

Short Communication

Income, democracy, and public policy: the effects of improved sanitation on life expectancy

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ABSTRACT

We argue that prominent macro-quantitative studies in economics, medicine and public health, and political science fail to test for the effect of improved sanitation, on countries' average life expectancy scores. Our study adds sanitation to a basic model focusing on income and democracy as central explanatory factors. We use a cross-sectional design and ordinary least squares (OLS) regression with the most recent data, i.e., 2012 or the latest available numbers, and work with the Economist Intelligence Unit 2012 democracy data. All other data are derived from the *CIA World Factbook*. Including sanitation in a cross-sectional model with recent country-level data and controlling for income and democracy increases the explained variance by as much as 11% points. This work identifies sanitation as a crucial variable omitted from existing work on life expectancy. Future studies should aim at the effects of additional public goods apart from sanitation and work with panel data.

Key words | democracy, income, life expectancy, public goods, sanitation

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INTRODUCTION

Average life expectancy differs greatly between countries: while people in Japan can expect to live up to 84 years, average life expectancy in Chad in 2014 was a mere 49 years. Determinants of life expectancy have been the topic of an ongoing debate in economics, medicine, and political science. Many analyses have found democracy and income to be the most important variables influencing life expectancy. A wide variety of additional variables was introduced, many of them also exerting significant effects. We argue that sanitation is a very relevant determinant of life expectancy. Although it is influenced by both income and democracy, we argue that it still exerts an independent effect on life expectancy. Introducing sanitation is expected to increase the model's overall performance while at the same time decreasing the effects of democracy and income.

The remainder is organized as follows. After reviewing existing work on the topic, the relevance of sanitation is

discussed, before a model is run to empirically test the claims. The final section concludes.

DEMOCRACY AND INCOME AS DETERMINANTS OF LIFE EXPECTANCY – A BRIEF REVIEW OF EXISTING WORK

Surprisingly, sanitation has not played a big role in the explanation of variation in countries' average life expectancy. Academic research in economics, medicine and public health, and political science has addressed the topic ([Muntaner et al. 2011](#)). Many studies in this area focus on two prominent explanatory variables in the overarching field of comparative political economy, i.e., income and democracy. Economic factors have previously been suggested to explain differences in countries' life expectancy

(Antonovsky 1967). Wilkinson (1992) showed a correlation between income distribution and life expectancy. After substantial criticism on both content and methods (Judge 1995), he clarified that income is ‘a determinant and indicator of a wide range of material factors, covering all aspects of the standard of living, as well as having a crucial impact on psychosocial factors such as sense of control, security, status, prestige, social distance, and cohesion’ (Wilkinson 1995, p. 1285). Income consequently remained an essential variable of most analyses of life expectancy.

More recently, more explanatory factors have been considered. Baum & Lake (2003) have used data from 1967 to 1997 for 124 countries; the authors work with the *Polity* data as their democracy measure and report that the lagged dependent variable plus a combination of democracy level and income affect female life expectancy. Franco *et al.* (2004) employ data for the year 1998 and for 158 countries; they use the *Freedom House* data to measure democracy and conclude that democracy dummies (free vs. not free), income, inequality, and the size of the public sector explain variation in average life expectancy. They report an independent effect of democracy on public health, even after including other variables, but state that ‘The underlying mechanisms for the association between democracy and health are still unknown’ (Franco *et al.* 2004, p. 1423). Besley & Kudamatsu (2006) analyze data from 1962 to 2002 for 92 countries; they also work with *Polity* to measure democracy and conclude that income, age of democracy (measured as years of democracy since 1956), and years of schooling matter; dummies for region, legal origin, and year are included. Wigley & Akkoyunlu-Wigley (2011) also work with *Polity* and use data from 1972 to 2000 for 153 countries. They put forward several different models and argue that it is the accumulated stock of democracy over time (i.e., age in combination with quality) plus electoral participation, income, presence of civil war, urbanization, religion (measured as proportion of Muslims), climate, health care spending, schooling, and calorie consumption that matter in explaining average life expectancy; they control for region, legal origin, year, and the lagged dependent variable.

The sole explanatory power of income was early doubted and there is evidence on the effect of sanitation. In developing countries, the effect of sanitation (measured as access to electricity, water, and excreta disposal systems)

on life expectancy grew between the 1950s and 1970s and is, alongside social factors, an important explanatory variable (Grosse & Perry 1982).

In summary, sanitation has been widely neglected by scholars researching life expectancy.

SANITATION – AND ITS INFLUENCE ON LIFE EXPECTANCY

The relevance of access to sanitation for health of individuals is obvious. It prevents the spread of diseases which can be life-threatening, especially in developing countries (Bartram *et al.* 2005). The access to sanitation in a country should hence also influence its population’s life expectancy. In fact, sanitation is one of the core public health factors considered by the World Health Organization (WHO). According to the WHO, 2.5 billion people do not have access to improved sanitation facilities (WHO 2014). There have been improvements in the past decade, but while the relative number of people without access to sanitation is declining, the absolute number of 2.5 billion people remains similar due to population growth (UNICEF 2013).

In 2004, the WHO estimated that 88% of the 1.8 million yearly deaths caused by diarrhea could be associated with poor access to safe water and sanitation facilities. The effect is clear and large: ‘Improved sanitation reduces diarrhea morbidity by 32%’ (WHO 2004). Equally impressive effects are found for other diseases, such as Schistosomiasis (160 million infections, 77% reduction by basic sanitation) or intestinal helminths (133 million infections, up to 29% morbidity reductions by basic sanitation, among other factors) (WHO 2004). These positive effects of improved sanitation have been known for decades, as an extensive WHO review published in 1991 shows (Esrey *et al.* 1991).

Consequently, we hypothesize a strong influence of sanitation on life expectancy. However, is sanitation an independent variable? Certainly, there is a correlation between a country’s GDP and its population’s access to sanitation. The richer a country, the better its infrastructure – the same is true on an individual level (Rodgers 1979). However, we argue that the independent effect of sanitation on life expectancy is not completely covered by this. There are low-budget choices to improve sanitation, which have

positive side-effects (Moe & Rheingans 2006; Bill & Melinda Gates Foundation 2012). The installation of such facilities in developing countries can improve the life expectancy, irrespective of whether there is an increase in GDP or not.

Also, a correlation of democracy and sanitation is not expected to wipe out sanitation's independent effect on life expectancy. Leaders in democracies depend on larger groups than do leaders in autocracies; they thus also provide more public goods – such as access to sanitation (Besley & Kudamatsu 2006; Deacon 2009). In fact, this provision of public goods might be one of the reasons for the impact of democracy. The process of voting itself does not make people any healthier. However, the same argument as above is valid here as well; while democracy certainly has a positive impact on sanitation, sanitation is still expected to exert an independent influence on life expectancy.

In summary, we hypothesize that both democracy and income affect life expectancy independently; and that sanitation is both an intermediate and an independent variable.

EMPIRICAL EVIDENCE ON THE EFFECT OF IMPROVED SANITATION

In the previous section, we argued that sanitation is an important factor in the explanation of a country's average life expectancy. Most of the above-mentioned works fail to control for improved sanitation.

This section offers a brief test of the hypothesis made above that sanitation is both an independent and an intermediate variable.

We use a cross-sectional design and OLS regression with the most recent data, i.e., 2012 or the latest available numbers, and work with the Economist Intelligence Unit (EIU 2012) democracy data to maximize the number of cases. All other data are retrieved from the *CIA World Factbook* (CIA 2012).

Improved sanitation is defined as 'use of any of the following facilities: flush or pour-flush to a piped sewer system, septic tank or pit latrine; ventilated improved pit latrine; pit latrine with slab; or a composting toilet'.

Unsurprisingly, sanitation correlates both with democracy (0.41) and income (0.81). Figure 1 displays the respective scatterplots. Also, democracy and income are correlated (0.59).

Table 1 presents the results of different regression models. In bivariate regressions for life expectancy, improved sanitation turns out to be the most relevant factor, followed by income and democracy. Adding improved sanitation to a model controlling for income and democracy adds an extra 11% points to the model's explained variation. The independent variables are correlated which leads to the question whether multicollinearity is a problem. The variance inflation factor (VIF) of the independent variables ranges between 1.6 and 3.76, which hints at light multicollinearity. Since all independent variables exert a significant influence in the expected way, this is of no further concern.

The results show that the argument made above is correct. Democracy and income do have an effect on life expectancy.

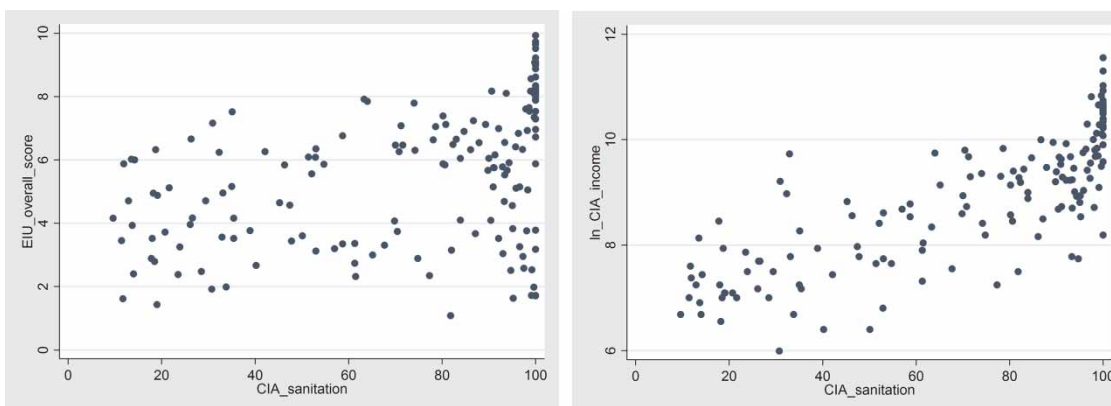


Figure 1 | Distribution of sanitation, democracy, and income.

Table 1 | Explaining life expectancy

	(1)	(2)	(3)	(4)	(5)
Income (ln)	5.746 (0.000)	–	–	5.236 (0.000)	1.609 (0.007)
Democracy	–	2.299 (0.000)	–	0.499 (0.053)	0.645 (0.004)
Improved sanitation	–	–	0.2549 (0.000)	–	0.182 (0.000)
Observations	165	165	160	165	160
Adj. R ²	61%	29%	68%	62%	73%

Estimates are OLS coefficients with *p*-values in parentheses.

Adding sanitation lowers the impact of both democracy and income, but adds much to the explained variation.

CONCLUSION

Research on life expectancy has failed to consider sanitation as an independent variable. While we acknowledge the overwhelming effects of democracy and income, we put forward sanitation as an independent and intermediate variable. Although influenced by democracy and income, sanitation has an independent effect on life expectancy. A regression analysis has shown its strong impact on life expectancy. Including sanitation improves the variance explained by the model, while decreasing the effects of democracy and income. Future work should depart from Besley & Kudamatsu's (2006) conclusion regarding detailed effects of political and bureaucratic behavior under different political systems. It should investigate how these interact with income to produce public goods such as sanitation which subsequently affect life expectancy.

The policy implications are clear. Improving access to sanitation has a positive effect on life expectancy and public health. Initiatives such as the Reinvent the Toilet Challenge (Bill & Melinda Gates Foundation 2012) show that improvements are not costly and are easy to implement. Data on the necessity are available. Combining the provision of sanitation and water facilities and education should be the way forward. The Millennium Development Goal 7.C was that by 2015, the proportion of people without access to water and improved sanitation should decrease by 50%. This goal is far from being reached (United Nations 2015). Our findings show the necessity of a stronger focus of state and non-state actors on improving sanitation in developing countries.

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