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1 Introduction

In this thesis, the German Phillips curve is tested and compared to similar data in the United States, while using inflation expectations of households. The standard expectation-augmented Phillips curve is the forward-looking New Keynesian Phillips Curve (NKPC). Thereby, the micro-founded model is derived from the optimization problem of a monopolist subject to the price stickiness following Calvo (1983). Additionally, it is assumed that the monopolist has full-information rational expectations (FIRE) on future inflation. Further, it is important to emphasize that inflation expectations are formed for the next period in the theoretical model (i.e., the following month or quarter).

The rise in availability of micro-founded data allowed a comparison of FIRE with the real-time inflation expectations of various economic agents (i.e., central bankers, economists, and households). Thereby, the usage of survey-based inflation expectations of these agents implies the assumption of non-rational expectations in the NKPC. Initially, macroeconomists were not convinced of the usefulness of survey-based data, arguing that the assumption of FIRE cannot be tested and that surveys cannot describe the behavior of individuals.[1] This opinion largely changed once the empirical evaluation of FIRE started. Fuhrer (2012) suggests that survey-based inflation expectations play a more significant role in the empirical Phillips curve (PC) than rational expectations. Therefore, it can be concluded that FIRE is too strict of an assumption for economic agents due to the systematic deviations of survey expectations.

Consequently, the empirical literature moved away from implementing FIRE as a strict assumption towards the non-rational expectations as Coibion et al. (2018) explain. After the debate ended in favor of survey-based inflation expectations, a large part of the literature concentrates on finding the right proxy variable for firms' inflation expectations for the next period. It is important to consider that there are two shortcomings with survey-based measures. Firstly, there is no historic survey on firms' expectations available which is the reason why surveys of other economic agents are used. Secondly, the inflation expectations of the economic agents are surveyed for one-year ahead instead of for the next period as in the theoretical NKPC.

The discussion of the measurement of inflation expectations is important because a large empirical literature has emerged about testing various specifications of the PC by changing the used variables for economic slack and inflation expectations. One central finding is that

[1] Coibion et al. (2018) aptly describe the literature concerning this discussion.

the relationship between real and nominal variables flattened out in the 1980s and mid-1990s and has proceeded to be flat since then (Blanchard, 2016). Another finding is the missing disinflation puzzle, emerging in advanced economies during the financial crisis, which is elaborated by the International Monetary Fund (IMF) (2013). Despite the constant inflation since 2007, the theory suggests a sharp decline in the price level, given the high unemployment rate. Blanchard (2016) and IMF (2013) use one-year ahead inflation expectations of professionals for their PC specification.

The observed puzzle led to the discussion of several explanations for this phenomenon as IMF (2013) states. One opinion on what the missing disinflation could explain is an increased credibility of central banks, which anchored inflation expectations at the two percent target as it is observed since the beginning of the 2000s. Another explanation for the inflation puzzle is related to a structural change in unemployment during the financial crisis. Thereby, the share of long-term unemployment increased, which has a smaller impact on the price level compared to short-term unemployment. Thus, the effect of economic slack measured by unemployment, which includes both short-term and long-term unemployment, became smaller due to the increased share of long-term unemployment. This mechanism is proposed to explain the observed missing disinflation. The third explanation is the considerably flatter PC as observed in Blanchard (2016). Therefore, the relationship between inflation and economic slack has weakened, which explains the missing disinflation.

However, no proposed explanation challenges the nature of the survey-based inflation expectations measures so far. Survey-based measures by professional forecasters or central bankers have been used as a standard proxy for purely forward-looking expectations until recently. Coibion and Gorodnichenko (2015) started to question this practice by arguing that the households' inflation expectations[2] approximate firms' expectations better, compared to the expectations of professional forecasters. The authors' main argument is that most firms are small or medium sized and do not hire any professional forecasters like large corporate firms.[3] Consequently, firms' expectations cannot be fitted appropriately with professional forecasters' expectations.

The introduction of survey-based inflation expectations for households promises important results for the PC in Germany. In doing so, the first research question examines how to derive a measure for German households' inflation expectations from the qualitative EC consumer

[2] Households' and consumers' inflation expectations are used as synonyms in the following.
[3] The arguments made by Coibion and Gorodnichenko (2015) are discussed in more detail in the Discussion section.

survey. The next step concludes on the question of whether the stability of the PC with households' expectations persists through the phase of missing disinflation in Germany. Additionally, these results are compared to the PC in the United States (U.S.). The final question is what the implications of the German empirical findings of this thesis are and how these results fit in the published literature.

In this thesis, the first task is to calculate an appropriate measure of consumers' inflation expectations from Question 6 of the EC consumer survey with the probability method. However, there is not only one way to compute quantitative inflation expectations of consumers, which is why four different inflation expectations with varying scaling factors are calculated. Further, the quality of these measures is assessed, and it is concluded that only one of the calculated measure of households' inflation expectations appears to be superior. Moreover, the stability of the German PC, using the measure of households' inflation expectations, reveals that the PC stopped existing after the financial crisis. In contrast, the PC in the U.S. shows stability throughout the whole period including the financial crisis. Thus, the question arises how the results from Germany fit into the research on households' expectations. The empirical results on households' inflation expectations in the U.S. and New Zealand suggest that they are comparable to firms' expectations due to the similar formation process. Therefore, it can be concluded that the measure of inflation expectations for Germany seems to be the problem, either because of the derivation methodology or because of the differences in the formation process on expectations between German firms and households.

The following thesis proceeds as follows to answer the research questions about the use of survey-based inflation expectations of consumers in the PC. First, a brief overview of the existing literature of the PC is given, using both professionals' and consumers' inflation expectations. Secondly, the EC consumer survey is presented and is accompanied by an explanation of the methodology to calculate the quantitative inflation expectations. This is followed by a summary of the empirical results in the U.S. by the paper of Coibion et al. (2018). Thereupon, the empirical results from Germany are presented and compared with those from the United States. This discussion focuses on whether the PC behaves similarly in Germany as in the U.S. and whether it still exists. In addition, the use of survey-based inflation expectations is discussed and it is assessed how the empirical results from Germany fit into the overall literature. Finally, the results of the thesis are summarized in the Conclusion and are accompanied by some policy implications.

2 Overview of Existing Literature

In the following subsections, a brief overview of the surveys of inflation expectations about professionals and consumers is given. After this, the existing literature on the PC of the U.S., the Euro zone and Germany is summarized. The presented authors use different kinds of model specifications and measures of inflation rate expectations, to test whether there exists a relationship between the change in price levels and economic slack.

2.1 Survey-Based Inflation Expectations

The U.S. have a great variety of survey-based quantitative measures for inflation expectations, as summarized in Coibion et al. (2018). In particular, the Regional Federal Reserve Banks and the survey research center at the Michigan university collect quantitative inflation expectations from professionals and consumers. The Michigan survey of consumers (MSC), for example, is the most frequently used when examining the inflation expectations of households in the United States. On the other hand, the Federal Reserve primarily measures the expectations of professionals, such as economists and central bankers.

In the Euro zone, a significant lack of available measures for inflation expectations rate is prevalent, restricting the research mainly on the Euro zone-level. There are two surveys interviewing economists and professionals about their future expectations on the change of the price level. The European Central Bank (ECB) releases a quarterly numeric survey of professional forecasters, which is available for the broad public but only estimates the expected inflation rate for the whole Euro zone (Ball and Mazumder, 2021). Another measure for survey-based professional expectations can be found in the Consensus Forecast on a quarterly basis, allowing to conduct research for the countries in the Eurozone (Vlekke et al., 2020). If it comes to test the suitability of survey-based households' inflation expectations, there is only the European Commission (EC) Business and consumer survey that provides access to qualitative data on national level consumers' expectations. The survey asks every month a representative number of households a qualitative question about their prospects on the inflation rate (Mestre, 2007). Further, the need of a numerical measure leads to the quantification of the surveys' data as it is done in this thesis.

2.2 United States

Most of the literature of the last twenty years on the PC has been orientated on proving its existence for both the EU and U.S. economies. Firstly, a weakening correlation between inflation and real economic activity has been observed since the 1980s (Blanchard, 2016).

Secondly, a missing disinflation phase is observed with the onset of the financial crisis in 2009 (IMF, 2013). The research on this topic is especially extensive in the U.S., due to a greater availability of survey-based measures of inflation expectations for consumers and professionals. Thus, this allowed the emergence of a broad literature testing a forward-looking expectation-augmented PC. In the following, two recent papers on this topic are presented.

The missing disinflation led to the search for alternative measurements of inflation expectations. Coibion and Gorodnichenko (2015) argue that explanations like anchored expectations, and structural changes on the labor market fail to explain the missing inflation. Therefore, the authors proposed the idea to use inflation expectations of households instead of professional forecasters. The main research question these authors examine is which of the survey-based measures approximate the expectations of firms better. Thus, they compare the usage of various proxy variables on firms' inflation expectations in the PC, like survey-based professionals, consumer beliefs and backwards-looking expectations. According to their findings, the expectations of households and firms show great similarities, while the inflation expectations of professionals seem to deviate. Coibion and Gorodnichenko (2015) successfully demonstrate that with the use of households' expectations the missing disinflation puzzle disappears. Therefore, households' inflation expectations seem to be superior to those of professionals.

Vlekke et al. (2020) test the PC, using professional forecasters and households' inflation expectations. Further, the authors compare their results with those of Coibion and Gorodnichenko (2015). The findings of Vlekke et al. (2020) observe a decline in the relationship between economic slack and inflation until the middle of the 1990s and the relationship increases from 2000 onwards until 2015. When this is compared to Coibion and Gorodnichenko (2015), the main difference is that Vlekke et al. (2020) already yield an increase of the slope in the beginning of the 2000s. Further, the rise of the slope of the PC is explained by the increase in households' inflation expectations in the papers Vlekke et al. (2020) and Coibion and Gorodnichenko (2015).

2.3 Euro area and Germany

In the Euro area, the relationship between the inflation rate and the economic slack holds as well, when the survey-based inflation expectations of professionals are used. Two recent papers assess the slope of the PC applying different approaches. Moretti et al. (2019) use two PC specifications, the first one is a simple PC and the second one aims to estimate a robust slope with the help of Dynamic Model Averaging. In both specifications, the inflation

expectations of professionals for the Euro zone are included, as well as market-based inflation forecasts. The authors prove the existence of the PC but point out that its represented relationship has decreased over time. Secondly, the paper of Ball and Mazumder (2021) focuses on the measurement of the survey of professional forecasters of the ECB. They examine the time period between 1999 and 2018 in order to test the disinflation puzzle occurring after the financial crisis. The application of the survey-based inflation expectations and the core inflation as dependent variable seems to diminish this puzzle. Hence, the PC exists and the missing disinflation puzzle disappears when survey-based inflation rate expectations of professionals are used.

The research of Coibion and Gorodnichenko (2015) was published recently and thus, empirical literature on the PC with survey-based inflation expectations for Germany is rare. Vlekke et al. (2020) examine a PC including inflation expectations of households and professionals for the German economy and four major European economies. Thus, the authors compare between the different survey-based measures for inflation expectations, allowing their explanatory power to be examined separately. Vlekke et al. (2020) investigate the often-stated declining relationship between the real activity of an economy and the inflation rate. The main conclusion of their work is a volatile and weak PC, which differs across the five largest economies in Europe. Another result of their study concerns the evaluation of the two different expectation measures of inflation. The authors conclude that households' inflation expectations have less explanatory power for the current inflation rate in comparison to the results from the United States and those dominate the expectations of professionals. Hence, they suggest that the survey-based households' measures of expectations are a less superior proxy for firms' expectations in Germany compared to the United States. Whether the inflation expectations are performing worse in the euro area, because of different assessment methods or institutional matters is not further discussed by Vlekke et al. (2020).

3 Econometric Framework

The research question of interest is to test whether survey-based one-year ahead households' inflation expectations can be used in Germany as a valid proxy variable for one-quarter ahead firms' inflation expectations in the NKPC. In order to answer this question, the empirical results of this thesis are compared with results from the U.S. presented in the paper of Coibion et al. (2018). Therefore, the simple Ordinary Least Square (OLS) regression of the authors in equation (1) is here utilized to generate comparable results for the PC with German data.

Equation (1) can be interpreted as follows: The measured quarter-on-quarter inflation rate of period t π_t is regressed on the one-year ahead inflation expectations $E_t[\pi_{t+1}]$ and on the unemployment rate UE_t as indicator of economic slack. While the error term is determined by ε_t.

$$\pi_t = \alpha + \beta * E_t[\pi_{t+1}] + \kappa * UE_t + \varepsilon_t \quad (1)$$

The inflation measure as a dependent variable is always subject of a discussion. Coibion et al. (2018) examine various common measures of inflation, such as headline inflation[4], core inflation[5], GDP deflator[6] and personal consumption expenditures. The result is that only the headline inflation yields a stable classical PC as in equation (1), excluding the application of the others. Hence, in the following empirical tests of the econometric framework, the headline inflation is used as the dependent variable.

One notable difference between the OLS regression of the paper by Coibion et al. (2018) and this thesis is the measure of economic slack. In the U.S., the Congressional Budget Office (CBO) calculates the natural rate of unemployment back for each quarter. Therefore, Coibion et al. (2018) can use the natural rate of unemployment to compute the unemployment gap for each time period (i.e., unemployment gap is the difference between the actual unemployment rate and the natural rate of unemployment). In Germany, the natural rate of unemployment is estimated for each year in the period between 1990 and 2012 (Organization for Economic Co-operation and Development, 2011). However, the natural rate of unemployment is needed for the period between 1985 and 2021. Instead of the unemployment gap, the unemployment rate for Germany is employed as the economic slack in the PC in this thesis.

The standard errors in the OLS regression of the time series are calculated using the Newey-West estimator, since the assumption of homoscedasticity is unlikely to hold. Thus, the utilization of the robust standard errors prevents the risk of calculating biased t-statistics, due to heteroscedasticity and autocorrelation in a time series. A biased t-statistic could lead to interpreting a coefficient as significant, even when the coefficient is insignificant once it is accounted for the biasedness. Therefore, this thesis uses Newey-West standard errors with five time period lags as the approach of Coibion et al. (2018) suggests.

[4] Headline inflation: CPI includes prices for food and energy
[5] Core Inflation: CPI excludes prices for food and energy
[6] GDP deflator: Ratio of nominal and real GDP

4 Data

4.1 Inflation Rate and Unemployment Rate

The data for the quarterly unemployment rate, quarter-on-quarter inflation rate and annual inflation rate on quarterly data are needed for the period between 1985 and 2021. FRED serves as the source for the variable and is publicly available. In the following, the variables and their characteristics are presented and explained.

The quarterly unemployment rate is measured as the average over the monthly registered unemployed relative to the labor force respective to the quartal it is belonging to (FRED, 2022a). This variable is already seasonally adjusted, does not require any further processing and can be used in the simple OLS, unlike the inflation rate.

The headline inflation rate is needed as the dependent variable of the PC and for calculating the inflation expectations of consumers for Germany. The first inflation rate is used in the regression as dependent variable in order to test the relationship between inflation rate and real economic activity (FRED, 2022b). Therefore, the quarter-on-quarter inflation rate in percent is calculated. The first step is to generate the quarterly consumer price index by taking the average of the monthly consumer price index (CPI) according to the quarter the month belongs.[7] Secondly, the percentage change of the quarterly CPI π_{t+1} is computed between each quarter and multiplied by 100. Equation (2) clarifies this last step with P_t being the quarterly consumer price index in period t.

$$\pi_{t+1} = \left(\frac{P_{t+1} - P_t}{P_t}\right) * 100 \quad (2)$$

The second inflation rate measure is needed as scaling factor[8] when inflation expectations are computed from the EC consumer survey. Thereby, the annual inflation rate is calculated based on the quarterly CPI for each quarter, while the computation is the same as explained in the previous paragraph (FRED, 2022b). To calculate the annual inflation rate for each quarter, equation (3) is used, and period t corresponds to one quarter (e.g., Quarter 1 in 2021). First, the difference between quarter t+4 (e.g., quarter 4 from 2020) and quarter t (e.g., quarter 4 from 2021) is taken and set relatively to the index from quarter t (e.g., quarter 4 from 2021). Finally, the inflation rate is multiplied by 100 to obtain the annual inflation rate in percent

[7] Quarter 1: January, February, March; Quarter 2: April, May, June; etc.
[8] Further explanation about the use of the inflation rate as scaling factor can be read in the subsection *Inflation Expectations of Consumers*.

π_{t+4}. The annual inflation rate calculated in this paragraph and used to calculate the inflation expectations is referred to as year-on-year inflation, actual inflation, or observed inflation.

$$\pi_{t+4} = \left(\frac{P_{t+4} - P_t}{P_t}\right) * 100 \quad (3)$$

Both measures of inflation rates are only seasonally unadjusted available. Therefore, the variables need to be seasonally adjusted, which is done with the method X13 provided in the r-package "JDemetra" developed by the National Bank of Belgium (Quartier-la-Tente et al., 2022).

4.2 Households' Inflation Expectations in Germany

The EC business and consumer survey observes the general economic position of consumers and businesses in the whole Euro zone for each month since the year 1985. The survey determines the opinion of respondents on a wide range of economically relevant topics (Mestre, 2007). In this thesis, one core challenge is to generate quantitative measures from the qualitative questions about inflation expectations and the perceived inflation of consumers as this is the single source of inflation expectations for households in the whole Euro zone (Mestre, 2007). Next to the qualitative questions, the European Commission started to evaluate quantitative measures of inflation expectations for the Euro zone and its member countries (Arioli et al., 2017). However, this data is still in an experimental phase and not available for the broad public, hence not a valuable source for this thesis (Arioli et al., 2017). Additionally, it has the major drawback that it only reaches back until the year 2003. At this point in time, households' expectations on inflation gained academic interest by including it as a measure for forward-looking inflation expectations (Arioli et al., 2017). The short time period for which this measure is available, makes it difficult for observing the long-term existence of the relationship between the inflation rate and real economic activity. Hence, it is necessary to derive the quantitative inflation expectations of households from the qualitative responses of the survey with the *probability method*, developed by Carlson and Parkin (1975). In the following, the necessary questions of the EC consumer survey for obtaining the one-year ahead inflation rate expectations are explained. After this, the section continues with the derivation of the inflation expectations of consumers, according to the *probability method* following the methodology of Mestre (2007) and Nielsen (2003).

In the next section, the two questions of interest are explained to introduce the data basis used to generate quantified inflation expectations in this thesis. Therefore, the questions in the EC

consumer survey are broadly discussed according to Mestre (2007). The first question is about the perceived inflation, evaluating how the consumer prices developed over the last 12 months according to the participating consumers (Q5)[9] (*Business and Consumer Survey Questionnaires United Kingdom Consumers*, 2016). The question has six different answer options: 1) risen a lot, 2) risen moderately, 3) risen slightly, 4) stayed about the same, 5) fallen and 6) don`t know.[10] It is important to define and understand the question well in order to make use of the *probability method*. Mestre (2007) specifies the backward-looking Q5 as a comparison between prices today and twelve months ago. Thereby, the second question is about the one-year ahead inflation expectations of consumers by asking the following question: "In comparison with the past 12 months, how do you expect consumer prices will develop in the next 12 months?" (Q6)[11] (*Business and Consumer Survey Questionnaires United Kingdom Consumers*, 2016). Again, it has six answer options: 1) Increase more rapidly, 2) Increase at the same rate, 3) Increase at a slower rate, 4) Stay about the same, 5) Fall and 6) Don't know. [12]

Before the *probability method* can be applied, the data has to be transformed in its correct form to generate quarterly inflation expectations. The EC consumer survey provides monthly data on qualitative inflation expectations and perceived inflation, as already explained. Thereby, the survey provides the monthly data as the percentage of the respondents which chose the response i (i.e., $i \in \{1, 2, 3, 4, 5, 6\}$) for each answer option. One important remark is that the *probability method* of Mestre (2007) only utilizes the first five responses since the last response does not inquire any substantial information. Therefore, response 6 of Q5 and Q6 is spread equally over the responses one to five as proposed by Mestre (2007). In order to test the PC, using households' inflation expectations, according to Coibion et al. (2018), quarterly data have to be generated. Therefore, the average over the monthly data is calculated respectively to the quarter the months belong to.[13] Once this transformation is done, the procedure of the *probability method* can be applied on the EC consumer survey to compute the quarterly inflation expectations of the consumers.[14]

[9] The question is the fifth question in the EC consumer questionnaire.
[10] Question 5 is available in the official survey of the EC Business and consumer survey. (*Business and Consumer Survey Questionnaires United Kingdom Consumers*, 2016)
[11] The question is the sixth question in the EC consumer questionnaire.
[12] Question 6 is available in the official survey of the EC Business and consumer survey. (*Business and Consumer Survey Questionnaires United Kingdom Consumers*, 2016)
[13] Quarter 1: January, February, March; Quarter 2: April, May, June; etc.
[14] There is to my knowledge no paper describing the methodology how to derive quarterly inflation expectation from the EC business and consumer survey.

First of all, to understand the *probability method* as described in Nielsen (2003) for Q5 and in Mestre (2007) for Q6, it is important to introduce the assumption on how the interviewed are responding to the questions. The authors assume that the respondents answer according to a certain distribution function. Individuals then match their expectation to one of the responses according to the quantiles of the distribution function (Mestre, 2007). These quantiles are the thresholds of the response options in the distribution function and are calculated with the percentages for each response (Mestre, 2007).

Nielsen (2003) empirically tests several possible distribution functions respondents could base their answers on. The set of distribution functions examined consists of the standard normal, logistic, and central t distribution function and a set of distribution functions allowing for skewedness. After evaluating all of the valid options, Nielsen (2003) concludes that skewedness of the distribution does not improve the quality of the quantification technique and applies the central t-distribution for further estimation purposes in her own paper. On the other hand, Mestre (2007) uses the standard normal distribution function arguing that the research done by Nielsen (2003) does not allow the conclusion that other distribution functions yield significant improvements. In this thesis, the assumption about the distribution function is adopted from the author Mestre (2007) for the stated reason above. The use of this standard normal distribution function is appropriate, since a large number of people are surveyed in the EC consumer survey and therefore, the law of large number can be applied (Mestre, 2007). Thus, the distribution of the consumers' responses should be sufficiently approximated to the standard normal distribution function. The next step is to calculate the already mentioned thresholds for each response within the standard normal distribution function as Mestre (2007) elaborates. For this to be achieved, the z-score i (i.e., $i \in \{1, 2, 3, 4, 5\}$) is computed for each answer option i. Therefore, the inverse distribution function of i is calculated from one minus the sum of the percentages up to response option i. (e.g., if the z- score of answer option 3 is calculated, the inverse distribution function is taken of one minus the sum of the percentages of the first three answer options). The z-scores are calculated for both questions in the EC consumer survey in order to be able to compute the mean of the perceived inflation rate and the inflation expectations according to the distribution function the respondents are following.

After introducing the distribution function and the z-scores, it is important to define and derive the scaling factor for the inflation expectations π_t^E. The scaling factor π_{t-1}^P for the inflation expectations is the perceived inflation rate, and there are four different possibilities for the

perceived inflation rate π_{t-1}^{P} in equation (5) according to Nielsen (2003). Those four measures of scaling factors can be categorized in two scaling factor types as summarized in table 1. The first type are direct measures of perceived inflation, or to be more precise actual observed inflation rates of previous periods. In equation (5), both direct measures, option 1 and 2, can be used as the perceived inflation rate π_{t-1}^{P}. Option 1 is the actual inflation rate of the quarter previous to the quarter when Q6 is surveyed (Nielsen, 2003). Option 2 is the mean of all actual inflation rates available previous to the quarter when Q6 is asked. This second option delivers the best forecast according to Nielsen (2003) and is used under the assumption that individuals learn from their mistakes over time.

Table 1: Different Scaling Factors for Inflation Expectations of Consumers

Scaling Factor Type	Option	Description of Scaling Factor
Direct Measure of Perceived Inflation / Actual Inflation	1	Actual inflation rate of the quarter previous to the quarter when Q6 is interviewed
	2	Mean of all actual inflation rates available previous to quarter when Q6 is interviewed
Perceived Inflation derived from Q5	3	Perceived inflation rate is derived with the actual inflation rate of the previous quarter when Q5 is interviewed
	4	Perceived inflation rate is derived with the mean of all actual inflation rates available previous to the quarter when Q5 is interviewed

Note:
Actual inflation is the annual inflation rate based on the quarterly CPI and calculate for each quarter between 1985 and 2021

The second scaling factor type is the perceived inflation rate of consumers derived from Q5 of the EC consumer survey. Calculating the perceived inflation rate requires a scaling factor δ_{t-1}, the same as for the computation of inflation expectations. For this purpose, the aforementioned direct measures of perceived inflation option 1 and option 2 can be used. The calculation is based on the approach of Nielsen (2003), which uses all five response options.[15]

When the approach of utilizing Q5 for generating the perceived inflation rate is chosen, the following procedure of Nielsen (2003) has to be applied. Firstly, the z-scores for each response in every time period t are calculated, assuming the standard normal distribution functions as previously discussed. Secondly, when all necessary variables are computed, they have to be inserted into equation (4)[16]. Thereby, two different scaling factors δ_{t-1} can be used, leading to two different perceived inflation rates from Q5 for each quarter between 1985

[15] The original probability approach by Carlson and Parkin (1975) derived inflation expectation from a survey with three response options.
[16] Equation is from Mestre (2007)

and 2021 as summarized in table 1. The first one is option 3: the perceived inflation π_t^P with the actual inflation rate of the previous quarter as a scaling factor δ_{t-1}. Option 4 is the perceived inflation rate π_t^P with the mean of all actual inflation rates of the previous quarters as scaling factor δ_{t-1}.

$$\pi_t^P = -\delta_{t-1} * \frac{z_{3,t} + z_{4,t}}{z_{1,t} + z_{2,t} - z_{3,t} - z_{4,t}} \quad (4)$$

After introducing the four different options of perceived inflation rate π_t^P, four different variants of inflation expectations π_t^E measures are calculated. First, the z-scores for each response of the Q6 are calculated, assuming the standard normal distribution function (Mestre, 2007). Secondly, the four variants of the inflation expectations of consumers π_t^E are computed according to equation (5)[17]. Therefore, the four different measures of perceived inflation rate π_t^P, option 1, 2, 3 and 4, are utilized as scaling factors π_{t-1}^P since there are multiple possibilities for the computation of inflation expectations. The first measure of inflation expectation π_t^E variant 1 uses option 1 as scaling factor. The second one, variant 2, utilizes option 2. Thirdly, the perceived inflation rate of option 3 is applied as scaling factor to compute the inflation expectations of consumers π_t^E variant 3. Finally, the final variant includes the perceived inflation π_t^P option 4 as scaling factor, in order to calculate the inflation expectations π_t^E variant 4 (Appendix A provides the formula for each variant of inflation expectations).

$$\pi_t^E = -\pi_{t-1}^P * \frac{z_{3,t} + z_{4,t}}{z_{1,t} + z_{2,t} - z_{3,t} - z_{4,t}} \quad (5)$$

In the end, all four different measures are valid quantified inflation expectations of consumers which are calculated according to the authors Mestre (2007) and Nielsen (2003). Consequently, it is evident that there are multiple calculation methods for households' inflation expectations. Therefore, all four variants are tested in the section *Econometric Framework*. Table 2 provides an overview of the existing inflation expectations variants, the scaling factor used to calculate the variant and the abbreviations of those scaling factors.

[17] Equation (5) is from Mestre (2007).

Table 2: Inflation Expectations and the corresponding Scaling Factors		
Inflation Expectations Variants	Abbreviation for Scaling Factor	Scaling Factor Option
1	Actual Inflation	1
2	Historical Inflation Mean	2
3	Perceived Inflation scaled by Actual Inflation	3
4	Perceived Inflation scaled by Historical Inflation Mean	4
Note: Table 2 can be interpreted as follows: Inflation expectation variant 1 uses the scaling factor option 1 as scaling factor		

5 Empirical Evidence in the United States

Coibion et al. (2018) give a general overview of FIRE, the use of survey-based inflation expectations in the NKPC and they empirically test the stability of the Phillips curve in the United States. Therefore, the authors divided the paper into three different sections, providing an overview of inflation expectations in the PC. First of all, it starts with a review of the theoretical successes of the PC with FIRE, but the problems associated with this assumption are discussed as well. This is followed by an overview of the various advantages of using survey-based inflation expectations as opposed to FIRE. In addition, the surveys of various economic agents (i.e., central bankers, professional forecasters, and households) are presented. In the last section, all survey-based inflation expectations are empirically compared by the authors to identify the measure that yields the most stable PC.

In this section of this thesis, the empirical part of Coibion et al. (2018) is reviewed and serves as a foundation for the comparison of the PC with inflation expectations of consumers between the U.S. and Germany. Therefore, the German PC tested in this thesis uses the same regression as Coibion et al. (2018) as previously discussed in the *Econometric Framework*. Additionally, the results of the PC with inflation expectations of professionals and the financial market are presented for U.S., due to the interest of examining the question on whether or not the decline of the PC exists as the IMF (2013) states.

Table 3: Stability of the Phillips Curve in the United States

STABILITY OF THE PHILLIPS CURVE

Dep. var.: π_t	1978–2014 (1)	1978–89 (2)	1990–99 (3)	2000–2014 (4)	p-value (5)
Panel A. MSC, 1978:I–2014:III					
$UEGap_t$	−0.229	−0.233	−0.210	−0.249	0.989
	(0.087)	(0.128)	(0.278)	(0.110)	
$E_t\pi_{t+1}$	1.432	1.500	1.388	0.828	
	(0.072)	(0.090)	(0.387)	(0.184)	
Observations	146	48	40	58	
R^2	0.773	0.843	0.516	0.218	
Panel B. Binder (2015), 1978:I–2014:II					
$UEGap_t$	−0.333	−0.568	−0.145	−0.237	0.105
	(0.102)	(0.130)	(0.217)	(0.112)	
$E_t\pi_{t+1}$	1.592	1.519	2.053	1.495	
	(0.068)	(0.093)	(0.474)	(0.276)	
Observations	145	48	40	57	
R^2	0.764	0.814	0.534	0.234	
Panel C. Naïve, 1978:I–2014:III					
$UEGap_t$	−0.216	−0.747	−0.217	−0.370	0.348
	(0.158)	(0.264)	(0.238)	(0.155)	
$E_t\pi_{t+1}$	0.818	0.856	0.706	−0.187	
	(0.111)	(0.097)	(0.217)	(0.198)	
Observations	146	48	40	58	
R^2	0.598	0.709	0.328	0.075	
Panel D. SPF, 1981:III–2014:III					
$UEGap_t$	−0.177	−0.374	−0.462	−0.157	0.520
	(0.103)	(0.122)	(0.226)	(0.192)	
$E_t\pi_{t+1}$	0.729	1.182	1.731	0.732	
	(0.116)	(0.222)	(0.336)	(1.188)	
Observations	132	34	40	58	
R^2	0.265	0.348	0.520	0.070	
Panel E. Greenbook, 1979:IV–2009:IV					
$UEGap_t$	−0.348	−0.495	−0.365	−0.174	0.185
	(0.164)	(0.149)	(0.267)	(0.098)	
$E_t\pi_{t+1}$	0.954	1.265	1.459	0.371	
	(0.128)	(0.125)	(0.338)	(0.506)	
Observations	120	41	40	39	
R^2	0.592	0.752	0.498	0.038	
Panel F. Financial markets (Cleveland Fed), 1982:I–2014:III					
$UEGap_t$	−0.141	−0.492	−0.063	−0.041	0.036
	(0.100)	(0.135)	(0.205)	(0.184)	
$E_t\pi_{t+1}$	0.613	1.105	1.626	1.068	
	(0.105)	(0.312)	(0.310)	(0.379)	
Observations	130	32	40	58	
R^2	0.205	0.216	0.460	0.125	

Notes: The dependent variable in specification (9) is the quarterly inflation rate (CPI, annualized). In all panels (except panel C), $E_t\pi_{t+1}$ is the one-year ahead inflation forecast (mean). In panel C, $E_t\pi_{t+1}$ is the average inflation rate over the previous four quarters. The top row indicates estimation samples. $UEGap_t$ is the difference between the actual unemployment rate and the CBO's NAIRU. All data are final vintage. Newey–West robust standard errors (five lags) are in parentheses. The last column reports p-values for the null hypothesis that the slopes are equal over the time periods listed in columns 2–4. The estimation sample excludes 2008:IV, which is an outlier in the data.

Source: Coibion et al. (2018)

The PC is tested with the econometric framework from equation (1) with the inflation expectations of consumers, professionals, and naive expectations for the available data between the years 1978 to 2014 by Coibion et al. (2018). In addition to examining the whole

time period, three different shorter time periods are tested to observe the evolution of the PC. The time periods analyzed are 1979-89, 1990-99, and 2000-2014. Especially, the period of 2000-2014 is of particular interest, due to the experienced phase of missing disinflation during and after the financial crisis. The results on these time periods of Coibion et al. (2018) are summarized in table 3.[18] A brief reminder, the PC used in Coibion et al. (2018) is represented in the following regression: the dependent variable is the quarter-on-quarter headline inflation rate regressed on the one-year ahead inflation expectations and on the unemployment gap. Table 3 includes seven different variants of the PC being distinguished by the different measures of survey-based inflation expectations. Panel A uses the Michigan Survey of Consumer (MSC) as a source for one-year ahead inflation expectations. Panel B is a consumer survey as well, with Binder (2015) interviewing consumers confident in their ability to correctly estimate inflation expectations. Panel C implements naive expectations into the PC, which use the mean of the last four quarter-on-quarter inflation rates as inflation expectations. Panels D and F use inflation expectations of professional forecasters (SPF)[19] and central bankers (Greenbook), which resemble measures, who are close to rational expectations. Finally, in panel G, market-based inflation expectations are applied.

In Panel A, the coefficient of the unemployment gap is negative and significant at the 1% level for the entire period of 1978-2014. The interpretation is as follows: when the unemployment gap rises by one percent, inflation falls on average by 0.229%, ceteris paribus. Therefore, the PC with consumers' inflation expectations is strong and alive. Furthermore, when looking at shorter time periods, it is evident that there is no decline in the relationship, in contrast to other literature which claims a decline in the slope (IMF, 2013). The coefficients are consistently below -0.2%, and all coefficients are significant except for the period 1990-99. When the coefficients for the one-year ahead consumers' inflation expectations are analyzed, a strong effect on quarter-on-quarter inflation can be observed. Interpreting the entire period of 1978-2014, a 1% increase in consumers' inflation expectations in period t leads to an average increase of 1.432% of the inflation rate in period t and is significant at the 1%-level. The same strong relationship between the two variables in the regression holds across the shorter time periods, although the value of coefficient loses in magnitude. Finally, it is important to note that the predictive power of the model decreases over the entire time periods. In 1978-89, the R-value is still at 0.843 and drops to 0.218 in the last period.

[18] Table 8 in Coibion et al. (2018)
[19] Survey of Professional Forecasters (SPF)

However, Coibion et al. (2018) argue that this does not impact the relevance of the PC and that the decline in predictive power has been confirmed in the existing literature.

Panel C presents the results on the PC with naive expectations as a measure of one-year ahead inflation rate. The economic slack coefficient has a negative sign and is significant for the entire time period 1978-2014. In the analysis of the shorter periods, it is noticeable that the coefficients of the unemployment rate have a greater volatility than in Panel A. The effect of naive inflation expectations is significantly smaller compared to Panel A. In particular, this is clarified in the period 2000-2014, when the coefficient of inflation expectations even has a negative sign. Instead, the direction of inflation expectations should be positive since the expectations of future inflation positively correlates with actual inflation. Coibion et al. (2018) conclude that the inflation expectation measure reflects firms' expectations poorly since these results are incomprehensible.

Panels D, E and F include inflation expectations measures from professionals such as professional forecasters (SPF), central bankers (Greenbook) and market-based inflation expectations (Financial Markets). Coibion et al. (2018) estimate a significant coefficient for the unemployment gap in panel E for the period 1978-2014, with the same magnitude as in panels A and B. In contrast, the coefficients of the economic slack are insignificant in the panels D and F for that same period. While analyzing the impact of economic slack on the inflation rate for the shorter periods, the authors observe a steady decline in the slope of the PC, as unanimously concluded in the literature (Blanchard, 2016). In the period 2000-2014, it becomes apparent that the coefficients are half as large as those of panel A and B for the same period. Thus, the slope of the PC, when one-year ahead inflation rate of professionals is used, weakens significantly compared to the use of MSC and measures of Binder (2015). The measures of the inflation expectations of the three panels are rather volatile and become insignificant for the period 2000-2014. On the other hand, the coefficients have on average the magnitude of 1% before the year 2000, pointing out a strong relationship between quarter-on-quarter inflation rate and inflation expectations for this time period. Overall, the slope of the PC with measures of professionals gets flatter, similar to the concerns already raised in the *Introduction* (Coibion et al., 2018).

In conclusion, the results of Coibion et al. (2018) suggest that a stable PC is only observed when inflation expectations are measured with inflation expectations of households. PC specifications with survey-based inflation expectations of professionals, such as SPF (Panel D) or Greenbook (Panel E), show a flattening of the slope. Additionally, insignificant

coefficients of inflation expectations are examined, which is not the case for households' inflation expectations. Hence, the inflation expectations of households play a significant role in the validation of the Phillips curve (Coibion et al., 2018).

6 Empirical Evidence in Germany

First, a brief overview of the results about the different variants of consumer inflation expectations calculated is given in the *Data* section of this thesis. The purpose of this section is to address the differences among the variants of the one-year ahead inflation expectations and compare them to the actual inflation rate based on the quarterly CPI. Additionally, the degree to which the variants of inflation expectations vary from one another is discussed. This first step, before continuing with the testing of the stability of the Phillips curve, is important to understand the impact of the different one-year ahead inflation rates within the model. After introducing the multiple variants of inflation expectations, the stability of the PC in Germany is examined with each of the measures in the already presented econometric framework of Coibion et al. (2018).

6.1 Inflation Expectations

In this section, the analysis of the consumers' inflation expectations in Germany is divided into three sections and is based on two graphs illustrating the course of the different variants between 1985 and 2021. The first compares annual inflation rate[20] with the two inflation expectations using the direct measure of perceived inflation rate as a scaling factor (i.e., variant 1 and 2). On the other hand, the second graph contains the two inflation expectations scaled with the perceived inflation rates from Q5, which are compared with the annual inflation rate (i.e., variant 3 and 4). In the final step, the inflation expectations of all scaling factors are discussed and compared with each other.

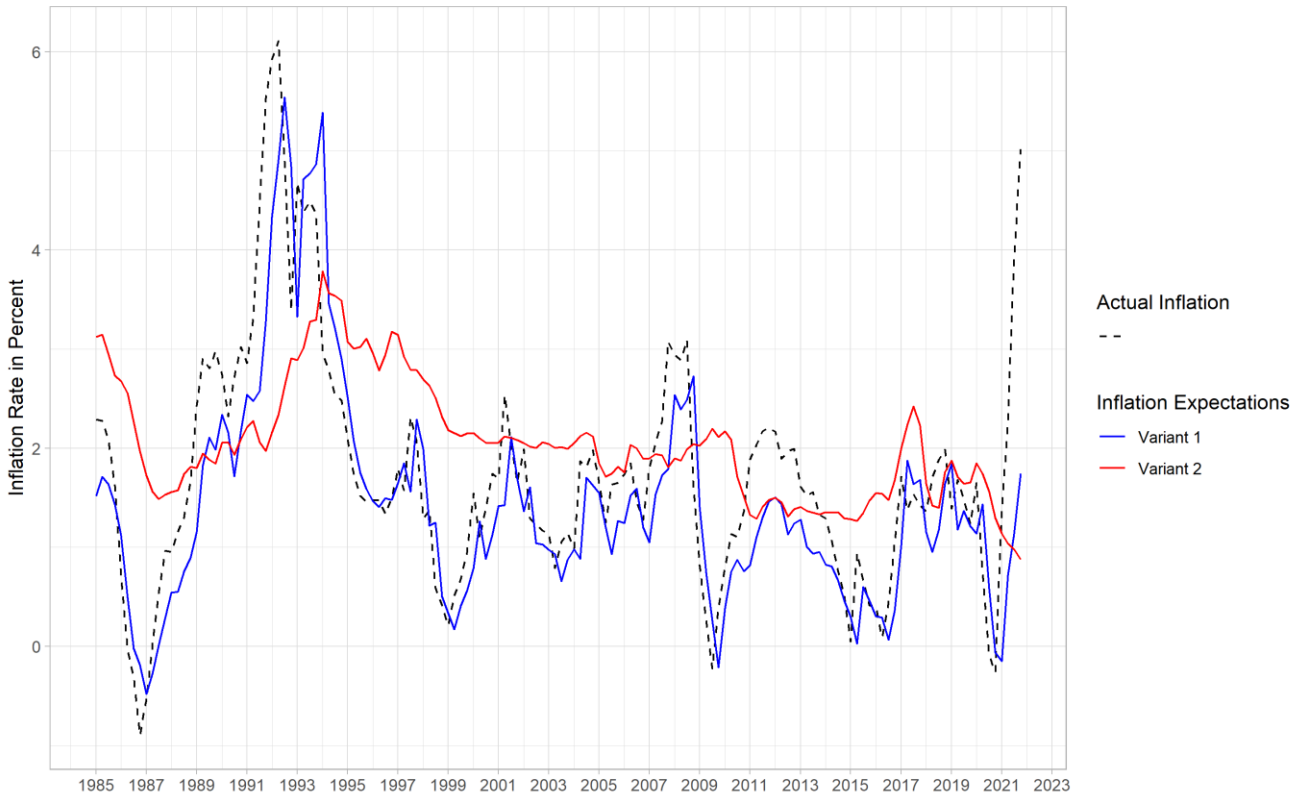
The courses of the inflation expectation measures, using the direct measures of perceived inflation rate (i.e., actual inflation) as scaling factor, can be seen in graph 1. In graph 2, the inflation expectations are represented, using the perceived inflation rate derived from Q5 as scaling factor. The interpretation of the axis is the following: the y-axis shows the inflation rate in percent, while the x-axis provides information about the year. The dashed line represents the actual inflation rate, also called the annual inflation rate. Graph 1 includes

[20] Reminder: annual inflation rate, actual inflation rate and observed inflation rate are used as synonyms.

variant 1 as a blue line and variant 2 as a red line, while graph 2 presents variant 3 as an orange line and variant 4 as a green line.

In graph 1, the actual inflation is very volatile, and the phase of high inflation experienced during the early 1990s is visible. In addition, the financial crisis (2008-2009) is strikingly

Graph 1: Actual Inflation vs. one-year ahead Inflation Expectations: Variant 1 and 2
Scaling Factor Type: Direct Measures of Perceived Inflation



(Source: Own Elaboration from German Data received from FRED and the European Comission consumer survey.)

observable in the graph, which is characterized by a sudden rise and followed by a sharp decline in the inflation rate. When looking at the course of the line, the negative trend of the inflation rate is clearly noticeable starting from the mid-1990s on.

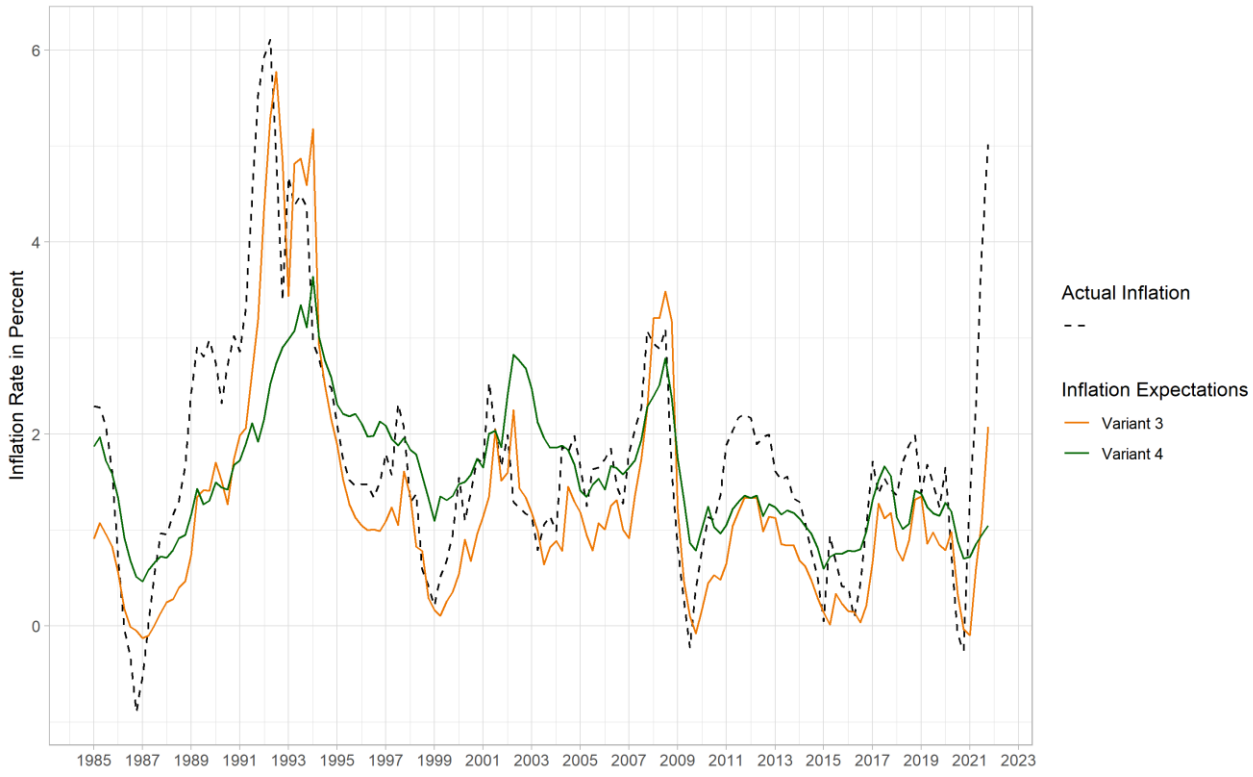
The comparison of inflation expectations variant 1 with the annual inflation, unveils that the blue line follows the volatile dashed line closely. However, consumers systematically expect lower inflation rates starting from 1999. Especially, inflation expectations are significantly lower than the annual inflation rate for the period 2011 to 2015, which coincides with the euro crisis. The next inflation expectations measure is variant 2, which has a smooth course and follows the same negative trend as variant 1 and the actual inflation. In contrast, to the actual

inflation, the inflation expectations of variant 2 are systematically higher on average by one percentage point for the years 1994 to 2005. After 2005, inflation expectations seem to be either higher or lower by one percentage point. Thereby, these deviations from the annual inflation rate do not seem to follow any pattern.

In the following, the results of graph 2 are presented. Furthermore, variants 1 and 3 are compared with each other since both variants use the actual inflation as a scaling factor in their computation. The same fact applies to variants 2 and 4 with the historical inflation mean as a common scaling factor.

Graph 2: Actual Inflation vs. one-year ahead Inflation Expectations: Variant 4 and 5

Scaling Factor Type: Perceived Inflations derived from Q5



(Source: Own Elaboration from German Data received from FRED and the European Comission consumer survey.)

Graph 2 shows the inflation expectations of consumers with the perceived inflation from Q5 as scaling factor type and compares it with the annual inflation rate. The annual inflation rate (dashed line) is the same as in graph 1 and the interpretation is stated in the paragraphs above. Variant 3 is similarly volatile as the annual inflation rate but follows it less closely than variant 1 from graph 1. During the financial crisis, inflation expectations of variant 3 match the annual inflation rate very closely. Additionally, consumers seem to underestimate actual

inflation in the euro crisis. In contrast to variant 1, the consumers' inflation expectations variant 3 underestimates inflation for the period 2017 to 2020. Variant 4 is smooth, and its course line seems to imitate a trendline of the actual inflation. Contrary to variant 2, there are no large deviations from the observed inflation rate in the year 1994 to 2005.

Overall, the four variants can be classified into two categories. Variants 1 and 3 are similar with respect to their ability to track the observed inflation rate fairly closely, which is owed to the common scaling factor: actual inflation rate. Their key characteristic is the volatile course of the inflation expectations over time. The variants 2 and 4 have a smooth course of the inflation expectations as common characteristic. Thereby, the two variants have the same scaling factor: historical inflation mean. Thus, it can be concluded that the mean value as a scaling factor explains the smoothness observed and represents the timeline of inflation expectations like a trendline of the actual inflation rate. However, it is noticeable that all variants are shifted twelve months into the future when compared to the actual inflation, which is mentioned by Nielsen (2003) as well. The inflation expectations are surveyed in quarter t for a year ahead and are compared with the actual inflation in quarter t (Nielsen, 2003). Therefore, the observed forward shift in inflation expectations compared to actual inflation rate occurs in both graphs.

6.2 The Phillips Curve and German Households' Inflation Expectations

In the following, the stability of the German Phillips curve using households' inflation expectations is evaluated and compared to the observations of the United States.

The regressions in the tables 4 to 7 have the same structure which is explained in the following. In each column, a different time period is examined for the PC. This thesis tests a total of eight time periods instead of four as in Coibion et al. (2018), due to two circumstances. The first reason is that data is available for Germany from 1985 onwards and not from 1978 as in the United States. Therefore, the first shorter period 1978-1989 cannot be sufficiently tested. The second reason is the extended analysis from the year 2014 to 2021, allowing a more comprehensive view on the period after the financial crisis. For the reasons mentioned above, the following time periods are observed. The period 1985-2021 tests all available data in Germany, whereas 1985-2014 serves as a foundation for the comparison with the results from Coibion et al. (2018). The time periods 1990-1999 and 2000-2014 can be directly compared to the results from table 3 (cf. column 3 and 4). Further, 1985-1999 is used as a proxy period to enable a comparison with the results from 1978-1989 of table 3 (cf. column 2). Finally, the extended period until 2021 is used to observe the period before, after

and during the financial crisis by utilizing the shorter time periods 1990-2007, 2010-2021 and 2000-2021. The central regression is the equation (1) from the section *Econometric Framework.*

$$\pi_t = \alpha + \beta * E_t[\pi_{t+1}] + \kappa * UE_t + \varepsilon_t \quad (1)^{21}$$

6.2.1 Variant 1

The analysis of the PC starts with variant 1 of consumers' inflation expectations scaled with the actual inflation and is represented in table 4. In general, looking at the periods 1985-2014 and 1985-2021, the coefficients for both inflation expectations and economic slack have a relatively small magnitude. Hereby, the coefficient for the unemployment rate is even as low as κ = -0.035 and not significant for the 1985-2021 period, whereas this coefficient is only weakly significant for the 1985-2014 period. Similar results can be observed in shorter time periods. Although the slope of the PC is strong and significant at κ = -0.133 for the period 1990-1999, it becomes insignificant in the period after the financial crisis and decreases in magnitude as well (cf. 1990-2007 and 2010-2021). In conclusion, the slope of the PC is rather small and mostly weakly significant, independent of the time period, especially in 1985-2014 and 1985-2021.

The impact of one-year ahead inflation expectations variant 1 on the quarter-on-quarter inflation rate is particularly small. For example, in the period 1985-2021, the interpretation is as follows: when consumers' inflation expectations increase by 1%, the quarter-on-quarter inflation rate increases on average by 0.135%, ceteris paribus. This outcome is confirmed in

Table 4: Stability of the Phillips Curve | Inflation Expectations: Variant 1

	Dependent variable: q-o-q inflation rate of period t							
	1985-2021 (1)	1985-2014 (2)	1990-1999 (3)	1985-1999 (4)	2000-2014 (5)	1990-2007 (6)	2010-2021 (7)	2000-2021 (8)
Households' Inflation Expectations	0.135***	0.139***	0.068**	0.142***	0.058	0.056***	0.015	0.033
	(0.031)	(0.030)	(0.026)	(0.036)	(0.071)	(0.019)	(0.120)	(0.065)
Unemployment Rate	-0.035	-0.047*	-0.133***	-0.094**	0.006	-0.125***	-0.052	-0.004
	(0.022)	(0.028)	(0.046)	(0.041)	(0.019)	(0.040)	(0.081)	(0.020)
Observation	147	119	40	59	60	72	48	88
R2	0.172	0.259	0.465	0.409	0.015	0.403	0.013	0.003

Note: *p<0.1; **p<0.05; ***p<0.01

(Source: Own Elaboration from German Data received from FRED and the European Comission consumer survey.)

[21] The regression specification equation (1) of section *Econometric Framework.*

the shorter periods, when comparing the evolution of the stability of the PC. Thereby, the size of the coefficient varies between $\beta = 0.056$ in the period 1990-2007 and $\beta = 0.142$ in the period 1985-1999. In addition, the coefficient becomes statistically insignificant after the year 2008/2009. Therefore, it can be concluded that the findings indicate that households' inflation expectations variant 1 is unlikely to have a large correlation with quarter-on-quarter inflation.

6.2.2 Variant 2

The PC with the inflation expectations variant 2 scaled with historical inflation mean can be seen in table 5. The slope of the unemployment rate appears to have increased minimally compared to variant 1 but remains insignificant or weakly significant for the time periods 1985-2014 and 1985-2014. When observing the result of shorter time periods, a relatively strong relationship can be identified that varies between coefficients $\kappa = -0.142$ and -0.166. However, the slope of the PC falls between the years 1990 and 2007. After the financial crisis, the slope is half the size compared to the pre-crisis time period and, therefore, turns insignificant (cf. 1990-2007, 2010-2021). Thus, it can be concluded that the correlation between the inflation rate and the unemployment rate is stable until the financial crisis and cannot longer be observed after the crisis.

Variant 2 of the inflation expectations seems to have a much smaller effect β on the quarter-on-quarter inflation rate than variant 1. All coefficients are small in magnitude and mostly insignificant, regardless of which period is examined. However, the only exception is the period 1985-1999, where the coefficient of one-year ahead inflation expectations $\beta = 0.191$ is the largest and the only significant. Variant 2 seems to be a predictor of the quarter-on-quarter inflation rate which should be handled with carefulness, due to its lack of significant

Table 5: Stability of the Phillips Curve | Inflation Expectations: Variant 2

	Dependent variable: q-o-q inflation rate of period t							
	1985-2021 (1)	1985-2014 (2)	1990-1999 (3)	1985-1999 (4)	2000-2014 (5)	1990-2007 (6)	2010-2021 (7)	2000-2021 (8)
Households' Inflation Expectations	0.071	0.126*	0.093	0.191**	-0.101	0.022	-0.439	-0.306
	(0.086)	(0.073)	(0.114)	(0.080)	(0.185)	(0.071)	(0.284)	(0.212)
Unemployment Rate	-0.040	-0.071*	-0.166***	-0.142***	0.019	-0.146***	-0.073	0.025
	(0.029)	(0.041)	(0.039)	(0.052)	(0.028)	(0.039)	(0.079)	(0.017)
Observation	147	119	40	59	60	72	48	88
R2	0.027	0.087	0.431	0.215	0.009	0.376	0.144	0.064

Note: *p<0.1; **p<0.05; ***p<0.01

(Source: Own Elaboration from German Data received from FRED and the European Comission consumer survey.)

coefficients. In contrast to variant 1, it is important to conclude that the insignificance of the slope of the PC and the inflation expectations is observed for all time periods, while it is not only related to the financial crisis.

6.2.3 Variant 3

The PC tested with households' inflation expectations variant 3 (i.e., scaling factor: perceived inflation scaled with actual inflation) is presented in table 6. First of all, the stability of the PC cannot be confirmed, because the coefficients are insignificant, for both the 1985-2014 and 1985-2021 time periods. Turning to the shorter periods prior to 2008 (cf. columns (3), (4) and (6) in table 6), the slope appears to be around κ = -0.14, indicating a strong negative relationship. Thus, a 1% increase in the unemployment rate is associated with an average decrease of -0.139% in inflation over the period 1985-1999. After 2008, the coefficient κ weakens and becomes insignificant (cf. 1990-2007, 2010-2021). Overall, the usage of variant 3 in the PC doesn't allow a stable slope for the whole period.

The coefficient of inflation expectations variant 3 is comparable to the magnitude of variant 1 and is highly significant for both periods 1985-2014 and 1985-2021. For the shorter periods, the same holds as for the coefficients of inflation expectations from variants 1 and 2. Hence, the period before the financial crisis has an intact relationship between quarter-on-quarter inflation expectations, which dissipates afterwards. Thus, it can be concluded that variant 3 delivers a small but highly significant coefficient for inflation expectations.

Table 6: Stability of the Phillips Curve | Inflation Expectations: Variant 3

	Dependent variable: q-o-q inflation rate of period t							
	1985-2021	1985-2014	1990-1999	1985-1999	2000-2014	1990-2007	2010-2021	2000-2021
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Households' Inflation Expectations	0.137***	0.131***	0.071**	0.137***	0.055	0.062***	0.163	0.070
	(0.032)	(0.030)	(0.027)	(0.039)	(0.051)	(0.021)	(0.110)	(0.052)
Unemployment Rate	-0.034	-0.044	-0.129***	-0.090**	0.007	-0.122***	-0.031	-0.008
	(0.021)	(0.029)	(0.045)	(0.042)	(0.019)	(0.039)	(0.067)	(0.020)
Observation	147	119	40	59	60	72	48	88
R2	0.189	0.255	0.479	0.409	0.025	0.412	0.048	0.019

Note: *p<0.1; **p<0.05; ***p<0.01

(Source: Own Elaboration from German Data received from FRED and the European Comission consumer survey.)

6.2.4 Variant 4

The households' inflation expectations variant 4 (i.e., scaling factor: perceived inflation with historical inflation mean) is used in the PC as the results in table 7 show. The slope of the PC

is significant for the whole period as well as for all shorter periods until the year 2007. Further, the magnitude of the coefficients ranges between $\kappa =$ -0.064 and -0.081 for both the periods 1985-2014 and 1984-2021. Hence, this PC yields the largest coefficients for the two entire periods. The coefficients for the short periods are rather stable at circa $\kappa =$ -0.140. Additionally, the results of the previous tables support that the PC becomes insignificant after the financial crisis, while having a stable slope before the recession. Therefore, the final variant of inflation expectations of consumers seems to be the most promising of all variants.

The inflation expectations of variant 4 have the largest impact on the quarter-on-quarter inflation rate of all four measures of inflation expectations, which is reflected in the magnitude of the coefficients. This is seen in the coefficients' magnitude of $\beta =$ 0.240 for both the periods 1985-2021 and 1985-2021, these are significant to the 1%-level. Furthermore, the impact of the inflation expectations is significant and stable until 2007 and turns insignificant afterwards as seen in the shorter periods. Nevertheless, this variant yields the largest coefficients for the inflation expectations, next to the strongest PC.

Table 7: Stability of the Phillips Curve | Inflation Expectations: Variant 4

	Dependent variable: q-o-q inflation rate of period t							
	1985-2021 (1)	1985-2014 (2)	1990-1999 (3)	1985-1999 (4)	2000-2014 (5)	1990-2007 (6)	2010-2021 (7)	2000-2021 (8)
Households' Inflation Expectations	0.238***	0.244***	0.165***	0.303***	0.071	0.085	0.010	0.058
	(0.069)	(0.065)	(0.059)	(0.076)	(0.085)	(0.065)	(0.313)	(0.088)
Unemployment Rate	-0.064**	-0.081**	-0.152***	-0.139***	-0.002	-0.141***	-0.054	-0.012
	(0.028)	(0.036)	(0.043)	(0.043)	(0.020)	(0.040)	(0.081)	(0.017)
Observation	147	119	40	59	60	72	48	88
R2	0.149	0.231	0.475	0.430	0.018	0.390	0.012	0.006

Note: *p<0.1; **p<0.05; ***p<0.01

(Source: Own Elaboration from German Data received from FRED and the European Comission consumer survey.)

6.2.5 Comparison of the Four Variants

After analyzing the four different PC an evaluation of the above stated results is done before continuing with the comparison of the results in the United States. The purpose is to determine the inflation expectations variant that achieves the best results for both components of the PC. Once this is done, the most promising variant is compared to the findings in the U.S. provided by Coibion et al. (2018).

A common observation of the empirical results from Germany is that all the coefficients turn insignificant after the financial crisis. In addition, the different PC specifications have many

shortcomings that are discussed in the following. The first PC to address uses households' inflation expectations variant 2 with a non-existing significance for the coefficient of inflation expectations. While this variant delivers a stable slope for the unemployment rate until 2007, it fails to provide an intact relationship between the quarter-on-quarter inflation and the one-year ahead inflation expectations, although this is key to an expectations-augmented PC. Therefore, variant 2 does not seem to represent a working PC model. The next two variants, 1 and 3, have the same shortcomings and are therefore analyzed together. When interpreting the two large periods 1985-2014 and 1985-2021, variants 1 and 3 deliver for the PC an insignificant coefficient, implying that the economic slack does not have an impact on the inflation. Hence, this neglects the existence of the observed relationship of the PC, but according to IMF (2013) the slope should not cease to exist. Thus, both variants seem to be invalid to apply in the PC and therefore are not considered as a foundation for a comparison to the United States. The last model left is the PC with variant 4, which utilizes the one-year ahead inflation expectations with the scaling factor option 4. Thereby, it is the only model specification delivering significant coefficients for economic slack and inflation expectations of relevant magnitude for both coefficients of the PC until 2007. On the other hand, the downside of using this variant is the loss of significance of the one-year ahead inflation expectations for the period 1990-2007. Thus, the coefficient of inflation expectations loses the significance before 2008, which is earlier compared to the other model specifications with variants 1,2 and 3.

After this evaluation, it is evident that all of the different variants of the one-year ahead inflation expectations show certain shortcomings. However, variant 4 seems to be the most promising due to its stable PC and an intact correlation between inflation and consumers' inflation expectations. Consequently, variant 4 is used as a proxy for firms' inflation expectations in the NKPC for the comparison between Germany and the U.S. in the discussion section *Does the Phillips Curve Still Exist?*.

7 Discussion

7.1 Does the Phillips Curve still exist? – Comparison between the United States and Germany

In the following, first the evidence of the Phillips curve with households' inflation expectations is discussed between both countries. Afterwards, the question of the suitability of these expectations in Germany is assessed. When the German PC is addressed, it is referred to

as the specification using variant 4 as one-year ahead inflation expectations of consumers. In addition, it is important to keep in mind that Coibion et al. (2018) implement the unemployment gap as economic slack while this thesis utilizes the unemployment rate.

The first step is to assess the PC over the entire period, including the financial crisis, which delivers a stable and strong slope for the PC in the U.S. (cf. 1978-2014 in table 3). In Germany, this result is only partially confirmed since the relationship is stable but in terms of magnitude much weaker than in the United States. The analyzation of the periods 1985-2014 and 1985-2021 clarifies that the magnitudes of the coefficients of the unemployment rate are 1/3 smaller compared to the U.S. in that same period (cf. table 3 in Panel A, table 7).[22] However, the impact of the inflation expectations of the EC consumer survey on the quarter-on-quarter inflation rate is even more worrisome in Germany. The coefficient only has 1/7 of the magnitude of the PC with MSC, implying that the effect is small though statistically significant. In addition, the weaker relationship is supported by evidence from Vlekke et al. (2020), but the authors examine a PC with inflation expectations of both households and firms. Thus, the comparison to the results of Vlekke et al. (2020) has to be handled with caution.

Secondly, the shorter periods test the stability of the PC throughout time and allow an insight in the years around the financial crisis. In the U.S., it was concluded that a fairly stable and significant relationship between inflation and the unemployment gap exists through all periods (cf. Panel A: 1978-89, 1990-99, 2000-2014 in table 3). In contrast, these results cannot be confirmed for Germany where the data imply a disappearing of the PC after the financial crisis. The magnitude is on average 1/4 smaller during the periods until 2007 (cf. 1990-99, 1985-1990 and 1990-2007), and the relationship completely disappears afterwards. The same can be concluded for the one-year ahead inflation expectations for which the magnitude is significantly lower in Germany. Thus, both coefficients show a weak relationship towards the quarter-on-quarter inflation rate in Germany which contradicts the findings in the U.S.

Therefore, the following two key findings for the usage of consumers' inflation expectations in the PC can be presented for Germany. First of all, the relationship is stable until the financial crisis but it does not yield any statistically significant relationship after 2007. Thus, this implies that the relationship between economic slack and inflation stops existing for

[22] The periods analyzed in Coibion et al. (2018) and this paper vary, due to the fact that consumers' expectations are only available from 1985 onwards in Germany, while they are available in the United States from 1978 onwards.

Germany, contradicting the prediction of a stable PC. Coibion et al. (2018) argued that the relationship of real and nominal variables is vivid and stable throughout the whole period between 1978 and 2014 when households' expectations are implemented. Hence, those inflation expectations revived the PC, while the usage of professional forecaster surveys yields a declining slope for the PC, and the relationship weakens and becomes less stable.

Secondly, the inflation expectations of the EC consumer survey do not provide a relevant magnitude and significant coefficients in contrast to the United States' MSC. Consequently, the results must be handled with caution since the calculation of the quantified consumers' inflation expectations for Germany are based on the qualitative survey of the EC. Therefore, the quality of such a measure cannot be as accurate as if the participants of a survey are asked for quantified expectations. In addition, the nature of the inflation expectations' question may differ between the two surveys, potentially leading to different responses of participants (Vlekke et al., 2020). In consequence, the results of both studies are only partially suited for a direct comparison since the method of surveying varies largely.

7.2 Households' Inflation Expectations – Classification of the Empirical Results

In the following, the implications of the results for the use of inflation expectations of consumers in the NKPC are discussed. Thereby, it is explained why households' inflation expectations are of interest in the first place and why they play a larger role in the evaluation of the PC, despite the rather weak empirical situation in Germany.

After the rational expectation assumption was largely abolished, survey-based inflation expectations of economic agents were applied into the PC, due to the contradicting findings in micro-level data as mentioned in the *Introduction* (Coibion et al., 2018). However, the crucial problem of empirically testing the NKPC is the lack of surveys on firms' inflation expectations, although it is their expectations that are needed for the micro-founded model. Instead, mostly survey-based inflation expectations of professional forecasters (e.g., SPF from the U.S.) or central bankers (e.g., Greenbook) are used (Coibion et al., 2018). The key weakness of these surveys is the unreliability of professionals to report true expectations about future inflation, as they may benefit from stating untruthful expectations, as Coibion et al. (2018) summarize.

Another possibility of survey-based measure seems to be the use of households' inflation expectations, which are less biased than the professionals (Coibion et al., (2018). Only a few macroeconomists have empirically tested the PC with consumers' inflation expectations and

compared the way firms form their expectations with those of consumers. The main conclusion of the literature is that firms' inflation expectations are better approximated by those of consumers than by those of professionals.

First of all, this conclusion was empirically confirmed by examining the PC in the U.S. by Coibion and Gorodnichenko (2015). The authors use a simple regression equation of the PC in which the one-year ahead inflation expectations of consumers and professionals are included at the same time. The outcome strongly supports the use of consumers' expectations in the PC, because the effect of consumers' expectations on inflation is consistently significant, irrespective of the use of the slack variable and whether or not the financial crisis of 2008 is included in the examined period. At the same time, professionals' inflation expectations are not significant, independently of the PC specification in Coibion and Gorodnichenko (2015). Therefore, it can definitely be concluded that households' inflation expectations approximate those of firms' expectations the closest.

Secondly, another approach for testing whether expectations of households are an appropriate proxy variable is to compare the characteristics of how firms and households form their expectations of inflation. Kumar et al. (2018) provide answers for this question by surveying general managers of firms in New Zealand. Thereby, the selected firms reflect the proportion of small, medium and large firms in the economy. When the general managers are asked about their formation of inflation expectations, a great share answers with either the gasoline price or their consumption basket as being the guiding factor. Consumers form their expectations in the same way since their forecast on inflation is closely linked to the gasoline price (Coibion and Gorodnichenko, 2015). Hence, it can be concluded that the characteristic to form inflation expectations based on gasoline prices is the same for households and firms and supports the usage of households' inflation expectations for representing the firms' expectations in the NKPC.

Overall, the evidence reveals that instead of the survey of professional forecasters, the expectations of consumers are the preferred measure of inflation expectations for the U.S. and New Zealand. In contrast, the results in Germany suggest the opposite since the slope of the PC is insignificant for the period after the financial crisis. Therefore, the question arises on how to fit these results into the overall research context and whether the rising importance of households' inflation expectations is in doubt. The question can be answered with a simple: no, households' inflation expectations as a proxy variable for firms' inflation expectations are not in doubt. Despite the German results, the research on this topic is far advanced in the U.S.

and New Zealand. Therefore, the literature proves a stable and existing PC for the U.S. and that the characteristic of forming inflation expectations is similar for firms and households. Hence, it cannot be neglected that households' inflation expectations seem to be an appropriate approximation of firms' inflation expectations.

However, this concern could be a national problem particularly for Germany. Therefore, a closer insight into the formation process of inflation expectations is needed for German firms and consumers in order to get clear answers on whether they build on the same characteristic. Once there is more certainty on this matter, it can be determined whether inflation expectations of German households have the potential to be an appropriate proxy variable for firms' inflation expectations.

8 Conclusion

Over the past few years, the relevance of consumers' inflation expectations as an approximation for firms' expectations has increased after Coibion and Gorodnichenko (2015) demonstrated the existence of a stable Phillips curve in the United States by using this approach. At the same time, a survey on the formation of inflation expectations by firms demonstrates that the firms' formation process is largely based on gasoline prices in New Zealand as it is the case for households (Kumar et al., 2018).

This thesis sheds light into the rarely tested PC based on households' inflation expectations in Germany by operationalizing the EC business and consumer survey. Thereby, quantitative inflation expectations of consumers are calculated from the qualitative survey according to the probability method in Mestre (2007) and Nielsen (2003). The most promising variant proved to be the inflation expectations of consumers variant 4, which has the following scaling factor: the perceived inflation derived from Q5 and scaled with historical inflation mean. Hence, variant 4 is used to analyze the stability of the German PC in this thesis.

The subsequent results on the PC revealed that the relationship between inflation and economic slack differs between the U.S. and Germany. The inflation expectations of German households deliver a stable PC before the financial crisis, but the PC ceases to exist after 2007. Thus, the missing disinflation puzzle cannot be solved in Germany with households' inflation expectations, contrary to the U.S. (Coibion et al., 2018). However, most of the empirical literature states an either stable (Vlekke et al., 2020) or a flattening of the PC (IMF, 2013) in Germany. Therefore, the conclusion that the PC stopped existing after the financial crisis cannot be confirmed for sure, which leads to the puzzling task on how to interpret these

results. Nevertheless, what can be stated with certainty, is that households' inflation expectations should still be pursued to be implemented in the PC, due to the evidence provided by the research. Thereby, it is empirically proven that households' and firms' inflation expectations are in many respects more similar than those of professional forecasters (Coibion and Gorodnichenko, 2015) (Kumar et al., 2018).

One possible explanation may lie in the conversion of qualitative to quantitative inflation expectations. Thereby, questions about the validity of the probability method for the EC consumer survey arises. In order to solve this problem, future research could be concentrated on improving the methodology of deriving quantitative data from qualitative data. However, this does not seem to be promising, as this thesis already pushed the possibilities to do this to a limit. Still, it could be worthwhile to use the probability method for households' inflation expectations of other countries in the Euro zone and examine the respective PC. On the other hand, if the methodology is proven to be reliable, the provided data type seems to be the problem. Hence, the data of the EC consumer survey does not allow to calculate appropriate quantitative measures of inflation expectations. So, capturing quantitative inflation expectations by surveys is necessary in Germany. In general, the quality of the collected data should be improved for the whole Euro zone, especially for inflation expectations. Otherwise, the testing of macroeconomic relationships will prove to be increasingly difficult in the future.

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10 Appendix A

In the following, the formulas[23] of the four different households' inflation expectations variants are presented including the actual used scaling factor instead of the variable notation π_{t-1}^{P} (Notice that the abbreviations of table 2 are used.).

1) Formula for Inflation Expectations variant 1 π_t^{E1}:
    a. Inflation Expectations: z-scores calculated from Q6

$$\pi_t^{E1} = (-1) * "Actual\ Inflation" * \frac{z_{3,t} + z_{4,t}}{z_{1,t} + z_{2,t} - z_{3,t} - z_{4,t}}$$

2) Formula for Inflation Expectations variant 2 π_t^{E2}:
    a. Inflation Expectations: z-scores calculated from Q6

$$\pi_t^{E2} = (-1) * "Historical\ Inflation\ Mean" * \frac{z_{3,t} + z_{4,t}}{z_{1,t} + z_{2,t} - z_{3,t} - z_{4,t}}$$

3) Formula for Inflation Expectations variant 3 π_t^{E3}:
    a. Perceived Inflations: z-scores calculated from Q5

$$\pi_t^{P1} = (-1) * "Actual\ Inflation" * \frac{z_{3,t} + z_{4,t}}{z_{1,t} + z_{2,t} - z_{3,t} - z_{4,t}}$$

    b. Inflation Expectations: z-scores calculated from Q6

$$\pi_t^{E3} = -\pi_{t-1}^{P1} * \frac{z_{3,t} + z_{4,t}}{z_{1,t} + z_{2,t} - z_{3,t} - z_{4,t}}$$

4) Formula for Inflation Expectations variant 4 π_t^{E4}:
    a. Perceived Inflations: z-scores calculated from Q5

$$\pi_t^{P2} = (-1) * "Historical\ Inflation\ Mean" * \frac{z_{3,t} + z_{4,t}}{z_{1,t} + z_{2,t} - z_{3,t} - z_{4,t}}$$

    b. Inflation Expectations: z-scores calculated from Q6

$$\pi_t^{E4} = -\pi_{t-1}^{P2} * \frac{z_{3,t} + z_{4,t}}{z_{1,t} + z_{2,t} - z_{3,t} - z_{4,t}}$$

[23] Formulas are used from Mestre (2007).

11 Declaration of Autonomy

I certify that I have written this bachelor thesis independently and without outside help, that I have not used any sources other than those indicated, and that I have identified the passages taken from the sources used as such. This applies to all graphics, drawings, maps and images included in the bachelor thesis. This bachelor thesis has not been presented in this or a similar form in any other course.

Munich, 13.07.2022

Place and date | Signature

12 Code

```
#Delete Environment

rm(list = ls())

#setting working directory

setwd("D:/Synology/x_Alexander/00 Studium VWL/00 Vorlesungen/300
Bachelorarbeit/Data/Final_data")

# Load Packages
library(tidyverse)
library(readxl)
library(lubridate)
library(seasonal)
library(seasonalview)
library(tsbox)
library(writexl)
library(forecast)
library(sandwich)
library(lmtest)
library(stargazer)
library(RJDemetra)
library(plm)

# Data import of unadjusted monthly data
data_m <- read_excel("D:/Synology/x_Alexander/00 Studium VWL/00 Vorlesungen/300
Bachelorarbeit/Data/Final_data/fred_data_01.xlsx",
                     sheet = "Monatsreihe") %>%
  remove_rownames()  %>%
  mutate(time = paste0(as.character(time), "-01")) %>%
  mutate(time = lubridate::as_date(time, format = "%Y-%m-%d")) %>%
  slice(., 1:(n() - 3))

# Data import of unadjusted quarterly data
data_q <- read_excel("D:/Synology/x_Alexander/00 Studium VWL/00 Vorlesungen/300
Bachelorarbeit/Data/Final_data/fred_data_01.xlsx",
                     sheet = "Quartalsreihe") %>%
          mutate(quartal, quartal = as_date(zoo::as.yearqtr(quartal, format = "%Y-Q%q"))))
%>%
          slice(., 1:(n() - 1 )) %>%
          rename(., time = quartal)


####
## Seasonally Adjustment - Quarterly Data
####

data_q1 <- data_q %>%
  select(time, ur_q, ur_qpc,u_person, inf_exp_acc, oil_price_eu)
```

```
data_qts <- data_q[, -1]

## cpi_q
ts4 <- ts(data_qts$cpi_q, start = 1980, frequency = 4)
s4 <- x13(ts4)
tm4 <- ts_df(s4$final$series)
tm4 <- rename(tm4, cpi_q = value)

## cpi_mpc_m
ts5 <- ts(data_qts$cpi_qpc, start = 1980, frequency = 4)
s5 <- x13(ts5)
tm5 <- ts_df(s5$final$series[,2])
tm5 <- rename(tm5, cpi_qpc = value)

## v_person

ts7 <- ts(data_qts$v_person, start = 1980, frequency = 4)
s7 <- x13(ts7)
tm7 <- ts_df(s7$final$series[,2])
tm7 <- rename(tm7, v_person = value)

### Data for final quarterly data used in the regression

data_qa <- as.data.frame(merge(tm4, tm5, by = "time"))
data_qa1 <- merge(data_qa, tm7, by = "time" )
data_qa2 <- as.data.frame(full_join(data_qa1, data_q1, by = "time"))
data_qa2$cpi_qpc <- tsclean(data_qa2$cpi_qpc)
data_final_q <- data_qa2 %>%
  subset(id == "sa")

#Export of Dataset to .xlsx
write_xlsx(data_final_q, "D:/Synology/x_Alexander/00 Studium VWL/00 Vorlesungen/300
Bachelorarbeit/Data/Final_data/fred_q_s.xlsx")

###
## Preparation of Data
###

# Import Inflation expectation based on year-on-year inflation rate derived from quarterly data

exp_qq <- read_excel("D:/Synology/x_Alexander/00 Studium VWL/00 Vorlesungen/300
Bachelorarbeit/Data/Final_data/datashares_nsa_m_nace2/consumer_expectations_m_07.xlsx"
,
                     sheet = "InfExp_Q") %>%
    select("quartal", "ie_1q", "ie_2q", "ie_ed1q", "ie_ed2q", "ie_1qa", "ie_2qa", "ie_ed1qa",
"ie_ed2qa") %>%
    mutate(quartal, quartal = as_date(zoo::as.yearqtr(quartal, format = "%Y-Q%q")))

# Import Adjusted year-on-year inflation rate
```

```
df_ir <- read_excel("D:/Synology/x_Alexander/00 Studium VWL/00 Vorlesungen/300
Bachelorarbeit/Data/Final_data/datashares_nsa_m_nace2/consumer_expectations_m_07.xlsx"
,
                    sheet = "AdjInf_Q") %>%
  select("time", "cpi_qa", "cum_mean_qa") %>%
  mutate(time, quartal = as_date(zoo::as.yearqtr(time, format = "%Y-Q%q"))) %>%
  select("quartal", "cpi_qa", "cum_mean_qa")

df_exp_q <- data_final_q %>%
  rename(., quartal = time) %>%
  full_join(., exp_qq, by ="quartal") %>%
  full_join(., df_ir, by = "quartal") %>%
  rename(., date = quartal) %>%
  drop_na()

#############
##### q-o-q inflation rate annualized as basis (Percentage change from a year ago; calculated
from the own seasonal adjusted data)
#############

###
## Plot - One-year ahead Inflation rate
###

## Perceived Inflation as scaling factor for inflation expectations

plot_iep <- ggplot(data=df_exp_q, aes(x=date))+
  geom_line(aes( y = cpi_qa, group =1L, linetype =""))+
  geom_line(aes( y = ie_1qa, group =1L, color="Variant 3"))+
  geom_line(aes( y = ie_2qa, group =1L, color="Variant 4"))+
  scale_linetype_manual(values = (c("dashed"))) +
  scale_color_manual(values=c("darkorange2","darkgreen")) +
  scale_x_date( date_breaks = "2 year", date_labels = "%Y") +
  ggtitle("Graph 2: Actual Inflation vs. one-year ahead Inflation Expectations: Variant 4 and
5") +
  ylab("Inflation Rate in Percent") +
  xlab("") +
  labs(subtitle = "Scaling Factor Type: Perceived Inflations derived from Q5",
       caption  = "(Source: Own Elaboration from German Data received from FRED and the
European Comission consumer survey.)",
       linetype = "Actual Inflation",
       color = "Inflation Expectations") +
  theme_light()

ggsave("Graph02.png", plot_iep, width = 10, height = 7)

## Actual Inflation as scaling factor for inflation expectations

plot_iea <-  ggplot(data=df_exp_q, aes(x=date))+
  geom_line(aes( y = cpi_qa, group =1L, linetype =""))+
  geom_line(aes( y = ie_ed1qa, group =1L, color="Variant 1"))+
```

```
  geom_line(aes( y = ie_ed2qa, group =1L, color="Variant 2"))+
  scale_linetype_manual(values = (c("dashed"))) +
  scale_color_manual(values=c("blue","red")) +
  scale_x_date( date_breaks = "2 year", date_labels = "%Y") +
  ggtitle("Graph 1: Actual Inflation vs. one-year ahead Inflation Expectations: Variant 1 and
2") +
  ylab("Inflation Rate in Percent") +
  xlab("") +
  labs(subtitle = "Scaling Factor Type: Direct Measures of Perceived Inflation",
       caption  = "(Source: Own Elaboration from German Data received from FRED and the
European Comission consumer survey.)",
       linetype = "Actual Inflation",
       color = "Inflation Expectations") +
  theme_light()

ggsave(filename = "Graph01.png", plot = plot_iea, width = 10, height = 7)

###
##  Stability of the PC | Variant 4
###

# Regression1: from 1985 to 2021

lm14 <- lm(cpi_qpc ~  ie_2qa + ur_q, df_exp_q)

reg14 <- coeftest(lm14, vcov. = NeweyWest(lm14, lag = 5, prewhite = F, adjust = T))

# Regression2: from 1985 to 2014

lm24 <- df_exp_q %>%
  filter(date >= "1985-01-01" & date <= "2014-10-01") %>%
  lm(cpi_qpc ~  ie_2qa + ur_q ,. )

reg24 <- coeftest(lm24, vcov. = NeweyWest(lm24, lag = 5, prewhite = F, adjust = T))

#Regression3: from 1990 to 99

lm34 <- df_exp_q %>%
  filter(date >= "1990-01-01" & date <= "1999-10-01") %>%
  lm(cpi_qpc ~  ie_2qa + ur_q, data = .)

reg34 <- coeftest(lm34, vcov. = NeweyWest(lm34, lag = 5, prewhite = F, adjust = T))

#Regression4: from 1985 to 1999

lm44 <- df_exp_q %>%
  filter(date >= "1985-01-01" & date <= "1999-10-01") %>%
  lm(cpi_qpc ~  ie_2qa + ur_q,. )

reg44 <- coeftest(lm44, vcov. = NeweyWest(lm44, lag = 5, prewhite = F, adjust = T))
```

```
#Regression5: from 2000 to 2014

lm54 <- df_exp_q %>%
  filter(date >= "2000-01-01" & date <= "2014-10-01") %>%
  lm(cpi_qpc ~  ie_2qa + ur_q,. )

reg54 <- coeftest(lm54, vcov. = NeweyWest(lm54, lag =  5, prewhite = F, adjust = T))

## Regression6: from 1990 to 2007 | Pre Crisis

lm64 <- df_exp_q %>%
  filter(date >= "1990-01-01" & date <= "2007-10-01") %>%
  lm(cpi_qpc ~  ie_2qa + ur_q ,. )

reg64 <- coeftest(lm64, vcov. = NeweyWest(lm64, lag = 5, prewhite = F, adjust = T))


# Regression7: from 2010 to 2021: Post Crisis

lm74 <- df_exp_q %>%
  filter(date >= "2010-01-01" & date <= "2021-10-01") %>%
  lm(cpi_qpc ~  ie_2qa + ur_q ,. )

reg74 <- coeftest(lm74, vcov. = NeweyWest(lm74, lag = 5, prewhite = F, adjust = T))

# Regression8: from 2000 to 2021

lm84 <- df_exp_q %>%
  filter(date >= "2000-01-01" & date <= "2021-10-01") %>%
  lm(cpi_qpc ~  ie_2qa + ur_q,. )

reg84 <- coeftest(lm84, vcov. = NeweyWest(lm84, lag = 5, prewhite = F, adjust = T))

## Table: Regression on q-o-q inflation rate

# With NeweyWest SE
stargazer(reg14, reg24, reg34, reg44, reg54, reg64, reg74, reg84,
        title = "Table 7: Stability of the Phillips Curve |  Inflation Expectations: Variant 4",
        dep.var.caption = "Dependent variable: q-o-q inflation rate of period t",
        covariate.labels = c("Households' Inflation Expectations", "Unemployment Rate"),
        column.labels = c("1985-2021","1985-2014", "1990-1999", "1985-1999","2000-2014",
"1990-2007", "2010-2021",
                          "2000-2021"),
        add.lines = list(c("Observation", "147", "119", "40", "59", "60", "72", "48", "88"),
                         c("R2", "0.149", "0.231", "0.475", "0.430", "0.018", "0.390", "0.012",
"0.006")),
        notes = "(Source: Own Elaboration from German Data received from FRED and the
European Comission consumer survey.)",
        omit = "Constant",
        type = "text",
```

```
        out = "D:/Synology/x_Alexander/00 Studium VWL/00 Vorlesungen/300
Bachelorarbeit/Data/Final_data/reg_ie6.html"
)

# Without NeweyWest SE

stargazer(lm14, lm24, lm34, lm44, lm54, lm64, lm74, lm84,
        title = "Stability of the Phillips Curve | NO NeweyWest | Inflation Exp. exp",
        dep.var.caption = "Dependent variable: q-o-q inflation rate of period t",
        covariate.labels = c("Expected Inflation of Households", "Unemployment Rate"),
        column.labels = c("1985-2021","1985-2014", "1990-1999", "1985-1999","2000-2014",
"1990-2007", "2010-2021",
                          "2000-2021"),
        omit = "Constant",
        type = "text"
)


###
##  Stability of the PC | Variant 3
###

# Regression1: from 1985 to 2021

lm15 <- lm(cpi_qpc ~  ie_1qa + ur_q, df_exp_q)

reg15 <- coeftest(lm15, vcov. = NeweyWest(lm15, lag = 5, prewhite = F, adjust = T))

# Regression2: from 1985 to 2014

lm25 <- df_exp_q %>%
  filter(date >= "1985-01-01" & date <= "2014-10-01") %>%
  lm(cpi_qpc ~  ie_1qa + ur_q ,. )

reg25 <- coeftest(lm25, vcov. = NeweyWest(lm25, lag = 5, prewhite = F, adjust = T))

#Regression3: from 1990 to 99

lm35 <- df_exp_q %>%
  filter(date >= "1990-01-01" & date <= "1999-10-01") %>%
  lm(cpi_qpc ~  ie_1qa + ur_q, data = .)

reg35 <- coeftest(lm35, vcov. = NeweyWest(lm35, lag = 5, prewhite = F, adjust = T))

#Regression4: from 1985 to 1999

lm45 <- df_exp_q %>%
  filter(date >= "1985-01-01" & date <= "1999-10-01") %>%
  lm(cpi_qpc ~  ie_1qa + ur_q,. )

reg45 <- coeftest(lm45, vcov. = NeweyWest(lm45, lag = 5, prewhite = F, adjust = T))
```

```
#Regression5: from 2000 to 2014

lm55 <- df_exp_q %>%
  filter(date >= "2000-01-01" & date <= "2014-10-01") %>%
  lm(cpi_qpc ~  ie_1qa + ur_q,. )

reg55 <- coeftest(lm55, vcov. = NeweyWest(lm55, lag =  5, prewhite = F, adjust = T))

## Regression6: from 1990 to 2007 | Pre Crisis

lm65 <- df_exp_q %>%
  filter(date >= "1990-01-01" & date <= "2007-10-01") %>%
  lm(cpi_qpc ~  ie_1qa + ur_q ,. )

reg65 <- coeftest(lm65, vcov. = NeweyWest(lm65, lag = 5, prewhite = F, adjust = T))

# Regression7: from 2010 to 2021: Post Crisis

lm75 <- df_exp_q %>%
  filter(date >= "2010-01-01" & date <= "2021-10-01") %>%
  lm(cpi_qpc ~  ie_1qa + ur_q ,. )

reg75 <- coeftest(lm75, vcov. = NeweyWest(lm75, lag = 5, prewhite = F, adjust = T))

# Regression8: from 2000 to 2021

lm85 <- df_exp_q %>%
  filter(date >= "2000-01-01" & date <= "2021-10-01") %>%
  lm(cpi_qpc ~  ie_1qa + ur_q,. )

reg85 <- coeftest(lm85, vcov. = NeweyWest(lm85, lag = 5, prewhite = F, adjust = T))

## Table: Regression on q-o-q inflation rate

# With NeweyWest SE
stargazer(reg15, reg25, reg35, reg45, reg55, reg65, reg75, reg85,
        title = " Table 6: Stability of the Phillips Curve |  Inflation Expectations: Variant 3",
        dep.var.caption = "Dependent variable: q-o-q inflation rate of period t",
        covariate.labels = c("Households' Inflation Expectations", "Unemployment Rate"),
        column.labels = c("1985-2021","1985-2014", "1990-1999", "1985-1999","2000-2014",
"1990-2007", "2010-2021", "2000-2021"),
        add.lines = list(c("Observation", "147", "119", "40", "59", "60", "72", "48", "88"),
                         c("R2", "0.189", "0.255", "0.479", "0.409", "0.025", "0.412", "0.048",
"0.019")),
        notes = "(Source: Own Elaboration from German Data received from FRED and the
European Comission consumer survey.)",
        omit = "Constant",
        type = "text",
        out = "D:/Synology/x_Alexander/00 Studium VWL/00 Vorlesungen/300
Bachelorarbeit/Data/Final_data/reg_ie5.html"
```

```
)

# Without NeweyWest SE

stargazer(lm15, lm25, lm35, lm45, lm55, lm65, lm75, lm85,
        title = "Stability of the Phillips Curve | NO NeweyWest | Inflation Exp. exp",
        dep.var.caption = "Dependent variable: q-o-q inflation rate of period t",
        covariate.labels = c("Expected Inflation of Households", "Unemployment Rate"),
        column.labels = c("1985-2021","1985-2014", "1990-1999", "1985-1999","2000-2014",
"1990-2007", "2010-2021", "2000-2021"),
        omit = "Constant",
        type = "text",
        out = "D:/Synology/x_Alexander/00 Studium VWL/00 Vorlesungen/300
Bachelorarbeit/Data/Final_data/reg_exp2.html"
)

###
##   Stability of the PC | Variant 1
###

# Regression1: from 1985 to 2021

lm16 <- lm(cpi_qpc ~ ie_ed1qa + ur_q, df_exp_q)

reg16 <- coeftest(lm16, vcov. = NeweyWest(lm16, lag = 5, prewhite = F, adjust = T))

# Regression2: from 1985 to 2014

lm26 <- df_exp_q %>%
  filter(date >= "1985-01-01" & date <= "2014-10-01") %>%
  lm(cpi_qpc ~  ie_ed1qa + ur_q ,. )

reg26 <- coeftest(lm26, vcov. = NeweyWest(lm26, lag = 5, prewhite = F, adjust = T))

#Regression3: from 1990 to 99

lm36 <- df_exp_q %>%
  filter(date >= "1990-01-01" & date <= "1999-10-01") %>%
  lm(cpi_qpc ~  ie_ed1qa + ur_q, data = .)

reg36 <- coeftest(lm36, vcov. = NeweyWest(lm36, lag = 5, prewhite = F, adjust = T))

#Regression4: from 1985 to 1999

lm46 <- df_exp_q %>%
  filter(date >= "1985-01-01" & date <= "1999-10-01") %>%
  lm(cpi_qpc ~  ie_ed1qa + ur_q,. )

reg46 <- coeftest(lm46, vcov. = NeweyWest(lm46, lag = 5, prewhite = F, adjust = T))

#Regression5: from 2000 to 2014
```

```
lm56 <- df_exp_q %>%
  filter(date >= "2000-01-01" & date <= "2014-10-01") %>%
  lm(cpi_qpc ~  ie_ed1qa + ur_q,. )

reg56 <- coeftest(lm56, vcov. = NeweyWest(lm56, lag =  5, prewhite = F, adjust = T))

## Regression6: from 1990 to 2007 | Pre Crisis

lm66 <- df_exp_q %>%
  filter(date >= "1990-01-01" & date <= "2007-10-01") %>%
  lm(cpi_qpc ~  ie_ed1qa + ur_q ,. )

reg66 <- coeftest(lm66, vcov. = NeweyWest(lm66, lag = 5, prewhite = F, adjust = T))

# Regression7: from 2010 to 2021: Post Crisis

lm76 <- df_exp_q %>%
  filter(date >= "2010-01-01" & date <= "2021-10-01") %>%
  lm(cpi_qpc ~  ie_ed1qa + ur_q ,. )

reg76 <- coeftest(lm76, vcov. = NeweyWest(lm76, lag = 5, prewhite = F, adjust = T))

# Regression8: from 2000 to 2021

lm86 <- df_exp_q %>%
  filter(date >= "2000-01-01" & date <= "2021-10-01") %>%
  lm(cpi_qpc ~  ie_ed1qa + ur_q,. )

reg86 <- coeftest(lm86, vcov. = NeweyWest(lm86, lag = 5, prewhite = F, adjust = T))

## Table: Regression on q-o-q inflation rate

# With NeweyWest SE
stargazer(reg16, reg26, reg36, reg46, reg56, reg66, reg76, reg86,
        title = " Table 4: Stability of the Phillips Curve | Inflation Expectations: Variant 1",
        dep.var.caption = "Dependent variable: q-o-q inflation rate of period t",
        covariate.labels = c("Households' Inflation Expectations", "Unemployment Rate"),
        column.labels = c("1985-2021","1985-2014", "1990-1999", "1985-1999","2000-2014",
"1990-2007", "2010-2021",
                          "2000-2021"),
        add.lines = list(c("Observation", "147", "119", "40", "59", "60", "72", "48", "88"),
                         c("R2", "0.172", "0.259", "0.465", "0.409", "0.015", "0.403", "0.013",
"0.003")),
        notes = "(Source: Own Elaboration from German Data received from FRED and the
European Comission consumer survey.)",
        omit = "Constant",
        type = "text",
        out = "D:/Synology/x_Alexander/00 Studium VWL/00 Vorlesungen/300
Bachelorarbeit/Data/Final_data/reg_ie3.html"
)
```

```
# Without NeweyWest SE

stargazer(lm16, lm26, lm36, lm46, lm56, lm66, lm76, lm86,
        title = "Stability of the Phillips Curve | NO NeweyWest | Inflation Exp. exp",
        dep.var.caption = "Dependent variable: q-o-q inflation rate of period t",
        covariate.labels = c("Expected Inflation of Households", "Unemployment Rate"),
        column.labels = c("1985-2021","1985-2014", "1990-1999", "1985-1999","2000-2014",
"1990-2007", "2010-2021",
                          "2000-2021"),
        omit = "Constant",
        type = "text",
        out = "D:/Synology/x_Alexander/00 Studium VWL/00 Vorlesungen/300
Bachelorarbeit/Data/Final_data/reg_exp2.html"
)

###
##   Stability of the PC | Variant 2
###

# Regression1: from 1985 to 2021

lm17 <- lm(cpi_qpc ~  ie_ed2qa + ur_q, df_exp_q)

reg17 <- coeftest(lm17, vcov. = NeweyWest(lm17, lag = 5, prewhite = F, adjust = T))

# Regression2: from 1985 to 2014

lm27 <- df_exp_q %>%
  filter(date >= "1985-01-01" & date <= "2014-10-01") %>%
  lm(cpi_qpc ~  ie_ed2qa + ur_q ,. )

reg27 <- coeftest(lm27, vcov. = NeweyWest(lm27, lag = 5, prewhite = F, adjust = T))

#Regression3: from 1990 to 99

lm37 <- df_exp_q %>%
  filter(date >= "1990-01-01" & date <= "1999-10-01") %>%
  lm(cpi_qpc ~  ie_ed2qa + ur_q, data = .)

reg37 <- coeftest(lm37, vcov. = NeweyWest(lm37, lag = 5, prewhite = F, adjust = T))

#Regression4: from 1985 to 1999

lm47 <- df_exp_q %>%
  filter(date >= "1985-01-01" & date <= "1999-10-01") %>%
  lm(cpi_qpc ~  ie_ed2qa + ur_q,. )

reg47 <- coeftest(lm47, vcov. = NeweyWest(lm47, lag = 5, prewhite = F, adjust = T))

#Regression5: from 2000 to 2014
```

```
lm57 <- df_exp_q %>%
  filter(date >= "2000-01-01" & date <= "2014-10-01") %>%
  lm(cpi_qpc ~  ie_ed2qa + ur_q,. )

reg57 <- coeftest(lm57, vcov. = NeweyWest(lm57, lag =  5, prewhite = F, adjust = T))

## Regression6: from 1990 to 2007 | Pre Crisis

lm67 <- df_exp_q %>%
  filter(date >= "1990-01-01" & date <= "2007-10-01") %>%
  lm(cpi_qpc ~  ie_ed2qa + ur_q ,. )

reg67 <- coeftest(lm67, vcov. = NeweyWest(lm67, lag = 5, prewhite = F, adjust = T))

# Regression7: from 2010 to 2021: Post Crisis

lm77 <- df_exp_q %>%
  filter(date >= "2010-01-01" & date <= "2021-10-01") %>%
  lm(cpi_qpc ~  ie_ed2qa + ur_q ,. )

reg77 <- coeftest(lm77, vcov. = NeweyWest(lm77, lag = 5, prewhite = F, adjust = T))

# Regression8: from 2000 to 2021

lm87 <- df_exp_q %>%
  filter(date >= "2000-01-01" & date <= "2021-10-01") %>%
  lm(cpi_qpc ~  ie_ed2qa + ur_q,. )

reg87 <- coeftest(lm87, vcov. = NeweyWest(lm87, lag = 5, prewhite = F, adjust = T))

## Table: Regression on q-o-q inflation rate

# With NeweyWest SE
stargazer(reg17, reg27, reg37, reg47, reg57, reg67, reg77, reg87,
        title = " Table 5: Stability of the Phillips Curve |  Inflation Expectations: Variant 2",
        dep.var.caption = "Dependent variable: q-o-q inflation rate of period t",
        covariate.labels = c("Households' Inflation Expectations", "Unemployment Rate"),
        column.labels = c("1985-2021","1985-2014", "1990-1999", "1985-1999","2000-2014",
"1990-2007", "2010-2021",
                          "2000-2021"),
        add.lines = list(c("Observation", "147", "119", "40", "59", "60", "72", "48", "88"),
                         c("R2", "0.027", "0.087", "0.431", "0.215", "0.009", "0.376", "0.144",
"0.064")),
        notes = "(Source: Own Elaboration from German Data received from FRED and the
European Comission consumer survey.)",
        omit = "Constant",
        type = "text",
        out = "D:/Synology/x_Alexander/00 Studium VWL/00 Vorlesungen/300
Bachelorarbeit/Data/Final_data/reg_ie4.html"
)
```

```
# Without NeweyWest SE

stargazer(lm17, lm27, lm37, lm47, lm57, lm67, lm77, lm87,
        title = "Stability of the Phillips Curve | NO NeweyWest | Inflation Exp. exp",
        dep.var.caption = "Dependent variable: q-o-q inflation rate of period t",
        covariate.labels = c("Expected Inflation of Households", "Unemployment Rate"),
        column.labels = c("1985-2021","1985-2014", "1990-1999", "1985-1999","2000-2014",
"1990-2007", "2010-2021",
                          "2000-2021"),
        omit = "Constant",
        type = "text",
        out = "D:/Synology/x_Alexander/00 Studium VWL/00 Vorlesungen/300
Bachelorarbeit/Data/Final_data/reg_exp2.html"
)


###
# END
###
```