Effect of Education on Income Inequality: A Cross-National Study

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Abstract

This paper explores the effects of education on income inequality. Data from over 50 countries was used and income inequality was measured through the Gini coefficient. Two regression models were created and controlled for other factors that might affect income inequality. We hypothesize that a negative correlation exists between education and income inequality, and the results corroborate that there is a slight negative relationship between these two variables. Additional methods to improve the model and suggestions are also provided.

Introduction

There are many negative effects that income inequality has on a society, with societal problems ranging from health and crime rates to debt and political instability. This can be most greatly exemplified in the Great Gatsby Curve (Jerrim, Macmillan, 2015), where inequality can be linked to immobility in social groups, and the inability to "climb the ladder". Thus, many studies have been done on determining the causes of income inequality, most widely measured as the Gini coefficient, in order to influence specific policies aimed at targeting inequality. If the world continues on a path of globalization, inequality within countries will only get larger.

Despite plentiful of literature on causation of income inequality, we wanted to ascertain a specific explanation: impacts of education attainment on the Gini coefficient. It is important to understand how education spending can cause inequality, given heated debates over public and private education as well as differing levels of educational quality and government spending on education. Policies targeting the distribution of educational attainment through targeted government expenditures can thus reduce educational inequality leading to possible future social mobilities in income inequality. Without acting upon education inequality, income inequality will only continue to degrade due to social mobility issues. Hopefully, our model will provide a useful backbone to support policy structures targeting specific policies or educational spending procedures to prevent the degradation of the economy due to the destructive social nature of income inequality.

In an exponentially increasing industrialized and globalized world, which made wealth retaining easier while reducing the quality of life of the labor force through longer and more demanding journeys; and given the correlations of education levels with mortality rates, healthcare quality and overall economic growth, in this paper we would like to reassure the negative relation between education and inequality; and, even further, to prove higher education expenditure percentages of government expenditures work in favor of reducing income and wealth gaps in the long run.

Literature Review

The impact of education on income inequality is hard to discern since there are multiple factors in play. Education changes the configuration of the labor force as unskilled workers become skilled. Indeed, Sylwester (2002) confirms that devoting more resources to education may be one way to reduce the level of income inequality within a country. Even though the initial effect might be increased income inequality, the effect of it is lessened and reversed as the labor force becomes more educated and skilled (Abdullah, Doucouliagos, Manning, 2015), in other words reducing the college premium. The fact that educational spending by the government mainly affects the upper echelons of society due to the

subsidization of higher education leads to contradictory evidence in how education can actually cause changes in inequality.

Abdullah, Doucouliagos, and Manning (2015) paint an image where education is able to have the most impact on the top and low bands of income sharers, reducing the income of the most rich and increasing the incomes of the most poor, and more effective with the latter than the former. One of the interesting findings from this study was that secondary schooling was much more effective than primary schooling or higher education, and that if the only policy objective was reduction of income inequality, rather than for education resource allocation, secondary schooling should be targeted. More importantly, Africa was found to have a greater negative correlation between education and inequality, while Asia was relatively statistically insignificant. Regardless of measuring primary or secondary educational attainment, both using Gini coefficient or share of income as the variable for income inequality led to a negative correlation with inequality. However, the negative relationship is much more apparent if using the share of income variables since it is mainly the top and bottom shares of income that are affected, rather than the middle class.

Jerrim and Macmillan (2005) assert that educational attainment and education spending are key to solving the mobility gap and inequality. They find that those with greater incomes are more likely to invest in a child's education through both capacity and incentive motives. This leads to an assumption where better access to education resources will thus be able to reduce income inequality by providing these greater incentives. By measuring wage against education levels of attainment as well as costs, there is a link between economic inequality and education, where more unequal countries are spending lesser percentages on education. Moreover, university and education costs are much higher in these unequal countries, creating a gap that only continues to grow wider. However, Jerrim and Macmillan stress that these are still only associations and solving educational inequality first might then led to solving income inequality. This is also supported by Lee and Lee (2018), who state that reduction in educational inequality counteracts unequal income factors and that greater government/public spending on education leads to improving education inequality and thus income inequality.

The already complex intricacies of education-income inequality causality parameters were only aggravated in the last 50 years by globalization. Globalization definitely pushed the boundaries of high-quality education, as the internet has been closing the gap between knowledge accessibility and those interested in learning. On the other hand, this worldwide trend raised a whole debate on economic freedom and protectionist measures, which relationship proved to be inconclusive due to varying results across multiple studies (Wells, 2006).

In economic terms, Wells (2006) states how neoliberal policies disseminated by increasing states' interconnections may be responsible for the shift from inequality across borders to greater inequality within borders. 'The reduction of the redistributive role of the state; the decline in union presence in the workplace; the increased competition at the international level; technological progress and all possible combinations of these' (Checchi, 2000) are possible causes, to name a few. Wells also mentions the pioneer study by Kuznets (1955) of the U-shaped curve association between economic development and income inequality, in which an initial growth burst leads to increasing inequality at first, but a persistent development eventually reduces inequality. A more detailed analysis suggests this curve to be extended to a "U-turn" as the relationship reverses once more for the highest-income countries.

Invariably, Wells urges globalization repercussions must be considered in the world inequality framework given its strong correlation to both education and economic development. His addition to the literature is the confirmation that a country's level of economic freedom affects the education's impact on inequality; thus, increasing secondary enrollment will not have equal effects in all countries. According to him, globalization has encouraged the commodification of education through decentralisation and privatization. In the context of more economic and individual freedom, upper classes may be able to propagate their educational advantages given an initial imbalance. The result is that even national policies expand access to education, levels of inequality may not decrease. Privatisation policies have the inherent danger “that they simply reinforce educational inequalities by encouraging the wealthy sectors of society to create a private educational system” (Morrow & Torres, 2000).

All previous assumptions stated here and in most of the literature are further corroborated by a behavioral study from Dias (2005). He analyses education policies' outcome in a democratic system under the assumption of the median voter theorem for two education system scenarios: 1. Only public education; 2. Combined public and private education. On the scenario with entirely public education, education investment and higher education quality will reduce income inequality over the long run. On the other hand, where there are simultaneous public and private education systems, income inequality will only be reduced if income tax converted to public education exceeds income invested in private education, therefore closing the quality gap between the two systems. Moreover, he concludes that if the existing system is chosen by the median voter, public and private combined system will prevail as it gives the greater income growth rate to the taxpayer. This study confirms that, indeed, investment in education can reduce inequality; it explains how economic freedom impacts the extent of educational attainment policies' efficacy; and it also presents why there is persistence in income inequality over time and across-countries.

Our contribution to the literature is bringing in newer data across multiple countries. Furthermore we are using the Gini coefficient, rather than income share or other measures of income inequality. This is mainly from a practicality standpoint given the ease of obtaining the Gini coefficient and the difficulty in obtaining income shares. We have also used educational spending as a proportion of government expenditure as a measure of educational levels rather than on just primary or secondary schooling, as this should give a more accurate measure of how the nation is spending its money as a proportion of its entire spending on education.

Data

There are 7 variables, 6 independent and 1 dependent. The independent variables are: government expenditure on education as a percent of total government expenditure, GDP per capita of the country in USD; mortality rate of infants per 1,000; school life expectancy (average number of years a student will spend in school); and Government Expenditure on education for Secondary and Tertiary school as a percent of GDP per capita. The Gini coefficient is our dependent variable. We are testing how the amount of education of a country's population affects income inequality: the Gini coefficient. The amount of money a government spends on education is likely to be correlated with how much education its population receives, and previous literature suggested that spending on secondary and tertiary education have opposite effects on income inequality, so they are separate variables. The same is true for a country's GDP. The more money a country has the more it can spend on education. Also the GDP of a country is also likely correlated with the countries' income inequality. The infant mortality rate is a good indicator to the health level of the family unit in a country which affects the amount of education a student would receive and the amount of income inequality in the country.

All data for the independent variables were taken from the World Bank and HDI index in the years 2010, 2011, and 2012. The Gini coefficient was taken from the World Bank in the years 2015, 2016, 2017. The independent variables were taken from earlier years, so that there is time for them to affect the Gini coefficient. A table with all of the countries and years is in the appendix.

Summary Statistics of the Data

Variable	Observations	Mean	Std. Dev.	Min	Max
GovtExpend	140	14.58%	5.41%	3.95%	37.5%
SecondaryExpend	114	19.15%	9.83%	2.59%	53.7%
TertiaryExpend	111	56%	77.84%	0%	571.4%
School Expectancy	191	12.9 years	2.84 years	4.9 years	20.3 years
GDP per Capita	251	$15615	$23119.8	$283.5	$166726.1
InfantMortRate	238	22.75 deaths	19.55 deaths	1.5 deaths	86.5 deaths

Summary Statistics of Variables. See Appendix for full variable information.

Summary statistics for the described variables are shown in the table above. The largest fluctuations are noticed in tertiary expenditure, where countries like Niger spent 571.4% of GDP per capita on tertiary expenditure, while the mean was only 56% of GDP per capita. The rest of the variables did not have as much of a standard deviation difference.

Gauss Markov Assumptions

- The model is linear by parameters.
- The sample is random because it is taken at random from the population data. It is all data that had both Gini and School Expectancy data with no other consideration taken into account.
- There is no perfect collinearity between the independent variables: The highest R^2 is .3395 between School Life Expectancy and GDP per capita. See appendix for a table of all R^2 values of the independent variable correlations.
- The R^2 from the multiple regression model is .4285. The sample size is 23. Based on the R^2 and small sample size, we would not assume Zero Conditional mean.
- Also based on the small sample size of our data set it is unikey that our data meets homoskedastic assumptions.
- Government expenditure and GDP are highly correlated, but they are not perfectly correlated, so there is no perfect collinearity.
- Based on the data above it is impossible to prove Zero Conditional Mean. It would also be hard to assume Zero Conditional Mean because of the small R^2. There is a high likelihood the data is biased in some way, see Interpret the Results for ways to improve the data set.
- Because of the high correlation between government expenditure and GDP and the small sample size it is unlikely that our data set meets the homoskedastic assumption. It would be wise to

increase the sample size or the number of independent variables before assuming homoskedasticity.

Results

Simple Regression Model

Simple Regression Equation:

Gini = 50.98387 - .97651Schoolexpect + u

Independent Variable	Number of Observations	Coefficient	R^2
School Life Expectancy	89	-1.1448***	.1449

Significant at * 10%, ** at 5%, *** at 1%

Multiple Regression Model

Multiple Regression Equation:

Gini = 29.691 - 1.0625SchoolExpectency + .0996InfantMortRate + .0000366GDPperCapita + .79217GovtExpend - .0358TertiaryExpend + .45467SecondaryExpend + u

Table

Independent Variable	Simple Regression	Multiple Regression [1]	Multiple Regression [2]	Multiple Regression [3]
SchoolExpectancy	-1.1448***	-.7651	-1.0625	-.3433
InfantMortRate	-	.2259**	.09963	.0605
GDP^	-	-1.08e-12	-	-
GovtExpend (in USD)^	-	.0000619	-	-

GovtExpend(% of Government Expenditure)	-	-	.7921	.2219
GDPperCapita	-	-	.0000366	-.000104*
TertiaryExpend	-	-	- .0358	-
SecondaryExpend	-	-	.45467**	-

Significant at * 10%, ** at 5%, *** at 1%

^GDP and GovtExpen in USD were replaced by GDP per Capita and GovtExpend % of Government Expenditure in latest models and are not included in summary statistics.

P-values

Independent Variable	Simple Regression	Multiple Regression [1]	Multiple Regression [2]	Multiple Regression [3]
SchoolExpectancy	.0000	.34	.398	.381
InfantMortRate	-	.038	.261	.203
GDP*	-	.855	-	-
GovtExpend (in USD)*	-	.610	-	-
GovtExpend (% of Government Expenditure)	-	-	.146	.215
GDPperCapita	-	-	.809	.098
TertiaryExpend	-	-	.256	-
SecondaryExpend	-	-	.022	-

*GDP and GovtExpen in USD were replaced by GDP per Capita and GovtExpend % of Government Expenditure in latest models and are not included in summary statistics.

Interpretation

In the simple regression model, School life expectancy has a negative correlation with Gini. As School Expectancy increases by one year the gini coefficient decreases by -1.1448. This is statistically significant to 1% according to t-statistics and according to p-values it is also statistically significant to 0.00%. This means that in the simple regression model increasing the amount of education the average student of a country gets decreases income inequality. There is a scatter plot in the appendix to show this correlation. The model as 89 observations, but the probability of factors in u affecting gini is high in single regression models.

We must look toward multiple regression models in order to gain a better understanding of the correlation between the amount of education and income inequality. We first added gdp in USD, Government Expenditure on Education in USD, and infant mortality. We assumed that GDP and infant mortality would affect the gini coefficient and wanted to be able to hold them constant. We also assumed Government Expenditure on Education would affect School Life expectancy, so we wanted to have that variable as well. After running the model we realized that GDP and Government Expenditure, both measured in USD were causing multicollinearity. We replaced these variables with GDP per capita and Government Expenditure on Education as a percent of total government expenditure. We also added percent of GDP spent on Secondary and Tertiary education after reviewing literature that states they affect income inequality.

After running this model, School life expectancy was no longer significant at 10% or lower and according to p-values started statistical significance at 39.8%. It also has a lower coefficient, in the new model one more year of education only decreases the gini coefficient by -1.0625. The only statistically significant variable is Secondary Expenditure which is significant at 5% according to t-statistics and 2.2% according to p-values. It has a positive correlation with gini coefficient, and increase in 1% of GDP spent on Secondary Education increases the gini coefficient by .45467. The means that an increase in spending on secondary education increase income inequality. Unfortunately the model only has 23 observations so the model is likely not a normal distribution and its conclusions don't follow CLM assumptions.

In an attempt to increase the number of observations, we removed Secondary and Tertiary Expenditures, this increased the number of observations to 65, but all variables remained statistically insignificant and the effect of School life expectancy on the gini coefficient dropped to -.3433. The R^2 also dropped dramatically from .4284 to .1974 while you can expect some decrease in R^2 when removing variables such a large drop leads us to believe that Secondary Expenditure and Tertiary Expenditure need to be in the model to get as accurate as possible result.

Ultimately our lack of observations makes it difficult to determine the actual effect of the amount of education on income inequality, but throughout all the models School life expectancy remained below zero, so we may infer that while we can't determine the magnitude of the effect of the amount of education on income inequality, we can suggest that is has a negative correlation. Therefore increasing the average amount of education decreases income inequality. All STATA outputs from our models will be in the appendix.

Extensions

F-tests

Unrestricted Critical Value: 2.67

Using the equation of:

$$\frac{(R^2_{UR}-R^2_R)/q}{(1-R^2_{UR})/(n-k-1}$$

If all variables were equal to 0, except for SchoolExpectancy(essentially the simple regression), then F= 1.6875, making the 5 variables of InfantMortRate, GovtExpend, GDPperCapita, TertiaryExpend, and SecondaryExpend not jointly significant.

If GovtExpend = GDP per Capita = 0 then F = .84878 making them not jointly significant. However if SecondaryExpend = TertiaryExpend = 0 then F = 2.72815 making them jointly significant.

We fail to reject the null hypothesis for these two restricted models and so they are not jointly significant. However, in the third F-test model for the types of education expenditure, the F-value was slightly higher than the critical value, and we can reject the null hypothesis that they are not jointly significant. We can say that at the 5% level of significance, the variables of SecondaryExpend and TertiaryExpend are jointly significant.

Confidence Intervals at 95%

Independent Variable	**Confidence Intervals at 95%**
SchoolExpectancy	(-3.54678, 1.5295)
InfantMortRate	(-.0815, .2808)
GovtExpend (% of Government Expenditure)	(-.30618, 1.89)

GDPperCapita	(-.000278, .0003316)
TertiaryExpend	(-.10024, .0286)
SecondaryExpend	(.07311, .8362)

The confidence intervals corroborate the t-statistics. Only Secondary Expenditures has an interval that doesn't include 0. This makes Secondary Expenditures our only significant variable in the multiple regression. This information is of course made less important by the fact that our model only has 23 observations meaning our data is likely not a normal distribution.

Conclusion

Education attainment does have a negative relationship with income inequality, however it was only statistically significant in the simple regression model; this might have been due to the fact that our multiple regression had a low amount of observations. When adding in other variables like specific types of education expenditure (secondary or tertiary), government expenditures in education, GDP per capita, and infant mortality rate, there is a decrease in the coefficient of school life expectancy. This may indicate that school life expectancy may not have a significant impact on income inequality. The only variable in the multiple linear regression model that was significant was secondary education expenditures, which has been supported by previous literature to provide greater social mobility to the working and middle classes thus reducing income inequality as shown by the Great Gatsby Curve (Jerrim, Macmillan 2015). However, our model showed that this was a positive correlation, indicating that greater secondary expenditure will actually cause greater income inequality. Furthermore the tertiary expenditure was also negative and statistically insignificant, suggesting that greater expenditures in tertiary education can reduce income inequality. When conducting our robustness tests, there were no joint significance, except for secondary and tertiary expenditures. Both of these specific education expenditure correlation coefficients goes against prior literature research, so further research should be done to extrapolate what is incorrect about our model and infer what the actual effect on different types of education expenditures have on inequality.

Our model is probably missing some important factors that we haven't controlled for, especially demographic and economic factors like age structure, urbanization, unemployment, and taxation. By reducing the omitted variable bias, by the inclusion of more variables or refining the variables, the model may show statistical significance for school life expectancy in the multiple linear regression model. One

other major problem our model faced was the lack of available data for a lot of countries, e.g. the simple linear regression model only had 89 countries and the multiple linear model had under 50 available countries. Going forward, an inclusion of more observations and a refinement of variables would strengthen the model.

Appendix

R^2 Table

	School Expectancy	InfantMortRate	GovtExpend	GDPperCapita	Tertiary Expend	SecondaryExpend
School Expectancy	-	.1254	-	-	-	-
InfantMortRate	-	-	-	-	-	-
GovtExpend (% of GDP)	.0995	.3828	-	.0928	.0003	.0094
GDPperCapita	.3395	0523	-	-	-	-
TertiaryExpend	.3366	.3906	-	.0599	-	-
SecondaryExpend	.0145	.0160	-	.0493	.0003	-

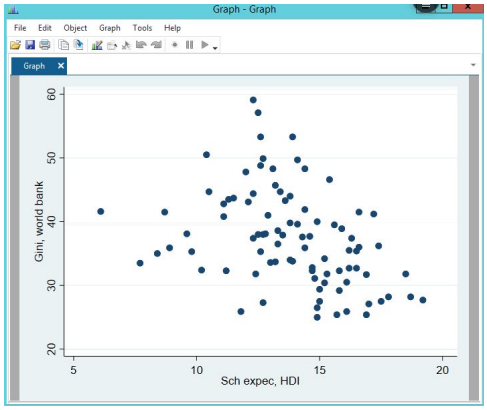
Variable Information

Variable	Variable Definition	Year	Source	No. of Instances
Gini	index (World Bank estimate)	2017	World Bank	25
Gini	index (World Bank estimate)	2016	World Bank	17
Gini	index (World Bank estimate)	2015	World Bank	50
School Expectancy	Expected years of schooling (years)	2012	HDI	191
InfantMortRate	Mortality rate, infant (per 1,000 live births)	2012	World Bank	238

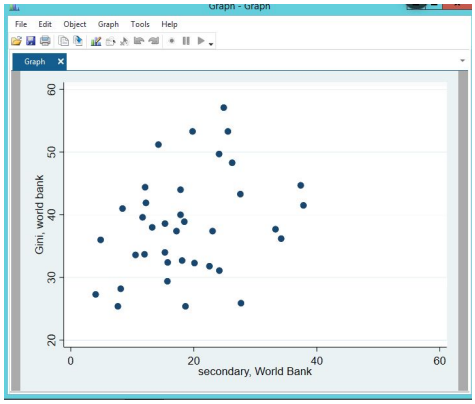
GovtExpend (% of Government Expenditure)	Government expenditure on education (% of Government Expenditure)	2012	World Bank	108
GovtExpend (% Government Expenditure)	Government expenditure on education (% of GDP)	2011	World Bank	21
GovtExpend (% Government Expenditure)	Government expenditure on education (% of Government Expenditure)	2010	World Bank	11
GDPperCapita	GDP per capita (current US$)	2016	World Bank	5
GDPperCapita	GDP per capita (current US$)	2017	World Bank	246
TertiaryExpend	Government expenditure per student, tertiary (% of GDP per capita)	2012	World Bank	84
TertiaryExpend	Government expenditure per student, tertiary (% of GDP per capita)	2011	World Bank	19
TertiaryExpend	Government expenditure per student, tertiary (% of GDP per capita)	2010	World Bank	7
SecondaryExpend	Government expenditure per student, secondary (% of GDP per capita)	2012	World Bank	87
SecondaryExpend	Government expenditure per student, secondary (% of GDP per capita)	2011	World Bank	25
SecondaryExpend	Government expenditure per student, secondary (% of GDP per capita)	2010	World Bank	11

Scatter Plots of Significant Variables

Gini and School Life Expectancy



Gini and Secondary Expenditure



STATA OUTPUT

SLR [1]

```
. regress Giniworldbank SchexpecHDI
```

Source	SS	df	MS	Number of obs	=	89
				F(1, 87)	=	14.74
Model	745.832455	1	745.832455	Prob > F	=	0.0002
Residual	4401.65563	87	50.5937429	R-squared	=	0.1449
				Adj R-squared	=	0.1351
Total	5147.48809	88	58.4941828	Root MSE	=	7.1129

Giniworldb~k	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
SchexpecHDI	-1.144886	.298188	-3.84	0.000	-1.737567	-.5522054
_cons	53.25807	4.190747	12.71	0.000	44.9285	61.58763

MLR [1]

```
. regress gini Schoolexpect mbirthrate GDP govtexpend
```

Source	SS	df	MS	Number of obs	=	35
				F(4, 30)	=	3.48
Model	522.628844	4	130.657211	Prob > F	=	0.0188
Residual	1125.38658	30	37.5128862	R-squared	=	0.3171
				Adj R-squared	=	0.2261
Total	1648.01543	34	48.471042	Root MSE	=	6.1248

gini	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
Schoolexpect	-.7119243	.7343384	-0.97	0.340	-2.211643	.7877947
mbirthrate	.225995	.1043354	2.17	0.038	.0129137	.4390763
GDP	-1.08e-12	5.88e-12	-0.18	0.855	-1.31e-11	1.09e-11
govtexpend	.0000619	.00012	0.52	0.610	-.0001832	.000307
_cons	42.99811	12.13305	3.54	0.001	18.21911	67.77711

MLR [2]

```
. regress Giniworldbank tertiaryWorldBank secondaryWorldBank govtexpenWorldBan
> k GDPperCapitaWorldBank SchexpecHDI InfantMrtaityRate
```

Source	SS	df	MS	Number of obs	=	23
				F(6, 16)	=	2.00
Model	426.019705	6	71.0032841	Prob > F	=	0.1257
Residual	568.353339	16	35.5220837	R-squared	=	0.4284
				Adj R-squared	=	0.2141
Total	994.373043	22	45.1987747	Root MSE	=	5.96

Giniworldb~k	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
tertiaryWo~k	-.0358139	.0303935	-1.18	0.256	-.1002453	.0286176
secondaryW~k	.4546793	.1799889	2.53	0.022	.0731199	.8362386
govtexpenW~k	.7921702	.5181173	1.53	0.146	-.3061894	1.89053
GDPperCapi~k	.0000366	.0001486	0.25	0.809	-.0002784	.0003516
SchexpecHDI	-1.062588	1.222739	-0.87	0.398	-3.654678	1.529502
InfantMrta~e	.0996352	.0854799	1.17	0.261	-.081574	.2808445
_cons	29.69128	20.38144	1.46	0.165	-13.51545	72.898

MLR [3]

```
. regress Giniworldbank tertiaryWorldBank secondaryWorldBank govtexpenWorldBan
> k GDPperCapitaWorldBank SchexpecHDI InfantMrtaityRate
```

Source	SS	df	MS	Number of obs	=	23
				F(6, 16)	=	2.00
Model	426.019705	6	71.0032841	Prob > F	=	0.1257
Residual	568.353339	16	35.5220837	R-squared	=	0.4284
				Adj R-squared	=	0.2141
Total	994.373043	22	45.1987747	Root MSE	=	5.96

Giniworldb~k	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
tertiaryWo~k	-.0358139	.0303935	-1.18	0.256	-.1002453	.0286176
secondaryW~k	.4546793	.1799889	2.53	0.022	.0731199	.8362386
govtexpenW~k	.7921702	.5181173	1.53	0.146	-.3061894	1.89053
GDPperCapi~k	.0000366	.0001486	0.25	0.809	-.0002784	.0003516
SchexpecHDI	-1.062588	1.222739	-0.87	0.398	-3.654678	1.529502
InfantMrta~e	.0996352	.0854799	1.17	0.261	-.081574	.2808445
_cons	29.69128	20.38144	1.46	0.165	-13.51545	72.898

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