Convergence

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Executive Summary

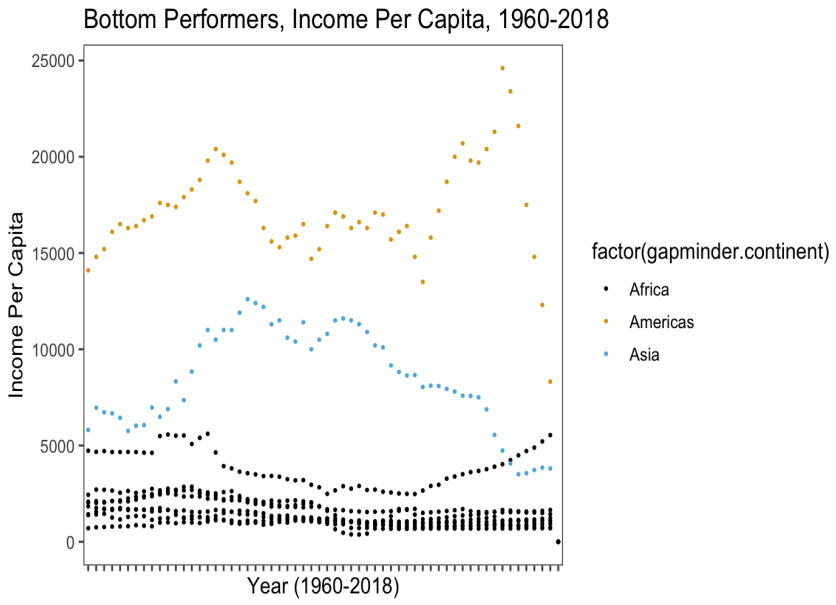
There is no evidence of economic convergence when using income per capita in 2011 dollars and examining the period between 1960 and 2018. In relative terms, the continent with the highest income per capita in 1960 (Europe) ended up with a much larger advantage in 2018. The continent with the lowest income per capita in 1960 (Africa) still had the lowest income in 2018, but by a larger margin. Additionally, the top 10 performing countries and bottom 10 performing countries all had very similar incomes in 1960 which suggests that income in 1960 is not a good predictor of growth. Finally, linear models (globally and continentally) all have slopes that are approximately 0 which again suggest that there is no relationship between income in 1960 and growth over the 58 year period. Not only is there no evidence of convergence, there is possibly evidence of divergence due to the effect of something like increasing returns or the Matthew Effect.

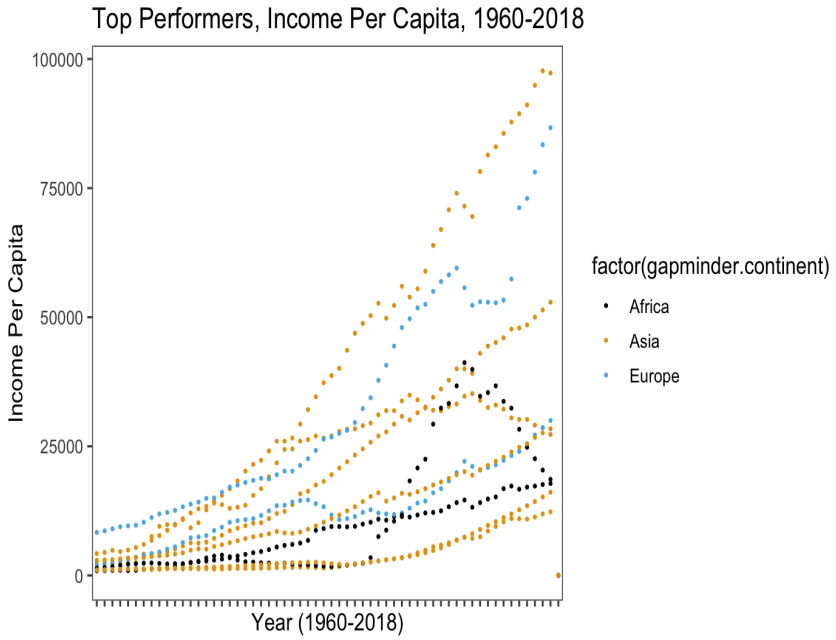
What Countries Have Grown the Most and Least?

Before going into detail on the findings for this question, I should say that there is some divergence in the dataset that I cleaned with what was used in the details of this question. The question suggests that the global growth rate since 1960 was 2.04%. The rate that I calculated was 2.24% which is based on per capita incomes of $19,199 in 2018 and $5,289 in 1960. The difference here must be due to the merge with the other gapminder data in order to find the continent for each country. During the merge, I lost 70 countries which surely caused the discrepancy.

	top.bottom.gapminder.country	top.bottom.gapminder.continent	top.bottom.growth
1	Singapore	Asia	5.5550062
2	Taiwan	Asia	5.3600900
3	Botswana	Africa	5.3337120
4	China	Asia	4.9331990
5	Oman	Asia	4.8403466
6	Romania	Europe	4.7263829
7	EquatorialGuinea	Africa	4.5998118
8	Mongolia	Asia	4.2834033
9	Ireland	Europe	4.1216239
10	Malaysia	Asia	3.9938774
11	Djibouti	Africa	0.2729050
12	Burundi	Africa	0.1113352
13	Niger	Africa	-0.2594220
14	Madagascar	Africa	-0.3985015
15	Liberia	Africa	-0.6022504
16	Syria	Asia	-0.7248625
17	Venezuela	Americas	-0.9053809
18	CentralAfricanRepublic	Africa	-1.1422809
19	Somalia	Africa	-1.1684683
20	CongoDem.Rep.	Africa	-1.3642089

In the table to the left, you'll find the top ten fastest growing countries as well as the bottom ten countries, most of which had negative growth. **The bulk of this volatility occurred in Africa and Asia. Asia experienced the most benefit while most struggling countries are in Africa.**



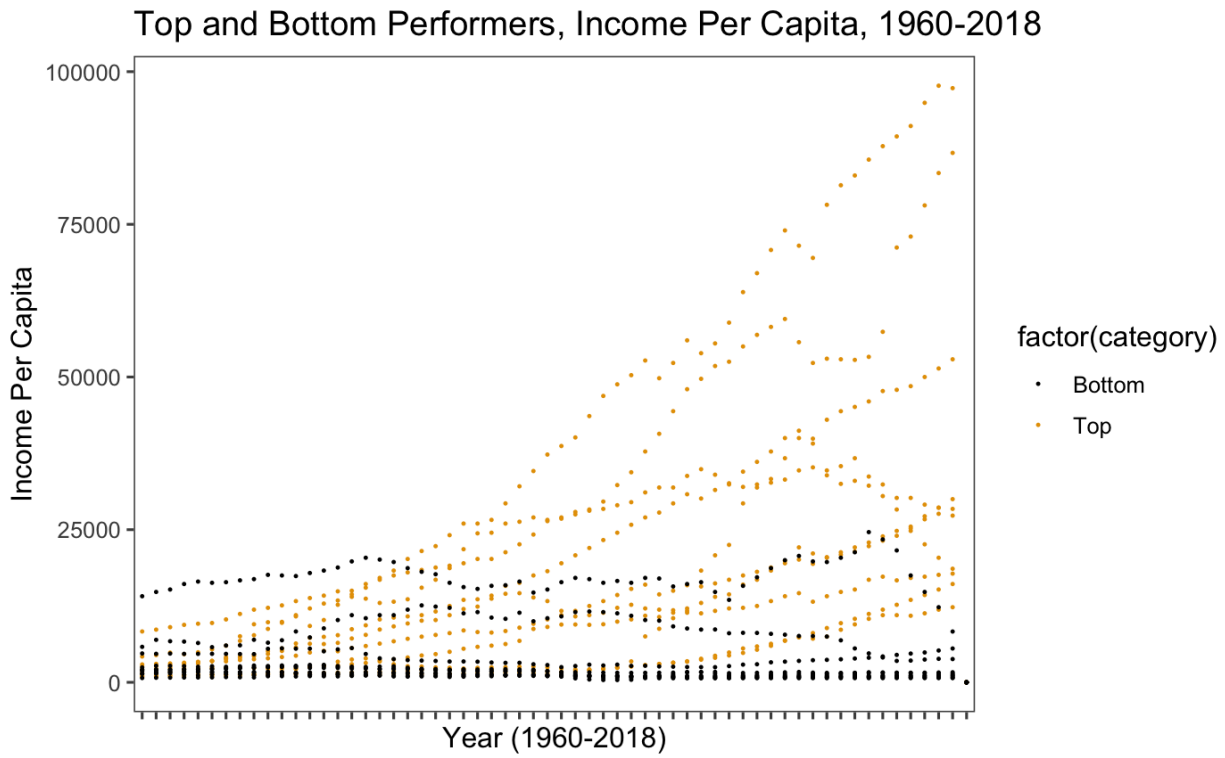


Plotted to the left are the top performing countries and bottom performing countries individually and also together (next page). What's noticeable in these plots is that the top performers all had similar starting points and similar trajectories in reaching their income levels in 2018. The bottom performers had a bit more variation in their starting point and were either erratic or completely stagnant. The most volatile country in the bottom performer plot is Venezuela. This is not entirely surprising as they are a country that is rich with resources but plagued by unstable governments. **This observation reinforces the idea that if there is any merit to the theory of economic convergence, there are certainly structural characteristics of economies and nations that will play a pivotal role in determining outcomes. This idea is called "conditional convergence".**

The most obvious trend or commonality between some of these countries is geographic. As noted earlier in the report, Africa tended to be most frequently observed in the bottom performing group whereas Asia tended to be overrepresented in the top performers. In fact, in the bottom performing group, all 8 countries that were stagnant were African. The only two countries that are not in Africa are Venezuela and Syria which suffer from massive political instability.

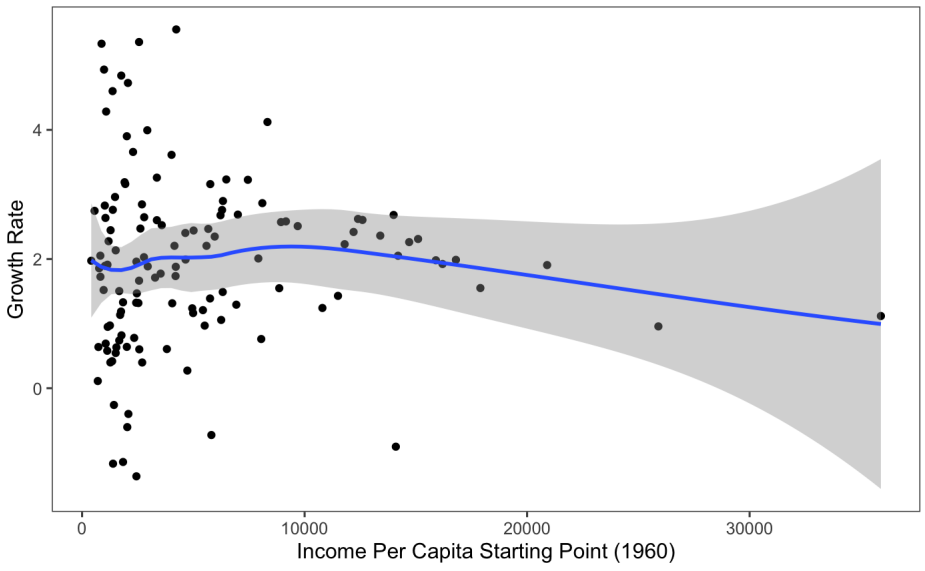
The plot that has top performers and bottom performers combined is quite revealing and is useful in answering the main question. All countries have roughly similar starting points but wildly different ending points. If convergence theory was correct, we would expect the starting points of bottom performers to be the highest income countries and they would have very little growth. We'd expect the top performers to have the lowest starting points and very high rates of growth. Under

those conditions, we would observe some measure of convergence by 2018. We actually see the opposite of this. **There's no trend to be observed.**

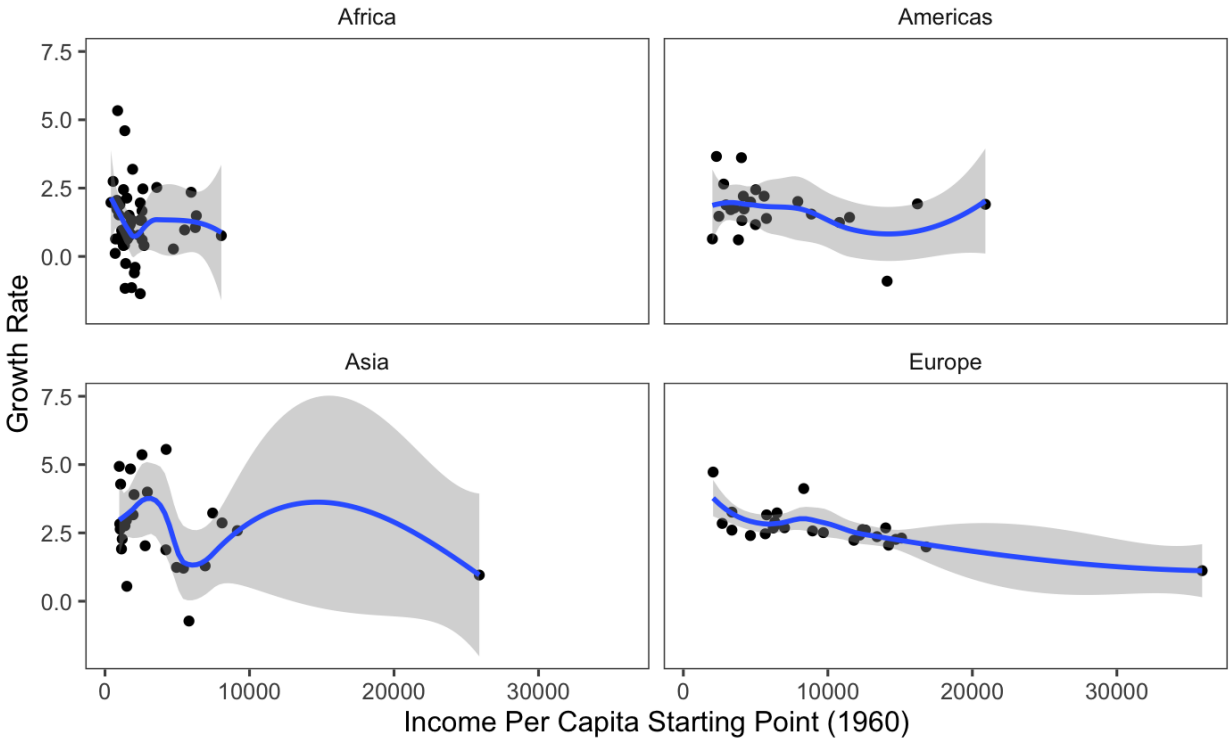


Has there been convergence since 1960?

I did not find any evidence that there has been any convergence since 1960. The plot below shows a linear model where the starting point (1960 income per capita) is a predictor of growth rate over the period 1960 to 2018. It's clear that this model is not useful. There were no transformations made to the data. The smoothing method used was LOESS which works by building models for subsets or "neighborhoods" of the data and using these as components of the final model. There are much fewer data points on the right side of the x-axis so we see a much wider confidence interval. Where most countries

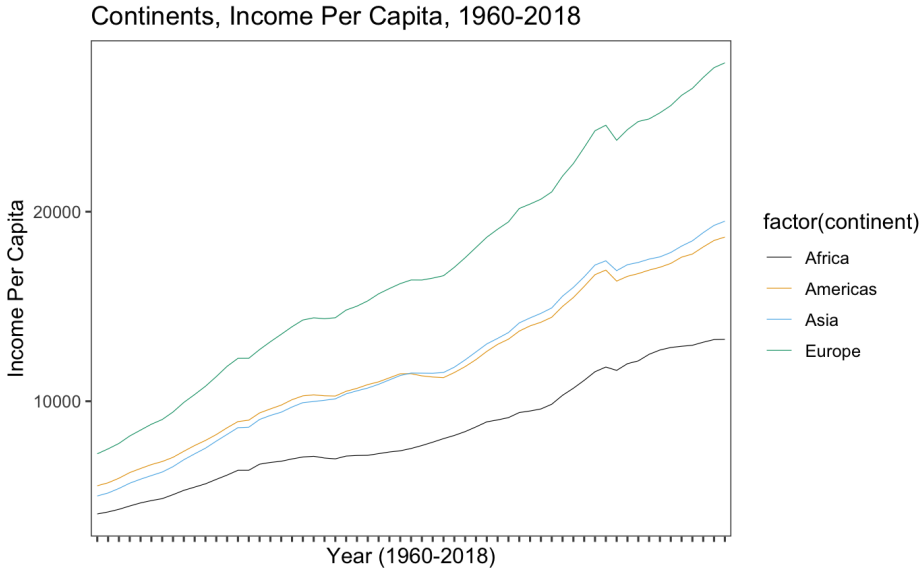


are on the left side of the x-axis, the line is almost perfectly horizontal indicating that income per



capita starting point is not a predictor for economic convergence. The same phenomenon can be observed in the below plot where the data is faceted by continent. All continents are approximately horizontal except for Asia has a sort of sinusoidal trend which goes further to disprove the idea of convergence. These lines were also smoothed using LOESS.

This final plot puts the nail in the coffin. Here, we can actually observe some divergence. All four continents have roughly similar starting points but very different ending points. Perhaps an argument could be made that Asia converged with America since their lines do cross over, but they were so close to one another to begin with it would not take very much for them to overtake one another. Europe started in the best position and finished in a *much* better position. Africa started in the worst



position and finished even worse off in relative terms. **The lines for each continent are about parallel which precludes any idea of convergence.**

Appendix

1. Here is a link to the data that was used for this study. To reproduce this, you'll want to export "Sheet-1" as a csv and read that into R-Studio. The data wasn't very clean and I took care of this in Google Sheets which was a more efficient use of my time. The primary challenge here was that the data downloaded from the gapminder website was using "k" to represent 1000, which is not useful for programming. I took care of this using "find and replace" and applying a formula to the necessary cells. I also removed punctuation from the names of the countries to increase the likelihood of finding a match in the gapminder package.
2. Here is another visualization that was not useful for the report but might be kind of interesting. Most of Europe has done alright for itself. There's quite a wide range in the Americas. Many Asian countries are doing pretty well. Africa needs some help.