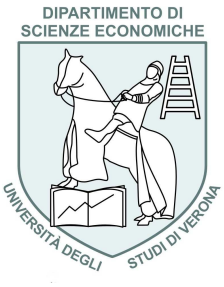


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# Anomalous empirical evidence on money long-run super-neutrality and the vertical long-run Phillips curve.

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Abstract

Money long-run super-neutrality and the vertical long-run Phillips curve are two widely shared beliefs in the economics profession and among economic policy-makers. The present survey is devoted to anomalous empirical evidence which challenges this view. We consider a variety of studies, differing in terms of models, estimation strategies, and countries analyzed. We conclude with a brief discussion of some future possible developments of the literature.

Keywords: long-run, money non-super-neutrality, non-vertical Phillips curve, empirical evidence

JEL Codes: E31, E40, E50, J64

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## 1. Introduction

Parkin (1998), in his presidential address to the 32nd annual general meeting of the Canadian Economics Association, brilliantly summarized in four propositions the present consensus regarding the effectiveness of monetary policy within the economics profession.

> *"First, the demand for money changes unpredictably, so targeting inflation directly is superior to targeting a monetary aggregate. Second, there are credibility and time-consistency problems, which make a contingency rule superior to discretion. Third, there is no long-run trade-off between inflation and unemployment, but there is a trade-off between the change in inflation and unemployment, with inflation constant at the natural unemployment rate. The natural rate varies for many reasons but is independent of monetary policy. So, targeting zero inflation brings lasting benefits but imposes no permanent costs. Fourth, the time lags in the effects of monetary policy extend beyond our forecast horizon, so it is impossible to fine-tune unemployment and inflation"* (Parkin, 1998, 1003-1004).

Four minorities are then highlighted. According to a neo-monetarist minority, the importance of changes in monetary aggregates should not be downplayed as they carry valuable information when devising monetary policy. Also monetary authorities should be well aware that the credibility of their commitment to their inflation goals has important implications for the inflation and unemployment trade-off. A second minority challenges the tenet that there is no long-run trade-off between inflation and unemployment on the basis of the existence of labor market frictions. A third minority stresses the importance of credit market frictions when studying the effects of monetary policy and it is not incompatible with other views. Finally, there are scholars thinking that a true understanding of the effects of monetary policy can be achieved thanks to quantitative dynamic general equilibrium analyses.

Similarly, Mishkin (2007) argues that a vertical long-run Phillips curve is one of the six ideas shared by almost all monetary authorities and governments around the world. ECB (2011, 55) writes "Real income or the level of employment in the economy are, in the long run, essentially determined by real (supply-side) factors. These are technology, population growth, the preferences of economic agents and all aspects of the institutional framework of the economy (notably property rights, tax policy, welfare policies and other regulations determining the flexibility of markets and incentives to supply labour and capital and to invest in human capital)."

More in general, the classical dichotomy, whereby nominal and real economic magnitudes have no long-run connection, is a shared belief in the economics profession. The intent of the present work is to review the empirical evidence that anomalously challenges this belief[1].

The literature on the Phillips curve is vast. Since the seminal paper by Phillips (1958), and even before considering Fisher (1973), economists have strived to understand the connection between inflation and some possible real variables such as the unemployment rate and the output gap. The literature on money neutrality and super-neutrality has nothing to envy to the one on the Phillips curve. Surveys followed aside

[1] Our usage of the word "anomaly" and its derivatives is reminiscent of Khun (1962).

the development of these literatures (see for instance the works quoted in Qin, 2011). Hence, a clear statement of our focus is warranted both in terms of the issues that we either cover or not and in terms of the economic magnitudes we consider.

We do not consider wage Phillips curve, namely models in which unemployment or the level of macroeconomic activity is related to wage changes unless these models are included as robustness checks in wider contributions. At the same time we exclude from the review works finding long-term effects of generic demand shocks, without specifying the very nature of these shocks (Dolado and Jimeno, 1997; Maidorn, 2003; Gambetti and Pistoresi, 2004; Amisano and Serati, 2003).

We review only published works, as either articles in refereed journals or book chapters, with some small exceptions of works expressing some insightful views on general trends in the literature. Regarding hysteresis, we consider only studies that document a link between inflation and the NAIRU (non-accelerating inflation rate of unemployment), not simply generically finding evidence of hysteresis[2] and, therefore, inferring that macroeconomic policy have long-lasting effects on the unemployment rate.

When papers report both standard and anomalous results – where we mean "standard" and "anomalous" results with respect to the mainstream view highlighted above – we tend to give more weight to the latter than to the former ones. As our purpose here is to give account of the anomalies that can be found in the literature.

Since we want to review the "anomalies" highlighted in the literature, we do not give full consideration to studies that find a persistent[3], but yet transitory effect of either monetary policy or inflation or money growth on either unemployment or output as the very transience of these effects can reconcile them with the mainstream view as highlighted above.

We do not focus on critiques to the hypothesis of either money or inflation long-run super-neutralities such as in Galbraith (1997), Schettkat and Sun (2009) or in the works quoted in Coen et al. (1999). We do not either delve into the empirical problems inherent in the estimation of the NAIRU as, for instance, in Eisner (1998), Stanley (2004, 2005) and Heyer et al. (2007). We focus, instead, on works that found *positive* empirical evidence that non-super-neutralities in fact exist.

Regarding the economic magnitudes taken into consideration, we privilege money growth and inflation with respect to the short-term interest rate. The best way to measure monetary policy – whether short-term interest rate or money growth – is subject to debate in the literature (see Estrella and Mishkin, 1997; Woodford, 2003, 2008; Nelson, 2003, 2008; Reynard, 2007, Favara and Giordani, 2009; Karanassou and Sala, 2010). However, De Grauwe and Costa Storti (2008) offer a meta-analysis of 83 empirical studies concerning the effects of monetary policy on output and prices by focusing on the effects of a 1 percent increase in the interest rate. We, instead, deal with the effect of inflation and money growth on measures of the level of macroeconomic activity. So our work is complementary to theirs. Moreover, we give a qualitative review of the literature to offer an in-depth discussion of, for instance, sample lengths, methodologies and model specifications. Nonetheless, the results by De Grauwe and Costa Storti (2008) are

[2] Namely of the dependence of the long-run or natural unemployment rate from the actual one.
[3] See for instance Alexius and Holmlund (2008).

interesting as they find that the output effects of monetary policy can last over five years – their definition of long-run.[4]

Given that, we are here mainly concerned with long-run non-super-neutralities regarding the connection of either money or inflation with either output or unemployment, we give less weight to the Fisher effect. Finally, De Grauwe and Costa Storti (2008) start their review from the early 1990s because from that date the VAR methodology became widespread in the economic literature. We find this motivation convincing. We also believe that the widespread adoption of the information and communication technology marked a turning point for the economics profession, making readily available estimation techniques previously confined to institutions able to afford large computing power. This leads further support to the appropriateness of starting our review from the early nineties.

The main body of this survey is structured according to the methodology applied by the various studies, namely SVARs (Structural Vector Auto-regressions), the Kalman filter, unit root and cointegration testing, stationary single equation models, and systems of equations applying the "Chain reaction theory". The final section concludes. Table 1 gives a broad picture of the surveyed literature, highlighting the adopted method, the country of reference, the frequency and the time period of the data, and, last but not least, the analyzed variables. Further notes of interest might be added. Studies in Table 1 are listed in chronological order.

## 2. Survey of empirical studies

### 2.1 SVAR studies

We distinguish SVAR studies according to their adoption of either long or short-run identification assumptions. Often this kind of studies does not find unequivocal support for the existence of either positive money super-neutralities or non-vertical Phillips curve in the long-run. However, there is always a (stubborn) piece of evidence supporting them.

#### *2.1.1 Short run identification restrictions*

King and Watson (1994) make use of structural VARs by imposing short run restrictions. First they show that, in presence of a unit root in the inflation generating process, it is possible to overcome the critique by Sargent (1971) and compute the long-run impact of inflation on unemployment. To better grasp this point it is useful to make reference to the simplified exposition of the Sargent's critique by Gordon (2011). Consider an expectation augmented Phillips curve

$$\pi_t = \alpha E\pi_t + \beta u_t + e_t$$

where $\pi_t$ is the inflation rate, $u_t$ is the unemployment rate, $\alpha$ and $\beta$ are coefficients, $e_t$ a stochastic error, and *E* is the expectation operator. Further suppose that expectations are adaptive

$$E\pi_t = v\pi_{t-1}$$

By substitution one obtains

$$\pi_t = \alpha v\pi_{t-1} + \beta u_t + e_t$$

[4] This result, though, can depend on the estimation methodology. In fact, structural VARs would tend to return no-long run effect. This, however, is hardly surprising as the hypothesis of the long-run ineffectiveness of monetary policy is often introduced a priori in the model to achieve identification.

In this context the long-run effect of unemployment on inflation, $\frac{\beta}{1-\alpha v}$, is not identified because $v$ is unknown. The argument by King and Watson (1994) is that this this point holds true unless inflation contains a unit root. Then the long-run effect of unemployment on inflation is just $\frac{\beta}{1-\alpha}$.

This notwithstanding, King and Watson (1994) show that the estimated long-run effect of inflation on unemployment, once reframed within a structural VAR, crucially depends on short-run identifying assumption. They distinguish between Keynesian, real business cycle (RBC) and monetarist approaches. In the first case, unemployment is dominated by demand shocks. In the second one, unemployment is not affected by nominal shocks. The third one consists in an instrumental variable approach, where the exact instrument set was not univocally defined in previous contributions. However, obtained results are consistent across different studies. The long-run effect of unemployment on inflation, over all the sample period from 1954 to 1992, ranges from -0.71 under the Keynesian identification approach, to -0.29 under the monetarist one, to 0 under the RBC.

King and Watson (1997) re-affirm the results contained in King and Watson (1994) regarding the long run Phillips curve. In addition they extend their analysis to money and output growth always using a bivariate structural VAR on the time period running from the first quarter of 1949 to the last quarter of 1990. They let the value of the contemporaneous coefficients of either money growth or output vary on a grid of plausible values in order to achieve identification. Furthermore, they also identify their SVAR by experimenting with different values of the long-run effect of output on money growth. Also in this case, identification assumptions drive long-run results and evidence of both positive and negative non-super-neutrality can be found as well as of money super-neutrality.

Koustas (1997) uses the methods by King and Watson (1994) on quarterly Canadian data running from 1955Q1 to 1993Q4. He estimates two bivariate SVARs one including money and output growth and the other including inflation and unemployment rates changes. In both cases evidence is found in favour of non-super-neutralities. Koustas and Serletis (2003) apply the same methods to quarterly data for Austria, Denmark, Finland, France, Germany, Italy, Spain, Sweden and the UK. They consider bivariate structural VAR in the consumer price inflation and unemployment. Their observation period ranges from 1962Q4 to 1999Q4. Their results are mixed depending on identification assumptions. A Keynesian short-run Phillips curve implies a non-vertical long-run Phillips curve in all the countries considered but Denmark, France and Germany. A monetarist-rational expectations approach leads to vertical long-run Phillips curves in all the countries but Italy.

Dolado et al. (2000) apply the approach by King and Watson (1994) to Spanish annualized quarterly data, without any seasonal adjustment, spanning from 1964Q1 to 1997Q4. As a matter of consequence, they adopt three identification strategies: a real business cycle one, a monetarist one, and a Keynesian one. In so doing, though, they introduce some modifications. In the first place, they introduce further exogenous variables to capture supply shocks that usually hit small open economies like Spain. In other words, they also consider, as exogenous variables, the EU15 (excluding Spain) inflation and unemployment rate. In addition, they modify the “Keynesian” and “monetarist” identification assumptions introduced by King and Watson (1994). They do so by assuming that the inflation impact on unemployment is at its maximum, in the first case, and that, in the long-run, inflation is fully driven by demand shock, in the second case. Moreover, in studying specific historical episodes, they interestingly make use of available prior information regarding the nature of the shock to detect the most suitable identification scheme. Finally they move from

a bivariate to a trivariate SVAR to distinguish fiscal shocks from other demand shocks and they perform sub-sample stability tests.

The long-run Phillips curve trade-off, defined as the ratio taken at a 4 years horizon between the derivative of the unemployment rate with respect to the demand shock and the derivative of the inflation rate with respect to the same shock, is -0.6 under the Keynesian identification scheme, -0.3 under the monetarist identification scheme and 0 under the real business cycle scheme. To be noted is that the monetarist identification scheme better suits prior information regarding disinflationary periods. In other words, the disinflations between 1987Q1-1988Q1 and between 1989Q3 and 1991Q3 are known to have had a monetary nature. On the other hand, the disinflation between 1992Q1 and 1993Q1 stemmed from labor market reforms, namely they had a supply side nature. Upon studying forecast error variance decompositions, the monetarist approach is the only one able to mirror the above prior information. Upon shifting to a trivariate SVAR including the short-run interest rate and sticking to a monetarist identification strategy, the long-run inflation-unemployment trade-off does not disappear though it halves and its significance level somewhat falls.

### *2.1.2 Long-run identification restrictions*

Bullard and Keating (1995) use unit root testing, in the form of Augmented Dickey-Fuller tests, and bivariate structural VARs including output growth and inflation. Note that long-run inflation shocks are here interpreted as inherently monetary phenomena. The authors adopt the Blanchard and Quah (1989) decomposition and their identification assumptions are, first, that output growth shocks have no long-run effects on inflation and, second, that they are uncorrelated with inflation growth shocks. Their sample include 58 countries over different time periods, which are at least of 25 years. For 16 countries they find that output and inflation have a unit root. Only for 5 of these 16 countries there is a significant long-run effect of inflation on output. In one country this effect is negative and in the other 4 it is positive. For 9 additional countries, there is evidence that inflation had permanent shocks but not output, which can be interpreted as evidence of money super-neutrality. For 31 countries, inflation had no permanent shock so that their data cannot shed light on the research question of the authors. The evidence regarding the remaining two countries, Peru and Bolivia, is interpreted following Fisher and Seater (1993). For Peru, inflation does not appear to have long-run effects on output. For Bolivia, inflation and output appear to be related in the long-run but the sign of this relationship is not stated. Bullard and Keating (1995) finally note that money non-super-neutralities are positive at low inflation rates, tend to vanish as inflation rates rise and, finally, turn negative for very high inflation rates. A limit of this study is to consider only bivariate relationships being exposed to the possible problem of omitted relevant variables.

Rapach (2003) extends the analysis of previous contributions by considering a trivariate structural VAR in the inflation rate, nominal interest rate and real output level, the aim being to check whether inflation has any permanent effect on the nominal interest rate and real output. Long-run super-neutrality will hold only if an inflation shock has a one-to-one long-run effect on the nominal interest rate (Fisher effect) and no effect on real output. Both annual and quarterly data for 14 industrialized countries were collected over periods spanning from 1949 to 1996, with the exact observation period varying from country to country and according to the frequency of the data. Considering different frequencies is important because Faust and Leeper (1997) stressed that temporal aggregation can affect the estimated dynamic effects of structural shocks in VARs. Rapach (2003) also checks his results to be robust to imposing identifying restrictions at long but finite horizons on the footsteps of Faust and Leeper (1997) and Lastrapes (1998).

Identification is achieved by means of two long-run assumptions. First, inflation is in the long-run a purely monetary phenomenon (a "monetarist" view) as in Roberts (1993) and Bullard and Keating (1995). Second, long-run technological changes do not affect the real interest rate, as in standard neo-classical growth models. Rapach (2003) finds strong evidence against the Fisher effect in all countries. Findings regarding the long-run effects of inflation and output are less clear-cut. Inflation has positive and statistically significant long-run impacts on output in Austria and the Netherlands, positive and nearly statistically significant long-run effects in Belgium, France and Ireland, no statistically significant long-run effect in the other countries. Changing either the frequency of the data or the identification horizon would not substantially alter these results.

Algan (2002) estimates a trivariate SVAR in labor productivity growth, the changes of the inflation and unemployment rates using French and US quarterly data from 1970Q1 to 1998Q4. The Blanchard and Quah decomposition is used and the long-run identification conditions are that: i) supply shocks can affect all variables; ii) demand shocks can affect inflation and unemployment only; iii) a residual shock can affect unemployment only. The residual shock is then explained thanks to its correlation to the unemployment benefit replacement ratio and to an indicator of the mismatch between labor demand and supply[5]. What is interesting to our purposes is that results point to the existence of a long-run Phillips curve in the US, as a 1% demand shock permanently reduces unemployment by 1% and increases inflation by 0.8%. Results for France are similar but the impulse response function of the unemployment rate is not significantly different from zero. A supply shock increases labor productivity and decreases inflation and unemployment in France, while in the US the response of inflation is more muted. The residual shocks have sizeable and significant effects on unemployment only, increasing it. Regarding the forecast error variance decomposition, inflation is mainly driven by demand shocks and productivity by supply shocks. France and the US differ with respect to the residual shock which accounts for an important portion of the forecast error variance of unemployment in the former country and less so in the latter one.

Bashar (2011) follows Cover et al. (2006) in criticizing the Blanchard and Quah (1989) identification assumption in a bivariate SVAR that demand shocks cannot have any long-run effect on output.[6] Their critique is based on the argument that increases in demand can positively affect innovation activity and technology adoption and it is modelled resorting to an AS-AD model, including a modified Lucas supply curve – with real output depending on it expectations, unanticipated inflation and a random shock – and a demand curve – where nominal demand depends on its expectation and a random shock. On these grounds it is possible to show that aggregate demand shocks can affect the aggregate supply curve, allowing a different identification approach than the one by Blanchard and Quah (1989). Hence, bivariate SVARs are estimated on seasonally adjusted data for real GDP growth and inflation for the G-7 countries at quarterly frequencies spanning from 1957Q1 to 2008Q4 (though time periods differ for different countries). According to their results, demand shocks can permanently affect output and inflation, inducing a long-run Phillips curve.

### 2.2 A Kalman filter study

Heyer et al. (2007) compares two estimation methods, respectively building on the Equilibrium Rate of Unemployment (ERU), derived from either price and wage setting schedules (WS/PS) or from a wage Phillips curve, and on the time varying NAIRU. In the first place, they show the common theoretical roots of

[5] Though it is worth noting that the replacement ratio does not display much variation during the period of observation with the exception of a marked increase in the late 70s.
[6] Cover et al. (2006) did not, though, explore the long-run implications of their critique.

the two approaches. In the second place, if wages are not fully indexed with respect to inflation, the long-run unemployment rate will depend on inflation in a WS/PS model. Further, they consider quarterly French data from 1973Q2 to 2003Q2 and they adopt a Kalman filter technique. Hence, they show that the model improves in terms of the significance of the regressors and of insensitiveness of the results to the signal-to-noise ratio, upon inserting in the equation for the long-run unemployment rate the inflation rate and the annual inflation rate especially. Heyer et al. (2007) also analyse US data, but their results here are more standard supporting the existence of a constant NAIRU through time.

## 2.3 Unit root and cointegration studies

Unit root and cointegration studies can be further divided into those mainly focusing on the unemployment and inflation rates, those mainly focusing on inflation and output, and, finally, three studies with their own peculiarities.

### *2.3.1 Unemployment and inflation*

Ribba (2006) investigates monthly US data from 1980M1 to 2001M12 concerning the CPI annualized inflation rate, the civilian unemployment rate and the federal funds rate. Series are taken to be I(1) on the basis of previous evidence available in the literature. The Johansen cointegration test detects a cointegration rank of two, accordingly the cointegration space is thought to include a long-run Phillips curve and a Fisher equation. Though the long-run Phillips curve finds empirical support, the Fisher equation to a lesser extent. The link between the inflation and the federal fund rates is found to exist, but to be less than one-to-one.

Ribba (2007) estimates a structural cointegrated VAR model on Italian data spanning from 1979Q1 to 1995Q4. Five variables are considered, namely the Italian unemployment rate, short term interest rate and inflation rate, together with the German short term interest rate and inflation rate. Inflation is measured by the annualized change in CPI. In order to achieve identification, a long-run direct effect of the German variables on the Italian unemployment rate is excluded. Further, inflation is supposed to increase the short-term interest rate in Italy on a one-to-one basis in the long-run. The Italian short-term interest rate can be affected by the German interest and inflation rates on the grounds that Italy is a small open economy and the German central bank was leading the other European central banks during the period of observation. Under these assumption increases in the inflation rate are showed to decrease the unemployment rate in the long-run.

Schreiber and Wolters (2007) argue that the existence of the NAIRU is often assumed without proper testing. They propose to adopt an integration and cointegration framework in order to overcome this limitation and they exploit both seasonally adjusted and unadjusted German data on the official unemployment rate and the first difference of the log of the GDP deflator. Their data run from 1975Q2 to 2002Q3. By adopting an Augmented Dickey-Fuller test evidence is found for both the unemployment and the inflation rates to be integrated of order one. A Johansen rank test further find them to be cointegrated. Note that, when testing for cointegration, they add to the VAR, as exogenous variables, an impulse dummy equal to 1 in 1991Q1 and zero otherwise, to account for the German reunification, and seasonal dummies, for seasonally unadjusted series. A structural vector error correction model is then estimated, including as further exogenous variables energy price inflation, imported goods inflation, productivity growth, and exchange rate changes vis à vis the US dollar. Evidence is found that the equilibrium relationship between the inflation and unemployment rates is

$$\pi=6-0.5u$$

By inspecting impulse-response functions then, Schreiber and Wolters (2007) infer that the system dynamics is dominated by the unemployment rate – and therefore the real side of the model - and not by the inflation rate.

Furuoka (2007) and Dritsaki and Dritsaki (2013) are two similar studies under a methodological point of view. The former refers to Malaysia from 1973 to 2004, while the latter to Greece from 1980 to 2010. They both make use of annual data. They both rely on unit root and cointegration testing to detect a long-run relationship between inflation and the *unemployment gap*. They differ regarding the way they compute the NAIRU. Furuoka (2007) defines the NAIRU as the unemployment rate that makes changes in the inflation rate null. Dritsaki and Dritsaki (2013) extract the NAIRU from the unemployment series by means of the Hodrick-Prescott filter with a smoothing parameter of 100. In both the cases, the unemployment gap and the inflation rate turn out to be I(1). To test for nonstationarity Furuoka (2007) adopts the Augmented Dickey-Fuller test with and without trend, Dritsaki and Dritsaki (2013), instead, use the Augmented Dickey-Fuller, the Phillips and Perron and the Kwiatoski, Phillips, Schmidt and Shin (KPSS) tests. What is worth noting is that both works find the unemployment gap to be non-stationary. In other words, the NAIRU does not work as an attractor for the actual unemployment rate. In addition, by making use of the Johansen cointegration test, they find a long-run relationship between inflation and the unemployment gap. Regarding Granger causality, results are more mixed. Furuoka (2007) finds that long-run Granger causality runs from the unemployment gap to the inflation rate. According to Dritsaki and Dritsaki (2013) the causality direction is the other way round.

Furuoka et al. (2013) applies the same methods of Furuoka (2007) to Philippines' annual data from 1980 to 2010, but using, along the inflation rate, the *unemployment rate* instead of the *unemployment gap*. Results are similar to those obtained by Furuoka (2007) for Malaysia.

### *2.3.2 Output and inflation*

Ericsson et al. (2001) criticize the adoption of cross-section datasets to investigate the connection between inflation and output growth for three reasons. This is because results might be biased by specific countries experiences, time averaging (in presence of underlying Granger causality running from either inflation to growth or the other way round), and an ignored cointegrating relationship between inflation and the level of output. Regarding the last aspect, Ericsson et al. (2001) use annual data on the G-7 countries from 1953 to 1992 on real GDP per capita (from the Summers and Heston's database) and CPI inflation from the International Monetary Fund's International Financial Statistics. On the basis of the Johansen test, they find that the level of output and inflation are cointegrated and inflation is positively connected to output. Note that they further remark that, even if the nonstationarity result of inflation would be due to the presence of structural breaks, cointegration tests can detect co-breaking between real output and inflation (see Campos et al., 1996; Hendry and Mizon, 1998).

Atesoglu (1998) extends Ericsson et al. (2001) by considering annual US data from 1960 to 1995 regarding the logs of real GDP and of real total government spending, as well as the first difference of the log of the GDP deflator. The US case is considered to shed light on the link between inflation and output at low inflation levels, whose rate averaged at 4.3 percent during the period of observation. It is showed that the Augmented Dickey-Fuller test points to all the three variables being I(1) and that the Johansen trace test detects the existence of a cointegrating relationship among them, where inflation has a positive impact on output. Further note that the inclusion of real total government spending in the model is motivated by the possible effects of government spending on output via the Keynesian multiplier and public investment (the relevant estimated coefficient is positive).

Mallik and Chowdhury (2002) extend the analysis by Atesoglu (1998) to Australia, Canada, Finland, New Zealand, Spain, Sweden, and the UK. They use quarterly data from 1960Q1 to 1998Q4, though the exact period of observation varies from country to country. They consider the same variables as Atesoglu (1998). According to the Augmented Dickey-Fuller test all the series are I(1). Evidence based on the Johansen cointegration test is not unequivocal. One cointegrating relationship is found for Australia, Canada and Sweden. For Spain no cointegrating relationship could be found, while two were found for Finland and the UK. For New Zealand the rank and maximum eigenvalue statistics are in conflict. All cointegrating tests include a trend. Authors proceed, then, in a rather mechanical way, to estimate the coefficients of one cointegrating vector for all countries and of the error correction mechanism. Inflation and government expenditure have both a positive long-run link with output – the latter variable has a greater coefficient than the former one - and the error correction mechanism significantly contributes to the short-run dynamics of variables. The largest recursive eigenvalue and the ratio between the log-likelihood and the number of observation denote stability of the model. Recursive coefficient estimates have in most cases confidence intervals including zero.

### *2.3.3 Three more studies*

Ahmed and Rogers (2003) is a unit root/cointegration study that stands out with respect to the works above due to its analysis of a broader set of variables. More specifically they use U.S. data on per capita output, consumption, investment and government spending on goods and services spanning from 1889 to 1995. They estimate two cointegrating relationships between the logs of real per capita consumption, investment, GDP, inflation and the ratio of government spending over output. Evidence is found that, after an increase in inflation, the consumption-output ratio falls, while the investment-output ratio rises. These changes are sizeable. A structural VECM is then estimated, where identification is achieved by assuming that shocks to inflation and productivity trends are independent and that the trend in inflation depends on the trend of the ratio between government spending and GDP. This latter assumption is intended to capture the possible either complementarity or substitutability of inflation and income taxes. Once again evidence is produced that permanent shocks to inflation increase output, investment and consumption.

Fisher and Seater (1993) is worth mentioning due to its influence on empirical studies concerning the way to think about the link between money and real variables in a-theoretical framework, notwithstanding that the evidence produced concerns a country during an hyperinflation period. They adopt a bivariate autoregressive integrated moving average (ARIMA) framework and build on the integration properties of the analysed variables in order to estimate the long run derivative of one variable with respect to the other. In order to provide evidence regarding money non-super-neutrality first it has to be that money is neutral, otherwise the effect of changes in the growth rate of money on the growth rate of real variables, can be traced back to their level relationship. Furthermore, in order to test for non-super-neutrality, money growth has to be at least integrated of order one. This is because the approach by Fisher and Seater (1993) is a-theoretical and it builds on the existence of permanent stochastic changes in money growth to assess their effect. Furthermore, if money is I(2) and real variables are I(0) then long-run super-neutrality will hold because it means that permanent changes in money are not accompanied by permanent changes in real variables, as these changes simply do not exist. If money is I(2) and real variables are I(1) or if they are both I(2) then one can test for money non-super-neutrality. In the first case, the test is based on regressing the growth rate of the real variable between time t and time t-k-1 on a constant and the percentage change in the growth rate of money between the same periods. It is possible to repeat the same exercise for different values of k, obtaining results over various time horizons. In particular Fisher and Seater (1993) analyse the case of Germany after World War I finding a negative impact of money growth on real balances. In the

second case, a test for long-run non-super-neutrality can be inferred to be implemented by regressing the percentage change in the growth rate of real variables on the percentage change of money growth. Two prominent limitations of the Fisher and Seater (1993) approach are its bivariate nature and its underlying identification assumptions. These entails that money variables has to be predetermined with respect to real variables due either to some lag in the transmission of monetary shock to the real economy or to the absence of feedbacks from the real economy to monetary variables. In addition, monetary and real shocks have to be uncorrelated.

Fair (2000) proposes a simple test for the existence of a constant NAIRU. Consider the following equation

$$\pi_t = \alpha + \sum_{i=1}^{n} \delta_i \, \pi_{t-i} + \sum_{i=1}^{m} \beta_i \, u_{t-i} + \sum_{i=1}^{q} \gamma_i \, s_{t-i} + \varepsilon_t$$

where $s_t$ is a set of cost-push variables, $\alpha$, $\delta$, $\beta$, and $\gamma$ denote coefficients and $\varepsilon_t$ a stochastic error. The existence of a constant NAIRU needs that the following restriction holds $\sum_{i=1}^{n} \delta_i = 1$. Adding to the above equations two terms, namely $\pi_{t-1}$ and the first lag of the log of the price level ($p_{t-1}$) breaks the summation restriction and the fact that the log of the price level has to be first differenced before entering the model. In other words, the mentioned additional variables provide a more general model within which testing the validity of the restrictions underlying the concept of the NAIRU, which requires the coefficients of the two further variables to be equal to zero. Furthermore, the addition of $\pi_{t-1}$ and $p_{t-1}$ is consistent with the theories presented in Fair (1974, 1984, and 1994) and with the underlying intuition to a model of a duopoly game with asymmetric information (Fair, 2000, 71).

Fair (2000) carries out the proposed test using quarterly US data from 1952Q1 to 1998Q1 on the business nonfarm price deflator, the civilian unemployment rate and the log of import price deflator. The proposed test requires numerical methods as the underlying test statistic is non-standard given the presence of unit roots in the considered variable and given the low power of the Augmented Dickey-Fuller test. The null that the coefficients of $\pi_{t-1}$ and $p_{t-1}$ are equal to zero is rejected at a 99% level. The strength of the rejection weakens somewhat once considering other price indexes such as CPI, the GDP deflator and the CPI without food and energy prices. On the basis of a root mean squared error criterion and on simulation exercises, the general model beats the restricted-NAIRU-consistent model in terms of predictive ability. However, the general model is not able to produce credible estimates of the long-run inflation-unemployment trade-off. In the view of Fair (2000) this is because the long-run Phillips curve is likely to be non-linear at low unemployment rates which are seldom observed.

## 2.4 Stationary single equation studies

Within this sub-stream of literature, one can find three groups of studies: those following the steps of Akerlof, Dickens and Perry (1996, 2000); disinflation studies; and studies using data on local labor markets.

### *2.4.1 The Akerlof, Dickens and Perry (1996, 2000) tradition*

Akerlof, Dickens and Perry (1996) contrast the performance of the model based on the NAIRU with a model leaving aside this concept. In particular, they regress the log change of the GDP deflator on its lag, the rate of total civilian unemployment, and a non-linear function of the profit share, able to account for the average increase in unit labor costs due to downward wage rigidity. They resort to nonlinear least squares and they investigate an annual US time-series dataset spanning from 1929 to 1995. They argue that though their model is able to explain trends characterizing the 1929 Great Depression, the NAIRU model is not. Note that they try to account for possible structural breaks by estimating a model for the Great Depression

years and a model including the entire sample and checking whether the estimated parameters are statistically equal by means of an F test. They further include dummies for the supply shocks of the 1970s and for the price controls introduced by Nixon. They do not make any reference to the stationarity properties of the series under analysis.

Akerlof, Dickens and Perry (2000) argue that there exist three kinds of departure from a fully rational use of the available information regarding inflation. In the first place, low inflation rates might be ignored when setting wages and prices. In addition, incomplete inflation projections can arise from an informal use of information about inflation. In other terms, in forming expectations, inflation is considered along other factors, each of whose receives a weight and the weight of inflation might be less than one. Finally, workers perceive inflation as an erosion of the purchasing power and not as resulting in an increase of the demand for their services. This misperception leads, on the one hand, workers to perceive nominal pay rises at low inflation rates as a sign of an appreciation of their work, on the other, employers to pay lower real wages than otherwise. According to Akerlof, Dickens and Perry (2000) it is enough that only one of these three mechanisms is in place to produce a non-linear Phillips curve, such that at low inflation rates, an increase in inflation reduces unemployment. As inflation further rises, unemployment starts increasing up to one point when inflation ceases to have any real effect. This implies that there exists a long-run inflation rate that minimizes the long-run unemployment rate. Akerlof, Dickens and Perry (2000) build a theoretical model encompassing the economic mechanisms above and look for corroborating empirical evidence in three directions.

First, they summarize the results obtained by Brainard and Perry (2010) on US data by using the Kalman filter and letting all parameter values of the Phillips curve to vary. On the basis of the value of the coefficients of lagged inflation terms, they find that inflation is non-super-neutral when it is low and close to super-neutral when it is high.

In the second place, Phillips curves incorporating both adaptive inflation expectations and direct measures of inflation expectations are estimated, so to overcome the Sargent (1971) critique. Low inflation periods are distinguished from high inflation ones, the former being those with average annualized inflation rates (at quarterly frequency) below 3 percent and the latter being those with average inflation above 4 percent. As dependent variable, the annualized inflation rate in either wages and prices is used. Explanatory variables include current and lagged unemployment, price inflation and (in the wage Phillips curve) trend productivity growth. Price inflation is measured by using the CPI, the GDP deflator and the personal consumption expenditure (PCE) deflator. The wage inflation series is built by linking the employment cost index from 1980 to 1999, the adjusted hourly earnings index for the nonfarm economy from 1961 to 1980 and the adjusted hourly earnings in manufacturing from 1954 to 1961. Three measures of unemployment are used, namely the unemployment rate of all workers, that of 25-54 years old males, and the demographically adjusted series by Shimer (1999). Two trend productivity series are built on the basis respectively of Gordon and Stock (1998) and Akerlof, Dickens and Perry (1996). Various lags of the different variables are used in 216 specifications. When using direct measures of inflation expectations, two sources are used, namely the Survey of Consumers of the University of Michigan and the Livingston Surveys of the Federal Reserve. Both in the adaptive expectations models and in the models with direct expectations measures, evidence is found of inflation non-super-neutrality in low inflation periods and of inflation super-neutrality in high inflation ones. In other terms, the sum of the coefficients of either lagged inflation terms (when relying on the adaptive expectations models) or price expectations variables (when relying on direct expectations measures) was close to one in high inflation periods and considerably smaller than one in low inflation periods.

Finally, Akerlof, Dickens and Perry (2000) derive an empirical model from their theoretical results

$$\pi_t = d + \Phi(\mathrm{D}+\mathrm{E}\pi_{L,t}^2)\pi_t^e - eu_t + gX_t + \epsilon_t$$

where $\Phi$ is the cumulative standard normal density function, $\pi_t^e$ is inflation expectations, $u$ is an unemployment term (also including lagged values), $X$ is a set of dummy variables controlling for oil shocks and price controls and $\epsilon$ is a stochastic error. $\pi_{L,t}$ captures how past inflation affects the likelihood that agents will act rationally towards inflation. It is specified in four different ways, the first of whose is a geometrically declining weighted moving average of past inflation rates. Parameters to be estimated include $d$, $D$, $E$, $e$ and $g$. The second measure of $\pi_{L,t}$ is

$$\pi_L = \frac{\sum_{\substack{i=1 \\ i\tau<1}}^{24} (1-i\tau)\pi_{-i}}{\sum_{\substack{i=1 \\ i\tau<1}}^{24} (1-i\tau)}$$

where $\tau$ is to be estimated. The third measure is a four year moving average of past inflation with equal weights, while the fourth one lets the parameters of the moving averages free to be estimated. Also $\pi_t^e$ is measured in different ways, including a twelve quarter unrestricted lag, the methods used to build $\pi_{L,t}$, and direct survey measures. Exact specifications of the dependent variables and of the unemployment variables are similar to the second empirical approach by Akerlof, Dickens and Perry (2000) we described above. 218 specifications are estimated, varying not only according to the exact series used and on how variables are built, but also regarding the number of included lags and the insertion of a term accounting for wage rigidity as in Akerlof, Dickens and Perry (1996). Models are estimated at quarterly frequency from 1954Q1 to 1999Q4, though the end of the sample varies in some estimations to account for the possible influence of the 1990s. The estimation method is nonlinear least squares[7]. Results support the view that the long-run Phillips curve is nonlinear, with unemployment first decreasing and after increasing as inflation rates rise, up to a point where inflation turns super-neutral.

Lundborg and Sacklen (2006) apply the model by Akerlof, Dickens and Perry (2000) to Swedish quarterly data from 1963Q1 to 2000Q2. They use a single equation maximum likelihood approach. The time series they consider include a corrected inflation index derived from the Consumer Price Index, the Import Price Index and Import shares so to generate an indicator concerning only domestically produced and consumed goods. Further, they consider survey data on expected inflation, the seasonally adjusted unemployment rate, an unemployment rate also including workers in active labor market programs and, finally, a seasonally adjusted male unemployment rate. Oil price changes are accounted for by inserting time dummies for the periods 1973-1974, 1979-1981 and 1986. Dummies are also used to capture price increases in food in the early 1970s, the 1990-1991 tax reform and the 1995-1996 large wage increases. Overall 120 specifications are estimated and Lundborg and Sacklen (2006) find that the Akerlof, Dickens and Perry (2000) model implies a nonlinear long-run Phillips curve in Sweden such that increasing inflation from 0 to 2% would decrease the unemployment rate from about 5% to about 2%. Further increasing inflation would increase unemployment. At about 6% inflation, the unemployment rate would be back to %5. Over 7%, inflation is super-neutral.

Boujelbène and Boujelbène (2009) apply the model by Akerlof, Dickens and Perry (1996) to Tunisian annual data from 1962 to 2004. They use series on nominal wages, the total unemployment rate, the labour

[7] Both in the second and in the third empirical approach dummies were used to account for oil price changes and changes in price controls.

productivity, the consumer price index and, to account for the notional wage, the inter-professional guaranteed minimum wage. They also include a time dummy from 1991 to 2004 to account for price liberalization. By relying on both OLS and non-linear least squares they find not completely consistent results with those of Akerlof, Dickens and Perry (1996). In particular, the statistical significance of the negative long-run relation between the unemployment and inflation rates depends on the way inflation expectations are modelled. Namely, if they are modelled as one year lagged inflation, there will be evidence supporting a long-run Phillips curve, but not so if they are modelled as adaptive expectations. Furthermore, wage rigidity has the opposite effect than in Akerlof, Dickens and Perry (1996). This result is attributed to unobserved factors such as increasing labour supply by young graduates and women as well as increasing lay-offs due to economic restructuring in both the private and public sectors.

### *2.4.2 Disinflation studies*

Ball (1997)[8] considers a cross-section of 20 OECD countries from 1980 to 1990. The NAIRU is computed following Elmeskov (1993), though, for robustness sake, the Hodrick-Prescott filter is also used. The Elmeskov procedure builds on an "accelerationist" Phillips curve without shocks

$$\pi_t - \pi_{t-1} = b(u_t - u^*)$$

where $u^*$ is the NAIRU and $b$ a negative coefficient. $u^*$ can be computed considering the Phillips curve over two periods. Ball (1997) then explains the change in $u^*$ as a function of the total fall of inflation[9] between 1980 and 1990, the length of the disinflation raised to the square and the duration of the unemployment benefit. Other features of the labor market are showed to have less explanatory power. The analysis is purely cross-sectional. To further exclude the possible influence of cyclical factors, the NAIRU is computed over the period from 1976 to 1994 confirming the importance of the explanatory variables highlighted above. Finally, in order to investigate the direction of causality - namely from either inflation to unemployment or the other way round - Ball (1997) drops the constraint of the coefficients of inflation in 1980 and in 1990 to be equal. This is because macroeconomic shocks can increase both the NAIRU and inflation, but they cannot produce an increase in the NAIRU and a low inflation rate at the end of the period of observation. So if the coefficient of inflation in 1990 is significant, it will mean that causality runs from inflation to unemployment, which is in fact what is found. In addition, the equality constraint between the two coefficients is not rejected[10].

[8] A parallel stream of literature originated from Ball (1994) including, among others, Senda and Smith (2008) and Hofstetter (2008). However, we do not focus on these works because they are concerned with deviations of output from trends rather than with changes in output trends during disinflations.

[9] Inflation is measured as the year-on-year change in consumer prices.

[10] Ball (1999) extends Ball (1997) in a number of different directions. First, the considered unemployment variables is not only the change in the NAIRU but also "the degree of hysteresis". This last concept is defined as the ratio between "the change in the NAIRU from peak to five years later", at the numerator, and "the greatest increase in actual unemployment over any period within five years after the peak in the denominator". This ratio is meant to "capture the rise in unemployment that feeds into the NAIRU" (Ball, 1999, 206). Also a different measure of monetary policy is considered, namely "the largest cumulative decrease in the real interest rate during any part of the recession's first year". Estimations focus on recessions only defined as "one or more consecutive years of growth below 1 percent a year" (Ball, 1999, 205). Finally, various historical episodes of economic policy interventions are reconstructed. Results are broadly consistent with those contained in Ball (1997). The analysis by Ball (1999) is further extended by Stockhammer and Sturn (2012) considering a longer time period, quarterly data, a broader set of labor market institutions, and changes in the definition of key variables. On the other hand, Romer and Romer (1994) find that changes in the federal funds rate both show considerable persistence and their effect on output is still sizeable after 4 years. Similar results are contained in Romer and Romer (1989) focusing on specific episodes of the US economic

Ball (2009) extends Ball (1997) using data from 20 OECD countries from 1985 with more than one million inhabitants. Data span from 1980 to 2007. The NAIRU is estimated building on Ball and Mankiw (2002). More precisely, first the parameter $\alpha$ from the following model is estimated

$$\pi = \pi_{-1} + \alpha(u - u^*) + \epsilon$$

where $\epsilon$ accounts for short-term supply shocks. From the above equation one can obtain

$$u^* - \left(\frac{1}{\alpha}\right)\epsilon = u - \left(\frac{1}{\alpha}\right)(\pi - \pi_{-1})$$

$u^* - \left(\frac{1}{\alpha}\right)\epsilon$ is then filtered with the Hodrick-Prescott procedure setting the smoothing parameter to 100. The estimation of $\alpha$ and filtering are iterated until convergence of both the parameter estimate and of the series of $u^*$. The analysis then focuses on episodes of changes in the NAIRU of at least 3% within a period of at least ten years and on large inflation changes, namely either falls or rises in "trend inflation" by at least 3%, where trend inflation is defined as a nine-quarter centered moving average of inflation. Results indicate that a disinflation is a necessary condition for a NAIRU increase, while either a previous NAIRU increase or an inflation run-up are necessary conditions for a NAIRU decrease.

Ball et al. (2013) focus on Latin America and the Caribbean. They build two datasets of unemployment rates. In the former, they made an effort to harmonize the definition of unemployment rates across countries, while, in the latter, across time. Both encompass 19 countries and are unbalanced. The former dataset runs from 1990 to 2007, while the latter from 1957 to 2007. When considering the former dataset, Ball et al. (2013) compute the long-run unemployment rate by regressing the actual unemployment rate on country and time dummies and adding the coefficient of each country's dummy to the average of all time effects. The long-run unemployment rate is then regressed on a number of development variables (real GDP per capita, educational attainment, the share of agricultural output in total GDP, the share of agricultural population in total population) and labor market variables (the advance time notice before being fired, indemnities for dismissal, firing costs, rigidity of employment, social security contributions, labor taxes). Various experimentations with cross-country regressions are carried out and the share of agricultural population in total population emerges as the most convincing and powerful explanatory variable with a negative sign. This is explained as result of a number of different factors: people crowding in large cities in search for high-paying scarce jobs, more self-employment and larger informal sectors in rural areas, less unionization and less labor matching problems in small rural communities.

Ball et al. (2013) then moves to consider some historical cases, on the basis of their second dataset. They focus on large increases of the long-run unemployment rate, on temporary increases of actual unemployment rates that did not feed in the long-run unemployment rate, and, finally, decreases of the long-run unemployment rate. Notice that the long-run unemployment rate is built by applying the Hodrick-Prescott filter to actual unemployment data with a smoothing parameter of 100. Further large changes of the long-run unemployment rate are defined as episodes in which the long-run unemployment rate "rises or falls monotonically and the total change from start to finish is greater than four percentage points in absolute values". Studying the single episodes, it is inferred that large increases of the long-run unemployment rate are due to marked fall in aggregate demand as a result of either monetary policy

history. In this review, we give less weight to these papers due to their measure of monetary policy which does not directly involve either inflation or money growth.

tightening or exchange rate parity defense in presence of capital flights. Temporary increases of the unemployment rate, without strong effects on the long-run unemployment rates, are explained as the result of devaluation in face of capital flights. Finally decreases in the long-run unemployment rate are explained as the result of a high starting level of long-run unemployment and accelerating economic growth (whose underlying causes can be, though, diverse).

### *2.4.3 Evidence from local labor markets*

Coen et al. (1999) explore the existence of long-run non-vertical Phillips curve in local US labor markets. They consider quarterly data from 1990Q1 to 1997Q4 concerning the unemployment rate and inflation measured in three different ways, namely CPI, average hourly earnings in construction and average hourly earnings in manufacturing. OLS regression yields negative coefficient estimates for unemployment, though significant only considering inflation in average hourly earnings and in manufacturing. The sum of the coefficients of inflation was always different than one, pointing to the existence of long-run super-neutralities. Note, though, that these results rest on the hypotheses of poolability across metropolitan areas, which is always rejected except for inflation in construction earnings. No reference is made regarding either the stationarity of the series or the possible existence of structural breaks.

Also Vaona (2007) focuses on local labour markets, by exploiting a dataset of 81 Italian provinces from 1986 to 1998 at an annual frequency. A dynamic panel data estimator is applied. A long-run Phillips curve is found to exist, negatively relating local inflation and unemployment rates[11]. This relation, though, shifts from year to year. In this context, it is possible to compute the long-run Phillips curve, because inflation expectations are not modelled as adaptive. Future inflation and past inflation rates are treated as endogenous. Instruments include all the available lags of inflation, both in differences and in levels, and the current level of the unemployment rate. A robustness check include only two inflation lags as instruments.

## 2.5 Applications of the "Chain reaction theory"

The "Chain reaction theory" is a frictional growth approach stressing the interplay between growth and nominal frictions, as surveyed in Karanassou et al. (2010). A key role in this approach is played by the discount rate, whereby "the current price is influenced more by its past level than its future one, and, thus, as money growth increases, the increasing price level falls behind the increasing money supply and the resulting increase in the real money balances lowers unemployment" (Karanassou and Sala, 2012). We start from the latest contributions to finish with the earliest ones.

Karanassou and Sala (2012) estimate a system of four equations both by ARDL and 3SLS on US annual data from 1970 to 2006. Endogenous and exogenous variables are clearly spelled out. The former ones include the GDP deflator, total compensation per employee, the unemployment rate, real total capital stock, capital accumulation (namely the first difference of the real total capital stock). The latter ones are money supply (M3), real labor productivity, real oil prices, indirect taxes, direct taxes on the business sector and social security benefits. The last three variables are taken as percentages of GDP. All the other variables, but the unemployment rate, are in logs. Their results point to the fact that a 10% increase in money growth leads, in the long-run, to a 2.79% decrease in the unemployment rate, implying a long-run slope of the Phillips curve of -3.58.

Karanassou and Sala (2010) offer both SVAR and single equation GMM estimates based on a semi-annual US dataset from 1960 to 2005. The choice of the frequency is intended to avoid (G)ARCH effects. Regarding

[11] Local value added and unit labor costs prove to have less explanatory power than unemployment with regard to inflation.

SVAR estimates, they are the results of a three-variables system including the unemployment rate, the inflation rate and money growth (broadly defined) - the last one measuring monetary policy. Identification is achieved recursively, whereby unemployment and inflation rates react to changes in money growth with a lag, while they can, in their turn, contemporaneously affect money growth. Moreover, the unemployment rate reacts to changes in the inflation rate with a lag, while the latter one can be contemporaneously affected by the former one. The KPSS test does not reject stationarity of the considered variables. Long-run inflation and unemployment effects of a one-off shock in money growth are computed as the cumulative sum of their significant responses. The implied slope of the long-run Phillips curve is -2.57, with an upper bound of -14.6 and lower bound of -0.33, where bounds are computed by making reference to the 95% confidence intervals of the impulse-response functions. In the three models underlying single-equation GMM estimates, the current rate of inflation is regressed on the inflation lead, two inflation lags, the unemployment rate, import prices and a constant. Models differ in terms of the instrument sets. In the first model, the adopted instruments are two inflation lags, two unemployment lags, one import prices lag and one money growth lag. In the second model, the current unemployment rate, money growth and import prices are further included. In the third model, the current unemployment rate is then excluded. The slope of the long-run Phillips curve ranges from -3.30 to -4.32 depending on the model.

Karanassou et al. (2008a) estimate a system of six equations by applying to each equation the ARDL approach by Pesaran et al. (2001)[12]. Data are from the US at an annual frequency covering the 1960-2005 period. Involved logged variables are the money supply (M3), the GDP deflator, the nominal compensation, the real wage, real labour productivity, employment, the labor force, price inflation, money growth, the real S&P 500 index (as measure of financial wealth), the real capital stock, the real oil price, real import prices, and the working age population. Variables not in logs include the unemployment rate, social security contributions, indirect taxes, private consumption, public expenditure, and export minus imports. All these variables, except the unemployment rate, are considered as percentages of GDP. The dependent variables of the six equations are the GDP deflator, the nominal wage, the real S&P 500 index, employment, the labour force, and real labour productivity. All equations pass diagnostic tests for structural stability, linearity, serial correlation, heteroskedasticity, autoregressive conditional heteroskedasticity, and normality. In presence of a permanent 10% shock to money growth, impulse response functions show inflation to rise by 10% and unemployment to fall by -2.86%.

Karanassou et al. (2008b) follow a similar approach for Spain, with the exception that a two-step procedure is adopted. First, a system of six equations is estimated equation-by-equation using an ARDL approach with the purpose to test three restrictions: i) constant returns to scale; ii) absence of money illusion; iii) a unit elasticity of the labour force with respect to the working age population. In a second step and on the basis of the three restrictions above – that are not rejected by the data – the system is estimated by three stage least squares[13]. The considered variables include money supply (M3), the GDP deflator, both nominal and real wages, real money balances, real labour productivity, real GDP, real capital stock, employment, the labour force, the unemployment rate, the working age population, indirect taxes as percentage of GDP, real social security benefits, the import price level and the ratio between the import price level and the GDP deflator as a measure of competitiveness. The six dependent variables are the nominal wage, the GDP deflator, the labour force, employment, the real capital stock and the real GDP. Multiplicative dummy variables are used to capture institutional and policy changes, such as the introduction of unionized wage

[12] Identification is not explicitly discussed as well as the underlying exogeneity assumption to the ARDL model (see Pesaran et al., 2001, p. 293)

[13] Though an exact instrument list is not elicited.

bargaining, oil price shock, institutional changes associated with the Moncloa Pacts, the 1984, 1993 and 1997 waves of labour market reforms, the entry into the EEC, and the entry into the EMS. Annual data from 1966 to 1998 are analysed. A 10% fall in money growth is found to produce a 10% increase in inflation and 3.7% decrease in the unemployment rate.

Karanassou et al. (2005) apply a similar procedure to Karanassou et al. (2008b) using annual US and EU data. More specifically, regarding the EU data, they consider 11 countries: Austria, Belgium, Denmark, Germany, Finland, France, Italy, the Netherlands, Spain, Sweden, and the United Kingdom. US data run from 1966 to 2000, while European ones from 1977 to 1998. Analysed variables are similar to those listed for Karanassou et al. (2008a, b). Results for the US are close to those obtained in Karanassou et al. (2008b). With difference to Karanassou and Sala (2012) capital accumulation is exogenous here. Regarding EU countries, a fixed effects estimator is applied equation-by-equation after pooling all the countries[14]. Before estimation, the Maddala and Wu (1999) test for unit root is run and non-stationarity is always rejected. Results imply that permanent increases in money growth and inflation of 10% induce a permanent fall of the unemployment rate of 3.14%.

Karanassou et al. (2003)[15] report GMM estimates of a single equation Phillips curve with the unemployment rate as driving force. GMM estimates allow overcoming the Sargent critique as inflation expectations are not simply modelled as adaptive. Instead, the inflation lead is instrumented not only resorting to two inflation lags but also to a constant, to unemployment rates lags, the real oil price, and the changes in real labor productivity, employment, and working age population. Data concern the whole of the EU. Two specifications are presented: in the former the unemployment rate is exogenous and in the latter endogenous. Results do not change much the slope of the long-run Phillips curve which is -3.13 in the former case and -3.43 in the latter one.

## 3. Conclusions

As can be seen from this work, "anomalies" regarding either the existence of a long-run vertical Phillips curve or, more in general, money non-super-neutralities can be found in the literature and they vary along a number of different dimensions such methods, countries, frequency of the data, time period under analysis, and the exact model specification. In concluding this work we would like to make some considerations that could help this literature to make further steps ahead.

In the first place, there is often need for more robustness of results or more transparence with regard to adopted instruments and identification assumptions. For instance, unit root studies often limit their analysis to results from the Augmented Dickey-Fuller test. However, many different unit root tests are nowadays available even in standard econometric packages and they are readily applicable.

In addition, as argued by Dickens (2001), the available literature tends to pay little attention regarding the direction of causality between either unemployment or, more in general, indicators of economic activity and either money or inflation. This issue has pervaded the literature for a long-time, suffice to compare Fisher (1973) and Phillips (1958). When the issue was more deeply investigate, results were not clear-cut. Further, Dickens (2001) points that data on low inflation rates are scarce. It is, therefore, difficult to properly estimate the connection between low inflation rates and either unemployment or other indicators

[14] Notwithstanding the panel structure of the EU dataset and the dynamic nature of the estimated equations, no dynamic panel data estimator was used.

[15] This work also includes panel data evidence later discussed in Karanassou et al. (2005).

of macroeconomic activity, as estimates might be driven by the bulk of the observations which usually regards either medium or high inflation rates.

Moreover, assessing the existence of the long-run Phillips curve at the subnational level is clearly an under-researched topic notwithstanding the advantage of observing lower inflation rates than at the national level, as argued by Coen et al. (1999).

Finally, non-linearities in long-run Phillips curve should be more investigated. For the reasons discussed by Dickens (2001), there is scattered evidence that inflation and the level of economic activity have a positive connection in low inflation countries and either a negative or no connection at all in high inflation countries. This might suggest a non-linear long-run Phillips curve, a hypothesis that should attract more attention in the empirical research also for its policy implications, whereby there could exist an unemployment-minimizing (or an output-maximizing) long-run inflation rate that central banks could target.

**Table 1 – Summary of the reviewed studies**

| Study | Method | Country | Frequency | Time-period | Involved variables | Notes |
|---|---|---|---|---|---|---|
| Fisher and Seater (1993) | ARIMA | Germany | Monthly | From February 1919 to August 1923 | Money growth rate and real balances | - |
| King and Watson (1994) | SVAR | US | Monthly and quarterly | From January 1954 to December 1992 | Inflation and unemployment rates | In the robustness checks, additional controls: relative price of food and energy |
| Bullard and Keating (1995) | SVAR | 58 countries | Annual | Various | Output growth and inflation | - |
| Akerlof, Dickens and Perry (1996) | Nonlinear Least Squares | US | Annual | 1929-1995 | Log change in GDP deflator, total civilian unemployment rate, a function of the profit share of output to account for the average increase in unit labor costs due to downward wage rigidity | The profit rate is measured by the ratio of the sum of domestic profits and inventory valuation adjustment to GDP. The series was de-trended from 1947 to 1984 to account for the possible effect of the increasing indebtedness of US firms. Dummies were inserted to account for the Nixon price controls and the supply shocks occurring between 1973 and 1979. Robustness checks include a test for the absence of structural change between the 1929 Great Depression years and the rest of the sample; the insertion in the model of the change in the unemployment rate; accounting for the effect of job changes by workers; experiments regarding the function of the profit share; the estimation of a model without the restriction that the coefficient of expected inflation is equal to 1. |

| | Method | Country | Frequency | Time-period | Involved variables | Notes |
|---|---|---|---|---|---|---|
| King and Watson (1997) | SVAR | US | Quarterly | 1949Q1-1990Q4 | Money and output growth rates | - |
| Ball (1997) | OLS on a cross-section of countries | 20 low inflation OECD countries | Changes over ten years | 1980-1990 | The percentage change in the NAIRU is the dependent variable. Independent variables include the percentage change in inflation from 1980 to 1990, the squared length of disinflation, the duration of unemployment benefits in years. | Further labor market indicators are tried as explanatory variables without success, such as the replacement ratio of the unemployment benefit, the coverage of collective bargaining, the employer coordination, union coordination and the expenditure on labor market programs. |
| Koustas (1998) | SVAR | Canada | Quarterly | 1955Q1-1993Q4 | Money and output growth rates (first SVAR); inflation and unemployment percentage changes (second SVAR) | - |
| Atesoglu (1998) | Unit root and cointegra-tion tests | US | Annual | 1960-1995 | Logs of real GDP and of real total government spending, as well as the first difference of the log of the GDP deflator | - |
| Cohen et al. (1999) | OLS | US (Metropol itan Statistical Areas) | Quarterly | 1990Q1-1997Q4 | Unemployment rate; inflation measured in three different ways: CPI; average hourly earnings in construction and in manufacturing | - |
| Ahmed and Rogers (2000) | VECM | US | Annual | 1889-1995 | Logs of real per capita consumption, investment, GDP, inflation and the ratio of government spending over output | - |
| Dolado et al. (2000) | VECM | Spain | Quarterly | 1964Q1 to 1997Q4 | The annualized CPI inflation rate and the official unemployment rate | Further controls: the EU15 (excluding Spain) inflation and unemployment rate; the short-term interest rate |

| | Method | Country | Frequency | Time-period | Involved variables | Notes |
|---|---|---|---|---|---|---|
| Fair (2000) | Tests based on numerical methods | US | Quarterly | 1952Q1 to 1998Q1 | Logs of business nonfarm price deflator, logs of the CPI, logs of the GDP deflator, logs of the CPI without energy and food prices; the civilian unemployment rate | The log of the import price deflator is used to capture cost-push shocks. |
| Akerlof, Dickens and Perry (2000) | OLS and nonlinear least squares | US | Quarterly | 1954Q1 to 1999Q4 | The dependent variables are price and wage inflation. Price inflation is measured by using the CPI, the GDP deflator and the personal consumption expenditure (PCE) deflator. The wage inflation series is built by linking the employment cost index from 1980 to 1999, the adjusted hourly earnings index for the nonfarm economy from 1961 to 1980 and the adjusted hourly earnings in manufacturing from 1954 to 1961. Three measures of unemployment were used: namely the unemployment rate of all workers, that of 25-54 years old males, and the series by Shimer (1998). Two trend productivity series were built after Gordon and Stock (1998) and Akerlof, Dickens and Perry (1996).<br>Measures of inflation expectations come from the Survey of Consumers of the University of Michigan and the Livingston Surveys of the Federal Reserve | More than 400 specifications are estimated within two different empirical approaches. Some specifications also include a wage rigidity term à la Akerlof, Dickens and Perry (1996). |

| | Method | Country | Frequency | Time-period | Involved variables | Notes |
|---|---|---|---|---|---|---|
| Mallik and Chowdhury (2002) | Unit root and cointegration tests, VECM | Australia, Canada, Finland, New Zealand, Spain, Sweden, the UK | Quarterly | 1960Q1-1998Q4 | Logs of real GDP and of real total government spending, as well as the first difference of the log of the CPI | The largest recursive eigenvalue and the ratio between the log-likelihood and the number of observations denote stability of the model. Recursive coefficient estimates have in most cases confidence intervals including zero. |
| Algan (2002) | SVAR | France and the US | Quarterly | 1970Q1-1998Q4 | Used variables are the level of GDP in 1990 prices, total employment, the CPI and the unemployment rate. The labor productivity measure is the log of real GDP over employment. The inflation rate is computed as the first difference of logged CPI | - |
| Karanassou et al. (2003) | Single equation GMM | EU | Annual | 1972-2001 | GDP deflator inflation and the unemployment rate | The instrument set includes a constant, two inflation lags, two unemployment rates lags, the real oil price, and the changes in real labor productivity, employment, and working age population. |
| Koustas and Serletis (2003) | SVAR | 9 European countries | Quarterly | 1962Q4-1999Q4 (varying from country to country) | Consumers price inflation and unemployment | - |
| Rapach (2003) | SVAR | 14 industrialized countries | Annual/Quarterly | 1949-1996 (varying from country to country) | Inflation rate, nominal interest rate and real output | - |

| | Method | Country | Frequency | Time-period | Involved variables | Notes |
|---|---|---|---|---|---|---|
| Karanassou et al. (2005) | ARDL and 3SLS estimation of a three equations structural model for the US. Pooled fixed effects panel for EU countries. | US and 11 European countries | Annual | 1966-2000 for the US; 1977-1998 for EU countries | Variables for the US include: money supply (M3), the price level, the nominal wage, the unemployment rate, real labour productivity, real money balances, real capital stock, the S&P 500 index normalized by labor productivity, the real oil price, real exports minus real imports (as a measure of real foreign demand), indirect taxes as percentage of GDP, real social security benefits, real social security contributions. All variables are in logs with the exceptions of the unemployment rate, real foreign demand and indirect taxes as percentage of GDP. The EU model encompasses seven more variables all in logs: the real wage, the real GDP, employment, the labor force, working age population, and the ratio of import prices to the GDP deflator. | The dependent variables of the US model are the unemployment rate, the price level and the nominal wage. The dependent variables of the EU model are: the nominal wage, the GDP deflator, the labour force, employment, the real capital stock, and real GDP. |
| Lundborg and Sacklen (2006) | Nonlinear single equation ML | Sweden | Quarterly | 1963Q1 to 2000Q2 | Inflation indicator concerning only domestically produced and consumed goods built from data on the CPI, the Import Price Index and Import shares. Further, survey data on expected inflation, the seasonally adjusted unemployment rate, an unemployment rate also including workers in active labor market programs and, finally, a seasonally adjusted male unemployment rate are all considered. | Oil price changes are accounted for by inserting time dummies for the periods 1973-1974, 1979-1981 and 1986. Dummies are also used to capture price increases in food in the early 1970s, the 1990-1991 tax reform and the 1995-1996 large wage increases. |
| Ribba (2006) | Unit root and cointegration testing | US | Monthly | 1980M1-2001M12 | CPI annualized inflation rate, civilian unemployment rate, and federal funds rate. | - |

| | Method | Country | Frequency | Time-period | Involved variables | Notes |
|---|---|---|---|---|---|---|
| Karanassou et al. (2007) | ARDL and 3SLS estimation of a six equations structural model | Spain | Annual | 1966-1998 | The considered variables include money supply (M3), the GDP deflator, both the nominal and real wages, real money balances, real labour productivity, real GDP, real capital stock, employment, the labour force, the unemployment rate, the working age population, indirect taxes as percentage of GDP, real social security benefits, the import price level and the ratio between the import price level and the GDP deflator as a measure of competitiveness. Multiplicative dummy variables are used to capture institutional and policy changes, such as the introduction of unionized wage bargaining, oil price shocks, institutional changes associated with the Moncloa Pacts, the 1984, 1993 and 1997 waves of labour market reforms, the entry into the EEC, and the entry into the EMS. | The six dependent variables are the nominal wage, the GDP deflator, the labour force, employment, the real capital stock and the real GDP. |
| Furuoka (2007) | Unit root, cointegration, and Granger causality tests | Malaysia | Annual | 1973-2004 | Inflation and the unemployment gap | The NAIRU to compute the unemployment gap is obtained supposing the change of the inflation rate to be zero. |

| | Method | Country | Frequency | Time-period | Involved variables | Notes |
|---|---|---|---|---|---|---|
| Schreiber and Wolters (2007) | Unit root and cointegra-tion testing, SVECM | Germany | Quarterly | 1975Q2 to 2002Q3 | Official unemployment rate and first difference of the log of the GDP deflator | Exogenous variables in the cointegration test: an impulse dummy equal to 1 in 1991Q1 and zero otherwise; seasonal dummies, for seasonally unadjusted series. Further exogenous variables in the SVECM: energy price inflation, imported goods inflation, productivity growth, and exchange rate changes vis à vis the US dollar |
| Heyer et al. (2007) | Kalman filter | France and US | Quarterly | 1973Q2 to 2003Q2 (but varying according to different specificati ons) | The independent variable in the inflation equation – where inflation is measured by the consumer price deflator - are lagged inflation, the difference between the current and the long-term unemployment rate, the change in the unemployment rate, the difference between the inflation in the deflator of imports of goods and services and in the consumer price deflator. The independent variables in the equation for the long-term unemployment rate include the annualized change in the real interest rate and in labor productivity growth as well as in the inflation rate. | - |
| Vaona (2007) | Dynamic panel data estimator | 81 Italian provinces | Annual | 1986-1998 | CPI inflation rate, unemployment rate, value added, unit labor cost. | The specification including as independent variable the unemployment rate outperforms those including value added and unit labor cost. |

| | Method | Country | Frequency | Time-period | Involved variables | Notes |
|---|---|---|---|---|---|---|
| Ribba (2007) | Structural cointegra-ted VAR | Italy | Quarterly | 1979Q1-1995Q4 | The variables involved are the Italian unemployment rate, short-term interest rate, and inflation rate, as well as the German short term interest rate and inflation rate. | - |
| Karanssou et al. (2008) | ARDL applied to a six equations structural system | US | Annual | 1960-2005 | Variables in logs: the money supply (M3), the GDP deflator, nominal compensation, the real wage, real labour productivity, employment, the labor force, price inflation, money growth, the real S&P 500 index (as measure of financial wealth), the real capital stock, real oil price, real import prices, and the working age population. Variables in per cent of GDP: social security contributions, indirect taxes, private consumption, public expenditure, and export minus imports. Also the unemployment rate is considered. | The dependent variables of the six equations are the GDP deflator, the nominal wage, the real S&P 500 index, employment, the labour force, and real labour productivity. All equations include a constant. The equation for real productivity includes a non-linear trend. |
| Boujelbène and Boujelbène (2009) | OLS and nonlinear least squares | Tunisia | Annual | 1962-2004 | Series on nominal wages, the total unemployment rate, the labour productivity, the consumer price index and, to account for the notional wage, the inter-professional guaranteed minimum wage. | They also include a time dummy from 1991 to 2004 to account for price liberalization. Results depend on the way inflation expectations are modelled. |

| | Method | Country | Frequency | Time-period | Involved variables | Notes |
|---|---|---|---|---|---|---|
| Karanassou and Sala (2010) | SVAR and single equation GMM | US | Semi-annual | 1963-2005 | SVAR involves money growth and the inflation and unemployment rates. The single equation GMM model regresses the current inflation rate on a constant, one inflation lead, two inflation lags, the unemployment rate and import prices. | The SVAR model is identified in a recursive way. Unemployment responds with a lag to both inflation and money growth. Inflation responds with a lag to money growth. The three GMM models differ in terms of the instrument sets. First, instruments include two inflation lags, two unemployment lags, one import prices lag and one money growth lag. Second, the current unemployment rate, money growth and import prices are added. Third, the current unemployment rate is excluded. |
| Bashar (2011) | Bivariate SVAR | G-7 countries | Quarterly | 1957Q1-2008Q4 (though varying from country to country) | Included variables are the logged growth rates of the GDP and of the CPI in 2000 prices in logs. For Germany the GDP deflator is used instead of the CPI, to overcome data problems induced by the reunification. | - |
| Karanassou and Sala (2012) | ARDL and 3SLS estimation of a system of 4 equations | US | Annual | 1970-2006 | Endogenous variables: the GDP deflator, total compensation per employee, the unemployment rate, real total capital stock, and the first difference of the real total capital stock. Exogenous variables: money supply (M3), real labor productivity, real oil prices, indirect taxes (as % of GDP), direct taxes on the business sector (as % of GDP) and social security benefits (as % of GDP). All variables, but the unemployment rate and ratios, are in logs. | - |

| | Method | Country | Frequency | Time-period | Involved variables | Notes |
|---|---|---|---|---|---|---|
| Ball et al. (2013) | Cross-sectional estimates and qualitative study of historical episodes | Latin American and Caribbean countries | Annual | First dataset: 1999-2007. Second dataset: 1957-2007. Both datasets are unbalanced. | The dependent variable is the long-run unemployment rate. In cross-sectional estimates, considered explanatory variables are real GDP per capita, educational attainment, the share of agricultural output in total GDP, the share of agricultural population in total population, the advance time notice before being fired, indemnities for dismissal, firing costs, rigidity of employment, social security contributions, labor taxes. The most convincing one is the percentage of rural population with a negative sign. | When studying historical episodes, explanations of changes in long-run unemployment are found in monetary and exchange rate policies. When they are too inflexible they produce rises in the long-run unemployment rate. |
| Dritsaki and Dritsaki (2013) | Unit root, cointegration and Granger causality tests | Greece | Annual | 1980-2010 | Inflation rate and unemployment gap | The NAIRU to compute the unemployment GAP is obtained by HP filtering the unemployment series with a smoothing parameter equal to 100 |
| Furuoka et al. (2013) | Unit root, cointegration and Granger causality tests | Philippines | Annual | 1980-2010 | Inflation and unemployment rates | - |

# References


Ahmed, S., John H. Rogers, Inflation and the great ratios: Long term evidence from the U.S., Journal of Monetary Economics, Volume 45, Issue 1, February 2000, Pages 3-35

Akerlof, George A., W. T. Dickens and G. L. Perry "Near-rational wage and price setting and the long-run Phillips curve." Brookings Papers on Economic Activity (2000): 1-60.

Akerlof, George A., W. T. Dickens and G. L. Perry "The macroeconomics of low inflation." Brookings papers on economic activity (1996): 1-76.

Alexius, Annika, and Bertil Holmlund. "Monetary policy and Swedish unemployment fluctuations." Economics: The Open-Access, Open-Assessment E-Journal 2 (2008): 4.

Algan Yann, How well does the aggregate demand–aggregate supply framework explain unemployment fluctuations? A France–United States comparison, Economic Modelling, Volume 19, Issue 1, January 2002, Pages 153-177, ISSN 0264-9993, http://dx.doi.org/10.1016/S0264-9993(00)00068-7.

Amisano, G. and Serati, M. (2003), What goes up sometimes stays up: shocks and institutions as determinants of unemployment persistence. Scottish Journal of Political Economy, 50: 440–470. doi: 10.1111/1467-9485.5004005

Atesoglu, H. Sonmez. "Inflation and real income." Journal of Post Keynesian Economics (1998): 487-492.

Ball, Laurence, 1994, “What Determines the Sacrifice Ratio?” in N. G. Mankiw (eds.), Monetary Policy, University of Chicago, 155-193.

Ball, L. M. (1997). Disinflation and the NAIRU. In Reducing inflation: Motivation and strategy (pp. 167-194). University of Chicago Press.

Ball, Laurence. "Aggregate demand and long-run unemployment." Brookings Papers on Economic Activity (1999): 189-251.

Ball, Laurence M. (2009) Hysteresis in unemployment: old and new evidence. In Fuhrer, J, Little, JS, Kodrzycki YK, Olivei GP (eds) Understanding inflation and the implications for monetary policy. A Phillips curve retrospective. The MIT Press, Cambridge, 361-382.

Ball, Laurence and N. Gregory Mankiw (2002), The NAIRU in Theory and Practice, Journal of Economic Perspectives, 16: 115-136.

Ball, Laurence, Nicolás De Roux, and Marc Hofstetter. "Unemployment in Latin America and the Caribbean." Open Economies Review 24.3 (2013): 397-424.

Bashar, Omar HMN. "On the permanent effect of an aggregate demand shock: Evidence from the G-7 countries." Economic modelling 28.3 (2011): 1374-1382.

Blanchard O. J. and Quah D. (1989), The dynamic effects of aggregate demand and aggregate supply disturbances. The American Economic Review 79, 655-673.

Boujelbène, Thouraya, and Younes Boujelbène. "The long run Phillips curve and the role of downward nominal wage rigidity in Tunisia." Economics Bulletin29.2 (2009): 1211-1223.

Brainard, William C. and George L. Perry (2010). Making policy in a changing world. In *Economic Events, Ideas and Policies: the 1960s and after*. Edited by James Tobin and George Perry, Brookings Institution Press, 2010

Bullard, James, and John W. Keating. "The long-run relationship between inflation and output in postwar economies." Journal of Monetary Economics 36.3 (1995): 477-496.

Campos et al. (1996). Cointegration tests in presence of structural breaks. Journal of Econometrics 43: 3, 275-292.

Coen, Robert M., Robert Eisner, John Tepper Marlin, and Suken N. Shah "The NAIRU and wages in local labor markets. "American Economic Review (1999): 52-57.

Cover, J. P., Enders, W., Hueng, J. C. (2006), Using the aggregate demand-aggregate supply model to identify structural demand-side and supply-side shocks: results using a structural bivariate VAR. Journal of Money, Credit and Banking 38, 777-790.

De Grauwe, Paul, and Cláudia Costa Storti. " Monetary policy and the real economy." in R. Schettkat and J. Langkau (eds.) Economic Policy Proposals for Germany and Europe, London-Routledge (2008): 29-53

Dickens, William T. "Comments on Charles Wyplosz's "Do we know how low inflation should be?"." stencil, The Brookings Institution (2001).

Dolado, Juan J., J. David López-Salido, and Juan L. Vega. "Unemployment and inflation persistence in Spain: Are there Phillips trade-offs?." Spanish Economic Review 2.3 (2000): 267-291.

Dritsaki, Chaido, and Melina Dritsaki. "Phillips curve inflation and unemployment: an empirical research for Greece." International Journal of Computational Economics and Econometrics 3.1 (2013): 27-42

ECB (2011), The monetary policy of the ECB, European Central Bank, Frankfurt, Germany.

Eisner R "The Decline and Fall of the NAIRU," in The Keynesian revolution, then and now: The selected essays of Robert Eisner, Vol. 1. Cheltenham, U.K.: Elgar,1998, pp. 454-87

Elmeskov, Jørgen. "High and persistent unemployment." (1993). OECD Economics Department Working Paper no. 132, Paris.

Ericsson, N.R., Irons, J.S. and Tryon, R.W. (2001), "Output and inflation in the long-run", Journal of Applied Econometrics, 16, 3, 241-253.

Estrella, A., & Mishkin, F. (1997). Is there a role for monetary aggregates in the conduct of monetary policy? Journal of Monetary Economics, 40(2), 279–304.

Fair, R. C. A Model of Macroeconomic Activity. Volume I: The Theoretical Model, Ballinger Publishing Co., 1974

Fair, R. C. Specification, Estimation, and Analysis of Macroeconometric Models, Harvard University Press, 1984,

Fair, R. C. Testing Macroeconometric Models, Harvard University Press, 1994

Fair, Ray C. "Testing the NAIRU model for the United States." Review of Economics and Statistics 82.1 (2000): 64-71.

Faust, Jon & Leeper, Eric M, 1997. "When Do Long-Run Identifying Restrictions Give Reliable Results?," Journal of Business & Economic Statistics, American Statistical Association, vol. 15(3), pages 345-53, July.

Favara, G., & Giordani, P. (2009). Reconsidering the role of money for output, prices and interest rates. Journal of Monetary Economics, 56(3), 419–430.

Fisher, Irving. "I Discovered the Phillips Curve:" A Statistical Relation between Unemployment and Price Changes"." The Journal of Political Economy (1973): 496-502.

Fisher, Mark E., and John J. Seater. "Long-run neutrality and super-neutrality in an ARIMA framework." The American Economic Review (1993): 402-415.

Furuoka, Fumitaka. "Does the “Phillips curve” really exist? New empirical evidence from Malaysia." Economics Bulletin 5.16 (2007): 1-14.

Fumitaka Furuoka & Qaiser Munir & Hanafiah Harvey, 2013. "Does the Phillips curve exist in the Philippines?," Economics Bulletin, vol. 33(3), pages 2001-2016.

Galbraith, James K. "Time to Ditch the NAIRU." The Journal of Economic Perspectives (1997): 93-108

Gambetti, L., & Pistoresi, B. (2004). Policy matters. The long run effects of aggregate demand and mark-up shocks on the Italian unemployment rate. Empirical Economics, 29(2), 209-226.

Gordon, R. J. (2011). The history of the Phillips curve: consensus and bifurcation. Economica. 78, 10-50.

Gordon, Robert J., and James H. Stock. "Foundations of the Goldilocks economy: supply shocks and the time-varying NAIRU." Brookings Papers on Economic Activity (1998): 297-346.

Hendry and Mizon (1998), Exogeneity, causality and co-breaking in economic policy analysis of a small econometric model of money in the UK. Empirical Economics, 23: 3, 267-294.

Heyer, Eric, Frédéric Reynès, and Henri Sterdyniak. "Structural and reduced approaches of the equilibrium rate of unemployment, a comparison between France and the United States." Economic Modelling 24.1 (2007): 42-65.

Hofstetter Marc, Disinflations in Latin America and the Caribbean: A free lunch?, Journal of Macroeconomics, Volume 30, Issue 1, March 2008, Pages 327-345.

Dolado Juan J., Juan F. Jimeno, The causes of Spanish unemployment: A structural VAR approach, European Economic Review, Volume 41, Issue 7, 1281-1307.

Karanassou, M., and H. Sala (2010), The US Inflation-Unemployment Tradeoff Revisited: New Evidence for Policy Making, Journal of Policy Modeling, 32, 758-777.

Karanassou, M., and H. Sala (2012), Productivity Growth and the Phillips Curve: A Reassessment of the US Experience, Bulletin of Economic Research, 64, 344-366.

Karanassou, M., Sala H., and D. J. Snower (2003), The European Phillips Curve: Does the NAIRU Exist?, Applied Economics Quarterly, 49, 93-121.

Karanassou, M., Sala, H., and D. J. Snower (2005), A Reappraisal of the Inflation-Unemployment Tradeoff, European Journal of Political Economy, 21(1), 1-32.

Karanassou, M., Sala, H., and D. J. Snower (2008a), Long-Run Inflation-Unemployment Dynamics: The Spanish Phillips Curve and Economic Policy, Journal of Policy Modeling, 30, 279-300.

Karanassou, M., Sala, H., and D. J. Snower (2008b), The Evolution of Inflation and Unemployment: Explaining the Roaring Nineties, Australian Economic Papers, 47, 334-354.

Karanassou, M., Sala, H., and D. J. Snower (2010), Phillips Curves and Unemployment Dynamics: A Critique and a Holistic Perspective, Journal of Economic Surveys, 24, 1-51.

Kuhn, Thomas S. The structure of scientific revolutions. University of Chicago press, 2012.

King, Robert G. and Mark W. Watson, The post-war U.S. Phillips curve: a revisionist econometric history, Carnegie-Rochester Conference Series on Public Policy, Volume 41, December 1994, Pages 157-219

King, Robert G., and Mark W. Watson. "Testing long-run neutrality." Economic Quarterly-Federal Reserve Bank of Richmond 83 (1997): 69-95

Koustas, Zisimos Canadian evidence on long-run neutrality propositions, Journal of Macroeconomics, Volume 20, Issue 2, Spring 1998, Pages 397-411, ISSN 0164-0704, http://dx.doi.org/10.1016/S0164-0704(98)00065-2.

Koustas, Zisimos, Apostolos Serletis, Long-run Phillips-type trade-offs in European Union countries, Economic Modelling, Volume 20, Issue 4, July 2003, Pages 679-701.

Lastrapes, W. D., 1998. "International evidence on equity prices, interest rates and money," Journal of International Money and Finance, Elsevier, vol. 17(3), pages 377-406, June.

Lundborg, Per, and Hans Sacklén. "Low-inflation Targeting and Long-run Unemployment*." The Scandinavian Journal of Economics 108.3 (2006): 397-418.

Maddala, G. S. and Wu, S. (1999), A Comparative Study of Unit Root Tests with Panel Data and a New Simple Test. Oxford Bulletin of Economics and Statistics, 61: 631–652

Maidorn, Susanne (2003) The effects of shocks on the Austrian unemployment rate – a structural VAR approach Empirical Economics 28 2 R 10.1007/s001810200137

Mallik, Girijasankar, and Anis Chowdhury. "Inflation, government expenditure and real income in the long-run." Journal of Economic Studies 29.3 (2002): 240-250.http://dx.doi.org/10.1007/s001810200137 387-402.

Mishkin, Frederic S. (2007) Monetary policy strategy: How did we get here?. In Mishkin, Frederic S., ed. Monetary policy strategy. Mit press, pp. 1-28.

Nelson, E. (2003). The future of monetary aggregates in monetary policy analysis. Journal of Monetary Economics, 50(5), 1029–1059.

Nelson, E. (2008). Why money growth determines inflation in the long-run: Answering the Woodford critique. Journal of Money, Credit and Banking, 40(8), 1791–1814.

Parkin, Michael. "Unemployment, inflation, and monetary policy." Canadian Journal of Economics (1998): 1003-1032.

Pesaran, M.H., Shin, Y., Smith, R.J., 2001. Bounds testing approaches to the analysis of level relationships. Journal of Applied Econometrics 16, 289–326.

Phillips, Alban W. "The Relation Between Unemployment and the Rate of Change of Money Wage Rates in the United Kingdom, 1861–1957." Economica 25 (1958): 283-299.

Qin, Duo. "The Phillips Curve from the Perspective of the History of Econometrics." History of Political Economy 43.suppl 1 (2011): 283-308.

Rapach, David E. "International evidence on the long-run impact of inflation." Journal of Money, Credit, and Banking 35.1 (2003): 23-48.

Reynard, S. (2007). Maintaining low inflation: Money, interest rates, and policy stance. Journal of Monetary Economics, 54(5), 1441–1471.

Ribba, Antonio. "The joint dynamics of inflation, unemployment and interest rate in the United States since 1980." Empirical Economics 31.2 (2006): 497-511.

Ribba Antonio, Permanent disinflationary effects on unemployment in a small open economy: Italy 1979–1995, Economic Modelling, Volume 24, Issue 1, January 2007, Pages 66-81, ISSN 0264-9993, http://dx.doi.org/10.1016/j.econmod.2006.06.004.

Roberts, John M. "The sources of business cycles: a monetarist interpretation." International Economic Review (1993): 923-934.

Romer, Christina D., and David H. Romer. "Does monetary policy matter? A new test in the spirit of Friedman and Schwartz." NBER Macroeconomics Annual 1989, Volume 4. MIT Press, 1989. 121-184.

Romer, Christina D., and David H. Romer. "What ends recessions?." NBER Macroeconomics Annual 1994, Volume 9. MIT Press, 1994. 13-80.

Sargent, T. J. (1971). A note on the accelerationist controversy. Journal of Money, Credit and Banking, 3, 50-60.

Schettkat, Ronald, and Rongrong Sun. "Monetary policy and European unemployment." Oxford Review of Economic Policy 25.1 (2009): 94-108.

Schreiber Sven, Jürgen Wolters, The long-run Phillips curve revisited: Is the NAIRU framework data-consistent?, Journal of Macroeconomics, Volume 29, Issue 2, June 2007, Pages 355-367, http://dx.doi.org/10.1016/j.jmacro.2005.08.003.

Senda, T. and Smith, J. K. (2008), inflation history and the sacrifice ratio: episode-specific evidence. Contemporary Economic Policy, 26: 409–419.

Shimer, Robert. "Why is the US unemployment rate so much lower?." NBER Macroeconomics Annual 1998, volume 13. MIT Press, 1999. 11-74.

Stanley, T. D. (2004), Does unemployment hysteresis falsify the natural rate hypothesis? a meta-regression analysis. Journal of Economic Surveys, 18: 589–612. doi: 10.1111/j.0950-0804.2004.00231.x

Stanley, T. D. (2005), Integrating the Empirical Tests of the Natural Rate Hypothesis: A Meta-Regression Analysis. Kyklos, 58: 611–634. doi: 10.1111/j.0023-5962.2005.00305.x

Stockhammer, Engelbert, and Simon Sturn. "The impact of monetary policy on unemployment hysteresis." Applied Economics 44.21 (2012): 2743-2756.

Vaona, Andrea. "Merging the Purchasing Power Parity and the Phillips Curve Literatures Regional Panel Data Evidence from Italy." International Regional Science Review 30.2 (2007): 152-172.

Woodford, M. (2003). Interest and prices: Foundations of a theory of monetary policy. Princeton, NJ: Princeton University Press.

Woodford, M. (2008). How important is money in the conduct of the monetary policy? Journal of Money, Credit and Banking, 40(8), 1561–1598.