Worldwide Poverty Convergence

Jacob Peirce

Abstract

Poverty impacts hundreds of millions of people around the world. Poor nutrition, housing and living conditions, and other adverse effects from poverty have a lasting impact on those unfortunate enough to be in poverty. In this paper, I test for convergence of the Watts index of poverty across over forty countries over a period of fifteen years.

My model is based on a previous model formulated by Miao and Dhongde (2013). We model the annual average growth rate of the Watts index as a function of the index in the initial year $t = 0$. We can then test for convergence or divergence across varying time horizons, such as $t = 5$, 10, or 15 years. We found that there is some significant evidence for divergence of the Watts index, rather than convergence.

Introduction

Poverty is an incredibly important and widespread problem. It is generally defined by a poverty line, where being below the poverty line defines you as being "in poverty". This line is based on the costs of living and varies by country. The poverty line in the United States for a single person with no children under the age of 65 in 2014 was $12,316, and that number only increases as the size of the family unit increases. In 2013, 14.5% of the entire population of the United States was considered to be in poverty, which totals up to be 45.3 million people considered to be in poverty. Poverty lines generally differ between countries. However, there is an international poverty line, which is currently set to be earning $1.25 a day or less.

It is important to make a distinction between absolute and relative poverty when dealing with poverty lines of different countries. Gross National Income per capita, or GNI, is a decent indicator of standards of living. The GNI per capita of the United States in 2013 was $53,470. This is a stark contrast to the $440 GNI per capita of Uganda. The poverty line for one person in the United States is $12,316 of income for one year. This means that an American with only $5,000 in income would be considered very deep into poverty in the United States. However, this same person with $5,000 of income in Uganda would be incredibly rich and far above the poverty line. A person in Uganda that earns only fifty cents a day would be considered both absolutely and relatively deep in poverty. This is an example of the importance of distinguishing between poverty lines and dealing with absolute vs. relative poverty when examining differing countries. This difference in countries becomes even more pronounced when Federal programs are introduced. Programs that assist the poor in the United States, such as the Supplemental Nutrition Assistance Program (SNAP, otherwise known as food stamps) and Federal subsidies do not count when determining who is in poverty. Thus, even the poorest Americans may still be better off than some of the slightly less poor, but still in poverty, Ugandans.

The Obama administration has made it a priority to fight poverty in the United States. There have been numerous programs introduced over the years in the United States to combat poverty. From food stamps to a progressive tax system to tax breaks, the number of benefits to those in need have increased in recent years due to the Great Recession. However, these increased benefits are still not enough to eliminate poverty in the United States, with a small, but

non-zero, number of people living underneath the World Bank's international poverty line of $1.25 a day.

This paper will look at poverty as measured by the Watts index. A more common measure of poverty until this point has been the headcount ratio, which is the proportion of people who live at or below the poverty line. This is an effective measurement, but does not pick up on absolute poverty changes. As an example, country "X" has a headcount ratio of 0.10 (that is, ten percent of the population in country X has income less than or equal to the poverty line). If those ten percent of people become poorer, then the country's poor fall deeper into poverty, but the headcount ratio will stay the same. Thus, I believe the Watts index is a superior measure of poverty because it takes into account both the number of people in poverty and how deep into poverty each person is. The Watts index is defined as

$$W = \frac{1}{N}\sum_{i=1}^{q}[\ln(z) - \ln(y_i)]$$

where W is the index, N is the population, q is the population living beneath the poverty line, z is the poverty line, and y_i is the income of person i. The Watts index incorporates important facets of an accurate representation of poverty in a country, and is, as a result, an effective representation of poverty in a country.

Literature Review

Poverty is the subject of much research by scholars and is important to understand for government officials as well. This is why an accurate and valid measure of poverty is critical to effective measurement and policy considerations. A poverty measure should not be affected by the income distribution of those not in poverty, it should increase if a poor person's income decreases, and it should be decomposable (that is, the index should increase when poverty in a subgroup of the population in poverty increases as well) (Foster, Greer, & Thorbecke, 1984). The Watts index is one of the few measures of poverty that satisfies these requirements.

There have been other studies conducted on poverty convergence. Classic economic theory dictates that countries with low mean income tend to have higher economic growth

(Ravallion, 2012). Mean income is related to a countries means of production, and countries with a lower mean income will generally have less human and physical capital than more developed countries. However, because of the law of diminishing returns, these well developed countries tend to have slower growth rates. In theory, businesses will invest in new capital in these poorer countries, where there is less capital so that there will not be diminishing returns. As a result, poorer countries will enjoy relatively quick growth in the form of "catch-up" effects. There are problems, however, with this theory in practice. For one, poorer countries may have higher potential returns, but their risk may also be substantially higher as well, which can severely hurt investment. The classic theory of convergence in economics also generally assumes that poorer countries can quickly and easily adapt and copy the new and very efficient methods of production of the richer countries, which is not always feasible. Ravallion found that high levels of initial poverty had a dampening effect on the growth rates of these countries, and he also found that there is no evidence of convergence of poverty levels. The populations in poverty stricken countries will, almost by definition, be forced to spend most or all of their money on simple subsistence and are not able to invest their money into their country or abroad. This leaves little room for capital investment in poor countries without foreign intervention. This problem is compounded by the already risky prospect of investing in countries without proper infrastructure. A family in poverty will also, in many cases, not have enough money to provide enough food and nutrition for themselves. This has long lasting effects on the population itself. Poor nutrition leads to a lower life expectancy on average, which reduces the aggregate output of an economy. Combine that with the very low savings and investment in a country with high initial poverty, and it is no surprise that high poverty levels can constrain growth and we have not seen poverty convergence.

In attempting to calculate the World Distribution of Income, or WDI, Xavier Sala-i-Martin also calculated poverty rates during the time period of 1970-2000. Once he calculated the WDI, he was able to use this information to find poverty rates for multiple regions and at multiple times. He analyzed four separate poverty lines. These lines were designated by the World Bank and calculated using a 1, 2, 1.5, or 3 dollar a day rate of income. He also analyzed poverty rates for East Asia, South Asia, Africa, Latin America, Eastern Europe, MENA, and the

entire World. By using headcount ratios, he found that, in general, the absolute number of people in poverty decreased over time worldwide and the rate of poverty steadily decreased from 1970 to 2000. Poverty decreased by nearly a factor of three worldwide over the thirty years analyzed. However, not all regions received this same reduction in poverty rates. World, Asia, and MENA (Middle East and North Africa) regions all experienced poverty decline over the thirty year period. Latin America and Eastern Europe saw both decline and increase, but they both saw an average decrease over the thirty year period. Africa, however, when analyzed during ten year intervals, saw no reduction in poverty over time. In fact, Africa, in 1970, accounted for 13.4% of the world's poor. But in 2000, Africa held 74.5% of the world's poor, despite having only 10.7% of the world's population! This information implies that poverty may be decreasing over time as a whole (and, thus, converging), but not in certain regions.

Martin also made it clear that careful analysis of variables and how they are used is critical to obtain valid observations derived from data analysis. In his paper, he tells us that the literature before him showed that incomes tended to diverge and that there was no correlation between growth rates and income per capita. However, these figures and facts used data that was not population weighted, which biased the data. Once the countries being used in the analysis were weighted by population, he found that "the incomes of poor citizens have grown faster (β-convergence), and measures of income inequality have declined (σ-convergence)" (Martin 2006).

Another factor that cannot be denied analysis is income inequality in poor countries. François Bourguignon found in his paper on growth, poverty, and income inequality that a high level of income inequality reduced the growth elasticity of poverty, which is the percentage reduction in poverty rates divided by a percentage change in mean income (Bourguignon, 2002). This essentially means that those who are both in poverty and in a country with high income inequality will see much smaller reductions in poverty given an increase in income per capita. This is important to policy makers and scholars alike because the typical response to reducing poverty in the long run has been to provide sustained growth in the economy. This is generally an effective strategy, but efforts to affect the elasticity of poverty in addition to sustained growth may be a more effective option in alleviating the poverty problem. Bourguignon suggests that a

permanent redistribution of income will "double dip" in reducing poverty by both alleviating some poverty through a "distribution effect" and by increasing the poverty elasticity of growth, which will result in an increase in the rate of poverty reduction.

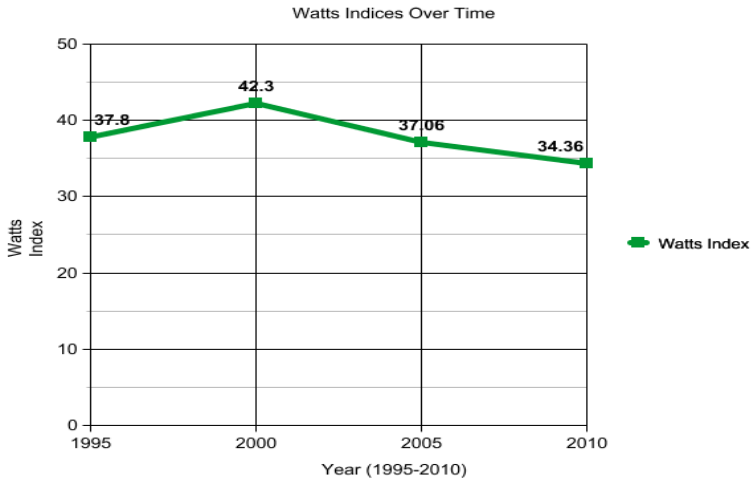
This paper aims to add to the current literature by looking at a different measure of poverty than the headcount ratio. The current literature has put an emphasis on using the headcount ratio, as it is widely available and intuitive to use and interpret. While the headcount ratio is useful for determining poverty rates, it is insufficient at measuring the depth of poverty beneath the poverty line and does not fulfill the principles that Ravallion claims make a good poverty index. Although the Watts index is not very intuitive to interpret, it is nevertheless a useful measure that can be used to add to current analysis using other, more intuitive, measure of poverty.

Data

All of the data has been compiled from the World Bank's PovcalNet (Povcal). The World Bank publishes information on income inequality and poverty. The headcount ratio, poverty gap, Watts index, and mean log deviation of income are just some of the numbers available. There are over one hundred countries for which data is available. However, many countries are missing data values for some years, and some countries have relatively little information available. As an example, there are only two points of data on the Watts index available for Algeria (in 1988 and 1995), whereas Brazil has all but four data points available from the years 1985 to 2012. In addition, while there is a lot of data available, not all of it is high quality. Many countries have data entries that are not valid and, as a result, are not good for data analysis. As an example, Burundi has a Watts index of 63.03 in the year 1992, but a data entry of "n/a" for 1998. There are also many entries of "not a number" for many of the countries, which does not make much sense and has little value for analysis. In addition, the regression equation I used estimated for convergence over five year increments, but some countries either had no data for those years or had no data within two years of the desired year. If a country was missing a year of data for either 1995, 2000, 2005, or 2010, but an adjacent year contained data, then either the average of the adjacent years or the closest year for which there was data was used. Finally, some data had

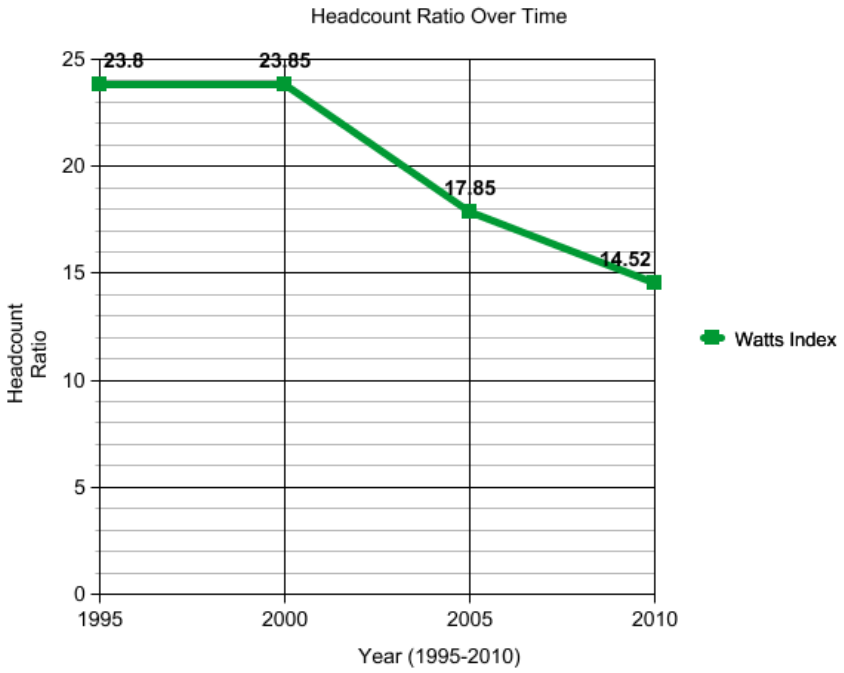
very large deviations and outliers in certain years. These outliers were corrected for by averaging the yearly data points before and after the outlier year. Because of these limitations, I only used data that had consistent data over time without any nonsensical data points and data that had outliers that could be corrected. This limited my data to only forty countries, but forty should be sufficient for a simple regression. Of these forty countries, some did not have data for 1995. Only thirty-three countries were able to be used in equations involving 1995, which is still enough for a simple regression. Graph 1 shows the average Watts index of all countries sampled for each year.

Graph 1



The graph shows that poverty has roughly trended downward over the past 15 years, with a spike in the year 2000. This is consistent with the literature's finding that poverty levels have been more or less decreasing over time. Graph 2 references the average headcount ratio from 1995 to 2010 in the sampled countries. I compiled this data in order to see if the decreasing trends in poverty mentioned in the literature are continuing today. It would seem that the trends of 1970 to 2000 are continuing today, with strong poverty decline being shown – especially in the more recent years of 2005 and 2010. These two graphs also highlight an interesting point to note regarding the measurement of poverty. The Watts index clearly trended upward from 1995 to 2000, but the headcount ratio stayed nearly the same. This implies that those who were in poverty actually became poorer between 1995 and 2000 since the ratio of poor to non-poor stayed constant.

Graph 2



My poverty line of choice was the line set forth by the World Bank, which is set to be an income of $1.25 a day. This line is consistent across all of our observations, which eliminates the need to account for different poverty lines when calculating the index.

Table 1

Variable	Obs	Mean	Std. Dev.	Min	Max
Y1995	33	38.36864	21.39916	1.6	76.97
Y2000	40	43.082	24.15671	.56	121.5
Y2005	40	38.06137	22.80407	.37	99.75
Y2010	40	34.54887	21.26019	.09	92.68

The descriptive statistics in Table 1 show the forty countries' means and standard deviations used in the analysis. A list of countries used with descriptive statistics is provided in the appendix. There is a very high variance in the data, with a relatively high standard deviation for each year. This is not surprising, considering the wide range of countries used in the analysis.

Because there were some countries with missing data on or around 1995, there are only 33 observations for the 1995 variable.

This paper uses the regression equation put forth by Miao and Dhongde in their paper on Gini index convergence. The dependent variable in the equation is a representation of the growth rate of the Watts index over time. Using the natural logarithm linearizes the numbers and turns them into growth rates. By dividing by the time over which the equation is estimated, we obtain the growth rate in the index from the initial to final year as the dependent variable. The independent variable is the natural logarithm of the Watts index in the initial year, along with a constant term and a zero mean error term.

$$\frac{1}{t}\left(\frac{Watts_{i,T}}{Watts_{i,T-t}}\right) = \alpha + \beta \ln\left(Watts_{i,T-t}\right) + u_i$$

Where t is the initial year, T is the final year, α is a constant, β is the convergence coefficient, and u_i is the zero mean error term. A negative convergence coefficient would imply that the growth of the Watts index is converging over time, and a positive coefficient would imply that the index growth is diverging over time.

When interpreting the results, it is important to remember the Gauss Markov assumptions and make sure they apply to the regression equation. The first assumption – linearity of parameters, is indeed satisfied in this equation. The expected value of the error term is also zero for all given observations. As there is only one independent variable, we do not have to worry about multicolinearity in our model. In addition, the error term is not correlated with our observations and the error term is independently distributed. Finally, are errors are homoscedastic, which means that all of our Gauss-Markov assumptions are satisfied by our model. However, the model does assume that all countries are structurally similar, which is certainly not the case. Miao and Dhongde found that Gini coefficients in developed countries converged to a different value than developing countries using the same model, and it is not a stretch to imagine the same can happen to poverty indices. When more data becomes available, it would be wise to separate developed and developing countries in the analysis.

Results

The results show that there is some evidence for divergence of the growth of the Watts index over time. The convergence coefficients ranged from -0.02 to 0.04. However, only two of the regression outputs were statistically significant. These two statistically significant outputs were from 2000 to 2010 and from 2005 to 2010, and these coefficients were 0.026 and 0.040, respectively. These significant coefficients are positive, which suggests that the growth in the Watts index diverged over these time periods, rather than converged as other measures of poverty have indicated. The time period of 1995 to 2010 did not have a significant coefficient, which suggests that the index has only been diverging in very recent years. This is further supported by the fact that the 2005 to 2010 time period coefficient is more significant than the 2000 to 2010 coefficient, and that the 2000 to 2005 coefficient is not statistically significant. Other time periods, such as from 1995-2000, were tested as well, but they were not statistically significant either. Table 2 shows the date ranges over which convergence was estimated, as well as the coefficient and standard error of the estimation.

Table 2

	1995	2000	2005	Constant	Observations	R^2
1995-2000	-0.0199 (0.0216)			0.0893 (0.0753)	33	0.027
1995-2005	0.00349 (0.0131)			0.00515 (0.0458)	33	0.002
1995-2010	0.0146 (0.0105)			-0.0689* (0.0365)	33	0.059
2000-2005		0.0107 (0.0112)		-0.0724* (0.0406)	40	0.023
2000-2010		0.0262*** (0.00879)		-0.128*** (0.0319)	40	0.190
2005-2010			0.0401*** (0.0100)	-0.170*** (0.0349)	40	0.297

(* indicates significance, significant at *10%, **5%, ***1% levels)

As is evident in the table, only the coefficients for 2000-2005 and 2000-2010 were significant. In order to test the robustness of these results for outliers, a robust regression was performed in Stata as well. A robust regression is used when possible outliers can heavily influence and affect both the statistical significance and the OLS estimators. The results are shown in Table 3. The data appeared to only contain one very strong outlier, which was removed for this regression. As can be seen in Table 3, the same hypothesis that the Watts index has been diverging in recent years is upheld. The significance of the 2005-2010 equation is reduced, but it is still a statistically significant finding, and the p-value of the 2005-2010 equation was 0.051, which is also incredibly close to 5% significance.

Table 3

	1995	2000	2005	Constant	Observations	R^2
1995-2000	-0.00243 (0.0169)			0.0132 (0.0597)	32	0.001
1995-2005	-0.0190 (0.0145)			0.0625 (0.0514)	32	0.054
1995-2010	-0.00814 (0.0106)			0.0154 (0.0376)	32	0.019
2000-2005		0.00952 (0.00960)		-0.0600* (0.0349)	40	0.025
2000-2010		0.0239*** (0.00782)		-0.120*** (0.0284)	40	0.197
2005-2010			0.0251* (0.0125)	-0.121*** (0.0440)	39	0.099

When considering the results, it is important to understand what the Watts index diverging actually "means". The form of equation used measures the growth in the index. If the growth were converging, then eventually the index would hover around a singular number across all countries as growth became slower and eventually reached zero. As it is diverging, this means

that the growth rate so far has not shown evidence that it is approaching a steady state yet and may not be able to reach a steady state for some time. The literature points to a relatively steady decrease in poverty over time, and the index has been shown to be decreasing over more recent time periods as well. The only explanation for this is that the Watts index of poverty is decreasing, and the growth rate of this decrease is not converging or slowing down. If this is the case, and we assume that the index itself is decreasing over time, this implies that countries are, on average, decreasing their levels of poverty faster than in the past. What exactly is changing in the country is not clear, however. A decrease in population beneath the poverty line will affect the index, but so will an increase in income of the poor in the country, which means a comparison to the headcount ratio will be required to pinpoint where the decrease in poverty happened. If it is true that the index is diverging and steadily decreasing over time, eventually we may see convergence to a much lower steady state. Further research would be required to verify or disprove this claim.

Conclusion

Poverty in the world we live in is a serious problem. There is evidence that poverty has been steadily decreasing in the world since as early as the 1970's, but we are far from done fighting poverty. Even in the United States there are people who live on less than $1.25 a day of income. Divergence in the growth of the Watts index implies that the change in poverty growth or decline is not slowing down or converging. This is uplifting news to hear when we can observe that poverty is decreasing overall in the world when measured by both the headcount ratio and the Watts index (and, thus, poverty is decreasing faster than in the past).

There are further research opportunities in inequality and poverty in countries. For one, having access to more high quality data will allow more accurate regressions and the ability to differentiate between structurally similar countries. Classical growth models imply that developed countries will slow their growth and converge to a relatively constant growth rate, while developing countries will grow much quicker due to the different in physical and human capital between the countries. An analysis of developing countries may yield different results than an analysis of developing countries. In addition, more research could be done in looking at

the results of poverty reductions. Nearly all of contemporary research uses the headcount ratio, which does not look at relative depth of poverty for those already under the line. Comparisons of the headcount ratio to the Watts index (or other, depth sensitive poverty indices) could show how poverty reduction policy is affecting those in the country. Finally, more in depth analysis of African countries and their structure and poverty rates could provide insight into how poverty works in these countries. The literature indicated a huge increase in poverty in African countries while the rest of the world's poverty rates either stayed relatively constant or fell dramatically. Further research into what's holding back African countries from seeing the same level of poverty reductions could be crucial to understanding poverty's causes and informing policy decisions that will be helpful to reduce poverty's influence.

Appendix

Table 3: Individual Country Data

Variable	Obs	Mean	Std. Dev.	Min	Max
D	0				
ArgentinaU~n	4	34.7175	7.269912	24.7	42.09
Armenia	4	19.88	10.22004	6.05	29.01
Bangladesh	4	21.0775	5.875011	14.15	26.88
Belize	4	45.86625	25.46708	21.28	68.21
Bolivia	4	90.7775	25.46284	62.78	121.5
Brazil	4	44.2075	1.149076	43.3	45.81
BurkinaFaso	4	36.5	16.40846	19.8	55.22
Chile	4	51.8925	3.59356	46.91	55.185
Colombia	4	48.9	8.031957	37.18	55.22
CostaRica	4	45.935	7.335873	37.75	52.21
DominicanR~c	4	38.4	6.592182	29.04	43.19
Ecuador	4	46.52	8.748962	34.23	54.54
ElSalvador	4	61.2225	15.45303	45.35	81.82
Estonia	3	33.16	14.2102	24.29	49.55
Ethiopia	4	19.6575	8.951716	12.3	31.95
Georgia	3	50.96333	6.320295	46.27	58.15
Guatemala	3	54.865	4.098253	51.38	59.38
Honduras	4	67.31	15.83694	52.54	88.88
Kazakhstan	3	22.385	3.615	18.77	26
KyrgyzRepu~c	4	29.88	10.57966	15.55	40.78
Lithuania	3	23.47	7.638344	19.06	32.29
Madagascar	4	73.24875	17.40359	50.45	92.68
Mauritania	4	8.8375	1.102251	7.26	9.83
Mexico	4	47.78625	4.851013	41.59	52.835
Moldova	4	27.19	15.32851	5.89	41.36
Nicaragua	4	62.2825	14.50598	48.66	76.97
Pakistan	4	7.765	5.394846	2.23	14.43
Panama	4	48.55	7.670128	37.49	55
Paraguay	4	53.4675	4.373323	48.35	58.72
Peru	4	48.6625	10.38507	37.92	59.68
Phillippines	4	7.27625	2.102964	4.49	9.405
Rwanda	3	54.6	15.26137	39.01	69.51
Senegal	4	19.04	5.512132	14.99	26.79
SouthAfrica	4	5.7025	4.188201	1.33	11.15
Tajikistan	3	31.26333	10.22042	22.73	42.59
Thailand	4	18.27	3.828133	12.62	20.7
Tunisia	4	.655	.6589132	.09	1.6
Uganda	4	28.3825	8.630923	16.46	35.11
UnitedStates	4	51.5275	9.205601	42.89	63.57
Zambia	4	59.04625	12.73628	43.28	74.24

References

Bourguignon, F. 2003. ―The Growth Elasticity of Poverty Reduction: Explaining Heterogeneity Across Countries and Time Periods. Retrieved from http://siteresources.worldbank.org/INTPGI/Resources/342674-1206111890151/13565_32322_growth_elasticity.pdf

Cooper, David, and Dan Essrow. *By the Numbers*. Digital image. *Economic Policy Institute*. Economic Policy Institute, n.d. Web. 6 Apr. 2015.

Foster, J., Greer, J., & Thorbecke, E. (1984). A Class Of Decomposable Poverty Measures. *Econometrica,* 52. Retrieved from http://www.jstor.org/stable/1913475?seq=1#page_scan_tab_contents

Martin, X. S. (May 2006). The World Distribution Of Income: Falling Poverty And … Convergence, Period*. *The Quarterly Journal of Economics*, *121*. Retrieved from http://qje.oxfordjournals.org/content/121/2/351.full.pdf

Ravallion, Martin. 2012. "Why Don't We See Poverty Convergence?" *American Economic Review*, 102(1): 504-23.

Shatakshee, D. & Miao, X. (March 2013). *Cross-Country Convergence in Income Inequality*. Retrieved from http://www.econ.gatech.edu/files/papers/ECINEQ2013-290.pdf

United States Census Bureau. (2014). *Poverty Thresholds.* Available from https://www.census.gov/hhes/www/poverty/data/threshld/

Vecchi, Giovanni. *Poverty Measurement*. [PDF document]. Retrieved from http://siteresources.worldbank.org/PGLP/Resources/200709gv-03-povertymeasurement.pdf

World Bank. (2014). *PovcalNet* [Data file]. Retrieved from http://iresearch.worldbank.org/PovcalNet