Master Thesis

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January 2024

1 Introduction

Inflation is the general increase of prices such that a consumer can buy fewer goods and services for a given amount of money. Different factors cause inflation; for example, if the overall demand for goods and services increases which can cause companies to raise the prices, or if the costs increase due to higher wages or other external factors. It could also be for example the expectation of future price increases which causes consumers and companies to adapt their behavior in anticipation.

Here I was not sure if I needed a reference or not, since the things I'm claiming here are pretty much "common knowledge" and not really controversial

To control the level of inflation, central banks can rely on their monetary policy by adjusting the policy rate. Lowering the policy rate typically leads to higher inflation whereas a higher policy rate leads to less inflation. Many central banks rely on the technique called inflation target, where they try to steer the inflation rate to a specific threshold predetermined threshold value such as 2 percent, by estimating and projecting how the inflation is going to develop in the future and then using their monetary policy to steer it toward the target rate. This is to make it more predictable.

There exists a large literature on monetary policy and the mechanisms through which it affects inflation and economic activity; the transmission mechanism of the monetary policy has been thoroughly examined due to its importance for various reasons. Policymakers must have an adequate assessment regarding how the monetary policy affects the economy as well as the timing of the effects to determine the monetary policy at a specific point in time (Boivin et al. 2010). A brief summary of the transmission mechanism is given in section 2.

Setting the short-term nominal interest rates gives the central banks control over the contemporaneous real rates as well as the expected rates in the future for some horizon ahead (Gertler & Karadi 2015). It is the real interest rates, hence not the nominal interest rates, that affect other asset pricing as well as the spending through the transmission channels. Furthermore, it is not only the current value of the interest rates but also the expected interest rates that affect economic activity. (Gertler & Karadi 2015).

Much of the previous research about the inflation rate and interest rates has typically revolved around making predictions. Usually by methods such as estimating VAR models and Granger causality for time series data, for example, revolving around analyzing monetary shocks. The concept of Granger causality is that some variable X is said to Granger to cause some other variable Y if past values of X help explain future values of Y, that is, it contains information about Y that is not available in Y's past (Moraffah et al. 2021). This is typically modeled by VAR models as:

$$Y_t = \sum_{\tau=1}^{\tau_{\max}} \phi(\tau) Y_{t-\tau} + e_t,$$

where $Y_t = (Y_{1t}, \ldots, X_{nt})$ indicates time series Y at time step t, $\phi(\tau)$ is the $N \times N$ coefficient matrix at lag τ, $\tau_{\max}$ denotes the maximum time lag, and e represents an independent noise. Using this equation, we say $_i$ Granger causes Y_j with lag τ if any of the coefficients in $\phi_{ji}(\tau)$ is nonzero. This relationship can be shown by $Y^i_{t-\tau} \to Y^j_t$ which demonstrates the causal link between Y_i and Y_j at lag τ.

Although these types of analyses have their usage, these are more oriented towards causal discovery, which is the task of identifying and understanding causal relationships in the data. However, such methods lack causal effect estimation, which is the estimation of the actual effect of a policy or treatment on a target variable. This is instead commonly done by other methods using metrics such as Average Treatment Effect (ATE), commonly associated with the causal inference framework as laid out by the Rubin Causal model. Whereas it has seen some use concerning policy rate and inflation, for example Angrist & Kuersteiner 2011. These are not as common as those based on Granger causality, and they still seem to be heavily focused on monetary shocks specifically.

This sentence is not something I have a direct source for, it was mostly based on what I've found, it could very well be wrong, but I don't know if this is a good selling point or not in trying to narrow it down a bit to prepare for this study specifi-

This paper then, will try to fill in this gap in the literature that exists for the causal effect estimation of the policy rate on inflation. More specifically, this study aims to estimate d $E\left[(Y(R_1|x) - Y(R_0|x)\right] = \eta(R_1, R_0, x)$ the causal dose-response curve and obtain the full density of the causal dose-response curve. By doing so, this study will provide an alternative way of seeing the actual causal effect of the policy rate on the inflation

2 Previous research and theoretical framework

This paper will not go into all the specific details about the monetary policy and its effects through which it affects the inflation rate by adjusting the policy rate. but a brief summary is as follows: The traditional view of monetary policy and the transmissions through which it affects the economy is based on the neoclassical channels, which are built on the neoclassical models of investment, consumption, and international trade (Gertler & Karadi 2015).

Is this strictly the neoclassical view? May need more backup on this

The demand for capital is dependent on the price of the user capital, whether it be investment goods, residential housing or consumer durable. (Jorgenson 1963). One of the main purposes of monetary policy is to steer the overnight rate on the market, which are the daily interest rates that typically banks use when lending and borrowing to one another; this, in turn, affects other interest rates in the economy such as the banks and mortgage institutions. Typically, businesses and households tend to look at the long horizon when factoring variation in interest rates into investment decisions. Although an increase of the policy rate increases the short-term interest rates, the long-term interest rates also tend to increase as they are linked to future short-term interest rates. Hence the user capital cost rises and the capital asset demand decreases, which causes lower spending on investment and in turn a decline in the aggregate spending and demand which has a dempening effecto nthe inflation.

Furthermore, as a result of falling interest rates, the domestic currency depreciates vis-à-vis other currencies. This is due to the return on domestic assets decreasing compared to that of foreign assets. Hence the value of domestic assets decreases relative to other currency assets. This in turn causes domestic goods to be cheaper compared to foreign goods and an increase in foreign demand for domestic goods, thereby leading to expenditure switching - a switch between foreign and domestic goods - and hence a rise in net exports. Thus the increase in economic activity as a result from the higher aggregate demand raises the inflation. Hence, the exchange rate channel plays an important role in how monetary policy affects the economy.

However, it should also be noted that there are several different mechanisms through which the monetary policy affects inflation. These act in parallel and with different time frames. Also, there are other factors affecting the interest rates and not only the monetary policy. For example, the general level of global interest rates. Hence the policy rate is not solely responsible for being the factor which affects the inflation rate, but it does nevertheless play an important role.

Here i was thinking if i should mention something more about for example the unemployment rate and its relation to inflation and thinks like the philips curve, seeing as

2.1 Previous research

[Here I originally had a short text about inflation and interest rate research, but felt it was too general about interest rates and inflation in general, and only about other methods used such as VAR, which is not what this study is about But perhaps i should just include it again? Else i was not really sure what the focus of the previous research should be strictly about].

3 Method

This section is currently the most lacking I think, but my plan was to write the specific method implemented after I got it to work in R so as to not have to change stuff on the fly. Though what I was planning to mention here was the causal null test hypothesis as well as the non-parametric regression used, in the form of the actual tests and models, as well as the evaluation metrics such as using cross-validation to determine the goodness of fit with respect to some criterion such as RMSE or whatever is used.

Depending on which specific method to use for estimating the density, this will be filled in later

Also i was not sure if i should include detailed descriptions of specific test uses, such as ljung-box for example or if it's considered redundant to have that in its own section

4 Data

The data set used for this is Panel data obtained by combining several different individual monthly time series data for the inflation rate, policy interest rate as well as the unemployment for USA and Sweden. Originally the individual time series for the different variables have different lengths since the starting years for each of them vary, but they all end in either December 2023 or January 2024. However, the data for the Swedish policy rate is the shortest of the individual time series due to it starting in June 1994 since that is when the data consistently started being tracked monthly. Hence, for the combined panel data used in this study, the other time series have been limited to also start from June 1994 to make it more comparable. The data is collected from various public governmental sources. The Swedish policy interest rate is from the Swedish Central Bank Riksbanken, and the inflation rate as well as the unemployment rate is retrieved from Statistics Sweden (Statistika Centralbyrån, SCB). The US Fed Funds rate is retrieved from the US Federal Reserve Bank, and the data for the unemployment and consumer price index is retrieved from the U.S. Bureau of Labor Statistics.

For both the US and Swedish data, the concept of inflation is operationalized through the consumer price index CPI, which is a measurement of the change in prices of goods and services acquired for private domestic consumption, based on weighted averages for specific sets or baskets of products (U.S. Bureau of Labor Statistics), (Statistics Sweden). Hence this is used as a proxy for the overall rate of inflation, though it is strictly a measure of consumer inflation.

Here im not sure either if this is somethign i ought to speak more about. Since i feel in general its good to be specific, but CPI is "common knowledge" and widely accepted i suppose so i did not feel it was really needed perhaps?

Regarding the unemployment rate, it should be noted that whereas they are roughly similarly defined in the Swedish and US cases, there are some differences in some of the details. In general, the unemployment rate for both countries refers to the people who are part of the labor force, meaning that they do not currently have a job but are actively seeking a job. Hence, people without jobs but who are not actively seeking jobs are not considered unemployed. For the US data, this data is originally collected from surveys done by Bureau of Labor Statistics, whereas the Swedish data is obtained from Arbetskraftundersökningarna (AKU), a survey done by Statistics Sweden. Thus there are some differences in the exact method by which the surveys were done such as the target population for the survey as well as some of the definitions used in the surveys. There have also been some changes over the years. For example, in 2021 AKU made some changes due to a new framework law implemented by the EU; this included changes in the target population of the surveys as well as some definitions used, and hence comparisons between the periods before and after this date are not strictly straightforward. (SCB 2023) However, SCB has worked on making the time series comparable through different means such as imputations. Nevertheless, overall this is considered a minor problem for this study, and potential differences are not further analyzed for this study.

I don't know if i should discuss this any more, since I feel like it should be fine anyway

Table 1: Summary statistics for the different variables

	n	mean	sd	median	min	max	skew	kurtosis
swe_CPI	355	1.72	2.25	1.40	-1.90	12.30	2.46	7.47
us_CPI	355	0.21	0.28	0.20	-1.80	1.40	-0.93	8.90
us_interest	355	2.45	2.24	1.75	0.05	6.54	0.37	-1.52
swe_interest	355	2.26	2.30	2.00	-0.50	8.91	0.84	0.39
us_unemployment	355	5.62	1.82	5.20	3.40	14.80	1.43	2.27
swe_unemployment	354	7.60	1.16	7.60	4.90	10.50	0.15	-0.66

Table 1 shows some summary statistics for the different variables. Comparing the Swedish and US data it can be seen that the Swedish inflation rate on average is higher than the US inflation rate at 1.72 compared to 0.21 as defined by their respective consumer price indices (CPI). These values seem reasonable with the inflation target rate of 2 percent in mind. Furthermore, the Swedish inflation rate exhibits more variation as indicated by the higher standard deviation at 2.25 compared to 0.28, as well as having a higher degree of asymmetry as indicated by the higher skewness. Both of them show a relatively high kurtosis at 7.47 and 8.90, indicating a relatively fat tail for their distribution. .

Here I was not sure if it's interesting for the context to talk more about the moments since we would not expect it to be more for example normally distributed or anything like that, e.g based on the inflation target

Comparing the interest rates, it can be seen that they are considerably closer to each other with regard to almost all aspects. . Likewise, the unemployment rates for both countries are somewhat close to each other; the mean of the US unemployment rate is slightly lower compared to the Swedish, though it has a little more spread as well as being more skewed and having a fatter tail by the kurtosis.

This got me thinking about the aspect that the Swedish interest rate likely is more dependent on the international interest rates and maybe especially the US Fed interest rate, though I don't know if that aspect also is relevant for the context here

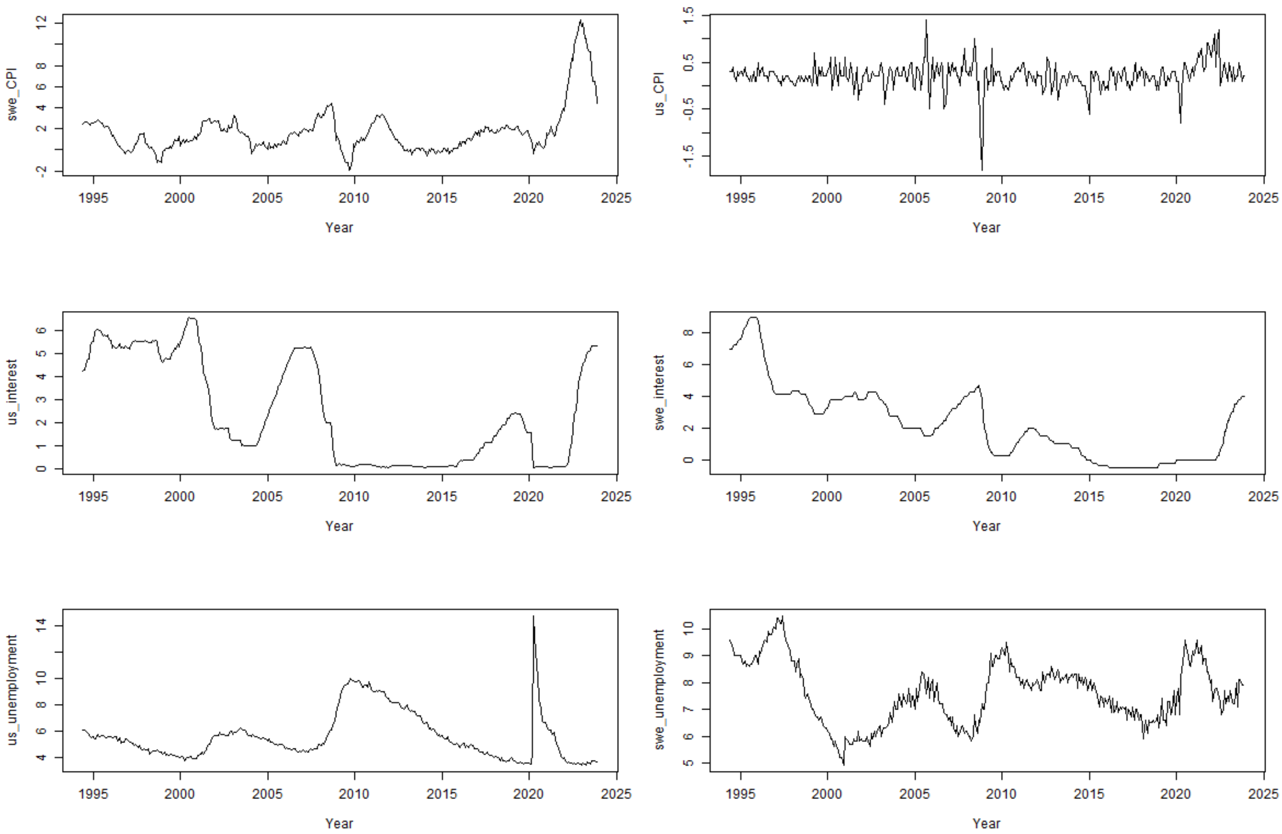

Figure 1: Variables over time

Figure 1 shows the different variables plotted over time. The visualized plots seem consistent with the results in table 1; the inflation rate for both countries seems fairly stable over time, though for the Swedish CPI there is one noticeable outlier for December 2022 at 12.3 percent. The interest rates are unemployment rates for both countries seem to roughly follow a similar pattern to each other concerning the overall trend and their different peaks during the different years. This is likely due to both countries following the same economic cycle and thus having both of the respective central banks taking similar action.

5 Results

Table 2: Ljung-Box test for white noise

	statistic	parameter	p.value
swe_CPI	2379	12	0.00
us_CPI	113	12	0.00
us_interest	3444	12	0.00
swe_interest	3410	12	0.00
us_unemployment	2386	12	0.00
swe_unemployment	2899	12	0.00

Notations

(not used in text as of now) $A \in \mathcal{A} =$ exposure of interest with support $A_0 \subseteq \mathcal{R}$

for each $a \in \mathcal{A}_0$, , then $Y(a) \in \mathcal{Y} \subseteq \mathcal{R}$ is a unit's potential outcome by setting exposure to $A = a$

$m(a) = E[y(a)]$ is the average outcome under assignment of the entire population to exposure level $A = a$

m is the resulting curve: $\mathcal{A} \to \mathcal{R}$, is the causal dose-response curve.

Null hypothesis: $m(a) = \gamma_0$ for all $a \longrightarrow \mathcal{A}_0$ and some $\gamma_0 \in \mathcal{R}$, that is, the dose-response curve is flat.

$W \in \mathcal{W} \in \mathcal{R}$ is a collection of possible confounders.a

Given that some conditions hold, then all $a \in \mathcal{A}_0$ are in the support of the conditional distribution of A given $W = w$ for almost every w, known as *positivity*, then $m(a) = \theta_0(a) := E[E(y|A = a, W)]$, which is known as the G-computed regression function. Hence under the conditions, m, is flat on $\mathcal{A}_0$ if and only if $theta_0$ is flat on $\mathcal{A}_0$

We assume we observe independent and identically distributed vectors $(Y_1, A_1, W_1), \ldots, , (Y_n, A_n, W_n$ from a distribution P_0 contained in the nonparametric model $\mathcal{M}_{NP}$

References

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