the relationship between LE and PHE per country Cuba and Costa Rica achieve the highest levels of both LE and public spending on health. In addition, Bolivia and Peru show the lowest public HEs. Bolivia and Honduras present the lowest LE. Likewise, Antigua and Barbuda, Argentina, Bahamas, Belize, Chile, Mexico, Panama, St Lucia, and Uruguay achieve a life expectancy of over 70 years with levels of HE around 3%. In contrast, with high levels of public healthcare, British Guyana and Nicaragua feature a low LE. For a few countries, such as Antigua and Barbuda, Argentina, Cuba, Costa Rica, British Guyana, Nicaragua, and Saint Vincent and the Grenadines, the public expenditure on health is over 3%.[F]

Table 2. Panel unit root tests [P-Values]

	IPS	ADF	PP
Life expectancy at birth in logs	0.0002	0.0000	0.0000
Public health spending-GDP in logs	0.0408	0.0242	0.0864
Real GDP per capita growth	0.0000	0.0000	0.0000
Fertility rate in logs	0.0000	0.0000	0.0000
Urban population in logs	0.0000	0.0030	0.0000
Food production per capita growth	0.0000	0.0000	0.0000
CO_2 emissions per capita in logs	0.0001	0.0000	0.0000

Notes: IPS stands for Ip, Pesaran and Shin, ADF stands for Augmented Dickey Fuller, and PP stands for for Phillip Perron. For IPS, the null hypothesis is all panels contain unit roots, and the alternative hypothesis some panels are stationary. For ADF and PP, the null hypothesis is all panels contain unit roots and the alternative hypothesis is at least one panel is stationary. For all tests, the lag length is one.



AB: Antigua and Barbudas; AR: Argentina; BE: Belize; BO: Bolivia; BR: Brazil; BG: British Guyana; CH: Chile; CO: Colombia; CR: Costa Rica; CU: Cuba; DR: Dominican Republic; EC: Ecuador; ES: El Salvador; GU: Guatemala; HO: Honduras; MX: Mexico; NI: Nicaragua; PA: Panama; PY: Paraguay; PE: Peru; SL: Saint Lucia; SV: Saint Vincent and the Grenadines; SU: Suriname; TB: The Bahamas; TT: Trinidad and Tobago; UY: Uruguay; VE: Venezuela.

Figure 1. Life Expectancy at birth & Public Healthcare Expenditure- Across LAC countries

Outcomes

Table 3 shows a set of estimates using Equation [1].[G] All coefficients of PHE are significant. For the pooled OLS specification, b0 is positive less than one, which means that if HE increases by 1%, LE increases by almost 0.012%. Including fixed effects, the coefficient of PHE is positive less than one as well. In this case, if PHE increases by 1%, LE increases by almost 0.006%. However, this setting does not includes time-specific effects because the use of the Driscoll-Kraay method to solve autocorrelation and heteroskedasticity problems for unbalanced panel data does not allow the inclusion of those effects.

For feasible generalized least squares (FGLS), the coefficient of PHE is positive close to zero. In this case, if PHE increases by 1%, LE increases by almost 0.004%. Individual fixed and time effects are included; however, here the shortcoming is that we are only allowed to assume heteroskedasticity due to the unbalanced panel data. Likewise, for generalized method of moments GMM in which there is dynamic panel data including a lag in LE, the coefficient of HE is 0.003, which is almost similar to the coefficients mentioned above. The GMM estimator is the most consistent and efficient estimator. Finally, using an iteratively reweighted least-squares (IRLS) specification to account for outliers, the coefficient of PHE is still 0.003. Individual fixed and time effects are included here as well.

F Currently, Antigua and Barbuda, British Guyana, Costa Rica, Cuba, Saint Vincent and the Grenadines, The Bahamas, Trinidad and Tobago, and Uruguay have integrated public health care systems. In addition, Belize, Bolivia, Dominican Republic, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru, Saint Lucia, Suriname, and Venezuela have segmented health care systems, which are usually financed by the government, employees, and employers (Giedion et al. 2010). Argentina, Chile, and Colombia have a mixture of regulated and contract-intensive systems. Finally, Brazil is the only country with a public, unified contract health care system.

G Using the Breusch-Pagan LM test of independence, we did not detect cross-dependence. In addition, there was no collinearity either.

Table 3. Estimates- Dependent variable: Life expectancy at birth in logs

Regressors	Pooled OLS (i)	Fixed effects (ii)	FGLS (iii)	GMM (iv)	IRLS (v)
Public health spending-GDP in logs	0.012‡	0.006†	0.004‡	0.003*	0.003‡
	(0.003)	(0.002)	(0.001)	(0.001)	(0.001)
Real GDP per capita growth rate	0.001†	-0.0001	0.00002	0.0001	0.0002*
	(0.0004)	(0.0003)	(0.0001)	(0.0001)	(0.0001)
Fertility rate in logs	-0.18‡	-0.141‡	-0.11‡	-0.004	-0.12‡
	(0.008)	(0.01)	(0.006)	(0.006)	(0.007)
Urban population in logs	0.046‡	0.21‡	0.18‡	-0.007	0.01‡
	(0.005)	(0.017)	(0.009)	(0.01)	(0.007)
Food production per capita growth rate	-0.002	0.02*	0.012‡	0.002	0.02†
	(0.028)	(0.012)	(0.007)	(0.002)	(0.01)
CO_2 emissions per capita in logs	0.004	0.012‡	0.008	-0.002	0.003
	(0.002)	(0.005)	(0.003)	(0.003)	(0.003)
Lag of life expectancy at birth in logs				0.96‡	
				(0.024)	
R-squared	0.66	0.83			0.97
Joint significance-p-values	0.0000	0.0000	0.0000	0.0000	0.00000

Notes: Standard errors in parenthesis. For (i), robust standard errors, and for (ii) Driscoll-Kraay standard errors. (iii), and (v) include individual fixed and time effects. For (iii), heteroskedasticity is assumed. For (iv), instruments for differenced equation: Public health spending in logs, real GDP per capita in logs, fertility rate in logs, Urban population in logs, food production per capita growth rate, CO_2 emissions metrics tons per capita in logs. In addition, fixed effects and the time effects are wipe out because the equation 2 is run in first differences. For (i), (ii), (v), the joint significance is using a F-test, and, for (iii) and (iv), the joint significance is using a chi-square test. ‡ Significant at 1%, † significant at 5%, and, * significant at 10%.

Likewise, the coefficient of real GDP per capita growth is almost zero, and in most cases is not significant. The coefficient of fertility rate is negative and, for almost all specifications, is significant. The effect of urban population on LE is positive and significant for almost all specifications. Likewise, CO_2 emissions and food product per capita present mixed results, mostly positive but in some cases significant. Regarding CO_2 emissions, we find different outcomes from Greenidge and Stanford (2009), who reported random effects. All coefficients are between zero and one in absolute value.

For robustness checks, we use non-overlapping 4-year averages of the data for each country to reduce the possibility of measurement errors in annual data for developing countries. Besides, averaged data is useful for analyzing the medium-term effects of fiscal health care spending on LE. In this dataset, there are 225 observations for 27 LAC countries and 10 periods. In addition, as another measure of health status, we use mortality rate instead of LE, and, in this case, we analyze the effect of public HEs on mortality rates. Finally, we use a sub-sample to get a balanced panel data. For the period 1995-2009, the sub-sample includes Antigua and Barbudas, Bolivia, Chile, Costa Rica, Cuba, El Salvador, Mexico, Panama, Paraguay, Peru, and St. Lucia.

Table 4 reports the results of the averaged data. The outcomes indicate that LE is still positive and less sensitive to increases in public spending on health, although the coefficient is not significant in all cases. In this specification, the GMM estimator is not significant. The results of averaged data indicate that PHE does not affect LE in the medium-term. In addition, Table 5 reports the outcomes for the mortality rate as a health status measure. These results are similar to those reported above. As we expected, the mortality rate has a small negative response to increases in fiscal health care spending; in other words, the mortality rate is inelastic to changes in PHEs. Finally, using the sub sample, the estimation in Table 6, indicates that there is a small response of LE to PHE changes.

All outcomes indicate that health status measures are less sensitive to changes in fiscal spending on health. The results are consistent with the findings of Self and Grabowski (2003), Lichtenberg (2004), Akinkugbe (2005), Akkoyunlu *et al.* (2009), Akinkugbe and Mohanoe (2009) and Yaqub *et al.* (2012). Furthermore, LE presents diminishing returns due to changes in HE, which is consistent with Grossman's model, in which LE increases at decreasing rates.

The results for LAC countries in this study differed from those in Meza-Carvajalino and Isaza-Castro's (2006). They found that the public health spending coefficient was 1.047, which indicates that health care production functions almost present constant returns; in other words, LE increases constantly and indefinitely due to changes in public HEs. This discrepancy may be due to processes in natural logs, which allow the adjustment of LE with diminishing returns. In addition, Meza-Carvajalino and Isaza-Castro used a smaller sample of 13 countries over a period of 20 years. Similarly, Greenidge and Stanford (2009) found that, in a data range of 20 years, LE in LAC countries was less sensitive to changes in total (private plus public) HEs.

Table 4. Estimates-4-year average- Dependent variable: Life expectancy at birth in logs

Regressors	Pooled OLS (i)	Fixed effects (ii)	FGLS (iii)	GMM (iv)	IRLS (v)
Public health spending-GDP in logs	0.014†	0.008†	0.006‡	0.0005	0.004*
	(0.006)	(0.003)	(0.002)	(0.001)	(0.002)
Real GDP per capita growth rate	0.002	-0.001	0.0001	-0.0001	-0.00002
	(0.001)	(0.001)	(0.0003)	(0.0001)	(0.0004)
Fertility rate in logs	-0.168‡	-0.133‡	-0.11‡	-0.019	-0.132‡
	(0.016)	(0.01)	(0.013)	(0.015)	(0.014)
Urban population in logs	0.048‡	0.214‡	0.18‡	0.031†	0.165‡
	(0.005)	(0.017)	(0.017)	(0.015)	(0.015)
Food production per capita growth rate	-0.012	0.14†	0.096‡	0.033	0.13†
	(0.091)	(0.05)	(0.033)	(0.028)	(0.037)
CO_2 emissions per capita in logs	0.006	0.013‡	0.005	-0.004	0.003
	(0.005)	(0.004)	(0.005)	(0.005)	(0.005)
Lag of life expectancy at birth in logs				0.80‡	
				(0.06)	
R-squared	0.65	0.84			0.96
Joint significance-p-values	0.0000	0.0000	0.0000	0.0000	0.00000

Notes: Standard errors in parenthesis. For (i), robust standard errors, and for (ii) Driscoll-Kraay standard errors. (iii), and (v) include individual fixed and time effects. For (iii), heteroskedasticity is assumed. For (iv), instruments for differenced equation: Public health spending in logs, real GDP per capita in logs, fertility rate in logs, Urban population in logs, food production per capita growth rate, CO_2 emissions metrics tons per capita in logs. In addition, fixed effects and the time effects are wipe out because the equation 2 is run in first differences. For (i), (ii), (v), the joint significance is using a F-test, and, for (iii) and (iv), the joint significance is using a chi-square test. ‡ Significant at 1%, † significant at 5%, and, * significant at 10%.

Table 5. Estimates- Dependent variable: Mortality rate in logs

Regressors	Pooled OLS (i)	Fixed effects (ii)	FGLS (iii)	GMM (iv)	IRLS (v)
Public health spending-GDP in logs	-0.044‡	-0.04‡	-0.023‡	-0.002†	-0.032‡
	(0.012)	(0.005)	(0.003)	(0.003)	(0.001)
Real GDP per capita growth rate	-0.004‡	-0.002*	-0.001*	-0.0001	-0.001*
	(0.001)	(0.001)	(0.0003)	(0.0001)	(0.0004)
Fertility rate in logs	0.45‡	0.46‡	0.14‡	0.056‡	0.324‡
	(0.026)	(0.056)	(0.021)	(0.02)	(0.023)
Urban population in logs	-0.19‡	-0.1	0.017	0.007	0.103‡
	(0.014)	(0.076)	(0.022)	(0.01)	(0.024)
Food production per capita growth rate	0.11	-0.05†	-0.04*	-0.003	-0.036
	(0.09)	(0.024)	(0.021)	(0.004)	(0.029)
CO_2 emissions per capita in logs	-0.002	0.003	0.006	0.002	0.023**
	(0.01)	(0.03)	(0.008)	(0.006)	(0.009)
Lag of life expectancy at birth in logs				0.91‡	
				(0.03)	
R-squared	0.55	0.70			0.97
Joint significance-p-values	0.0000	0.0000	0.0000	0.0000	0.0000

Notes: Standard errors in parenthesis. For (i), robust standard errors, and for (ii) Driscoll-Kraay standard errors. (iii), and (v) include individual fixed and time effects. For (iii), heteroskedasticity is assumed. For (iv), instruments for differenced equation: Public health spending in logs, real GDP per capita in logs, fertility rate in logs, Urban population in logs, food production per capita growth rate, CO_2 emissions metrics tons per capita in logs. In addition, fixed effects and the time effects are wipe out because the equation 2 is run in first differences. For (i), (ii), (v), the joint significance is using a F-test, and, for (iii) and (iv), the joint significance is using a chi-square test. ‡ Significant at 1%, † significant at 5%, and, * significant at 10%.

Conclusions

The goal of this study was to examine whether LE experiences diminishing returns due to increases in fiscal HEs using data from Latin American and Caribbean countries. To accomplish this, we set non-linear specifications using a 41-year dataset. Consistent with the Grossman model, the evidence indicates that LE is less sensitive to variations in public HEs; in other words, LE presents diminishing returns due to increases in public spending on health care. The evidence found might be used as an input to make better decisions on fiscal sources allocation.

With limited fiscal resources, LAC countries should mainly focus on better management of those resources. This sug-

Table 6. Estimates sub-sample - dependent variable: life expectancy at birth in logs

Regressors	Pooled OLS (i)	Fixed effects (ii)	FGLS (iii)	GMM (iv)	IRLS (v)
Public health spending-GDP in logs	0.0307‡	-0.0021	0.0001*	0.0122†	0.0016
	(0.005)	(0.004)	(0.002)	(0.005)	(0.003)
Real GDP per capita growth rate	0.0001	-0.0001	-0.0001	0.0005†	-0.0001
	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)
Fertility rate in logs	-0.1015‡	0.038	0.013	-0.0261†	0.013
	(0.021)	(0.050)	(0.013)	(0.012)	(0.013)
Urban population in logs	0.0758‡	0.1682‡	0.1937‡	0.0092	0.1937‡
	(0.006)	(0.018)	(0.011)	(0.023)	(0.011)
Food production per capita growth rate	-0.048	-0.021	0.0178†	-0.01	0.0178†
	(0.040)	(0.018)	(0.009)	(0.013)	(0.009)
CO_2 emissions per capita in logs	0.0314‡	-0.006	0.0114*	-0.0049	0.0114*
	(0.005)	(0.013)	(0.007)	(0.012)	(0.007)
Lag of life expectancy at birth in logs				0.7244‡	
				(0.072)	
R-squared					
Joint significance-p-values					

Notes: Standard errors in parenthesis. For (i) and (ii), robust standard errors in parenthesis. (ii) includes time effects. (iii), and (v) include individual fixed and time effects. For (iii), heteroskedasticity and correlation of order 1 are assumed. For (iv), instruments for differenced equation: Public health spending in logs, real GDP per capita in logs, fertility rate in logs, Urban population in logs, food production per capita growth rate, CO_2 emissions metrics tons per capita in logs. In addition, fixed effects and the time effects are wipe out because the equation 2 is run in first differences. For (i), (ii), (v), the joint significance is using a F-test, and, for (iii) and (iv), the joint significance is using a chi-square test. For the period 1995-2009, the countries of the sub sample are : Antigua and Barbudas, Bolivia, Chile, Costa Rica, Cuba, El Salvador, Mexico, Panama, Paraguay, Peru, and Saint Lucia
‡ Significant at 1%, † significant at 5%, and, * significant at 10%.

gestion is consistent with Leung and Wang (2010), who state that better use of public funds in health care improves health status and LE. In addition, WHO (2010) indicates that one of the health problems of developing countries is to provide universal health coverage. This has brought a significant increase of the direct healthcare payment, meaning 15% to 20% of total HE. WHO suggests an increase of combined public funding and compulsory insurance expenditure around 5 to 6 percent of a country's GDP.

Taking into account the different health care systems, some policy implications point out that improving the organization of health care systems and using their resources efficiently will ensure that people will be able to obtain high-quality medical services. It is also important to note that some LAC countries should modify their health care reforms because of the demographic changes that they are experiencing.

In addition, LAC countries should invest not only in research, drug development, and highly competent health care professionals, but also in prevention and educational programs to ensure a better quality of life for their citizens. Moreover, further research is necessary to examine the responses of life expectancy to variations in fiscal spending on health by taking into account the different health care systems that operate in LAC countries.

Finally, the effects of low, middle, and high incomes on determining LE should be studied in LAC countries. This might help to explain the significant role that public and private HEs have in producing health outcomes.

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