# The Philips Curve in Europe – A Zeon's paradox approach

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Master's thesis

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**Abstract**

This paper aims to investigate the Phillips curve on a regional level in Europe. For this purpose, I fully follow the strategy of Fitzgerald and Nicolini (2014) and inspect the negative relationship between unemployment rate and future inflation in Austrian and German provinces. I collected a novel data set by combining inflation data provided by Beck, Hubrich, and Marcellino (2009) with regional unemployment data. Heart of this paper is to explore the connection between unemployment rate and inflation rate. However, both variables are affected by monetary policies. The European Central Bank (ECB), in our case, sets the interest rate to ensure price stability. By doing so the ECB influences both unemployment rate and future inflation. That both variables are linked not only through their relationship but also through monetary policies is called an endogeneity problem. Thus, the relationship between unemployment rate and inflation rate could further be explained via a model through monetary policies, which distorts my research. This triangle of reciprocal interaction between unemployment rate, inflation rate and monetary policies needs to be dissolved to discover the true effect between only unemployment rate and inflation rate. To overcome this problem and detangle the triangle, only leaving the relationship between unemployment rate and inflation rate, I am using regional European data and follow Fitzgerald and Nicolini (2014) approach. Since monetary policies only focus on stabilizing average inflation, just like the European Central Bank only focuses to stabilize inflation in the whole European currency area, I can use local disturbances in each region to investigate the relationship between unemployment rate and future inflation rate. I isolate the connection of interest between unemployment rate and inflation rate by subtracting the average inflation rate and unemployment rate from the regional inflation rate and the regional unemployment rate. The difference leaves me solely with the local relationship between only unemployment rate and inflation rate and cuts of the tip of the triangle (monetary policies) from both unemployment rate and future inflation rate. The essence of this paper is to use those local independent, exogenous shocks to discover a possible structural and robust relationship between unemployment rate and future inflation rate. I refer to this method of using regional shocks as the ‘Zeno’s paradox approach’. Based on the assumption that the NAIRU model is true, I find in line with previous research of regional American data that a 1 percent point increase in the unemployment rate is related with a roughly 0.15 -0.4 percentage point decline in Inflation over the following year. However, due to ambiguous results in my analysis, I caution that my findings do not provide conclusive evidence of a stable Philips curve.

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## 1 Introduction

This paper investigates the stability of the Phillips curve in Europe. Fully following the strategy of Fitzgerald and Nicolini (2014) in the United States, I make use of a novel dataset containing regional inflation and unemployment rate data to continue economic research in forecasting inflation.[2] The idea is to use disaggregated inflation and unemployment data, which is immune to policy changes, in an attempt to estimate a robust and stable relationship for the euro area.

Traditionally, aggregated data has been used to forecast inflation, however, aggregated data is uninformative to recover the true structural relationship between inflation and economic activity, since the relationship suffers of endogeneity. As Fitzgerald and Nicolini (2014) argue, aggregated data of unemployment rate and inflation is endogenous - meaning both variables can be explained by the relationship between functions within the model, causing them to be endogenous. This mechanism works, inter alia, through the channel of monetary policy, which effects both inflation as well as unemployment rate.

To overcome this problem I make use of more detailed data recovering an exogenous variable. In the spirit of Zeno's paradox that we keep converging to that finite moment and then reinvent a new further room for us to inhabit[3], this thesis zooms into regional space to reveal the next layer of truth in disaggregated data instead of aggregated data. Just like in Zeno's paradox I am able to[4]

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[2] To be precise, I fathom out the coefficient of a European Old Keynesian NAIRU-type Phillips curve. Read in greater detail in 2.2.

[4] Zeno of Elea, a pre-Socratic Greek philosopher, is credited with creating the Zeno's paradox. "In a race, the quickest runner can never overtake the slowest, since the pursuer must first reach the point whence the pursued started, so that the slower must always hold a lead." –Aristoteles. Zeno's key assumption (which breaks down in theory like general relativity according to Hans Reichenbach) is that time and distance can be infinitely split up to an infinite series. Further information can be found here: http://www.iep.utm.edu/zeno-par/#SSH3ai and here: https://plato.stanford.edu/entries/paradox-zeno/#Bac.

divide space into even smaller units - in my case regional data - while remaining spatially on the same overarching question: “Is there a stable relationship between unemployment and future inflation?” I refer to this approach as the ‘Zeno’s paradox approach’.

In my NAIRU-type method the central bank, by implication, reacts to global shocks using monetary policies to absorb disturbances on an average, aggregated level. However, the structural relationship between unemployment rate and inflation can be recovered by creating a variable which holds the residue between the regional level and the aggregate. The difference holds the effect of unemployment rate on future inflation, because exogenous regional shocks are not controlled for by the central bank and therefore, if the average effect is crossed out, the model finally yields an exogenous structural relationship.

This paper is structured as follows: Chapter two presents a historical literature review of the Philips curve, studying the evolution of the Philips curve and introduces the NAIRU model. Chapter three develops the implication of the theory and presents my empirical strategy. It also gives special emphasis to the various biases potentially plaguing my work. The data set for my main analysis is presented in chapter four, together with a descriptive analysis. Building on the baseline ideas, chapter five displays the core of my empirical analysis, presenting the relationship between regional unemployment and future inflation. Its robustness is tested in chapter 6 by carrying out the same approach using two different data sets. Finally, chapter seven summarizes my findings and concludes.

# 2 Literature overview

## 2.1 Historical context of the Philips curve

The history of the Philips curve can be roughly split into two different time periods: The period before 1975, characterized by the initial discovery of the Philips curve, and the post 75's time when literature split up in various directions. For most of the literature an American perspective is adopted and also research has been dominated by US-Americans (Gordon 2008).

The Philips curve has first been documented and analyzed by Irving Fisher in 1926. Fisher explained the mechanism in a reversed order, starting with a change in the rate of inflation which he believed to induce changes in the level of unemployment. He later reprinted and published his work again in 1973. However, much more attention attracted William Philips, the namesake of the relationship, in 1958, who published his research using historical data from the United Kingdom. He built upon an astonishing dataset of nearly a century, tracing a rather stable structural relationship between unemployment and wage growth. Very low unemployment was accompanied with a high inflation rate which reinforced the support for his theory (Gordon 2008).

In the 1960s economists soon estimated the Philips curve for that time and discovered a close fit between the appraised curve and the actual data. Leading economists such as Robert Solow and Paul Samuelson focused on large scale macro econometric models, making use of new computer-based technology, and treated the Philips curve as a new menu of policy options. Policy advisors took the Philips curve seriously and thought that at the cost of higher inflation the government could stimulate the economy to lower unemployment.[5]

In his work from 1968, Milton Friedman argued that well-informed, rational agents would consider only real wages and therefore react instantly to an expansive monetary policy. Hence, according to Friedman, policy makers had no ability to control the natural unemployment rate in the long-run, because the micro econometric structure of both labor and product market would “ground out” monetary policies.

Friedman’s models premised on the assumption of continuous market clearing and imperfect information. In 1972 Lucas added rational expectations, as a third element, instead of slowly-adjusting adaptive expectations. Accordingly, agents would learn from past history and apply their observations of fallen or risen wages in future bargaining. Rational expectations indicates that previous errors are accounted for and expectational errors are not repeated (Lucas 1972).

Lucas’ path breaking approach, as well as Friedman’s contribution, suggests that a deviation of the natural level requires a surprise effect. Due to the unexpected shocks on the market the central bank cannot change output by predictable changes in their monetary policies. Consequently, anticipated monetary policies cannot change the gross domestic product in a predictable way.[6]

The 70s were an era of impressive affirmation for Friedman’s and Lucas’ essential point (Nelson 2009). Inflation rose while the unemployment rate did not only fall but actually increased from

[5] Mainly the policy advisors of the Kennedy and Johnson administration led by Walter Heller. This led to major cuts in the federal income tax in the 60s. Nevertheless the economy was already at an unemployment rate of 5.5 percent. According to the calculations from Samuelson and Solow this would already accelerate inflation even leaving out the fiscal glut of money due to the Vietnam War (Gordon 2008).
[6] Long and short run expectations can also be combined known as the expectations-augmented Phillips curve. The quicker the expectations of price inflations return to its natural rate the less effective is the monetary policy.

about 4 to 6 percent in the United States. Within academia excitement diminished about the fact that a mechanism between economic activity and inflation is exploitable. However, the Philips Curve remained in the books of economic theory as well as in the minds of the economic establishment.

Multiple approaches have emerged after 1975, of which I will only place emphasis on the NAIRU model. The relationship was proven instable by the groundbreaking research by Atkeson and Ohanian (2001), who demonstrated in their paper that the Philips curve is highly unstable during the period of 1960 to 2000 in the United States. By providing compelling evidence using a naïve prediction rule for inflation, where past inflation systematically outperforms NAIRU-type Philip curves, they proofed an instable relationship. The time period covered by Atkeson and Ohanian is exposed to various changing policy regimes, which leads to resultant shifts in parameters and serves as a proof that the relationship is unsteady. Consequently, one could argue, that this tradeoff between inflation and unemployment is not steadfast and should not be used as a policy measure. The analysis of Fitzgerald and Nicolini (2014), however, investigates whether or not by using a different approach a potential stable relationship can be recovered.

## 2.2 The NAIRU-model

NAIRU stands for non-accelerating inflation rate of unemployment and was first introduced by Franco Modigliani and Lucas Papademos in 1975. It was seen as an improvement to Friedman's concept of the natural rate of unemployment. This new form of the Phillips curve includes the concept of short run phenomena, meaning that real effects of monetary policies are taken into account. This is often referred to as the NAIRU hypothesis: Once the short run push in inflation is acknowledged the unemployment rate returns to its natural rate which is consistent with a stable inflation. (Ball et al. 2002)[7]

# 3 Methodology

The usual approach for examining the existence of the Phillips curve is a statistical analysis between current unemployment and future inflation. Many different concepts have been used varying by data or functional form. This research fully implements the research strategy of Fitzgerald and Nicolini (2014). Their research focused on American data, whereas I continue their work by cross checking the relationship and approach for the European currency area. This is interesting for two reasons. First of all, it is interesting if a similar approach is even feasible in the European Union with European data. I managed to prove this point to be true by writing this thesis and using European data. Second and more importantly, is there a stable Philips curve? Meaning, can I find a similar coefficient like previously found by academia using different data? If yes, that would imply that we have proven a structural relationship. A reaction of future inflation to unemployment which is forecastable. If not, then future inflation may not be impacted by unemployment rate and there is no causation. Having those two, last questions in mind, I would like to outlay my methodology. First I explain the general concept of a regional NAIRU model. In 3.1 I will continue by presenting the Zeno's paradox approach, so how regional data is used to recover the Zeno's paradox variable and yielding a possible stable relationship. And as the last

[7] The natural unemployment rate is also referred to as the baseline rate, which is easy to imagine and is nicely explained by Atkeson and Ohanian (2001): "These specifications are based on the idea that there is a baseline rate of unemployment at which inflation tends to remain constant. The idea is that when unemployment is below this baseline rate, inflation tends to rise over time, and when unemployment is above this rate, inflation tends to fall."

step of my methodology design I introduce the two stage least square approach. Another additional approach to investigate the relationship between unemployment rate and future inflation.

But for now, I would like to introduce the general NAIRU model for each of our European regional areas' region $j$. For each region I form a NAIRU regional inflation regression model solution and a NAIRU unemployment model solution.

$$\pi_{t+1}(j) = A + B\pi_t(j) + \; Cu_t(j) + Fi_t(j) + \mathcal{E}_{t+1}^{\pi}(j) - \xi_{t+1}^{\pi}$$

This regression above presents the NAIRU future inflation regional regression model solution for each region, where $\pi_{t+1}(j)$ stand for future inflation (for each region $j$). $\mathcal{E}_{t+1}^{\pi}(j)$ represents regional inflation shocks. This variable holds the unexpected fluctuation on a regional level, a key element in this paper. $\xi_{t+1}^{\pi}$ captures the unexpected variation on an aggregated level. I need to assume zero unconditional mean for both parameter. $Fi_t(j)$ holds immediate monetary effects of policy changes on the two endogenous variables inflation and unemployment.

Similar as the future inflation regression above is the NAIRU model for unemployment (Fitzgerald and Nicolini 2014).:

$$u_{t+1}(j) = A' + B'\pi_t(j) + \; C'u_t(j) + F'i_t(j) + \mathcal{E}_{t+1}^{u}(j) - \xi_{t+1}^{u},$$

where $u_{t+1}(j)$ presents future unemployment for each region. $\mathcal{E}_{t+1}^{u}(j)$ and $\xi_{t+1}^{u}$ present regional and aggregated unexpected shocks. Those two parameter capture the deviation of the expected future unemployment and I am assuming zero unconditional mean. $F'i_t(j)$ holds immediate monetary effects of policy changes on the two endogenous variables inflation and unemployment. This can be seen as the expected effect.

All models of all region $j$ form two aggregated models, which is one equation each for future inflation and unemployment.[8] The local error term drops out by nature, since the model is presenting the aggregate Fitzgerald and Nicolini 2014).

$$\pi_{t+1} = A + B\pi_t + Cu_t + Fi_t + \xi_{t+1}^{\pi}$$

$$u_{t+1} = A' + B'\pi_t + C'u_t + F'i_t + \xi_{t+1}^{u}.$$

Three assumptions should be discussed. First, monetary authority sets their policy before observing $t + 1$, which makes sense since the central bank cannot foresee the future. If the Central Bank could do that, our error term would drop to zero because the central bank would perfectly predict the interest rate. Second, all regions are independent and identical across the regional level[9]. This assumption is justifiable since all regions in Austria and Germany are similar from size and economic power. However, this assumption is rather strong, since in reality there is economic inequality. And last, my main parameter of interest $C$ has the same dynamic in all regions. This implies, for instance, higher future inflation in regions with comparably low unemployment and vice versa. This dynamic is assumed to be the true for all regions.

I am trying to explore the connection between unemployment rate and inflation rate. However, both variables are affected by monetary policies. The European Central Bank (ECB), in our case, sets an interest rate to ensure price stability. By doing so the ECB influences both unemployment

[8] The aggregate can be written as the sum of all regions as Fitzgerald and Nicolini (2014) did in my lead paper: $\pi_{t+1} = \int_0^1 \pi_{t+1}(j)dj$, $u_{t+1} = \int_0^1 \pi_{t+1}(j)dj$.

[9] Regions could also be weighted depending on population or economic power for instance. Since in our main data set I use Austrian and German regional data this is justifiable, because mean and standard deviation are similar across all regions, see appendix. For future research I suggest using NUTS 2 data. NUTS data is classified data provided by the European Union, sorted by a hierarchical system for dividing up the economic territory of the EU.

rate and future inflation. That both variables, I am trying to investigate, are linked not only through their relationship but also through monetary policies is called an endogeneity problem. This triangle of reciprocal interaction between unemployment rate, inflation rate and monetary policies needs to be dissolved to discover the true effect between only unemployment rate and inflation rate. To overcome this problem and detangle the triangle only leaving the relationship between unemployment rate and inflation rate, I use regional European data and follow Fitzgerald and Nicolini (2014) approach. Since monetary policies only focus on stabilizing average inflation, just like the European Central Bank only focuses to stabilize inflation in the whole European currency area, I can use local disturbances in each region to investigate the relationship between unemployment rate and future inflation rate. I am doing this by subtracting the average inflation rate and unemployment rate from the regional inflation rate and the regional unemployment rate. The difference leaves me solely with the local relationship between only unemployment rate and inflation rate and cuts of the tip of the triangle (monetary policies) from both unemployment rate and future inflation rate. The essence of this paper is to use those local independent, exogenous shocks to discover a possible structural and robust relationship between unemployment rate and future inflation rate. I refer to this method of using regional shocks as the ‘Zeno’s paradox approach’.

Also note that the ECB only has a single mandate which is price stability. I am assuming that monetary policies are a short-run phenomenon and have a predictable and structural effect on real activity, which is precisely what I am aiming to proof. This is known as the NAIRU hypothesis and already discussed in 2.2.

## 3.1 Zeno's paradox approach

To shed light on the empirical validity of the theoretical ideas outlined in the previous section, I will investigate the relationship between inflation and unemployment rate using the "Zeno' paradox approach"[10]. As I have explained in the section before, I have to overcome the endogeneity problem. Or as I like to see it, the triangle of reciprocal interaction between unemployment rate, inflation rate and monetary policies, where we have to cut of the tip of the triangle: monetary policies. And are then solely left with the connection between unemployment rate and inflation rate. I hereby fully follow Fitzgerald and Nicolini (2014).

I think its best explained using an example. Let me describe the approach using Vienna, my former home, as a model. To illustrate this I present Figure 1 and 2 on page 17. Figure 1 depicts inflation rate and unemployment rate as well as the European average for both from 1996 until 2004. One can clearly observe that from January 2001 forward the Unemployment rate (red line) in Austria deviates from the European average (yellow line). What we are observing is a local negative economic shock in Vienna causing the unemployment rate to jump above the European average. That difference is captured in the Zeno's paradox variable Z. In other words, the difference between average unemployment rate and regional unemployment rate leaves me with the Zeno's

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[10] A personal side note to appreciate a wonderful answer in my favorite podcast "Freakonomics", where I first heard of the Zeno's paradox mentioned by Jeremey Greene: To the question in the first episode "bad medicine" "[…] how would you assess the share of the body and its functions that we truly understand and the share that we don't really yet understand?" Jeremey Greene answered in a brilliant way: "There is a Rumsfeldian answer of the known knowns, known unknowns and unknown unknowns. A different way of answering that question would have to do with what the idea of relevant science of medicine is. (…) So as a historian, rather than giving you a fixed percent of where we are, I can give you a Zeno's paradox that we keep on getting close to that finite moment and then reinvent a new broader room for us to inhabit." I think that this answer also fits the Philips curve drama; I can break it up further and further, reinvent a new broader space, to try to get closer to the answer of that ever moving question.
http://freakonomics.com/podcast/bad-medicine-part-1-story-98-6/
https://www.hopkinshistoryofmedicine.org/content/jeremy-greene

paradox variable Z. This variable then only holds local, exogenous (independent form monetary policies) shocks. One can also notice that from January 2002 forward the inflation in Vienna (blue bars) is below the European average (light blue colored area). Same procedure, I am taking the difference between average European inflation and local Viennese inflation (Vienna's inflation is below the European average). Again, this is done to ensure that monetary policy influences are crossed out and I am ending up with only exogenous, independent data for inflation rate. Figure 2 nicely sums up the exogenous, independent data: the inflation deviation (light blue bars) for Vienna as well as the unemployment deviation (red bars) for Vienna. In other words, it presents the independent (unemployment deviation, also called Zeno's variable Z) and dependent variable (inflation deviation) for our Viennese model. The negative relationship is clearly visible, if unemployment deviation is positive (meaning Vienna has a higher unemployment rate then the European average) inflation deviation is negative (meaning Vienna has a lower inflation then European average). How strong this mechanic is and if it is structural or robust, meaning a universal stable link between unemployment rate and inflation rate is the heart of this paper.

Moving from our Viennese example to my model, I can phrase what I have just explained into a regression. I have done this for three different models, which only differ slightly from each other in forecasting time and dummy variable variation.

As explained, the parameter of interest is $Z$, the coefficient of my Zeno's paradox variable. To be precise, $Z$ is the coefficient of the deviation of the regions away from the national average. Moreover, $Z$ is supposed to be negative since prices are not fully flexible and therefore prices adjust slowly to restore the equilibrium.

Hereafter, I present the regressions I used[11]:

$$\pi_{t+3}(j) = B(\pi_t(j) - \pi_t) + Z(u_t(j) - u_t) + G_{\varepsilon_{t+1}}(j) + G(\xi_{t+1} - E_t\xi_{t+1}) \quad (1)$$

$$\pi_{t+6}(j) = S_j + R_j + B(\pi_t(j) - \pi_t) + Z(u_t(j) - u_t) + G_{\varepsilon_{t+1}}(j) + G(\xi_{t+1} - E_t\xi_{t+1}) \quad (2)$$

$$\pi_{t+12}(j) = D_a + S_j + R_j + B(\pi_t(j) - \pi_t) + Z(u_t(j) - u_t) + G_{\varepsilon_{t+1}}(j) + G(\xi_{t+1} - E_t\xi_{t+1}) \quad (3)$$

, where $\pi_t(j)$ represents regional inflation and $u_t(j)$ regional unemployment. $R_i$ represents national dummies[12], $S_j$ stands for state dummies and $D_a$ for an annual time dummy, which can be interpreted as an estimate of the inflation target for this period. The coefficient $G$ is the coefficient of an idiosyncratic error term. It is composed of a general forecasting error for each region $G_{\varepsilon_{t+1}}(j)$ and a forecasting error by the Central Bank $G(\xi_{t+1} - E_t\xi_{t+1})$[13]. Both errors are assumed to be independent across states and countries and have a mean zero. $Z$ represents the coefficient of interest, the difference between regional and national unemployment $(u_t(j) - u_t)$. The main difference between those three models is the forecasting period, either being in three months, in six months or in twelve months' time. They are also varying in dummy variables.

Since there is no official target rate published by the European Central Bank, I calculate the average using regional German and Austrian data. The limitations are obvious, as Austria and Germany are considered countries with both lower unemployment and inflation rate then the

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[11] Including time, country and state dummies therefore model (3).

[12] Takes the value of one for all German states and zero for Austrian states.

[13] When a constant inflation target is assumed, which is not the case in my model, however, for explanatory purposes it is here simplified, then:

$$\pi_t^* = \pi^*, \pi_{t+1} - \pi_t = (\xi_{t+1}^{\pi} - E_t\xi_{t+1}^{\pi}) + G(\xi_t^{\pi} - E_{t-1}\xi_t^{\pi}),$$

current unemployment $u_t$ is affected by the change in inflation to the degree to which the forecast error over- or underestimates inflation. However, if the estimate is different from zero it is not directly related to Z. Fitzgerald and Nicolini (2014)

European average, my calculated average will be below the true European average. As a consequence, my Zeno's paradox variable will have an upwards bias, since the amount I subtract is less than the true European average.

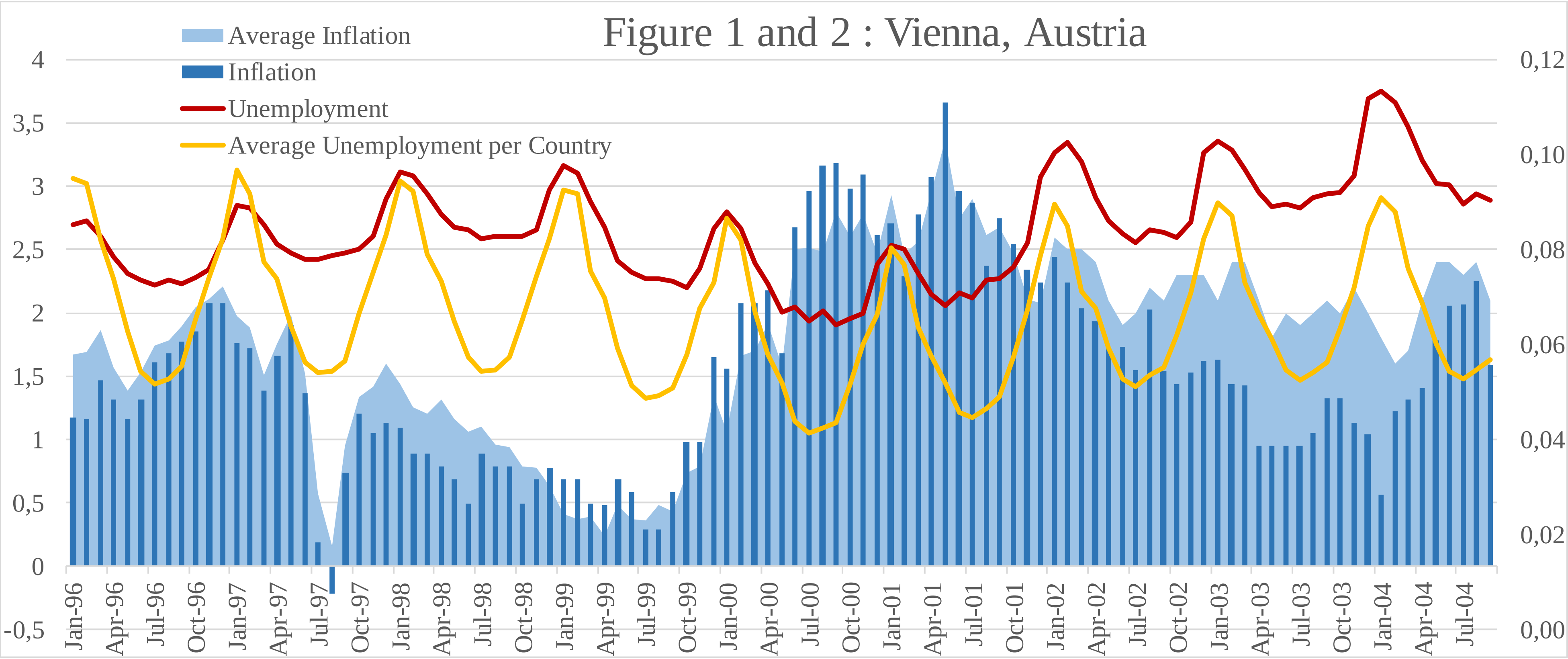

Figure 1 and 2 : Vienna, Austria
Average Inflation
Inflation
Unemployment
Average Unemployment per Country
4
3,5
3
2,5
2
1,5
1
0,5
0
-0,5
0,12
0,10
0,08
0,06
0,04
0,02
0,00
Jan-96
Apr-96
Jul-96
Oct-96
Jan-97
Apr-97
Jul-97
Oct-97
Jan-98
Apr-98
Jul-98
Oct-98
Jan-99
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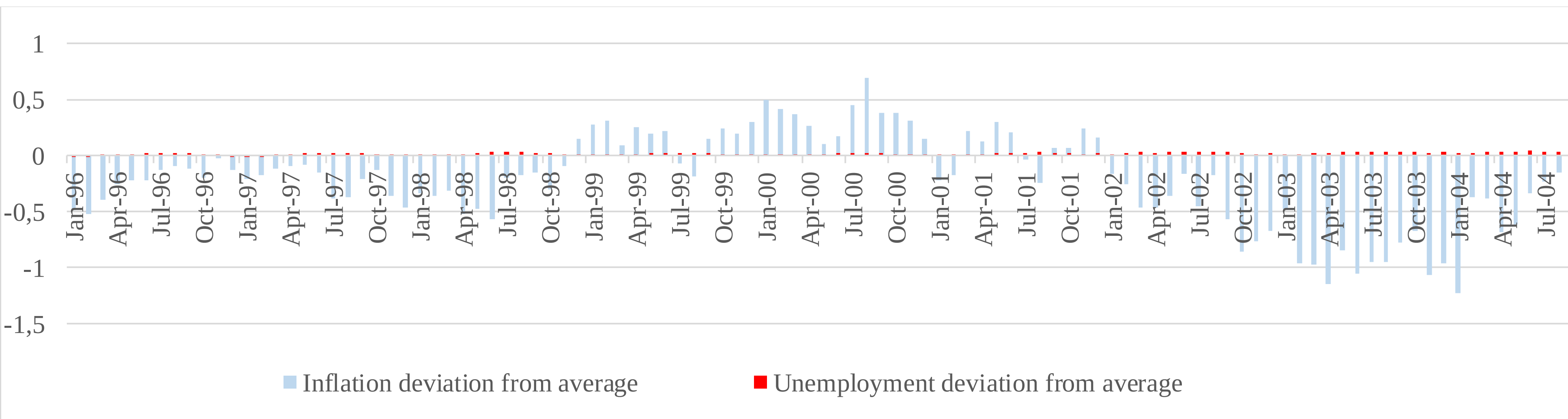
Jan-04
Apr-04
Jul-04

1
0,5
0
-0,5
-1
-1,5
Jan-96
Apr-96
Jul-96
Oct-96
Jan-97
Apr-97
Jul-97
Oct-97
Jan-98
Apr-98
Jul-98
Oct-98
Jan-99
Apr-99
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Jul-01
Oct-01
Jan-02
Apr-02
Jul-02
Oct-02
Jan-03
Apr-03
Jul-03
Oct-03
Jan-04
Apr-04
Jul-04
Inflation deviation from average
Unemployment deviation from average

## 3.2 Two stage least square

The equations when estimated by Ordinary Least Squares (OLS) yield the correlation between inflation rate and unemployment. However, there are several reasons that speak against attributing a causal interpretation to the OLS estimates gained from equation (3). The main reason is that they might suffer from autocorrelation bias since the shock $\varepsilon_{t+1}$ might correlate with inflation as well as unemployment $(\pi_t, u_t)$. This would result in an overestimation of the effect due to an omitted variable bias. I can solve this problem partially by adding year dummies, state dummies and country dummies to the equation, however, there certainly are other unobserved factors driving the relation between inflation and unemployment. In order to overcome the autocorrelation problem I follow yet again Fitzgerald and Nicolini (2014) and carry out a two-stage least-squares regression (2SLS), where I lag unemployment rates in the first stage. Equation (4) represents the first stage with regional unemployment lagged and equation (5) presents my original model including the instrumental variable, where $\bar{\beta}$ depicts my instrument.

$$\beta(u_t(j) - u_t) = D_a + B(\pi_t(j) - \pi_t) + C\,u_{t-1}(j) + G_{\varepsilon_{t+1}}(j) + G(\xi_{t+1} - E_t\xi_{t+1}) \quad (4)$$

$$\pi_{t+1}(j) = D_a + B(\pi_t(j) - \pi_t) + Z\,\bar{\beta} + H_{\varepsilon_{t+1}}(j) + H(\xi_{t+1} - E_t\xi_{t+1}) \quad (5)$$

Two assumptions need to hold to ensure the validity of the instrument. First, the instrument must have a strong correlation with the original variable of interest. Second, it should only effect inflation rate through my instrument $Z$; this assumption is called exclusion restriction. I will discuss both assumptions in my analysis part.

# 4 Data description

My main variables of interest are inflation and unemployment rate on two different dimensions. First, the province or state level, as a geographical dimension. And second, a time dimension, for which I collected cross sectional data on a 1996 to 2004 time horizon. Data for both variables are typically published by Eurostat, the OECD and available at the office of statistics from each individual member state, whereby the data varies in terms of availability and frequency for each country and state.

Due to sketchy availability, especially with regards to the regional geographical dimensions, I compile three different data sets. One main data[14] set and two additional datasets for robustness checks. For my main inflation variable this paper draws heavily on the provided novel dataset by Beck et al. (2009) I would like to express my gratitude and appreciation to them for providing me access to their data. It includes data on province-level for inflation of a total of 4876 observations, covering a time frame from 1996 to 2004. For more details and a thorough discussion of the data sources and definitions I would like to refer the reader to their paper.[15] Most important, for my purpose, are the countries I could match with unemployment data on a monthly time dimension and on a regional level. I achieved this in my main dataset for almost all German states and all Austrian provinces.

[14] The main dataset holds data of the following states in Germany: Bend-Wuertenberg, Bayern, Berlin, Brandenburg, Hessen, Mecklenburg Vorpommern, Niedersachsen, Nordreinwestfahlen, Saarland, Sachsen, Thueringen. And in Austria: Burgenland, Kaernten, Nierderoesterreich, Oberoesterreich, Salzburg, Steiermark, Tirol, Voralberg, Wien.

[15] Following an excerpt of Beck et al.'s data description: "The dataset contains consumer price index (CPI) data from six EMU member countries (Austria, Finland, Germany, Italy, Norway and Spain), and comprises a total of 70 locations. These data cover about two-thirds of the euro area in terms of economic activity and span the period 1995(1) to 2004(10) on a monthly frequency. For the remaining euro area countries comparable regional data are not available or at least not for a similar time span."

The information for unemployment rate, on a monthly disaggregated and aggregated basis, is provided by the respective national employment agency of Austria and Germany.[16]

A few words of caution are in order. First, using state provinces as a measurement proxy for disaggregated data I necessarily need to assume that all states are comparable to each other. However, states differ among other things in size, economic strength and population. For the purpose of my research, data on NUTS 2 level[17] would be more suitable. This data is unfortunately not yet available for my specific case but should be considered for future research. Second, the time horizon from 1996 to 2004 is plagued by a crisis in the year 2001. This might impact my study, since far more parameter than inflation influence future inflation especially in times of economic depression. Third, the time period can be divided into a time before and after the introduction of the euro currency in 2002. I took this fact into account by using the average inflation rate for each country before 2002 and after 2002 the European average. Fourth, for the purpose of testing my hypothesis, using regional data from all provinces in Europe would be the ideal method. However, my study is limited to data on a state level for Austria and Germany due to scarce data availability. In the absence of additional data, especially from southern countries, I must assume that the same relationship can be revealed with a richer dataset. Finally, the definition of unemployment rate differs slightly between Austria and Germany.[18]

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[16] More information online. Links to the German and Austrian federal agency of employment (Statistik der Bundesagentur fuer Arbeit; Arbeitsmarktservice Oesterreich):
https://statistik.arbeitsagentur.de/ http://www.ams.at/ueber-ams/medien/arbeitsmarktdaten

[17] The NUTS classification (Nomenclature of territorial units for statistics) is a hierarchical system for dividing up the economic territory of the EU. Nuts 2 is defined as "basic regions for the application of regional policies" and is collected for the purpose of socio-economic research. Please find more information to this topic on the following website: http://ec.europa.eu/eurostat/web/nuts

[18] I would like to refer the reader to the handbook of the respective labor agencies.

Table 1 presents a summary statistic for the variable inflation and unemployment rate.[19] The German states make up a larger share of my data with a total of 1155 observations compared to 945 observations from Austria.

**Table 1: summary statistics: main data set**

| | | Mean | Standard Error | Max | Min | N |
|---|---|---|---|---|---|---|
| Inflation | AUT | 1.622 | 0.786 | 3.672 | -0.380 | 945 |
| | DEU | 1.338 | 0.762 | 4.302 | -1.066 | 1155 |
| | Total | 1.466 | 0.786 | 4.302 | -1.066 | 2100 |
| Unemployment rate | AUT | 0.066 | 0.023 | 0.158 | 0.023 | 945 |
| | DEU | 0.136 | 0.049 | 0.239 | 0.052 | 1155 |
| | Total | 0.104 | 0.053 | 0.239 | 0.023 | 2100 |

The second data set includes provinces from Germany, Austria, Italy and Spain[20]. The frequency is annual, beginning in the year 2002 and dates until 2016. All states are selected by data availability. The main source for inflation data continues to be the paper by Beck et al (2009). Data for the variable unemployment rate has been provided by each national employment agency for Germany and Austria, whereas I handpicked unemployment data for states from Italy and Spain from regional government websites.

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Germany: https://statistik.arbeitsagentur.de/Statischer-Content/Grundlagen/Kurzinformationen/Generische-Publikationen/Kurzinformation-Arbeitsmarktstatistik.pdf
Austria: https://statistik.arbeitsagentur.de/Statischer-Content/Grundlagen/Glossare/Generische-Publikationen/AST-Glossar-Gesamtglossar.pdf

[19] For greater detail I kindly refer you to Appendix one.

[20] The second dataset holds data of the same states for Austria and Germany as the main data set. In addition it contains Italian and Spanish data. Italian provinces are: Bari, Cagliari, Campobasso, Firenze, Genova, L'Aquila, Milano, Napoli, Palermo, Perugia, Potenza, Roma, Torino, Trento, Trieste, Venezia. Spanish provinces are the following: Madrid, Murcia, Asturias, Oviedo, Valencia.

Table 3 and figure 3 present information for the third data set. This data set operates on an annual and national level for each state with the euro currency. Since not all countries have been members of the euro-area, observations vary for each individual state. The timeframe is here from 2002 until 2016.

Data sets two and three are mainly used for robustness checks.

# 5 Analysis: The relationship between unemployment rate and future inflation

## 5.1 The Zeno's paradox OLS regression

In the empirical analysis, I investigate the impact of the 'Zeno's paradox approach' making use of an ordinary least squared regression (OLS). As I have already explained before, a naïve OLS regression is not likely to disclose the true causal relationship, due to an endogeneity bias and a possible autocorrelation problem. The Zeno's paradox approach will correct the endogeneity bias, as elucidated previously. However, a potential autocorrelation can occur when $\xi_t(j)$ will be correlated with $\pi_t(j)$ and $u_t(j)$. I will therefore report, in the next section, a two-stage least square regression, in which lagged values of unemployment are used in the first stage.

OLS estimates yet do serve as valuable benchmarks. Table 2 presents three OLS model outputs which vary in composition of different control variables and dependent variables.[21] The country

[21]Regressions are as followed:

$$\pi_{t+3}(j) = B(\pi_t(j) - \pi_t) + Z(u_t(j) - u_t) + G_{\varepsilon_{t+1}}(j) + G(\xi_{t+1} - E_t\xi_{t+1}) \quad (1)$$

$$\pi_{t+6}(j) = S_j + R_j + B(\pi_t(j) - \pi_t) + Z(u_t(j) - u_t) + G_{\varepsilon_{t+1}}(j) + G(\xi_{t+1} - E_t\xi_{t+1}) \quad (2)$$

dummy is equal to 1 for all German states and 0 for all Austrian States. I also included a time dummy for each year, 1996 to 2004. State dummies are in place to capture individual characteristics for each state.

The results are remarkable. It can be observed that the estimate coefficients on the Zeno's paradox variable for all models are negative and, after correction of a potential omitted variable bias, even within the range of the output of my lead paper from Fitzgerald and Nicolini (2014). Moreover, for model (1) and (2) the results are significantly different from 0.[22] Furthermore, the coefficient tends to increase in magnitude over time, which could be explained by a lagged price adjustment response to a change in unemployment rate. The country dummy enters with a negative sign for all models. Overall, the models forecasting inflation for 3 and 6 months find exactly the same coefficient range as Fitzgerald and Nicolini (2014), although not always significant. However, the exact comparison of a one-year forecast does not match precisely with the American findings of a coefficient around 0.3. In this case, I find that a 1 percentage point increase in the unemployment rate is related with a roughly 1.9 percentage point decline in inflation over the following year, which is almost five times as much as the coefficient of Fitzgerald and Nicolini (2014). This might be due to an overestimation caused by an omitted variable bias. One reason for an omitted variable bias could be that I only have observations for rather strong economical players within the union and lack counterbalance of weaker countries. The ECB, however, reacts on the sake of all member states and, therefore, disregarding countries in my regression must cause distortions in my results. I control for this in two ways. First, by comparing the coefficients before and after the introduction

$$\pi_{t+12}(j) = D_a + S_j + R_j + B(\pi_t(j) - \pi_t) + Z(u_t(j) - u_t) + G_{\varepsilon_{t+1}}(j) + G(\xi_{t+1} - E_t\xi_{t+1}) \quad (3)$$

[22] Please find the complete output in the appendix.

of the euro currency. I split the data into two sets - before and after the introduction of a single currency - and compare the coefficients of all models in both time frames with each other.[23] The coefficient average of all models results in a drop by 1.3. When I subtract it from my estimate, it drops to the expected scale of around 0.5, which supports my hypothesis that I have an omitted variable bias.[24] This approach can be seen as an attempt to correct for my omitted variable bias. However, it would be more rigorous to rely on a more balanced data set. Further I will carry our my robustness check using two different data sets, which both include observations of other (economically weaker) member states and should drive down my overestimated coefficient. I will investigate this further in section 6, the chapter dedicated to my robustness check.

[23] Since I consider the relationship between unemployment rate and future inflation a structural liaison, the problem of comparing two different time periods with each other can be disregarded. I therefore assume that the only change is the change of the introduction of one currency. This is a strong assumption and it should be regarded consciously.
[24] Please find the details in table 7 in the appendix.

**Table 2: Model 1: OLS regression output**

| | OLS (1) | OLS (2) | OLS (3) | OLS (1) | OLS (2) | OLS (3) | OLS (1) | OLS (2) | OLS (3) |
|---|---|---|---|---|---|---|---|---|---|
| | | Inflation t+3 | | | inflation t+6 | | | inflation t+12 | |
| Zeno's paradox variable: Z | -0.89* | -0.70* | -0.22 | -1.39** | -1.29*** | -0.475 | -2.24*** | -2.35*** | -1.90 |
| | (-2.15) | (-2.50) | (-0.23) | (-3.09) | (-4.09) | (-0.42) | (-4.46) | (-6.70) | (-1.55) |
| DEU | | -0.16*** | -0.32*** | | -0.21*** | -0.20* | | -0.27*** | -0.23* |
| | | (-7.45) | (-3.85) | | (-8.58) | (-2.36) | | (-10.08) | (-2.52) |
| Country dummy | NO | YES | YES | NO | YES | YES | NO | YES | YES |
| Time dummies | NO | YES | YES | NO | YES | YES | NO | YES | YES |
| State dummies | NO | NO | YES | NO | NO | YES | NO | NO | YES |
| N | 2040 | 2040 | 2040 | 1980 | 1980 | 1980 | 1860 | 1860 | 1860 |

T statistics in parentheses, *,** and *** denote significance at a 10, 5 and 1% significance level, respectively. The dependent variable indicated with Inflation t+3, Inflation t + 6 and Inflation + 12.

## The Zeno's paradox two-stage least square regression

I continue by reporting the Zeno's paradox two stage least square regression, where I use lagged unemployment as an instrument. As previously explained the main advantage of a two-stage least squared approach is that it corrects for the autocorrelation problem.

Hereafter, I present the regressions for the output (5.1) 2SL2 (3):

$$\beta(u_t(j) - u_t) = D_a + S_j + R_j + B(\pi_t(j) - \pi_t) + C\, u_{t-4}(j) + G_{\varepsilon_{t+1}}(j) + G(\xi_{t+1} - E_t\xi_{t+1}) \quad (4.1)$$

$$\pi_{t+1}(j) = D_a + S_j + R_j + B(\pi_t(j) - \pi_t) + U\,\bar{\beta} + H_{\varepsilon_{t+1}}(j) + H(\xi_{t+1} - E_t\xi_{t+1}) \quad (5.1)$$

, where I use unemployment with a four-month lag as an instrument, $C\, u_{t-4}(j)$. Consequently (5.2) 2SL2 (3) and (5.3) 2SL2 (3) hold respectively, $C\, u_{t-6}(j)$ and $C\, u_{t-12}(j)$.

I chose to refrain from using multiple lags as a combined instrument due to overidentification problems. I tested multiple variations, almost all suffered from overidentification. To test for overidentification I carried out the standard Sargan and Basmann test. The null hypothesis for both the Sargan and the Basmann test were rejected, which means that my instruments were not valid and my model was incorrectly specified. For this reason, my models will only be defined with single instruments.

Table 3 presents my 2SLS output for three different models. The models differ in lagged value used as instruments and in dummy sets.[25] The coefficient for almost all models are similar to my OLS results. However, the magnitude of my coefficient is still surprisingly high. The same caveats are in order as in the previous section. The models still suffer from an omitted variable bias in the same magnitude. As previously described a more balanced data shall deliver smaller coefficients. The robustness check will provide more insights as the coefficient should drop, due to an overestimation in my main models.

Reporting the first stage regression, I am most interested in partial r-squared and the F-statistic. The first stage assumption appears to hold, since the F-statistic is by far large enough for all three models[26]. The partial r-square is in most cases over 0.75 which is reasonable.[27] Therefore I can reject my $H_0$ hypothesis that my instruments are weak and can conclude that the first assumption is met. The second assumption required is the exclusion restriction, which denotes that my instrumental variable should be related to my outcome variable future inflation, $\pi_{t+1}(j)$, only

[25] I am sticking to the same dummy variable set as previously used in my OLS regression.
[26] Standard is that the value exceeds the critical value of 10.
[27] The partial r-square measures the correlation between future inflation, $\pi_{t+1}(j)$, and my instrument, lagged unemployment rate, after partialling out the unemployment variable.

through its impact on the unemployment variable and is not correlated with the error term in equation (4.1).

**Table 3: Model 1: 2SLS regression output**

| | (5.1) | | | (5.2) | | | (5.3) | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2SLS (1) | 2SLS (2) | 2SLS (3) | 2SLS (1) | 2SLS (2) | 2SLS (3) | 2SLS (1) | 2SLS (2) | 2SLS (3) |
| Instrument: | lag t-4 | | | lag t-6 | | | lag t- 12 | | |
| Unemployment lagged | Inflation t+1 | | | Inflation t+1 | | | Inflation t+1 | | |
| Unemployment | -2.31*** | -0.47 | 3.25 | -2.40*** | -0.58* | -1.9* | -2.43*** | -0.61* | -1.97* |
| | (-6.38) | (-1.58) | (0.95) | (-7.18) | (-2.25) | (-2.32) | (-7.27) | (-2.34) | (-2.40) |
| DEU | | -0.052 | -0.361 | | -0.049 | 0.099 | | -0.043 | 0.106 |
| | | (-1.78) | (-1.15) | | (-1.63) | (1.02) | | (-1.58) | (1.08) |
| Country dummy | NO | YES | YES | NO | YES | YES | NO | YES | YES |
| Time dummies | NO | YES | YES | NO | YES | YES | NO | YES | YES |
| State dummies | NO | NO | YES | NO | NO | YES | NO | NO | YES |
| N | 1760 | 1760 | 1760 | 1760 | 1760 | 1760 | 1760 | 1760 | 1760 |

T statistics in parentheses, *, ** and *** denote significance at a 10, 5 and 1% significance level, respectively. The dependent variable is Inflation + 1 for all models. Model (5.1) utilizes a 4-month lag as instrument, model (5.2) 6 months and model (5.3) 12 months.

# 6 Robustness checks

After a visual inspection of my data a number of concerns for the robustness of my coefficients became apparent. In order to address those concerns, I collected two further data sets, for which I matched inflation and unemployment data in Europe on a yearly basis. The data sets mainly differ in frequency of the observation and in country composition. The rationale for two further data sets lies in the expectation that I should be able to proof similar results as in my main data set but with different data. Moreover, the third data set is valuable for the reason that it has a more balanced country composition and could deliver less biased results.

## 6.1 Second data set

The second data set is an extension of the main data set. It contains regional data from Germany, Austria and provinces of two southern European countries, namely, Italy and Spain. However, it is based on a yearly frequency instead of a monthly frequency and therefore has substantially less observations. It covers a timespan from 1999 to 2004 with a total of 200 observations. I added a dummy variable measuring the north south country difference. German and Austrian states take the value 1 in my variable “North” in order to capture possible differences between northern European and southern European countries.

Table 4 reports output for three different OLS and 2SLS models. The models vary in control variable composition. The coefficient of interest for all models is negative. Those results confirm a slightly negative link. The North dummy enters the equation with a negative sign.

**Table 4: Model 2: OLS and 2SLS regression output**

| | OLS (1) | OLS (2) | OLS (3) | 2SLS (1) | 2SLS (2) | 2SLS (3) |
|---|---|---|---|---|---|---|
| | | Inflation t+1 | | | Inflation | |
| OLS: Zeno's paradox variable: Z | -0.0164 | 0.0193 | -0.00460 | -0.00344 | -0.0258 | -0.148*** |
| 2SLS: Unemployment | (-1.65) | (0.55) | (-0.16) | (-0.31) | (-0.52) | (-3.99) |
| Germany | | -0.884* | 0 | | -1.606*** | -1.144*** |
| | | (-2.16) | (.) | | (-4.30) | (-4.05) |
| Austria | | 0 | 0.651* | | -1.309*** | -1.743*** |
| | | (.) | (1.98) | | (-3.56) | (-6.26) |
| Italy | | -1.237*** | -1.061** | | -1.061** | -0.446 |
| | | (-3.59) | (-3.04) | | (-2.83) | (-1.58) |
| Spain | | 0 | 0 | | 0 | 0 |
| | | (.) | (.) | | (.) | (.) |
| Nord dummy | | -1.421*** | -2.015*** | | 0 | 0 |
| | | (-4.13) | (-4.68) | | (.) | (.) |
| constant | 2.199*** | 3.199*** | 3.278*** | 2.051*** | 3.557*** | 4.590*** |
| | (42.01) | (13.93) | (16.27) | (33.50) | (6.03) | (10.24) |
| Country dummy | NO | YES | YES | NO | YES | YES |
| Time dummies | NO | NO | YES | NO | NO | YES |
| State dummies | NO | YES | YES | NO | YES | YES |
| Nord dummy | NO | YES | YES | NO | YES | YES |
| N | 191 | 191 | 191 | 160 | 160 | 160 |

T statistics in parentheses, *, ** and *** denote significance at a 10, 5 and 1% significance level, respectively. The dependent variable is Inflation + 1 for all OLS models and Inflation for all 2SLS models.

## 6.2 Third data set

The third data set reports data on a national level for a total of 15 European countries. I report a time horizon from 2002 until 2016, from the very beginning of the euro area, for all member states on a yearly basis. Countries like Latvia, which joined the currency union later, have respectively fewer observations. This data sets holds all countries using the euro currencies at the respective moments in time. Thus, this data set can be seen as the most balanced and should therefore deliver trustworthy results.

The results demonstrate that both robustness data sets deliver consistent estimates. All models from the third data set report mathematically significant estimates on a 1 percent level. The magnitude of the estimate ranges from 0.07 to 0.24.

This final attempt to unravel the effect of unemployment on inflation confirms again, and in a very convincing manner, that there is a slightly negative relationship between unemployment rate and future inflation.

**Table 5: Model 3: OLS and 2SLS regression output**

| | OLS (1) | OLS (2) | OLS (3) | 2SLS (1) | 2SLS (2) | 2SLS (3) |
|---|---|---|---|---|---|---|
| | | Inflation t+1 | | | Inflation | |
| OLS: Zeno's paradox variable: Z | -0.0717** | -0.178*** | -0.138*** | -0.110*** | -0.239*** | -0.156*** |
| 2SLS: Unemployment | (-2.67) | (-4.51) | (-5.70) | (-4.49) | (-7.34) | (-6.68) |
| | | (1.01) | (-0.55) | | (.) | (.) |
| constant | 1.743*** | -0.00169 | 2.200** | 2.814*** | 3.327*** | 1.290*** |
| | (14.43) | (-0.00) | (3.05) | (11.00) | (8.86) | (4.00) |
| Country dummy | NO | YES | YES | NO | YES | YES |
| Time dummies | NO | NO | YES | NO | NO | YES |
| N | 180 | 180 | 180 | 180 | 180 | 180 |

T statistics in parentheses, *,** and *** denote significance at a 10, 5 and 1% significance level, respectively. The dependent variable is Inflation + 1 for all OLS models and Inflation for all 2SLS models.

# 7 Summary and Conclusion

This study aims to continue empirical research of the NAIRU-typed Philips Curve in Europe. For this purpose, I fully follow the strategy of Fitzgerald and Nicolini (2014) and inspect the negative relationship between unemployment rate and future inflation in Austrian and German provinces.

By combining inflation data provided by Beck, Hubrich, and Marcellino (2009) with regional unemployment data I collected a novel data set. The goal is to explore the connection between unemployment rate and inflation rate. However, both variables are affected by monetary policies. The European Central Bank (ECB), in our case, sets an interest rate to ensure price stability. By doing so the ECB influences both unemployment rate and future inflation. That both variables are linked not only through their relationship but also through monetary policies is called an endogeneity problem. This triangle of reciprocal interaction between unemployment rate, inflation rate and monetary policies needs to be dissolved to discover the true effect between only unemployment rate and inflation rate. To overcome this problem and detangle the triangle only leaving the relationship between unemployment rate and inflation rate, I used regional European data and follow Fitzgerald and Nicolinis (2014) approach. Since monetary policies only focus on stabilizing average inflation, just like the European Central Bank only focuses to stabilize inflation in the whole European currency area, I use local disturbances in each region to investigate the relationship between unemployment rate and future inflation rate. I do this by subtracting the average inflation rate and unemployment rate from the regional inflation rate and the regional unemployment rate. The difference leaves me solely with the local relationship between only unemployment rate and inflation rate and cuts of the tip of the triangle (monetary policies) from both unemployment rate and future inflation rate. The essence of this paper is to use those local independent, exogenous shocks to discover a possible structural and robust relationship between unemployment rate and future inflation rate.

For this purpose, I have aligned a novel dataset of regional inflation data provided by Beck et al. (2009) with disaggregated European unemployment rate data. Three data sets deliver a unique opportunity to investigate this relationship on multiple geographical layers as well as in different time periods. In line with previous research, I find that there is a statistically negative relationship between unemployment rate and inflation, also known as the Philips curve. Using data from 1996 until 2016 my analysis finds that a 1 percentage point increase in the unemployment rate is associated with a 0.15 - 0.4 percentage point decrease in inflation over the following year.

Overall, I can confirm my main hypothesis of there being a negative link between unemployment rate and inflation. However, data constraints have prevented me from being able to arrive at an unambiguous estimate. The estimates of my main data set suffer from an omitted variable bias and report an overestimated coefficient of a magnitude around 1.9. Both of my smaller data sets, however, provide smaller estimates. Therefore, I am conscious of the fact that that my findings do not provide conclusive evidence of a stable Philips curve.

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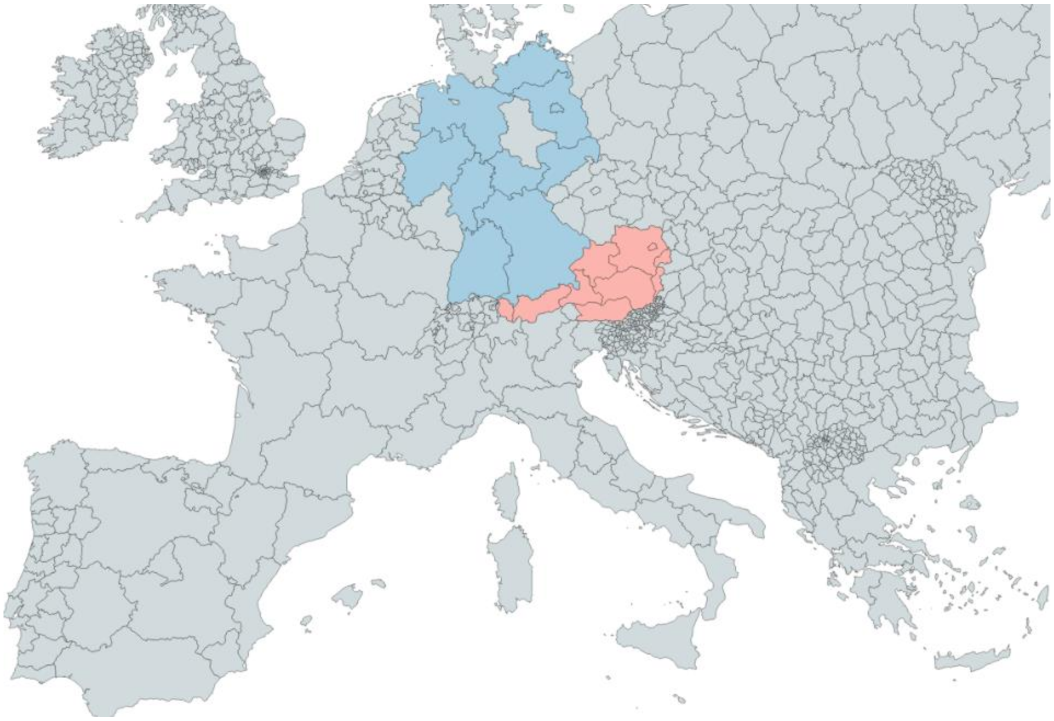
# Appendix

**Figure 3: Map of Europe: main data set contains observations from colored states**



This map illustrates all selected states from the main data set. German provinces are colored in blue and Austrian are colored in red.

**Table 6: Summary statistics: main data set**

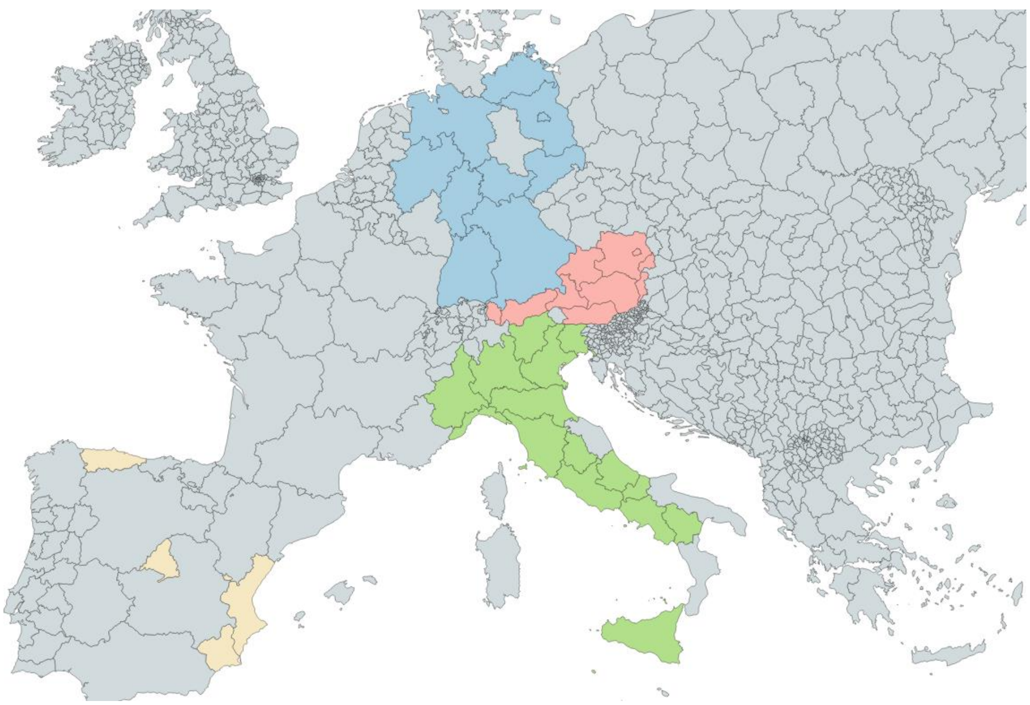
| | | Mean | Standard Error | Max | Min | N |
|---|---|---|---|---|---|---|
| inflation | Austria | 1.622136 | 0.786859 | 3.672869 | -0.38075 | 945 |
| | Germany | 1.338549 | 0.762926 | 4.302723 | -1.06635 | 1155 |
| | Total | 1.466163 | 0.786367 | 4.302723 | -1.06635 | 2100 |
| unemployment rate | Austria | 0.066307 | 0.023897 | 0.158629 | 0.023711 | 945 |
| | Germany | 0.136213 | 0.049495 | 0.239 | 0.052 | 1155 |
| | Total | 0.104755 | 0.053045 | 0.239 | 0.023711 | 2100 |

**Table 7: Summary statistics: main data set**

| | OLS (1) | OLS (2) | OLS (3) | OLS (1) | OLS (2) | OLS (3) | OLS (1) | OLS (2) | OLS (3) | OLS (1) | OLS (2) | OLS (3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Zeno's paradox variable: Z | Inflation t+3 | | | Inflation t+4 | | | Inflation t+6 | | | Inflation t+12 | | |
| 1996-2004 | -0.90* | -0.70* | -0.23 | -1.05* | -0.92** | -0.30 | -1.4** | -1.3*** | -0.47 | -2.2*** | -2.36*** | -1.91 |
| | (-2.15) | (-2.50) | (-0.23) | (-2.45) | (-3.09) | (-0.28) | (-3.09) | (-4.09) | (-0.42) | (-4.46) | (-6.70) | (-1.55) |
| 1996-2001 | -0.43 | -0.43 | 0.67 | -0.62 | -0.62 | 0.66 | -1.16 | -1.16** | -0.29 | -2.18*** | -2.18*** | -2.21 |
| | (-0.75) | (-1.13) | (0.50) | (-1.06) | (-1.57) | (0.48) | (-1.94) | (-2.87) | (-0.21) | (-3.47) | (-5.09) | (-1.50) |
| 2002-2004 | -0.60 | -1.6*** | -3.07 | -0.89 | -2.1*** | -3.6 | -1.16* | -2.2*** | -2.73 | -2.6*** | -3.6*** | -1.6 |
| | (-1.44) | (-4.41) | (-1.64) | (-1.85) | (-5.19) | (-1.76) | (-2.04) | (-4.43) | (-1.11) | (-3.48) | (-6.29) | (-0.60) |
| Difference | 0.167 | 1.17 | 3.746 | 0.272 | 1.474 | 4.269 | -0.004 | 0.98 | 2.435 | 0.396 | 1.418 | -0.555 |

Difference is defined by difference of coefficient of estimates from 1996-2001 and 2002-2004. Difference has an average across all models of 1.3. T statistics in parentheses, *,** and *** denote significance at a 10, 5 and 1% significance level, respectively. The dependent variable is Inflation t + 3, Inflation t + 4, Inflation t + 6 and Inflation t + 12 for all three OLS models.

**Figure 4: Map of second data set**



This map illustrates all selected (=colored) states from the second data set. German provinces are colored in blue, Austrian are colored in red, Italian states in green and Spanish states in yellow.

**Table 8: second data set: descriptive statistics**

| | | Mean | Standard Error | Max | Min | N |
|---|---|---|---|---|---|---|
| Inflation | Austria | 1.72 | 0.78 | 2.99 | 0.19 | 45 |
| | Germany | 1.27 | 0.074 | 3.16 | 0.06 | 55 |
| | Spain | 3.19 | 0.56 | 4 | 2.01 | 20 |
| | Italy | 2.28 | 0.53 | 3.32 | 0.41 | 80 |
| | Total | 1.96 | 0.87 | 4 | 0.57 | 200 |
| Unemployment | Austria | 4.27 | 1.39 | 8.3 | 2 | 45 |
| | Germany | 10.92 | 5.4 | 20.3 | 3.7 | 55 |
| | Spain | 11.19 | 2.93 | 17.7 | 7 | 20 |
| | Italy | 10.56 | 6.68 | 24.3 | 3.1 | 80 |
| | Total | 9.303 | 5.85 | 24.3 | 2 | 200 |

**Figure 5: Map of third data set**

This map illustrates all selected states from the third data set. Colored states have been selected.

**Table 9: Summary statistics: third data set: Inflation & Unemployment rate**

| | | Mean | Standard Error | Max | Min | N |
|---|---|---|---|---|---|---|
| Inflation | Austria | 1.85 | 0.84 | 3.55 | 0.4 | 15 |
| | Belgium | 1.9 | 1.13 | 4.48 | 0 | 15 |
| | Germany | 1.45 | 0.82 | 2.75 | 0.13 | 15 |
| | Spain | 2.08 | 2.06 | 4.7 | -1.039 | 15 |
| | Estonia | 3.51 | 3.23 | 10.6 | 0.06 | 11 |
| | France | 0.15 | 5.05 | 3.15 | -17.08 | 14 |
| | Greece | 2.08 | 2.06 | 4.7 | -1.39 | 15 |
| | Ireland | 1.48 | 1.92 | 4.69 | -1.69 | 15 |
| | Italia | 1.85 | 1.16 | 3.49 | -0.05 | 15 |
| | Luxemburg | 0.29 | 7.28 | 4.09 | -24.49 | 14 |
| | Latvia | 0.33 | 0.31 | 0.69 | 0.09 | 3 |
| | Netherlands | 1.65 | 1.05 | 3.85 | 0.1 | 15 |
| | Portugal | 1.85 | 1.44 | 3.7 | -0.91 | 15 |
| | Slovakia | 1.25 | 1.77 | 4.08 | -0.48 | 8 |
| | Slovenia | 1.84 | 1.89 | 5.52 | -0.76 | 10 |
| | Total | 1.63 | 2.83 | 10.6 | -24.49 | 195 |

| | | Mean | Standard Error | Max | Min | N |
|---|---|---|---|---|---|---|
| Unemployment rate | Austria | 5.05 | 0.62 | 6.01 | 3.95 | 15 |
| | Belgium | 7.95 | 0.51 | 8.5 | 6.97 | 15 |
| | Germany | 7.337 | 2.27 | 11.16 | 4.1 | 15 |
| | Spain | 16.47 | 6.53 | 26.09 | 8.23 | 15 |
| | Estonia | 8.86 | 3.86 | 16.7 | 4.59 | 11 |
| | France | 8.9 | 0.99 | 10.35 | 7.06 | 14 |
| | Greece | 15.5 | 7.61 | 27.46 | 7.76 | 15 |
| | Ireland | 8.86 | 4.18 | 14.67 | 4.33 | 15 |
| | Italy | 9.09 | 2.161 | 12.67 | 6.06 | 15 |
| | Luxemburg | 5.09 | 0.84 | 6.65 | 3.65 | 14 |
| | Latvia | 10.11 | 0.63 | 10.84 | 9.46 | 3 |
| | Netherlands | 4.78 | 1.57 | 7.41 | 2.75 | 15 |
| | Portugal | 10.04 | 3.49 | 16.18 | 4.99 | 15 |
| | Slovakia | 12.81 | 1.69 | 14.38 | 9.67 | 8 |
| | Slovenia | 7.6 | 1.99 | 10.1 | 4.37 | 10 |
| | Total | 9.11 | 4.88 | 27.46 | 2.75 | 195 |

**Table 10: First data set: OLS output**

| | OLS (1) | OLS (2) | OLS (3) | OLS (1) | OLS (2) | OLS (3) | OLS (1) | OLS (2) | OLS (3) |
|---|---|---|---|---|---|---|---|---|---|
| | Inflation t + 3 | | | Inflation t + 6 | | | Inflation t + 12 | | |
| OLS:Zeno's paradox variable: Z | -0.895* | -0.704* | -0.228 | -1.393** | -1.29*** | -0.475 | -2.24*** | -2.35*** | -1.908 |
| | (-2.15) | (-2.50) | (-0.23) | (-3.09) | (-4.09) | (-0.42) | (-4.46) | (-6.70) | (-1.55) |
| Inflation deviation from average | 0.562*** | 0.670*** | 0.645*** | 0.419*** | 0.476*** | 0.435*** | 0.106*** | 0.0401 | -0.0448 |
| | (21.62) | (27.60) | (25.36) | (15.18) | (17.72) | (15.45) | (3.47) | (1.37) | (-1.48) |
| Germany | | -0.16*** | -0.32*** | | -0.21*** | -0.204* | | -0.27*** | -0.237* |
| | | (-7.45) | (-3.85) | | (-8.58) | (-2.36) | | (-10.08) | (-2.52) |
| 1996 | | -0.136** | -0.110* | | -0.67*** | -0.65*** | | -0.141* | -0.0481 |
| | | (-2.68) | (-2.14) | | (-8.65) | (-8.37) | | (-2.20) | (-0.75) |
| 1997 | | -0.24*** | -0.21*** | | -0.84*** | -0.82*** | | -0.78*** | -0.68*** |
| | | (-4.69) | (-4.12) | | (-10.91) | (-10.63) | | (-12.14) | (-10.75) |
| 1998 | | -0.99*** | -0.97*** | | -1.75*** | -1.73*** | | -1.19*** | -1.10*** |
| | | (-19.67) | (-18.90) | | (-22.59) | (-22.32) | | (-18.57) | (-17.21) |
| 1999 | | -0.87*** | -0.85*** | | -1.09*** | -1.07*** | | 0.170** | 0.263*** |
| | | (-17.27) | (-16.53) | | (-14.15) | (-13.87) | | (2.65) | (4.12) |
| 2000 | | 0.387*** | 0.413*** | | 0.168* | 0.190* | | 0.702*** | 0.795*** |
| | | (7.67) | (8.08) | | (2.17) | (2.45) | | (10.94) | (12.45) |
| 2001 | | 0.589*** | 0.615*** | | -0.36*** | -0.34*** | | -0.39*** | -0.29*** |
| | | (11.66) | (12.01) | | (-4.64) | (-4.37) | | (-6.02) | (-4.60) |
| 2002 | | 0.0413 | 0.0448 | | -0.82*** | -0.83*** | | -0.68*** | -0.66*** |
| | | (0.94) | (1.02) | | (-10.65) | (-10.87) | | (-12.10) | (-12.02) |
| 2003 | | 0 | 0 | | -0.45*** | -0.47*** | | 0 | 0 |
| | | (.) | (.) | | (-5.78) | (-6.06) | | (.) | (.) |
| 2004 | | 0.536*** | 0.551*** | | 0 | 0 | | 0 | 0 |
| | | (9.67) | (9.89) | | (.) | (.) | | (.) | (.) |
| Bedenwuertenberg | | | 0.165 | | | 0.00777 | | | -0.106 |
| | | | (1.27) | | | (0.06) | | | (-0.70) |
| Bayern | | | 0.138 | | | -0.0363 | | | -0.193 |
| | | | (1.09) | | | (-0.27) | | | (-1.31) |
| Berlin | | | 0 | | | -0.26*** | | | -0.52*** |
| | | | (.) | | | (-3.40) | | | (-6.23) |
| Brandenburg | | | 0.115 | | | -0.0736 | | | -0.122 |
| | | | (1.69) | | | (-0.96) | | | (-1.47) |
| Hessen | | | 0.123 | | | -0.0537 | | | -0.191 |
| | | | (1.07) | | | (-0.44) | | | (-1.44) |
| Mecklenburgvorpommern | | | 0.0395 | | | -0.200* | | | -0.33*** |
| | | | (0.56) | | | (-2.49) | | | (-3.74) |
| Nidersachsen | | | 0.165 | | | 0.00238 | | | -0.0879 |
| | | | (1.70) | | | (0.02) | | | (-0.80) |
| Nordreihn- Westphalen | | | 0.143 | | | -0.0259 | | | -0.119 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | (1.45) | | | (-0.25) | | | (-1.05) |
| Sachsen | | | 0.112 | | | -0.0815 | | | -0.113 |
| | | | (1.63) | | | (-1.08) | | | (-1.37) |
| Saarland | | | 0.0719 | | | -0.147 | | | -0.350** |
| | | | (0.75) | | | (-1.45) | | | (-3.19) |
| Thueringen | | | 0.167* | | | 0 | | | 0 |
| | | | (2.42) | | | (.) | | | (.) |
| Burgenland | | | -0.00081 | | | 0.00747 | | | 0.00975 |
| | | | (-0.01) | | | (0.10) | | | (0.12) |
| Kaernten | | | -0.103 | | | -0.178* | | | -0.36*** |
| | | | (-1.46) | | | (-2.27) | | | (-4.26) |
| Niederoesterreich | | | 0 | | | 0 | | | 0 |
| | | | (.) | | | (.) | | | (.) |
| Oberoesterreich | | | -0.0391 | | | -0.0692 | | | -0.171* |
| | | | (-0.56) | | | (-0.89) | | | (-2.02) |
| Salzburg | | | -0.0288 | | | -0.0441 | | | -0.137 |
| | | | (-0.41) | | | (-0.56) | | | (-1.61) |
| Steiermark | | | -0.0576 | | | -0.121 | | | -0.256** |
| | | | (-0.85) | | | (-1.61) | | | (-3.12) |
| Tirol | | | -0.0365 | | | -0.0712 | | | -0.139 |
| | | | (-0.54) | | | (-0.94) | | | (-1.69) |
| Voralberg | | | -0.0239 | | | -0.0347 | | | -0.0781 |
| | | | (-0.35) | | | (-0.46) | | | (-0.94) |
| Wien | | | -0.0479 | | | -0.0825 | | | -0.161 |
| | | | (-0.69) | | | (-1.07) | | | (-1.92) |
| constant | 1.603*** | 1.832*** | 1.846*** | 1.563*** | 2.396*** | 2.445*** | 1.471*** | 1.902*** | 1.962*** |
| | (93.61) | (45.64) | (31.17) | (85.24) | (34.15) | (28.59) | (73.71) | (35.81) | (26.55) |
| N | 2040 | 2040 | 2040 | 1980 | 1980 | 1980 | 1860 | 1860 | 1860 |

T statistics in parentheses, *,** and *** denote significance at a 10, 5 and 1% significance level, respectively. The dependent variable is Inflation + 3, inflation t+6 and inflation t + 12 for all OLS.

**Table 11: First data set 2SLS output**

| | 2SLS (1) | 2SLS (2) | 2SLS (3) | 2SLS (1) | 2SLS (2) | 2SLS (3) | 2SLS (1) | 2SLS (2) | 2SLS (3) |
|---|---|---|---|---|---|---|---|---|---|
| | Inflation t + 3 | | | Inflation t + 3 | | | Inflation t + 3 | | |
| Unemployment | -2.31*** | -0.474 | 3.246 | -2.51*** | -0.642* | 5.111* | -2.42*** | -0.602* | -2.377** |
| | (-6.38) | (-1.58) | (0.95) | (-6.86) | (-2.09) | (2.35) | (-7.23) | (-2.32) | (-2.86) |
| Inflation deviation from average | 0.589*** | 0.858*** | 0.852*** | 0.584*** | 0.855*** | 0.852*** | 0.586*** | 0.856*** | 0.852*** |
| | (20.49) | (36.62) | (35.17) | (20.31) | (36.43) | (34.94) | (20.51) | (36.77) | (35.05) |
| Germany | | -0.0521 | -0.361 | | -0.0409 | -0.528* | | -0.0435 | 0.142 |
| | | (-1.78) | (-1.15) | | (-1.38) | (-2.57) | | (-1.59) | (1.43) |
| 1996 | | 0 | 0 | | 0 | 0 | | 0 | 0 |
| | | (.) | (.) | | (.) | (.) | | (.) | (.) |
| 1997 | | -0.60*** | -0.60*** | | -0.60*** | -0.60*** | | -0.60*** | -0.60*** |
| | | (-12.19) | (-12.12) | | (-12.16) | (-12.04) | | (-12.17) | (-12.07) |
| 1998 | | -1.28*** | -1.28*** | | -1.28*** | -1.29*** | | -1.28*** | -1.28*** |
| | | (-29.62) | (-29.43) | | (-29.57) | (-29.43) | | (-29.59) | (-29.33) |
| 1999 | | -1.53*** | -1.51*** | | -1.53*** | -1.50*** | | -1.53*** | -1.53*** |
| | | (-35.35) | (-32.96) | | (-35.32) | (-33.64) | | (-35.33) | (-35.12) |
| 2000 | | -0.17*** | -0.119* | | -0.17*** | -0.0968 | | -0.17*** | -0.19*** |
| | | (-3.83) | (-2.01) | | (-3.84) | (-1.91) | | (-3.84) | (-4.16) |
| 2001 | | 0.255*** | 0.300*** | | 0.254*** | 0.321*** | | 0.255*** | 0.236*** |
| | | (5.91) | (5.15) | | (5.89) | (6.40) | | (5.90) | (5.30) |
| 2002 | | -0.121** | -0.104* | | -0.124** | -0.0929* | | -0.123** | -0.135** |
| | | (-2.76) | (-2.15) | | (-2.81) | (-2.02) | | (-2.80) | (-3.04) |
| 2003 | | -0.23*** | -0.23*** | | -0.23*** | -0.23*** | | -0.23*** | -0.24*** |
| | | (-5.14) | (-5.18) | | (-5.19) | (-5.14) | | (-5.18) | (-5.20) |
| 2004 | | 0 | 0 | | 0 | 0 | | 0 | 0 |
| | | (.) | (.) | | (.) | (.) | | (.) | (.) |
| Bedenwuertenberg | | | 0.376 | | | 0.575* | | | -0.222* |
| | | | (1.02) | | | (2.39) | | | (-2.02) |
| Bayern | | | 0.346 | | | 0.535* | | | -0.226* |
| | | | (0.98) | | | (2.32) | | | (-2.12) |
| Berlin | | | -0.0836 | | | -0.103 | | | -0.0243 |
| | | | (-1.12) | | | (-1.48) | | | (-0.37) |
| Brandenburg | | | -0.0639 | | | -0.0966 | | | 0.0345 |
| | | | (-0.72) | | | (-1.28) | | | (0.52) |
| Hessen | | | 0.296 | | | 0.458* | | | -0.191* |
| | | | (0.98) | | | (2.29) | | | (-1.97) |
| Mecklenburgvorpommern | | | -0.131 | | | -0.184* | | | 0.0264 |
| | | | (-1.13) | | | (-2.05) | | | (0.38) |
| Nidersachsen | | | 0.228 | | | 0.349* | | | -0.137 |
| | | | (0.99) | | | (2.24) | | | (-1.62) |
| Nordreihn- Westphalen | | | 0.218 | | | 0.343* | | | -0.156 |
| | | | (0.92) | | | (2.15) | | | (-1.83) |
| Sachsen | | | -0.0770 | | | -0.106 | | | 0.00929 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | (-0.92) | | | (-1.44) | | | (0.14) |
| Saarland | | | 0.192 | | | 0.312* | | | -0.171* |
| | | | (0.83) | | | (2.01) | | | (-2.03) |
| Thueringen | | | 0 | | | 0 | | | 0 |
| | | | (.) | | | (.) | | | (.) |
| Burgenland | | | 0.0356 | | | 0.0374 | | | 0.0301 |
| | | | (0.55) | | | (0.57) | | | (0.46) |
| Kaernten | | | 0.00290 | | | 0.0118 | | | -0.0239 |
| | | | (0.04) | | | (0.18) | | | (-0.37) |
| Niederoesterreich | | | 0.0954 | | | 0.132 | | | -0.0143 |
| | | | (1.03) | | | (1.69) | | | (-0.21) |
| Oberoesterreich | | | 0.144 | | | 0.218* | | | -0.0795 |
| | | | (0.95) | | | (2.01) | | | (-1.09) |
| Salzburg | | | 0.143 | | | 0.215* | | | -0.0736 |
| | | | (0.97) | | | (2.02) | | | (-1.02) |
| Steiermark | | | 0.0401 | | | 0.0654 | | | -0.0361 |
| | | | (0.50) | | | (0.91) | | | (-0.55) |
| Tirol | | | 0.105 | | | 0.161 | | | -0.0662 |
| | | | (0.85) | | | (1.74) | | | (-0.95) |
| Voralberg | | | 0.119 | | | 0.180 | | | -0.0668 |
| | | | (0.91) | | | (1.86) | | | (-0.95) |
| Wien | | | 0 | | | 0 | | | 0 |
| | | | (.) | | | (.) | | | (.) |
| Constant | 1.865*** | 2.251*** | 1.916*** | 1.886*** | 2.262*** | 1.749*** | 1.877*** | 2.259*** | 2.418*** |
| | (46.30) | (57.00) | (6.17) | (46.33) | (56.94) | (8.65) | (49.34) | (59.03) | (26.06) |
| N | 1760 | 1760 | 1760 | 1760 | 1760 | 1760 | 1760 | 1760 | 1760 |

T statistics in parentheses, *, ** and *** denote significance at a 10, 5 and 1% significance level, respectively. The dependent variable is Inflation + 1 for all models. Model (5.1) utilizes a 4-month lag as instrument, model (5.2) 6 months and model (5.3) 12 months.

**Table 12: Model 2 output**

| | OLS (1) | OLS (2) | OLS (3) | 2SLS (1) | 2SLS (2) | 2SLS (3) |
|---|---|---|---|---|---|---|
| | Inflation t+1 | | | Inflation | | |
| OLS:Zeno’s paradox variable: | | | | | | |
| Z | -0.0164 | 0.0193 | -0.00460 | -0.00344 | -0.0258 | -0.15*** |
| 2SLS: Unemployment | (-1.65) | (0.55) | (-0.16) | (-0.31) | (-0.52) | (-3.99) |
| Inflation deviation from | | | | | | |
| average | 0.258*** | -0.0303 | 0.0531 | | | |
| | (3.92) | (-0.57) | (0.97) | | | |
| Germany | | -0.884* | 0 | | -1.61*** | -1.15*** |
| | | (-2.16) | (.) | | (-4.30) | (-4.05) |
| Austria | | 0 | 0.651* | | -1.31*** | -1.74*** |
| | | (.) | (1.98) | | (-3.56) | (-6.26) |
| Italy | | -1.24*** | -1.061** | | -1.061** | -0.446 |
| | | (-3.59) | (-3.04) | | (-2.83) | (-1.58) |
| Spain | | 0 | 0 | | 0 | 0 |
| | | (.) | (.) | | (.) | (.) |
| Nord dummy | | -1.42*** | -2.02*** | | 0 | 0 |
| | | (-4.13) | (-4.68) | | (.) | (.) |
| Burgenland AT | | 0.370 | 0.326 | | -0.173 | -0.445 |
| | | (1.01) | (1.12) | | (-0.51) | (-1.72) |
| Kaernten AT | | 0.0536 | 0.00817 | | -0.361 | -0.716** |
| | | (0.14) | (0.03) | | (-1.02) | (-2.67) |
| Niederoesterreich AT | | 0.176 | 0.0912 | | -0.0367 | -0.450 |
| | | (0.47) | (0.30) | | (-0.10) | (-1.63) |
| Oberoesterreich AT | | 0.295 | 0.207 | | -0.0827 | -0.529 |
| | | (0.78) | (0.68) | | (-0.22) | (-1.89) |
| Salzburg AT | | 0.375 | 0.252 | | 0.00267 | -0.572 |
| | | (0.96) | (0.81) | | (0.01) | (-1.90) |
| Steiermark AT | | 0.0671 | 0.0259 | | -0.349 | -0.679* |
| | | (0.18) | (0.09) | | (-1.00) | (-2.56) |
| Tirol AT | | 0.122 | 0.00833 | | -0.0512 | -0.605* |
| | | (0.31) | (0.03) | | (-0.13) | (-2.03) |
| Voralberg AT | | 0.0888 | -0.0145 | | -0.0733 | -0.587* |
| | | (0.23) | (-0.05) | | (-0.19) | (-2.02) |
| Wien AT | | 0 | 0 | | 0 | 0 |
| | | (.) | (.) | | (.) | (.) |
| Badenwuertenberg DE | | 1.015 | 0.627 | | -0.00075 | -1.251** |
| | | (1.77) | (1.36) | | (-0.00) | (-2.77) |
| Bayern DE | | 0.805 | 0.434 | | -0.240 | -1.47*** |
| | | (1.41) | (0.94) | | (-0.40) | (-3.29) |
| Berlin DE | | 0.136 | 0.0763 | | -0.544 | -0.410 |
| | | (0.41) | (0.29) | | (-1.66) | (-1.65) |
| Brandenburg DE | | 0.455 | 0.390 | | -0.0548 | 0.245 |
| | | (1.41) | (1.51) | | (-0.16) | (0.94) |

| | | | | |
|---|---|---|---|---|
| Hessen DE | 0.601 | 0.261 | -0.341 | -1.4*** |
| | (1.14) | (0.62) | (-0.63) | (-3.46) |
| Mecklenburg Vorpommern DE | 0 | 0 | -0.419 | 0.0553 |
| | (.) | (.) | (-1.11) | (0.19) |
| Niedersachsen DE | 0.769 | 0.452 | -0.162 | -1.083** |
| | (1.53) | (1.12) | (-0.33) | (-2.91) |
| Nordrhein-Westphalen DE | 0.712 | 0.398 | -0.153 | -1.076** |
| | (1.42) | (0.98) | (-0.31) | (-2.89) |
| Saarland DE | 0.532 | 0.241 | -0.444 | -1.35*** |
| | (1.06) | (0.60) | (-0.90) | (-3.67) |
| Sachsen DE | 0.262 | 0.207 | -0.209 | 0.0937 |
| | (0.81) | (0.80) | (-0.61) | (0.36) |
| Thueringen De | 0.535 | 0.406 | 0 | 0 |
| | (1.56) | (1.47) | (.) | (.) |
| Madrid ES | 0.116 | 0 | -0.00175 | -0.323 |
| | (0.34) | (.) | (-0.01) | (-1.22) |
| Musica ES | 0.479 | 0.374 | 0.445 | 0.387 |
| | (1.48) | (1.43) | (1.38) | (1.57) |
| Oviedo ES | 0 | -0.0334 | 0.0479 | 0.137 |
| | (.) | (-0.12) | (0.15) | (0.55) |
| Valencia ES | 0.00883 | -0.0479 | 0 | 0 |
| | (0.03) | (-0.18) | (.) | (.) |
| Bari IT | 0.487 | 0.442* | 0.595* | 0.448* |
| | (1.76) | (2.00) | (2.08) | (2.06) |
| Firenze It | 0.246 | -0.0239 | -0.135 | -1.429** |
| | (0.53) | (-0.06) | (-0.23) | (-3.20) |
| Genova It | 0.439 | 0.203 | 0.161 | -0.922* |
| | (1.08) | (0.62) | (0.31) | (-2.36) |
| L'Aquila It | 0.473 | 0.223 | 0.0318 | -1.207** |
| | (1.08) | (0.63) | (0.06) | (-2.80) |
| Milan It | 0.241 | -0.0665 | -0.236 | -1.71*** |
| | (0.47) | (-0.16) | (-0.36) | (-3.46) |
| Napoli It | 0.430 | 0.523 | 0.708 | 1.451*** |
| | (1.25) | (1.89) | (1.72) | (4.69) |
| Palermo It | 0.0290 | 0.148 | 0.364 | 1.055*** |
| | (0.09) | (0.54) | (0.92) | (3.54) |
| Perguina It | 0.436 | 0.160 | 0.0531 | -1.216** |
| | (0.95) | (0.43) | (0.09) | (-2.77) |
| Potenza It | 0.110 | 0.107 | 0.0372 | 0.0953 |
| | (0.40) | (0.49) | (0.13) | (0.45) |
| Roma It | 0.616 | 0.428 | 0.410 | -0.321 |
| | (1.80) | (1.55) | (1.01) | (-1.04) |
| Torino It | 0.984* | 0.675 | 0.534 | -0.739 |
| | (2.17) | (1.84) | (0.91) | (-1.68) |
| Trento It | 0.508 | 0.177 | 0.0445 | -1.454** |
| | (0.99) | (0.43) | (0.07) | (-2.90) |
| Trieste It | 0.848 | 0.498 | 0.491 | -0.968* |
| | (1.69) | (1.23) | (0.75) | (-1.97) |

| | | | | | | |
|---|---|---|---|---|---|---|
| Venezia It | | 0.774 | 0.414 | | 0.408 | -1.094* |
| | | (1.51) | (1.00) | | (0.61) | (-2.18) |
| 1999 | | | 0 | | | |
| | | | (.) | | | |
| 2000 | | | 0.449*** | | | 0.419*** |
| | | | (4.51) | | | (5.32) |
| 2001 | | | -0.248* | | | 0.688*** |
| | | | (-2.03) | | | (8.43) |
| 2002 | | | -0.34*** | 2.202*** | | 0.105 |
| | | | (-3.43) | (18.86) | | (1.35) |
| 2003 | | | -0.127 | 160 | | 0 |
| | | | (-1.26) | | | (.) |
| constant | 2.199*** | 3.199*** | 3.278*** | 2.051*** | 3.557*** | 4.590*** |
| | (42.01) | (13.93) | (16.27) | (33.50) | (6.03) | (10.24) |
| Country dummy | NO | YES | YES | NO | YES | YES |
| Time dummies | NO | NO | YES | NO | NO | YES |
| State dummies | NO | YES | YES | NO | YES | YES |
| Nord dummy | NO | YES | YES | NO | YES | YES |
| N | 191 | 191 | 191 | 160 | 160 | 160 |

T statistics in parentheses, *,** and *** denote significance at a 10, 5 and 1% significance level, respectively. The dependent variable is Inflation + 1 for all OLS models and Inflation for all 2SLS models.

**Table 13: Model 3 Output**

| | OLS (1) | OLS (2) | OLS (3) | 2SLS (1) | 2SLS (2) | 2SLS (3) |
|---|---|---|---|---|---|---|
| | | Inflation t+1 | | | Inflation | |
| OLS: Zeno's paradox variable: Z | -0.072** | -0.18*** | -0.14*** | -0.11*** | -0.24*** | -0.16*** |
| 2SLS: Unemployment | (-2.67) | (-4.51) | (-5.70) | (-4.49) | (-7.34) | (-6.68) |
| Inflation deviation from average | 0.0760 | 0.0217 | 0.0196 | | | |
| | (1.72) | (0.48) | (0.68) | | | |
| Germany | | 0 | 0 | | 0 | 0 |
| | | (.) | (.) | | (.) | (.) |
| Austria | | 1.339 | -0.267 | | 0.135 | 0.132 |
| | | (1.19) | (-0.39) | | (0.35) | (0.58) |
| BEL | | 0 | 0 | | 0 | 0 |
| | | (.) | (.) | | (.) | (.) |
| EST | | 3.237** | 1.764* | | 2.279*** | 2.220*** |
| | | (2.73) | (2.47) | | (4.39) | (7.18) |
| Spain | | 3.131** | 1.138 | | 2.651*** | 1.794*** |
| | | (2.62) | (1.57) | | (4.79) | (5.03) |
| FRA | | 1.364 | -0.287 | | 0.295 | 0.129 |
| | | (1.17) | (-0.41) | | (0.62) | (0.45) |
| GRC | | 2.902* | 0.960 | | 2.428*** | 1.649*** |
| | | (2.46) | (1.34) | | (4.52) | (4.80) |
| IRL | | 1.111 | -0.586 | | 0.0774 | -0.127 |
| | | (0.96) | (-0.84) | | (0.17) | (-0.46) |
| Italy | | 1.677 | -0.0260 | | 0.649 | 0.435 |
| | | (1.45) | (-0.04) | | (1.40) | (1.56) |
| LUX | | 1.404 | -0.0946 | | 0.118 | 0.266 |
| | | (1.20) | (-0.13) | | (0.25) | (0.93) |
| LVA | | 0 | 0 | | -0.839 | 0.485 |
| | | (.) | (.) | | (-0.83) | (0.79) |
| NLD | | 0.628 | -0.908 | | -0.652 | -0.519 |
| | | (0.54) | (-1.29) | | (-1.39) | (-1.86) |
| PRT | | 1.797 | 0.0522 | | 0.891 | 0.568* |
| | | (1.55) | (0.07) | | (1.89) | (1.99) |
| SVK | | 1.736 | 0.393 | | 1.057 | 0.824* |
| | | (1.41) | (0.53) | | (1.72) | (2.26) |
| SVN | | 1.143 | -0.375 | | 0 | 0 |
| | | (1.01) | (-0.55) | | (.) | (.) |
| 2002 | | | 0.160 | | | 0 |
| | | | (0.38) | | | (.) |

| | | | | | | |
|---|---|---|---|---|---|---|
| 2003 | | | 0 | | | 1.978*** |
| | | | (.) | | | (5.60) |
| 2004 | | | 0.0887 | | | 1.808*** |
| | | | (0.22) | | | (5.47) |
| 2005 | | | 0.0875 | | | 1.939*** |
| | | | (0.22) | | | (5.86) |
| 2006 | | | 0.196 | | | 1.843*** |
| | | | (0.50) | | | (5.54) |
| 2007 | | | 1.706*** | | | 1.819*** |
| | | | (4.36) | | | (5.55) |
| 2008 | | | -2.14*** | | | 3.329*** |
| | | | (-5.44) | | | (10.41) |
| 2009 | | | -0.420 | | | -0.154 |
| | | | (-1.10) | | | (-0.50) |
| 2010 | | | 0.797* | | | 1.676*** |
| | | | (2.06) | | | (5.53) |
| 2011 | | | 0.325 | | | 2.868*** |
| | | | (0.83) | | | (9.45) |
| 2012 | | | -1.014** | | | 2.545*** |
| | | | (-2.63) | | | (8.33) |
| 2013 | | | -2.059*** | | | 1.306*** |
| | | | (-5.36) | | | (4.25) |
| 2014 | | | -2.32*** | | | 0.167 |
| | | | (-6.12) | | | (0.55) |
| 2015 | | | -2.02*** | | | -0.194 |
| | | | (-5.31) | | | (-0.66) |
| 2016 | | | | | | 0 |
| | | | | | | (.) |
| constant | 1.743*** | -0.00169 | 2.200** | 2.814*** | 3.327*** | 1.290*** |
| | (14.43) | (-0.00) | (3.05) | (11.00) | (8.86) | (4.00) |
| Country dummy | NO | YES | YES | NO | YES | YES |
| Time dummies | NO | NO | YES | NO | NO | YES |
| N | 180 | 180 | 180 | 180 | 180 | 180 |

T statistics in parentheses, *,** and *** denote significance at a 10, 5 and 1% significance level, respectively. The dependent variable is Inflation + 1 for all OLS models and Inflation for all 2SLS models.