

# Has inflation changed regime?

*In this post I show how to use a basic clustering algorithm to identify different inflation regimes across time*

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*I demonstrate how to use a basic clustering algorithm to identify different inflation regimes over time. I compare the regimes for both headline and core US inflation. At the time of writing, core inflation did not change regime unlike headline inflation, which includes food and oil prices. This analysis suggests that supply-side factors might be driving inflation dynamics. Therefore, it is quite likely that core inflation might change regime too.*

## Introduction

Writing about inflation is not an easy task. Definitely not now, where all you hear in the financial press is whether inflation is here to stay or is a matter of time to return to more normal levels. Investors, governments, and central bankers alike are trying to evaluate whether inflation is transitory or permanent. Investors care about this distinction to position their portfolios accordingly, governments to re-assess their budgetary policy, and central banks to evaluate their next move.

This article will go through a simple statistical analysis that aims to cluster inflation dynamics into different regimes using the [Dynamic Time Wrapping approach](#) — a basic time-series clustering method in machine learning (ML). This technique has been used to cluster different series, but in this article what I want to show how to use the very same approach to detect regimes across time. Another motivation for writing this article is to help promote use-cases of ML tools in macroeconomics.

I will focus on the US and the CPI index and repeat the analysis with and without energy and food prices. I will first start with some basic exploration of the raw series, and then I will move on to the clustering exercise. I will use monthly data as I believe this gives a better sense of the inflation dynamics. The series are seasonally adjusted from the source (Fed St. Louis). The sample uses the latest available information (the series end Aug 2021 when I did it). The scope is to find similar to each other periods based on the underlying trend in inflation. From

the economics point of view, the objective is to check which period in the past is the most similar to the current inflation dynamics. But instead of using human judgment would let the machine tell me.

## Transitory and Permanent shocks

But before I go to the analysis, I think it is good to briefly discuss the meaning of the terms “transitory” and “permanent” as I don’t feel that everybody is on the same page. It also helps to understand better the methodology taken here.

My gut feeling says that if you ask ten different people the meaning of *transitory*, is quite likely to hear eleven different answers. I remember a well-respected Chief Economist, who works for a top asset manager, saying that central banks will change the definition of transitory inflation to extend from a few months (say three) to a little longer (say nine months).

On this issue, I have noticed two types of people. Those who use the term transitory to refer to the duration of the cycle and those who use the term transitory to refer to the type of economic shock. These are not necessarily the same concepts. In this post, the use of transitory refers to the type of economic shock, which mostly relates to how people (markets) are behaving when they know or expect that a shock is temporary relative to when they know or expect the shock would alter things forever.

For example, when a government announces a temporary tax hike lasting for a year this is unlikely to cool off demand much. In contrast, a tax reform that would last in the foreseeable future the effects on the economy would be quite strong. In some cases, like now with inflation, is not very easy to make such an assessment. Nevertheless, the indication from the bond markets and the reaction of gold (a traditional inflation hedge) indicate that this type of inflation shock relate more to a transitory economic shock. This is more obvious when looking at the bond markets, where the increase in interest rates **relative** to the size of inflation shock that we are experiencing is quite weak.

More generally, a transitory shock is expected to disappear after some point, as happens with business cycles like recessions. A typical business cycle may last up to 2 years, for example. Of course, from the practical point of view the duration of such a cycle matters. That’s a related, worth considering, type of question. But to keep things simple, I will not cover it here though you should know that transitory does not mean that is necessarily short-lived.

Another sloppy analysis that I noted is that sometimes people are mixing things up between inflation and price levels. A transitory inflation shock implies a permanent increase in price levels. Inflation is the growth rate of prices, so even if you have a one-off shock to the growth rate you get a permanent change in the levels. So, statements like “*the recent rise in consumer prices will be transitory or more permanent*” that I read in the news are not very meaningful.

On the other hand, a permanent shock is something that you expect to endure far ahead in the future. It is equivalent to a regime shift in other words. In this case that would mean a shift

in the underlying inflation trend that depends on the fundamentals, like the natural rate of unemployment or the (de-)anchoring of the inflation expectations. Fundamentals also include the policy regime, that is preferences of governments and central banks about inflation. For a change in inflation regime, what really matters is the so-called  $\pi^*$  (pi star), that is the rate of inflation that prevails when the economy is back to potential output or to use more jargon the rate of inflation consistent with the natural rate of unemployment. It is in this case that there is a serious chance that the inflation regime might change. The problem here is that  $\pi^*$  is unobservable and so an ideal experiment would require estimating  $\pi^*$ .

To proxy this case, however, in the analysis I have removed the cyclical component of the raw statistics and focused on the underlying trend. I did this using economists' favorite [HP filter](#). But you can apply any other filtering method you want or you think is more appropriate such as the Kalman Filter. Good data scientists usually smooth the raw series because they know it is better for the time-series clustering algorithms. It also makes nicer interpretations when you are using time-series data. But here is the difference between “doing the right thing” vs “doing things right”.

What my “ML research assistant” told me is that the regime for the core inflation (i.e. ex-food and energy prices) hasn't changed. However, adding to this picture the food and energy sectors — which I like to think of them as representing the supply side of the economy — and we are back to the record high inflation regime of the 70s.

Combining these signals, it looks that what matters is the supply-side factors. For example, do you believe that the semi-conductor shortages are going to be short-lived? Then it is a matter of time for supply to meet demand and be back to normal (maybe we need to be a bit more patient this time). On the other hand, do you believe that there is a significant re-organization on the supply side? Or that a ship stuck in a Chinese port is re-shaping trading networks? Then we might already be in a new inflation regime similar to the one in the 70s, and so is a matter of time for the core inflation to change regime too. The more weight you put on the latter scenarios, the more likely is for the Fed to start thinking about raising interest rates.

## **Inflation over time and the New “Bretton Woods”**

Before I go to the details of the results, I think it is useful to go through a brief history of inflation. Figure 1 below shows how the inflation rate (annualized) evolved over the last 70 years. The blue and orange lines are rolling averages that remove the big cycles and the noise from monthly data to see the series better. The green and red lines are the underlying trends of the headline and core inflation, respectively.

In general, inflation has gone through two broad periods. The first one begins with the so-called Golden Age of Capitalism (roughly from the '50s to early '70s) and ends late '70s to early '80s. After crisis upon crisis (the collapse of the Bretton Woods system, oil crisis, a few political crises etc.), we then decided to bring a “better” version of capitalism where the only “serious” argument you hear is that now people have (a tiny) chance to get rich by



Figure 1: Inflation Over time

exploiting opportunities that few can have. Political manifestos aside, the second broad phase for inflation begins in the early '80s when inflation started declining and then stayed relatively low and stable until recently.

Suppose now that you are an investor standing at the peak of the inflation rate in the late '60s and then you saw this subsequent big dive in the early '70s that seems to have lasted about two years. By the equivalent standards that many people currently think this decline in inflation rate might have signaled to you a permanent shock (fall) to inflation — after all two years of falling inflation ain't enough permanent situation for you?

You might have already shorted gold, resisted investing in commodities, and so ended up losing a lot of money based on how history unfolded. We move forwards, and as we are approaching the end of that decade, inflation scores new highs. You now think that this time you have it right and repeat the same mistakes losing money again.

You start blaming Keynes for your miserable life because he taught you that everything was demand-driven, and so you were looking at the unemployment numbers. Later, you found some solace in some smart economists who agreed with you that Keynes was to blame on this occasion. These economists also picked up that you also got a little smarter by not looking too much at the past when you think about the future and taught new tricks to central banks and politicians — who by that time got a bitter divorce after a decade of remorse.

Heartbroken central bankers found your new forward-looking thinking charming and made you a marriage proposal which you happily accepted. The agreement is that whatever central

banks want to do will do and will tell you in advance (or at least close the eye), so your whims or mood would not destabilize the economy much. The fact that central banks stayed away from their ex- ( i.e. politicians) helped make the agreement credible and the marriage prosperous. Managing aggregate demand was never easier for central banks.

Such forward guidance and the anchoring of expectations contributed to creating a relatively stable environment where inflation was declining at a steady pace. In fact, between 1980–2007, things were so boring compared to the past that economists decided to call this period the “Great Moderation”. The Global Financial Crisis and the period that followed, [except that ridiculed Nobel Prize winners and the intellectual originators of the Great Moderation](#), did not shake this relationship. Maybe it made the (modern version of) Philips curve more irrelevant and inflation expectations more dominant for stabilizing inflation, but no real drama.

Now you are wondering, am I standing in the same peak where it all began? Effectively, what you are asking here is if the new “Bretton Woods” system, where everybody in the last few decades got used to the idea that inflation expectations remain anchored (within bands), would collapse. There is no answer to this question yet, but what the 70s taught us was that inflation expectations mattered (to be more specific the formation of inflation expectations) for the inflation regime during the 70s. Detecting in which inflation regime we are now, could signal how inflation expectation might develop.

## **Inflation Regimes**

I told you before what signals I got from applying the basics of a basic ML tool. So, let me now show you the analysis. I will not write anything extensive here, beyond going through a few pictures and some talk. Perhaps not as entertaining as before.

Figure 2 shows the different clusters (regimes) according to the DWT clustering technique (twisted for my purpose here). This basic analysis suggested that there are three regimes when looking at core inflation. For the record, I used the elbow method to determine the optimal clusters. One can also try other metrics like the Silhouette. For those not familiar, what this means is that I did not pick the number of regimes myself but let the machine suggest this to me. Each regime has its own color in Figure 2. The interesting bit is to check if the current regime has changed or not.

According to the results, the machine it essentially says that there three inflation regimes: low-, medium, and high- inflation. Sounds quite sensible to me. But different to human judgments, here the basis for low, medium or high inflation are not determined by some arbitrary threshold which is what a more judgment based approach might do.

Going back to the analysis of the results, everything after 1990 (and before 1970) belongs to the same inflation regime (dark purple line). We have the case where core inflation was either trending upwards or downwards but with a few bumps (cycles) in between (green line). The

third regime — the “outlier” — covers most of the stagflation era and its turning phase, which begins roughly at the time of the third oil shock in 1979 (yellow line).

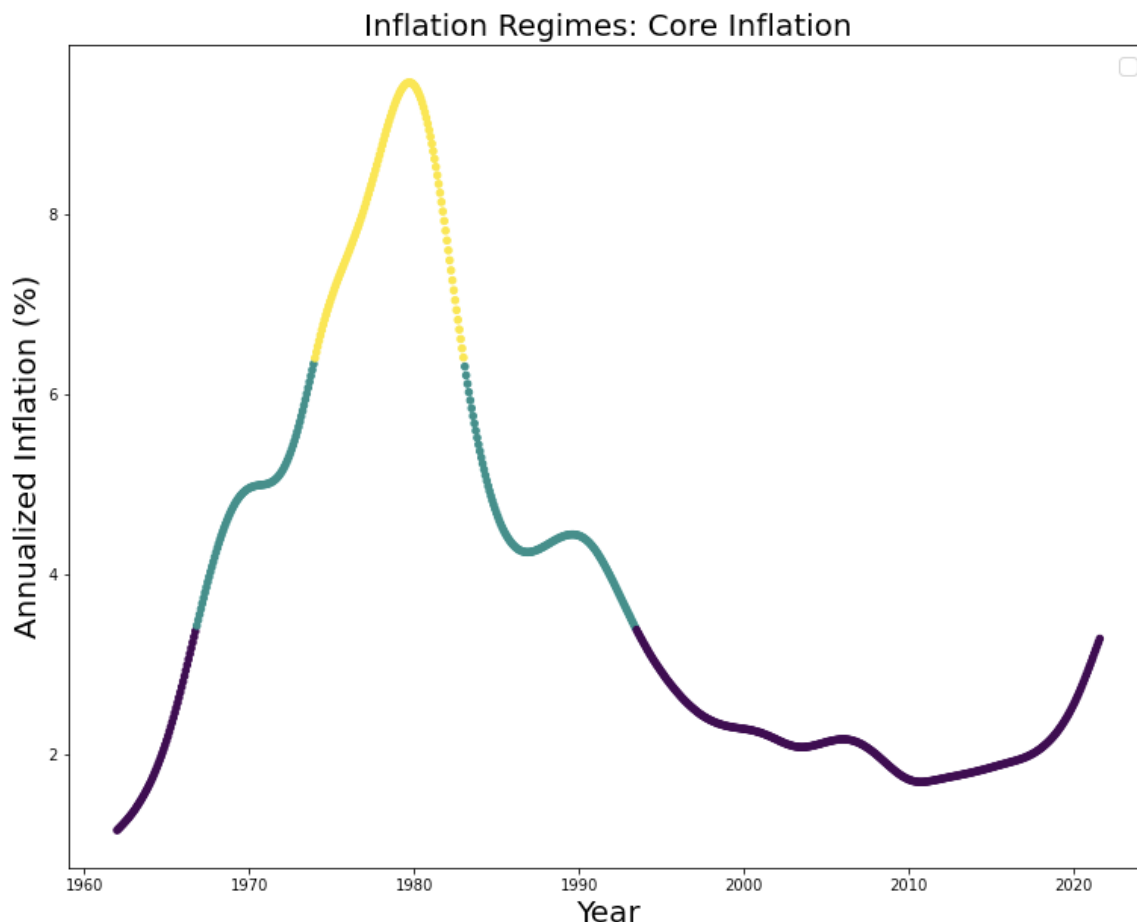


Figure 2: Core Inflation

For headline inflation, the machine again suggested three regimes. However, what has changed is that the current regime seems similar to the 70s (Figure 3, yellow line). The difference is that headline inflation includes the food and energy sectors. I am assuming that these sectors are good proxies in picking up the developments on the supply side. So, the current regime looks more like the early stages of stagflation. My “ML research assistant” seems to be reasonable<sup>1</sup>.

<sup>1</sup>I implicitly assume a “Markov property”, which is quite common for time-series. That is, if we begin from the “dark purple” regime in figure 3, the next possible regime is necessarily the “yellow” one where inflation would be trending upwards. So, one could then model the switch in the inflation regime through a Markov model.



Figure 3: Headline Inflation

## Conclusions

At face value, and in line with what many people are saying or what we already know, the supply side of the economy seems to be the differentiating factor here. And, supply factors aren't easily controlled by central banks. I let you place your own judgment and make your own conclusions. Have already placed my quick thoughts before, but you can expand with yours. Keep also in mind that the analysis does not have the most up-to-date information of the last month (Sept 2021).

There is also more serious stuff that you can do, like model the switch in the inflation regime or think about the more serious scenario in which the Fed might lose control in managing inflation expectations. You might of course crunch your own ML clustering methods and extend them to understand the underlying factors that explain the differences in the regimes. Also, you can just simply repeat the same analysis by looking at different inflation metrics ( there are many ) and combining insights.