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MODELING GOVERNMENT INVESTMENT AND PERFORMANCE IN PUBLIC EDUCATION

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ABSTRACT

Governments have tried to implement budget methods like PPBS (Planning Programming Budgeting System), ZBB (Zero Base Budget) and RBB (Results Based Budgeting) for decades. However, in practice budgeting has been mostly incremental in most areas, and the results obtained have seldom been linked to the investment made years before. This paper tries to create models to make the investment more rational and proactive and less based on political pressures and results guessing.

The public policy selected for this study is the public education.

Two models are created to study this public policy under the modelling method.

The first model is a simulator and its focus is on gains of productivity as a function of years of education and the cost of education.

Initially the study surveys for data on years of education and costs of education and GDP per capita as time series, and then builds a model on how the investment in education can reflect gains in GDP per capita, and therefore more income taxes. In this way it's possible to see education as having a return on investment for the government.

The available data indicates that a strong correlation exists between HDI and GDP per capita, and HDI education index and GDP per capita, in a way that estimates are possible. A correlation between years of study and GDP per capita can be pointed out, meaning that the more study the higher the income in adult life.

There is also a high correlation between energy consumption and GDP per capita that causes some distortions particularly in countries that are energy producers.

A time lag between education improvement and GDP per capita growth is hard to obtain and can only be estimated.

This model serves as a basis for discussing the budget in a more rational way, even when optimization is not possible due to political constraints. This is an important move toward implementing RBB, since the model allows for forecasting the results based on the size and type of investment eliminating the need for guessing the results. Performance and results intended in a given period can serve as a basis for the simulation of investments and therefore evaluation of possible policies of investment, and whether the results intended are realistic, or just a wishful thinking.

From this point the study tries to develop a second more systemic model for public policy involving factors outside this policy, like the effect of education on the reduction of crime, improving health, , reducing fertility rates, and growth of the economy as productivity increases allowing to understand the positive and negative feedbacks of the system.

This systemic model is not as strong mathematically but serves the purpose of understanding the phenomenon of public policy in a larger context and thus allowing for integration of policies and strategic projects that support public security indirectly.

This allows for a better PPBS and RBB method usage since it can be used to search for synergies in the various projects and programs in several public policies, but also to design new programs and projects to support public education.

Keywords: Strategy, Budget, Performance, Public administration, Forecast

INTRODUCTION

BACKGROUND OF THE RESEARCH

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GOAL OF THIS ARTICLE

This paper tries to create models to make the investment more rational and proactive and less based on political pressures and results guessing.

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Two models are created to study this public policy under the modelling method.

The first model is a simulator and its focus is on gains of productivity as a function of years of education and the cost of education.

The second model is more systemic for public policy involving factors outside this policy, like the effect of education on the reduction of crime, improving health, reducing fertility rates, and growth of the economy as productivity increases allowing to understand the positive and negative feedbacks of the system.

RELEVANCE

These models are important moves toward implementing RBB, since the model allows for forecasting the results based on the size and type of investment eliminating the need for guessing the results.

They allow for a better PPBS and RBB method usage since it can be used to search for synergies in the various projects and programs in several public policies, but also to design new programs and projects to support public education.

QUESTION TO BE ANSWERED

The main research question is “how can we model the effect of public investment in the public education?”

OVERVIEW OF PREVIOUS RESEARCH

This study involves three bodies of knowledge: public budget, systems modeling, and public education. Each of these three has extensive previous research. We intend here to give a brief overview of each one.

PUBLIC BUDGET

Public budget is a major theme of public administration and has been used as a planning tool since at least mid XXth century. The PPBS method has been introduced in the 1960`s was a major step toward rationalization of the budget and formally implement it as a tool for planning. The idea of PPBS was to tie budget to programs instead of departments. This method tries to break to the departamentalization of governments by creating program that involved many budgetary units, and also stop the incrementalism in budget by tying the budget to a more clear purpose.

Despite being a relative success worldwide, the political forces managed to adapt to the PPBS and created department specific programs and the problems of departamentalization and incrementalism reappeared.

Then ZBB was introduced, also in the 1960`s. It was trying to eliminate incrementalism in the most radical way, by not making a new budget from the previous one, but rather “zeroing” the budget from year to year. It did not attack departamentalization straightforward but rather indirectly as the departments needed to justify its budget each year.

ZBB made some advance but in the public sector the existing infra-structure could not be zeroed from year to year and the long term nature of some public services prevented it to be of widespread use. ZBB never became very important in the public sector.

RBB or PBB (Performance based budget) has been introduced at least since 1990`s around the world in both public and private sector. The idea here is that we should not spend more money but rather better spend the money and get more results from it. It’s a direct attack on incrementalism and an indirect attack on departamentalization. It can be viewed as a new tentative of creating programs but this time viewing for results and not means.

RBB has been on the rise in the last decades but it’s hard to implement mainly because it’s not ease to create consistent cause-effect relationships. In the public sector some of these relations are even more complex and sometimes with a lag of many years between budget use and its results.

BSC (Balanced Score Card) has been a form of RBB that appeared in the 1990`s and became fashionable in the private sector has found its way to the public budgeting. BSC was not created for the public sector and therefore it needed adaptations to it.

The main cause of failure in RBB (including BSC) is due to systems modeling problems, as will be explained below.

SYSTEMS MODELLING

Systems modeling derive from the Systems Theory (Bertalanffy, 2001). It is a mathematical model to describe how parts of a system interact with each other. It can either be just a description done on paper or implemented in a spreadsheet or even in a computer model.

The main purpose of a model is to understand the interactions, but some of the behaviors of a system are very complex, even as simple equations interact with each other. This has led to the development of theories as the complexity theory (or chaos theory) as a subset of system theory.

Some interactions form loops of positive and negative feedback. Negative feedbacks are self-controlling and create stable systems, while positive feedbacks are self-reinforcing leading the system into a direction or other all the way. Mapping such loops is an important part of system modeling.

In social sciences there has been much literature to find the causal links and finding the elasticities between variables as well as the correlation coefficients. But there has been very little attention to try to form the loops by looking at the chain of causalities. Mapping such loops can lead to new understanding why some systems are stable (negative feedbacks) while other are unstable (positive feedbacks).

In public policy history there are many examples of policies that were insignificant because they acted upon self-regulating systems. In contrast policies acting upon self-reinforcing systems can be either very successful or disastrous depending on what the system reinforces.

This leads us to the importance in understanding those loops before starting a policy or more specifically before spending money on it. Mapping such loops and models can lead us to better understand the models and how much effort is needed to achieve some goals.

Another question central to the system model is the causality. In creating models establishing the causality is not very easy. In natural sciences we use laboratories to test hypothesis and verify causalities and elasticities and interaction formulas. That's not so easy in social sciences because there are no laboratories, and experiences are hard to execute. This is why models can help us predict outcomes before they happen, reducing the risks involved in implementing public policies, but also why they are hard to create.

There are four main problems in creating those: intuition, positive relations bias, number of variables bias and time lag.

First, most RBB models are created using intuition in Planning departments and strategic planning sessions where solid mathematical modeling does not find its way due to time-pressures and lack of scientific training. Many causal relations pictured in RBB models (and BSC in particular) are not tested and either false or too weak.

Second, many RBB (and most BSC) have only positive feedback links that create an illusion that acting upon a few variables will lead to a prosperity cycle. The negative feedbacks that prevent growth are neglected.

Third, a lot of variables are left outside, which is inevitable otherwise the number of variables would grow too fast and became unintelligible. Those variables can create loops on their own and create disastrous positive feedbacks or new negative feedbacks that are not even being monitored.

Fourth, there is a time lag between one variable change and its effect on the other. Some time lags can be of years or decades, so the political fruition of a policy can be sometimes be perceived on a different administration. This brings a bias of implementing only short time-lag policies for political reasons, and adds to the stress between the bureaucracy and the politicians.

This has contributed to the frustration with the use of RBB systems, and as said before this is due to poor understanding of systems modeling and a naïve approach of complex situations.

PUBLIC EDUCATION

We have chosen public education as our focus in this study for a number of reasons. Firstly it's a very important public policy and a nearly central function of the State. Secondly, it has a reasonable amount of data available so that correlations and causal links can be explored. Thirdly, its importance in budget is high and some decisions can be done based on modeling it.

Public education began during the early stages of industrial revolution when it was necessary to transform a mass of rural workers into a mass of industrial workers. The model evolved for fifty or so years from 1770 to 1820.

In the end a very efficient system of indoctrination and training was capable of teaching the behavior and skills for industrial work for the masses.

However the increase in sophistication of industry skills since them forced the system to increase the length of education beyond the primary school into the secondary and tertiary schools. In the 1980's the service industry became too relevant in economic terms and required new skills and behaviors from the workers.

Currently the public education systems face a twofold crisis: costs and model.

The cost crisis is that increasing the expenditure in education is becoming prohibitively high and not necessarily means that a gain in productivity is being achieved. The cost of the system can be measured in many terms but as any service the cost of salaries is a keypoint and it's hard to find, if possible at all, a correlation between salaries and student performance.

This brings us to the model crisis, which designed for an industry-based economy and not a service-based economy. Instead of a reproductive, passive and reactive workforce a service-based economy needs a proactive, enterpreneurial and creative workforce.

Currently this crisis is unsolved worldwide. A new public education model is being searched but none so far has been sufficiently good. The cost crisis is being attacked by vouchers systems and privatization but with varying degrees of success. The model crisis is being attacked with constructivism methods and on-line education but also with varying degrees of success. Nobody truly knows what will be this new model of a service-based economy. This model is still under construction and it may take decades before this problem is solved.

We know however that a student performance is a composite of three factors: education system, family support, and individual choice. Only one is controllable by the system and this is not necessarily the most important. Mizala and Romaguera (2000) have show that, at least in Chile, the family contribution is more important than the quality of the schools. The hardest part to measure is certainly the student choice itself since it varies from student to student.

METHODOLOGY

The method used for this work is the simulation.

Simulations evolved from the systems theory as a way of creating artificial systems to work and study them. They are applicable to systems that are either to expensive to test in real world or even impractical to do so.

In social sciences simulations are very useful to circumvent the limits of testing and experiencing. Bruyne et al (1977) describe four methods of investigation in which are from he most open to the most controlled: case studies, comparisons, experimentation and simulation. Management sciences have concentrated in cases studies and comparisons and neglecting simulations since they are more complex and require some knowledge in systems theory and preferably spreadsheets and computer programming.

Kleiboer (1997) indicates the use of simulation in five cases: research tool, teaching instrument, planning method, decision support tool and a method for selection of personnel. Our interest here is to use it as a planning method and decision support tool.

Chussil and Reibstein (1999) describe the simulation techniques as an important tool for planning and decision support and include in them: computer analyzes, wargames, war rooms, and war councils. His main interest is in forecasting results of actions.

Alves (2005) indicates the possible situations in which simulations can be used. The table 1 below shows the description.

Table 1 – Modes of use of a simulation in social sciences research

		Do empirical data exist?	
		Yes	No
Do a model exist?	Yes	Confirmatory	Forecast
	No	Search of a Model	

Source: adapted from Alves (2005)

This article is trying to "search for a model". We will develop two models. One more formal will use correlations to create a model that can later be used for forecast. A second less formal model will try just to establish a model for later confirmation.

The main source of data is secondary sources in literature as is typical in simulations.

FINDINGS

We have created two models for modeling the government investment and performance in public education. But before we reach these models we have to analyze the existing data in order to build the models. Tables 3 and 4 show the data acquired from CIA's world factbook (2012), UNDP (2010), and UNESCO (2012), they are included in the data appendix.

We have selected the top 45 economies of the world for this study s they represent 90% of the world economy, instead of all possible nations because introducing many small nations could distort the correlations with exceptions that would statistically have the more weight of a few large nations. The methodological cut was set at 90% of world economy, which is in fact entirely arbitrary.

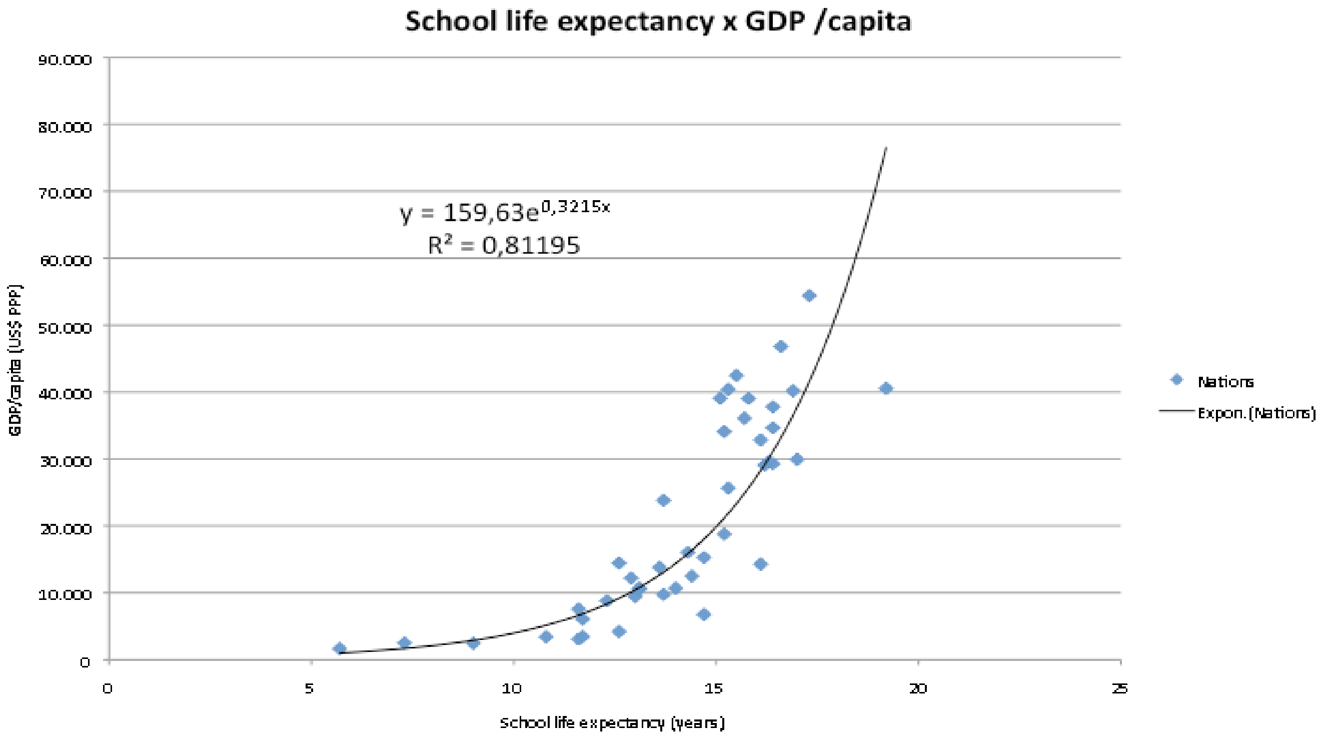
The first test done with this data set was whether there was a correlation between School life expectancy (SLE) and GDP per capita, meaning that the more study the better income in adult life.

Figure 1 shows the graphic of the two variables. As expected there was a strong correlation in an exponential form (R^2=0.812; $p<0.01$). A linear correlation is also good but not as good (R^2=0.62; $p<0.01$) but the model is simpler to apply and points to a gain of US$ PPP 4,316 in GDP per capita per year of education. In the equations below Y is the GDP per capita in adult life, and X in the school life expectancy (or LSE):

$$Linear - Y = a + bX = -41{,}647 + 4{,}445X \quad (1)$$

$$Exponential - Y = ae^{bX} = 159.63e^{0.3215X} \quad (2)$$

Figure 1 – Correlation between School Life expectancy and GDP per capita



Another test is whether this is correlated to more spending and the results are negative. Figure 2 show the graphic of Public spending in education and GDP per capita. It's very clear that the correlation is low (Linear model; R^2=0.20; $p>0.01$) and that means that more spending does not necessarily implies in a higher GDP per capita, or simply it's not about more spending but rather better spending, or better management of resources, and a better educational system.

Singapore appears as an outlier with only 3.1% of spending and a GDP per capita of US$ PPP 61,573. However even removing it as an outlier the model is not very good with (Linear model; R^2=0.349; $p<0.01$) but at least is significant.

However, some nations have a high GDP per capita due to the production of oil and other natural resources and not education. Alves (2008, 2010) has also shown that there is a high correlation between Energy consumption per capita and GDP per capita, indicating that access to energy is a limiting factor in economic growth and lays a central role in development. Alves (2012) has show an even higher correlation too between Energy consumption per capita and HDI (logarithmic model; R^2= 0.83; $p<0.01$).

In this way we modelled the effects of both Energy consumption per capita and SLE into GDP per capita. Using the logarithm of GDP per capita as the dependent variable we found a good correlation (linear model; R^2=0.862; R^2 adj =0.855, $p<0.01$). This means that adding up the energy consumption improves the correlation from 0.812 to 0.855 but that not critical. In fact both variable are good explainers and probably there is a high correlation between them too.

The final test is the correlation between public spending in Education and School life expectancy. The correlation is show in Figure 4 and is average (linear Model; R^2=0.433; $p<0.01$) but not very good.

This means that public spending is important for determining School life expectancy but not the only factor and therefore two models can be derived. One model can be more directly related for public spending and school life expectancy as variables determining GDP per capita. However another model taking into account the managerial side is also important to determine the results.

Figure 3 shows the correlation between these variables as a model.

Figure 2 – Correlation between Public spending in education and GDP per capita

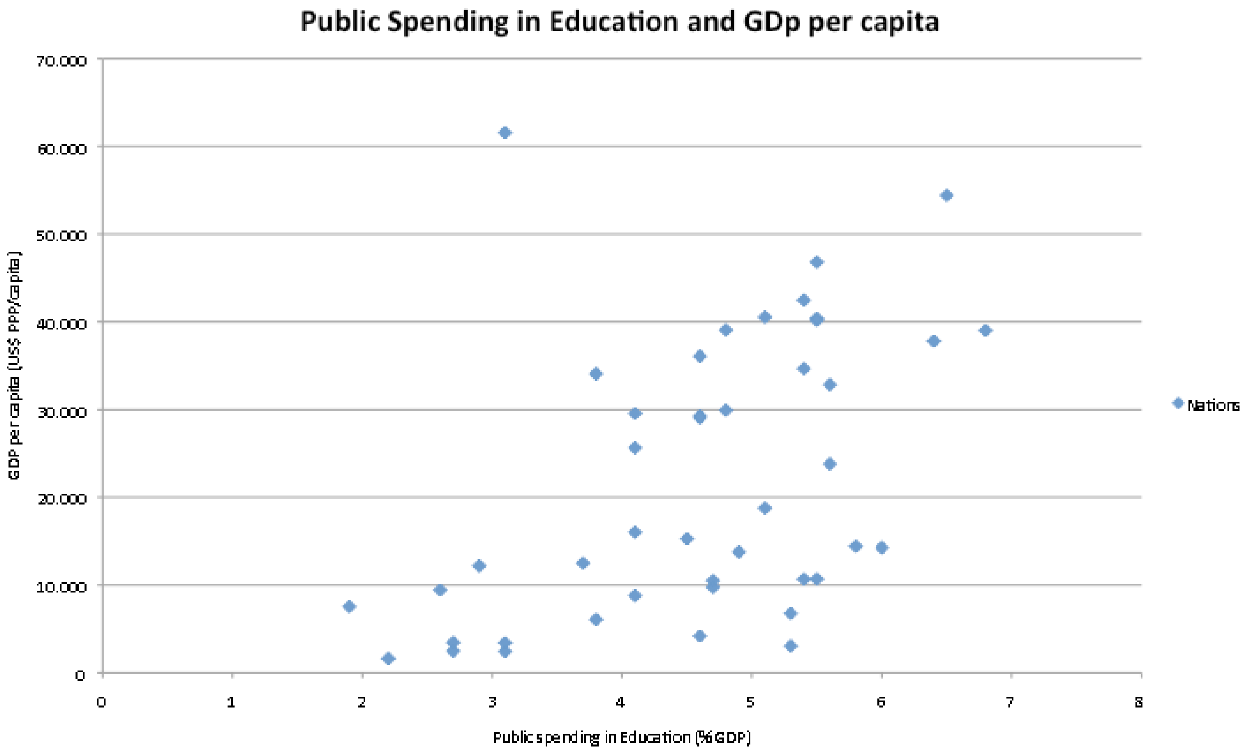


Figure 3 – Correlation system between variables (Linear models)

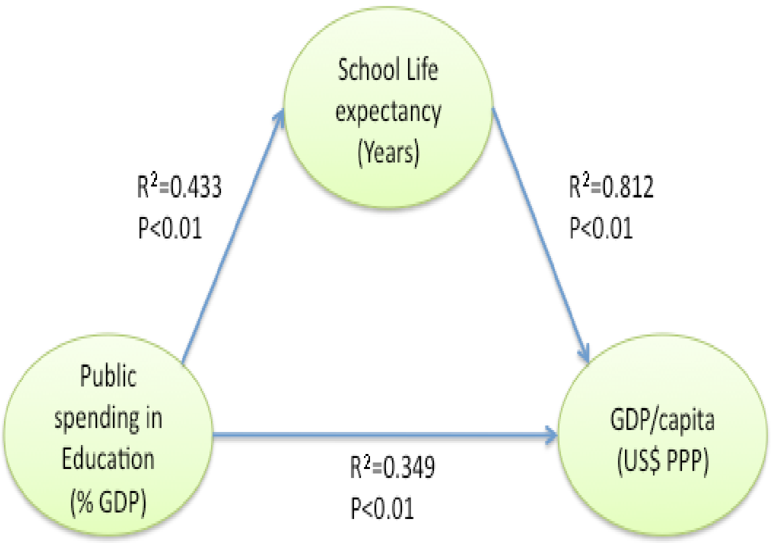


Figure 4 – Correlation between Public spending in education and School life expectancy

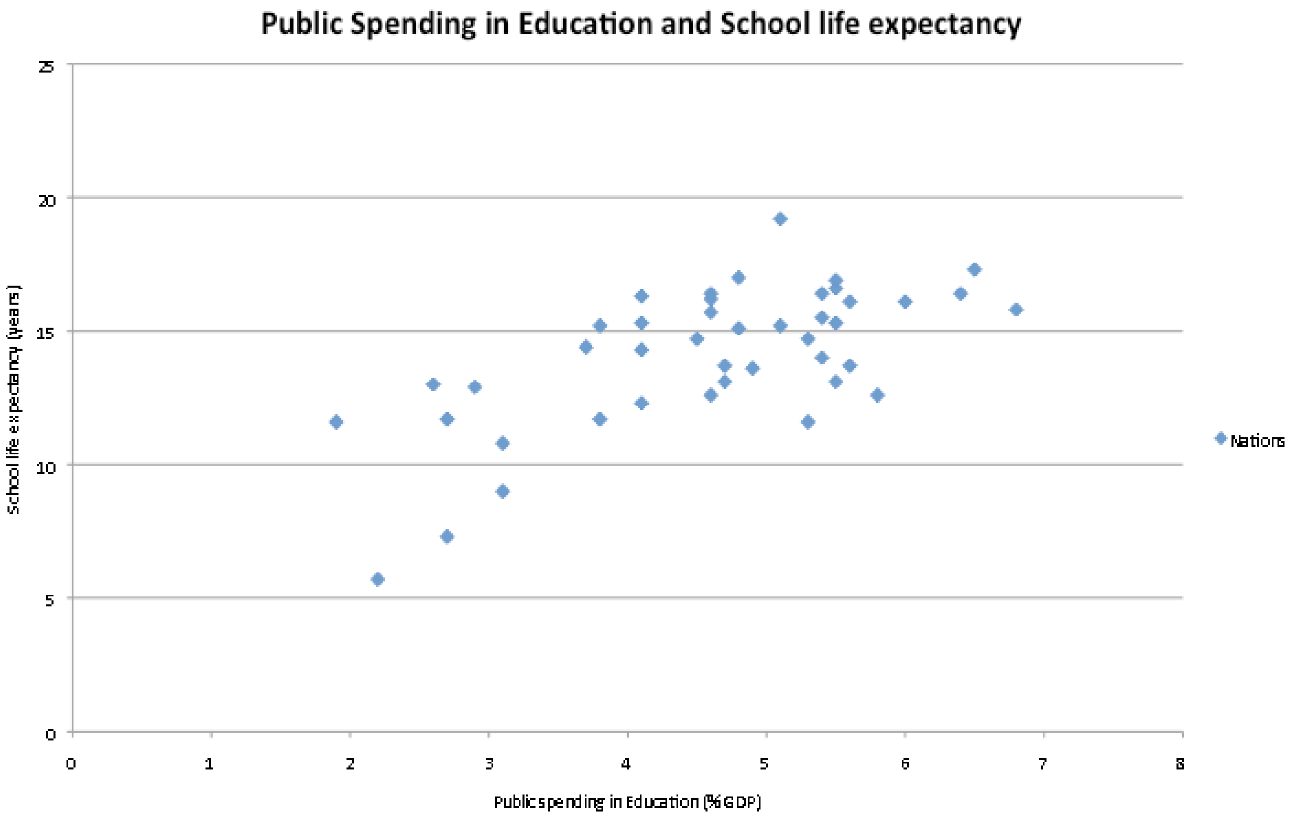


Figure 5 – School Life expectancy effect on fertility

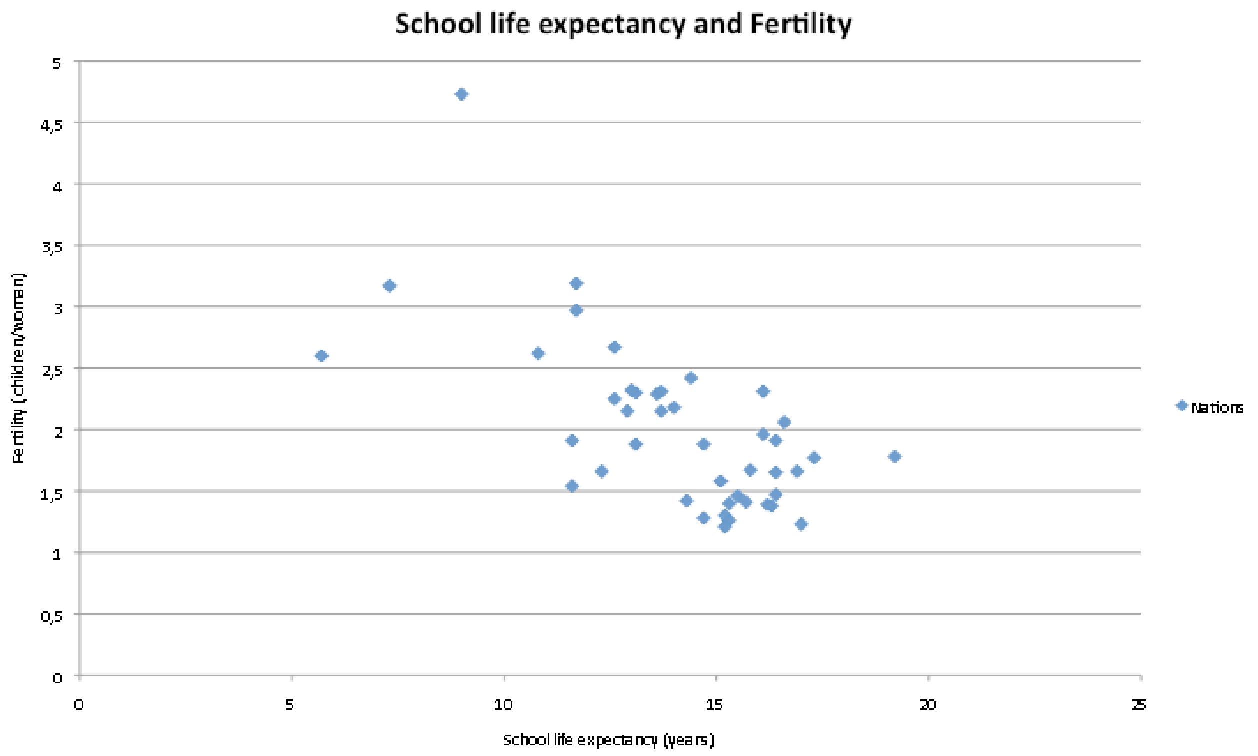
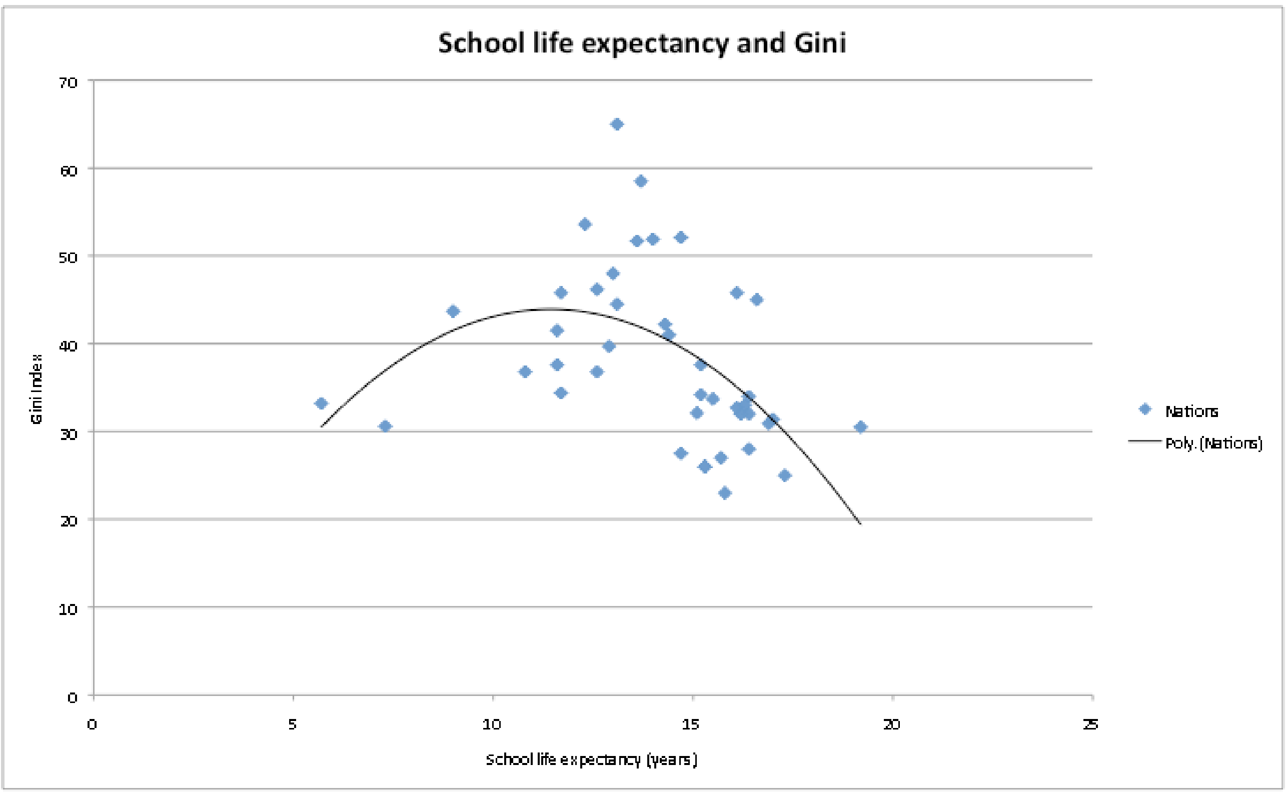


Figure 6 – School Life expectancy effect on inequality



Once established the importance of School Life expectancy (SLE) we can look at its effects on the society. The two tests made here are the effects on fertility and inequality.

Figure 5 show the correlation between SLE and fertility rate indicating that the higher the education the smaller the fertility rate (linear Model; R^2=0.453; p<0.01). Figure 6 show the correlation between SLE and Gini index (polynomial second grade Model; R^2=0.314; p<0.01) indicating that with SLE increase at first there is an increase in inequality and then the trend reverses.

This exposes the externalities, or effects, of improvement in education through increase in SLE.

Fertility rates are reduced and therefore population reduces in the long term as it increases in GDP/capita. This effect takes long, but makes families richer as they can concentrate more resources in fewer children, meaning that the next generation will better off.

The inequality is more complex to understand as it rise at first probably because not all individuals make good use of education, but also because we are not controlling for the inequality in education itself. After some point the improvement in education takes effect reducing inequality even if the distribution of education is unequal itself.

MODEL 1

The first model was implemented in excel for ease of use but could have been implemented in any spreadsheet, or in a simple programming code. The model can be reached by e-mailing the author.

It has used two panels of data: inputs and outcomes.

The main equation used is the linear model between School life expectancy and GDP per capita shown in equation (1). A second implied equation is that total life expectancy (TLE) is composed of childhood, school life expectancy (SLE), and work life expectancy (WLE). All other calculations are ratios.

Important in this model is that the population is simplified as being equally distributed in terms of age in order to calculate the working population and student population, this is of course a simplification but not assuming that would require to model the entire demographic pyramid which would be much more complex.

Also, the long term impact of SLE on fertility and thus population size has not been calculated as this would require a more sophisticated model with a time variable and resulting in long term effects and a dynamic model.

Notice also that with very few years of SLE the GDP per capita is negative that is of course an impossibility that was left to remind users of the model limitations and that any model is just a simplification of reality, not reality itself.

Figure 7 shows the input table with dummy factors of a hypothetical political entity (HPE).

Our Hypothetical political entity (HPE) has a population of 100 million people, the size of a large national state, total life expectancy of 70 years, childhood duration of 5 years, and it expends 5% of the GDP in public education.

Real data would substitute the data provided as default. Readers are encouraged to use data provided in the Data Appendix to model other nations, since a simulator is all about simulating other realities.

Figure 7 – Model 1 applied to HPE (hypothetical political entity)

Inputs		
total life expectancy	70	years
infancy	5	years
population	100	millions
fixed	-41,65	thousand dollars PPP
variable	4,445	thousand dollars PPP
public edu exp	5	%

item	short	unit
total life expectancy	tle	years
infancy	inf	years
school life expectancy	sle	years
work life expectancy	wle	years
population	pop	millions
infancy population	inf pop	millions
school life population	stu pop	millions
work life population	wl pop	millions
gdp /cap	gdp/cap	thousand dollars PPP
GDP	gdp	billion dollars PPP
public education exp	exp	% of gdp
public education exp	edu exp	million dollars PPP
Per student exp	per stu	dollars PPP/sudent
ROI	ROI	

Outcomes										
tle	inf	sle	wle	stu pop	wl pop	gdp /cap	gdp (bil)	edu exp (mil)	per stu(dollars)	ROI
70	5	7	58	10,0	82,9	-10,532	-0,87	-43,6	-4,4	-1018,7
70	5	8	57	11,4	81,4	-6,087	-0,50	-24,8	-2,2	-2049,8
70	5	9	56	12,9	80,0	-1,642	-0,13	-6,6	-0,5	-8701,3
70	5	10	55	14,3	78,6	2,803	0,22	11,0	0,8	5766,5
70	5	11	54	15,7	77,1	7,248	0,56	28,0	1,8	2498,5
70	5	12	53	17,1	75,7	11,693	0,89	44,3	2,6	1721,4
70	5	13	52	18,6	74,3	16,138	1,20	59,9	3,2	1377,2
70	5	14	51	20,0	72,9	20,583	1,50	75,0	3,7	1185,6
70	5	15	50	21,4	71,4	25,028	1,79	89,4	4,2	1065,6
70	5	16	49	22,9	70,0	29,473	2,06	103,2	4,5	984,9
70	5	17	48	24,3	68,6	33,918	2,33	116,3	4,8	928,3
70	5	18	47	25,7	67,1	38,363	2,58	128,8	5,0	887,5
70	5	19	46	27,1	65,7	42,808	2,81	140,7	5,2	857,8
70	5	20	45	28,6	64,3	47,253	3,04	151,9	5,3	836,2
70	5	21	44	30,0	62,9	51,698	3,25	162,5	5,4	820,7
70	5	22	43	31,4	61,4	56,143	3,45	172,4	5,5	810,1
70	5	23	42	32,9	60,0	60,588	3,64	181,8	5,5	803,5
70	5	24	41	34,3	58,6	65,033	3,81	190,5	5,6	800,2
70	5	25	40	35,7	57,1	69,478	3,97	198,5	5,6	799,7
70	5	26	39	37,1	55,7	73,923	4,12	205,9	5,5	801,7
70	5	27	38	38,6	54,3	78,368	4,25	212,7	5,5	806,0
70	5	28	37	40,0	52,9	82,813	4,38	218,9	5,5	812,4
70	5	29	36	41,4	51,4	87,258	4,49	224,4	5,4	820,7
70	5	30	35	42,9	50,0	91,703	4,59	229,3	5,3	830,9
70	5	31	34	44,3	48,6	96,148	4,67	233,5	5,3	843,0
70	5	32	33	45,7	47,1	100,593	4,74	237,1	5,2	857,0
70	5	33	32	47,1	45,7	105,038	4,80	240,1	5,1	872,8
70	5	34	31	48,6	44,3	109,483	4,85	242,4	5,0	890,6
70	5	35	30	50,0	42,9	113,928	4,88	244,1	4,9	910,4
70	5	36	29	51,4	41,4	118,373	4,90	245,2	4,8	932,3
70	5	37	28	52,9	40,0	122,818	4,91	245,6	4,6	956,5
70	5	38	27	54,3	38,6	127,263	4,91	245,4	4,5	983,1
70	5	39	26	55,7	37,1	131,708	4,89	244,6	4,4	1012,5
70	5	40	25	57,1	35,7	136,153	4,86	243,1	4,3	1044,7
70	5	41	24	58,6	34,3	140,598	4,82	241,0	4,1	1080,2
70	5	42	23	60,0	32,9	145,043	4,77	238,3	4,0	1119,2
70	5	43	22	61,4	31,4	149,488	4,70	234,9	3,8	1162,4
70	5	44	21	62,9	30,0	153,933	4,62	230,9	3,7	1210,1
70	5	45	20	64,3	28,6	158,378	4,53	226,3	3,5	1263,0
70	5	46	19	65,7	27,1	162,823	4,42	221,0	3,4	1321,9

It can be seen in this example that as the SLE grows and TLE remains the same there is an optimal point for SLE in terms of total GDP. The GDP per capita grows as SLE grows due the equation (1) but since TLE and population are constant, than WLE is reduced, and so is the working population, therefore the GDP which is a result of the multiplication of GDP per capita and working population has a superior limit.

In the case of the HPE this limit is about the 37 or 38 years of SLE. This optimum is far above real world levels that are reaching 17 years of SLE. That means there is a lot of room to grow in SLE in real life. However, if you reduce TLE to for example 40 years, and readers are encouraged to do that in the spreadsheet, this maximum will reduce to 22 years of SLE (GDP will reduce to almost a third), meaning that it makes sense that in nations with smaller life expectancies that school life would have to be also smaller.

Another interesting fluctuation is the ROI (return over investment), which is calculated by calculating the public spending in terms of percentage of GDP and by the number of student population to find the investment. The return is fixed in US$ PPP 4,445, as per equation (1), since the spending in one year of school life implies for the society a gain in that number of GDP per year.

This means there is a minimum ROI. This occurs because the public spending is fixed in percentage terms but not absolute terms. As the GDP grows with SLE so grows the spending but also grows the portion of the population that is studying (student population). At some point there is a minimum ROI.

For the HPE this minimum ROI is about 800, meaning 80,000% at an SLE of 25 years. That is a huge ROI compared to any other investment, however this does not take into account that for the government the revenues are only over a part of this GDP, proportional to the taxes in the nation and also that there is a time lag between investment and return as people have to leave school life before entering working life.

As it is the model is still a starting model upon which refinements can be done and especially it doesn't improve school life expectancy with more spending since the correlation was show as being small.

In fact SLE is a function of three factors at least: education system, family support, and individual choice. The government can control only the education system that is responsible for 43% of the variance if the correlation between public spending and SLE is taken into account. This can improve if we model other management factors like education structure and equipment quality (hardware), pedagogical methods and management processes (software), and teacher and management personnel quality and dedication ("humanware"). In fact a complete modeling is hard to achieve due to the differences between nations.

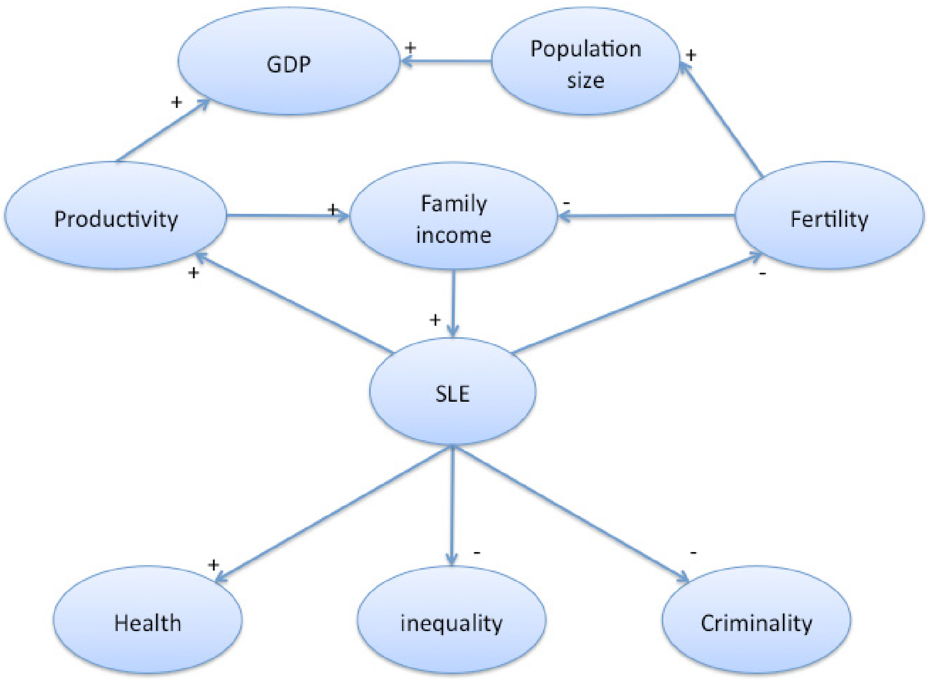
MODEL 2

This model is created based on general perception of the education effects. It's show in figure 8 and contains nine variables correlated as positive or negative effects. Arrows with a plus symbol are positive feedbacks or correlations and those with a minus symbol are negative feedback or negative correlations.

The central part is composed of the two positive feedback loops created by SLE, productivity and Family income; and SLE, fertility and family income. Together these loops indicate how an increase in SLE is self-sustainable.

The correlation of SLE and productivity and SLE and fertility was show in figures 1 and 5 respectively. The correlation between productivity and family income is more or less easy to show as GDP per capita increases, so family income. The correlation between fertility and family income is less obvious, but as a woman has fewer children, it has more time for work and so in theory her income would increase. Also she can concentrate the income on fewer children so family income may not rise, but family income per capita rises.

Figure 8 – Model 2 set of correlations



Fertility however will affect population size in the long term, making the society smaller and richer as SLE is driven up by the positive feedback. It's arguable if this will lead to the society depopulating too much, or not, and whether there is an optimal point for SLE that maximizes GDP. A specific model can be assembled to test this.

SLE has also other positive externalities by improving health conditions, reducing inequality as show in figure 6 and reducing criminality. Health conditions will improve as people make preventives measures for health in particular sanitation issues related to water safety. Inequality is reduced, but not directly, as show in figure 6. Criminality is reduced because people have more access to opportunities. This means that they have less need to find sources of income in illegal activities.

The main importance of such model is to show the importance of education beyond education policy itself and to understand how this is central to the society.

Education is an important stake for health, crime, economy, population and inequality policies.

CONCLUSIONS

At this point we should return to the goal of the paper and ask if we could properly modeled the effects of public investment on public education.

The models presented are not finished products and need careful use by readers that will need to adapt them to their reality.

However these are important steps to implementing RBB, since the model allows for forecasting the results based on the size and type of investment eliminating the need for guessing the results.

The key issue however is that Education is critical for development of a society but its effectiveness is less based on how much you spend and more on how you spend it.

They also allow for a better PPBS and RBB method usage since it can be used to search for synergies in the various projects and programs in several public policies, but also to design new programs and projects to support public security.

Further improvement may be context specific depending on the political entity using them.

DATA APPENDIX

Table 3 – General Data for the 45 top economies of the world in 2012

Rank	Nation	GDP PPP	GDP	Sum	GDP/Cap	Energy /Cap	Population
GDP		Billion US$ PPP	% total	% total	US$/cap PPP	Kwh/cap	Millions
1	United States	14,660	19.67%	19.67%	46,802	12,365	313.2
2	China	10,090	13.54%	33.20%	7,548	2,572	1336.7
3	Japan	4,310	5.78%	38.99%	34,078	6,788	126.5
4	India	4,060	5.45%	44.43%	3,414	478	1189.2
5	Germany	2,940	3.94%	48.38%	36,086	6,718	81.5
6	Russia	2,223	2.98%	51.36%	16,023	6,181	138.7
7	United Kingdom	2,173	2.92%	54.27%	34,658	5,515	62.7
8	Brazil	2,172	2.91%	57.19%	10,677	1,987	203.4
9	France	2,145	2.88%	60.07%	32,842	6,847	65.3
10	Italy	1,774	2.38%	62.45%	29,074	5,163	61.0
11	Mexico	1,567	2.10%	64.55%	13,779	1,596	113.7
12	Korea, South	1,459	1.96%	66.51%	29,925	8,245	48.8
13	Spain	1,369	1.84%	68.34%	29,280	5,905	46.8
14	Canada	1,330	1.78%	70.13%	39,082	15,753	34.0
15	Indonesia	1,030	1.38%	71.51%	4,194	486	245.6
16	Turkey	960.5	1.29%	72.80%	12,191	2,514	78.8
17	Australia	882.4	1.18%	73.98%	40,539	10,199	21.8
18	Taiwan	821.8	1.10%	75.08%	35,619	9,570	23.1
19	Iran	818.7	1.10%	76.18%	10,511	2,654	77.9

20	Poland	721.3	0.97%	77.15%	18,764	3,364	38.4
21	Netherlands	676.9	0.91%	78.06%	40,179	7,366	16.8
22	Saudi Arabia	622.0	0.83%	78.89%	23,803	6,318	26.1
23	Argentina	596.0	0.80%	79.69%	14,269	2,375	41.8
24	Thailand	586.9	0.79%	80.48%	8,796	2,014	66.7
25	South Africa	524.0	0.70%	81.18%	10,693	4,389	49.0
26	Egypt	497.8	0.67%	81.85%	6,065	1,268	82.1
27	Pakistan	464.9	0.62%	82.47%	2,482	385	187.3
28	Colombia	435.4	0.58%	83.06%	9,735	863	44.7
29	Malaysia	414.4	0.56%	83.61%	14425	3,265	28.7
30	Belgium	394.3	0.53%	84.14%	37,799	8,137	10.4
31	Nigeria	377.9	0.51%	84.65%	2,435	124	155.2
32	Sweden	354.7	0.48%	85.12%	39,026	14,799	9.1
33	Philippines	351.4	0.47%	85.60%	3,451	534	101.8
34	Venezuela	345.2	0.46%	86.06%	12,491	3,004	27.6
35	Austria	332.0	0.45%	86.50%	40,403	7,992	8.2
36	Switzerland	324.5	0.44%	86.94%	42,474	7,526	7.6
37	Greece	318.1	0.43%	87.37%	29,563	5,416	10.8
38	Ukraine	305.2	0.41%	87.78%	6,762	2,982	45.1
39	Singapore	291.9	0.39%	88.17%	61,573	7,828	4.7
40	Vietnam	276.6	0.37%	88.54%	3,055	945	90.5
41	Peru	275.7	0.37%	88.91%	9,426	1,085	29.2
42	Czech Republic	261.3	0.35%	89.26%	25,642	5,242	10.2
43	Bangladesh	258.6	0.35%	89.61%	1,631	151	158.6
44	Chile	257.9	0.35%	89.95%	15,271	3,392	16.9
45	Norway	255.3	0.34%	90.29%	54,414	27,452	4.7

Source: Adapted from CIA, 2012, UNDP, 2010 and UNESCO, 2012

Table 4 – Educational Data for the 45 top economies of the world in 2012

Rank	Nation	HDI educ	School life exp	Total life expectancy	public exp	HDI	Gini
GDP		2007	years (2008)	years (2009)	% gdp 2008	Index	Index
1	United States	0.968	16.6	78	5.5	0.902	45.0
2	China	0.851	11.6	73	1.9	0.663	41.5
3	Japan	0.965	15.2	83	3.8	0.884	37.6
4	India	0.643	10.8	65	3.1	0.519	36.8
5	Germany	0.954	15.7	80	4.6	0.885	27.0
6	Russia	0.933	14.3	69	4.1	0.719	42.2
7	United Kingdom	0.957	16.4	80	5.4	0.849	34.0
8	Brazil	0.891	14.0	73	5.4	0.699	51.9
9	France	0.978	16.1	81	5.6	0.872	32.7
10	Italy	0.965	16.2	81	4.6	0.854	32.0
11	Mexico	0.886	13.6	76	4.9	0.750	51.7
12	Korea, South	0.949	17.0	80	4.8	0.877	31.4
13	Spain	0.975	16.4	81	4.6	0.893	32.0
14	Canada	0.991	15.1	81	4.8	0.888	32.1
15	Indonesia	0.84	12.6	68	4.6	0.600	36.8
16	Turkey	0.828	12.9	73	2.9	0.679	39.7
17	Australia	0.993	19.2	82	5.1	0.937	30.5
18	Taiwan	0.874				0.868	32.6
19	Iran	0.793	13.1	72	4.7	0.702	44.5
20	Poland	0.952	15.2	76	5.1	0.795	34.2
21	Netherlands	0.985	16.9	81	5.5	0.890	30.9
22	Saudi Arabia	0.828	13.7	74	5.6	0.752	
23	Argentina	0.946	16.1	75	6.0	0.775	45.8
24	Thailand	0.888	12.3	74	4.1	0.654	53.6
25	South Africa	0.843	13.1	52	5.5	0.597	65.0
26	Egypt	0.697	11.7	73	3.8	0.620	34.4

27	Pakistan	0.492	7.3	65	2.7	0.490	30.6
28	Colombia	0.881	13.7	73	4.7	0.689	58.5
29	Malaysia	0.851	12.6	74	5.8	0.744	46.2
30	Belgium	0.994	16.4	80	6.4	0.867	28.0
31	Nigeria	0.657	9.0	51	3.1	0.423	43.7
32	Sweden	0.974	15.8	81	6.8	0.885	23.0
33	Philippines		11.7	68	2.7	0.638	45.8
34	Venezuela	0.913	14.4	74	3.7	0.696	41.0
35	Austria	0.962	15.3	80	5.5	0.851	26.0
36	Switzerland	0.936	15.5	82	5.4	0.874	33.7
37	Greece	0.981	16.3	80	4.1	0.855	33.0
38	Ukraine	0.939	14.7	69	5.3	0.710	27.5
39	Singapore	0.913		81	3.1	0.846	47.8
40	Vietnam	0.81	11.6	75	5.3	0.572	37.6
41	Peru	0.891	13.0	74	2.6	0.723	48.0
42	Czech Republic	0.938	15.3	77	4.1	0.841	26.0
43	Bangladesh	0.53	5.7	68	2.2	0.469	33.2
44	Chile	0.919	14.7	79	4.5	0.783	52.1
45	Norway	0.989	17.3	81	6.5	0.938	25.0

Source: Adapted from CIA, 2012, UNDP, 2010 and UNESCO, 2012

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