Kiel
Working Papers

Kiel Institute
for the World Economy

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

by Andrea Vaona

No. 2038 | April 2016

Web: www.ifw-kiel.de

Kiel Working Paper No. 2038 | April 2016

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

by Andrea Vaona

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.

JEL Classification: E31, E40, E50, J64

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

Andrea Vaona
Kiel Institute for World Economy
Kiellinie 66
24105 Kiel, Germany

University of Verona
Via dell'Artigliere 8
37129 Verona, Italy
Phone: +39-45-8028537
Email: andrea.vaona@univr.it

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

Andrea Vaona
Department of Economic Sciences
University of Verona, Italy,
and
Kiel Institute for the World Economy, Germany

andrea.vaona@univr.it

Phone: +390458028537
Fax: +390458028529

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

Acknowledgements:

The author thanks Dennis Snower, for his great help in better focusing the paper and in stressing its underlying theme, and Antonio Ribba for helpful comments and emails. The usual disclaimer applies.

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

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 on 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).

Parkin then highlighted four minorities. According to a neo-monetarist minority, the importance of changes in monetary aggregates should not be downplayed because 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. Hence inflation targeting is not a panacea. 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 labour market frictions. As we shall see, since the time when Parkin wrote his address, there have emerged also studies focusing on price stickiness in order to understand long-run inflation-output tradeoffs. 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 who maintain that a true understanding of the effects of monetary policy can be achieved by means of quantitative dynamic general equilibrium analyses. This last minority has turned into a majority since the time when Parkin was writing.

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 classic dichotomy whereby nominal and real economic magnitudes have no long-run connection is generally accepted in the economics profession. The intent of the present work is to review the empirical evidence that anomalously challenges this belief. [1] The interest in this issue is also motivated

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

by a growing body of theoretical literature on it, which is reviewed in the Appendix. We do not focus on criticisms of the hypothesis of either money or inflation long-run super-neutralities as in Galbraith (1997), Schettkat and Sun (2009) or in the works quoted in Coen et al. (1999). Nor do we delve into the empirical problems inherent in the estimation of the non-accelerating inflation rate of unemployment (NAIRU) as, for instance, in Eisner (1998), Stanley (2004, 2005) and Heyer et al. (2007). We instead focus on works that have found *positive* empirical evidence that either the level of macroeconomic activity is enhanced by inflation in the long-run or that inflation and the level of macroeconomic activity have a nonlinear relationship, positive at low inflation rates and negative at high ones. Hence we will focus either on papers of the second minority – to use Parkin's expression – or on works that are close to them in spirit. Our main aim is therefore not to give a fair assessment of the overall and vast literature, but rather to bring to the fore evidence that the existing paradigm tends to neglect.

As just mentioned, the literature on the Phillips curve is vast. Since the seminal papers by Phillips (1958) and Fisher (1973), economists have endeavoured to understand the connection between inflation and some possible real variables such as the unemployment rate and the output gap. Also the literature on money neutrality and super-neutrality is vast. The development of these literatures has been followed by surveys (see for instance the works cited in Qin, 2011). Hence, further clarification of our focus is warranted both in terms of the issues that we either cover or not and in terms of the economic magnitudes that we consider.

Since we are looking for evidence regarding money and price inflation non-superneutralities, we do not consider wage Phillips curves, 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 more extensive analyses. 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[2] (Dolado and Jimeno, 1997; Maidorn, 2003; Gambetti and Pistoresi, 2004; Amisano and Serati, 2003).

Hysteresis has been defined in different ways in the literature. Examples are the presence of a unit root in the unemployment generation process and, more generally, the dependence of the long-run or natural unemployment rate on the actual one. Here, we consider only studies that document a long-run effect of inflation on the NAIRU – not simply generically finding evidence of hysteresis and, therefore, inferring that macroeconomic policy has long-lasting effects on the unemployment rate. To be noted is that here we use the NAIRU, the natural rate of unemployment, and the long-run unemployment rate as synonyms.

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

For the same reason, we do not give full consideration to studies that find a persistent[3] yet transitory effect of either monetary policy or inflation or money growth on either unemployment or output because the very transience of these effects can reconcile them with the mainstream view as highlighted above. Although we reckon that this distinction is often blurred – given, for instance, the well-known power problems of unit root tests in finite samples – we want to give more weight to results that definitely cannot

[2] For instance, whether they are either fiscal or monetary in nature.
[3] See for instance Alexius and Holmlund (2008).

be reconciled with the classic dichotomy, with the exception of studies that have either methodologically or conceptually informed the subsequent literature.

Regarding the economic magnitudes taken into consideration, we focus on money growth and inflation, and not on the short-term interest rate. The best way to measure monetary policy – whether short-term interest rate or money growth – is a matter of 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. It is obvious that the two just-mentioned aspects of monetary policy – setting either the interest rate or money growth – are strongly connected, given how open market operations work. The ECB, in fact, closely monitors also changes in money aggregates (https://www.ecb.europa.eu/pub/economic-bulletin/html/eb201601.en.html). All the more that a growing body of theoretical literature illustrated in the Appendix stresses the role of trend money growth and inflation.

Moreover, we conduct a qualitative review of the literature to offer an in-depth discussion of, for instance, sample lengths, methodologies and model specifications. Nonetheless, the results of De Grauwe and Costa Storti (2008) are interesting because they find that the output effects of monetary policy can last over five years – their definition of 'long-run'.[4]

Given that here we are mainly concerned with long-run non-superneutralities 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 then onwards, the Vector Autoregression (VAR) methodology became widespread in the economic literature. We find this reason convincing. We also believe that the widespread adoption of information and communication technology has marked a turning point for the economics profession by making readily available estimation techniques previously confined to institutions able to afford large computing power. This lends further support to the appropriateness of starting our review in the early 1990s.

The main body of this survey is largely structured according to the methodology applied by the various studies: SVARs (Structural Vector Auto-regressions), the Kalman filter (KF), unit root and cointegration testing (when they are jointly used and are the main methodology adopted to obtain final results), stationary single equation models, and structural systems of equations applying the "Chain reaction theory". The final section concludes. This structure is used flexibly so that it does not act as a straitjacket artificially containing a highly diverse literature in which results are often obtained by a variety of methods. For this reason, we mix an "econometric" structure with an "economic" one, the purpose being to let the reader better appreciate the evolution of separate corpuses of research within the literature.

Table 1 focuses only on the studies from which it is possible to quantify the long-run non-superneutralities found, also stressing how these non-superneutralities are measured. The studies in Table 1 are listed in chronological order. Finally, note that different measures of non-superneutralities also imply different definitions of 'long run', as often discussed in the body of the text and in Table 1.

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

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. Studies of this kind often do not find unequivocal support for the existence of either positive money non-super-neutralities or non-vertical Phillips curves in the long-run. Nonetheless, these two concepts always find support in a (stubborn) piece of evidence.

2.1.1 Short run identification restrictions

King and Watson (1994) make use of SVARs by imposing short-run restrictions: that is, they exploit? theories that exclude contemporaneous effects of some variables on others. First they show that, in the 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 grasp this point better, it is useful to refer to the simplified exposition of Sargent's critique by Gordon (2011). Consider an expectation augmented Phillips curve

$$\pi_t = \alpha E\pi_t + \beta u_t + e_t \tag{1}$$

where π_t is the inflation rate at time *t*, u_t is the unemployment rate, α and β are coefficients, e_t a stochastic error, and *E* is the expectation operator. Further suppose that expectations are adaptive

$$E\pi_t = v\pi_{t-1} \tag{2}$$

By substitution one obtains

$$\pi_t = \alpha v\pi_{t-1} + \beta u_t + e_t \tag{3}$$

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 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 SVAR, crucially depends on short-run identifying assumptions and, therefore, on the priors with which scholars approach the data. They distinguish among 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 of an instrumental variable approach, where the exact instrument set was not univocally defined in previous contributions. However, the results obtained are consistent across different studies. The long-run effect of unemployment on inflation, over the entire 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 again using a bivariate SVAR on the time period 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 developed 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 SVAR 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 except 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 developed by King and Watson (1994) to Spanish annualized quarterly data, without any seasonal adjustment, spanning from 1964Q1 to 1997Q4. They adopt three identification strategies: a real business cycle one, a monetarist one, and a Keynesian one. In so doing, however, they introduce some modifications. Firstly, they include 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 rates. Furthermore, unlike King and Watson (1994), they define the "Keynesian" identification assumption by assuming that inflation has a very large short-run impact on unemployment. In their monetarist identification assumption, instead, inflation is only driven by demand shocks in the long-run. 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-year 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 been monetary in nature. On the other hand, the disinflation between 1992Q1 and 1993Q1 stemmed from labour-market reforms: that is, they had a supply-side nature. On studying forecast error variance decompositions, the monetarist approach is the only one able to mirror the above prior information. On 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, although it halves and its significance level falls somewhat.

2.1.2 Long-run identification restrictions

Bullard and Keating (1995) use unit root testing, in the form of ADF tests, and bivariate SVARs 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 includes 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. For these countries the long-run effect of inflation on output is measured by resorting to the long-run derivative:

$$LRD_{GDP,\pi} = \lim_{k\to\infty}\left(\partial y_{t+k}/\partial \varepsilon_{\pi,t}\right)/\left(\partial\ \pi_{t+k}/\partial \varepsilon_{\pi,t}\right) \quad (4)$$

where y is output, *k* is a time subscript and $\varepsilon_{\pi,t}$ is the identified inflation shock. Only for 5 of these 16 countries is there a significant long-run effect of inflation on output. In a hyper-inflation country (Argentina) this effect is negative, and in the other low-inflation ones (Germany, Austria, Finland and the UK) it is positive. For 9 further countries, there is evidence that inflation has permanent shocks but not output, which can be interpreted as supporting money super-neutrality. For 31 countries, inflation has no permanent shock, so that Bullard and Keating's data cannot shed light on their research question. 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, as the former is integrated of order 2 and the latter of order 1. For Bolivia, inflation and output appear to be related in the long-run, but the sign of this relationship is not stated. The connection is noted by considering the facts that inflation is integrated of order 1, output of order 2 and, regressing the first difference of inflation on second differences of output, it is possible to reject the null that the estimated coefficient is equal to zero. 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 limitation of this study is that it considers only bivariate relationships, thus? being exposed to the possible problem of omitted relevant variables.

Rapach (2003) extends the analysis of previous contributions by considering a trivariate SVAR 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. The hypothesis investigated by Rapach is that 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 verifies that his results are robust to imposing identifying restrictions at long but finite horizons in 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 on 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 does not substantially alter these results.

Algan (2002) estimates a trivariate SVAR in labour 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 with the unemployment benefit replacement ratio and with an indicator of the mismatch between labour demand and supply.[5] What is interesting for our purposes here is that the 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%. The results for France are similar, but the impulse response function of the unemployment rate is not significantly different from zero. A supply shock increases labour 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 of that in the latter.

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] His critique is based on the argument that increases in demand can positively affect innovation activity and technology adoption. This work resorts to an Aggregate Supply-Aggregate Demand (AS-AD) model, including a modified Lucas supply curve – with real output depending on its expectations, unanticipated inflation and a random shock – and a demand curve – where nominal demand depends on its expectations and a random shock. On these grounds it is possible to show that aggregate demand shocks can affect the aggregate supply curve, allowing an identification approach different from the one used 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 Bashar's results, demand shocks can permanently affect output and inflation, inducing a long-run Phillips curve. Note that Bashar's identification strategy is based on the hypothesis that the AS curve is vertical in the long-run. However, movements of AD shift the AS by generating innovation and raising productivity.[7]

2.2 A KF study

Heyer et al. (2007) compare two estimation methods, respectively building on the Equilibrium Rate of Unemployment (ERU), derived either from price and wage setting schedules (WS/PS) – as in Layard et al. (1991) – or from a wage Phillips curve, and on the time varying NAIRU – as in Gordon (1997). Firstly, they show the common theoretical roots of the two approaches. Secondly, 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 KF technique. Hence, they show that the model[8] improves in terms of the significance of the regressors and of insensitiveness of the

[5] It is worth noting, however, that the replacement ratio does not display much variation during the period of observation with the exception of a marked increase in the late 1970s.

[6] Cover et al. (2006) did not, though, explore the long-run implications of their critique.

[7] Bashar (2011) compares BQ and Cover et al. (2006). More technically, Bashar (2011) estimates an AB SVAR in output growth and inflation changes. The A matrix is $\begin{bmatrix} 1 & -\alpha \\ 1 & 1 \end{bmatrix}$ and the B matrix is $\begin{bmatrix} \cdot & \cdot \\ 0 & \cdot \end{bmatrix}$, where the dots denote the parameters to be estimated. The value of α descends from the identification strategy, whereby changes in AD can shift the AS in the long-run.

[8] In the baseline model estimated by the Kalman filter, the dependent variable is the inflation in the GDP deflator. Explanatory variables are lagged inflation, the difference between the unemployment rate and the long-run

results to the signal-to-noise ratio upon inserting into 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 in this case their results are more standard, supporting the existence of a NAIRU constant through time.

2.3 Unit root and cointegration studies

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

2.3.1 Unemployment and inflation

Ribba (2007) estimates a structural cointegrated VAR model on Italian and German 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 the Consumer Price Index (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 because 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 assumptions, increases in the inflation rate are shown 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 adopting 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. On adopting an ADF test, evidence is found that both the unemployment and the inflation rates are integrated of order one. A Johansen rank test further finds them to be cointegrated. Note that, when testing for cointegration, Schreiber and Wolters add to the VAR, as exogenous variables, an impulse dummy equal to 1 in 1991Q1 and zero otherwise to account for 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

$$\pi=6-0.5u \qquad (5)$$

By inspecting impulse-response functions, Schreiber and Wolters (2007) then infer that the system's dynamic 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 from a methodological point of view. The former refers to Malaysia from 1973 to 2004, and the latter to Greece from 1980 to 2010. They

unemployment rate (which is a coefficient allowed to vary over time), the difference between inflation in imports and inflation in the consumer price deflator, hourly labour productivity, and changes in the real interest rate. In the WS/PS model, the WS equation has as independent variables the change in the hourly wage in the business sector, lagged inflation in the consumer price deflator, the unemployment rate, the first difference of the unemployment rate, lagged labour productivity growth. In the PS curve, instead, the inflation in the consumer price deflator is regressed on the inflation of imported goods.

both make use of annual data; and they both rely on unit root and cointegration testing to detect a long-run relationship between inflation and the *unemployment gap*. They differ in how 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 cases, the unemployment gap and the inflation rate turn out to be I(1). To test for nonstationarity, Furuoka (2007) adopts the ADF test with and without trend. Dritsaki and Dritsaki (2013), instead, use the ADF test, as well as the Phillips and Perron and the Kwiatoski, Phillips, Schmidt and Shin (KPSS) tests. To be noted 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, the 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) apply the same methods as employed by 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) criticise the adoption of cross-section datasets to investigate the connection between inflation and output growth for three reasons: the results may be biased by specific countries experiences, by? time averaging (in the presence of underlying Granger causality running from either inflation to growth or the other way round), and by? 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 levels of output and inflation are cointegrated, and that inflation is positively connected to output. Note that they further remark that, even if the nonstationarity result of inflation were 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 shown that the ADF 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, although the exact period of observation varies from country to country. They consider the same variables as Atesoglu (1998). According to the ADF 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 can be found, while two are found for Finland and the UK. For New Zealand the

rank and maximum eigenvalue statistics are in conflict. All cointegrating tests include a trend. The authors then proceed, rather mechanically, to estimate the coefficients of one cointegrating vector for all countries and of the error correction mechanism. Inflation and government expenditure both have a positive long-run link with output[9] – the latter variable having 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 Further non-stationary studies

Ahmed and Rogers (2000) conduct a unit root/cointegration study that stands out with respect to the above works due to its analysis of a broader set of variables. More specifically, they use US 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 Vector Error Correction Model (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 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's (1993) work is worth mentioning because of its influence on empirical studies concerning how to treat the link between money and real variables in a-theoretical framework, even though the evidence produced concerns a country during an hyperinflation period, and even though their results support a negative long-run link between money growth and neither output or unemployment, but real monetary balances. 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, it is first necessary for money to be 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 used 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 since 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 former 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 latter 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.

[9] With the exception of the UK, whose inflation-output link is negative.

These entail that money variables must 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

$$\pi_t = \alpha + \sum_{i=1}^{n} \delta_i \pi_{t-i} + \sum_{i=1}^{m} \beta_i u_{t-i} + \sum_{i=1}^{q} \gamma_i s_{t-i} + \varepsilon_t \quad (6)$$

where s_t is a set of cost-push variables, α, δ, β, and γ denote coefficients and ε_t a stochastic error. The existence of a constant NAIRU requires that the following restriction holds $\sum_{i=1}^{n} \delta_i = 1$. . Adding to the above equations two terms, namely π_{t-1} and the first lag of the log of the price level – $\log(p)_{t-1}$ – 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 additional variables mentioned provide a more general model within which to test 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 π_{t-1} and $\log(p)_{t-1}$ is consistent with the theories presented in Fair (1974, 1984, and 1994) and with the intuition underlying 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 because the underlying test statistic is non-standard, given the presence of unit roots in the variables considered and given the low power of the ADF test. The null that the coefficients of π_{t-1} and $\log(p)_{t-1}$ are both equal to zero is rejected at a 99% level. T-tests on the single coefficients produce similar results. The strength of the rejection weakens somewhat on 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 of 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

This sub-stream of literature comprises three groups of studies: studies on non-linearities; disinflation studies; and studies using data on local labour markets.

2.4.1 Studies on nonlinearities

Akerlof, Dickens and Perry (1996) contrast the performance of the model based on the NAIRU with a model omitting 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 labour 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, whilst 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 are three kinds of departure from a fully rational use of the available information regarding inflation. First, low inflation rates may be ignored when setting wages and prices. In addition, incomplete inflation projections may arise from an informal use of information about inflation. In other words, in forming expectations, inflation is considered along with other factors, each of which receives a weight, and the weight of inflation may be less than one. Finally, workers perceive inflation as an erosion of their purchasing power and not as resulting in an increase of demand for their services. This misperception induces, on the one hand, workers to perceive nominal pay rises at low inflation rates as a sign of appreciation of their work, and on the other, employers to pay lower real wages than otherwise. According to Akerlof, Dickens and Perry (2000), only one of these three mechanisms need to be in place to produce a non-linear Phillips curve such that, at low inflation rates, an increase in inflation reduces unemployment. As inflation rises further, unemployment starts increasing up to a 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 above economic mechanisms 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 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.

Second, Phillips curves incorporating both adaptive inflation expectations and direct measures of inflation expectations are estimated, so as to overcome the Sargent (1971) criticism. 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 or 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: the unemployment rate of all workers, that of 25-54 year 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 words, 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

$$\pi_t = d + \Phi(\mathrm{D}+\mathrm{E}\pi_{L,t}^2)\pi_t^e - eu_t + gX_t + \epsilon_t \tag{7}$$

where Φ is the cumulative standard normal density function, π_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 ϵ 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*.

$$\pi_L = \frac{\sum_{\substack{i=1 \\ i\tau<1}}^{24} (1-i\tau)\pi_{-i}}{\sum_{\substack{i=1 \\ i\tau<1}}^{24} (1-i\tau)} \tag{8}$$

where τ is to be estimated and *i is a time index*. 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 average free to be estimated. Also π_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 of Akerlof, Dickens and Perry (2000) described above. 218 specifications are estimated. They vary not only according to the exact series used and on how variables are built but also according to the number of lags included 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, although 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.[10] The results support the view that the long-run Phillips curve is nonlinear, with unemployment first decreasing and then increasing as inflation rates rise, up to a point where inflation turns super-neutral.

Lundborg and Sacklen (2006) apply the model developed 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 that they consider includes a corrected inflation index derived from the Consumer Price Index, the Import Price Index, and Import shares so as 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 labour 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%. Above 7%, inflation is super-neutral.

Building on Ackerlof, Dickens and Perry (2000), Svensson (2015) considers Sweden from the fourth quarter of 1997 to the fourth quarter of 2011, the US from the first quarter of 2000 to the second quarter of 2011 and Canada from the first quarter of 1997 to the fourth quarter of 2012. Svensson (2015) argues that, during these periods, the considered economies were on the negatively sloped portion of the long-run Phillips curve theorized by Ackerlof, Dickens and Perry (2000). Most of the study focuses on Sweden, though. According to the author, inflation expectations were anchored to 2%. However, the Swedish

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

central bank systematically set inflation at a lower level, leading to a higher real wage and, therefore, to a higher unemployment rate than otherwise. The unemployed could not put pressure on wage setters due to insider-outsider mechanisms. Moreover, the central bank pursued this kind of policy for various reasons. Firstly, it had asymmetric preferences, favoring lower inflation rates over higher ones. Secondly, potential unemployment and inflation pressures were systematically overestimated – the latter one because of imported inflation and productivity growth being respectively lower and higher than expected. Finally, either credit market frictions or policy mistakes hampered the transmission of monetary policy, leading to undesired tight monetary conditions notwithstanding low repo rates. According to Svensson (2015), these mechanisms can produce a long-run Phillips curve, which can be estimated by regressing the CPI inflation rate on its own lags and on the lags of the unemployment rate and inflation expectations. Inflation expectations are obtained from survey data. The adopted estimation method is ordinary least squares and zero-coefficient restrictions are imposed on the basis of Wald tests and corroborated by lack of serial correlation in the residuals as indicated by the Durbin-Watson statistic. Findings point to the existence of a long-run Phillips curve having a benchmark slope of -0.75. In other words, lowering the long-run inflation rate by 1 percentage point comes at a cost of increasing the unemployment rate by 1.33 percentage points. These results survive a series of robustness checks, such as dropping the observations concerning the crisis years from 2008 to 2011; adopting alternative inflation measures (depending on how mortgages are considered or whether real-time or revised data are used or resorting to the GDP deflator); letting the long-run unemployment rate, as estimated by the Swedish central bank, to vary over time; and, finally, using older lags of the unemployment rate either as regressors or as instruments to avoid contemporaneous correlation with the error term. Regarding the US and Canada, Svensson (2015) uses similar data and methods to those adopted for Sweden. The slopes of the long-run Phillips curves are -0.23 for the US and -0.42 for Canada respectively. However, these countries did not have to face an unemployment cost over the period of observation, as actual and expected inflation rates were very close. Finally, the existence of the long-run Phillips curve does not imply that it can be exploited for monetary policy purposes - with the exception of keeping the actual and the expected inflation rates close. This is because its underlying economic mechanism builds on the credibility of the monetary authority, which would vanish if it systematically announced a lower inflation target than the one it really practiced.

The results on the US by Svensson (2015) are similar to those obtained by Fuhrer (2011), who - modelling the annual rate of the quarterly core CPI inflation (published by the Bureau of Labor Statistics) as a function of the unemployment gap for the period between the first quarter of 2000 to the second quarter of 2011 - finds a slope of -0.26.

2.4.2 Disinflation studies

Notwithstanding the critique by Ericsson et al. (2001), a body of literature based on cross-sectional data has developed. Ball (1997)[11] considers a cross-section of 20 OECD countries from 1980 to 1990. The NAIRU is computed following Elmeskov (1993), although, for the sake of robustness, the Hodrick-Prescott filter is also used. The Elmeskov procedure builds on an "accelerationist" Phillips curve without shocks

$$\pi_t - \pi_{t-1} = b(u_t - u^*) \tag{9}$$

[11] A parallel stream of literature has 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.

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[12] between 1980 and 1990, the length of the disinflation raised to the square, and the duration of the unemployment benefit. Other features of the labour market are shown 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 being 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. Hence if the coefficient of inflation in 1990 is significant, this 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.[13]

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 α from the following model is estimated

$$\pi = \pi_{-1} + \alpha(u - u^*) + \epsilon \tag{10}$$

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

$$u^* - \left(\frac{1}{\alpha}\right)\epsilon = u - \left(\frac{1}{\alpha}\right)(\pi - \pi_{-1}) \tag{11}$$

$u^* - \left(\frac{1}{\alpha}\right)\epsilon$ is then filtered with the Hodrick-Prescott procedure setting the smoothing parameter to 100. The estimation of α and filtering are iterated until convergence of both the parameter estimates 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: that is, either falls or rises in "trend inflation" by at least 3%, where trend inflation is defined as a nine-quarter centred moving average of inflation. The 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.

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

[13] Ball (1999) extends Ball (1997) in a number of different directions. First, the unemployment variable considered is not only the change in the NAIRU but also "the degree of hysteresis". This latter 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. The 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 have a still sizeable effect on output after 4 years. Similar results are contained in Romer and Romer (1989) focusing on specific episodes of the US economic 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.

Ball et al. (2013) focus on Latin America and the Caribbean. They build two datasets of unemployment rates. In the first, they make an effort to harmonize the definition of unemployment rates across countries, while, in the second, they do so across time. Both encompass 19 countries and are unbalanced. The former dataset runs from 1990 to 2007, while the latter runs 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 labour-market variables (the advance time notice before being fired, indemnities for dismissal, firing costs, rigidity of employment, social security contributions, labour 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 resulting from a number of different factors: people crowding into large cities in search of high-paying scarce jobs, more self-employment and larger informal sectors in rural areas, less unionization, and fewer labour-matching problems in small rural communities.

Ball et al. (2013) then consider some historical cases on the basis of their second dataset. They focus on large increases in the long-run unemployment rate, on temporary increases in actual unemployment rates that did not feed into the long-run unemployment rate, and, finally, on decreases in the long-run unemployment rate. Note 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 in 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". On studying the single episodes, it is inferred that large increases in the long-run unemployment rate are due to marked falls in aggregate demand resulting from either monetary policy tightening or exchange rate parity defence in the presence of capital flights. Temporary increases in the unemployment rate, without strong effects on the long-run unemployment rates, are explained as resulting from devaluation in face of capital flights. Finally decreases in the long-run unemployment rate are explained as resulting from a high starting level of long-run unemployment and accelerating economic growth (whose underlying causes, however, may be diverse).

2.4.3 Evidence from local labor markets

Coen et al. (1999) explore the existence of long-run non-vertical Phillips curves in local US labour 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 they are significant only on considering inflation in average hourly earnings and in manufacturing. The sum of the coefficients of inflation is always different from one, pointing to the existence of long-run super-neutralities. Note, however, that these results rest on the hypothesis of poolability across metropolitan areas, which is always rejected except for inflation in construction earnings. No reference is made to either the stationarity of the series or the possible existence of structural breaks.

Also Vaona (2007) focuses on local labour markets. He does so by exploiting a dataset of 81 Italian provinces from 1986 to 1998 at an annual frequency. A dynamic panel data estimator is applied following Blundell and Bond (1998). A long-run Phillips curve is found to exist, and it negatively relates local inflation

and unemployment rates.[14] This relation, however, 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 includes only two inflation lags as instruments.

2.5 Structural multi-equation models with interactions between growing variables and adjustment costs

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 most recent studies and finish with the earliest ones.

Karanassou and Sala (2012) estimate a system of four equations both by ARDL and 3SLS (three stage least squares) on US annual data from 1970 to 2006. Endogenous and exogenous variables are clearly spelled out. The former include the GDP deflator, total compensation per employee, the unemployment rate, real total capital stock, and capital accumulation (more precisely the first difference of the real total capital stock). The latter are money supply (M3), real labour 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 except the unemployment rate are in logs. Karanassou and Sala's 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 – defined as the ratio between the long-run responses of the inflation and unemployment rates – of -3.58.

Karanassou and Sala (2010) offer both SVAR and single equation Generalized Method of Moments (GMM) estimates based on a semi-annual US dataset from 1960 to 2005. The choice of the frequency is intended to avoid Generalized Autoregressive Conditional Heteroscedasticity - (G)ARCH – effects. Regarding 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 in a recursive manner 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 rate 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 a 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. The 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,

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

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 of Pesaran et al. (2001).[15] Data are from the US at an annual frequency covering the 1960-2005 period. The logged variables involved are the money supply (M3), the GDP deflator, the nominal compensation, the real wage, real labour productivity, employment, the labour 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 net exports. 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 the 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) take 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 of testing 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 – which are not rejected by the data – the system is estimated by three-stage least squares[16]. The variables considered 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 bargaining, oil price shocks, institutional changes associated with the Moncloa Pacts, the 1984, 1993 and 1997 waves of labour market reforms, entry into the European Economic Community, and entry into the European Monetary System. Annual data from 1966 to 1998 are analysed. A 10% increase in money growth is found to produce a 10% increase in inflation and a 3.7% decrease in the unemployment rate.

Karanassou et al. (2005) apply a procedure similar to that of 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 the European ones do so from 1977 to 1998. The variables analysed are similar to those listed for Karanassou et al. (2008a, b). The results for the US are close to those obtained by Karanassou et al. (2008b). Unlike in Karanassou and Sala (2012) here capital accumulation is exogenous. In regard to EU countries, a fixed effects estimator is applied equation-by-equation after pooling all the countries.[17] Before estimation, the Maddala and Wu (1999) test for unit root is run, and non-stationarity is

[15] Identification is not explicitly discussed. Nor is the exogeneity assumption underlying the ARDL model (see Pesaran et al., 2001, p. 293).
[16] Though an exact instrument list is not elicited.
[17] Notwithstanding the panel structure of the EU dataset and the dynamic nature of the estimated equations, no dynamic panel data estimator is used.

always rejected. The results imply that permanent increases in money growth and inflation of 10% induce a permanent fall in the unemployment rate of 3.14%.

Karanassou et al. (2003)[18] report GMM estimates of a single equation Phillips curve with the unemployment rate as driving force. The GMM estimates make it possible to overcome the Sargent critique because inflation expectations are not simply modelled as adaptive. Instead, the inflation lead is instrumented by resorting not only to two inflation lags but also to a constant, to unemployment rates lags, the real oil price, and the changes in real labour productivity, employment, and working age population. Data concern the whole of the EU. Two specifications are presented: in the first the unemployment rate is exogenous, and in the latter it is endogenous. The results do not significantly change the slope of the long-run Phillips curve, which is -3.13 in the former case and -3.43 in the latter.

3. Conclusions

As can be seen from this survey and as summarized in Table 1, "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 as estimation methods, countries, frequency of the data, time period under analysis, and the exact model specification. In concluding this paper, we offer some suggestions that could help this literature take further steps ahead.

Firstly, there is often a need for greater robustness of results or more transparency in regard to the instruments adopted and identification assumptions. For instance, unit root studies often limit their analysis to results from the ADF test. However, many different unit root tests are today available even in standard econometric packages, and they are readily applicable. Examples are the tests developed by Phillips and Perron (1988), Kwiatkowski et al. (1992), Elliot et al. (1996), Ng and Perron (2001). Furthermore, this method is often applied to small samples, which are well known to make its reliability questionable. Regarding identification assumptions, it is clear that they can affect results in bivariate SVARs, which is a very important point in a field dominated by strong priors. More Bayesian studies and a greater endeavour to achieve alternative identification approaches could give rise to interesting research developments. Another example is the scarce attention paid by the literature to the problem of omitted variables.

Moreover, as argued by Dickens (2001), the available literature tends to pay little attention to the direction of causality between either unemployment or, more in general, indicators of economic activity and either money or inflation. This issue has long pervaded the literature: suffice it to consider Fisher (1973) and Phillips (1958). When the issue has been more deeply investigated, the results have not been clear-cut. For instance, Ball (1997) found that causality runs from inflation to unemployment. Similarly, in studies on the "Chain Reaction Theory" money supply is an exogenous variable and unemployment and inflation are both endogenous. On the other hand, studies adopting GMM estimators, such Karanassou et al. (2003), Vaona (2007) and Karanassou and Sala (2010), and Svensson (2015) support a causality direction going from unemployment to inflation. Further, Dickens (2001) stresses that data on low inflation rates are scarce. It is therefore difficult properly to estimate the connection between low inflation rates and either unemployment or other indicators of macroeconomic activity because estimates may be driven by the bulk of the observations, which usually regards either medium or high inflation rates.

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

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 inflation rates below the national level, as argued by Coen et al. (1999).

Finally, non-linearities in long-run Phillips curves should be investigated more closely. 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 ones. An example of this evidence is provided by Bullard and Keating (1995), who found that inflation increased output in low inflation countries, decreased output in one hyperinflation country, and did not affect output in the others. This might suggest a non-linear long-run Phillips curve; a hypothesis that should attract more attention in empirical research also for its policy implications, in that there may exist an unemployment-minimizing (or an output-maximizing) long-run inflation rate that central banks could target, as stressed by Akerlof et al. (2000) and by recent theoretical studies (see the Appendix). In this regard, non-linear cointegration testing could offer interesting insights (Sephton, 1994; Choi and Saikonnen, 2010).

Appendix. Theoretical works on the long-run Phillips curve

A recent growing body of theoretical literature has questioned the existence of a vertical long-run Phillips curve. We focus here on micro-founded models in order to highlight contributions robust to the Lucas critique, and therefore accepting one of tenets of the mainstream approach to economics, obtaining, this notwithstanding,? anomalous results.

King and Wolman (1996) show that, under Calvo price staggering and in a New Keynesian (NK) setting, it is possible to obtain a positive linear connection between output and inflation. This is because some firms do not change prices as the aggregate inflation rate rises. Their markup is therefore eroded and their output increases. Deveraux and Yetman (2002) show that, once the frequency of price adjustments is endogenized, the connection between inflation and output becomes nonlinear. Under their calibration, it is positive below 2% trend inflation, negative above 2%, and null above 40% trend inflation. At 2% trend inflation, output is 0.8% higher than at zero inflation. Levin and Yun (2007) obtained similar results but within a NK model with endogenous price adjustment. Under this hypothesis, inflation has large effects on output and labour, though these vanish at high inflation rates.

Graham and Snower (2004, 2008) also adopt NK frameworks. These works focus on the mechanics of long-run inflation non-superneutrality under wage staggering. This depends on three channels: employment cycling, labour supply smoothing, and time discounting. In the first case, a negative inflation-output nexus arises because firms' labour demand shifts from one cohort to the other in search of the lower real wage and labour kinds are not perfect substitutes, giving rise to inefficiencies. Through the second channel, employment cycling induces households to demand higher wages because they would prefer to smooth working time over the contract period. As a consequence, labour supply and aggregate output decrease. Finally, because of time discounting, labour demand is spurred by inflation because the contract wage depends more on the current (lower) level of prices than on the future (higher) level of prices. Time discounting dominates at low inflation rates, while labour supply smoothing and employment cycling do so at higher ones. Therefore, a hump-shaped long-run Phillips curve arises. Under hyperbolic discounting, the effect of inflation on output is magnified (Graham and Snower, 2008). Vaona and Snower (2008) show that,

upon assuming increasing returns to scale, the diseconomies deriving from employment cycling turn into economies leading to a positive long-run Phillips curve.[19]

Vaona (2013) considers the effects of money illusion within a similar model to those above. Money illusion is defined as a "biased subjective way economic agents have to evaluate real variables" (p. 88) and it is modelled by resorting to Stevens' ratio estimation function. In other words, suppose an agent has two pieces of information: his nominal wage and the general level of prices, s/he will have to compute their ratio to obtain her/his real wage. However, money illusion biases this assessment and, following Stevens (1946, 1951), this bias can be modelled by resorting to powers of the ratio under analysis. On these grounds, Vaona (2013) shows that households' over-perception of real variables leads to positive money non-superneutralities.

Vaona (2010, 2012) proposed a theory of money non-superneutrality based on a different structure of the labour market, namely an efficiency wages one. In this context, a gift exchange between firms and workers takes place. As empirically documented by Bewley (1999), firms are not favourable to wage indexation. However, they are concerned that trend inflation (produced by trend money growth) – eroding the purchasing power of wages – may demotivate workers. Therefore they defend the real wage against inflation. In exchange, workers make greater effort. Because firms perceive workers as more productive, they hire new people, ending with a decrease in the unemployment rate.

Di Bartolomeo et al. (2012) introduce strategic interaction in wage setting. Wage setters anticipate the fall in money holdings due to wage increases translating into price inflation, and the consequent fall in consumption. Labour supply decreases. As a consequence, wage setting is disciplined and the employment increases below 6% inflation and decreases thereafter. Di Bartolomeo et al. (2014) extend their analysis from the inflation-employment nexus to the inflation-output one.

Ahrens and Snower (2014) introduce psychological considerations within a standard NK model with Calvo wage staggering and monopolistically competitive workers. Wage dispersion generates envy in workers with lower incomes and guilt in those with higher ones. Hence, the former increase their labour supply and the latter decrease it. According to the available empirical evidence, the envy effect dominates, reinforcing the discounting effect. This produces a sizeable increase in output and employment in response to higher inflation at low inflation levels. Overall, the long-run Phillips curve is hump-shaped, reaching the maximum level of output and employment at around 2% trend inflation.

Snower and Tesfaselassie (forthcoming) consider job turnover and trend productivity growth in a NK model. They reach three conclusions. First, under job turnover and at low inflation rates, a permanent change in long-run money growth has significant positive real effects. Second, if agents are sufficiently eager to smooth consumption over the contract period, trend productivity growth has positive long-run real effects. Third, the two effects tend to reinforce each other, leading to an optimal inflation that is higher in the

[19] Benigno and Ricci (2011) consider idiosyncratic shocks and downward wage rigidities. They further derive a positive nonlinear relationship between the long-run averages of wage inflation and the output gap. This curve shifts outwards with macroeconomic volatility, increasing output and employment costs. However, they focus on wage inflation, while here we consider price inflation arising from trend money growth. Also Colombo and Weinrich (2003) focus on the Phillips curve defined as a negative relationship between wage inflation and unemployment, but within a chaotic system. Note that, in this work, quantities adjust faster than prices, and agents are rationed. Hughes-Hallet (2000) derive a long-run connection between inflation and unemployment by aggregating regional/sectoral Phillips curves, however not in a micro-founded context.

presence of job turnover than otherwise. The following explanations can be given for the three above effects. Given nominal wage rigidity, higher job turnover makes wage setting less forward-looking, thereby reducing the wage markup and increasing employment. Higher trend growth has similar effects: it raises the real interest rate and hence the effective discount rate (this effect is stronger, the higher the degree of consumption smoothing). Moreover, in the presence of nominal price rigidity, the discounting effect of growth reduces the price markup, increasing output.

Table 1 – Summary of the reviewed studies with quantifiable long-run super-neutralities.

Study	Method	Country	Frequency	Time-period	Measure of long-run super-neutralities	Quantification of long-run super-neutralities
Fisher and Seater (1993)	ARIMA	Germany	Monthly	From February 1919 to August 1923	Long-run derivative of real balances with respect to money growth.	A permanent increase of 1% in money growth reduces real balances by about 1.8%.
King and Watson (1994)	SVAR	US	Monthly and quarterly	From January 1954 to December 1992	Long-run derivative of unemployment with respect inflation.	Under a Keynesian identification scheme, a 1% increase in inflation induced by a demand shock produces a 0.7% fall in unemployment. Under a monetarist identification approach, a 1% increase in inflation induced by a demand shock produces a 0.3% fall in unemployment. Under an RBC identification approach, a 1% increase in inflation induced by a demand shock does not produce any change in unemployment.
Bullard and Keating (1995)	SVAR	58 countries	Annual	Various	Long-run derivative of output with respect to inflation.	For most of the countries, there is evidence of long-run super-neutrality with the exception of four low-inflation countries (Germany, Austria, Finland and the UK) and one hyperinflation country (Argentina). In Germany, Austria and Finland, a 1% increase in inflation induced by a demand shock produces about a 1.5% increase in output. In the UK, the increase in output is about 0.6%. In Argentina, the effect is negative.
Akerlof, Dickens and Perry (1996)	Nonlinear Least Squares	US	Annual	1929-1995	Changes in the long-run unemployment rate in correspondence to changes in the long-run inflation rate.	The long-run link between inflation and unemployment is nonlinear, resembling a rectangular hyperbola in the positive part of a Cartesian plane defined by the unemployment and inflation rates. As long-run inflation increases from zero to 3%, unemployment falls from 8% to about 5.9%. Above 3%, inflation is super-neutral. Zero inflation and slight deflation are associated with unemployment rates above 8%.

Study	Method	Country	Frequency	Time-period	Measure of long-run super-neutralities	Quantification of long-run super-neutralities
King and Watson (1997)	SVAR	US	Quarterly	1949Q1-1990Q4	Long-run derivative of output with respect to money growth, and long-run derivative of inflation with respect to unemployment.	Results change depending on the short-run identifying assumptions. For instance, if the short-run effect of output on money growth is zero, a 1% increase in money growth will increase output by 3.8%. On increasing the short-run effect of output on money growth, the long-run effect of money growth on output will decrease. Similarly, upon considering unemployment and inflation, short-run impacts of unemployment on inflation greater than 2.3% lead to a long-run effect between -0.2% and -0.4%.
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. The coefficient of the change in inflation can be considered as the measure of the slope of the long-run Phillips curve.	At mean NAIRU and inflation values, a 1% decrease in inflation raises the NAIRU by 0.55%.

Study	Method	Country	Frequency	Time-period	Measure of long-run super-neutralities	Quantification of long-run super-neutralities
Koustas (1998)	SVAR	Canada	Quarterly	1955Q1-1993Q4	Long-run derivatives of unemployment with respect to inflation, and of inflation with respect to unemployment.	The results change according to the identifying assumptions. If the short-run impact of unemployment on inflation is smaller than about 2.4%, the long-run impact of unemployment on inflation ranges approximately between -0.5% and -1.7%. Similar values can be obtained by varying the short-run impact of inflation on unemployment and the long-run impact of inflation on unemployment. Evidence on the long-run impact of inflation on unemployment, depending on the assumptions regarding the other short- and long-run impacts, is more in favour of a vertical long-run Phillips curve.
Atesoglu (1998)	Unit root and cointegra-tion tests	US	Annual	1960-1995	Coefficient of inflation in the cointegrating vector including the logs of real GDP, of real total government spending, and the first difference of the log of the GDP deflator.	A 1 % increase in inflation leads to a 0.06% rise in real income.
Coen et al. (1999)	OLS	US (Metropol itan Statistical Areas)	Quarterly	1990Q1-1997Q4	Slope of the long-run Phillips curve measured by the ratio of the sum of the coefficients of the lags of the unemployment rate over one minus the sum of the coefficients of inflation lags measured in three different ways: CPI; average hourly earnings in construction and in manufacturing.	The slope of the long-run Phillips curve is equal to -0.16 when using CPI inflation, to -0.45 when using inflation in construction wages, and to -0.20 when using inflation in manufacturing wages.

Study	Method	Country	Frequency	Time-period	Measure of long-run super-neutralities	Quantification of long-run super-neutralities
Ahmed and Rogers (2000)	VECM	US	Annual	1889-1995	Coefficients of inflation in two cointegrating vectors also including the logs of real per capita consumption, investment, GDP, and the ratio of government spending over output	Increasing inflation by one percentage point decreases the consumption-output ratio by 2.5% and increases the investment share by 1%.
Dolado et al. (2000)	VECM	Spain	Quarterly	1964Q1 to 1997Q4	Long-run derivative of the unemployment rate with respect to the inflation rate.	Under the monetarist identifying assumptions, preferred by the authors on the basis of study of historical episodes, a 1% increase in inflation reduces unemployment by 0.3% in the long-run.
Akerlof, Dickens and Perry (2000)	OLS and nonlinear least squares	US	Quarterly	1954Q1 to 1999Q4	Effect of the change of inflation on the unemployment rate within a nonlinear model.	Depending on the specification, increasing the inflation rate from just below zero to 2% decreases the unemployment rate from 6-8% to 2.3-4.7%. Increasing inflation further raises unemployment to 4.5%-7.5% first and then no longer has a real effect.
Mallik and Chowdhury (2002)	Unit root and cointegration tests, VECM	Australia, Canada, Finland, New Zealand, Spain, Sweden, the UK	Quarterly	1960Q1to 1998Q4	Coefficients of inflation (measured as the first difference of the log of the CPI) in a cointegrating vector also including the logs of real GDP and of real total government spending.	The effect of a 1% increase in inflation changes from one country to another, ranging from a minimum rise in output of 0.05% in Canada and New Zealand to a maximum one of 2.72% in Spain. Only in the UK does a 1% increase in inflation reduce output by 0.06%.
Algan (2002)	SVAR	France and the US	Quarterly	1970Q1to 1998Q4	Computation of impulse response functions at a 30 quarters horizon.	In the US, a 1% demand shock permanently reduces unemployment by 1% and increases inflation by 0.8%. In France, the effects of demand shocks are not statistically significant.

Study	Method	Country	Frequency	Time-period	Measure of long-run super-neutralities	Quantification of long-run super-neutralities
Karanassou et al. (2003)	Single equation GMM	EU	Annual	1972-2001	The slope of the long-run Phillips curve is defined as the ratio of the long-run responses of the inflation and unemployment rates to a permanent 10% increase in money growth.	The unemployment rate shrinks by 3.14 percentage points and inflation increases by 10% after a 10% monetary shock. The slope of the long-run Phillips curve is -3.18.
Koustas and Serletis (2003)	SVAR	9 European countries	Quarterly	1962Q4-1999Q4 (varying from country to country)	Long-run derivatives of unemployment with respect to inflation and of inflation with respect to unemployment.	Results are similar to those obtained by King and Watson (1994, 1997) and Koustas (1998).
Rapach (2003)	SVAR	14 industrialized countries	Annual/Quarterly	1949-1996 (varying from country to country)	Long-run derivative of the unemployment rate with respect to the inflation rate.	Significant estimates indicate that a 1% permanent increase in inflation raises output in the long-run by a percentage ranging between 0.35 and 0.95.
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	The slope of the long-run Phillips curve is defined as the ratio of the long-run responses of the inflation and unemployment rates to a permanent 10% increase in money growth.	The slope of the long-run Phillips curve is -3.66 for the US and -3.18 for European countries.
Lundborg and Sacklen (2006)	Nonlinear single equation ML	Sweden	Quarterly	1963Q1 to 2000Q2	Effect of the change of inflation on the unemployment rate within a nonlinear model	When inflation permanently rises from 0 to 2 percent, the unemployment rate permanently declines from 5 to 2%. Further inflation rises bring the unemployment rate back to 5% . Above 6% the inflation rate turns super-neutral.

Study	Method	Country	Frequency	Time-period	Measure of long-run super-neutralities	Quantification of long-run super-neutralities
Furuoka (2007)	Unit root, cointegra-tion, and Granger causality tests	Malaysia	Annual	1973-2004	Coefficient of the log of the unemployment gap in the cointegrating vector including the inflation rate, the unemployment gap and a time trend.	A 1% increase in the unemployment gap is approximately associated with a 0.9% decrease in the inflation rate.
Schreiber and Wolters (2007)	Unit root and cointegra-tion testing, SVECM	Germany	Quarterly	1975Q2 to 2002Q3	Coefficient of the unemployment rate in the cointegrating vector including the inflation rate and the unemployment rate.	The long-run relation between the inflation (π) and unemployment (u) rates is π=6-0.5u.
Vaona (2007)	Dynamic panel data estimator	81 Italian provinces	Annual	1986-1998	Slope of the long-run Phillips curve measured by the ratio of the sum of the coefficients of the lags of the unemployment rate over one minus the sum of the coefficients of CPI inflation terms.	The slope of the long-run Phillips curve is -0.65.
Ribba (2007)	Structural cointegra-ted VAR	Italy	Quarterly	1979Q1-1995Q4	Long-run derivative of the unemployment rate with respect to the inflation.	A 1% permanent increase in the inflation rate after a demand shock reduces unemployment by about 0.24%.
Karanassou et al. (2008a)	ARDL and 3SLS estimation of a six equations structural model	Spain	Annual	1966-1998	The slope of the long-run Phillips curve is defined as the ratio of the long-run responses of the inflation and unemployment rates to a permanent 10% increase in money growth.	The slope of the long-run Phillips curve is -3.49.

Study	Method	Country	Frequency	Time-period	Measure of long-run super-neutralities	Quantification of long-run super-neutralities
Karanssou et al. (2008b)	ARDL applied to a six equations structural system	US	Annual	1960-2005	The slope of the long-run Phillips curve is defined as the ratio of the long-run responses of the inflation and unemployment rates to a permanent 10% increase in money growth.	The slope of the long-run Phillips curve is -2.7.
Karanassou and Sala (2010)	SVAR and single equation GMM	US	Semi-annual	1963-2005	The slope of long-run Phillips curve is computed as the ratio of the sums of the significant responses of inflation and unemployment to a monetary shock.	The slope of the long-run Phillips curve ranges between -2.57 and -4.32 depending on the estimation techniques.
Bashar (2011)	Bivariate SVAR	G-7 countries	Quarterly	1957Q1-2008Q4 (though varying from country to country)	Long-run ratio of the derivative of output with the inflation rate.	The long-run derivative changes from country to country, ranging from 20 in Japan to 1.33 in the UK.
Fuhrer (2011)	OLS, single equation	The US	Quarterly	2000Q1-2012Q2	Coefficient of the unemployment gap in a regression of the core CPI inflation rate on the unemployment gap and either constant or long-run, survey-based inflation expectations.	The slope of the long-run Phillips curve is -0.26.

Study	Method	Country	Frequency	Time-period	Measure of long-run super-neutralities	Quantification of long-run super-neutralities
Karanassou and Sala (2012)	ARDL and 3SLS estimation of a system of 4 equations	The US	Annual	1970-2006	The slope of the long-run Phillips curve is defined as the ratio of the long-run responses of the inflation and unemployment rates to a permanent 10% increase in money growth.	The slope of the long-run Phillips curve is -3.58.
Furuoka et al. (2013)	Unit root, cointegra-tion and Granger causality tests	Philippines	Annual	1980-2010	Coefficient of the unemployment rate in the cointegrating vector including the inflation rate and the unemployment rate.	The long-run relation between the inflation (π) and unemployment (u) rates is π=*-2.247u.*
Svensson (2015)	OLS, single equation	Sweden, Canada, the US	Quarterly	1997Q1-2012Q4 (though varying from country to country).	Coefficient of lagged unemployment in a regression of the quarterly inflation at an annual rate on a constant, the first difference of the unemployment rate, the first lag of the unemployment rate and lags of inflation expectations.	The slope of the long-run Phillips curve is -0.8 for Sweden, -0.23 for the US and -0.42 for Canada.

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

Ahrens, S, Snower, DJ, 2014. Envy, guilt, and the Phillips curve Journal of Economic Behavior and Organization, 99, 69-84.

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

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

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

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

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

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.

Benigno, P., Ricci, L., 2011. The inflation-unemployment trade-off at low inflation. American Economic Review 101, 1436–1466.

Bewley, T. (1999). Why Wages Don't Fall During a Recession. Cambridge MA.: Harvard University Press.

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

Blundell R., Bond, S., 1998. Initial conditions and moment restrictions in dynamic panel data models. Journal of Econometrics 87, 115-143.

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.

Choi, In, and Pentti Saikkonen. "Tests for nonlinear cointegration." Econometric Theory 26.03 (2010): 682-709.

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.

Colombo, Luca & Weinrich, Gerd, 2003. "The Phillips curve as a long-run phenomenon in a macroeconomic model with complex dynamics," Journal of Economic Dynamics and Control, Elsevier, vol. 28(1), pages 1-26, October.

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

Devereux, MP, Yetman, J, 2002. Menu costs and the long-run output inflation trade-off. Economics Letters 76, 95–100.

Di Bartolomeo, Giovanni & Tirelli, Patrizio & Acocella, Nicola, 2014. "Trend inflation, the labor market wedge, and the non-vertical Phillips curve," Journal of Policy Modeling, Elsevier, vol. 36(6), pages 1022-1035

Di Bartolomeo, Giovanni, Patrizio Tirelli, Nicola Acocella, Inflation targets and endogenous wage markups in a New Keynesian model, Journal of Macroeconomics, Volume 34, Issue 2, June 2012, Pages 391-403.

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

Dolado Juan J., Juan F. Jimeno (1997), The causes of Spanish unemployment: A SVAR approach, European Economic Review, Volume 41, Issue 7, 1281-1307.

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.

Elliott, G., Rothenberg, T. J., & Stock, J. H. (1996). Efficient Tests for an Autoregressive Unit Root. Econometrica: Journal of the Econometric Society, 813-836.

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.

Fuhrer J. C. 2011 *Inflation expectations and the evolution of U.S. Inflation*. Federal reserve bank of Boston Public Policy Brief 11-4.

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

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

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, R.J., 1997. The time-varying NAIRU and its implications for economic policy. Journal of Economic Perspectives 11 (1), 11–32.

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.

Graham, L. and Snower D. J. (2004). The Real Effects of Money Growth in Dynamic General Equilibrium. European Central Bank Working Paper n. 412.

Graham, L, Snower DJ, (2008), Hyperbolic Discounting and the Phillips Curve. Journal of Money, Credit and Banking, 40, 427-448.

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.

Hughes-Hallett, A.J. 2000. "Aggregate Phillips Curves Are Not Always Vertical: Heterogeneity And Mismatch In Multiregion Or Multisector Economies," Macroeconomic Dynamics, Cambridge University Press, vol. 4(04), pages 534-546, December

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.

Khun, T. (1962), The structure of scientific revolutions, University of Chicago Press, Chicago.

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

King, R. G., & Wolman, A. L. (1996). Inflation targeting in a St. Louis model of the 21st century (No. w5507). National Bureau of Economic Research.

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.

Kuhn, Thomas S., 1962, The structure of scientific revolutions. University of Chicago press.

Kwiatkowski, D.; Phillips, P. C. B.; Schmidt, P.; Shin, Y. (1992). "Testing the null hypothesis of stationarity against the alternative of a unit root". Journal of Econometrics 54 (1–3): 159–178.

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.

Layard, R., Nickell, S., Jackman, N., 1991. Unemployment, Macroeconomic Performance and the Labour Market. Oxford University Press.

Levin, Andrew & Yun, Tack, 2007. "Reconsidering the natural rate hypothesis in a New Keynesian framework," Journal of Monetary Economics, Elsevier, vol. 54(5), pages 1344-1365, July.

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.

Ng, Serena, and Pierre Perron (2001). "Lag length selection and the construction of unit root tests with good size and power." Econometrica 69, 1519-1554.

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.

Phillips, P. C. B.; Perron, P. (1988). "Testing for a Unit Root in Time Series Regression". Biometrika 75 (2): 335–346.

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, 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

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

Sephton, P. S. (1994). Cointegration tests on MARS. Computational Economics, 7(1), 23-35.

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

Snower, D., Tesfaselassie, M. (Forthcoming). Trend Growth, Job Turnover and Phillips Curve Tradeoffs. Macroeconomic Dynamics

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

Stevens, S.S.,1946. On the theory of scales of measurement. Science, 103,677–680.

Stevens, S.S.,1951. Handbook of Experimental Psychology. Wiley, NewYork.

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

Svensson, Lars E. O. (2015). “The possible unemployment cost of average inflation below a credible target”, American Economic Journal: Macroeconomics, 7, 258-296.

Vaona, A, Snower, DJ (2008), “Increasing Returns to Scale and the Long-Run Phillips Curve”, Economics Letters, 100, 83-86.

Vaona, Andrea (2007) "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.

Vaona, Andrea (2010), "Six variations on fair wages and the Phillips curve", Working Papers Series, Department of Economics, University of Verona, WP 17/2010.

Vaona, Andrea (2012), "The most beautiful variations on fair wages and the Phillips curve", Journal of Money, Credit and Banking, 45, 1069-1084.

Andrea Vaona (2013) Money illusion and the long-run Phillips curve in staggered wage-setting models, Research in Economics, 67, 1, 88-99.

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.