EC1B1 Group Project: Spain and Bretton Woods

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Please see the Jupyter Notebook titled "EC1B1_coursework_notebook.ipynb" on the GitHub repository found at: *https://github.com/andresoats/EC1B1-Coursework* for our Python code.

5.1 Comprehension and Warm Up

- What was the date that your country left the Bretton Woods system?

We believe Spain left the Bretton Woods system in August of 1971, as this was the first month in the continuous period of exchange rate fluctuations that followed. There was a singular month with exchange rate changes before this, in November of 1967, but this was a unique change that more likely represents a singular shift to nominal exchange rates, fixing them at a new level.

- Describe the sense in which the departure from Bretton Woods represents a "natural experiment" about the effects of real exchange rate fluctuations on the macroeconomy.

The departure from Bretton Wood represents a natural experiment because of how sudden it was. The transition from fixed exchange rates to volatile exchange rates occurring so suddenly means that other variables within the economy would not have had time to change and remain independent. This means that the post-shock outcomes on the larger economy are dependent only on the increased volatility of exchange rates.

5.2. Cleaning

- How many monthly observations are there in your dataset? Is this the number you were expecting?

There are 372 monthly observations in our dataset, this is what we expect since from January 1960 to December 1990 there are effectively 13 years worth of data and 13 x 12 = 372

- Why are we studying monthly data? Why not some lower-frequency such as quarterly or annual data?

We are studying monthly data as a higher frequency is ideal to see if there are any direct impacts of leaving a fixed exchange rate system. If we used quarterly or annual data we may not see the true impact as the economy may *correct* itself.

- What is industrial production? Why are we studying industrial production instead of another series, such as GDP?

Industrial production "refers to the output of industrial establishments and covers sectors such as mining, manufacturing, electricity, gas and steam and air-conditioning" and is measured as an index based on a reference point. We are studying industrial production because this sector, while contributing a small amount to GDP, is sensitive to interest rates and consumer demand. Using GDP may obscure the true impact of leaving the fixed exchange rate system because GDP takes into account other sectors of the economy that may be less sensitive to changes in demand.

- Why are you dropping outliers?

We are dropping outliers since outliers may obscure our analysis of data as we may infer a relationship that is not present and is instead simply the outlier. In our data, it seems there are virtually no outliers — *see the Data Cleaning Section of the Jupyter Notebook on GitHub for more information.*

- Discuss some pros and cons of the interpolation procedure we are using.

A pro of the interpolation procedure is that we are not removing months in which we do not have data but are instead attempting to correct these gaps by using an average between the prior and following period.

However, there are numerous cons. Firstly, by interpolating we may conduct analysis on data that has been interpolated and thus not completely accurate. Secondly, a major issue is that this interpolation means that in cases where there are multiple consecutive periods of missing data or, as in our case, where there is missing data at the beginning of the series we cannot interpolate using this method.

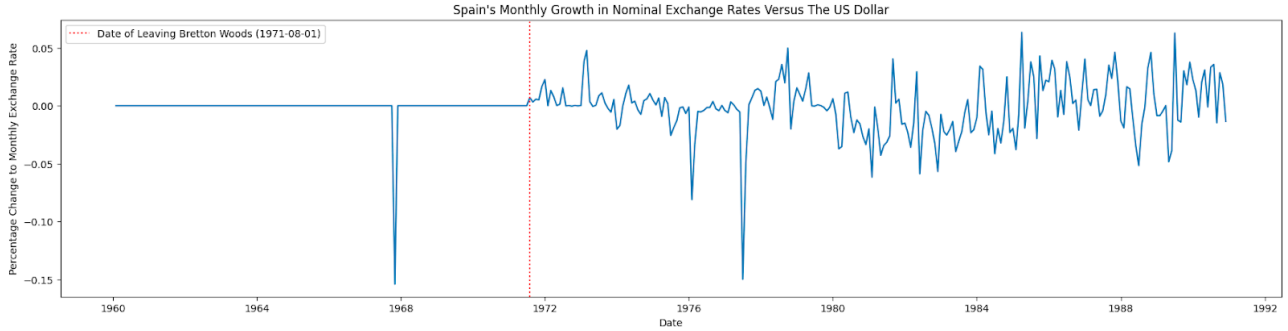
In our case, the measure of industrial production does not begin until 1961 and thus we have 12 months of no industrial production data. We choose to keep the missing values and also not interpolate because the only interpolation method that we could utilise is backwards filling the data, which we do not believe to be a good method of filling 12 months of data. By not filling the missing values, we have multiple columns with missing data at the beginning of the series (all the columns depending on industrial production), however these missing months do not affect our analysis. Instead, since our data for industrial production begins in 1961, we can simply begin our analysis of industrial production in 1961 without affecting our analysis of Spain leaving the Bretton Woods system as this is around 10 years before the end of the Bretton Woods.

5.3 Analysis

5.3.1 Exchange Rate and International Reserves Graphs

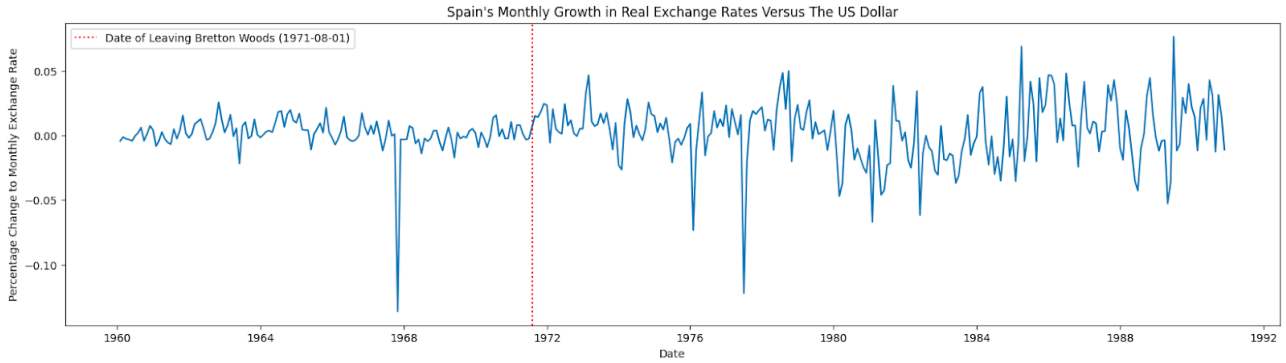
- Plot a time series graph of the monthly growth in nominal exchange rates of your country, versus the US dollar, for every month from the start to the end of the sample. Clearly indicate the time at which that country left the Bretton Woods system.

Figure 5.3.1.1



- Plot a time series graph of the monthly growth in real exchange rates of your country, versus the US dollar, for every month from the start to the end of the sample. Clearly indicate the time at which that country left the Bretton Woods system.

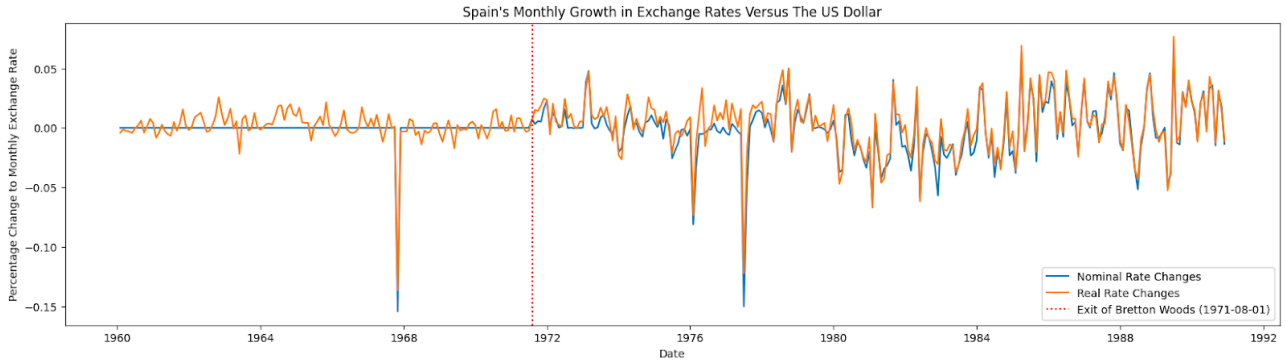
Figure 5.3.1.2



- Why is it useful to plot both real and nominal exchange rate growth?

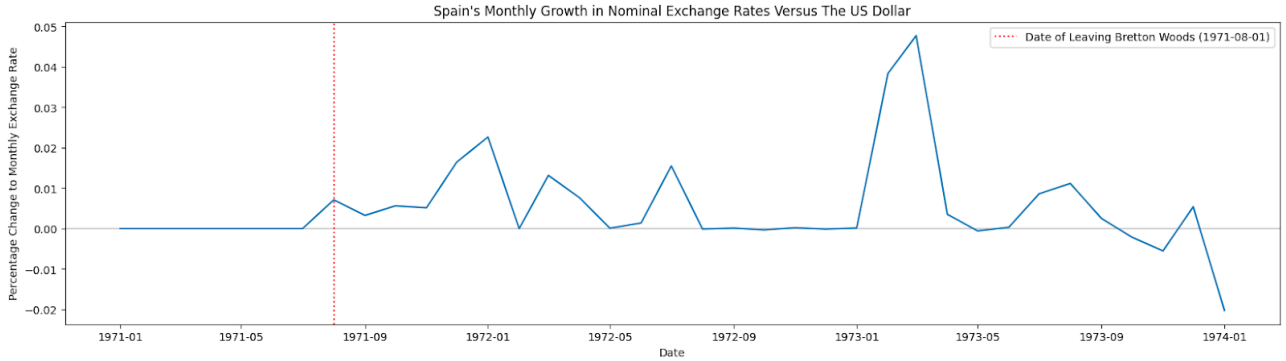
Plotting both real and nominal exchange rate growths is useful as it allows us to observe the relationship between the two, and identify how responsive nominal price changes were able to be to real changes, before and after Bretton Woods ended. For ease of comparison, the two can be plotted simultaneously (*Figure 5.3.1.3*)

Figure 5.3.1.3



- Was the US dollar over or undervalued in the Bretton Woods system? Refer to data or figures in your answer.

Figure 5.3.1.4



Under Bretton Woods, the US Dollar was **Overvalued** against the Spanish Peseta. We can see this by looking at *figure 5.3.1.4*, a closer view of *figure 5.3.1.1* observing the immediate effect of exiting the Bretton Woods system on nominal exchange rates.

This figure shows that immediately after leaving, the nominal exchange rate $E^{\$/Pes}$ increased for several monthly, and save for a few minor adjustments in late 1972, kept generally increasing until late 1973, over 2 years after the exit.

As exiting Bretton wood lead nominal exchange rates to move freely, through the principle of no arbitrage we can suggest that these adjustments represented the transition from the nominal value of the dollar to its real value, which is also reflected by *figure 5.3.1.3* mapping the nominal and real exchange rate changes very closely.

As the increases made more dollars affordable per Spanish Peseta, making a dollar comparatively cheaper, we can deduce that the US dollar used to be overvalued under Bretton Woods, at least compared to the Spanish Peseta. For a more comprehensive analysis of its valuation, we would have to observe the exchange rate changes relative to the other currencies it was fixed against.

- Plot a time series graph of the monthly indexed value of international reserves of your country and the US from January 1960 until the exit of the US from Bretton Woods.

I chose to plot the two graphs separately, as the magnitude of increase in Spanish gold relative to its index was so much larger than the magnitude of decrease in US gold reserves that the shared axis lost a lot of the clarity in changes for the US data

Figure 5.3.1.5

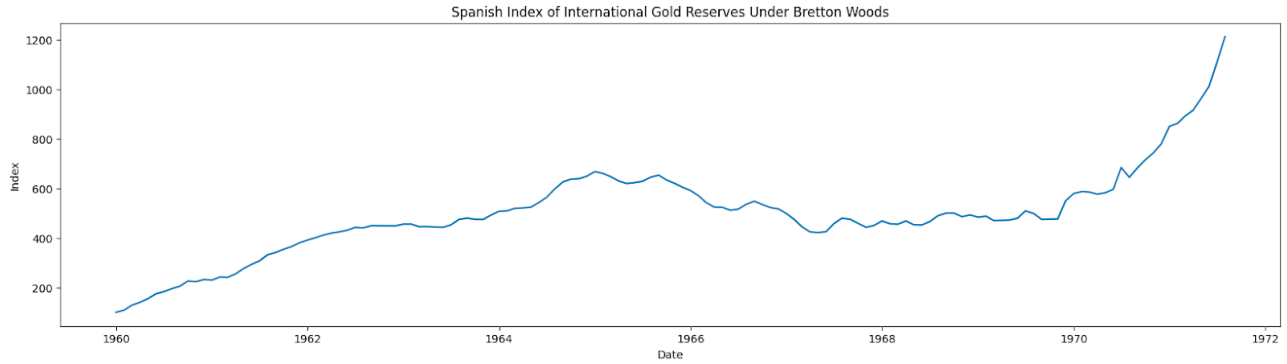
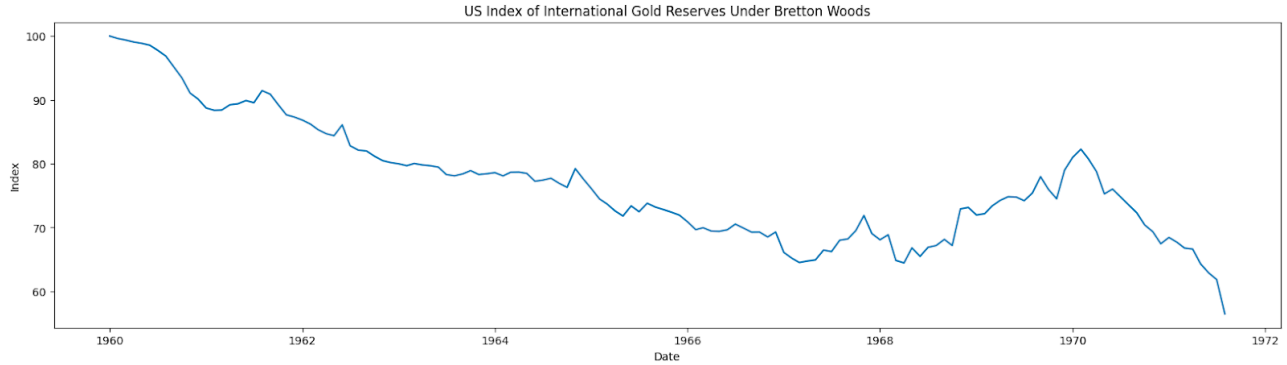


Figure 5.3.1.6



- Using your graph of international reserves over time, explain one reason for the US's departure from the Bretton Woods system.

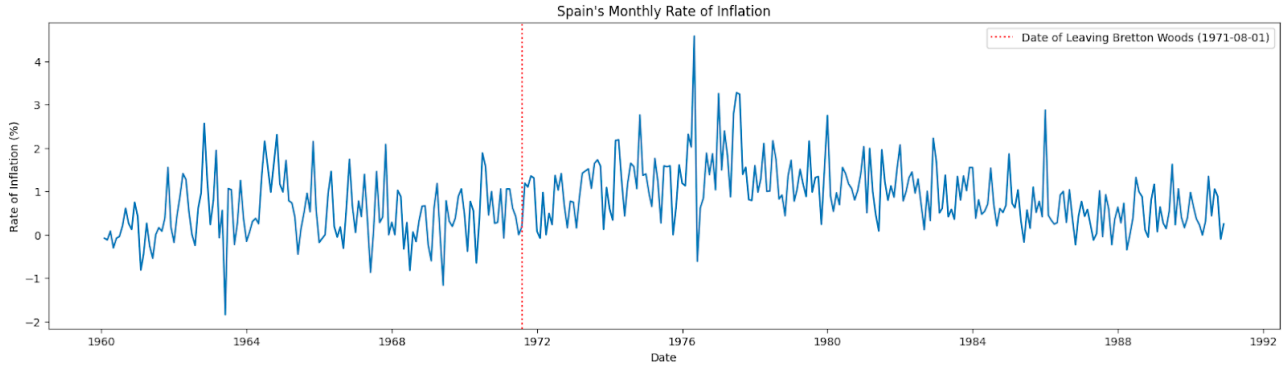
In the 11 years represented by *figure 5.3.1.6*, The US's Gold reserves decreased by roughly 45%, as the overvalued USD made imports cheaper over this period, so gold flowed out of the nation.

This reduction would have led to a lower gold cover ratio, and the currency being overvalued relative to the gold that backed it. This would have been difficult to recover, and it appears that an attempt to do so in 1969-1970 was semi-successful but short lived. Knowing this, there was a high risk of runs on the USD as people may have wished to purchase other currencies with more stable gold backings. If the entire nation's currency was run-on there would be no way to bail out the US, and so exiting the Bretton Woods System and removing the gold backing was a solution to prevent this.

5.3.2 Inflation and Industrial Production Graphs

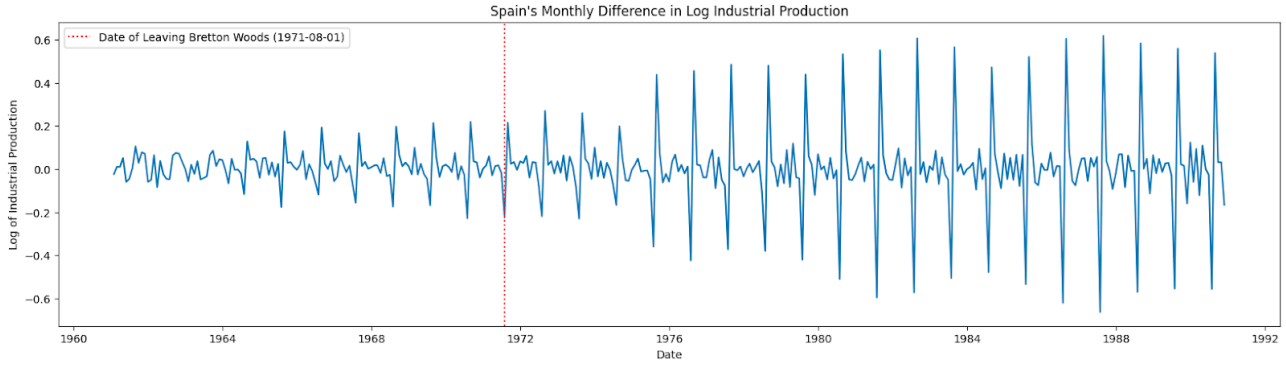
- Plot a time series graph of monthly inflation, for every month from the start to the end of the sample. Clearly indicate the time at which that country left the Bretton Woods system

Figure 5.3.2.1



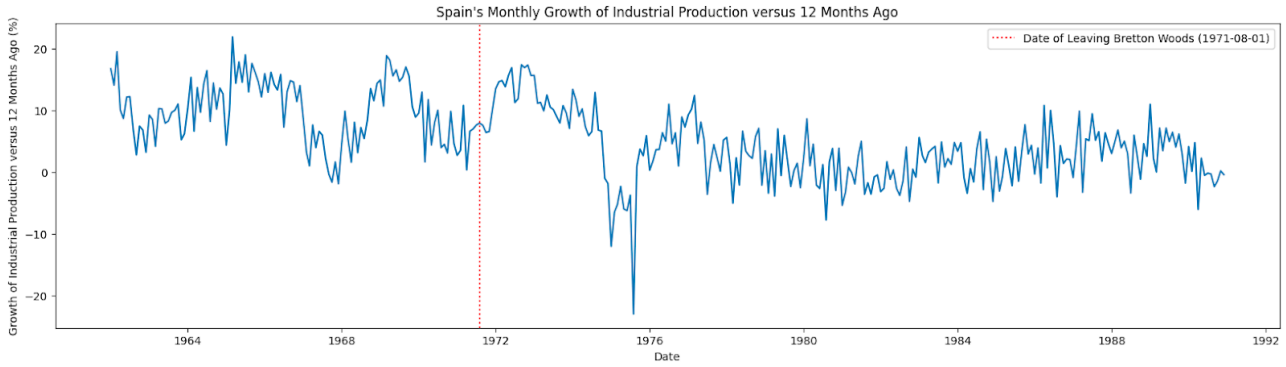
- Plot a time series graph of the monthly growth in industrial production, for every month from the start to the end of the sample. Clearly indicate the time at which that country left the Bretton Woods system.

Figure 5.3.2.2



- Plot a time series graph of the growth in industrial production versus 12 months ago, for every month from the start to the end of the sample. Clearly indicate the time at which that country left the Bretton Woods system.

Figure 5.3.2.3



- Why are your results for the monthly versus 12 monthly growth in industrial production so different? Which measure is more useful?

Figure 5.3.2.2 shows the sensitivity of the industrial sector to interest rates and consumer demand which fluctuates on a monthly basis whereas *figure 5.3.2.3* takes into account a longer time frame so data values don't vary as much.

It is much harder to identify any trends in *figure 5.3.2.2* as the monthly growth often fluctuates between positive and negative values whereas in *figure 5.3.2.3*, trends in industrial production that compare growth to 12 months ago can be observed therefore *figure 5.3.2.3* is likely to be more useful.

5.3.3 Comparison Statistics

Table 5.3.3.1

	SD Before	SD After	Ratio of SD before vs after
Nominal Exchange Rate	0.013468	0.025096	1.863387
Real Exchange Rate	0.014438	0.024909	1.725252
Inflation Rate in Spain	0.734174	0.735608	1.001953
Difference in Inflation between Spain and US	0.797628	0.742377	0.93073
12 Month Industrial Production Growth	5.099472	4.544481	0.891167

Data from 10 months before and after the time Spain left the Bretton Woods system (here we have taken this date to be August 1971, when the US unilaterally declared its abandoning of Bretton Woods) is ignored as at this time the shock decision led to increased volatility for our variables of interest. Therefore, we ignore the data from this point to reflect the true impact on the variables from using the Bretton Woods system.

5.3.4 What are the effects of exchange rates?

- Taken together, what do your results imply about the effect of real exchange rate fluctuations? Is there a reason why your results are particularly compelling?

Our results imply that the real exchange rate does not have a strong effect on real variables in the economy. In the plots, we see that whilst the real and nominal exchange rates became much more volatile post-Bretton Woods, the other variables, such as inflation and industrial production were not significantly changed. Looking at the standard deviations, we see that the ratio between before and after are roughly equal to one for the non exchange rate variables, whereas the exchange rate variables have standard deviations different from 1. This implies that the volatility of inflation and industrial production were unchanged, even though the volatility of both nominal and real exchange rates almost doubled. These results may be compelling as we may be surprised by the fact that the real exchange rate does not have an impact on real variables, something that may be counter-intuitive given the typical reporting about the importance of exchange rates in the media.

- It is perhaps more natural to consider changes in levels rather than changes in volatility. Is there evidence that the average level of nominal exchange rates changed post Bretton woods? What could be some pitfalls of using this to infer causal changes in the level of industrial production due to exchange rate differences?

Changes in levels is more natural to consider than changes in volatility, because the volatility demonstrated in the period immediately surrounding the exit was short lived and gives us little useful information to view the direction in which figures were moving. Changes in levels, while based on previous figures to index against, give us directional information as well as practical measures of magnitude.

Based on the standard deviation figures in *5.3.3* and the hypothesis test conducted in our code for *5.3.4*, there is sufficient statistical evidence to say that the mean nominal exchange rates changed post Bretton wood, with our observed difference in pre and post-exit means being more than two standard errors away from the null hypothesis of no gap (significant at the 5% level).

One pitfall of using the exchange rate changes to infer the level of industrial production is that it ignores any other confounding factors which may affect the level of industrial production. This is because as we are solely using the relationship between the changes in the exchange rate and the changes in industrial production we end up ignoring any changes in any other macroeconomic indicators which have the potential to impact the level of industrial production independently from the nominal exchange rate.

However, if we consider the nature of the withdrawal from Bretton Woods, which was a natural experiment, we may able to consider that due to the abrupt end to the Bretton Woods system, other macroeconomic aggregates may have not had enough time to respond aside from the change in the nominal exchange rate and therefore confounding factors may not play an as important part in describing this relationship.