

CEMENT CONSUMPTION vs GDP PER CAPITA: A REVIEW

1. GDP and Cement Consumption

It is common that the description of a country's cement industry, feasibility studies and industry assessments include a reference to the relationship between cement consumption and GDP, both on a *per capita* basis. According to the established understanding, these two variables would be related by an inverted U curve, with the following features:

- At low GDPs, countries would have low cement consumption;
- As the country develops, the cement consumption grows with the GDP;
- But beyond a certain consumption rate, saturation or peak, further economic development is achieved with a decrease in the cement consumption.

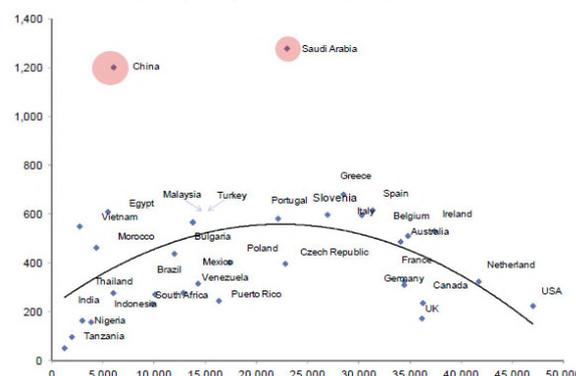
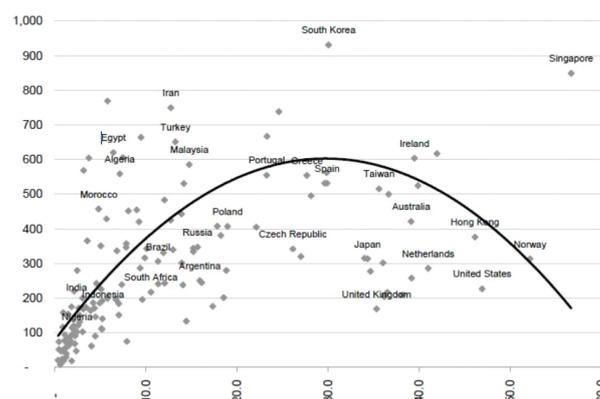
There is economic and technical logic behind this: cement needs to be manufactured, so the starting point must be 0 kg/capita by necessity. Economic development requires heavy investment in physical capital, which since the beginning of the XX century pulls cement consumption: housing, ports, roads. And once the main infrastructure is built, the incremental additions and maintenance works require much less cement: the country can still grow, but not by its continuous large investment in bulky infrastructure, but through lighter or less tangible assets; eventually, the cement may be substituted by other products, and technological progress also reduces the unit consumption rate.

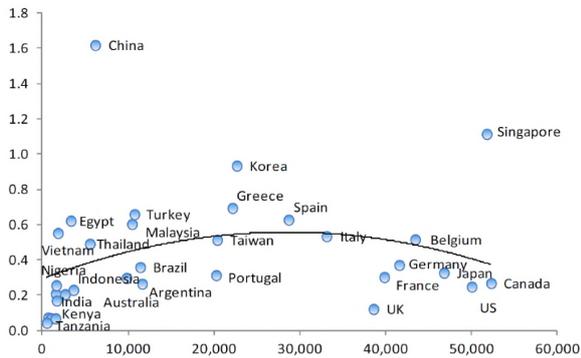
In fact, this set of arguments is applied in general industrial and ecology economics, not only in cement. But despite this apparently clear reasoning there are some aspects which are not always properly interpreted.

2. Some Cherry Picking

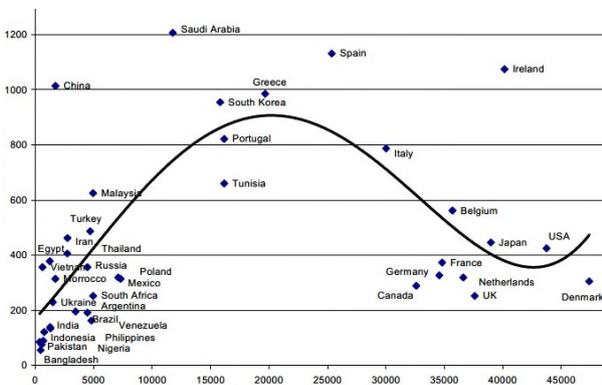
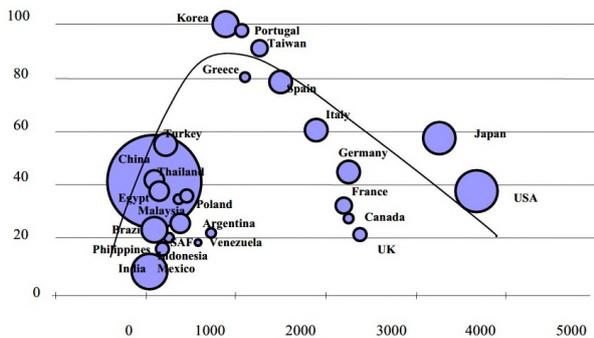
In statistics “cherry picking” is the selection of data that suits one’s preferences. It is well known that enough manipulation of data can yield almost any desired result: let me copy some instances of this tendency.

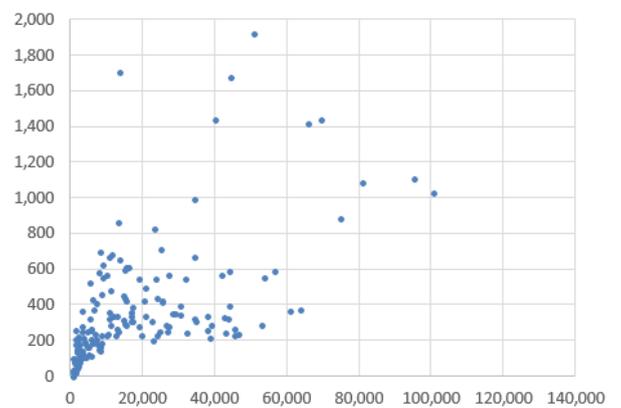
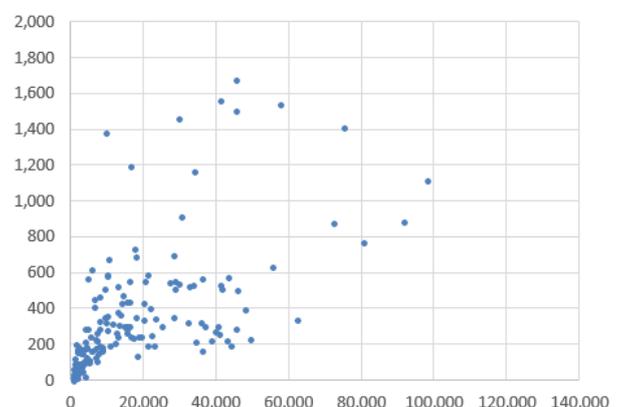
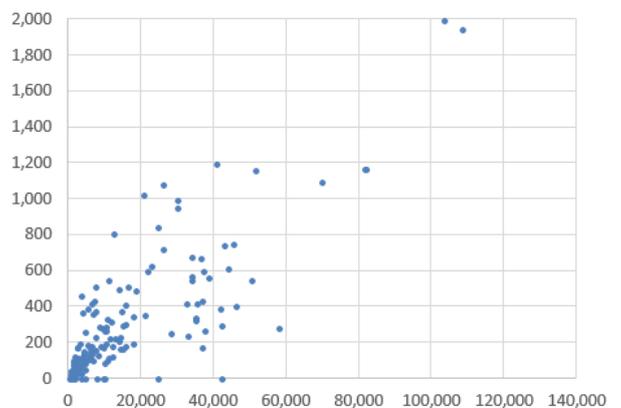
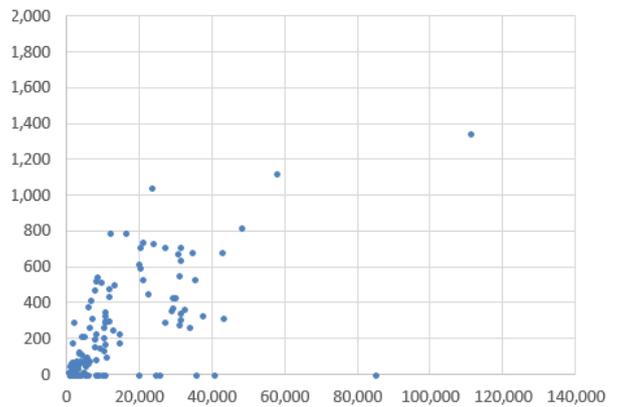
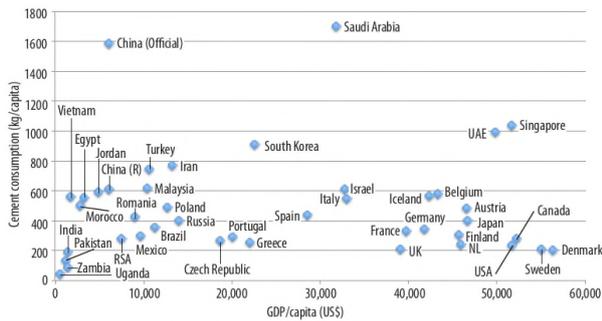
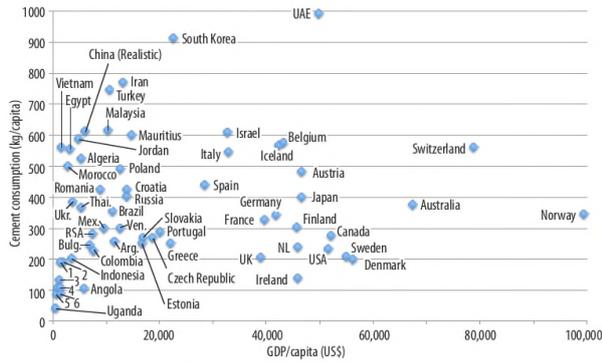
The following three images present “consumption vs GDP” charts taken from professional sources. They all show the GDP (in USD or kUSD) vs the cement consumption (kg or ton), all *per capita*, for the years 2010 (top), 2011 and 2012 (bottom)





My personal favorites are the following two, from 2001 and 2008, the first from an international strategist (but all figures need to be multiplied by 10), the second from a top American investment bank.





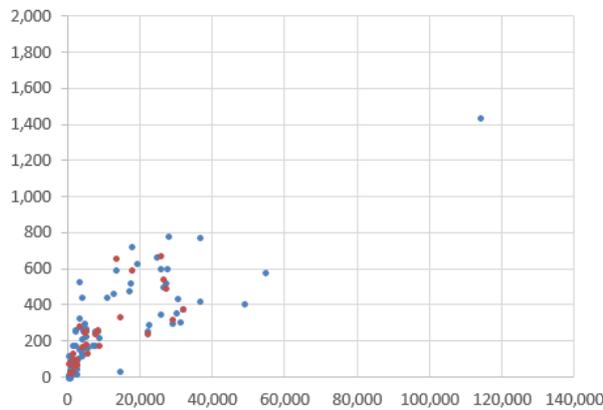
But these non-attractive plots show something closer to what seems to be the factual reality.

The next four charts present the results for ~170 countries in the years 1990 (top), 2000, 2010 and 2015 (bottom). Units are kg of cement per capita, and GDP in USD.

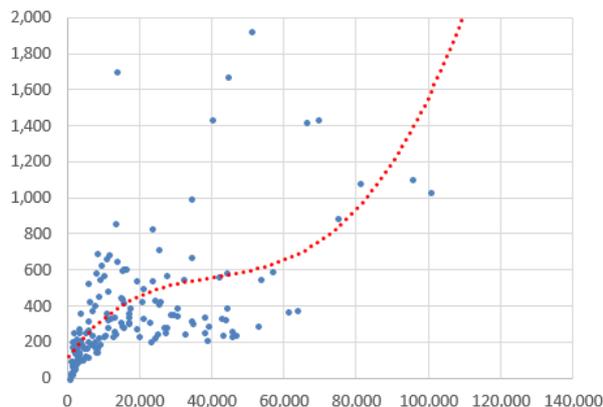
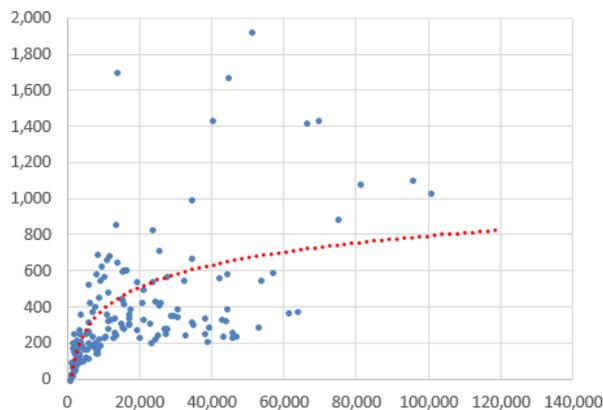
Four remarks on the data:

- The dataset is homogenous: consumption from ICR (www.cemnet.net), population from UN, and GDP from the World Bank.
- The vertical axis measures domestic cement consumption, not production.
- The horizontal axis measures GDP (not GNP), and it is expressed as PPP (Purchase Power Parity) in constant US dollars of 2011.
- There is one country (Qatar) with a consumption above 2,000 kg/ca, not shown in the charts.

And for 1980 also ¹:

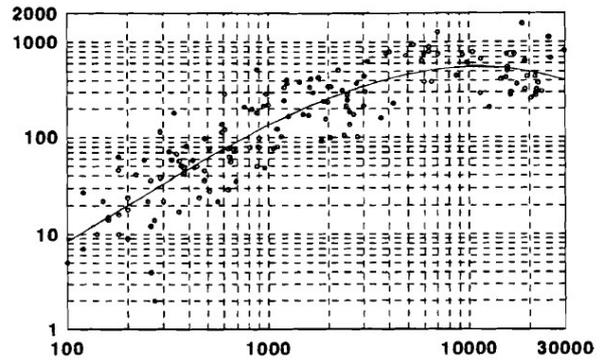


Unless one removes a considerable number of data (“cherry picks”), there is no obvious fitting curve with the pattern of an inverted U that can be observed in the last 40 years: the fits show a growing pattern and their fitting degree is low, as shown for 2015 with different curves:

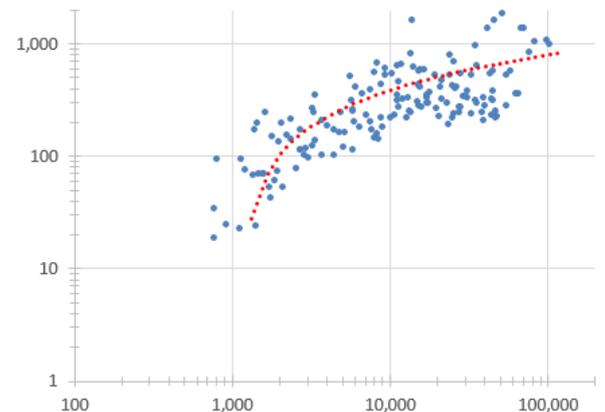
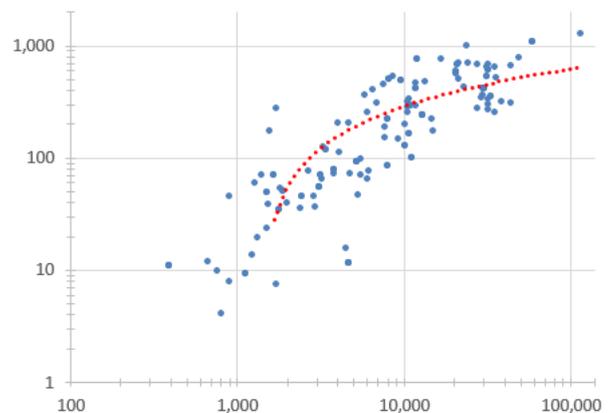


A document from 1994 reported a fitting for 1990, based on GNP (note the log-log scale):

¹ In this latter chart, GDP is not expressed as PPP, but as constant 2010 US, as standard PPP series often



However, the full set of data used for this article is not showing that pattern, neither in 1990 (above) nor in 2015 (below):

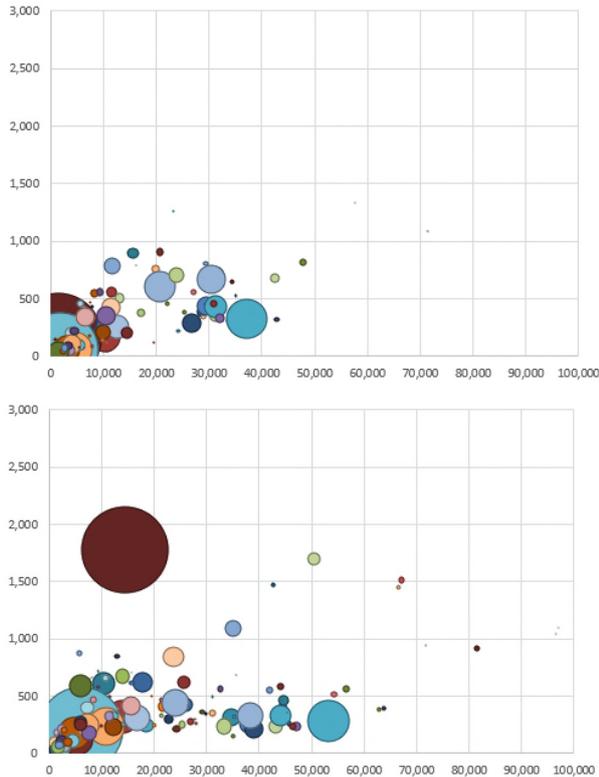


It is necessary to remove a number of “outliers” to make the charts look like an inverted U-shape. But, what is an “outlier” here?

First, allow me one step back. While it is possible to fit curves to the dot charts presented above, it is important to note that not all dots have the same importance: India or

start in 1990. The coloured dots represent various sources of data.

China far outweigh Lesotho or Lichtenstein. When these weighs are introduced, the fitting requires even more “cherry picking”, especially after the year 2000 (bubble charts for 1990 and 2016):



Despite these drawbacks, the inverted-U curve is not only mentioned in technical documents, as shown above: it is also often used in scientific reports assessing CO2 emissions from the global cement industry.

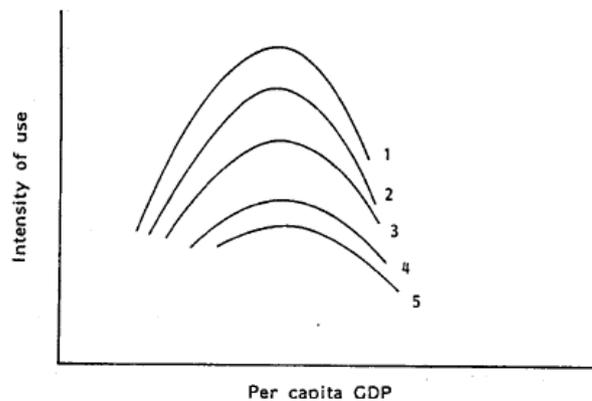
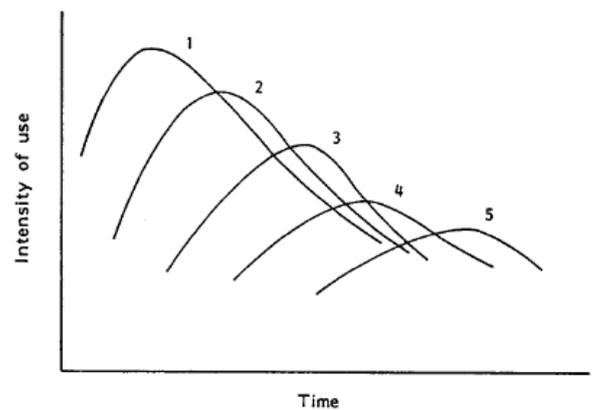
So, is this supposed relationship between cement consumption and GDP just common and established nonsense? Is it used because there is nothing better?

There are two complementary answers to this question:

- *Massaging* the data is dangerous and can create illusionary constructs. A single, inverted U-shaped curve that fits all countries at once seems to be an abstraction, and its factual support appears to be based on partial data; but

- There is some value in the consumption/GDP relationship, although not where/how it is normally shown.

The use of these consumption/GDP curves dates from the late 70s, but a relevant original aspect seems to have been lost since then: the fact that **technical progress may prevent countries to follow the same path**. This hindsight was represented in the following charts from 1978, and it seems to have been forgotten.

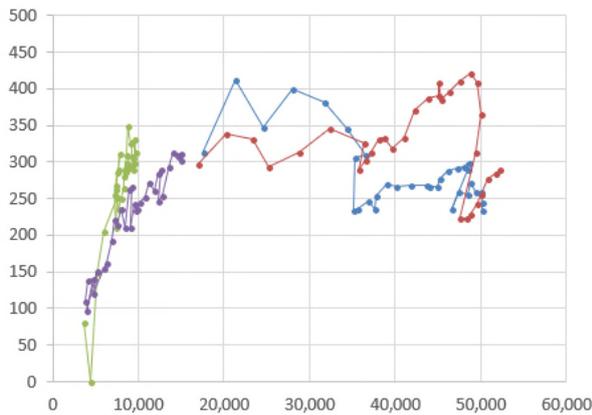


5. Comparison of Time Series

The sequence of charts presented above, from 1980 to 2015, raises the possibility of looking at how countries behave along time.

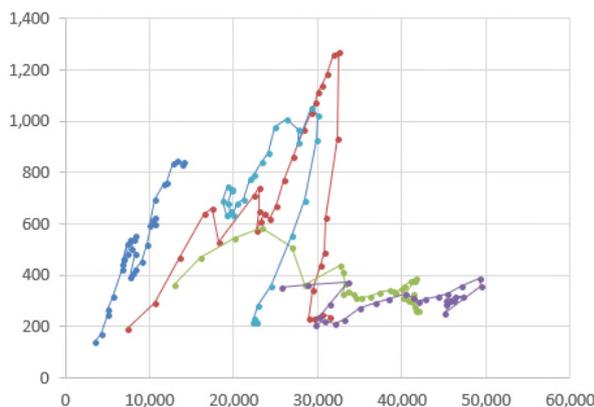
Although each country has its own history, there are certain similarities which may be of relevance. They are only semiquantitative; and they are not general: **there does not seem to exist a single law applicable to all countries**.

The following chart is a “cherry picking” of four American countries: Mexico (green), Chile (purple), USA (reddish), and Canada (blue). It presents consumption vs GDP from 1960 to 2016.



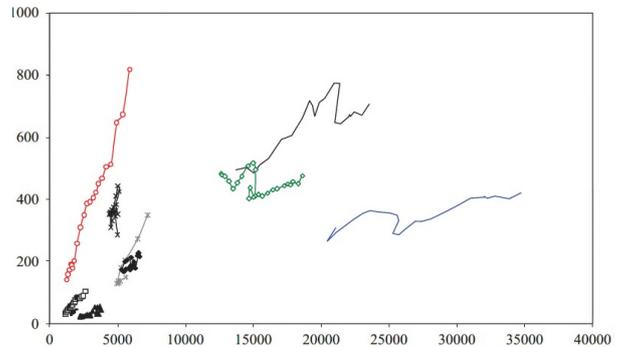
This is probably close enough to the best that can be achieved without entering into historical data researching for data prior to 1960. Joining the pattern described by the four countries seems to yield the U-shaped curve, on a time-series basis.

However, it is important to remark that the previous chart is a construction in which the countries have been carefully picked. One similar counter-example can highlight this:

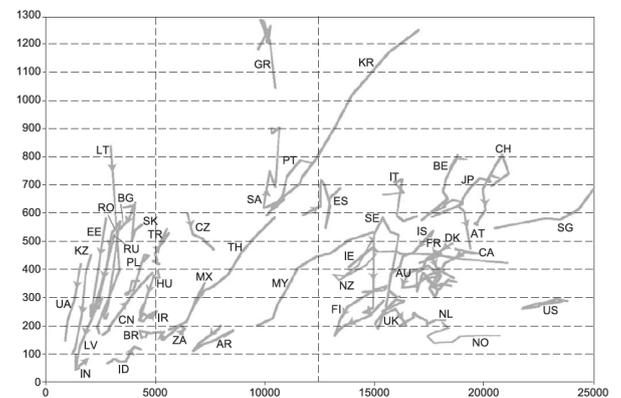


This latter diagram shows the same relationship for Turkey, Spain, France, Finland and Greece. Here, the “path of the U-shaped law” is much more difficult to ascertain, if it exists at all, and it is far from obvious that the same “law” is behind these observed behaviours.

A similar result is presented in the following chart, for different regions (red = China; green = Europe-33; blue = North America).



Or for some countries:



(Both latter charts have the per capita GDP expressed in international 1995-USD).

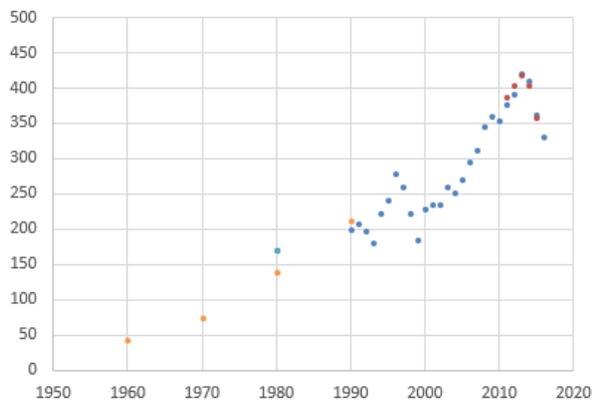
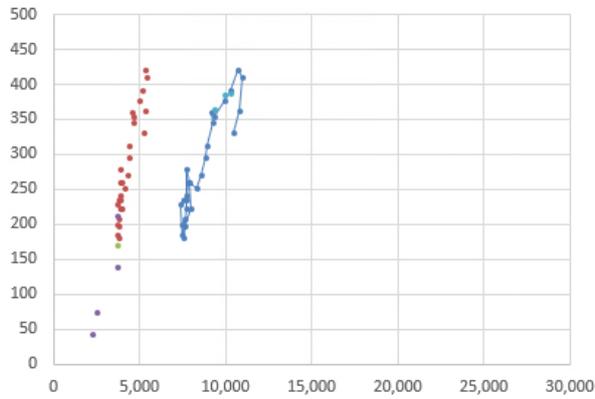
There is hardly any visible cross-country trend in these factual time-series – other than a general difference in slope!

6. Clusters for Comparison

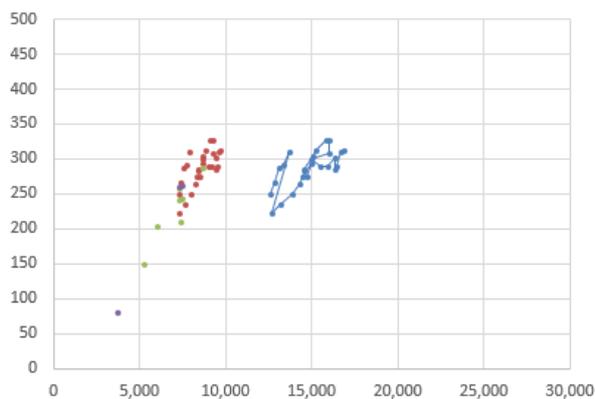
While it is actually difficult to find a common fitting curve which is meaningful for all countries, it is possible to find clusters of countries with similar behaviour. In the case of the Americas at least four such groups can be identified.

Panama, Ecuador, Peru and even Brazil or Colombia show a steep and rather uniform link between consumption and GDP, with a reduction after the last global crisis, which is

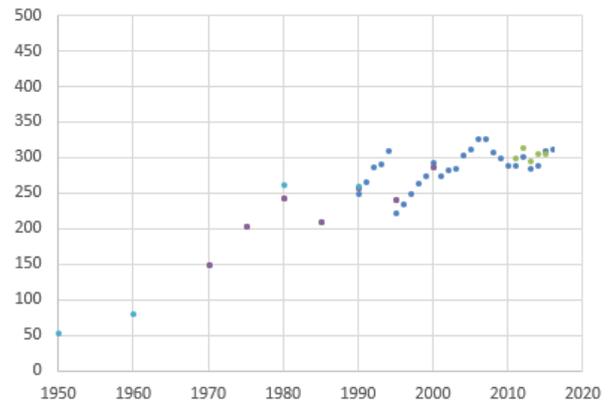
deeper on milder depending on the country.
For Ecuador²:



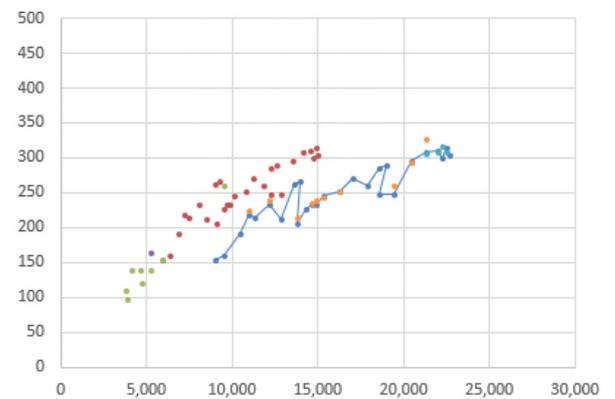
Countries like Mexico or Guatemala seem to have found a ceiling related to the financial crisis, longer but less intense that the previous group. For Mexico:



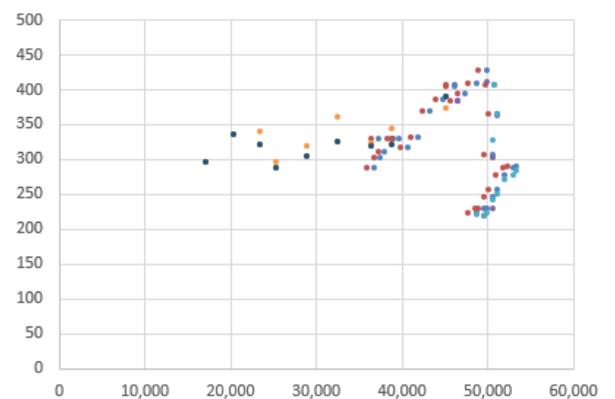
² In this set of charts, the sources are more heterogeneous and are identified with different colours.



Chile seems to have found its own rather smooth growth pattern:



Finally, Canada and the USA come from a stable or steadily diminishing consumption, and have gone through “adjustments” in the latest crisis, very large in the case of USA:



The GDP is in PPP (blue, always to the right of the chart) or expressed as 2010 USD (other colours).