

5. Questions and Analysis

5.1 Comprehension Questions

What was the Bretton Woods system? Discuss some advantages it had over the previous gold standard system.

The Bretton Woods system was an international monetary system established in 1944, which aimed to create a stable global financial environment after World War II. Under the system, countries maintained a fixed exchange by pegging their currencies to the U.S. dollar which was pegged to gold at \$35 per ounce. The system was backed by The International Monetary Fund which helped nations stabilise their economies and The World Bank which supported post-war reconstruction

Advantages of Bretton Woods over the Gold Standard:

- Greater exchange rate stability - under the gold standard, exchange rates depended directly on gold reserves which fluctuated unpredictably. Under Bretton Woods, countries pegged currencies to the U.S dollar, meaning exchange rates were fixed.
- Economic Growth and Stability – The stability that came with fixed exchange rates provided an atmosphere that encouraged international trade and investment among nations
- More Flexibility than the Gold Standard – The gold standard forced nations to maintain reserves, limiting their ability to respond to economic downturns however under Bretton Woods, if a country faced economic trouble, they were able to adjust exchange rates with IMF approval, preventing sudden collapses
- Avoidance of Competitive Devaluations – The Bretton Woods system discouraged currency devaluations like in the interwar period France devalued the Franc, contributing to the Great Depression, and required IMF approval for devaluations, helping to maintain fair competition in global trade

What disadvantages did it have and to what extent did the gold standard system suffer from similar issues?

One major disadvantage of the Bretton Woods system was its **reliance on the U.S. dollar as the central reserve currency**, which was the only currency convertible to gold. This created a dependency where other nations had to hold significant amounts of dollars for international trade, requiring the U.S. to run trade deficits to supply enough dollars globally. Over time, this created problems because the U.S. had to keep printing dollars, eventually leading to doubts about whether it had enough gold to back them. As the U.S. could not devalue its currency, it struggled to meet the growing demand for dollars, leading to a loss of confidence in the dollar's gold convertibility, which contributed to the system's collapse in 1971.

Another issue was the rigidity of fixed exchange rates. Countries could not freely adjust their currencies to address economic crises or trade imbalances. While adjustments were possible with IMF approval, this process was slow and often ineffective, limiting the system's flexibility.

The gold standard shared some similar issues. Like Bretton Woods, it tied currencies to gold, creating inflexibility. This caused deflation and economic crises, particularly when gold reserves were insufficient, as seen during the Great Depression. Unlike Bretton Woods, however, the gold standard lacked a central institution like the IMF, making adjustments even harder. Moreover, it was even more restrictive since currency values were directly tied to gold, making economic management during crises more difficult.

What was the date that your country left the Bretton Woods system? Explain how you determined this (if two dates seem plausible, pick one and explain why you're chosen that particular date)

Germany left the Bretton Woods System on 10th May 1971. The figures showing monthly growth in the nominal and real exchange rate of the German Deutsche Mark vs the US dollar shows that around this time and after this date, exchange rates became extremely volatile which was expected as a consequence of a shift from fixed exchange rates to free-floating ones.

Describe how the departure from Bretton Woods represents a “natural experiment” on the effects of real exchange rate fluctuations on the macroeconomy.

When the Bretton Woods System ended, countries transitioned to floating exchange rates, allowing currencies to fluctuate more freely as opposed to fixed exchange rates.

The departure from the Bretton Woods System **represents a ‘natural experiment’ because it provided an exogenous shock** - a sudden shift from fixed to floating exchange rates. It presented an opportunity to observe the effects of real exchange rate fluctuations on the macroeconomy in a way that had not been possible under the system which had fixed exchange rates.

With floating exchange rates, currency values could respond to changes in economic variables such as inflation, offering insight into how these fluctuations affect an economy – e.g. currency devaluation could improve a country's trade balance. Other macroeconomic factors such as inflation, global capital mobility and fiscal policy were changing continuously rather than abruptly as real exchange rates did. This continuity meant that the effects of these variables on the economy were more predictable and so allowed researchers to isolate and analyse the effect of real exchange rate volatility on the macroeconomy and ensure that any observable changes in macroeconomic variables can be more confidently attributed to exchange rate fluctuations.

It was found that despite increased volatility in real exchange rates, the impact on GDP and consumption volatility was minimal, suggesting that economies adapted well to floating exchange rates.

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

Using monthly data is preferable in this data analysis as it offers greater granularity, allowing for a more detailed understanding of how economic variables change in the short-run and over time. Annual data would only provide a broad overview of how economic variables change, potentially missing key fluctuations and short-term dynamics or volatility that may hold significant meaning, especially during periods of major and unexpected economic change, such as the shift from fixed to floating exchange rates post collapse of Bretton Woods in 1971.

Additionally, monthly data is crucial in studying the immediate effects of sudden economic events. For instance, when analysing the impact of the departure from Bretton Woods, monthly data provides a strong level of precision needed to observe how quickly economies respond to the sudden change in exchange rate regimes. This is particularly useful for comparing how different countries were affected and allows researchers to analyse the varying effects on different economies.

Quarterly or annual data falls short in these traits. They do not capture the short-term volatility and rapid, unexpected changes that occur in response to such events. Data with longer time frames could obscure important dynamics, making it harder to accurately measure the immediate responses to sudden economic changes.

Why are we studying industrial production instead of GDP, which seem to be the more obvious choice? You may want to view the available GDP data from the IMF.

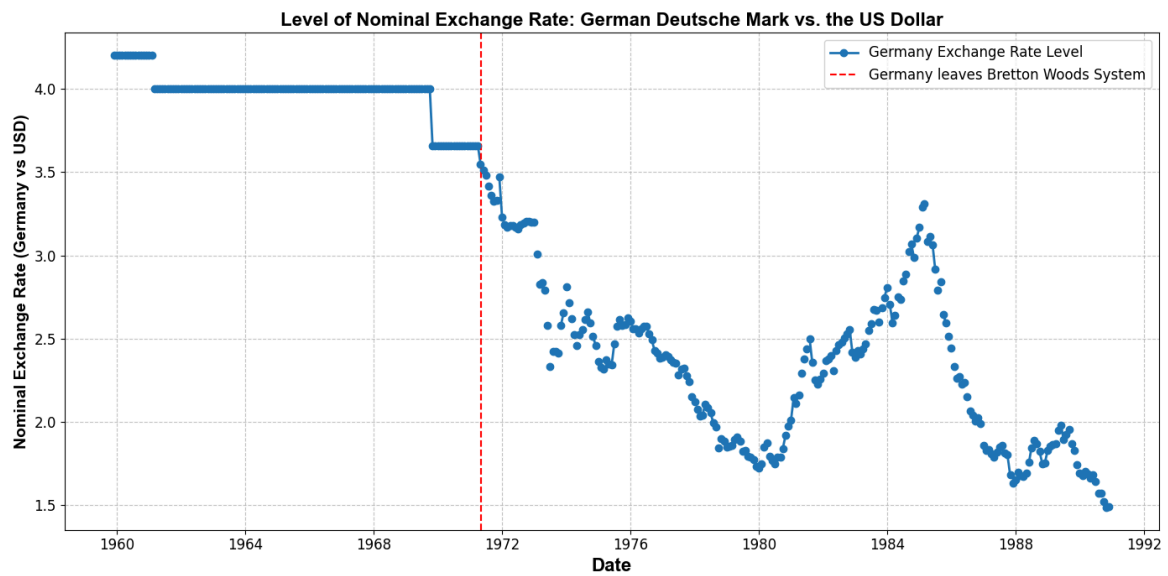
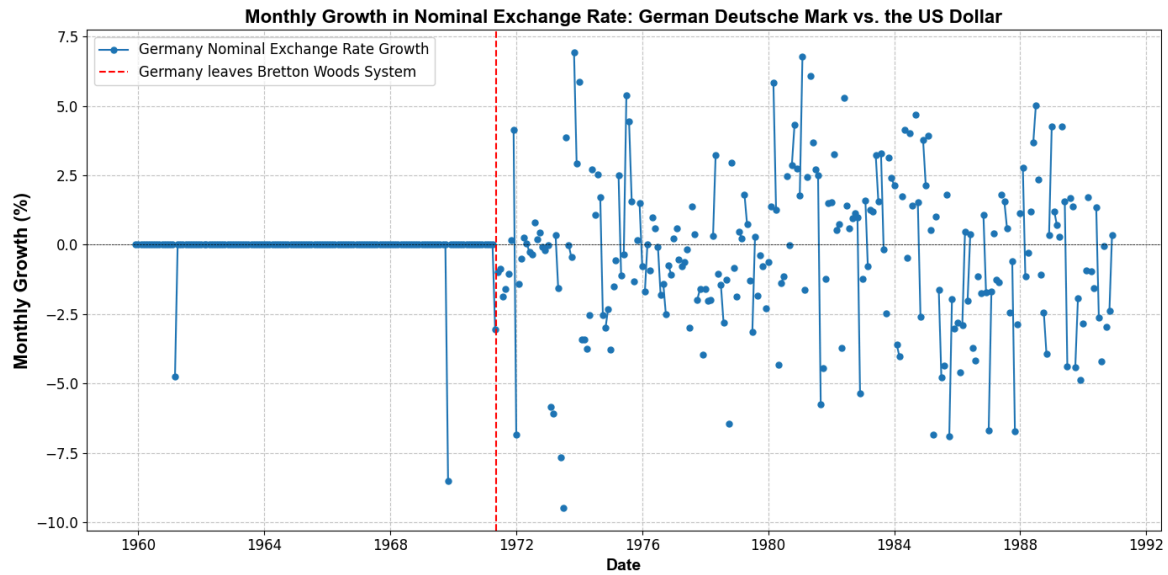
We study industrial production instead of GDP because it provides a more focused view of the specific sectors most affected by the economic changes around the end of the Bretton Woods System and the shift to floating exchange rates. GDP is a broad measure of overall economic activity and can mask underlying sectoral differences, potentially failing to capture the dynamics of sectors that are more sensitive to exchange rate changes.

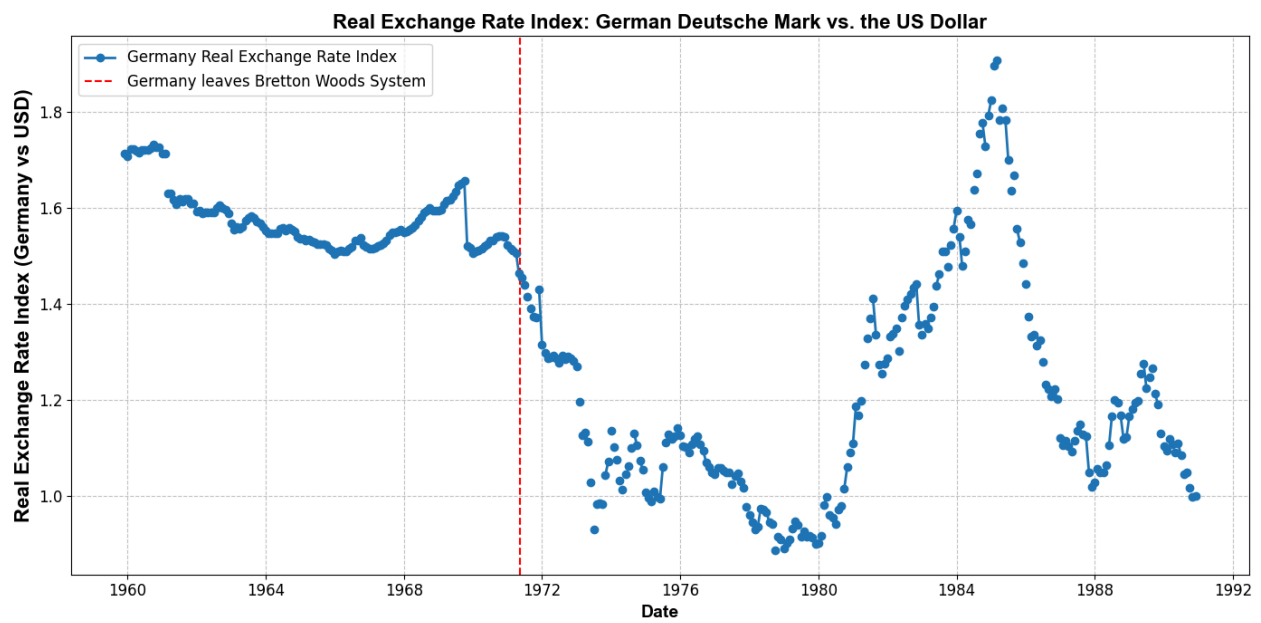
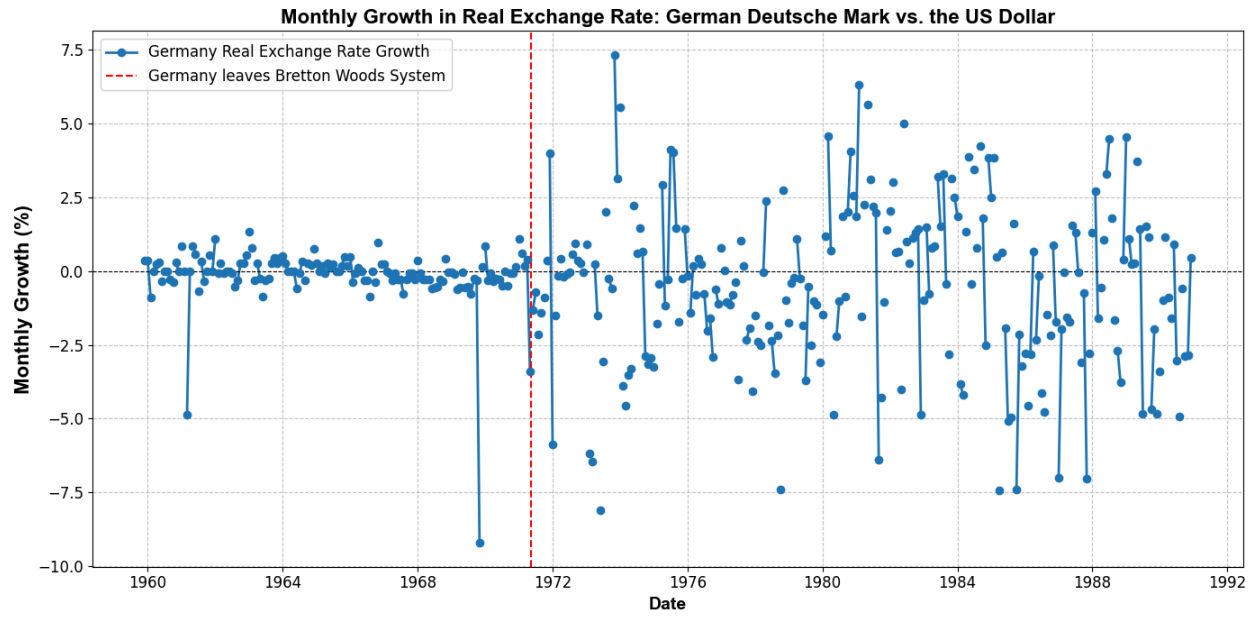
For example, the manufacturing sector is more sensitive to exchange rate movements because it relies heavily on the import and exports of goods. When a nation's currency depreciates, exports become cheaper and more competitive in international markets, boosting demand, while imports become more expensive leading to potentially higher costs for consumers. In contrast, the services industry (e.g. healthcare) is less directly affected by exchange rate changes since it depends less on cross-border transactions. This means that exchange rate fluctuations will have differing impacts depending on the sector in question.

By focusing on industrial production, we can isolate the effects of economic changes on sectors that are more sensitive to these changes, such as manufacturing, which is more impacted by exchange rate shifts. GDP, as an aggregate measure that includes all sectors of an economy (many of which may not be as sensitive to exchange rate fluctuations as others), could underestimate the scale of the impact in the sectors most affected.

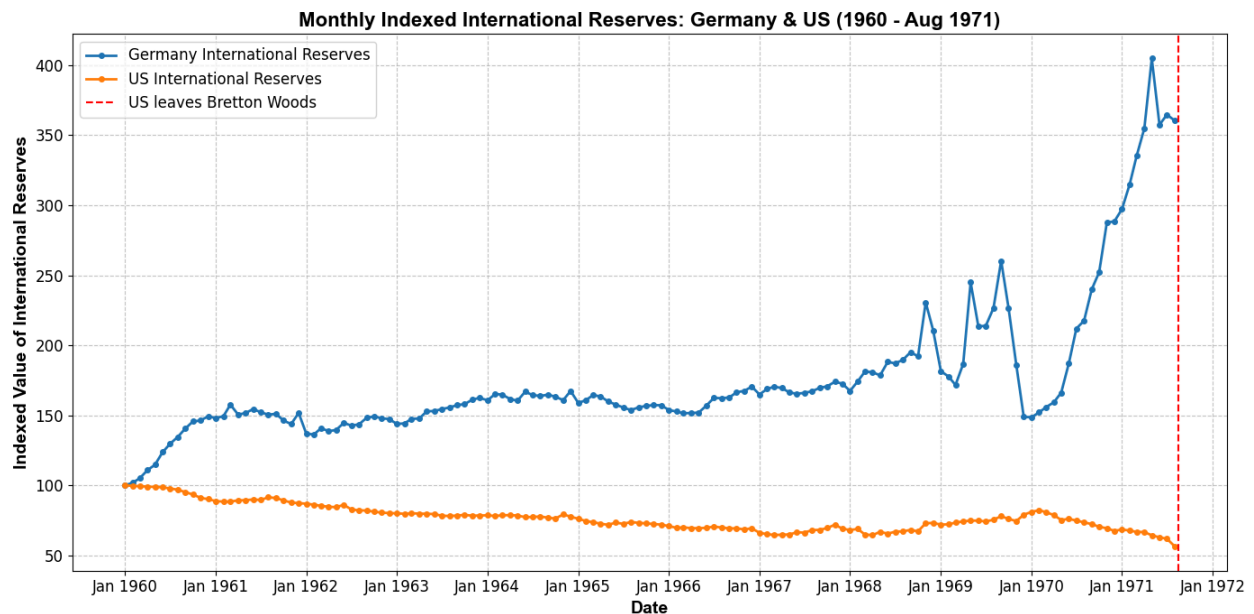
5.2 Analysis

5.2.1 Exchange Rate and International Reserve Graphs





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



The blue line in the graph above shows that from 1960 onwards, Germany's international reserves increased. This is because Germany was running a trade surplus, selling goods to the US in return for US dollars. German exporters needed to convert their dollars into Deutsche Marks (DM), which would increase the demand for the DM and put upward pressure on its value, making exports more expensive and reducing Germany's international competitiveness.. To prevent the DM from appreciating, the German Central Bank (Bundesbank) bought U.S dollars from exporters in exchange for DM, increasing the supply of DM and counteracting the demand-side pressure which added Germany's international reserves.

In contrast, the United States' international reserves were falling due to several reasons. The U.S was running a trade deficit meaning more dollars flowed out than came in, depleting its reserves. Additionally, since the U.S was running a trade deficit, other nations began to lose confidence in the dollar's ability to maintain its fixed value. As a result, they began redeeming their dollars for gold, further decreasing U.S reserves. Moreover, this triggered a speculative attack whereby investors and central banks of other countries sold their dollars in exchange for stronger currencies, increasing the supply of dollars on the market and reducing its value and forcing the U.S to spend more reserves to defend the fixed exchange rate.

These signs indicate a lack of confidence in the dollar's value which suggest that the **U.S dollar was overvalued under the Bretton Woods System.**

Using your above figures, explain one reason for the US's departure from the Bretton Woods system.

The figure above shows that U.S international reserves declined continuously from 1960 until the collapse of the Bretton Woods System in August, 1971.

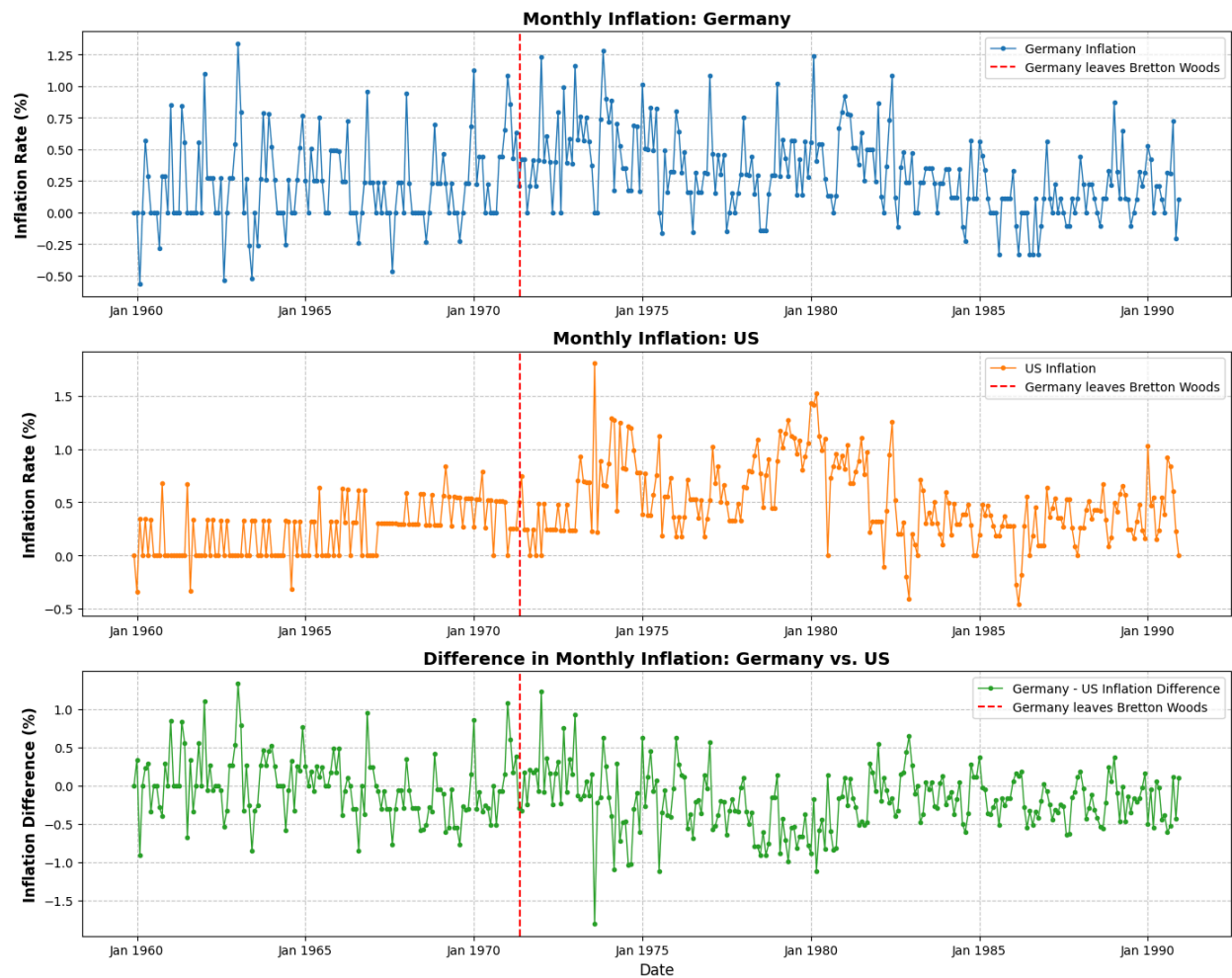
One key reason for this was a **speculative attack triggered by a loss in confidence in the dollar's convertibility to gold.**

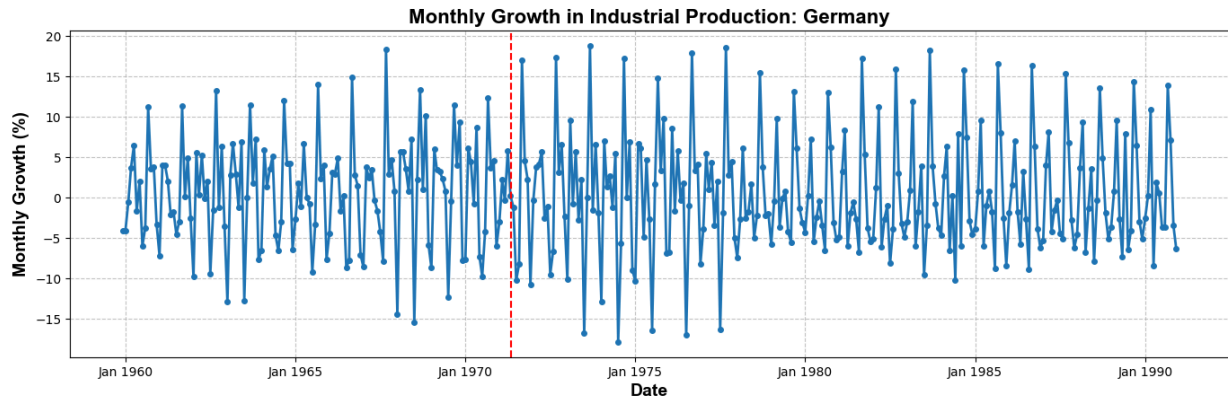
Since the U.S was running persistent trade deficits, investors and central banks began doubting the dollar's fixed exchange rate and so started to sell their dollars in exchange for stronger currencies like the German Deutsche Mark, flooding the global market with dollars.

In order to defend the fixed exchange rate, the U.S had to use its reserves to buy back dollars and maintain demand to sustain its stable value. However, the U.S didn't have infinite reserves, confirming the dollar's fixed rate was unsustainable at this level, leaving it unable to defend the fixed exchange rate. As a result, President Nixon ended the dollar convertibility to gold, effectively ending the Bretton Woods System on the 15th August, 1971.

5.2.2 Inflation and Industrial Production Graphs

Inflation Graphs





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

The monthly growth graph showing industrial production has a lot more volatility compared to the 12-monthly one since it captures **short-term, unexpected fluctuations that can arise**. These can be caused by temporary factors such as sudden supply chain disruptions or seasonal effects. The 12-monthly growth graph, in turn, helps to filter out shorter-term dislocations and provides a clearer picture of longer-term trends.

The 12-monthly growth graph is a more useful measure for analysing industrial production as it helps to capture broader long-term economic trends like booms or recessions, and smooths out short-term fluctuations which can obscure the bigger picture.

The impact of Germany leaving the Bretton Woods System and switching to floating exchange rates appears to be minimal in the monthly graph as volatility remains relatively constant before and after the transition.

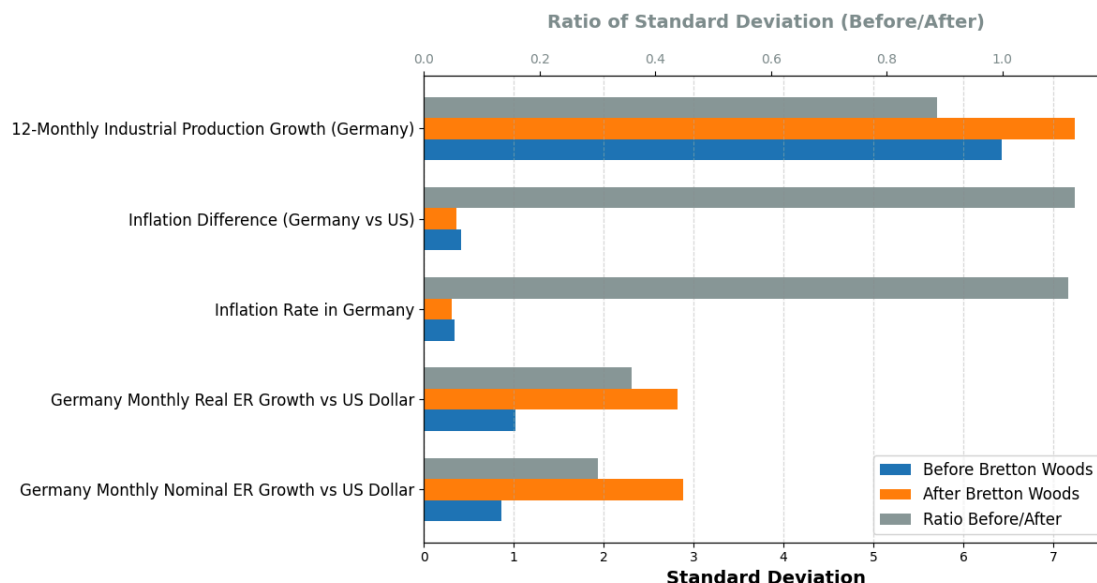
5.2.3 Comparison Statistics and Visualisation

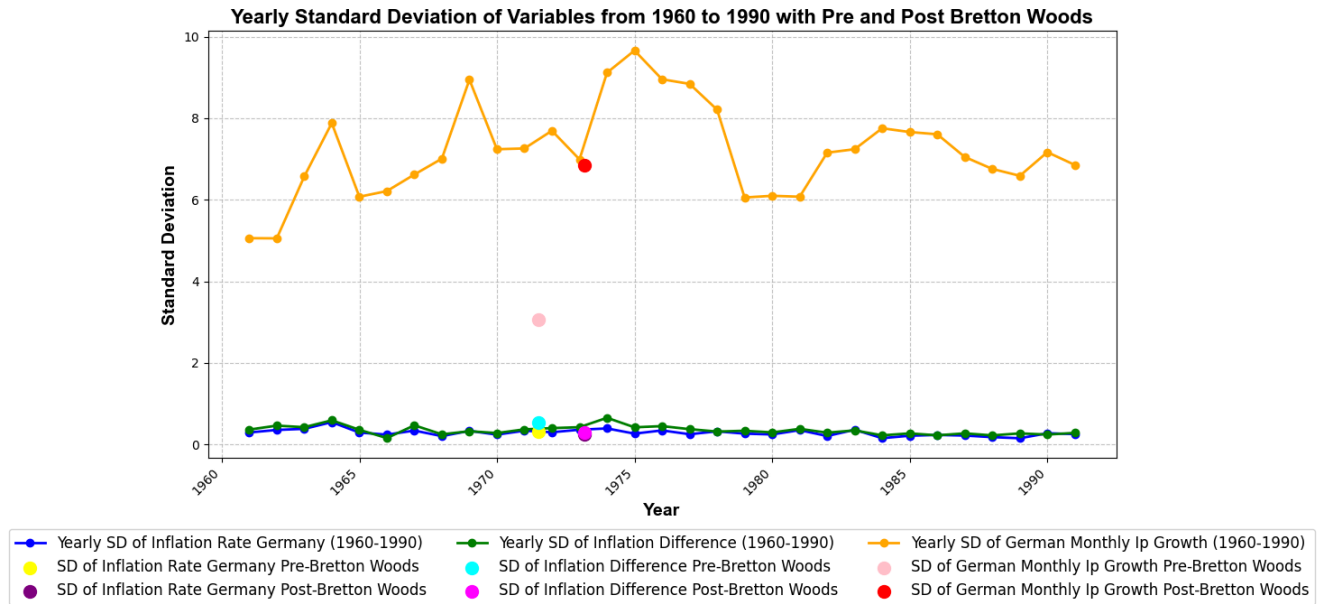
	Std Before Bretton Woods	Std After Bretton Woods	Ratio Before/After
Germany Monthly Nominal ER Growth vs US Dollar	0.8642	2.8794	0.3001
Germany Monthly Real ER Growth vs US Dollar	1.0149	2.8245	0.3593
Inflation Rate in Germany	0.3415	0.3068	1.1131
Inflation Difference (Germany vs US)	0.4131	0.3671	1.1252
12-Monthly Industrial Production Growth (Germany)	6.422	7.2397	0.8871

Why might it be a good idea to exclude data from 07/1971- 02/1973 for the above calculations of standard deviation?

During the period between July 1971 - February 1973, there was significant exchange rate volatility as the Bretton Woods System had collapsed and countries shifted from fixed exchange rates to floating ones. This period could be **considered as a 'transition phase'** where the economy is still adjusting to the shock and is unstable, leading to disruptions to variables such as inflation rates (as per the graphs above). Consequently, it reflects turbulence rather than stable economic conditions so including this period may distort calculations. Thus, it is better to exclude this period to avoid the influence of the 'transition phase' and focus the analysis on more stable pre and post Bretton Woods periods which will likely give a more accurate representation of the relationship between economic variables before and after the collapse of the system.

Standard Deviations of Key Economic Indicators Before and After Bretton Woods



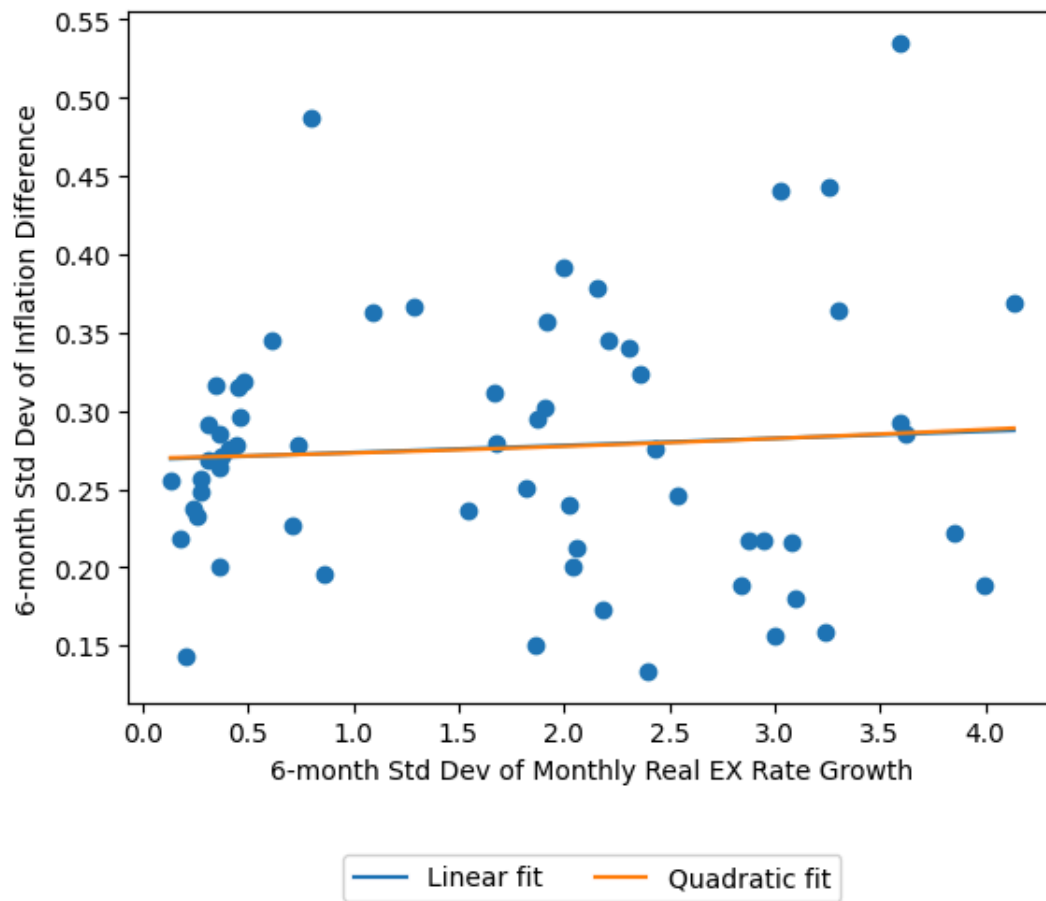


5.2.4 Regression Analysis

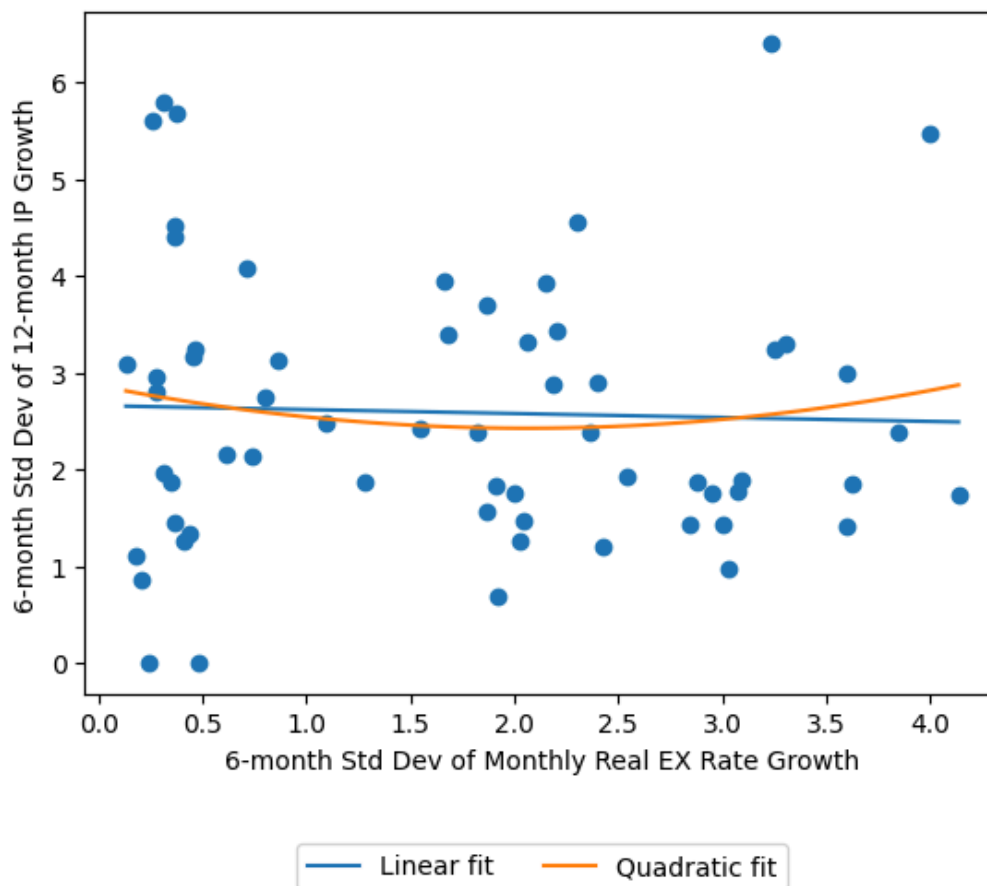
Standard deviations for every 6-month period:

- Monthly growth in real exchange rate: 3.254239
- Inflation difference (Germany vs. US): 0.442947
- 12-monthly industrial production growth: 3.234031

6-month Std Dev of Inflation Difference vs Real EX Rate Growth Std (6-month)



6-month Std Dev of 12-month IP Growth vs Real EX Rate Growth Std (6-month)



5.2.5 Conclusion

Taken together, what does your analysis in Section 5.2 imply about the effect of real exchange rate fluctuations? How is the end of Bretton Woods being a ‘natural experiment’ important for your conclusions here?

The analysis in this section has shown that Germany leaving the Bretton Woods and ensuing real exchange rate fluctuations have not affected macroeconomic variables such as inflation since the diagram representing monthly inflation shows that **volatility in inflation both before and after Bretton Woods has remained fairly consistent**. The same intuition can be applied for the monthly growth in industrial production.

Looking at the bar chart representing the standard deviation of variables (REFERENCE THIS FIGURE), we see that before and after Bretton Woods, **the standard deviation of Germany's monthly nominal and real exchange rate growth VS the US dollar are very different**, with post Bretton Woods standard deviation being a lot larger.

However, for variables such as German inflation rate, the difference between German and US inflation rate and the 12-monthly industrial production growth, we see that the **standard deviation before and after Bretton Woods are fairly similar**, further supporting the claim that the effect of real exchange rate fluctuations has a minimal effect on macroeconomic variables.

The end of Bretton Woods being a 'natural experiment' is helpful for the conclusions here since it provided an exogenous shock. Macroeconomic variables such as inflation were changing continuously as opposed to abruptly like real exchange rates did and this continuity meant that the effects of real exchange rate fluctuations could be analysed in isolation and any changes in other macroeconomic variables could be confidently attributed to exchange rate fluctuations.

6. Extensions

6.1 Studying Levels vs Volatility

6.1.1 Time Frames Chosen for Analysis

	Time Frame	Pre-Bretton Woods Period	Post-Bretton Woods Period
Short-Term	± 1 year	1970 - 1971	1971 - 1972
Medium-Term	± 5 years	1966 - 1971	1971 - 1976
Long-Term	$\pm >10$ years	1959 - 1971	1971 - 1990

The chosen time frames are aligned with **Dornbusch's Overshooting Model**.

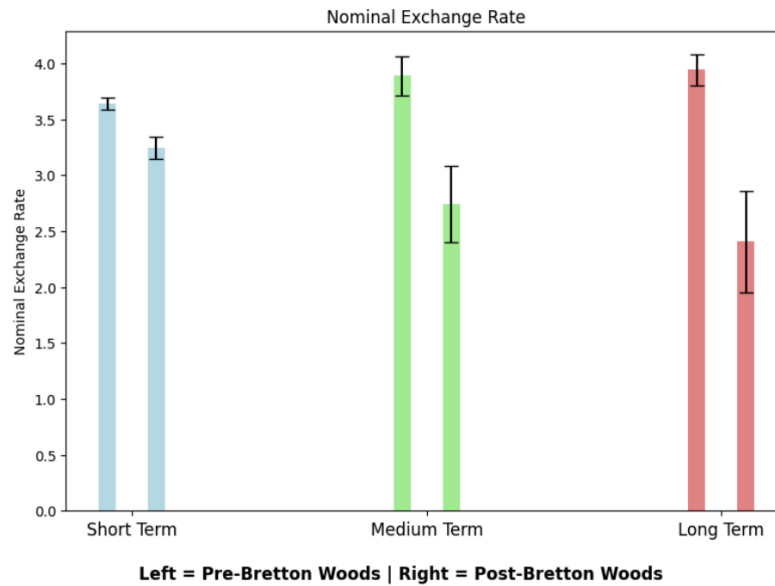
The model suggests that when a monetary shock occurs (in our case the collapse of the Bretton-Woods agreement), the exchange rate initially overreacts (overshoots) its new equilibrium due to the rapid adjustment of financial markets compared to the slower movement of goods prices and wages. This results in a sharp appreciation or depreciation of the currency before gradually stabilizing over time.

- **1-year Period:** Captures the immediate overshooting effect where financial markets react quickly causing heightened exchange rate volatility before price levels adjust.
- **5-year Period:** Represents the medium-term adjustment phase during which inflation, wages, and industrial output respond to the new exchange rate dynamics, gradually moving toward a new equilibrium.
- **10+ year Period:** Studies long-term structural shifts where the economy has fully adjusted to the floating exchange rate system and broader macroeconomic trends such as trade balances, monetary frameworks, and economic stability become evident.

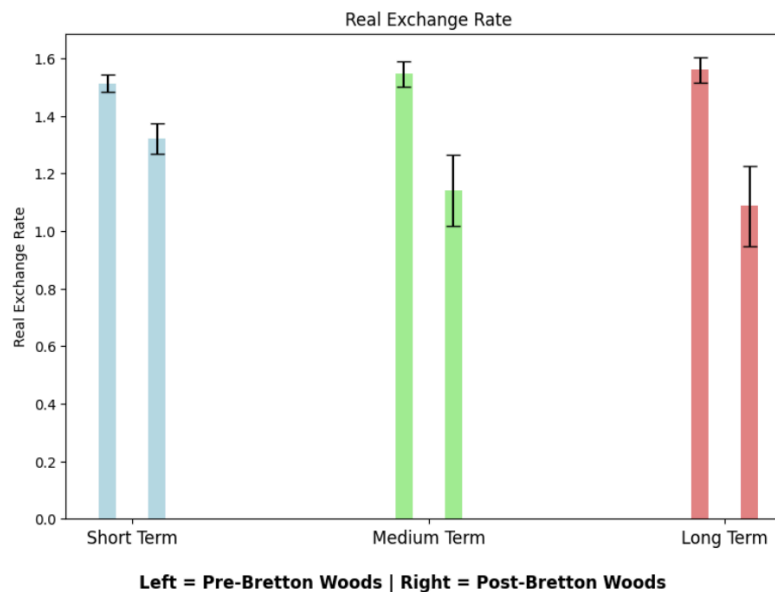
This staggered approach provides a comprehensive analysis of exchange rate behavior, capturing both short-term volatility and long-term macroeconomic realignments.

6.1.2 Analysis of Real and Nominal Exchange Rates

Comparison of Nominal Exchange Rate Before and After Bretton Woods



Comparison of Real Exchange Rate Before and After Bretton Woods



There is a significant difference in both nominal and real exchange rates, in all observation periods (short, medium and long-term) which **provide ample evidence that exchange rates changed markedly around the end of the Bretton-Woods agreement**. We can see that as

the time frame lengthens, both nominal and real exchange rates depreciate more – possibly due to stagnated growth and political instability (East vs West) in Germany without the counterbalancing effect of the Bretton-Woods agreement.

6.1.3 Analysis of Inflation Rate



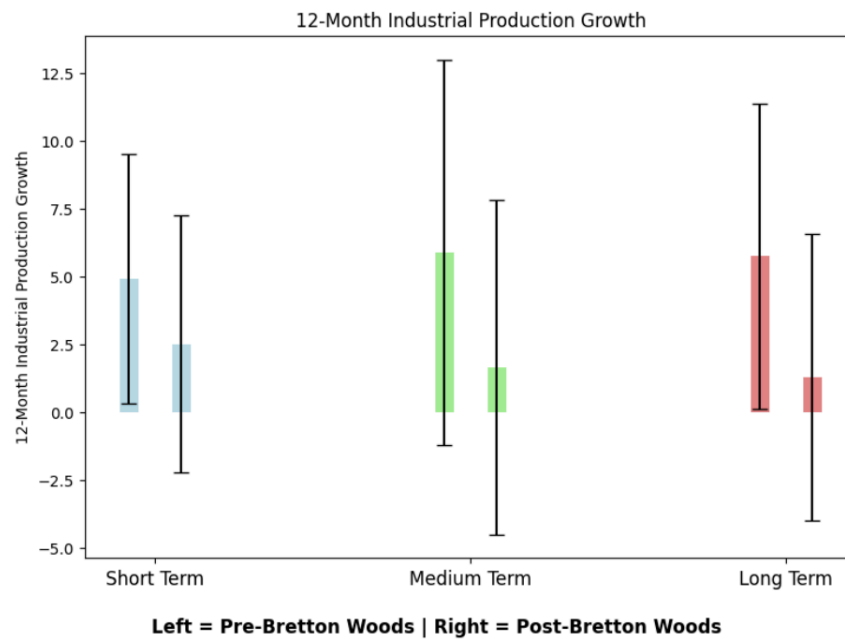
Looking at the inflation rate, we can see that there is **some increase when observing the medium and long-term**. This is to be expected because the abolishment of the Bretton-Woods agreement leads to the depreciation of the Deutsche Mark which may contribute to significant import-led inflation.

Interestingly, we can see that the **extent of increase is slightly greater for the medium-term compared to the long-term**. This may be because the medium-term was generally associated with a period of stubborn stagflation (1970s) mainly arising from the 1973 oil price spike. Otherwise, it makes sense for the inflation to trend lower in the longer-term as the **broader macroeconomy adapts to the floating exchange rates and implements appropriate policies** to deal with exchange rate-led inflation.

However, the **extent of change in inflation numbers are not significantly different** across all the 3 different time frames because the error bars are overlapping. This is unsurprising because inflation is affected by a broad spectrum of factors like economic confidence, commodity prices, monetary policy etc. As exchange rate strength isn't the sole determinant of inflation statistics, it's reasonable to observe that the abolishment of Bretton-Woods did not significantly affect inflation numbers.

6.1.4 Analysis of 12-Month Industrial Production Growth

Comparison of 12-Month Industrial Production Growth Before and After Bretton Woods



We can observe that 12-month industrial production growth **decreases across all 3 time frames**, and that the extent of decrease gets marginally larger as our time frame lengthens.

It appears that there is no significant difference between inflation rate and 12-month industrial production growth post Bretton-Woods for all given observation periods because the error bars overlap. Hence, **we do not have sufficient evidence to prove that inflation rates and industrial production growth rates were affected** by the abolishment of the Bretton-Woods agreement. Even if we lengthen the time frame of observation

What issues are there with using analysis based on longer periods to infer causal changes in the level of industrial production growth or inflation due to exchange rate differences?

Using long-term data to infer causal effects of exchange rate changes on industrial production growth or inflation presents several significant challenges.

First, **long-run averages tend to smooth out short-term fluctuations** which are often critical to understanding how exchange rate changes affect inflation and output. For example, a sharp depreciation might initially increase inflation through higher import prices, but the long-term data may understate this effect if it is later offset by disinflationary monetary policy or supply-side

adjustments. In this way, relying on longer-term trends risks masking important short- and medium-term dynamics that are central to causal inference.

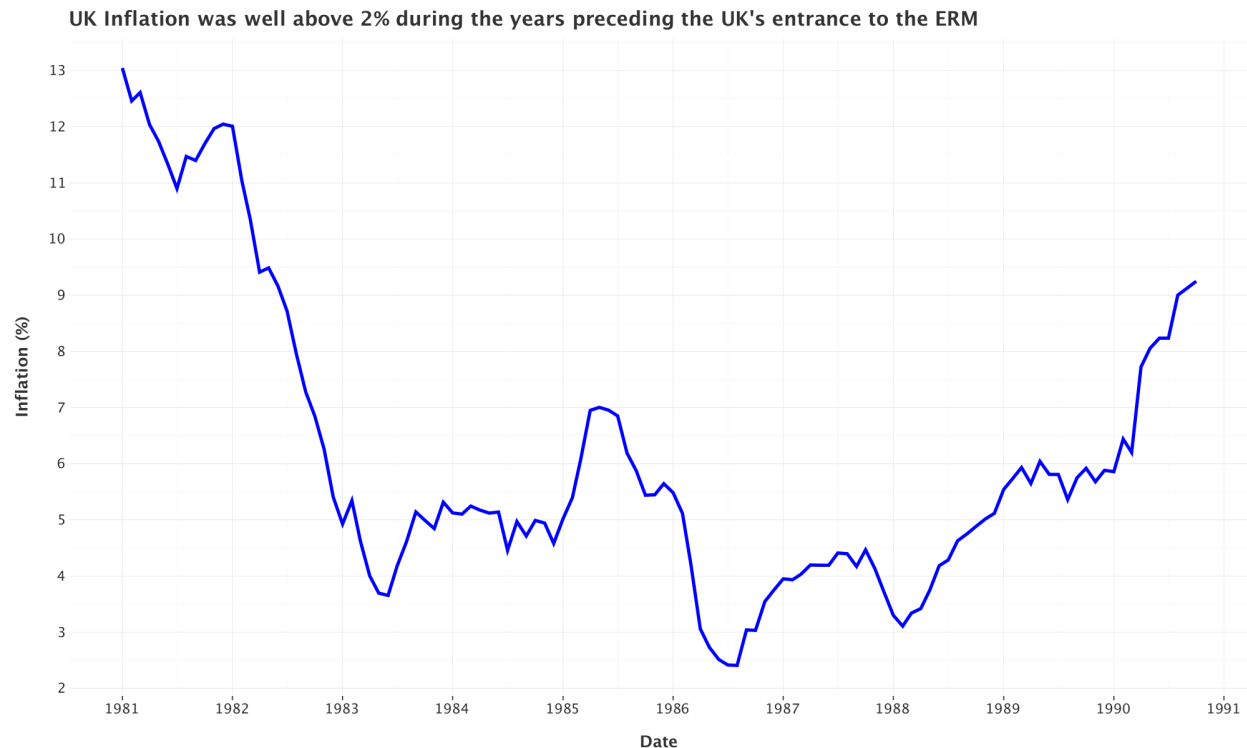
Moreover, **reverse causality also poses a serious challenge**. Exchange rate influences aren't one-directional – inflation and industrial production growth can in turn influence exchange rates via policy effects. For instance, inflation might be met with contractionary monetary policy which leads to higher interest rates and a stronger currency. When observing a broader timeline of data, the direction of influence can be blurred – making it difficult to distinguish cause and effect.

Next, **omitted variable bias becomes more likely** in long-run analysis. In shorter-term analyses, it might be easier to isolate certain events/factors that drive changes in the broader macroeconomy. However, it can be very difficult to account for all the variables when we're taking a decades-long horizon and the effect of the Bretton-Woods abolishment might be understated/overstated. Examples would include changes in trade openness, central bank credibility and political stability which are all challenging to account for.

6.2 Black Wednesday: The UK Joining & Leaving the ERM

What was a key reason for why the UK decided to join the ERM?

During the 1970s and 1980s there had been high inflation in the UK and the Major Government thought that would lead to low and stable inflation.



The ERM meant it was not likely that there would be a sudden depreciation of the Pound against other European currencies. This reduced the risk of a depreciation of the pound increasing the price, in pounds, of imports, which would be inflationary.

Furthermore, it effectively delegated their monetary policy to an international regime, enabling the UK to enforce harsh monetary conditions without all of the associated political damage. Finally, it also prevented the BoE from freely issuing pounds. There were other perceived benefits, for example, it was thought exchange rate stability would improve confidence allowing for more investment.

What factors led to George Soros and other speculators to run on the pound?

The UK joined the Exchange Rate Mechanism (ERM) on October 8, 1990, at a rate of 2.95 Deutsche Marks per pound. This was perceived to be an overvaluation of the pound. The President of the Bundesbank thought the fair exchange rate was 2.6DM to the pound, yet the UK unilaterally entered at 2.96Dm to the pound. This meant that maintaining this peg was going to be challenging anyway.

But, during this period, the UK and Germany faced significant, but very different, economic challenges. In 1992, inflation in the UK had fallen to 3.7%, but unemployment had risen to 9.9%, up from 7.1% in 1990. The economy was in recession, with GDP growth averaging -0.2% from 1990 to 1992. Yet, UK interest rates remained high at around 10%, despite the economic downturn. The UK was forced to maintain these high rates to shadow German monetary policy so that the peg between the pound and the Deutsche Mark was maintained, as the Bundesbank had raised interest rates to check post-unification inflation.

So, this brought into question whether, even if the UK was fully committed to the ERM, they would be able to take the burden of lower unemployment by tracking German rates to maintain the peg against the Deutsche Mark. Thus, the credibility of the UK's involvement in the ERM was diminished as it was in the UK's best economic interest to leave the ERM and cut their rates. The credibility was reduced because, even though the Major government claimed it had every intention to stay in the ERM, it was in the UK's best economic interest to either devalue the pound or exit the ERM if there was a run on the pound. For this reason, there was significant political pressure to exit from the opposition and within the conservative party, so he may not have had a choice.

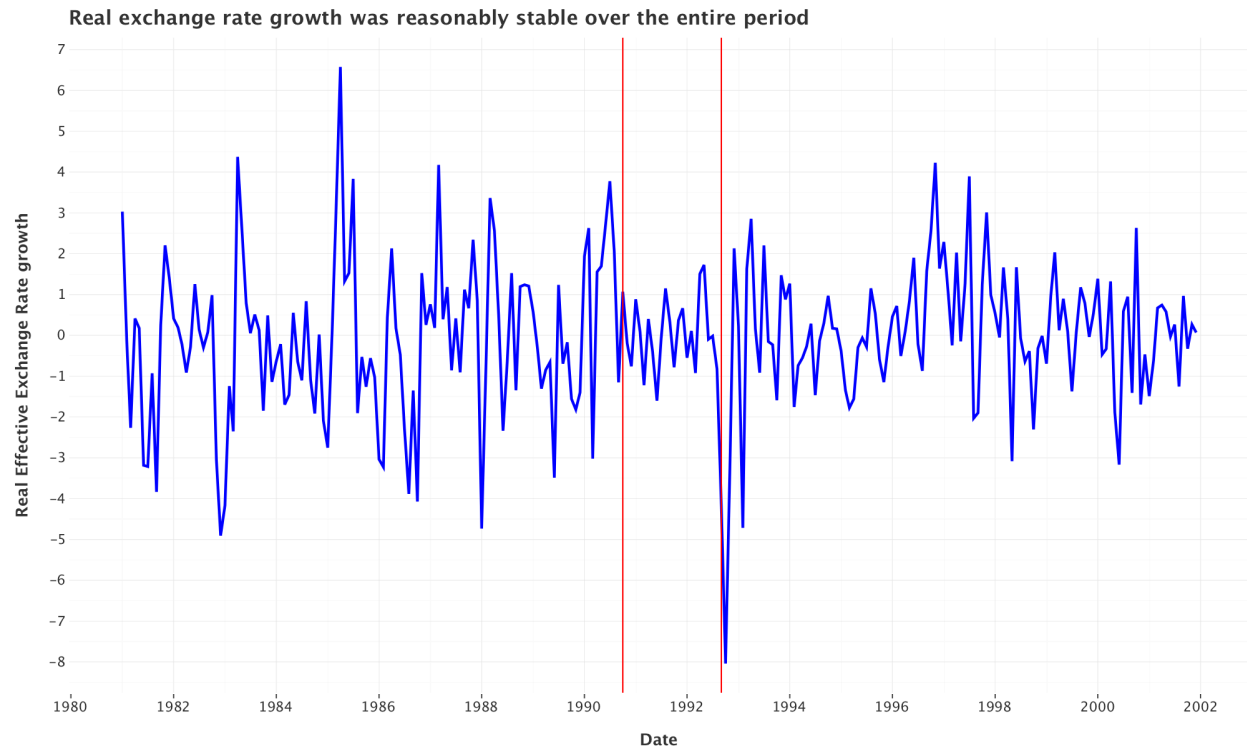
George Soros saw the lack in credibility of the threat to defend the pound and went short against the pound, creating an information cascade. As Soros began building his positions against the pound, other market participants observed his actions and inferred he had the view that the UK's involvement in the ERM was uncredible.

This accelerated as more speculators joined in selling the pound, creating a self-reinforcing cycle. Each additional participant increased the pressure on the Bank of England's reserves and raised the probability of an eventual devaluation, thereby making the trade even more attractive to subsequent market participants. Furthermore, the BoE's response to raising rates may have reinforced the view that their involvement in the ERM was uncredible.

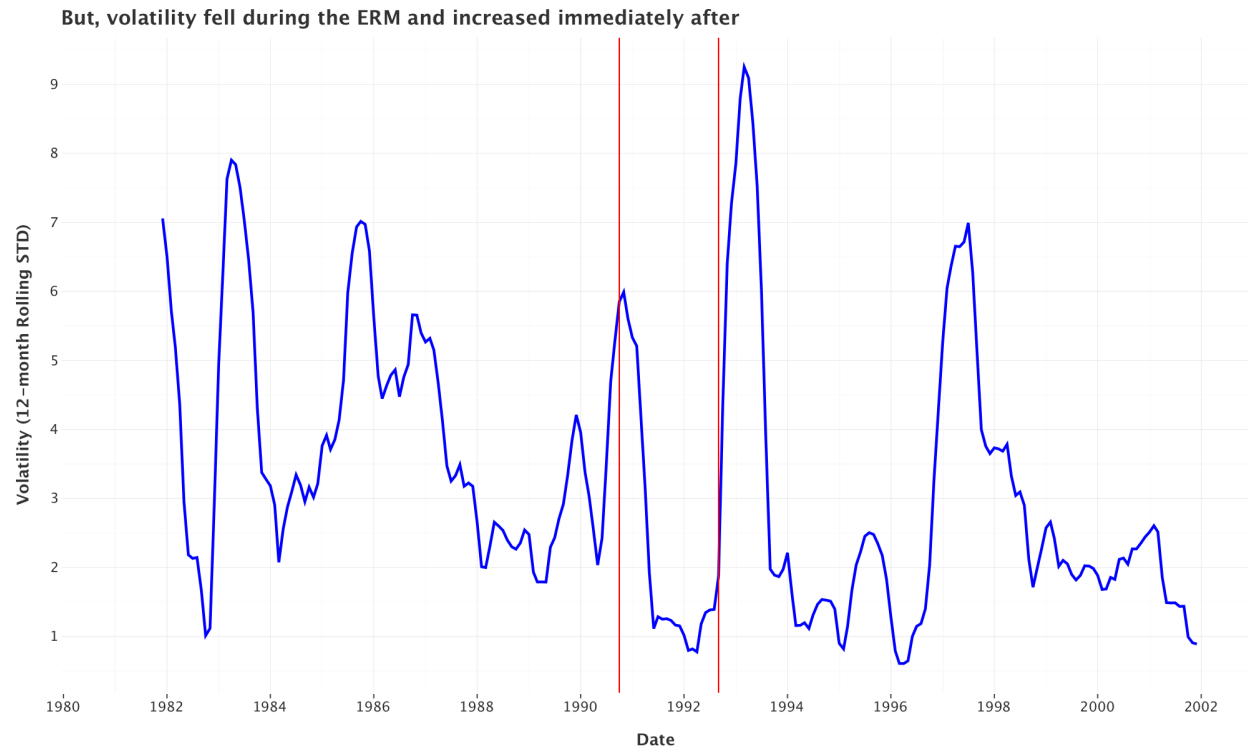
Is there evidence that the UK joining the ERM and leaving after Black Wednesday led to changes in the volatility of the monthly growth in the real exchange rate? Are there corresponding changes in either the volatility of the either the difference in inflation between the UK and Germany or the growth in industrial production?

Real exchange rate analysis

We conducted t-tests and Wilcoxon tests on monthly rolling volatility data of real exchange rate growth to see if there were changes in the volatility of the real exchange rate associated with the UK's membership in and departure from the Exchange Rate Mechanism (ERM). The results indicate that joining the ERM statistically significantly reduced volatility compared to pre-membership levels, as evidenced by both a t-test (p-value = 0.00062) and a Wilcoxon test (p-value = 0.00085).



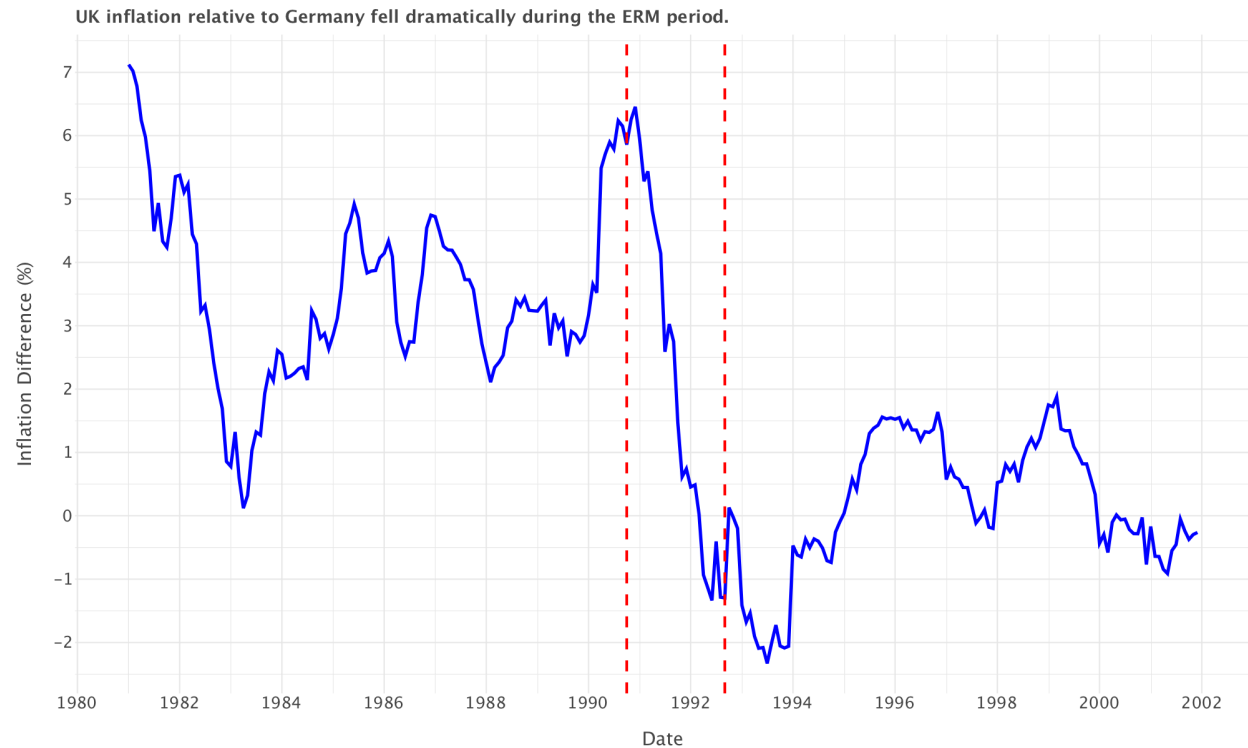
However, our statistical tests comparing "During ERM" and "After ERM" (Black Wednesday to 2002) periods revealed no statistically significant difference in volatility levels (t-test p-value = 0.243; Wilcoxon test p-value = 0.9406). This suggests that while leaving the ERM caused a temporary spike in volatility around Black Wednesday, exchange rate movements re-stabilised under a floating regime. This may not be what you would expect if a fixed exchange rate caused a reduction in the volatility of the real exchange rate. However, this could be explained by either hysteresis or some exogenous factor.



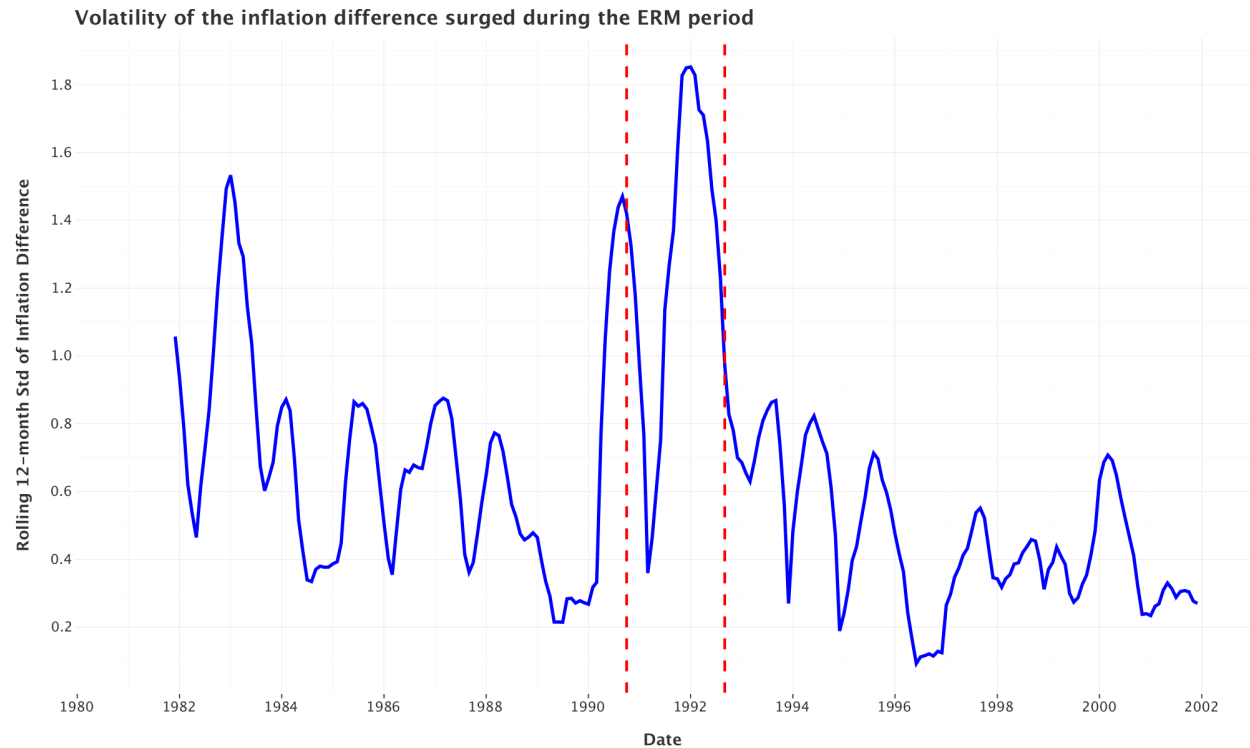
Visual analysis further reinforces these results: rolling volatility declined sharply upon joining the ERM and spiked briefly upon exiting but returned to moderate levels shortly thereafter.

If the UK's membership of the ERM causally led to a fall in the real exchange rate, you would expect there to be a substantial sustained increase in volatility to the before ERM trend in the UK. Given this is not the case, further analysis is required.

Analysis of the difference in inflation between UK and Germany

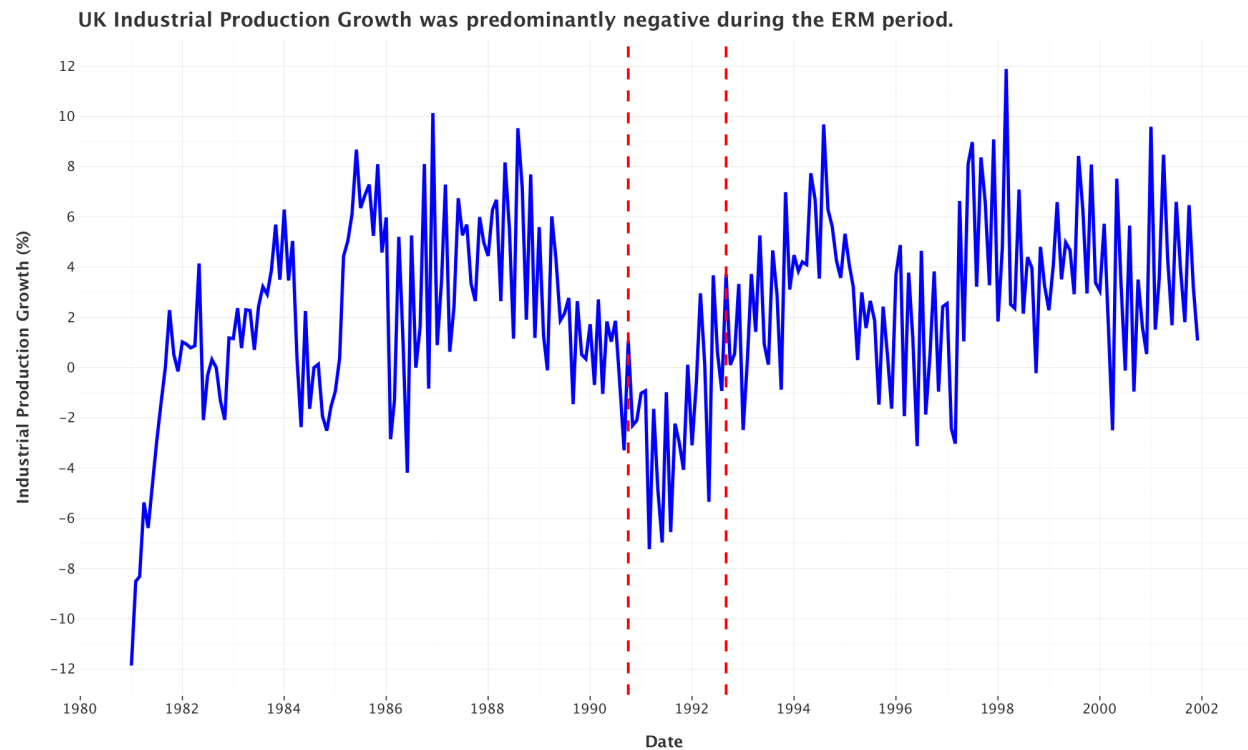


We examined the monthly inflation differential (Germany minus the UK) to see whether the UK's membership in and departure from the ERM corresponded to any notable shifts. The Pre vs. During tests reveal a statistically significant decrease in the differential, based on both the t-test ($p < 0.000001$) and the Wilcoxon test ($p \approx 0.00004$). This implies that when the UK joined the ERM, the gap between German and UK inflation rates narrowed appreciably.

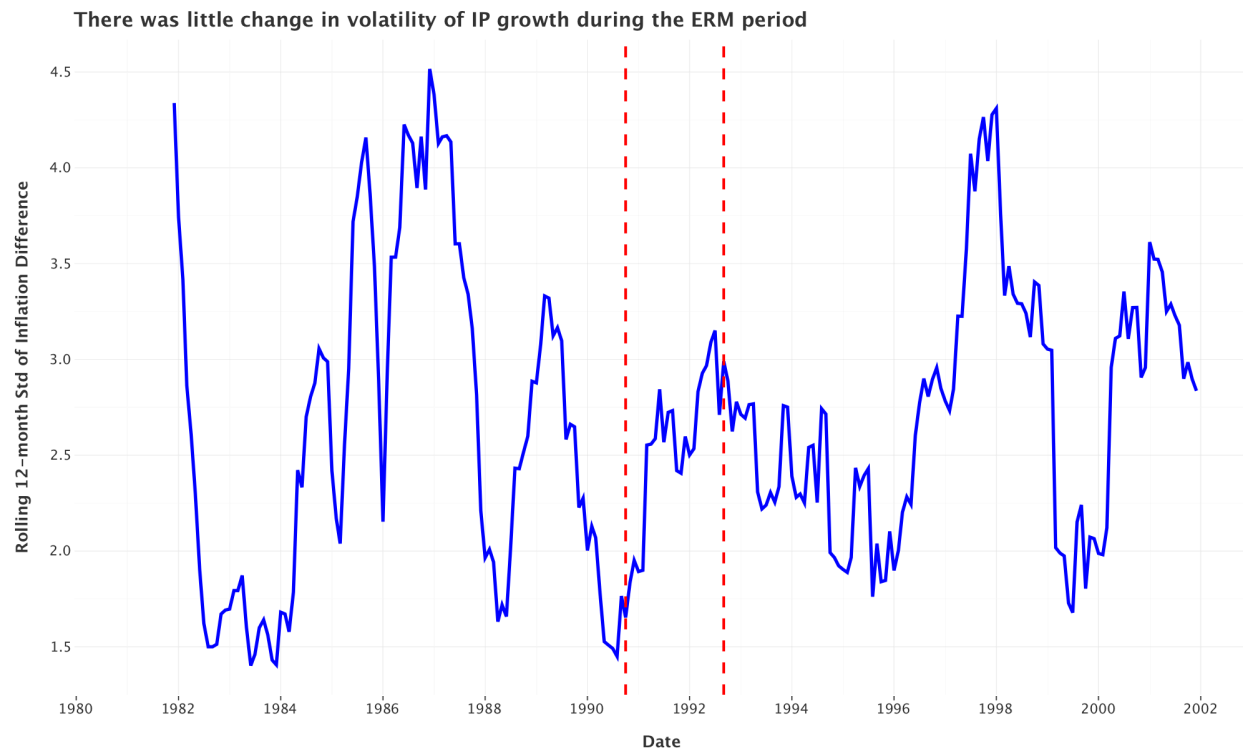


Moving from the During to Post-ERM periods, the difference increased sharply, as indicated by the t-test ($p < 0.00000001$). The Wilcoxon result ($p \approx 0.00001$) is also highly significant, reinforcing the conclusion that after the UK left the ERM, inflation in the UK diverged further from Germany's than it had during membership. This jump contrasts with the more moderate changes observed in other measures (e.g., exchange rate volatility), suggesting that once the UK exited the ERM, inflation differentials did not stay near the levels seen under a partially fixed exchange arrangement but instead widened substantially.

Industrial Production Analysis



Comparing simple averages, the UK's industrial production (IP) growth volatility dipped slightly upon joining (2.65 to 2.54) and rose modestly after leaving (2.54 to 2.74). The change in volatility of IP growth was not statistically significant in both tests in either joining the ERM (t-test p-value = 0.37; Wilcoxon test p-value = 0.05) or leaving the ERM (t-test p-value = 0.05; Wilcoxon test p-value = 0.64). This suggests that there was not a meaningful effect of a fixed exchange rate on the volatility of UK IP growth.



This is apparent visually, there is no clear change in the trend of the volatility of UK IP growth upon joining the ERM.

Whilst it appears the level of UK IP growth fell during the period of the ERM and rose immediately after, this does not provide causal evidence that a fixed exchange rate causes a change in the level of IP growth as during this period there were high interest rates, which likely caused this.

Regression analysis

We ran an OLS regression, analysing the relationship between real exchange rate volatility and industrial production growth volatility, showing a statistically significant positive relationship (coefficient = 0.08, p-value = 0.001). However, this relationship explains only a minimal portion of the variation (R-squared = 0.043), suggesting that while exchange rate stability may contribute to industrial production stability, its influence is remarkably limited.

Similarly, the relationship between real exchange rate volatility and inflation differential volatility is even weaker (coefficient = 0.0221, p-value = 0.072, R-squared = 0.013). This marginal significance at the 10% level, coupled with the extremely low explanatory power, indicates that real exchange rate volatility has limited direct influence on the volatility of inflation differentials between the UK and Germany.

However, without a difference in difference analysis, with a country which it is fair to reasonably say the UK would have followed in a similar way in terms of these macroeconomic measures, it is hard to determine whether this provides any causal evidence either way.

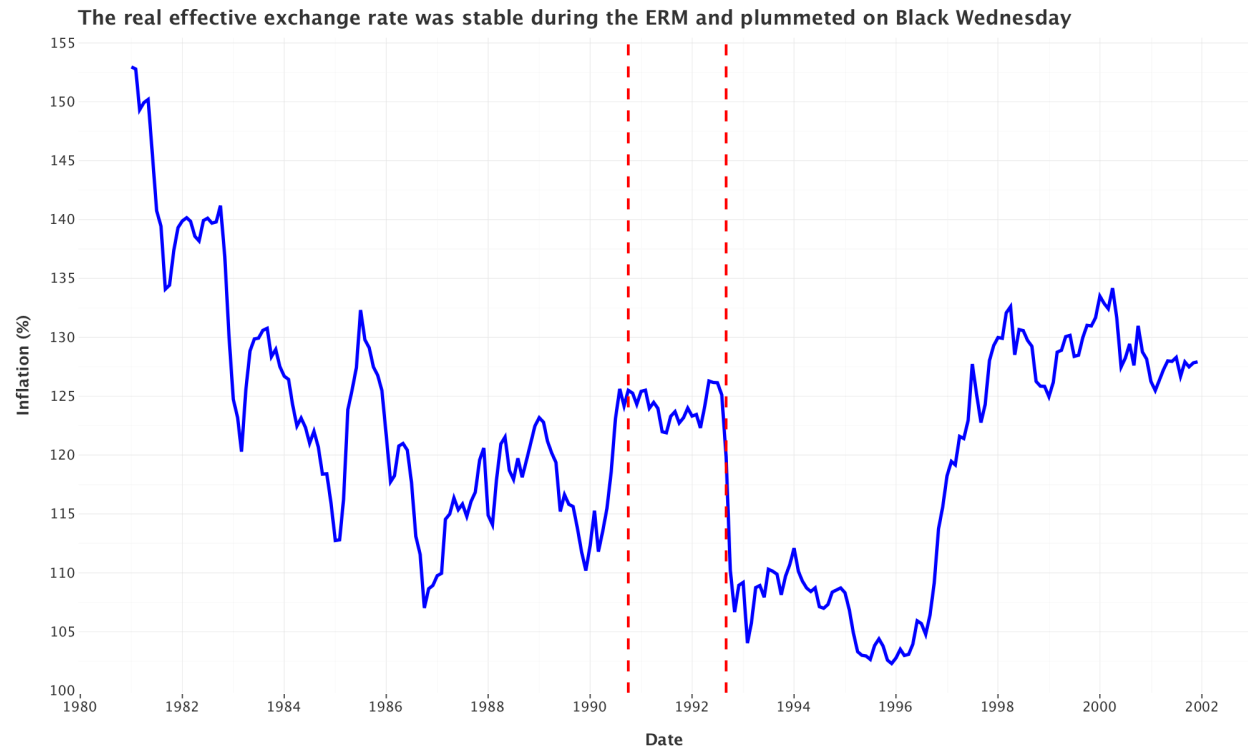
Overall

So, we think that **there is evidence that joining the ERM led to a fall in the volatility of the real exchange rate**, given that there was a statistically significant fall in the volatility of the exchange rate. The fact that after a significant spike in volatility upon leaving the ERM, volatility fell significantly, we do not believe to necessarily provide evidence against the ERM reducing the volatility of the real exchange rate. There are two possible explanations. One, there was a hysteresis effect after leaving the ERM, whereby the membership of the ERM caused a persistent fall in the real exchange rate volatility. Or, the second, more likely reason that there was a fall in the real exchange rate due to exogenous reasons after the ERM in the late 1990s as a result of general macroeconomic stability.

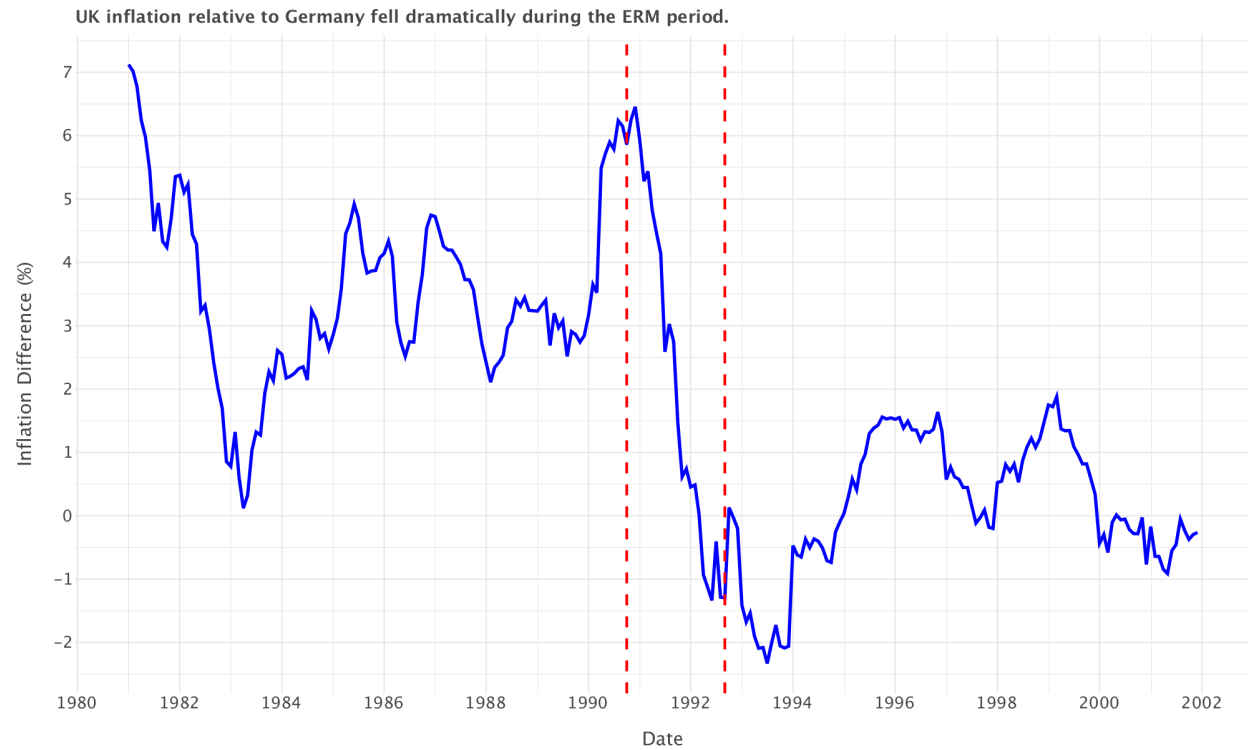
There is statistical evidence, if we assume joining and leaving the ERM acts as a natural experiment, that the real exchange rate had a causal impact on the gap in inflation between the UK and Germany. Yet, this assumption may not necessarily hold given that there are many other factors (notably interest rates and the difference in the challenges the two countries were facing). As a result, it may not be justifiable to take this statistical evidence as evidence for causality. In terms of industrial production growth, there is insufficient evidence to even say that there was a difference in volatility between when the UK was and wasn't in the ERM. So, this does not provide evidence that real exchange rates have an impact on industrial production growth.

Analyse the extent of the change in exchange rates following Black Wednesday and any corresponding changes in the inflation difference and industrial production growth.

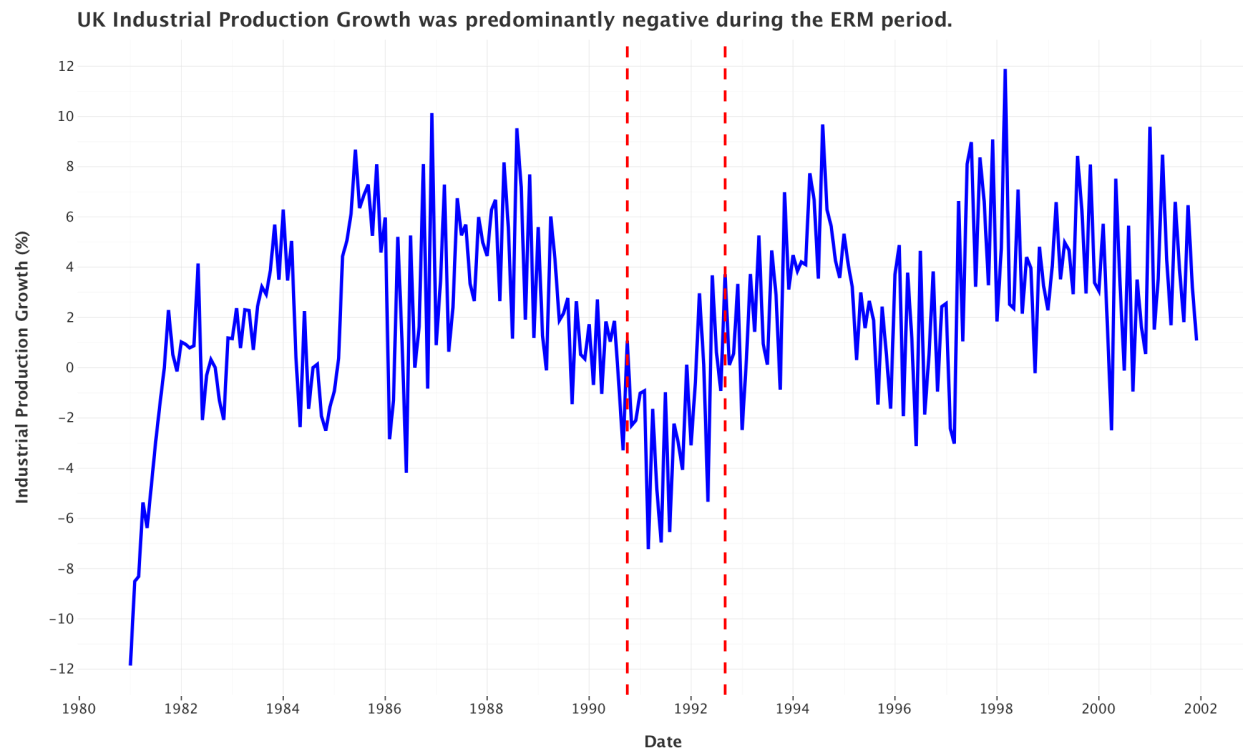
The real effective exchange rate averaged 123.93 during ERM membership (October 1990 to September 1992) but fell to 107.13 in the post-ERM period (1992 to 1996), representing a 13.55% depreciation. The immediate impact, measured by comparing three months before and after Black Wednesday, showed an 11.43% depreciation.



The UK-Germany inflation differential shifted substantially following ERM exit. During ERM membership, UK inflation exceeded Germany's by an average of 2.11 percentage points. After exit, this differential reversed to -0.38 percentage points, indicating UK inflation fell significantly, and fell below Germany's. This represents a 118.18% reduction in the differential. The immediate three-month impact showed a 65.45% narrowing of this gap.



Industrial production growth demonstrated the most dramatic transformation. During ERM membership, UK industrial production contracted at an average rate of 1.85%. In the post-ERM period, this reversed to 2.99% expansion, constituting a 261.92% improvement relative to the During-ERM baseline. The immediate three-month impact revealed a 71.88% acceleration in growth.



Overall, what do your findings suggest about the importance of exchange rates? What concerns do you have about drawing such conclusions from the analysis of this particular period?

Our analysis offers insufficient evidence that real exchange rates caused changes in the key macroeconomic variables in question. Although some initial tests indicate reduced volatility in the exchange rate during ERM membership and a short-lived surge after exit, there is little evidence that this has a robust or sustained impact on inflation differentials or industrial production growth. Furthermore, the strength of the explanation from regression analyses are minuscule (as indicated by very low R-squared values), even if they are statistically significant. However, it would appear that if real exchange rates have any impact on either variable, it is most likely to have a relationship with inflation.

However, it may be unreasonable to draw meaningful conclusions from this data for three main reasons, interest rates, expectations and the length of time we have data for.

During the early 1990s, the Bank of England raised interest rates sharply to defend sterling within the ERM. These historically high borrowing costs—peaking at 15%—would have influenced price levels, constrained industrial output, and affected exchange rate movements more powerfully than the fixed or floating regime alone. Because no systematic correction is made for these monetary policy shifts in our analysis, it remains unclear whether any observed changes in inflation differentials or production growth stemmed from exchange rate policy or from the prevailing high-interest-rate environment.

Market participants' expectations can move exchange rates and other macroeconomic variables even before official policy changes. Widespread speculation against the pound in anticipation of a potential ERM exit, for instance, may have driven much of the volatility and subsequent economic adjustments. Such forward-looking dynamics complicate attempts to disentangle genuine policy effects from the self-fulfilling impact of market beliefs.

Black Wednesday and its aftermath were characterised by abrupt swings and policy interventions over a relatively brief period. This short, turbulent window obscures any meaningful assessment of longer-run trends in exchange rates, inflation, or industrial production. It is difficult to identify a stable baseline from which to measure the impact of leaving the ERM, raising doubts about the robustness of conclusions drawn solely from this volatile episode.

As a result, we conclude that if exchange rates do have a meaningful impact on macroeconomic variables, our analysis of Black Wednesday and the entire ERM period does not provide evidence for this assertion. But, given the issues of using this period for analysis, we are hesitant to say that our analysis provides evidence against the idea exchange rates are important.