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„Monetary policy transmission in the euro area:

an empirical study"

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Abstract

In January 2002, the euro was introduced as cash and thus as legal tender in Austria and other countries of the so-called eurozone. Since then, the European Central Bank has been responsible for monetary policy in the eurozone countries. In order to fulfil its task of maintaining price stability (which corresponds to an inflation target of 2%) as assigned by EU treaties, the ECB uses its monetary policy instruments and makes particular use of the three interest rates it sets (main refinancing rate, marginal lending facility rate and deposit facility rate). The paper therefore attempts to answer the following question: "Can the ECB use the interest rate to influence real, macroeconomic variables such as consumption or investment in selected eurozone countries (Austria, Germany, France, Italy, Spain)?". This question is answered with the help of a VAR model/SVAR model and an impulse response analysis. In conclusion, I am able to disprove the hypothesis that the interest-rate channel has no effect for all the countries in question. How exactly the transmission channel works is the subject of further research.

Im Januar 2002 wurde der Euro als Bargeld und damit als gesetzliches Zahlungsmittel in Österreich und anderen Ländern der sogenannten Eurozone eingeführt. Seitdem ist die Europäische Zentralbank für die Geldpolitik in den Ländern der Eurozone zuständig. Um die ihr durch die EU-Verträge zugewiesene Aufgabe der Gewährleistung von Preisstabilität (was einem Inflationsziel von 2 % entspricht) zu erfüllen, setzt die EZB ihre geldpolitischen Instrumente ein und bedient sich insbesondere der drei von ihr festgelegten Zinssätze (Hauptrefinanzierungssatz, Zinssatz für die Spitzenrefinanzierungsfazilität und Zinssatz für die Einlagefazilität). In der Arbeit wird daher versucht, die folgende Frage zu beantworten: "Kann die EZB den Zinssatz nutzen, um reale, makroökonomische Variablen wie den Konsum oder die Investitionen in ausgewählten Ländern der Eurozone (Österreich, Deutschland, Frankreich, Italien, Spanien) zu beeinflussen?". Diese Frage wird mit Hilfe eines VAR-/SVAR-Modells und einer Impuls-Response-Analyse beantwortet. Im Ergebnis kann ich die Hypothese widerlegen, dass der Zinskanal für alle betrachteten Länder keine Wirkung hat. Wie genau der Transmissionskanal funktioniert, ist Gegenstand weiterer Forschung.

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1. Introduction

The introduction of the euro in the form of cash and thus as a means of payment on 1 January 2002 not only marked the end of a long era of the schilling in Austria (as well as many other currencies in Europe), but also the surrender of a degree of political autonomy, as in future it would no longer be the Austrian National Bank (OeNB) but the European Central Bank (ECB) that would make monetary policy decisions for the so-called "eurozone".

In its more than 20 years as cash (and 25 years as book money), the euro has experienced turbulent times and survived several crises of various kinds (financial crisis, debt crisis, coronavirus crisis). The ECB was forced to use its entire range of monetary policy instruments and not only to cut interest rates sharply in some cases (financial crisis and then even more so during the debt/euro crisis), but also to intervene exceptionally strongly in the financial markets (various bond-buying programmes, various forms of support for financial institutions). Due to the sometimes turbulent times that the euro has gone through since its introduction, it experienced massive resistance from the population, who derided it as the "Teuro" (the word was even the word of the year 2002, the year it was introduced as cash[1]), and led - almost forgotten today - to the founding of the Alternative for Germany (AfD) party, which was founded by economics professors who were critical of the euro at the time (Decker, 2022). Quite apart from pompous hymns of praise for the euro, which - probably not entirely surprisingly - came from the EU and ECB (Donohoe, Lagarde, Metsola, Michel & von der Leyen, 2023), there were nevertheless quite favourable articles on the 10th and 20th anniversaries, although the latter already addressed the ECB's long-standing low interest rate policy and its possible repercussions (see Hahn (2021), Pfluger (2010) and Staudacher (2011)).

Regardless of the praise or criticism, the ECB stubbornly sticks to its delegated mandate. The ECB, as the authority responsible for monetary policy has the mandate to maintain price stability in the Euro area as laid down in the "Treaty on the Functioning of the European Union" (see article 127). According to the ECB (see

[1] https://oewort.at/wort-des-jahres/2002/

www.ecb.europa.eu), an inflation target of 2% over the medium term is best to maintain price stability. To keep inflation around 2% (symmetric target) the ECB relies on several monetary policy tools. The primary policy tool of interest is the set of rates. These three rates are the main refinancing rate, the marginal lending facility rate, and the deposit facility rate.

According to the ECB, the monetary policy decisions affect the economy in various ways (see figure). However, because the mechanism is characterised by so-called time lags, the precise effects are difficult to predict. One of the many channels is the so-called interest-rate channel, in which rising/falling interest rates are intended to influence consumption and/or investment decisions.

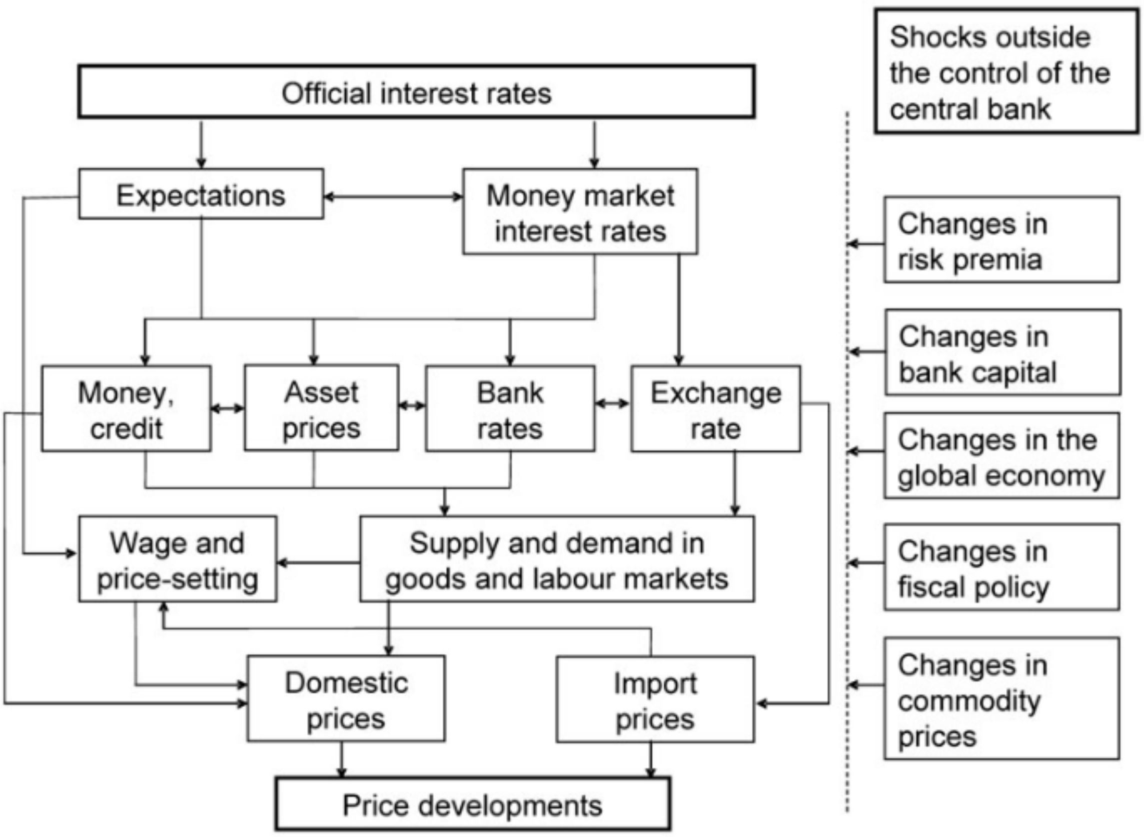

Figure 1: Schematic illustration of transmission mechanism. Source: https://www.ecb.europa.eu/mopo/intro/transmission/html/index.en.html

The website of the OeNB (see www.oenb.at), which implements the ECB's monetary policy decisions as the central bank of Austria, also adopts the ECB's objective and emphasises that "the primary objective of the Eurosystem's monetary policy is to maintain price stability. Price stability is achieved when the inflation rate of the Harmonised Index of Consumer Prices (HICP) in the euro area is 2% in the medium term."

The OeNB also sees the interest rate channel as one of the many transmission channels and writes about this: "Through this channel, an increase in key monetary policy interest rates triggers higher short-term market interest rates. If inflation expectations are stable, the real interest rate and the real cost of capital for companies rise as a result of the key interest rate hikes and investment therefore falls. In addition, households will also save more and consume less due to higher interest rates. As a result, there is a reduction in demand."

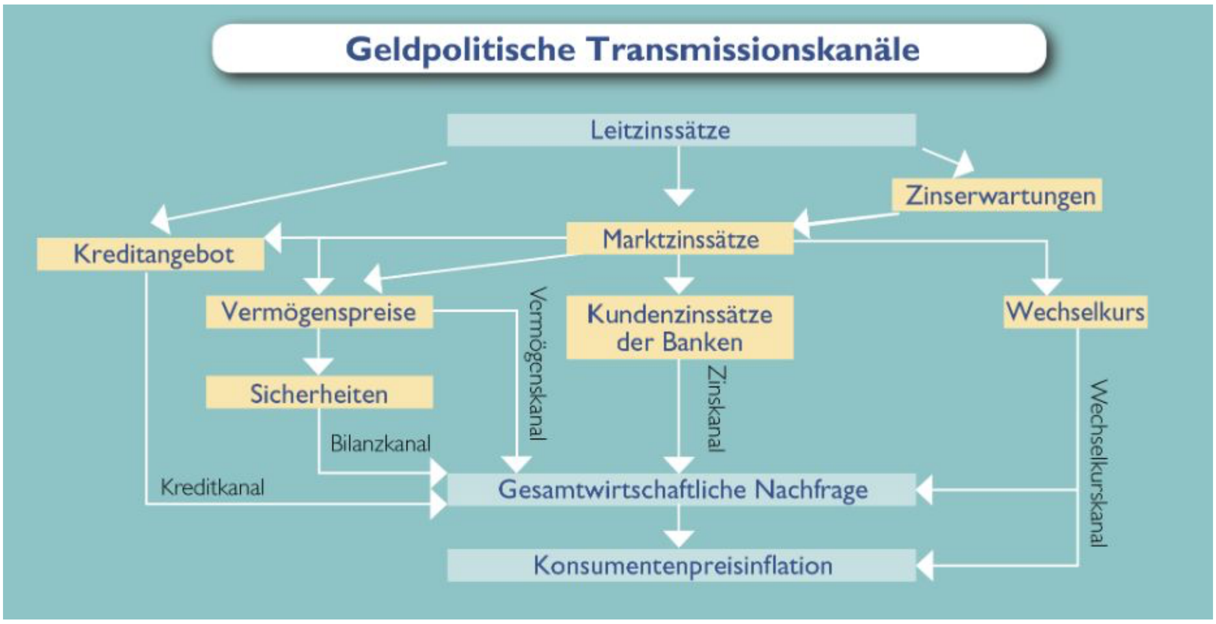

Figure 2: Schematic illustration of transmission mechanism. Source: https://www.oenb.at/Geldpolitik/Wirkung-der-Geldpolitik.html

But how exactly does this monetary policy interest rate channel work? Does it have the same effect in all eurozone countries? And if not, can it even influence the desired macroeconomic variables (consumption and investment are explicitly mentioned)? After all, the key interest rate is set for the whole eurozone by the ECB Governing Council primarily on the basis of the Harmonised Index of Consumer Prices (HICP), which is measured for the eurozone as a whole, and not individually for each country according to its economic requirements.

The paper therefore attempts to answer the following question: "Can the ECB use the interest rate to influence real, macroeconomic variables such as consumption or investment in selected eurozone countries (Austria, Germany, France, Italy, Spain)?". This question is answered with the help of a VAR model/SVAR model and an impulse response analysis. Particular attention is paid to the response of the variables, which is triggered by a shock of the interest rates.

The further structure of the thesis is as follows. The second chapter contains a literature review in which the academic literature is categorised according to various aspects of the work and the points of reference for this work are presented. The actual empirical work is then carried out in the third chapter. The data for the five countries studied in the eurozone are presented, analysed and prepared, the VAR models/SVAR models are estimated and then an impulse response analysis is carried out. The final chapter draws a conclusion.

2. Literature review

The beginning of the analysis of transmission channels in macroeconomics is usually traced back to John Maynard Keynes, the father of macroeconomics. In his work The General Theory of Employment, Interest and Money, Keynes referred to a connection between investment expenditure and the interest rate, particularly in the case of investment. He wrote (Keynes, 2015, p. 135) that the so-called marginal efficiency of capital, which Keynes interprets as the interest rate that brings the future profits of an asset in line with its replacement costs, is particularly important for investments. Furthermore, Keynes (2015, p. 136) concludes that it now follows from economic logic that investments are driven forward to such an extent that the marginal efficiency of capital is equal to the interest rate for all capital goods.

Probably the best-known representation, which is based on Keynes and eventually became useful for analysing the interest rate channel and the relationship between interest rates and investment expenditure, is the IS-LM by Hicks and Hansen from the 1930s/1940s. This postulates (Blanchard, 2017, p. 110) a direct classical relationship between investment and the interest rate (rising interest rates reduce investment), whereby the interest rate can directly influence the attractiveness of investments and thus have a much more direct influence on investment activities.

Mishkin (2016, p. 673) points out that although "Keynes originally emphasised the interest-rate channel as operating through businesses' decisions about investment spending, the search for new monetary transmission mechanisms led economists to recognize that consumers' decisions about housing and consumer durable expenditure also are investment decisions". He continues (Mishkin, 2016, p. 674) that "Some economists (...) [John Taylor] take the position that strong empirical evidence exists for substantial interest-rate effects for consumer and investment spending through the real cost of borrowing (...)". Others (Bernanke and Gartler) believe that the empirical evidence does not support strong interest-rate effects that operate through the real cost of borrowing.

Benassy-Quéré, Cœuré, Jacquet & Pisani- Ferry (2019, p. 263) write that the "Short-run disconnect between money growth and inflation is existence of nominal rigidities - the fact that, following shock on money supply, prices and/or nominal wages adjust less than fully in short run". A fall in interest rate leads to rise in money supply if prices do not adjust upwards, private agents hold more money balances lower interest rate in turn stimulates demand for goods and services. This is the reason why monetary policy in the short run can influence real variables. Furthermore, Benassy-Quéré et. al. (2019, p. 270) see that "In the presence of nominal rigidities, monetary expansion leads to a fall in the interest rate, hence to a revival of investment and durable goods consumption. (...). The only interest rate which is directly affected by conventional monetary policy is the overnight, nominal interest rate (...)."

In its method, this work follows a long tradition of VAR models, which were introduced into macroeconomic analysis by Christopher Sims (1980, 1986, 1992).

Kuttner & Mosser (2002) and Boivin, Kiley & Mishkin (2010) also provide an insight into the various transmission channels. With regard to the various transmission channels, there are interesting studies by Bernanke (1986), Bernanke & Blinder (1992), Bernanke & Gartler (1995) and Bernanke & Mihov (1998), which primarily focus on the so-called credit channel, but have also focussed on the federal funds rate as a policy tool. Tsatsaronis (1995) also focusses on the credit channel in his paper. Taylor (1995), on the other hand, clearly mentions the interest rate channel in his paper. Other interesting studies in connection with the monetary transmission mechanism, but also how central banks use the new models in connection with the transmission channels, are Gerlach & Smets (1995) and Smets (1995).

Works that provide an overview of the state of research at the end of the 20th century are Christiano, Eichenbaum & Evans (1998) and Leeper, Sims, Zha, Hall & Bernanke (1996).

Other notable papers focussing primarily on the effects of monetary policy and its transmission through the transmission channels in the United States are Blanchard & Watson (1986), Friedman & Kuttner (1992), Christiano, Eichenbaum & Evans (1994), Strongin (1995), Bagliano & Favero (1998) and Uhlig (2005).

Older papers dealing with the transmission of monetary policy or the effectiveness of the transmission channels in the eurozone and on the part of the ECB include Barran, Condert & Mojon (1996), Clarida & Gertler (1997), Monticelli & Tristani (1999), Angeloni, Kashyap & Mojon (2001), Mojon & Peersman (2001), Peersman & Smets (2001).

Recent papers dealing with the transmission of monetary policy and the effectiveness of transmission channels in the euro area are Altavilla, Brugnolini, Gürkaynak, Motto & Ragusa (2019), Altavilla, Carboni & Motto (2021), Arias, Caldara & Rubio-Ramirez (2019), Benecká, Fadejeva & Feldkircher (2020), Burriel & Galesi (2018), Ciccarelli, Maddaloni & Peydró (2013), Mandler & Scharnagl (2023), Mandler, Scharnagl and Volz (2022).

3. Data, Empirical Model and Results

This section presents the empirical part of the work. The data sets used are explained, the empirical model used for further analysis is presented and the results are discussed. The process for Austria is described in detail in order to give a better understanding of the approach taken during the work. The other countries (Germany, France, Italy and Spain) are not presented in the same detail as Austria. Nevertheless, the data sets are presented and the results discussed.

3.1. Austria

3.1.1. Data and descriptive statistics

Quarterly, seasonally and calendar adjusted datasets were used for all variables. The period of the datasets ranges from Q1 2002 to Q2 2023. 86 observations per variable. With 6 variables, we therefore have a total of 516 observations for Austria in the period analysed. In order to capture consumption and investment, I used the datasets for consumption expenditure (ex durables), durable goods consumption expenditure, dwellings, fixed gross capital formation (ex dwellings) from the Eurostat database (see Appendix). I also used the Eurostat database for the GDP deflator, which I used to convert the nominal variables to real values. For consumption expenditure ex durables and durable goods consumption expenditure, the GDP deflator of total consumption expenditure was used. For the variables dwellings and fixed gross capital formation (ex dwellings) I used the respective deflators. For the inflation data, I used the HICP data from the ECB Data Portal (see Appendix), which was changed from monthly to quarterly. For the interest rate, I used the EONIA and €STR (Euro short-term rate) data series, as the EONIA reference rate was changed to the €STR during the observation period. I also obtained these two data series from the ECB Data Portal (see Appendix). The individual time series of the variables are briefly presented and introduced below.

The first chart (figure 3) shows the overnight rate in the eurozone from Q1 2002 to Q2 2023. As mentioned above, the overnight rate in this case is the EONIA or, since its replacement, the €STR. Both reference interest rates reflect the interest rate that has to be paid when borrowing unsecured deposits for a period of one night (hence the name). The chart clearly shows how the overnight rate follows the ECB's key interest rates (especially the deposit rate). The sharp fall in interest rates during the financial crisis in 2008 and the sharp rise due to the high inflation rates in 2022/2023 are particularly striking. You can also see how the overnight rate falls into negative territory in 2015, after this also happened with the deposit rate. In general, it is noticeable that, apart from the sharp falls and rises in interest rates in 2008 and 2022/2023, the interest rate is not very volatile.

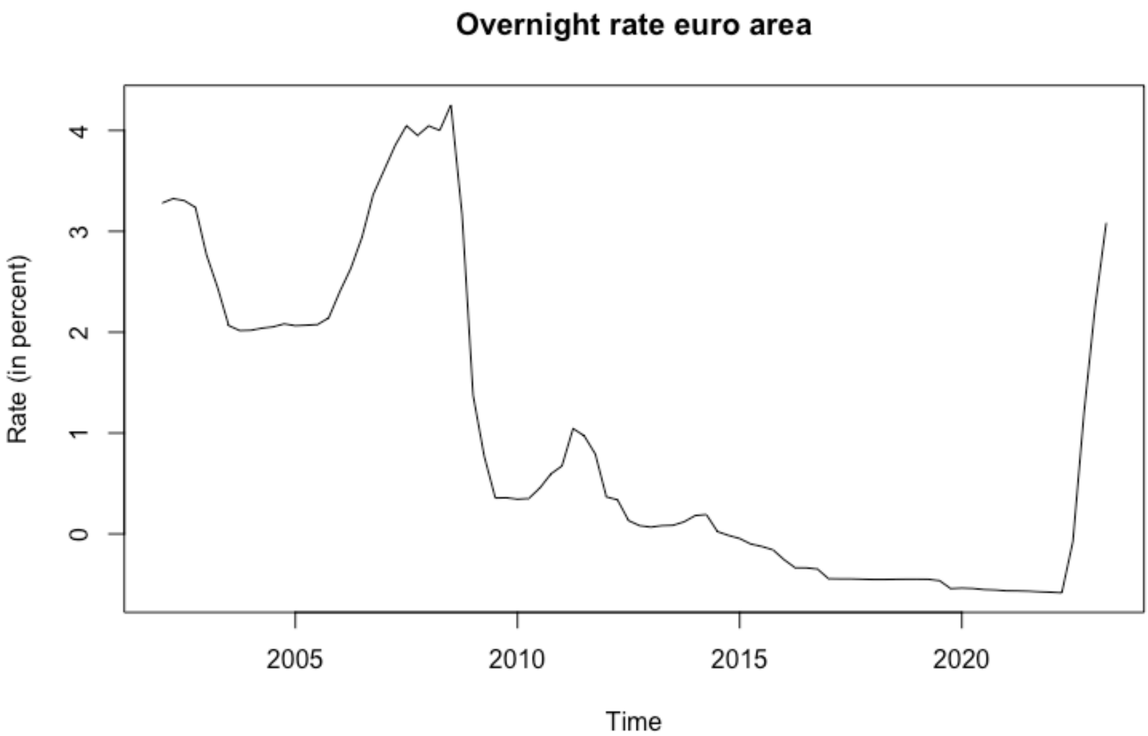

Figure 3: Illustration of the overnight rate in the eurozone Q1 2002 - Q2 2023 (EONIA or €STR; source: ECB)

The next chart (figure 4) shows real consumer spending excluding consumer durables. As in the chart above, these figures refer to the period Q1 2002 to Q2 2023. Although, counterintuitively at first glance, there was even a real increase in spending during the financial crisis, which can be explained by the fact that the real value of constant nominal spending increases when prices fall, the sharp decline in real consumer spending excluding consumer durables during the coronavirus pandemic, which was due to the lockdowns, is clearly visible. The probably unprecedented decline in consumer spending was combined with an explosive increase in spending to the previous level after the end of the pandemic. It is noticeable that, apart from the sharp slump during the coronavirus pandemic, the time series probably follows an increasing, linear trend.

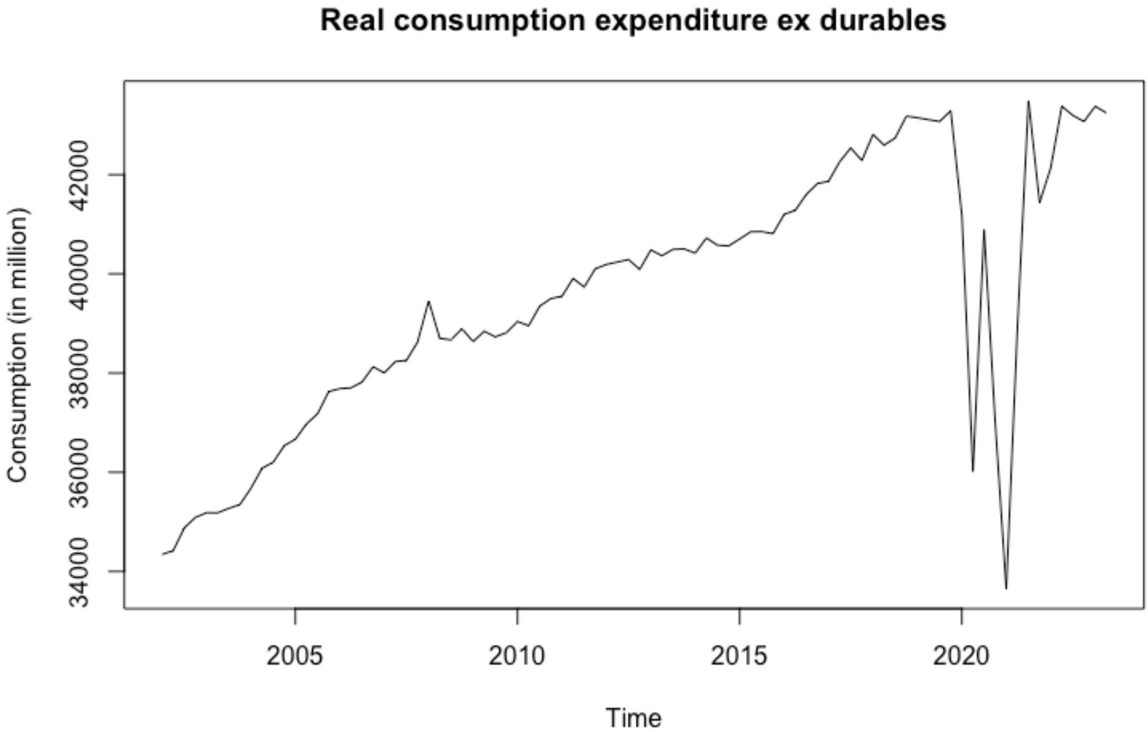

Figure 4: Real consumer spending excluding consumer durables by households Q1 2002 - Q2 2023 (source: Eurostat)

The figure below (figure 5) shows real consumer spending on durable consumer goods (kitchen appliances and similar), again for the period from Q1 2002 to Q2 2023. In contrast to non-durable consumer goods, a decline can be seen here during the financial crisis and the massive decline during the coronavirus pandemic. In general, it can be seen that this time series is far more volatile than the non-durable consumer spending in the chart above. It is also noticeable that there is no linear trend as in the figure above. Rather, it appears that real durable consumer spending fluctuates around a constant over the observed period.

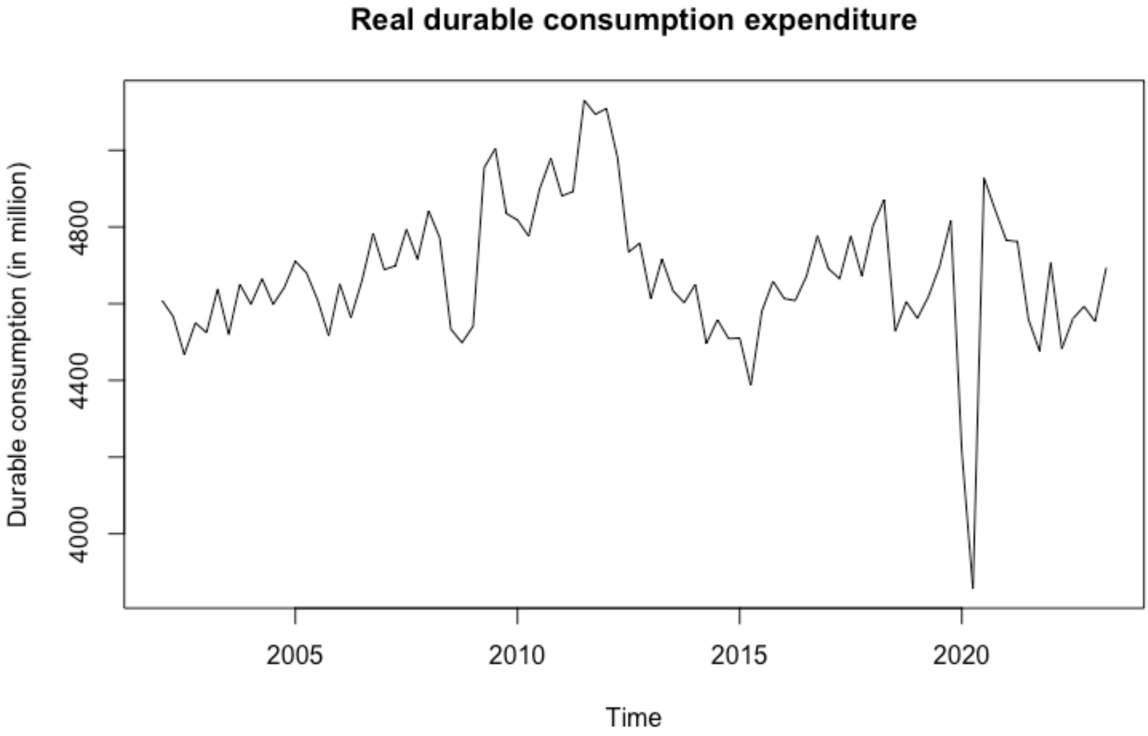

Figure 5: Presentation of real durable household consumption expenditure Q1 2002 - Q2 2023 (source: Eurostat)

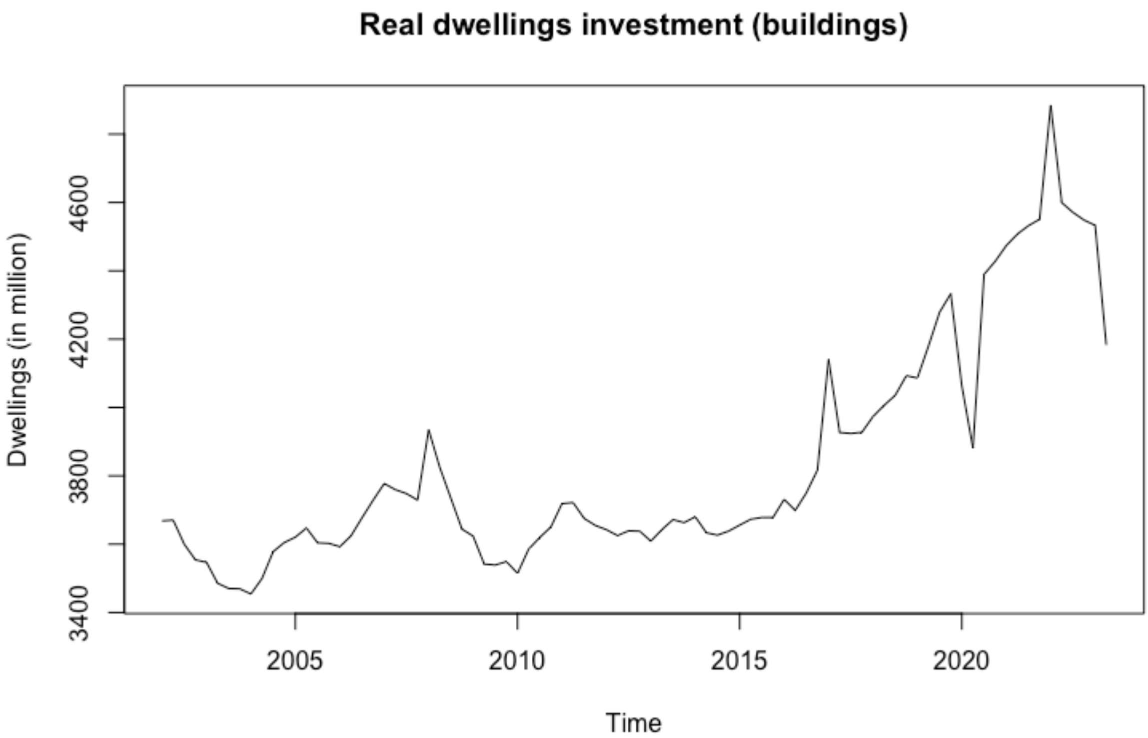

Figure 6: Presentation of real expenditure on dwellings (residential buildings) Q1 2002 - Q2 2023 (source: Eurostat)

In the figure above (figure 6, we see the real expenditure on dwellings (residential buildings) from Q1 2002 to Q2 2023. A fundamentally increasing linear trend can clearly be seen in the period under review, as well as the marked declines during the 2008 financial crisis, the corona pandemic from 2020 and Q4 2022, which was triggered by the sharp rise in interest rates and the sharp rise in construction costs.

The penultimate figure (figure 7) shows the real expenditure on gross fixed capital formation excluding dwellings (residential buildings) in the period Q1 2002 to Q2 2023. Here, too, a clear decline in expenditure can be seen during the 2008 financial crisis and a slump during the coronavirus pandemic. Apart from these declines, however, the figure shows an increasing linear trend.

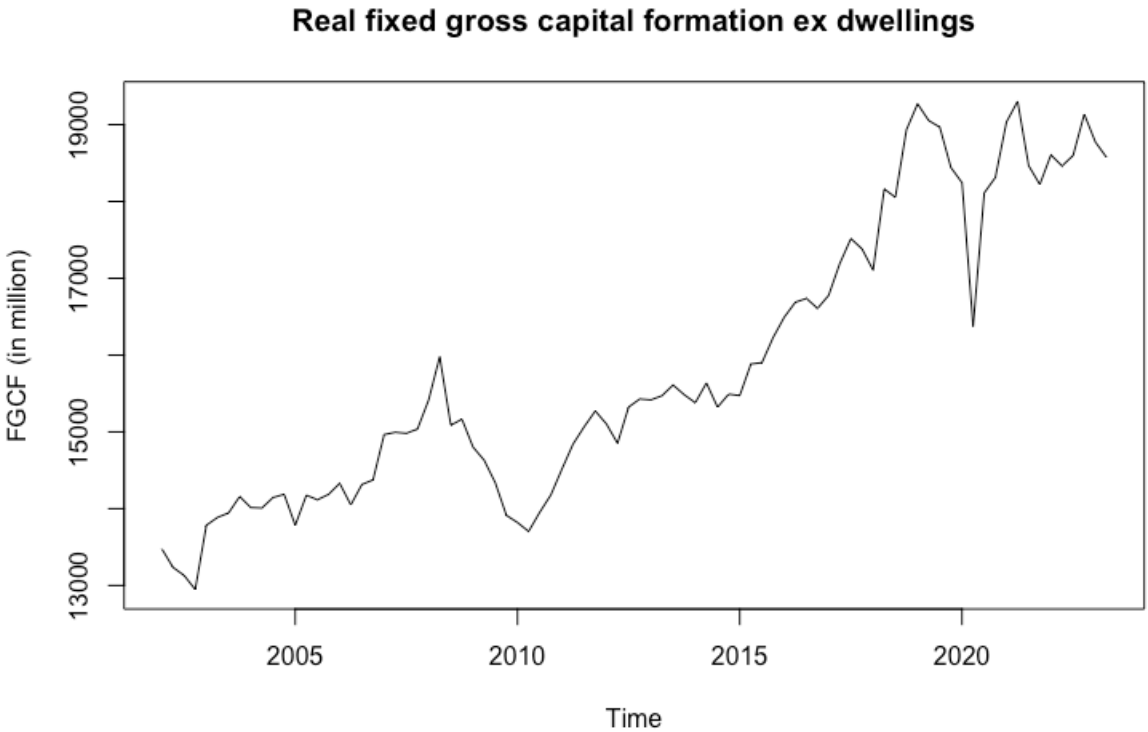

Figure 7: Presentation of real gross fixed capital formation excluding residential buildings Q1 2002 - Q2 2023 (source: Eurostat)

In the last figure (figure 8), we see the inflation rate (based on the harmonised consumer price index) in Austria from Q1 2002 to Q2 2023. It can be seen that the inflation rate is largely around the inflation target of 2%, has risen sharply since 2022 and peaked at 11.1% (European calculation) in Q4 2022 and has been falling ever since. The marked declines in inflation during the financial crisis and the coronavirus pandemic are also striking.

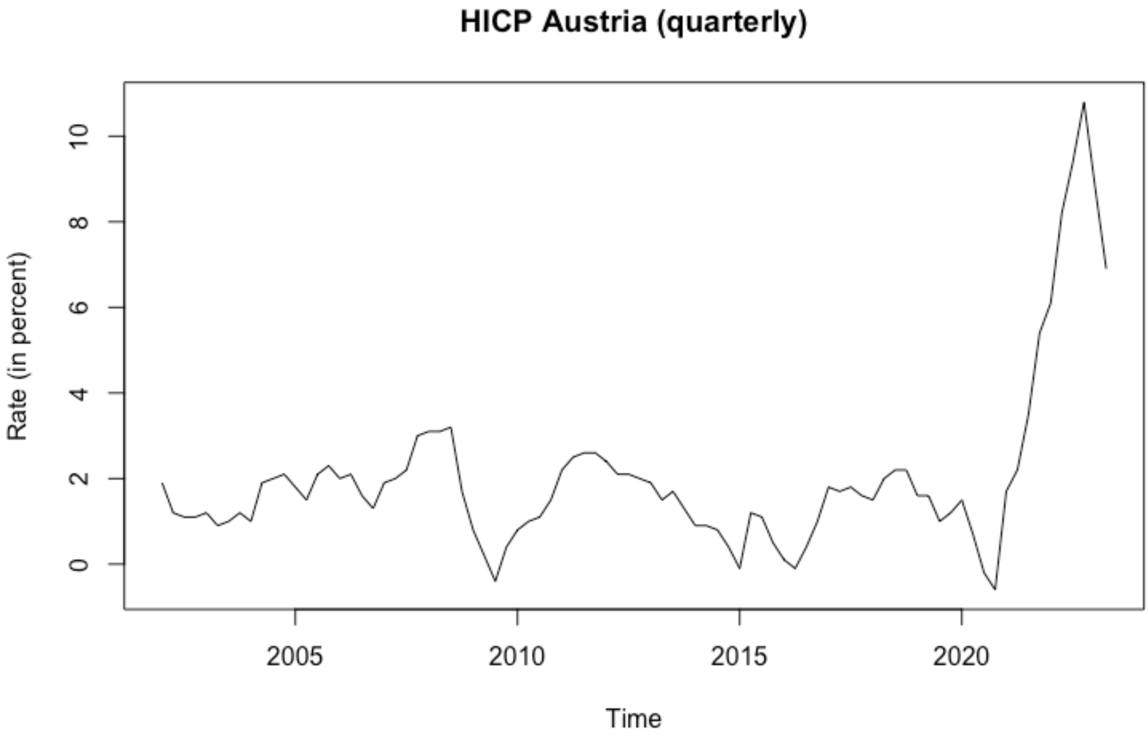

Figure 8: Illustration of the Austrian inflation rate Q1 2002 - Q2 2023 (source: ECB)

3.1.2. Unit root tests and cointegration test

In this section, the results of the unit root tests and a possible cointegration test according to the Johansen procedure are presented. To test for possible unit roots, I apply the augmented Dickey-Fuller (ADF) test. In this test, three different test regressions are tested to see whether the null hypothesis of a unit root can be rejected and whether null hypotheses regarding a trend variable or a drift term can be rejected. The 3 possible variants are as follows:

$$\Delta y_t = \beta_1 + \beta_2 t + \pi y_{t-1} + \sum_{j=1}^{k} \gamma_j \Delta y_{t-j} + u_{1t}$$

The upper regression describes the ADF test with a constant β_1 (drift term) and a trend term $\beta_2 t$. This regression tests as a null hypothesis whether $\beta_1 = \beta_2 = \pi = 0$ holds.

$$\Delta y_t = \beta_1 + \pi y_{t-1} + \sum_{j=1}^{k} \gamma_j \Delta y_{t-j} + u_{1t}$$

This regression describes the ADF test with a constant β_1 (drift term), but without the trend term as it was included in the first regression. This regression tests as a null hypothesis whether $\beta_1 = \pi = 0$ holds.

$$\Delta y_t = \pi y_{t-1} + \sum_{j=1}^{k} \gamma_j \Delta y_{t-j} + u_{1t}$$

The last regression describes the ADF test without a constant β_1 (drift term) and a trend term $\beta_2 t$. This regression tests as a null hypothesis whether $\pi = 0$ holds. In the following, the procedure is shown and explained using the variable "Overnight rate euro area". A table summarising the test results for all variables is then presented and discussed.

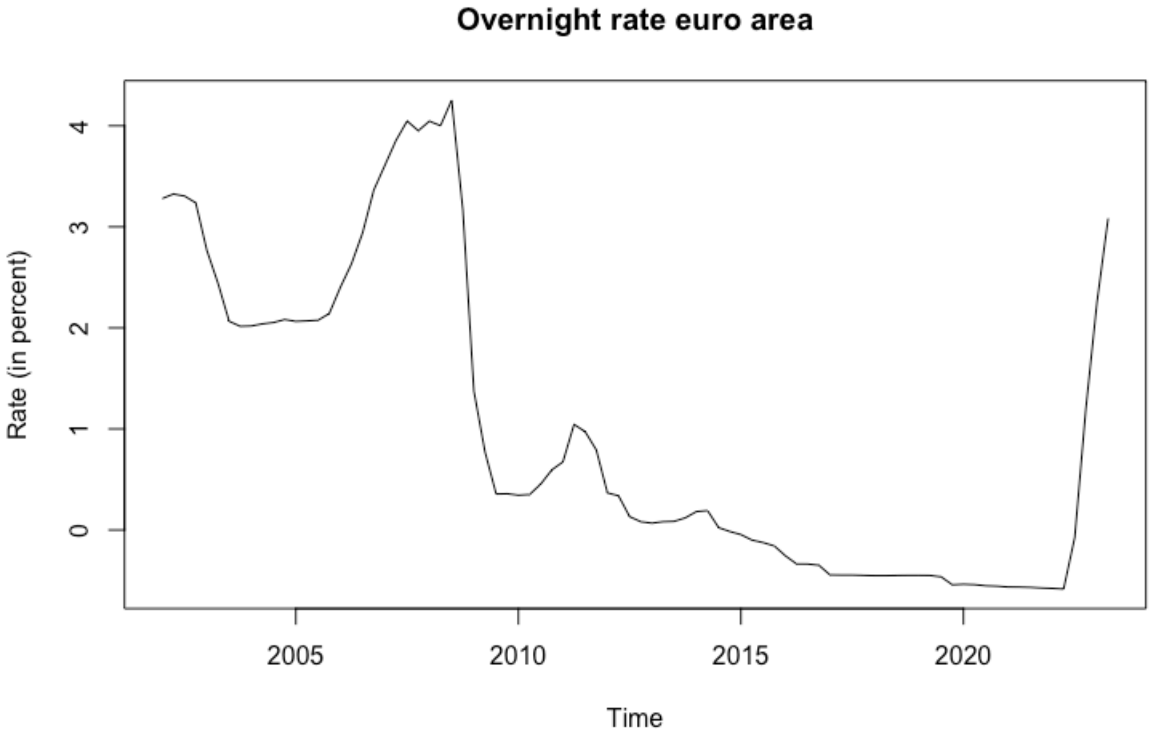

Figure 9: Illustration of the overnight rate in the eurozone Q1 2002 - Q2 2023 (EONIA or €STR; source: ECB)

The variable "Overnight rate euro area" has already been presented above, but I would like to briefly describe the data again. It is a data set from Q1 2002 to Q2 2023, the data describe the overnight rate in the euro area determined at the end of the quarter. In a first step, the ADF test is now carried out with a constant (drift term) and a trend term.

	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	0.117352	0.119090	0.985	0.3274
z.lag.1	-0.058260	0.032425	-1.797	0.0761.
tt	-0.001304	0.002050	-0.636	0.5266
z.diff.lag	0.752066	0.091227	8.244	$2.69e^{-12}$***

Table 1: ADF-test regression output for real consumption expenditure ex durables (Significance levels: "." 10%, "" 5%, "**" 1%, "***" 0,1%)*

The upper table (table 1) shows the regression output for "Overnight rate euro-area" with constant and trend. One lagged endogenous variable was used, whereby the number of lagged endogenous variables was selected using the Akaike Information

Criterion (AIC). At the same time as this regression, it was also tested whether $\beta_1 = \beta_2 = \pi = 0$ holds.

	Test statistic	1%	5%	10%
τ_3	1.7968	-4.04	-3.45	-3.15
ϕ_2	1.8375	6.50	4.88	4.16
ϕ_3	2.7334	8.73	6.49	5.47

Table 2: ADF-test for regression including constant and trend (test values and respective significance levels)

Table 2 now shows the test results for the various hypotheses that can be tested with the ADF test. First of all, you can see that the value at τ_3 is 1.7968, which is outside the 10% significance level. This means that we cannot reject the null hypothesis that a unit root exists. As mentioned above, we have also tested the hypothesis that $\beta_1 = \beta_2 = \pi = 0$. Let us now look at ϕ_3, which represents this hypothesis. The value of the test statistic is 2.7334, which is also outside the significance level of 10%. This means that we cannot reject the hypothesis that $\beta_2 = 0$. We can therefore rule out a trend. Next, we now test whether we can also rule out a drift, i.e. whether $\beta_1 = \pi = 0$ holds.

	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	0.04445	0.03222	1.380	0.1715
z.lag.1	-0.04125	0.01827	-2.258	0.0266*
z.diff.lag	0.72592	0.08114	8.946	$1.01e^{-13}$***

Table 3: ADF-test regression output for real consumption expenditure ex durables (Significance levels: "." 10%, "" 5%, "**" 1%, "***" 0,1%)*

In the upper table (table 3) you can see the regression output for "Overnight rate euro area" as in the first test, but this time without trend. Once again, 1 lagged endogenous variable was used, whereby the number of lagged endogenous variables was again selected using the Akaike Information Criterion (AIC)

	Test statistic	1%	5%	10%
τ_2	-2.2583	-3.51	-2.89	-2.58
ϕ_1	2.5729	6.70	4.71	3.86

Table 4: ADF-test for regression including constant (test values and respective significance levels)

Table 4 shows the test results for the various hypotheses that can be tested with the ADF test. As mentioned above, we have tested the hypothesis that $\beta_1 = \pi = 0$. Let's take a look at ϕ_1, which represents this hypothesis. The value of the test statistic is 2.5729, which is outside the significance level of 10%. This means that we do not reject the hypothesis that $\beta_1 = \pi = 0$. We can therefore reject a drift.

As we have established from the tests that the variable "Overnight rate euro area" obviously has a unit root, the variable is now differenced and tested to see whether the variable integrated of an order is higher than 1.

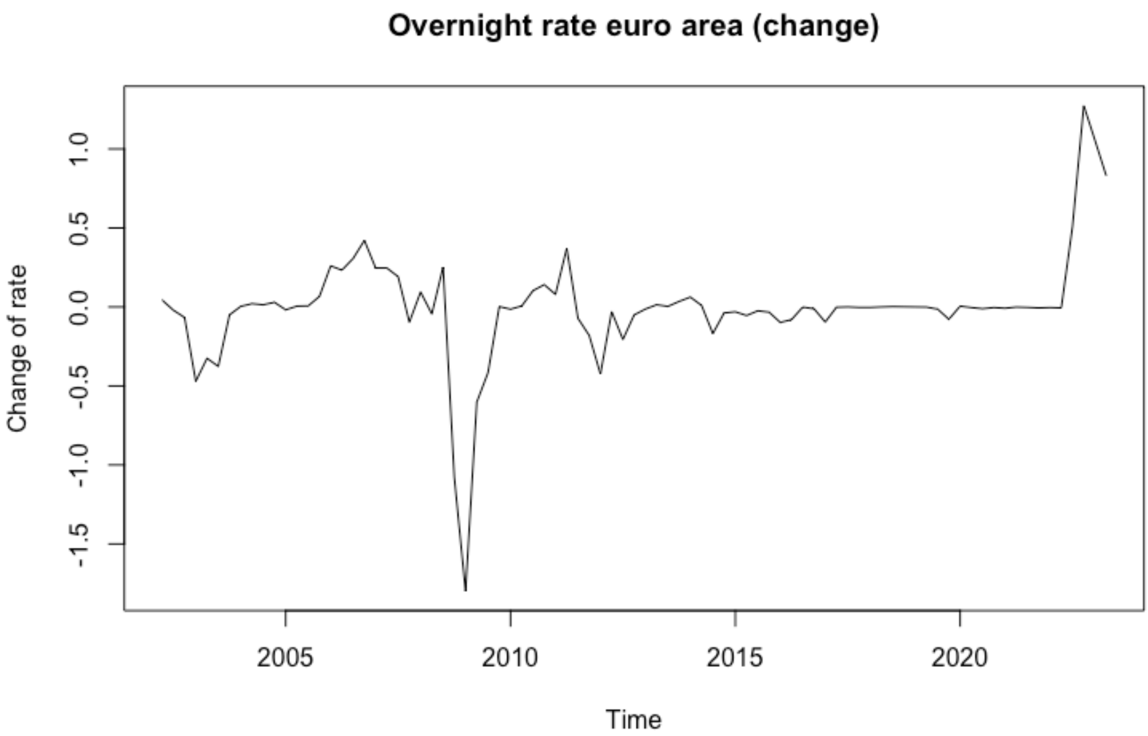

Figure 10: Illustration of the differenced overnight rate in the eurozone Q2 2002 - Q2 2023 (EONIA or €STR; source: ECB)

The upper chart (figure 10) shows the change in the differenced overnight rate in the euro area from Q1 2002 to Q2 2023. It can be seen that the change is mostly 0 or fluctuates around 0. There were sharp changes during the 2008/2009 financial crisis and after the corona pandemic as a result of high inflation rates.

	Estimate	Std. Error	t value	Pr(>|t|)
z.lag.1	-0.35611	0.09326	-3.818	0.000262***
z.diff.lag1	0.18259	0.11647	1.568	0.120844

Table 5: ADF-test regression output for differenced real consumption expenditure ex durables (Significance levels: "." 10%, "" 5%, "**" 1%, "***" 0,1%)*

As in the previous tests, the upper table (table 5) shows the regression output for the differenced "Overnight rate euro area" variable. Once again, 1 lagged endogenous variable was used, whereby the number of lagged endogenous variables was again selected using the Akaike Information Criterion (AIC).

	Test statistic	1%	5%	10%
τ_1	-3.8184	-2.6	-1.95	-1.61

Table 6: ADF-test for regression including constant (test values and respective significance levels)

Table 6 now shows the test result for the various hypotheses that $\pi = 0$. If we look at τ_1, we see that the value of the test statistic is -3.8184, which is within the significance level of 1%. This means that we can reject the hypothesis that $\pi = 0$. Thus, the variable "Overnight rate euro area" is integrated of order one, I(1).

The following table (table 7) provides an overview of the ADF test of the variables. To keep the table clear, the variables are labelled as follows: "Overnight rate euro area" as rate, "Real consumption expenditure ex durables" as cons, "Real durable consumption expenditure" as consdur, "Real dwellings investment (buildings)" as dwellings, "Real fixed gross capital formation ex dwellings" as fixedcapex and "HICP Austria (quarterly)" as price.

Variable	Deterministic terms	Lags	Test Value	Critical Values		
				1%	5%	10%
rate	none	1	-1.7908	-2.6	-1.95	-1.61
Δrate	none	1	-3.8184	-2.6	-1.95	-1.61
cons	constant, trend	1	-3.7478	-4.04	-3.45	-3.15
consdur	constant, trend	1	-4.844	-4.04	-3.45	-3.15
dwellings	none	1	0.6338	-2.6	-1.95	-1.61
Δdwellings	none	1	-7.3719	-2.6	-1.95	-1.61
fixedcapex	none	1	1.6308	-2.6	-1.95	-1.61
Δfixedcapex	none	1	-10.9705	-2.6	-1.95	-1.61
price	constant	1	-3.1392	-3.51	-2.89	-2.58

Table 7: ADF-test for all variables (Δ stands for differenced variable)

3.1.3. VAR/SVAR model setup and impulse response analysis

In this section, an unrestricted vector autoregressive (VAR) model, a restricted VAR and subsequently a structural VAR (SVAR) model are defined for the variables presented above and the impulse response function (IRF) for the "rate" variable is analysed on the basis of these models. With the help of the IRF for the variable "rate" it is possible to derive empirical statements about the influence of an interest rate increase on the variables in question. The VAR model is now briefly presented and defined.

According to Lütkepohl (2007, p. 13), a VAR model is defined as follows:

$$y_t = v + A_1 y_{t-1} + \cdots + A_p y_{t-p} + u_t, t = 0, \pm 1, \pm 2, \ldots$$

A VAR(p) model, i.e. a VAR model of order p, which is described by y_t, a $(K \times 1)$-random vector, A_i, a $(K \times K)$ fixed coefficient vector, v, a $(K \times 1)$ intercept vector and u_t, a K-dimensional white noise process. The subscript p stands for the lag order, i.e. the lags of the variables that are included in the model.

The number of lags, i.e. the lag order, is determined with the help of a multivariate information criterion. The most common information criteria (Verbeek, 2017, p. 69) are the Akaike Information Criterion or Schwarz Information Criterion, which are known as AIC or BIC. Depending on the choice of information criterion, a specific criterion is minimised and the corresponding lag or number is selected.

According to Lütkepohl (2007, p. 146-151), the AIC is a very suitable information criterion for forecasting, while the BIC (Schwarz Criterion) or the Hannan-Quinn Criterion (HQ) would be more suitable for the correct lag order. In addition to the forecasting aspect, the sample size also plays a decisive role. For a smaller sample, the AIC is more suitable than the SC. Accordingly, the various information criteria are considered below and the corresponding models are compared with each other.

The first step is to estimate an unrestricted VAR model. All the variables mentioned and presented above (Overnight rate, Real consumption expenditures excluding durable goods, Real durable goods consumption expenditure, Dwellings expenditure, Fixed capital goods formation expenditure excluding dwellings, Inflation) are used in the model. The variables are called "Rate", "ConsExDur", "ConsDur", "Dwellings", "FixedCapFormEx" and "Inflation" respectively.

In the next step, as mentioned above, the optimal lag order is determined using the information criteria mentioned above. The following optimal lag orders were determined:

	AIC(n)	HQ(n)	SC(n)	FPE(n)
Optimal lag order	8	8	1	8

Table 6: Optimal lag order selection for model

Since both the AIC and the HQ information criterion (and also the FPE criterion) show an optimal lag order of 8, a lag order of 8 is selected. In the following, a VAR model was estimated. However, it is not the prediction of the different variables that is of particular interest, but how changes in one variable may affect other variables. This is possible with the help of impulse response analysis. According to Lütkepohl (2007, p. 52), a unit shock is assumed for a variable at time $t = 0$, which affects the other variables in the subsequent time periods. It is therefore assumed that $u_{i,0}$ is changed by 1 in a VAR model and these effects are tracked in the VAR model over various periods.

Again according to Lütkepohl (2007, p.56-58), the problem with the previous impulse response analysis is that it assumes, as described, that a unit shock only occurs in one variable. However, it does not take into account the case that a shock to one variable also leads to an immediate shock to another variable. In order to represent these possible simultaneous shocks, so-called orthogonal impulse responses are used, which can show these direct influences. In addition, the order of the variables is also important in orthogonal impulse responses, as the first-ordered variable in this method is only influenced by itself, while the last-ordered variable is influenced by all variables (Wold causal ordering). Another significant difference is that the shocks here do not have the size 1 as in the previous approach but operate in the size of a standard deviation in each case. Figure 11 below shows the orthogonal impulse responses of the various variables to a shock of the variable "rate" (i.e. the interest rate).

As can be seen in figure 11, there is, as expected, a significant positive change in the "Rate" variable after a shock to this variable. The variable "ConsEx" (i.e. household consumption expenditure excluding durable goods) shows almost no influence of the variable "Rate", but there is a significant, positive effect in periods 0 and 5. The variable "ConsDur" shows no influence from a shock of the variable "Rate", here there is no significant effect in the entire 10 periods. The variable "Dwellings" shows a positive, significant effect in period 0 and a negative, significant effect of the variable "Rate" in period 9. For the variable "FixedCapFormEx" (this variable describes the expenditure for fixed capital formation excluding dwellings), there is no significant effect in the 10 periods analysed. For the variable "Inflation", there is initially a positive, significant effect in periods 2 and 3, which turns into a negative, significant effect from period 10 onwards.

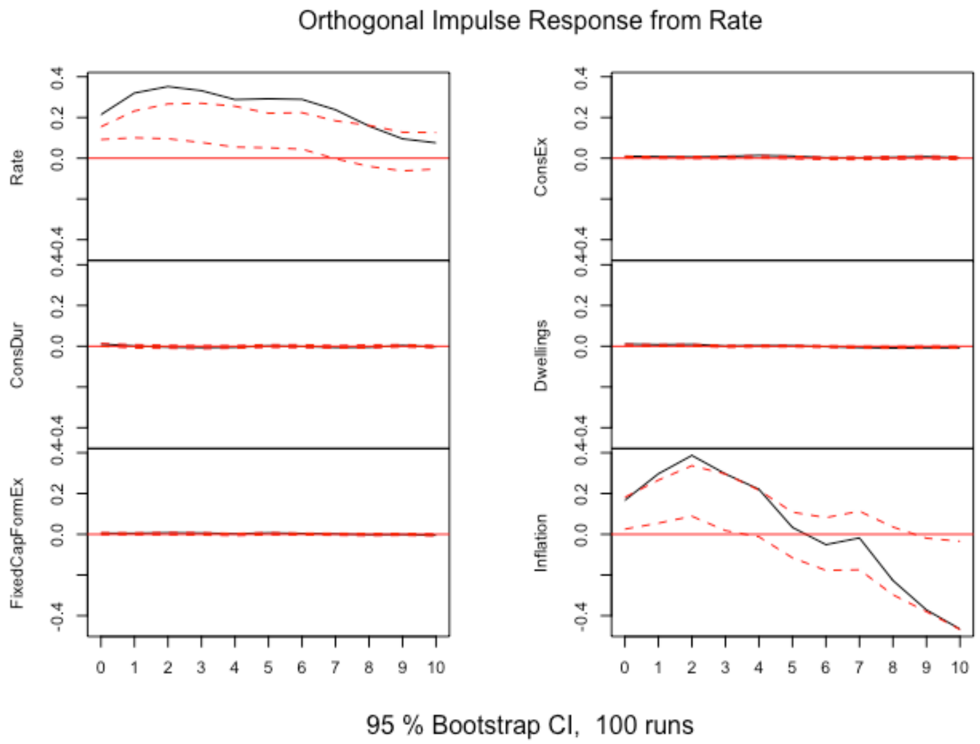

Figure 11: Orthogonal impulse responses given shock of variable “Rate”, unrestricted VAR

A restricted VAR model was then estimated as a second model. In this model, only those regressors were used that could demonstrate a significance level of 5%. Once again, the orthogonal impulse responses of the various variables to a shock of the variable "rate" (i.e. the interest rate) were created and summarised. As can be seen in figure 12, there is again a significant positive change in the "Rate" variable following a shock to this variable. The variable "ConsEx" (i.e. the consumption expenditure of private households without durable goods) shows no significant influence of the variable "Rate" in all periods. The variable "ConsDur" shows no influence of a shock of the variable "Rate", there is no significant effect in the entire 10 periods. The variable "Dwellings" also shows no significant influence of the variable "Rate". For the variable "FixedCapFormEx" (this variable describes the expenditure for fixed capital formation excluding dwellings), there is no significant effect in the analysed 10 periods. For the variable "Inflation", there is a positive, significant effect first in period 3, but again no significant effects in the subsequent periods.

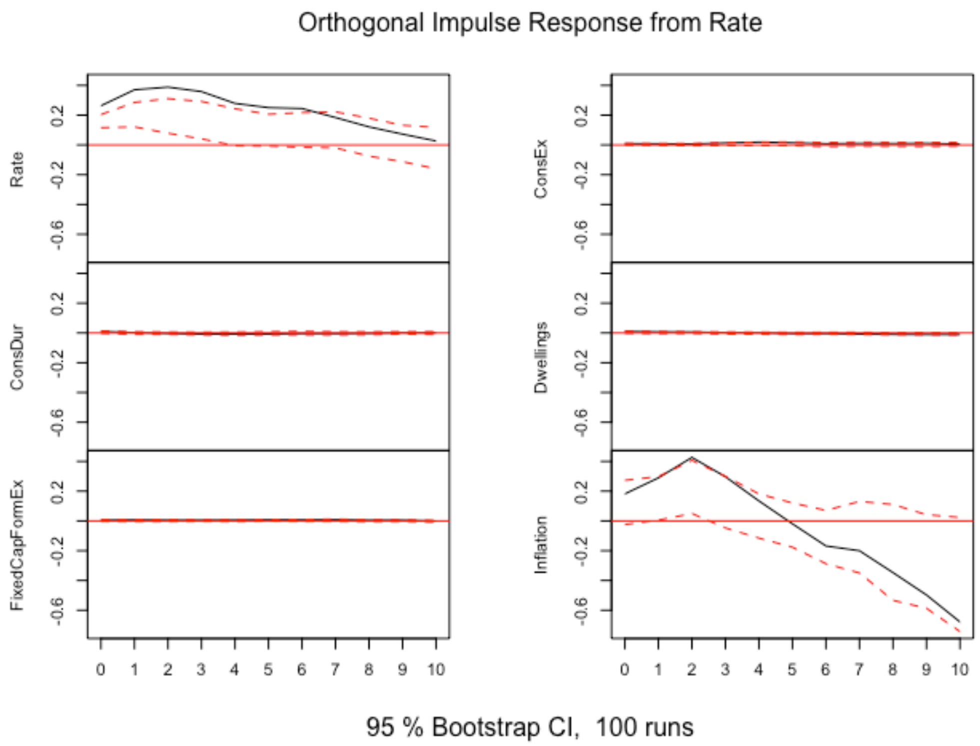

Figure 12: Orthogonal impulse responses given shock of variable “Rate”, restricted VAR

After analysing impulse responses of VAR-models in the two figures above, we now come to the SVAR-model. The SVAR model is based on the functionality of the orthogonal impulse responses, but is even more specific (Lütkepohl, 2007, p. 358). As with the orthogonal impulse responses, the variance-covariance matrix is also of particular importance with the SVAR. This matrix contains the variances of the endogenous variables on the diagonal of the matrix and the covariances of the error terms on the offdiagonal elements of the matrix. While a Cholesky decomposition is also used for orthogonal impulse responses, the SVAR method involves modelling the variance-covariance matrix itself, i.e. setting certain elements to 0 (or other values). These restrictions are usually based on economic theory and thus bring "structure" to the otherwise atheoretical VAR models (hence the name).

To analyse the data, a B-model of the SVAR model was estimated and the impulse responses were then analysed. A B-model is a model (Lütkepohl, 2007, p. 362) that assumes a structural relationship between the forecast errors u_t and the structural errors ϵ_t The following relationship then applies, $u_t = B\epsilon_t$. Furthermore, for ϵ_t, $\epsilon_t \sim (0, I_K)$ applies. As described above, the model can now be given a "structure" by directly modelling the B-matrix. In the course of this analysis, the following B-matrix is modelled and taken into account for the further analyses.

$$B = \begin{matrix} NA & 0 & 0 & 0 & 0 & 0 \\ NA & NA & 0 & 0 & 0 & 0 \\ NA & NA & NA & 0 & 0 & 0 \\ NA & 0 & 0 & NA & 0 & 0 \\ NA & 0 & 0 & 0 & NA & 0 \\ NA & NA & NA & NA & NA & NA \end{matrix}$$

The values NA in the upper matrix generally represent values that are estimated in the course of the SVAR model, i.e. are not modelled in advance. The further modelling of this B-matrix can now be explained as follows. In the first row, we find the variable "Rate", which is not influenced by any other shock apart from a shock from "Rate". The second row contains the variable "ConsEx", which would be influenced by a shock from "Rate" and itself. The third line describes the relationship for the variable "ConsDur", where shocks from the variables "Rate", "ConsEx" and "ConsDur" have an influence. The influence of a shock from "ConsEx" is modelled because it can be assumed that the same shocks that lead to an increase in the consumption of non-durable goods also have an influence on the consumption of durable consumer goods. In row 4, for the variable "Dwellings", only shocks from "Rate" and "Dwellings" have an influence on the variable. In the penultimate line 5, which describes the variable "FixedCapFormEx", only the shocks from "Rate" and "FixedCapFormEx" have an effect. In the last line 6 for the variable "Inflation", it is assumed that a shock from all variables can have an effect. This is followed by the impulse responses for all variables, including a shock to the "Rate" variable.

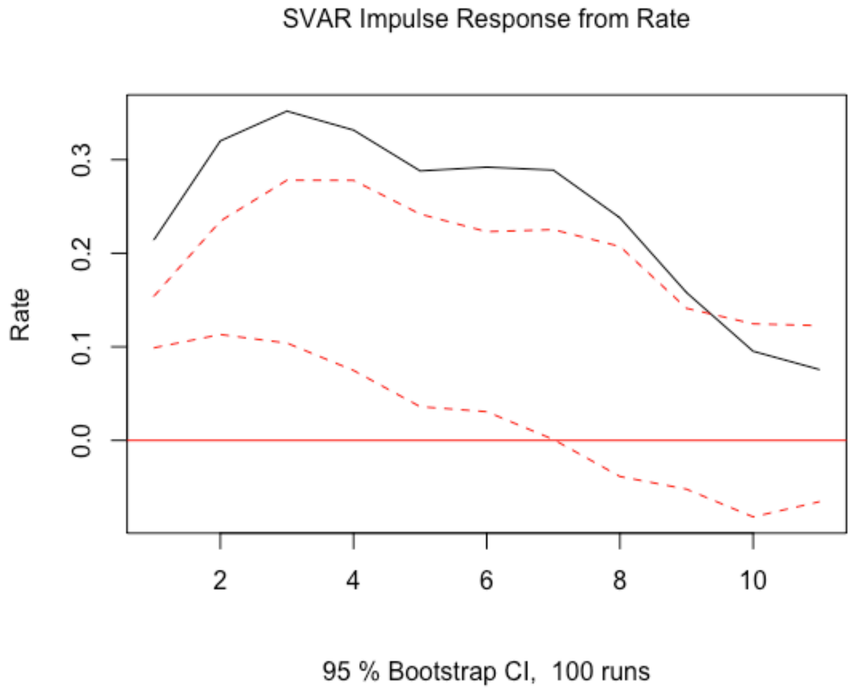

Figure 13: Impulse response of variable "Rate"

In the figure above (figure 13), we now see the impulse response for variable "Rate" of the SVAR to a shock of the variable "Rate". The red dashed line shows the 95% confidence interval, which also allows us to make statements about the statistical significance of a shock. The rate variable reacts to a shock of one standard deviation, which is 1 by construction, with a positive, significant reaction of 0.21 standard deviations. The effect of the shock remains positive and significant in the further course. From period 7 onwards, the influence of the shock is no longer statistically significantly different from 0.

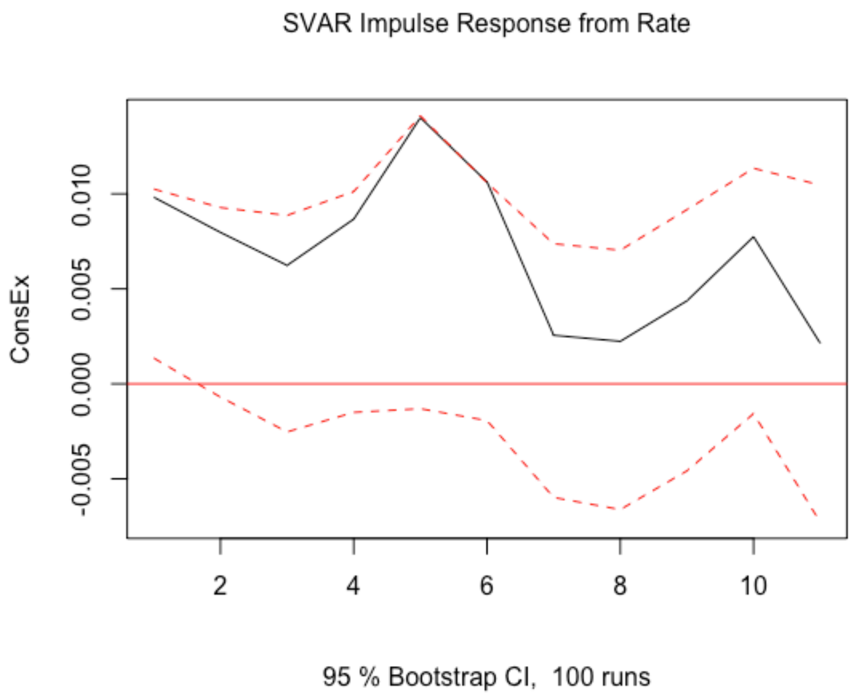

Figure 14: Impulse response of variable "ConsEx"

In the figure above (figure 14) we see the impulse response for variable "ConsEx" of the SVAR to a shock of the variable "Rate". In response to a shock of one standard deviation, which by construction is 1, the variable "ConsEx" reacts with a positive, significant response of 0.01 standard deviations in period 1. In the further course, however, the effect of the shock remains statically not significantly different from 0.

In the figure below (figure 15) we see the impulse response for variable "ConsDur" of the SVAR to a shock of the variable "Rate". The variable "ConsDur" reacts to a shock of one standard deviation, which is 1 by construction, with a response that does not deviate significantly from 0 in the 10 periods analysed.

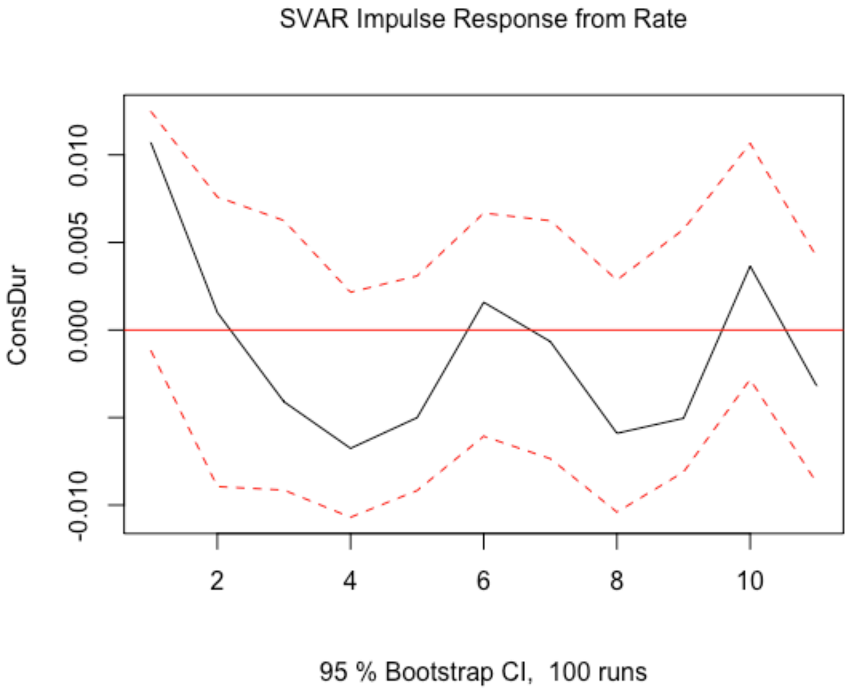

Figure 15: Impulse response of variable "ConsDur"

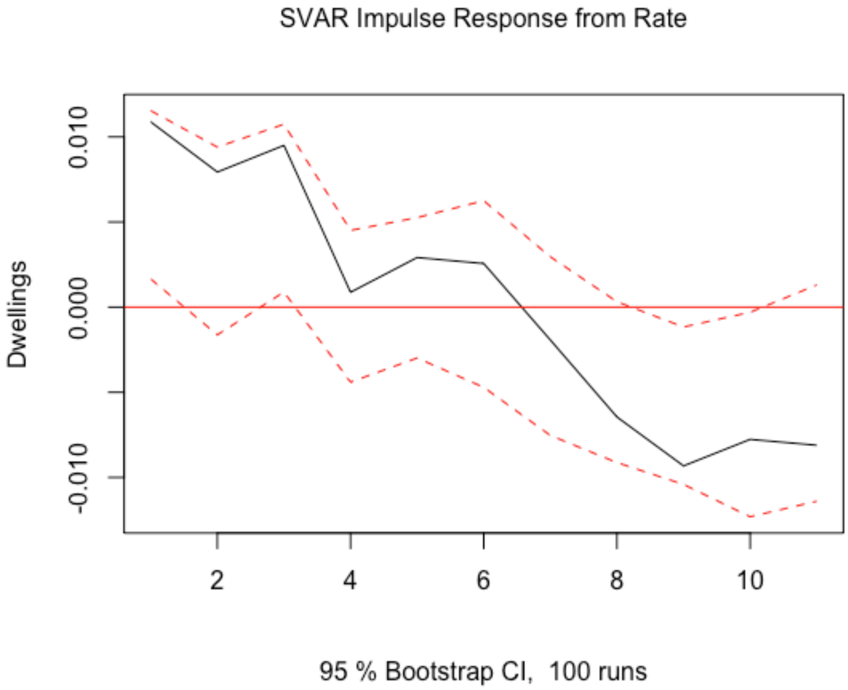

Figure 16: Impulse response of variable "Dwellings"

In the figure above (figure 16) we see the impulse response for variable "Dwellings" of the SVAR to a shock of the variable "Rate". The variable "Dwellings" reacts to a shock of one standard deviation, which is 1 by construction, with a positive, significant response of 0.011 standard deviations. In the further course, the effect of the shock remains positive and significant in period 3, but negative and significant in period 9. In the other periods, the effect is not statistically significantly different from 0.

In the figure below (figure 17) we now see the impulse response for Variable "FixedCapFormEx" of the SVAR to a shock of the variable "Rate". The variable "FixedCapFormEx" reacts to a shock of one standard deviation, which is 1 by construction, with a response that does not differ significantly from 0 in the 10 periods analysed.

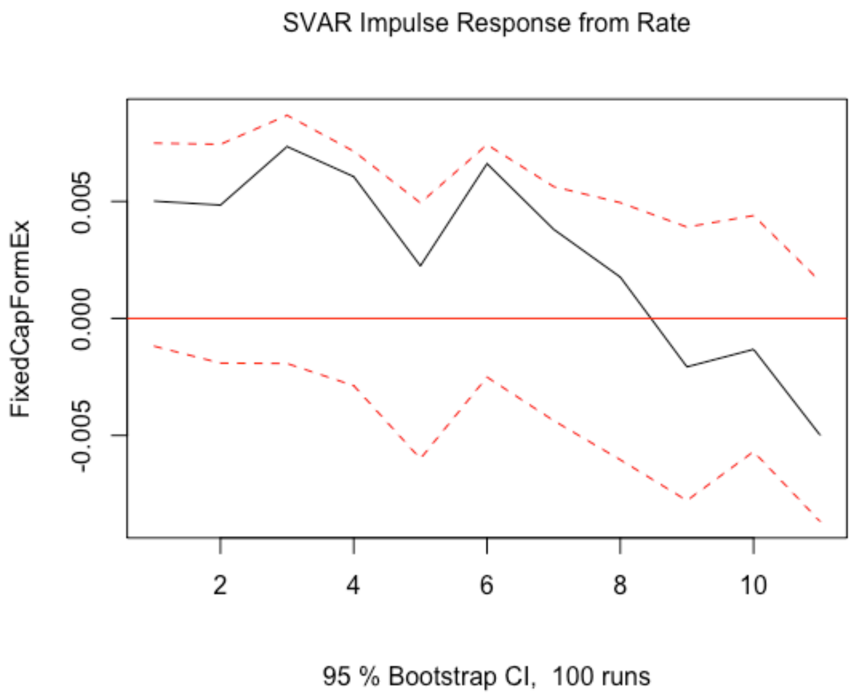

Figure 17: Impulse response of variable "FixedCapFormEx"

In the figure below (Figure 18), we finally see the impulse response for the variable "Inflation" of the SVAR to a shock of the variable "Rate". The variable "Inflation" reacts to a shock of one standard deviation, which is 1 by construction, with a positive, significant reaction of 0.17 standard deviations. The effect of the shock remains positive and significant until period 3. Up to period 10, the influence of the shock can no longer be statistically significantly distinguished from 0. In period 10, the effect is then negative and significant.

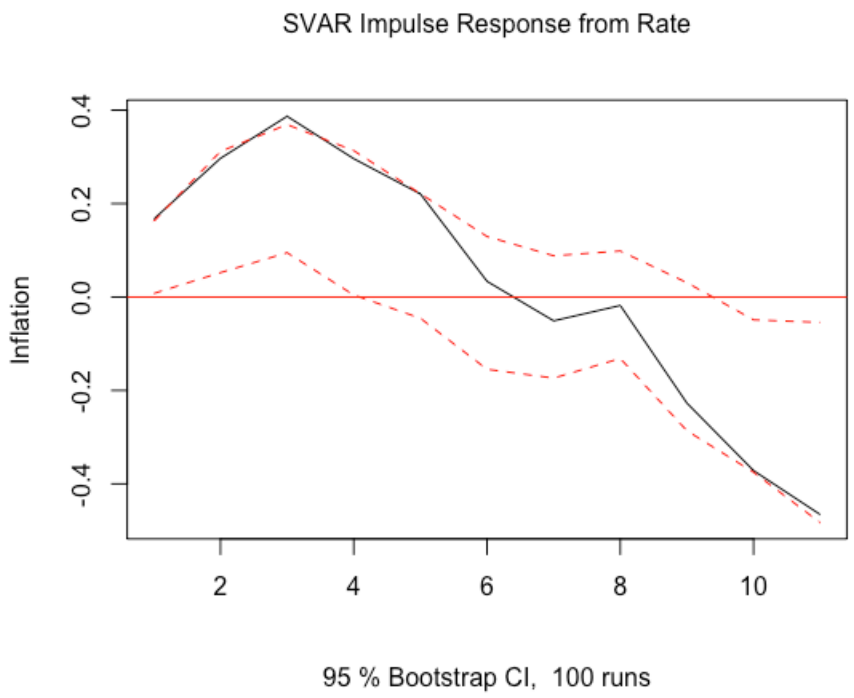

Figure 18: Impulse response of variable "Inflation"

3.1.4. Conclusion

At the beginning, the macroeconomic variables of and their time series were presented and analysed. Based on this, the time series were tested for unit roots using the adf-test. It was found that some time series have unit roots and are therefore integrated of order one. VAR-models and SVAR-models were then created and an impulse response analysis carried out. It was found that there are significant effects for the variables "Rate", "ConsEx", "Dwellings" and "Inflation", while there are no significant effects for the variables "ConsDur" and "FixedCapFormEx". This means that the analysed interest-rate channel could at least not be rejected for "ConsEx" and "Dwellings".

3.2. Germany

In this section, the data for Germany is presented, illustrated, and statistically analysed. A VAR model/SVAR model is also estimated, and the impulse responses are analysed.

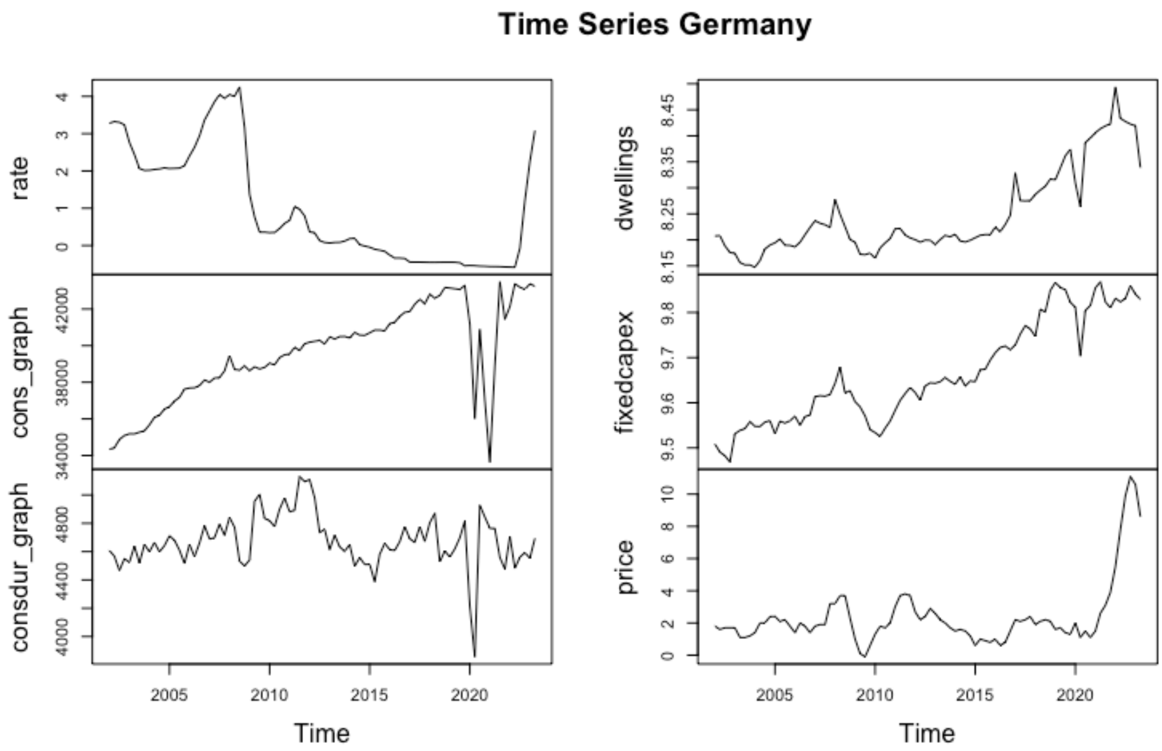

Figure 19: Illustration of the time series of Germany (Source: Eurostat, ECB)

In the upper chart (figure 19), we see the time series for the overnight rate in the euro-zone, consumption expenditure ex durables, durable goods consumption expenditure, dwellings, fixed gross capital formation (ex dwellings) and the HICP rate for Germany in the period from Q1 2002 to Q2 2023. The time series for the overnight rate again clearly shows the initially sharp interest rate hikes during the 2008/2009 financial crisis and the sharp interest rate hikes triggered by the high inflation rates following the coronavirus pandemic. In the time series for consumption expenditure ex durables, dwellings and fixed cross-capital formation (ex dwellings), you can see the generally rising trend, but also the sometimes sharp declines during the coronavirus pandemic or, in the time series for dwellings, the sharp decline after the sharp rise in interest rates.

The durables consumption expenditures seem to be fairly stable, even though there is a big drop throughout the coronavirus pandemic.

The time series were then tested for unit roots using adf-tests. First, an adf-test with trend and constant was tested. If the null hypothesis of the unit root cannot be refuted, attention is paid to whether the null hypothesis regarding the trend can be refuted or not. If this is not possible, this is also tested for the constant. If the null hypothesis cannot be refuted here either, the variable is differentiated and tested to see whether a unit root is still present or not.

The results for all variables are shown in the following table. The deterministic terms describe whether or not the null hypotheses could be refuted for constant or trend. The critical values always refer to the test with regard to the unit root.

Variable	Deterministic terms	Lags	Test Value	Critical Values		
				1%	5%	10%
rate	none	1	-1.7908	-2.6	-1.95	-1.61
Δrate	none	1	-3.8184	-2.6	-1.95	-1.61
cons	none	1	1.5052	-2.6	-1.95	-1.61
Δcons	none	1	-9.0767	-2.6	-1.95	-1.61
consdur	constant, trend	1	-4.9647	-4.04	-3.45	-3.15
dwellings	none	1	0.7569	-2.6	-1.95	-1.61
Δdwellings	none	1	-7.2095	-2.6	-1.95	-1.61
fixedcapex	none	1	1.3766	-2.6	-1.95	-1.61
Δfixedcapex	none	1	-9.0767	-2.6	-1.95	-1.61
price	none	1	-1.2919	-2.6	-1.95	-1.61
Δprice	none	1	-4.3511	-2.6	-1.95	-1.61

Table 7: ADF-test for all variables (Δ stands for differenced variable)

In the next step, the optimal lag order was determined using the information criteria mentioned above. The following optimal lag orders were determined:

	AIC(n)	HQ(n)	SC(n)	FPE(n)
Optimal lag order	8	1	1	8

Table 8: Optimal lag order selection for model

A VAR model with a lag order of 1 was then estimated and a SVAR model was estimated based on this. A B-model was selected, which was explained above. The B-matrix was modelled as above:

$$B = \begin{matrix} NA & 0 & 0 & 0 & 0 & 0 \\ NA & NA & 0 & 0 & 0 & 0 \\ NA & NA & NA & 0 & 0 & 0 \\ NA & 0 & 0 & NA & 0 & 0 \\ NA & 0 & 0 & 0 & NA & 0 \\ NA & NA & NA & NA & NA & NA \end{matrix}$$

In the figure below (figure 20), we now see the impulse response for variable "Rate" of the SVAR to a shock of the variable "Rate". The red dashed line shows the 95% confidence interval, which also allows us to make statements about the statistical significance of a shock. The variable "Rate" reacts to a shock of a standard deviation, which by construction is 1, with a positive, significant reaction of 0.30 standard deviations. The effect of the shock remains positive and significant in the further course. From period 7 onwards, the influence of the shock is no longer statistically significantly different from 0.

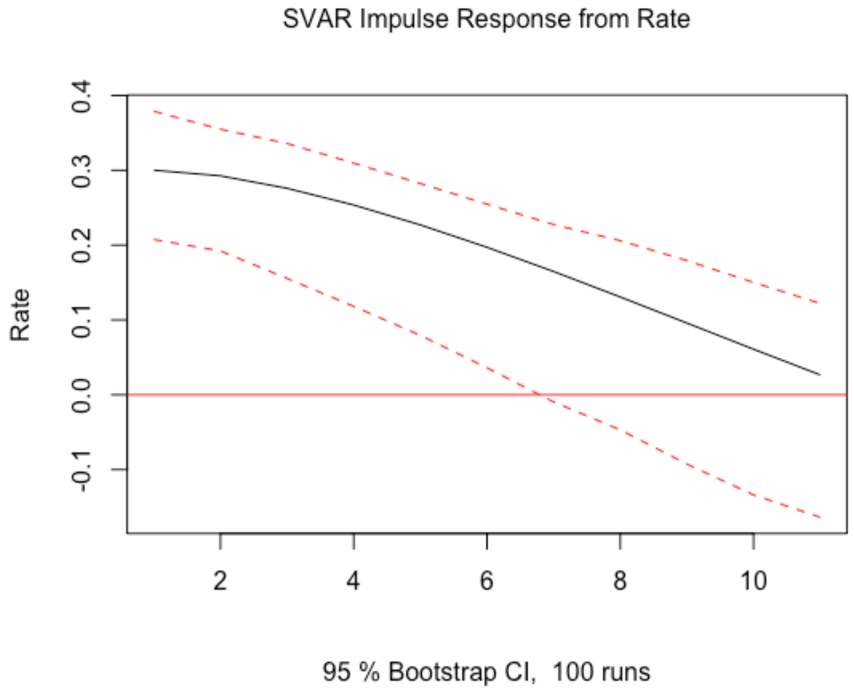

Figure 20: Impulse response of variable "Rate"

In the figure below (figure 21) we see the impulse response for variable "ConsEx" of the SVAR to a shock of the variable "Rate". In response to a shock of one standard deviation, which is 1 by construction, the "ConsEx" variable reacts with a response that does not deviate significantly from 0 in the 10 periods analysed.

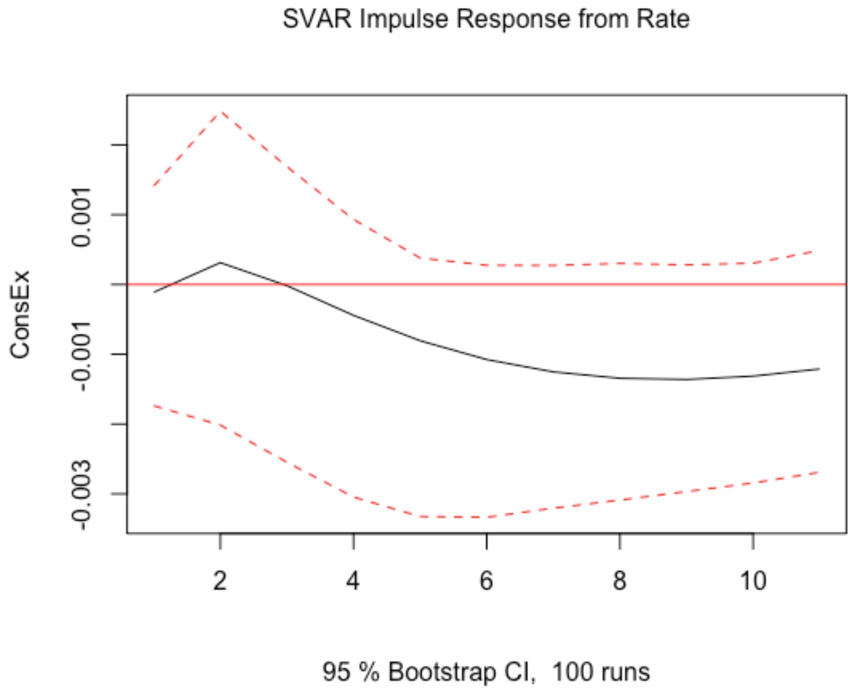

Figure 21: Impulse response of variable "ConsEx"

In the figure below (figure 22) we see the impulse response for variable "ConsDur" of the SVAR to a shock of the variable "Rate". The variable "ConsDur" reacts to a shock of one standard deviation, which is 1 by construction, with a response that does not deviate significantly from 0 in the 10 periods analysed.

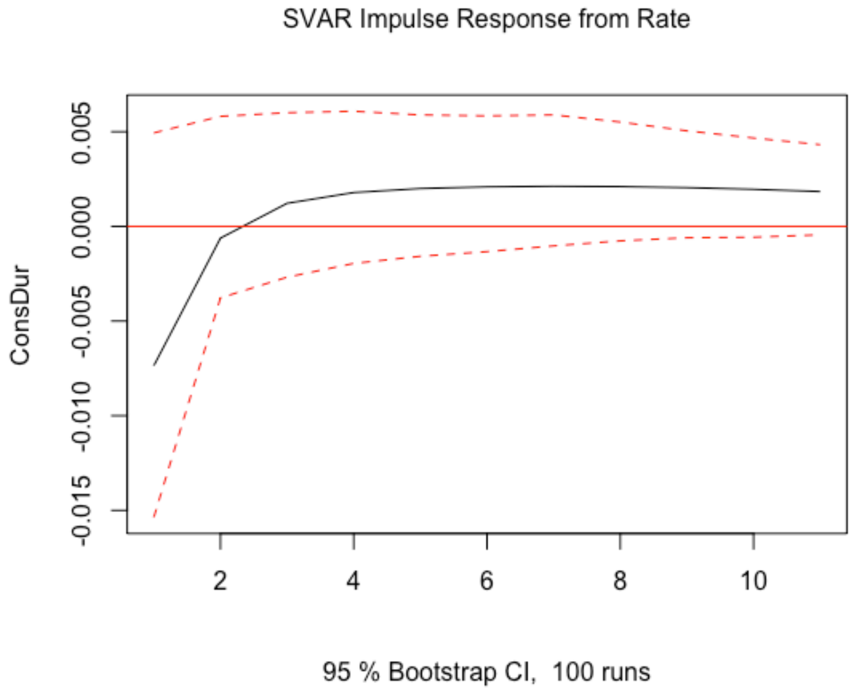

Figure 22: Impulse response of variable "ConsDur"

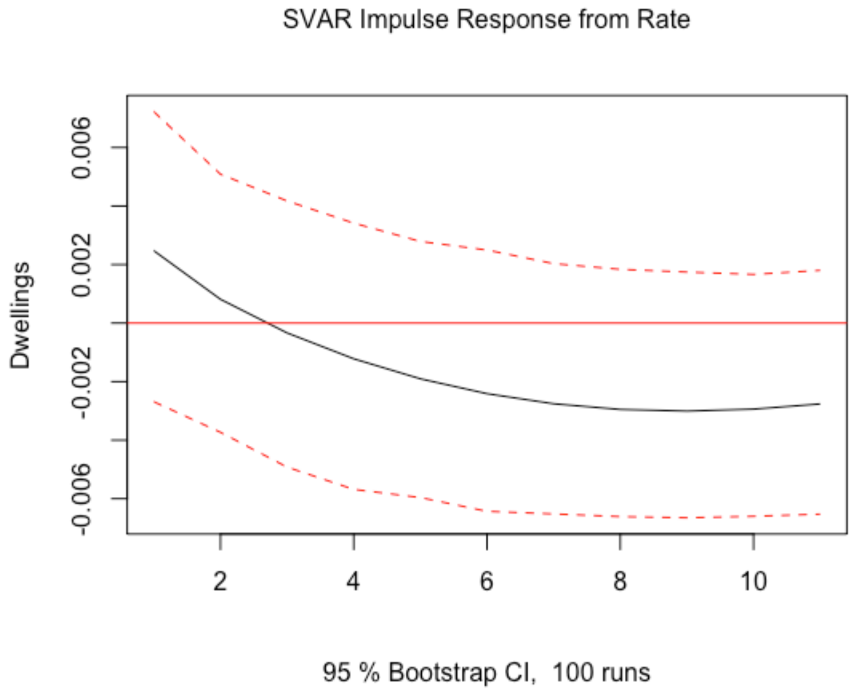

Figure 23: Impulse response of variable "Dwellings"

In the figure above (Figure 23) we see the impulse response for the variable "Dwellings" of the SVAR to a shock of the variable "Rate". The "Dwellings" variable reacts to a shock of one standard deviation, which is 1 by construction, with a response that does not deviate significantly from 0 in the 10 periods analysed.

In the figure below (Figure 24) we now see the impulse response for variable "FixedCapFormEx" of the SVAR to a shock of the variable "Rate". The Rate variable reacts to a shock of one standard deviation, which is 1 by construction, with a positive, significant reaction of 0.011 in period 1. The effects are also still positive and significant in periods 2 and 3. From period 4 onwards, there is no significant deviation from 0.

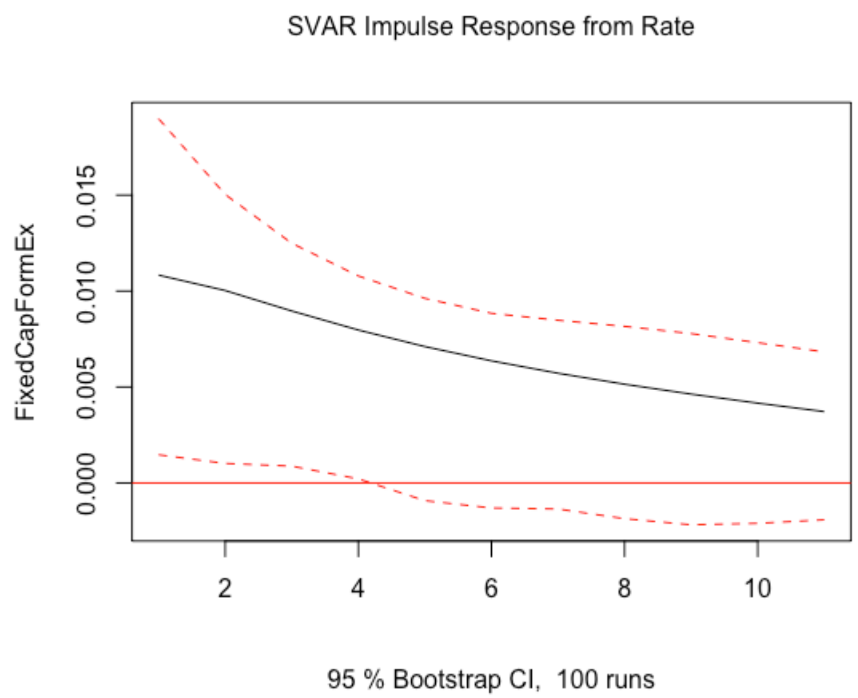

Figure 24: Impulse response of variable "FixedCapFormEx"

In the figure below (figure 25), we finally see the impulse response for the variable "Inflation" of the SVAR to a shock of the variable "Rate". In response to a shock of one standard deviation, which is 1 by construction, the rate variable initially shows no significant response other than 0. From period 7 onwards, there is a negative, significant reaction.

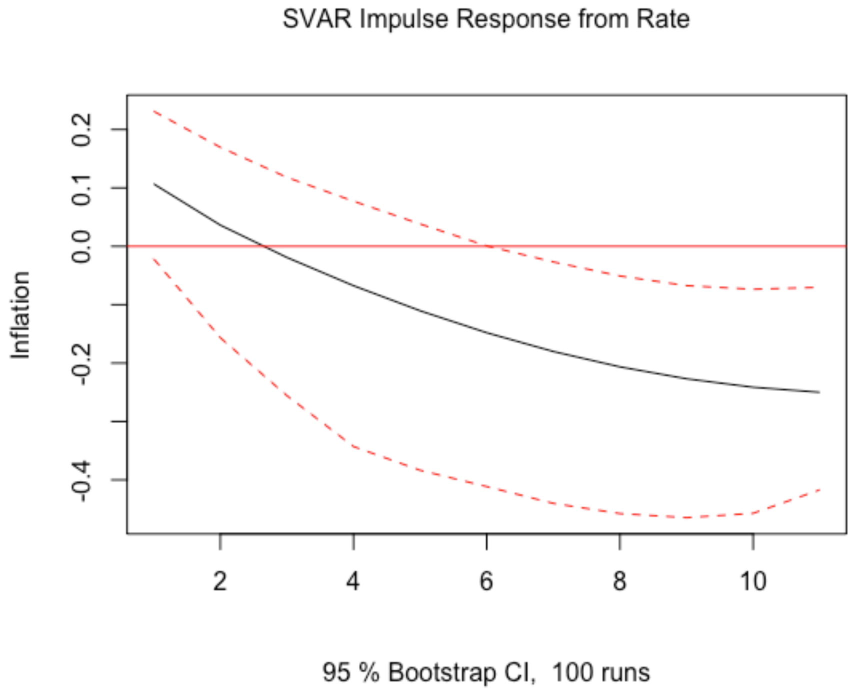

Figure 25: Impulse response of variable "Inflation"

3.3. France

In this section, the data for France is presented, illustrated, and statistically analyzed. A VAR model/SVAR model is also estimated, and the impulse responses are analyzed.

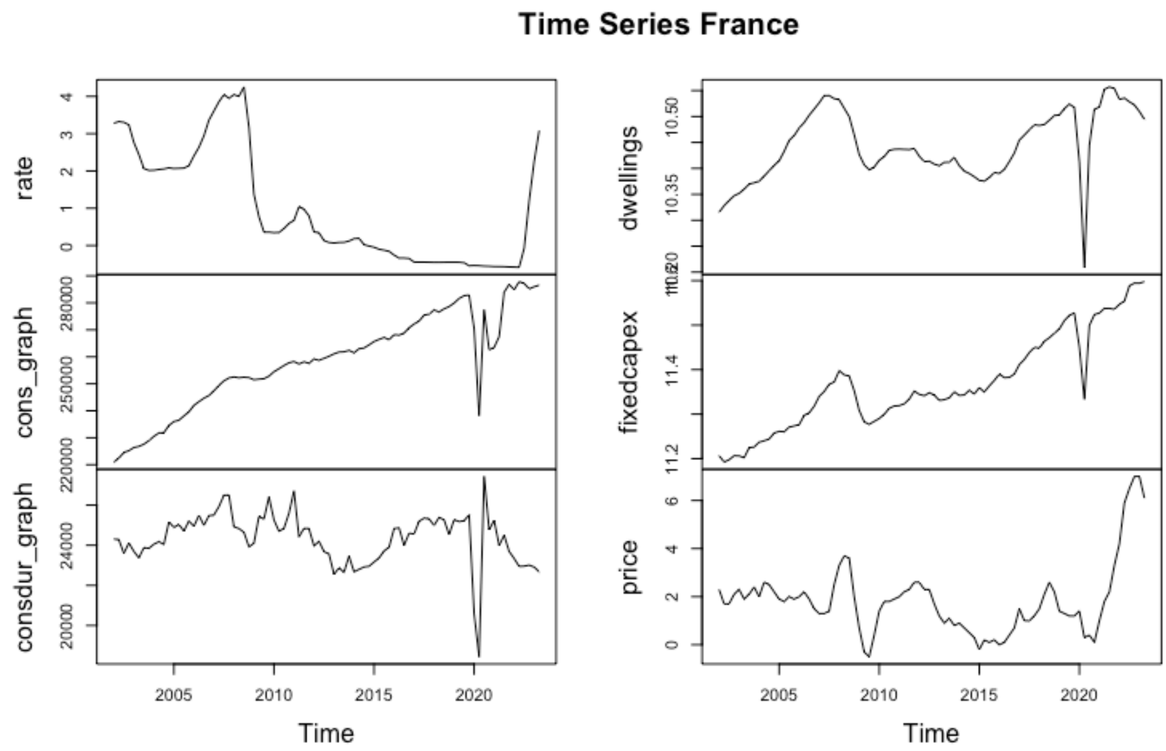

Figure 26: Illustration of the time series of France (Source: Eurostat, ECB)

In the figure above (figure 26), we see the time series for the overnight rate in the eurozone, consumption expenditure ex durables, durable goods consumption expenditure, dwellings, fixed gross capital formation (ex dwellings) and the HICP rate for France in the period from Q1 2002 to Q2 2023. The time series for the overnight rate again clearly shows the initial sharp interest rate cuts during the 2008/2009 financial crisis and the sharp interest rate hikes triggered by the high inflation rates following the coronavirus pandemic. The time series for consumption expenditure ex durables and fixed cross-capital formation (ex dwellings) show the generally rising trend, but also the sometimes sharp declines during corona. The time series for dwellings shows an extremely strong increase before the 2008/2009 financial crisis and the subsequent decline. There was also a sharp decline during the corona pandemic. The durables consumption expenditures seem to be fairly stable, even though there is a big drop throughout the coronavirus pandemic.

The time series were then tested for unit roots using adf-tests. First, an adf-test with trend and constant was tested. If the null hypothesis of the unit root cannot be refuted, attention is paid to whether the null hypothesis regarding the trend can be refuted or not. If this is not possible, this is also tested for the constant. If the null hypothesis cannot be refuted here either, the variable is differentiated and tested to see whether a unit root is still present or not.

The results for all variables are shown in the following table (table 9). The deterministic terms describe whether or not the null hypotheses could be refuted for constant or trend. The critical values always refer to the test with regard to the unit root.

Variable	Deterministic terms	Lags	Test Value	Critical Values		
				1%	5%	10%
rate	none	1	-1.7908	-2.6	-1.95	-1.61
Δrate	none	1	-3.8184	-2.6	-1.95	-1.61
cons	none	1	1.7483	-2.6	-1.95	-1.61
Δcons	none	1	-8.985	-2.6	-1.95	-1.61
consdur	constant, trend	1	-4.732	-4.04	-3.45	-3.15
dwellings	cons	1	-3.1802	-3.51	-2.89	-2.58
fixedcapex	none	1	1.6851	-2.6	-1.95	-1.61
Δfixedcapex	none	1	-8.985	-2.6	-1.95	-1.61
price	none	1	-1.2136	-2.6	-1.95	-1.61
Δprice	none	1	-4.527	-2.6	-1.95	-1.61

Table 9: ADF-test for all variables (Δ stands for differenced variable)

In the next step, the optimal lag order was determined using the information criteria mentioned above. The following optimal lag orders were determined:

	AIC(n)	HQ(n)	SC(n)	FPE(n)
Optimal lag order	8	2	2	5

Table 10: Optimal lag order selection for model

A VAR model with a lag order of 1 was then estimated and a SVAR model was estimated based on this. A B-model was chosen, which was explained above. The B-matrix was modeled as above:

$$B = \begin{matrix} NA & 0 & 0 & 0 & 0 & 0 \\ NA & NA & 0 & 0 & 0 & 0 \\ NA & NA & NA & 0 & 0 & 0 \\ NA & 0 & 0 & NA & 0 & 0 \\ NA & 0 & 0 & 0 & NA & 0 \\ NA & NA & NA & NA & NA & NA \end{matrix}$$

In the figure below (figure 27), we now see the impulse response for variable "Rate" of the SVAR to a shock of the variable "Rate". The red dashed line shows the 95% confidence interval, which also allows us to make statements about the statistical significance of a shock. The variable "Rate" reacts to a shock of one standard deviation, which is 1 by construction, with a positive, significant reaction of 0.24 standard deviations. The effect of the shock remains positive and significant in the further course. From period 7 onwards, the influence of the shock is no longer statistically significantly different from 0.

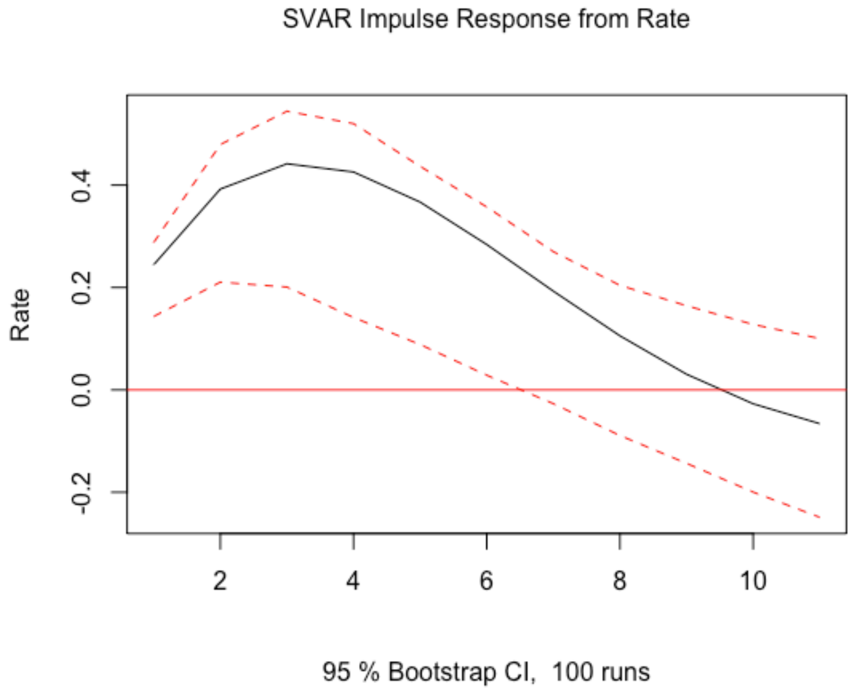

Figure 27: Impulse response of variable "Rate"

In the figure below (figure 28) we see the impulse response for variable "ConsEx" of the SVAR to a shock of the variable "Rate". The "ConsEx" variable reacts to a shock of one standard deviation, which is 1 by construction, with a response that does not deviate significantly from 0 in the 10 periods analysed.

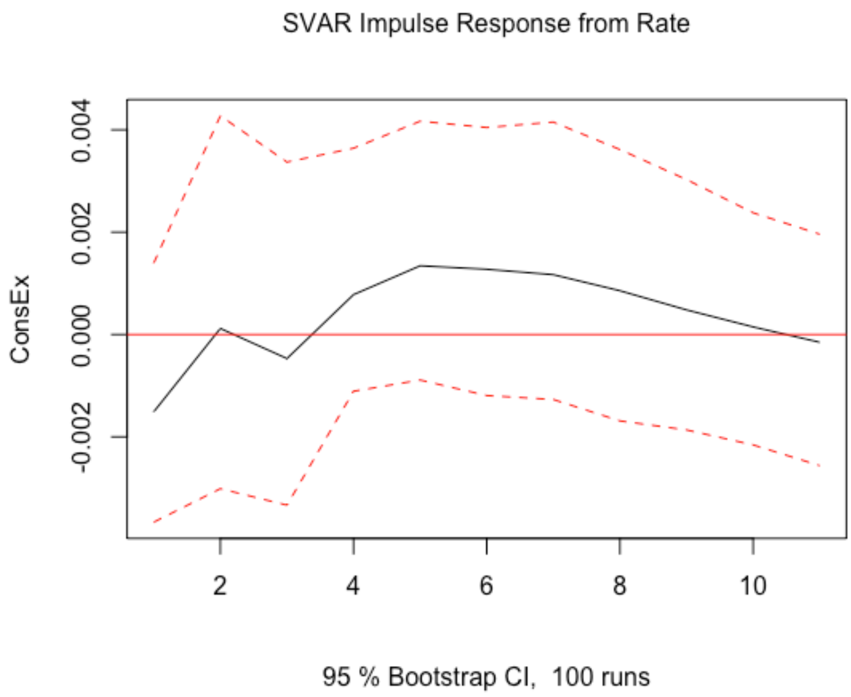

Figure 28: Impulse response of variable "ConsEx"

In the figure below (figure 29) we see the impulse response for variable "ConsDur" of the SVAR to a shock of the variable "Rate". The "ConsDur" variable reacts to a shock of one standard deviation, which is 1 by construction, with a response that does not deviate significantly from 0 in the 10 periods analysed.

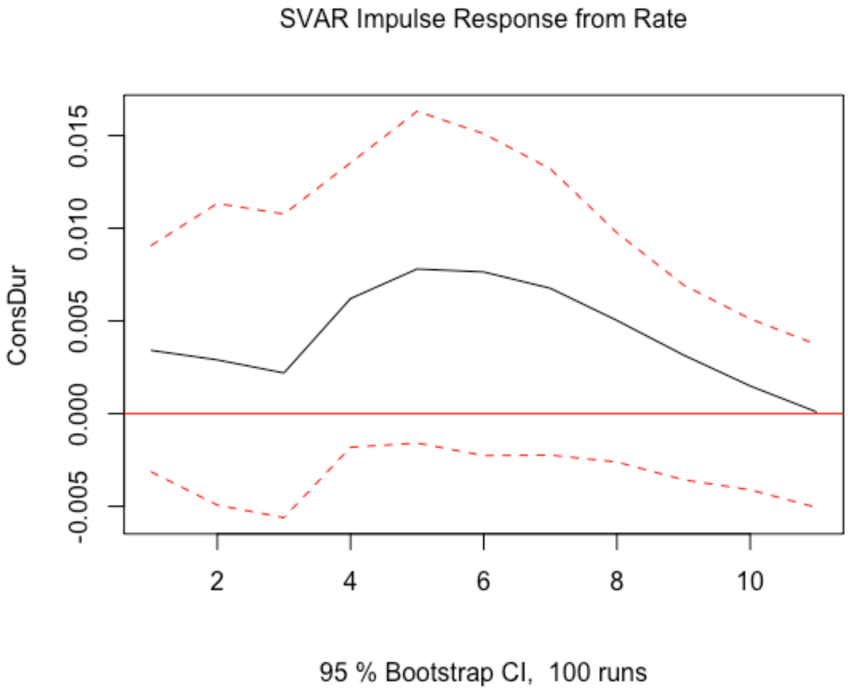

Figure 29: Impulse response of variable "ConsDur"

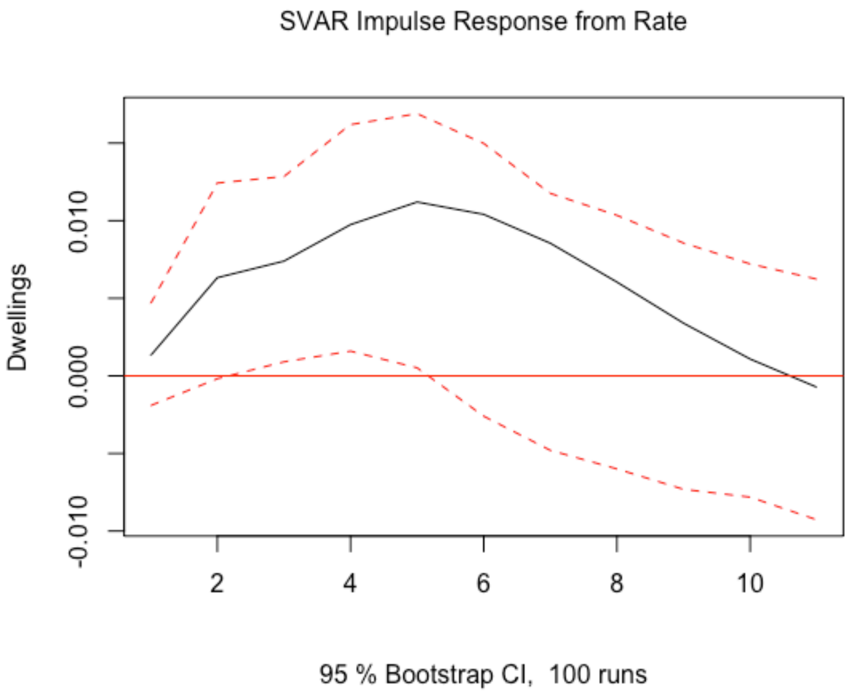

Figure 30: Impulse response of variable "Dwellings"

In the figure above (figure 30) we see the impulse response for variable "Dwellings" of the SVAR to a shock of the variable "Rate". In response to a shock of one standard deviation, which is 1 by construction, the Rate variable initially reacts with a non-significant response deviating from 0. In the further course, the effect of the shock is positive and significant in periods 3 to 5. In the later periods, the effect is again not statistically significant deviating from 0.

In the figure below (figure 31), we now see the impulse response for variable "FixedCapFormEx" of the SVAR to a shock of the variable "Rate". The variable Rate initially reacts to a shock of one standard deviation, which is 1 by construction, with a non-significant response that deviates from 0. Later on, the effect of the shock is positive and significant in periods 2 to 6. In the later periods, the effect is again not statistically significantly different from 0.

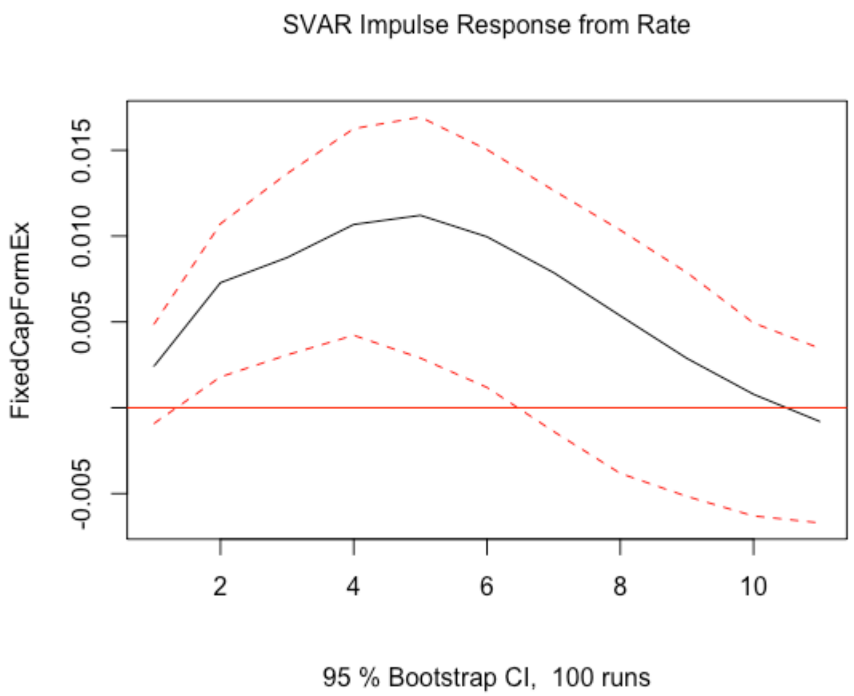

Figure 31: Impulse response of variable "FixedCapFormEx"

In the figure below (figure 32), we finally see the impulse response for the variable "Inflation" of the SVAR to a shock of the variable "Rate". In response to a shock of one standard deviation, which is 1 by construction, the "Inflation" variable reacts with a response that does not deviate significantly from 0 in the 10 periods analysed.

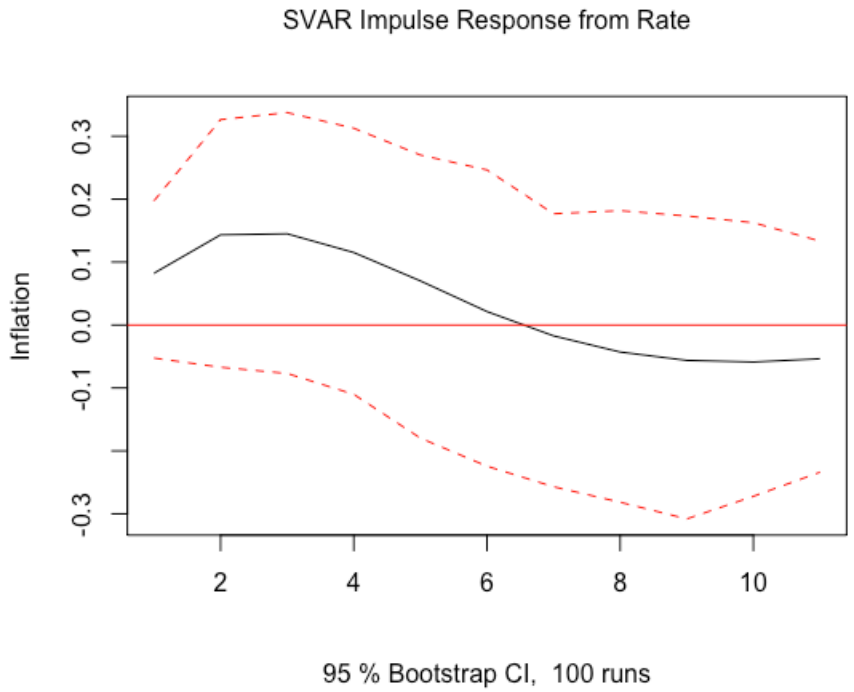

Figure 32: Impulse response of variable "Inflation"

3.4. Italy

In this section, the data for Italy are presented, illustrated, and statistically analysed. A VAR model/SVAR model is also estimated, and the impulse responses are analysed.

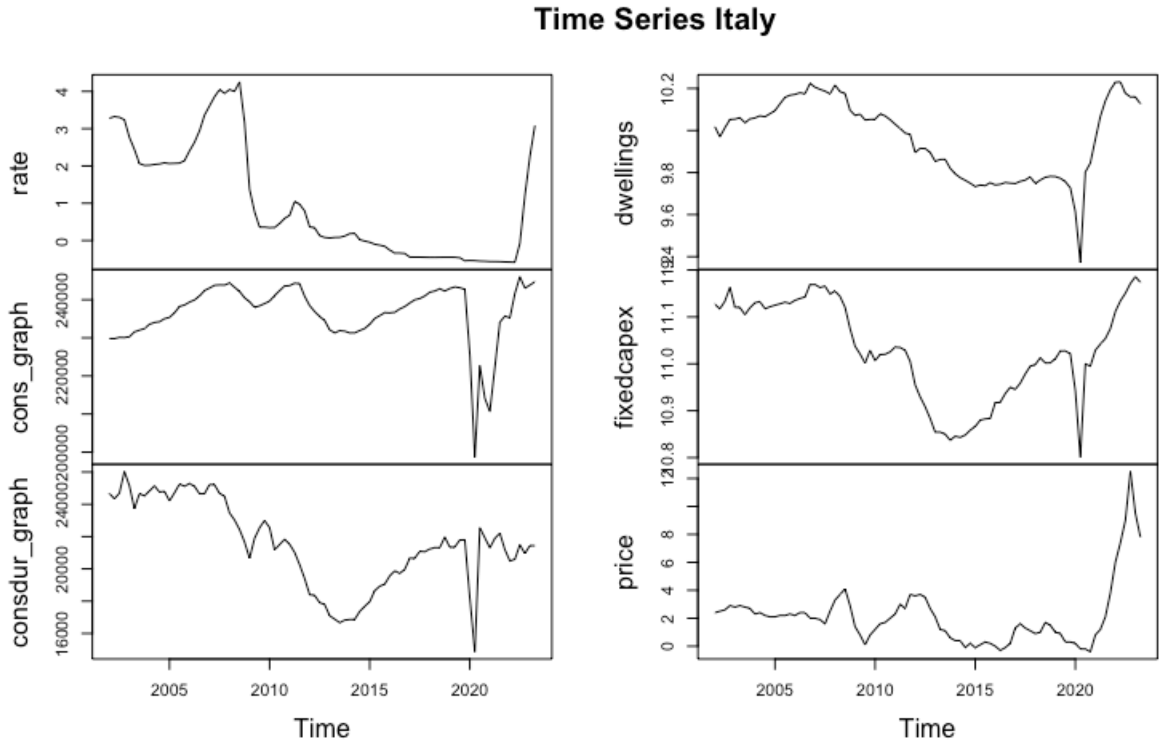

Figure 33: Illustration of the time series of Italy (Source: Eurostat, ECB)

In the figure above (figure 33), we see the time series for the overnight rate in the eurozone, consumption expenditure ex durables, durable goods consumption expenditure, dwellings, fixed gross capital formation (ex dwellings) and the HICP rate for Italy in the period from Q1 2002 to Q2 2023. The time series for the overnight rate again clearly shows the initially sharp interest rate cuts during the 2008/2009 financial crisis and the sharp interest rate hikes triggered by the high inflation rates following the coronavirus pandemic. The time series for consumption expenditure ex durables, dwellings and fixed cross capital formation (ex dwellings) show that all three started from a very high level, while dwellings and fixed cross capital formation (ex dwellings) have also seen a sharp decline since the financial crisis, while consumption expenditure ex durables has remained stable. The decline during the coronavirus pandemic can also be seen in all three variables. A similar picture as for dwellings and fixed cross capital formation (ex dwellings) can also be seen for durables goods consumption expenditure.

The time series were then tested for unit roots using adf-tests. First, an adf-test with trend and constant was tested. If the null hypothesis of the unit root cannot be refuted, attention is paid to whether the null hypothesis regarding the trend can be refuted or not. If this is not possible, this is also tested for the constant. If the null hypothesis cannot be refuted here either, the variable is differentiated and tested to see whether a unit root is still present or not.

The results for all variables are shown in the following table. The de-terministic terms describe whether or not the null hypotheses could be refuted for constant or trend. The critical values always refer to the test with regard to the unit root.

Variable	Deterministic terms	Lags	Test Value	Critical Values		
				1%	5%	10%
rate	none	1	-1.7908	-2.6	-1.95	-1.61
Δrate	none	1	-3.8184	-2.6	-1.95	-1.61
cons	constant	1	-2.9985	-3.51	-2.89	-2.58
consdur	none	1	-0.2991	-2.6	-1.95	-1.61
Δconsdur	none	1	-9.6586	-2.6	-1.95	-1.61
dwellings	none	1	0.2569	-2.6	-1.95	-1.61
Δdwellings	none	1	-6.0648	-2.6	-1.95	-1.61
fixedcapex	none	1	0.1906	-2.6	-1.95	-1.61
Δfixedcapex	none	1	-8.1145	-2.6	-1.95	-1.61
price	none	1	-1.1231	-3.51	-2.89	-2.58
Δprice	none	1	-4.2626	-3.51	-2.89	-2.58

Table 11: ADF-test for all variables (Δ stands for differenced variable)

In the next step, the optimal lag order was determined using the information criteria mentioned above. The following optimal lag orders were determined:

	AIC(n)	HQ(n)	SC(n)	FPE(n)
Optimal lag order	8	8	1	8

Table 12: Optimal lag order selection for model

A VAR model with a lag order of 1 was then estimated and a SVAR model was estimated based on this. A B-model was selected, which was explained above. The B-matrix was modelled as above:

$$B = \begin{matrix} NA & 0 & 0 & 0 & 0 & 0 \\ NA & NA & 0 & 0 & 0 & 0 \\ NA & NA & NA & 0 & 0 & 0 \\ NA & 0 & 0 & NA & 0 & 0 \\ NA & 0 & 0 & 0 & NA & 0 \\ NA & NA & NA & NA & NA & NA \end{matrix}$$

In the figure below (figure 34), we now see the impulse response for variable "Rate" of the SVAR to a shock of the variable "Rate". The red dashed line shows the 95% confidence interval, which also allows us to make statements about the statistical significance of a shock. The variable "Rate" reacts to a shock of one standard deviation, which is 1 by construction, with a positive, significant reaction of 0.24 standard deviations. The effect of the shock remains positive and significant in the further course. From period 5 onwards, the influence of the shock is no longer statistically significantly different from 0.

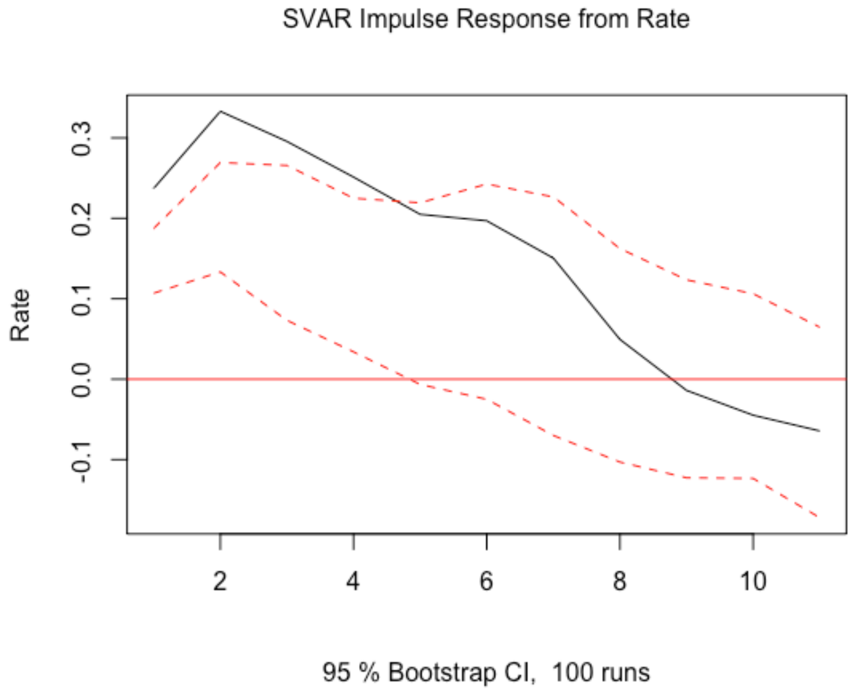

Figure 34: Impulse response of variable "Rate"

In the figure below (figure 35) we see the impulse response for variable "ConsEx" of the SVAR to a shock of the variable "Rate". The "ConsEx" variable reacts to a shock of one standard deviation, which is 1 by construction, with a response that does not deviate significantly from 0 in the 10 periods analysed.

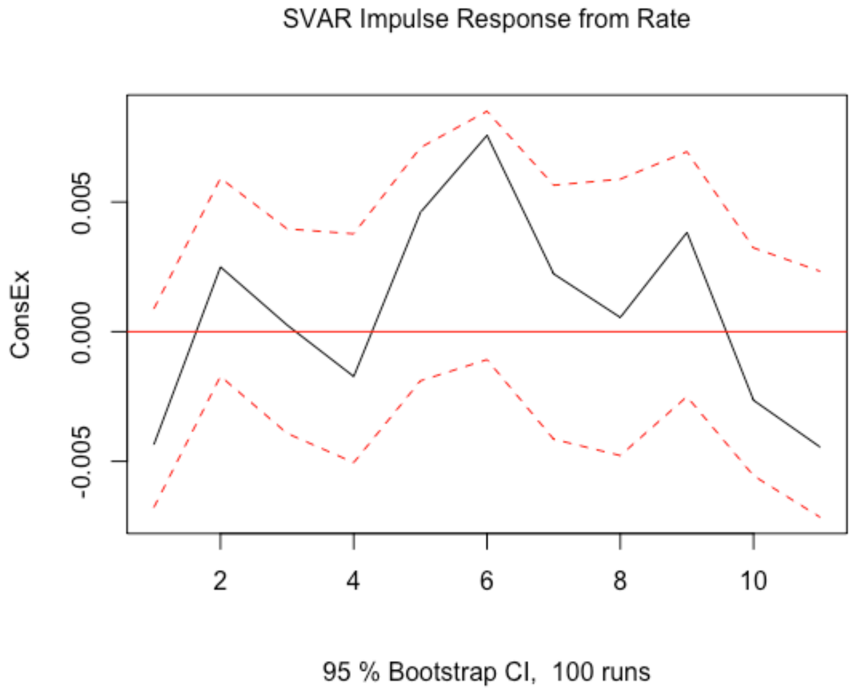

Figure 35: Impulse response of variable "ConsEx"

In the figure below (figure 36) we see the impulse response for variable "ConsDur" of the SVAR to a shock of the variable "Rate". The "ConsDur" variable reacts to a shock of one standard deviation, which is 1 by construction, with a response that does not deviate significantly from 0 in the 10 periods analysed.

Figure 36: Impulse response of variable "ConsDur"

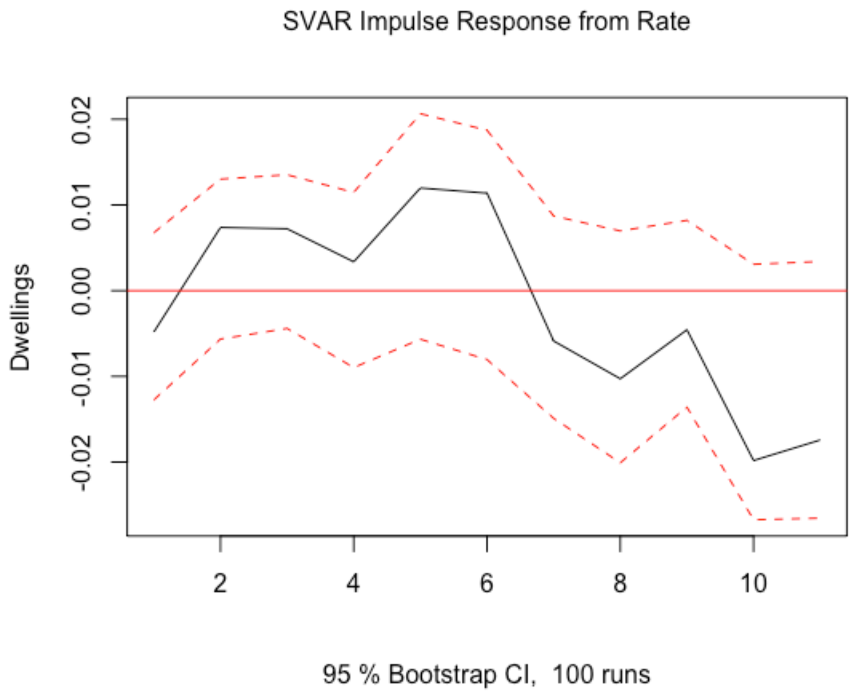

Figure 37: Impulse response of variable "Dwellings"

In the figure above (figure 37) we see the impulse response for the variable "Dwellings" of the SVAR to a shock of the variable "Rate". The "Dwellings" variable reacts to a shock of one standard deviation, which is 1 by construction, with a response that does not deviate significantly from 0 in the 10 periods analysed.

In the figure below (figure 38) we now see the impulse response for variable "Fixed-CapFormEx" of the SVAR to a shock of the variable "Rate". The variable Rate initially reacts to a shock of one standard deviation, which is 1 by construction, with a response that does not deviate significantly from 0. In periods 2 and 3, there is a positive and significant deviation from 0. In the following periods, the response is again not significantly different from 0.

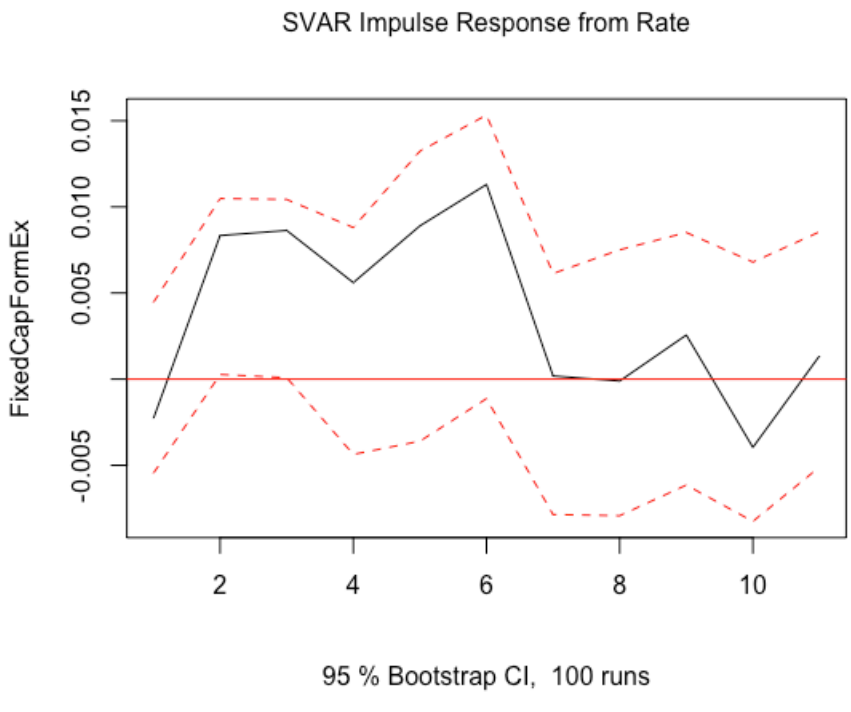

Figure 38: Impulse response of variable "FixedCapFormEx"

In the figure below (figure 39), we finally see the impulse response for the variable "Inflation" of the SVAR to a shock of the variable "Rate". The rate variable responds to a shock of one standard deviation, which is 1 by construction, with a positive, significant response of 0.23 standard deviations. Up to period 10, the influence of the shock is no longer statistically significantly different from 0.

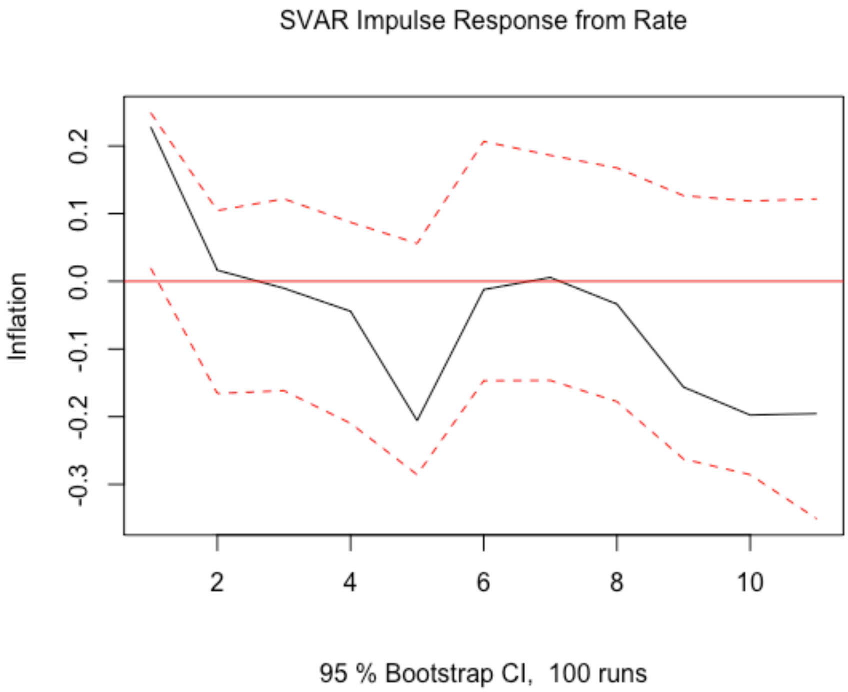

Figure 39: Impulse response of variable "Inflation"

3.5. Spain

In this section, the data for Spain is presented, illustrated, and statistically analysed. A VAR model/SVAR model is also estimated, and the impulse responses are analysed.

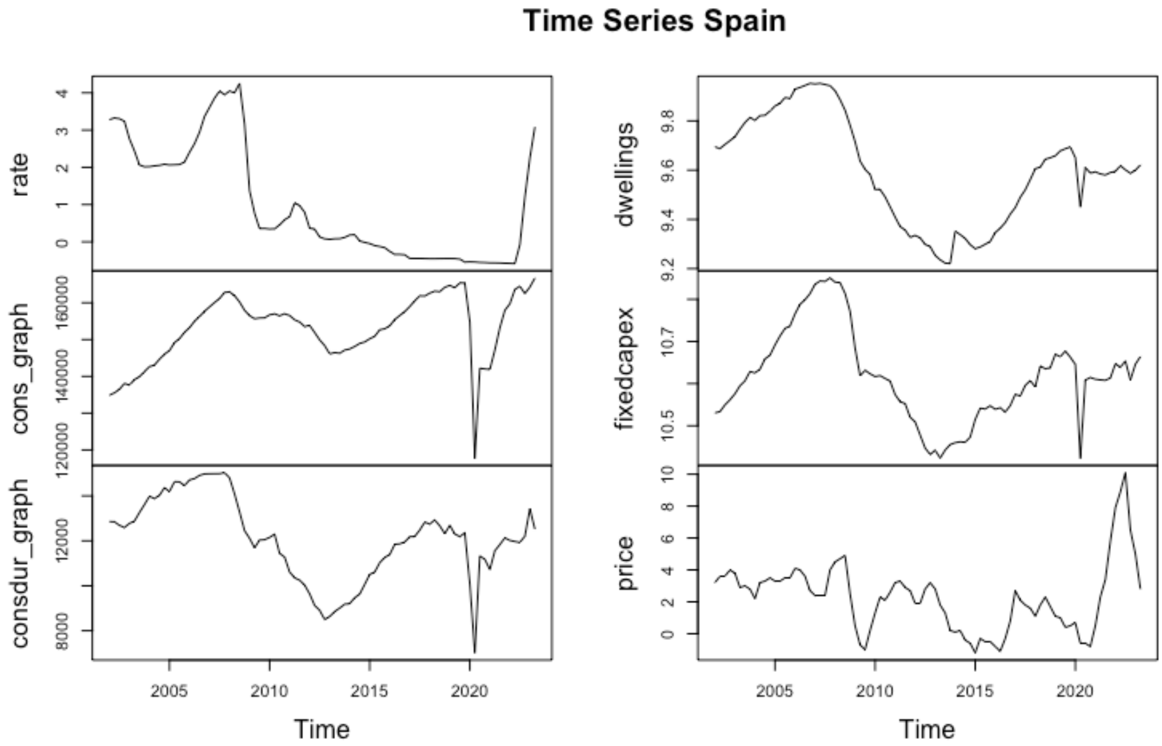

Figure 40: Illustration of the time series of Spain (Source: Eurostat, ECB)

In the figure above (figure 40), we see the time series for the overnight rate in the eurozone, consumption expenditure ex durables, durable goods consumption expenditure, dwellings, fixed gross capital formation (ex dwellings) and the HICP rate for Spain in the period from Q1 2002 to Q2 2023. The time series for the overnight rate again clearly shows the initial sharp interest rate cuts in the context of the 2008/2009 financial crisis and the sharp interest rate hikes triggered by the high inflation rates following the coronavirus pandemic. The time series for consumption expenditure ex durables, durable goods consumption expenditure, dwellings and fixed cross capital formation (ex dwellings) all show the start from a very high level or the very sharp rise before the financial crisis, while durables goods consumption expenditure, durables dwellings and fixed cross capital formation (ex dwellings) also show the sharp decline since the financial crisis. The decline during the coronavirus pandemic can also be seen for three variables.

The time series were then tested for unit roots using adf-tests. First, an adf-test with trend and constant was tested. If the null hypothesis of the unit root cannot be refuted, attention is paid to whether the null hypothesis regarding the trend can be refuted or not. If this is not possible, this is also tested for the constant. If the null hypothesis cannot be refuted here either, the variable is differentiated and tested to see whether a unit root is still present or not.

The results for all variables are shown in the following table. The deterministic terms describe whether or not the null hypotheses could be refuted for constant or trend. The critical values always refer to the test with regard to the unit root.

Variable	Deterministic terms	Lags	Test Value	Critical Values		
				1%	5%	10%
rate	none	1	-1.7908	-2.6	-1.95	-1.61
Δrate	none	1	-3.8184	-2.6	-1.95	-1.61
cons	none	1	-0.7142	-2.6	-1.95	-1.61
Δcons	none	1	-7.9402	-2.6	-1.95	-1.61
consdur	none	1	-0.0561	-2.6	-1.95	-1.61
Δconsdur	none	1	-8.8458	-2.6	-1.95	-1.61
dwellings	none	1	-0.1788	-2.6	-1.95	-1.61
Δdwellings	none	1	-4.8596	-2.6	-1.95	-1.61
fixedcapex	none	1	0.4133	-2.6	-1.95	-1.61
Δfixedcapex	none	1	-7.9402	-2.6	-1.95	-1.61
price	constant, trend	1	-3.68	-4.04	-3.45	-3.15

Table 13: ADF-test for all variables (Δ stands for differenced variable)

In the next step, the optimal lag order was determined using the information criteria mentioned above. The following optimal lag orders were determined:

	AIC(n)	HQ(n)	SC(n)	FPE(n)
Optimal lag order	8	2	1	5

Table 14: Optimal lag order selection for model

A VAR model with a lag order of 1 was then estimated and a SVAR model was estimated based on this. A B-model was selected, which was explained above. The B-matrix was modelled as above:

$$B = \begin{matrix} NA & 0 & 0 & 0 & 0 & 0 \\ NA & NA & 0 & 0 & 0 & 0 \\ NA & NA & NA & 0 & 0 & 0 \\ NA & 0 & 0 & NA & 0 & 0 \\ NA & 0 & 0 & 0 & NA & 0 \\ NA & NA & NA & NA & NA & NA \end{matrix}$$

In the figure below (figure 41), we now see the impulse response for variable "Rate" of the SVAR to a shock of the variable "Rate". The red dashed line shows the 95% confidence interval, which also allows us to make statements about the statistical significance of a shock. The variable "Rate" reacts to a shock of one standard deviation, which is 1 by construction, with a positive, significant reaction of 0.24 standard deviations. The effect of the shock remains positive and significant in the further course. From period 6 onwards, the influence of the shock is no longer statistically significantly different from 0.

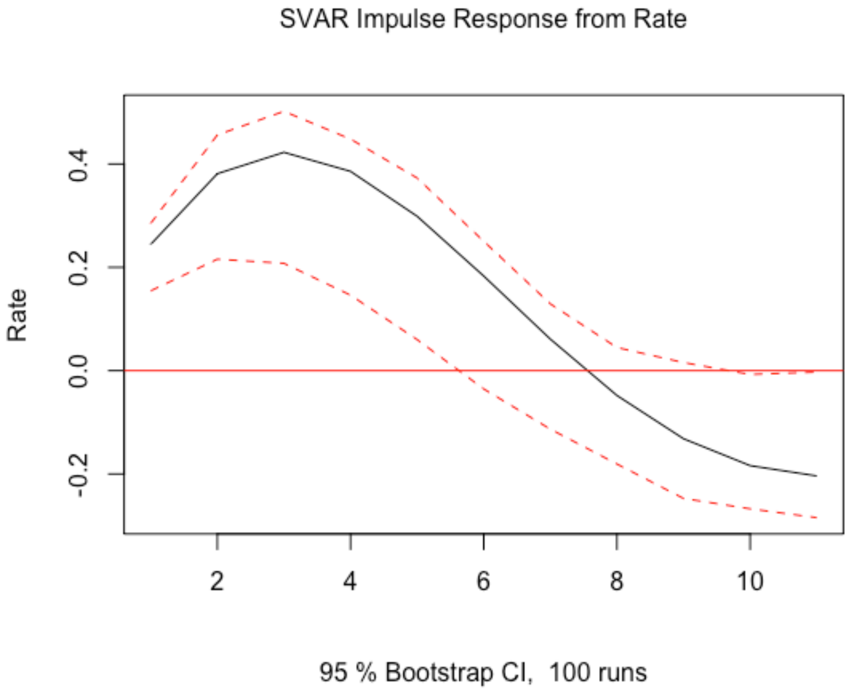

Figure 41: Impulse response of variable "Rate"

In the figure below (figure 42) we see the impulse response for variable "ConsEx" of the SVAR to a shock of the variable "Rate". The "ConsEx" variable reacts to a shock of one standard deviation, which is 1 by construction, with a response that does not deviate significantly from 0 in the 10 periods analysed.

Figure 42: Impulse response of variable "ConsEx"

In the figure below (figure 43) we see the impulse response for variable "ConsDur" of the SVAR to a shock of the variable "Rate". In response to a shock of one standard deviation, which is 1 by construction, the "ConsDur" variable initially reacts with a response that does not deviate significantly from 0. In period 9, there is a negative, significant reaction to the shock.

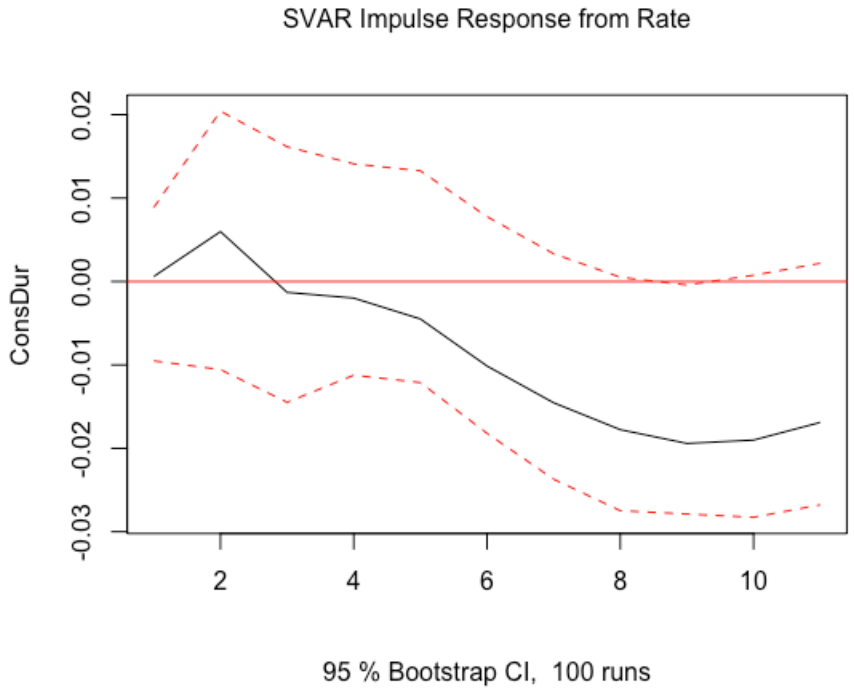

Figure 43: Impulse response of variable "ConsDur"

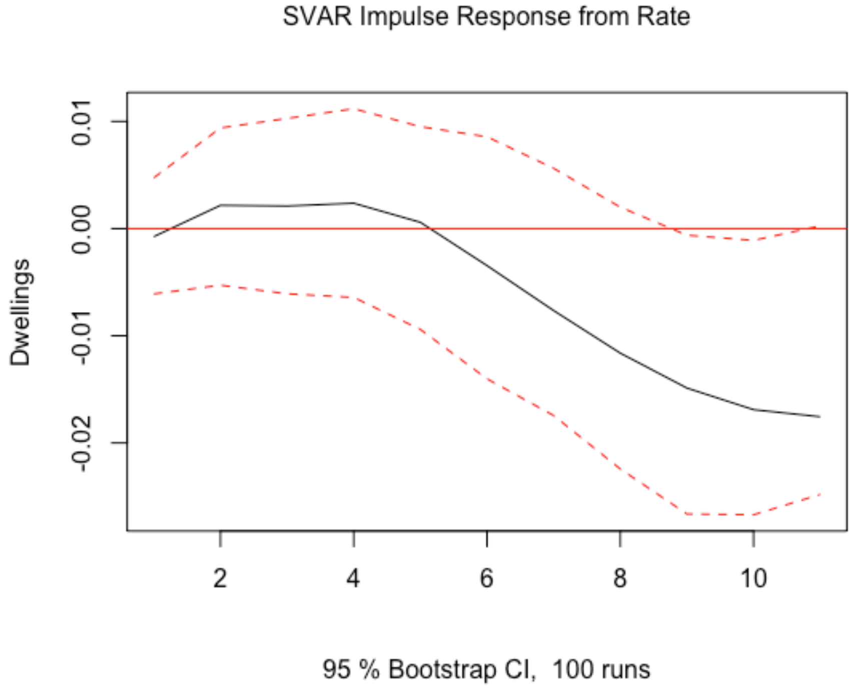

Figure 44: Impulse response of variable "Dwellings"

In the figure above (figure 44) we see the impulse response for variable "Dwellings" of the SVAR to a shock of the variable "Rate". The "Dwellings" variable initially reacts to a shock of one standard deviation, which is 1 by construction, with a response that does not deviate significantly from 0. This remains the case until period 9. In periods 9 and 10, the effect is then negative and significant.

In the figure below (figure 45), we now see the impulse response for variable "FixedCapFormEx" of the SVAR to a shock of the variable "Rate". The variable "FixedCapFormEx" initially reacts to a shock of one standard deviation, which is 1 by construction, with a response that does not deviate significantly from 0. In period 2 there is then a positive and significant reaction. Up to period 8, the effect is again not significant. From period 8 to 10, the effect is negative and significant.

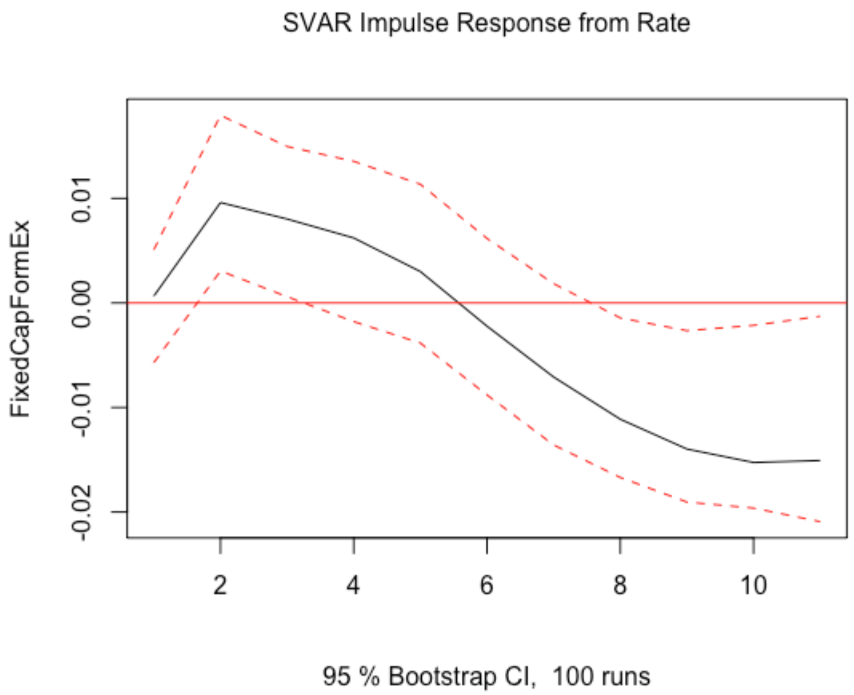

Figure 45: Impulse response of variable "FixedCapFormEx"

In the figure below (figure 46), we finally see the impulse response for the variable "Inflation" of the SVAR to a shock of the variable "Rate". In response to a shock of one standard deviation, which is 1 by construction, the "Inflation" variable reacts with a response that does not deviate significantly from 0 in the 10 periods analysed.

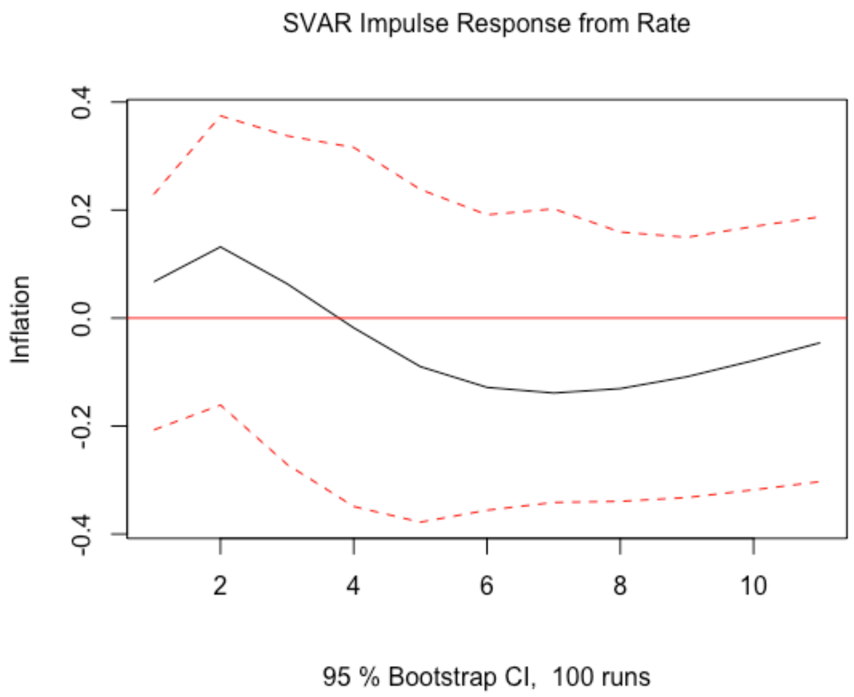

Figure 46: Impulse response of variable "Inflation"

4. Conclusion

The introduction of the euro in the form of cash and thus as a means of payment on 1 January 2002 brought not only the end of the schilling in Austria (as well as many other currencies in Europe), but also the abandonment of a piece of political autonomy, as in future it would no longer be the Austrian National Bank (OeNB) but the European Central Bank (ECB) that would make monetary policy decisions for the so-called "euro area".

In these now more than 20 years as cash (and 25 years as book money), the euro has experienced turbulent times and has survived several crises of varying nature (financial crisis, debt crisis, corona crisis). The ECB was forced to use its entire range of monetary policy instruments and not only to cut interest rates sharply in some cases (financial crisis and then even more in the context of the debt/euro crisis), but also to intervene extraordinarily strongly in the financial markets (various bond-buying programmes, various support measures for financial institutions). Alongside criticism and ridicule of the ECB, there was also serious praise for the realisation of the idea of a single currency on the European continent.

To keep inflation around 2% (symmetric target) the ECB relies on several monetary policy tools. The primary policy tool of interest is the set of rates. These three rates are the main refinancing rate, the marginal lending facility rate, and the deposit facility rate. According to the ECB, the monetary policy decisions affect the economy in various ways (see figure). However, because the mechanism is characterised by so-called time lags, the precise effects are difficult to predict. One of the many channels is the so-called interest-rate channel, in which rising/falling interest rates are intended to influence consumption and/or investment decisions.

The paper therefore attempted to answer the following question: "Can the ECB use the interest rate to influence real, macroeconomic variables such as consumption or investment in selected eurozone countries (Austria, Germany, France, Italy, Spain)?". This question is answered with the help of a VAR model/SVAR model and an impulse response analysis. Particular attention is paid to the response of the variables, which is triggered by a shock of the interest rates.

At the beginning, the individual variables and their time series were presented and analysed. Based on this, the time series were tested for unit roots using the adf-test. It was found that some time series have unit roots and are therefore integrated of order one. VAR-models and SVAR-models were then created and an impulse response analysis carried out. All the variables mentioned and presented (Overnight rate, Real consumption expenditures excluding durable goods, Real durable goods consumption expenditure, Dwellings expenditure, Fixed capital goods formation expenditure excluding dwellings, Inflation) are used in the models. The variables are called "Rate", "ConsExDur", "ConsDur", "Dwellings", "FixedCapFormEx" and "Inflation" respectively.

In the case of Austria, it was found that there are significant effects on a shock of the variable "Rate" for the variables "Rate", "ConsEx", "Dwellings" and "Inflation", while there are no significant effects for the variables "ConsDur" and "FixedCapFormEx". In the case of Germany, it was found that there are significant effects on a shock of the variable "Rate" for the variables "Rate", "Dwellings" and "Inflation", while there are no significant effects for the variables "ConsEx", "ConsDur" and "FixedCapFormEx". In the case of France, it was found that there are significant effects on a shock of the variable "Rate" for the variables "Rate", "Dwellings" and "FixedCapFormEx", while there are no significant effects for the variables "ConsEx", "ConsDur" and "Inflation". In the case of Italy, the variables "Rate", "FixedCapFormEx" and "Inflation" were found to have significant effects on a shock to the variable "Ra-te", while the variables "ConsEx", "ConsDur" and "Dwellings" were found to have no significant effects. In the case of Spain, it was found that there are significant effects for the variables "Rate", "ConsDur", "Dwellings" and "FixedCapFormEx" on a shock of the variable "Rate", while there are no significant effects for the variables "ConsEx" and "Inflation".

In conclusion, I am able to disprove the hypothesis that the interest-rate channel has no effect for all the countries in question. How exactly the transmission channel works is the subject of further research. Analysing it with other methods, such as Bayesian techniques or structural vector error correction models, is also a starting point.

Bibliography

Altavilla, C., Brugnolini, L., Gürkaynak, R. S., Motto, R., & Ragusa, G. (2019). Measuring euro area monetary policy. *Journal of Monetary Economics*, *108*, 162–179. www.doi.org/10.1016/j.jmoneco.2019.08.016

Altavilla, C., Carboni, G., & Motto, R. (2021). Asset Purchase Programs and Financial Markets: Lessons from the Euro Area. *International Journal of Central Banking*, *17*(4), 1–48.

Angeloni, I., Kashyap, A., & Mojon, B. (2003). Introduction. In I. Angeloni, A. Kashyap, & B. Mojon (Eds.), *Monetary Policy Transmission in the Euro Area: A Study by the Eurosystem Monetary Transmission Network* (pp. 1-12). Cambridge: Cambridge University Press. doi: 10.1017/CBO9780511492372.002

Arias, J. E., Caldara, D., & Rubio-Ramírez, J. F. (2019). The systematic component of monetary policy in SVARs: An agnostic identification procedure. *Journal of Monetary Economics*, *101*, 1–13. www.doi.org/10.1016/j.jmoneco.2018.07.011

Bagliano, F. C., & Favero, C. A. (1998). Measuring monetary policy with VAR models: An evaluation. *European Economic Review*, *42*(6), 1069–1112. www.doi.org/10.1016/S0014-2921(98)00005-1

Barran, F., Coudert, V. & Mojon, B. (1996). The Transmission of Monetary Policy in the European Countries. Centre d'Etudes Prospectives et D'Informations Internationales, Working Paper No. 96-03.

Benecká, S., Fadejeva, L., & Feldkircher, M. (2020). The impact of euro Area monetary policy on Central and Eastern Europe. Journal of Policy Modeling, 42(6), 1310–1333. www.doi.org/10.1016/j.jpolmod.2020.05.004

Bernanke, B. S. (1986). *Alternative Explanations of the Money-Income Correlation*. Cambridge, Mass.: National Bureau of Economic Research.

Bernanke, B. S., & Blinder, A. S. (1992). The Federal Funds Rate and the Channels of Monetary Transmission. *The American Economic Review*, *82*(4), 901–921.

Bernanke, B. S., & Gertler, M. (1995). Inside the Black Box: The Credit Channel of Monetary Policy Transmission. *The Journal of Economic Perspectives*, *9*(4), 27–48. https://doi.org10.1257/jep.9.4.27

Bernanke, B. S., & Mihov, I. (1998). Measuring Monetary Policy. *The Quarterly Journal of Economics*, *113*(3), 869–902. www.doi.org10.1162/003355398555775

Boivin, J., Kiley, M. T., & Mishkin, F. S. (2010). How has the Monetary Transmission Mechanism Evolved Over Time? Finance and Economics Discussion Series, 2010(26), 1–88. https://doi.org/10.17016/FEDS.2010.26

Blanchard, O. (2017). *Macroeconomics* (7th edition, global edition). London: Pearson

Blanchard, O. J., & Watson, M. W. (1986). Are Business Cycles All Alike? In *The American Business Cycle,* (Vol. 25, pp. 123–180). Chicago: University of Chicago Press. www.doi.org10.7208/9780226304595-005

Burriel, P., & Galesi, A. (2018). Uncovering the heterogeneous effects of ECB unconventional monetary policies across euro area countries. *European Economic Review*, *101*, 210–229. www.doi.org/10.1016/j.euroecorev.2017.10.007

Ciccarelli, M., Maddaloni, A., Peydró, J.-L., & Monacelli, T. (2013). Heterogeneous transmission mechanism: monetary policy and financial fragility in the eurozone. *Economic Policy*, *28*(75), 459–512. www.doi.org/10.1111/1468-0327.12015

Clarida, R., Gertler, M. (1996). *How the Bundesbank Conducts Monetary Policy*. Cambridge, Mass.: National Bureau of Economic Research.

Decker, F. (2022, 2. Dezember). Etappen der Parteigeschichte der AfD. [Bundeszentrale für politische Bildung]. Retreived from https://www.bpb.de/themen/parteien/parteien-in-deutschland/afd/273130/etappen-der-parteigeschichte-der-afd/#node-content-title-0

Deutsche Bundesbank (2023). Heterogene Wirkungen der Geldpolitik im Euroraum?. *Monatsbericht September 2023, 75(9)*, 37-61.

Donohoe, P., Lagarde, C., Metsola, R., Michel, C. & von der Leyen, U. (2023, 30. Dezember). 25 Jahre Euro: Der Wert der Einheit. [Der Standard]. Retreived from https://www.derstandard.at/story/3000000201348/25-jahre-euro-der-wert-der-einheit

Evans, C., Christiano, L., & Eichenbaum, M. S. (1994). The Effects of Monetary Policy Shocks: Some Evidence from the Flow of Funds. NBER Working Paper Series, 4699. https://doi.org/10.3386/w4699

Evans, C., Christiano, L., & Eichenbaum, M. S. (1998). Monetary Policy Shocks: What Have We Learned and to What End? NBER Working Paper Series, 6400. https://doi.org/10.3386/w6400

Friedman, B. M., & Kuttner, K. N. (1992). Money, Income, Prices, and Interest Rates. *The American Economic Review*, *82*(3), 472–492.

Gerlach, S., Smets, F.(1995) "The monetary transmission mechanism: evidence for the G-7 countries", in: BIS (1995), in: BIS (1995), pp. 154-187.

Hahn, A. (2021, 31. Dezember). Aus D-Mark und Schilling wurde der schwache Euro. [Der Standard]. Retreived from https://www.derstandard.at/story/2000132243677/aus-d-mark-und-schilling-wurde-der-schwache-euro

Keynes, J. M. (2015). The General Theory of Employment, Interest and Money (4th edition). In Robinson, A. & Moggridge, D. (Eds.), The Collected Writings of John Maynard Keynes: VII. Cambridge: Cambridge University Press

Kuttner, K. N., & Mosser, P. C. (2002). The monetary transmission mechanism: some answers and further questions. (Overview). Economic Policy Review - Federal Reserve Bank of New York, 8(1), 15.

Leeper, E. M., Sims, C. A., Zha, T., Hall, R. E., & Bernanke, B. S. (1996). What Does Monetary Policy Do? *Brookings Papers on Economic Activity*, *1996*(2), 1–78. www.doi.org/10.2307/2534619

Lütkepohl, L. (2007). *New Introduction to Multiple Time Series Analysis* (2nd edition). Springer: Berlin Heidelberg

Mandler, M., & Scharnagl, M. (2023). The effects of shocks to interest rate expectations in the euro area: Estimates at the country level. *Journal of Forecasting*, *42*(3), 643–656. www.doi.org/10.1002/for.2943

Mandler, M., Scharnagl, M., & Volz, U. (2022). Heterogeneity in Euro Area Monetary Policy Transmission: Results from a Large Multicountry BVAR Model. *Journal of Money, Credit and Banking*, *54*(2-3), 627–649. www.doi.org/10.1111/jmcb.12859

Mishkin, F. (2016). *The economics of money, banking, and financial markets* (11. ed., global ed.). London: Pearson.

Mojon, B., & Peersman, G. (2003). A VAR description of the effects of monetary policy in the individual countries of the euro area. In I. Angeloni, A. Kashyap, & B. Mojon (Eds.), *Monetary Policy Transmission in the Euro Area: A Study by the Eurosystem Monetary Transmission Network* (pp. 56-74). Cambridge: Cambridge University Press. doi:10.1017/CBO9780511492372.005

Monticelli, C. & Tristani, O.(1999), What does the single monetary policy do? A SVAR benchmark for the European Central Bank, ECB Working Paper 2

Peersman, G., & Smets, F. (2003). The monetary transmission mechanism in the euro area: Evidence from VAR analysis. In I. Angeloni, A. Kashyap, & B. Mojon (Eds.), *Monetary Policy Transmission in the Euro Area: A Study by the Eurosystem*

Monetary Transmission Network (pp. 36-55). Cambridge: Cambridge University Press. doi:10.1017/CBO9780511492372.004

Pfluger, B. (2010, 29. Dezember). „Gewisse Nostalgie nach der Euro-Einführung“. [Der Standard]. Retreived from https://www.derstandard.at/story/1293369697281/schweizer-oekonom-gewisse-nostalgie-nach-der-euro-einfuehrung

Sims, C. A. (1980). Macroeconomics and Reality. *Econometrica*, 48(1), 1–48. www.doi.org10.2307/1912017

Sims, C. (1986). Are Forecasting Models Usable for Policy Analysis? Quarterly Review - Federal Reserve Bank of Minneapolis, 10(1), 2. www.doi.org/10.21034/qr.1011

Sims, C. A. (1992) : "Interpreting the macroeconomic time series facts. The effects of monetary policy", *European Economic Review* n°36, pp 975-1011

Smets, F.(1995) “Central bank macroeconometric models and the monetary policy transmission mechanism”, in: BIS (1995), in: BIS (1995), pp. 154-187.

Staudacher, A. (2011, 27. Dezember). Warum der Euro kein „Teuro“ ist. [Kurier]. Retreived from https://kurier.at/wirtschaft/warum-der-euro-kein-teuro-ist/753.272

Strongin, S. (1995). The identification of monetary policy disturbances explaining the liquidity puzzle. *Journal of Monetary Economics*, *35*(3), 463–497. www.doi.org/10.1016/0304-3932(95)01197-V

Taylor, J. B. (1995). The Monetary Transmission Mechanism: An Empirical Framework. *The Journal of Economic Perspectives*, *9*(4), 11–26. https://doi.org/10.1257/jep.9.4.11

Tsatsaronis, C. (1995) “Is there a credit channel in the transmission of monetary policy? Evidence from four countries”, in: BIS (1995), pp. 154-187.

Uhlig, H. (2005). What are the effects of monetary policy on output? Results from an agnostic identification procedure. *Journal of Monetary Economics*, *52*(2), 381–419. www.doi.org/10.1016/j.jmoneco.2004.05.007

Verbeek, M. (2017). *A Guide to Modern Econometrics* (5th edition). Weinheim: Wiley-VCH

Appendix: Data and manipulation

Data

Final consumption expenditures of households [current prices] (Eurostat):
https://ec.europa.eu/eurostat/databrowser/view/namq_10_fcs__custom_8016705/default/table

Final consumption expenditures of households, durable goods [current prices] (Eurostat):
https://ec.europa.eu/eurostat/databrowser/view/namq_10_fcs__custom_8016705/default/table

Final consumption expenditures of households [price index] (Eurostat):
https://ec.europa.eu/eurostat/databrowser/view/namq_10_gdp__custom_8016675/default/table

Total fixed assets [current prices] (Eurostat):
https://ec.europa.eu/eurostat/databrowser/view/namq_10_an6__custom_8016825/default/table

Total fixed assets [price index] (Eurostat):
https://ec.europa.eu/eurostat/databrowser/view/namq_10_an6__custom_8016825/default/table

Dwellings [current prices] (Eurostat):
https://ec.europa.eu/eurostat/databrowser/view/namq_10_an6__custom_8016825/default/table

Dwellings [price index] (Eurostat):
https://ec.europa.eu/eurostat/databrowser/view/namq_10_an6__custom_8016825/default/table

HICP – Overall index Austria (ECB):

HICP Overall index - Austria

HICP – Overall index Germany (ECB):

HICP Overall index - Germany

HICP – Overall index France (ECB):

HICP Overall index - France

HICP – Overall index Italy (ECB):

HICP Overall index - Italy

HICP – Overall index Spain (ECB):

HICP Overall index - Spain

Eonia rate (ECB):

Eonia rate

Pre Euro short term rate (ECB):

Pre-Euro short term rate

Euro short term rate (ECB):

Euro short term rate

Calculation of real GDP components

For every component of GDP, the following calculation was applied:

$$realGDP = \frac{nominalGDP}{deflatorGDP} \times 100$$