Long-Run Inflation-Unemployment Dynamics: The Spanish Phillips Curve and Economic Policy

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Abstract

This paper takes a new look at the long-run dynamics of inflation and unemployment in response to permanent changes in the growth rate of the money supply. We examine the Phillips curve from the perspective of what we call “frictional growth”, i.e. the interaction between money growth and nominal frictions. After presenting theoretical models of this phenomenon, we construct an empirical model of the Spanish economy and, in this context, we evaluate the long-run inflation-unemployment tradeoff for Spain and examine how recent policy changes have affected it.

**Keywords:** Inflation-unemployment tradeoff, Phillips curve, staggered wage contracts, nominal inertia, forward-looking expectations, monetary policy.

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1. Introduction

This paper takes a new look at the long-run dynamics of inflation and unemployment in response to permanent changes in the growth rate of the money supply. We examine the Phillips curve from the perspective of what we call “frictional growth,” i.e. the interaction between money growth and nominal frictions. After presenting theoretical models of this phenomenon, we construct an empirical model of the Spanish economy that aims to capture the essential features of the interplay between money growth and prolonged nominal adjustment processes. In this context, we evaluate the long-run inflation-unemployment tradeoff for Spain and examine how recent policy changes have affected it.

The mainstream analysis of inflation and unemployment rests on the standard assumption that economic agents make their demand and supply decisions on the basis of real variables alone and thus, in the long-run labor market equilibrium, a change in the money supply has no real effects; it simply changes all nominal variables in proportion. It was on the basis of such money neutrality that Friedman (1968) and Phelps (1968) formulated the natural rate (or NAIRU) hypothesis, in which there is no permanent tradeoff between inflation and unemployment.

We show that in the presence of money growth and time-contingent nominal contracts, this argument does not necessarily hold. Under plausible circumstances specified below, changes in money growth may affect the unemployment rate and other real variables in the long run. This result enables our analysis to avoid a well-documented - but frequently ignored - counterfactual prediction of the NAIRU theory: Supposing that the NAIRU is reasonably stable through time - a commonly made assumption - inflation falls (rises) without limit when unemployment is high (low).

Another problem with the NAIRU theory is that, when combined with the rational expectations hypothesis, it implies that an inverse relation between inflation and unemployment manifests itself primarily in response to unanticipated demand shocks. However, over the 1980s and 1990s many OECD countries had reasonably stable demand conditions (with a few notable exceptions), and nevertheless they frequently experienced large fluctuations in unemployment along-side relatively small changes in inflation for periods as long as five or ten years, or even longer. This evidence is difficult to reconcile with a stable NAIRU.\(^1\) Large and

\(^1\)One may, of course, drop the assumption of a stable NAIRU and use the data to infer NAIRU movements, in accordance with the NAIRU theory. In that case, however, the NAIRU theory loses much of its predictive power.
prolonged demand-side shocks were, in many countries, followed by prolonged changes in unemployment accompanied by only very slow declines in inflation. Even longer-term inflation-unemployment tradeoffs were found by Phillips (1958), Lipsey (1960) and others over the century preceding the late 1960s. Macroeconomic policy authorities often make monetary and fiscal policy decisions with prolonged inflation-unemployment tradeoffs in mind.

This paper presents a model of the Phillips curve that avoids these difficulties. Our analysis rests on three empirical regularities: (i) the growth rate of the money supply is nonzero, (ii) there is some nominal inertia, so that a current nominal variable is slow to adjust to money growth shocks, and (iii) unemployment is influenced by the ratio of the nominal money supply to that nominal variable (such as the ratio of the money supply to the price level).

The first regularity provides a reasonable time-series description of the money supply in most OECD countries. The second stylized fact is well-established empirically and has been rationalized theoretically. In the presence of staggered time-contingent nominal contracts, current wages are a weighted average of their past and expected future values. A well-known result in the literature on the microfoundations of wage-price staggering is that when the rate of time discount is positive, the past is weighted more heavily than the future. It is in this sense that current prices and wages may be taken to be characterized by nominal inertia. The third regularity can take a variety of conventional forms, e.g. a change in the ratio of the money supply to the price level may affect aggregate demand and thereby the unemployment rate.

In Section 2, we present a theoretical model of the Phillips curve to show how frictional growth can lead to a long-run inflation-unemployment tradeoff. In Section 3, we discuss the empirical implications of our theoretical analysis and the various unresolved issues in the recent literature on the estimation of the Phillips curve. Section 4 contains an empirical model of the Spanish inflation-unemployment tradeoff; we find that this tradeoff is far from vertical in the long run. Section 5 evaluates how this tradeoff has been affected by major shifts in economic policy. Finally, Section 6 concludes. Our analysis suggests that a

\footnote{See, for example, Taylor (1979) on wage staggering, Calvo (1983), or Lindbeck and Snower (1999) on price precommitment with production lags. The literature on the effectiveness monetary policy under wage-price staggering has been surveyed by Clarida, Gali and Gertler (1999), Goodfriend and King (1997), Mankiw (2001), and others.}

\footnote{For example, Ascari (2000), Ascari and Rankin (2002), Graham and Snower (2002), and Helpman and Leiderman (1990).}
significant portion of Spain’s high unemployment has been due to tight monetary policy. Our empirical model indicates that the Spanish unemployment rate would have been substantially higher in the early 1990s had there been no contractionary monetary policy.

2. A Theoretical Model

We present a transparently simple macro model, belonging to a wider, well-known family that has been given microfoundations in Graham and Snower (2002) and related work by Ascarí (1998, 2000) and Karanassou, Sala, and Snower (2002). In what follows, all uninteresting constants are ignored.

We consider a labor market containing a fixed number of identical firms with monopoly power in the product market. The $i$'th firm has a production function of the form

$$q_{i,t}^S = An_i^\sigma,$$

where $q_{i,t}^S$ is output supplied, $n_{i,t}$ is employment, $A$ and $\sigma$ are positive constants, and $0 < \sigma < 1$. Each firm faces a product demand function of the form

$$q_{i,t}^D = \left(\frac{p_{i,t}}{p_t}\right)^{-\eta} \frac{q_t^D}{f},$$

where $q_t^D$ stands for aggregate product demand (to be specified below), $f$ is the number of firms, $p_{i,t}$ is the price charged by firm $i$, $p_t$ is the aggregate price level, and $\eta$ is the price elasticity of product demand (a positive constant).

The firms' profit-maximizing employment decisions under diminishing returns to labor can be shown to imply the following aggregate employment equation:

$$N_t = a - a_w (W_t - P_t)$$

The labor supply is constant

$$L_t = L,$$

so that the unemployment rate (not in logs) can be approximated as

$$u_t = L - N_t.$$
Taking logs, defining $h = \log (A f^{1-\sigma})$ and $Q^D_t = \log (q^D_t)$, and rearranging gives: $N_t = \frac{1}{\sigma} Q^D_t - \frac{h}{\sigma}$. Substituting this equation into the aggregate employment equation (2.2), we obtain the following price equation:
\[ P_t = W_t + \rho Q^D_t - \delta, \]  
(2.5)
where $\rho = \frac{1}{\sigma a_w} - \frac{1}{\sigma}$, and $\delta = \frac{a}{a_w} + \frac{h}{\sigma a_w}$.

Our nominal frictions are the staggered wage contracts of Taylor (1979, 1980a). Along the standard lines, we suppose that there are two wage contracts, evenly staggered, each lasting for two periods. Let $Q_t$ be the (log of the) contract wage negotiated at the beginning of period $t$ for periods $t$ and $t+1$. Taylor’s staggered contract equation is
\[ Q_t = \alpha Q_{t-1} + (1 - \alpha) E_{t} T_{t+1} + \gamma (c + \alpha T_{t} + (1 - \alpha) E_{t} T_{t+1}) + \zeta_t, \]  
(2.6)
where $\zeta_t$ is a white noise process, $\alpha$, $\gamma$, and $c$ are positive constants, and $E_t$ is the expectations operator, denoting the expectation conditional on information available at time $t$. We assume that agents do not have information about $\zeta$ when they set their wage contracts at time $t$, so $E_t \zeta_t = 0$. The variable $T_t$ is what Taylor calls “excess demand,” specified as actual output ($Q^*_t$) less full-employment output (in logs). By the production function (2.1), full-employment output is $Q^*_t = \sigma L + h$, or $Q_t = \sigma L + h$ since we assume that the product market clears. Thus excess demand (in logs) is
\[ \Gamma_t = Q_t - \sigma L - h. \]  
(2.7)

The microfoundations of the contract equation under time discounting\(^5\) - which, for brevity, we need not summarize here - indicate that the coefficient $\alpha$ is a discounting parameter equal to $\frac{1}{1+\beta}$, where $\beta$ is the discount factor.\(^6\) $\gamma$ is a “demand sensitivity parameter” (describing how strongly wages are influenced by demand), and $c$ as a “cost-push parameter” (describing the upward pressure on wages in the absence of excess demand). Since $\beta < 1$, we infer that $\alpha > 1/2$, i.e. discounting gives rise to an asymmetry in wage determination: the current wage $t$ is affected more strongly by the past wage $t-1$ than the future expected wage $E_{t+1}$.

\(^4\)To see this, rewrite the employment equation as $P_t = -\frac{a}{a_w} + W_t + \frac{1}{a_w} N_t$.

\(^5\)Ascarì (2000), Ascarì and Rankin (2002), Graham and Snower (2002), Helpman and Leiderman (1990), and others. See also Huang and Liu (2002).

\(^6\)Since this result is derived by linearizing a wage equation around a steady state of zero money growth, the theoretical analysis of this section applies only to money growth rates that are sufficiently low.
The average wage is

\[ W_t = \frac{1}{2} (t + t_{-1}). \]  

(2.8)

Aggregate demand \((Q_t^D)\) depends on real money balances

\[ Q_t^D = M_t - P_t, \]  

(2.9)

where \(M_t\) is the log of the money supply. (For brevity, again, we omit the standard microfoundations.)

Since we wish to focus on the long-run inflation-unemployment tradeoff and since movements along this tradeoff arise from permanent changes in money growth, let money growth have a unit root:

\[ \Delta M_t \equiv \mu_t = \mu_{t-1} + \varepsilon_t, \]  

(2.10)

where \(\varepsilon_t\) is a white-noise error term. However, it is easy to show that our qualitative conclusions do no depend on the random walk assumption. Any stochastic process that allows for a permanent change in money growth is sufficient for our purposes.\(^7\)

This implies that the contract wage may be expressed in terms of its own lagged value and the money supply:\(^8\)

\[
\begin{align*}
\ell &= (1 - \lambda_1) (1 + \rho) (c - \sigma L - h) + (1 - \lambda_1) \delta + \lambda_1 \ell_{t-1} \\
&+ (1 - \lambda_1) M_t + \kappa (1 - \lambda_1) \mu_t + \zeta_t,
\end{align*}
\]

(2.11)

\(^7\)Karanassou, Sala, and Snower (2002, Appendix 1) show that our central results can be derived from other money growth processes as well.

\(^8\)To see this, substitute the price equation (2.5) and the wage equation (2.8) into the aggregate demand equation (2.9):

\[ Q_t = \left( \frac{1}{1 + \rho} \right) M_t - \frac{1}{2 (1 + \rho)} (t + t_{-1}) + \frac{\delta}{1 + \rho}. \]

Next, substitute this equation and (2.7) into the contract equation (2.6):

\[
\begin{align*}
\ell &= \alpha \ell_{t-1} + (1 - \alpha) E_t \ell_{t+1} + \gamma (c - \sigma L - h) + \frac{\delta}{1 + \rho} + \zeta_t \\
&+ \gamma \alpha \left[ \left( \frac{1}{1 + \rho} \right) M_t - \frac{1}{2 (1 + \rho)} (t + t_{-1}) \right] \\
&+ \gamma (1 - \alpha) \left[ \left( \frac{1}{1 + \rho} \right) E_t M_{t+1} - \frac{1}{2 (1 + \rho)} (E_t \ell_{t+1} + t) \right].
\end{align*}
\]

Apply the expectations operator \(E_t\) on the above equation, recall that \(E_t \zeta_t = 0\), collect terms
where \( \lambda_{1,2} = \frac{\phi_2 \mp \sqrt{\phi_2^2 - 4\phi_1 \phi_3}}{2\phi_3} \), and \( \kappa = \frac{\lambda_2}{\lambda_2 - 1} - \alpha \). It can be shown that \( 0 < \lambda_1 < 1 \) and \( \lambda_2 > 1 \) when \( 0 < \gamma < 2(1 + \rho) \).

Substituting (2.11) into (2.8), we obtain the aggregate nominal wage dynamics equation:

\[
W_t = (1 - \lambda_1) (1 + \rho) (c - \sigma L - h) + (1 - \lambda_1) \delta + \lambda_1 W_{t-1} + (1 - \lambda_1) M_t \\
+ \left( \kappa - \frac{1}{2} \right) (1 - \lambda_1) \mu_t - \frac{1}{2} \kappa (1 - \lambda_1) \varepsilon_t + \frac{1}{2} \left( \zeta_t + \zeta_{t-1} \right).
\]

(2.12)

Note that in the long-run, wage inflation is equal to the money growth rate: \( \Delta W_t^{LR} = \mu_t^{LR} \). \(^9\)

To derive the dynamics of the real wage, we first express price in terms of wages and money (i.e., insert (2.9) into (2.5)):

\[
P_t = (1 - \theta) W_t + \theta M_t - (1 - \theta) \delta,
\]

(2.13)

where \( \theta = \frac{1}{1 + \rho} \). Observe that equation (2.12) and (2.13) imply that in the long-run, inflation is equal to the money growth: \( \pi_t^{LR} = \mu_t^{LR} \). Observe that money illusion is absent in the above system of equations: if all nominal variables are changed in equal proportion, then the associated real variables remain unchanged. Nevertheless, it can be shown that there is a long-run inflation-unemployment tradeoff and that changes in money growth can move the economy along this tradeoff.

Assuming that the contract wage \( \varepsilon_t \) is dynamically stable, the rational expectations solution of the previous equation is given by (2.11).

\(^9\)The wage inflation equation is given by the first difference of (2.12):

\[
(1 - \lambda_1 B) \Delta W_t = (1 - \lambda_1) \mu_t + \left( \kappa - \frac{1}{2} \right) (1 - \lambda_1) \varepsilon_t \\
- \frac{1}{2} \kappa (1 - \lambda_1) \Delta \varepsilon_t + \frac{1}{2} \left( \Delta \zeta_t + \Delta \zeta_{t-1} \right),
\]

where \( B, \Delta \) are the backshift and first difference operators, respectively. The long-run solution of the above equation is obtained by setting the error terms \( (\zeta_t, \varepsilon_t) \) equal to zero and the backshift operator \( B \) equal to unity.
Substituting (2.12) into (2.13), we find the real wage dynamics equation:\textsuperscript{10}

\[ W_t - P_t = (1 - \lambda_1) \left( c - \sigma L - h + \delta \right) + \lambda_1 (W_{t-1} - P_{t-1}) - (1 - \lambda_1) \left( \frac{2\alpha - 1}{\gamma} \right) \mu_t \]

\[ - \frac{\theta}{2} \kappa (1 - \lambda_1) \varepsilon_t + \frac{\theta}{2} \left( \zeta_t + \zeta_{t-1} \right). \]

(2.14)

An obvious deficiency of the above real wage equation is that, on its own, it implies that real wages always move counter-cyclically, and this prediction is counterfactual. The evidence suggests that although real wages are counter-cyclical in some countries during some time periods, there are plenty of occasions in which they are pro-cyclical and acyclical. In practice, however, the real wage channel is unlikely to operate in isolation. Furthermore, it is well to keep in mind that, in practice, the real wage moves in response to many determinants, of which the money supply is only one. Thus an inverse relation between the real wage and money growth may coexist with pro-cyclical real wage behavior.

Inserting the real wage (2.14) into the employment equation (??) and the unemployment rate (2.4), we derive the unemployment dynamics equation:

\[ u_t = (1 - \lambda_1) (1 - a_w) \sigma L + (1 - \lambda_1) \left[ a_w (c + \delta - h) - a \right] + \lambda_1 u_{t-1} \]

\[ - a_w (1 - \lambda_1) \left( \frac{2\alpha - 1}{\gamma} \right) \mu_t - a_w \frac{\theta}{2} \kappa (1 - \lambda_1) \varepsilon_t + a_w \frac{\theta}{2} \left( \zeta_t + \zeta_{t-1} \right). \]

(2.15)

Thus the long-run unemployment rate is

\[ u_{t}^{LR} = (1 - a_w) \sigma L + a_w (c + \delta - h) - a - a_w \left( \frac{2\alpha - 1}{\gamma} \right) \mu_{t}^{LR}. \]

(2.16)

Given that \( \pi_t^{LR} = \mu_t^{LR} \), the long-run Phillips curve is\textsuperscript{11}

\[ \pi_t^{LR} = - \frac{\gamma}{(2\alpha - 1)} u_{t}^{LR} + \frac{\gamma}{(2\alpha - 1)} \left[ c + (1 - 2\sigma) \left( L + \frac{h}{\sigma} \right) \right]. \]

(2.17)

\textsuperscript{10}Equations (2.12) and (2.13) imply

\[ W_t - P_t = (1 - \lambda_1) \left( c - \sigma L - h + \delta \right) + \lambda_1 (W_{t-1} - P_{t-1}) \]

\[ - \theta \left[ \frac{1}{2} (1 + \lambda_1) - \kappa (1 - \lambda_1) \right] \mu_t - \frac{\theta}{2} \kappa (1 - \lambda_1) \varepsilon_t + \frac{\theta}{2} \left( \zeta_t + \zeta_{t-1} \right). \]

It can be shown that \( \theta \left[ \frac{1}{2} (1 + \lambda_1) - \kappa (1 - \lambda_1) \right] = (1 - \lambda_1) \left( \frac{2\alpha - 1}{\gamma} \right) \), and thus we obtain (2.14).

\textsuperscript{11}Specifically, the long-run Phillips curve is

\[ \pi_t^{LR} = - \frac{\gamma}{a_w (2\alpha - 1)} u_{t}^{LR} + \frac{\gamma}{a_w (2\alpha - 1)} \left[ (1 - a_w) \sigma L + a_w (c + \delta - h) - a \right]. \]
Note that, since $\frac{1}{2} < \alpha < 1$, there is a tradeoff between inflation and unemployment both in the short-run and the long-run.\(^{12}\)

As we can see, the long-run Phillips curve is flatter,

- the greater is the real interest rate, and thus the more backward-looking is the wage contract (i.e. the greater is $\alpha$), and
- the less sensitive is the contract wage to aggregate demand (i.e. the lower is $\gamma$)
- the greater is $\sigma$, i.e., the less diminishing are the returns to labor.

Intuitively, when $\alpha$ or $\gamma$ falls, the average nominal wage - and therefore the price level - responds more slowly to an increase in money growth. Thus a given increase in money growth leads to a larger increase in the real wage, a larger rise in labor demand, and thus a larger decline in unemployment.

It is easy to see that, for parameter values common in the literature, the long-run Phillips curve is far from vertical. We can express the slope of this Phillips curve as $-\frac{\gamma(2+\sigma)(1-\sigma)}{r}$, where $r$ is the real discount rate ($\beta = \frac{1}{1+r}$). When $\sigma = 0.75$ and $\gamma$ is 0.1,\(^{13}\) the slope is -2.53 for a real discount rate of 2 percent, and it is -1.03 for a real discount rate of 5 percent.

It is important to emphasize, however, that the real wage channel is unlikely to be operative in isolation. Indeed, the theoretical model above is far too narrowly focused to generate reliable measures of the inflation-unemployment tradeoff. We can gain a broader perspective through an estimated macro model, to which we turn in the following three sections.

### 3. Empirical Considerations

Modeling the inflation-unemployment tradeoff involves some hard choices. Our theoretical model in the previous section provides the following insights for our empirical concerns:

Recalling that $a_w = \frac{1}{1-\sigma}$ and $\delta = \frac{a}{a_w} + \frac{h}{\sigma a_w}$, substituting these expressions into the above equation, and through some algebraic manipulation, we obtain the long-run Phillips curve (2.17).

\(^{12}\)Of course, this occurs under diminishing returns to labor ($0 < \sigma < 1$). Increasing returns to labor will produce an upward-sloping Phillips curve.

\(^{13}\)There is broad disagreement about the appropriate value of $\gamma$. Empirical estimates range from around 0.5 to 0.1 (see, for example, Taylor (1980b) and Sachs (1980)), whereas calibration of microfounded models often assigns values between 0.2 and 1 (see, for example, Huang and Liu (2002)).
1. The phenomenon of frictional growth cannot be captured by estimating a single-equation Phillips curve. The reason is that a single-equation Phillips curve does not contain money growth as an argument. After all, the Phillips curve is simply an equation that translates the impulse-response function of inflation to a monetary shock into the impulse-response function for unemployment to that shock; thus the monetary shock is substituted out in deriving the relation between inflation and unemployment. Consequently, the single-equation Phillips curve cannot portray the interplay between money growth and nominal frictions, which is the focus of our analysis.

2. This phenomenon of frictional growth can be assessed by estimating a multi-equation system, containing wage-price equations as well as real equations. The nominal wage-price equations are to describe how the nominal variables depend on the money supply and, via the nominal frictions, on the past and future nominal variables. Then, in the presence of frictional growth, money growth shocks lead to changes in the relative magnitudes of nominal variables, such as changes in real money balances or changes in the real wage. On this basis, the real equations are to describe how real variables, such as unemployment, respond to these changes in the relations among nominal variables.

3. The relation of wages and prices to their past and expected future values may be expressed in terms of nominal equations that are backward-looking. The reason, as explained above, is that when the general equilibrium model is solved, the expected future values of nominal variables can be expressed in terms of current and past endogenous variables.

The mainstream empirical literature on the Phillips curve, however, has pursued a different tack, focusing on single-equation estimation. Overall, there is no agreement about the appropriate method of estimating the New Phillips curve (NPC) and how to test it against the traditional Phillips curve. The core of the forward-looking NPC is an equation of the form

\[ \pi_t = \beta E_t \pi_{t+1} + \gamma x_t, \]  

(3.1)

where the forcing variable \( x_t \) is a measure of excess demand (unemployment rate, output gap) or a measure of real marginal costs (such as the labor share in GNP). The hybrid Phillips curve is commonly expressed as

\[ \pi_t = \beta^f E_t \pi_{t+1} + \beta^b \pi_{t-1} + \gamma x_t. \]  

(3.2)
It is customary to use the lead of inflation as a proxy for expected future inflation and rewrite the forward-looking NPC (3.1) as

$$\pi_t = \beta \pi_{t+1} + \gamma x_t + \epsilon_{t+1}$$

(3.3)

where the expectational error $\epsilon_{t+1}$ is proportional to $(E_t \pi_{t+1} - \pi_{t+1})$. Under rational expectations this error is unforecastable at time $t$, i.e. it is uncorrelated with information dated $t$ and earlier. Thus the NPC can be consistently estimated by using a set of variables $z_t$ (dated $t$ and earlier) to instrument actual future inflation $\pi_{t+1}$. The orthogonality condition $E_t [(\pi_t - \beta \pi_{t+1} - \gamma x_t) z_t] = 0$ can be used to estimate the model (3.3) via the generalized method of moments (GMM). Alternatively, two stage least squares can be used since the model is linear in the parameters. Bardsen, Jansen and Nymoen (2002) show that the empirical results of the above model are sensitive to the choice and exact implementation of the estimation method.

The choice of the forcing variable is crucial when estimating the inflation dynamics associated with the Phillips curve. Gali and Gertler (1999), Gali, Gertler and Lopez (2001) estimate (3.3) with GMM and find evidence in support of the NPC only when they use labor income share (rather than the output gap or unemployment) as the forcing variable. As Gali and Gertler indicate, the resulting equation should be called an inflation dynamics equation, rather than a Phillips curve, since the latter is meant to describe the relation between inflation and some measure of the magnitude of macroeconomic activity.

Rudd and Whelan (2001) observe that rational expectations should also be model consistent and thus use repeated substitution to express equation (3.1) in terms of a present value term of the forcing variable: $\pi_t = \beta \pi_{t+1} E_t \pi_{t+k+1} + \gamma \sum_{j=0}^{k} \beta^j E_t x_{t+j}$. When they include lagged inflation terms in the above equation and estimate it with GMM, they report results that are consistent with a backward-looking (traditional) Phillips curve. However, Gali, Gertler, Lopez-Salido (2003) argue that the Rudd-Whelan framework cannot provide consistent estimates of the structural parameters of the hybrid model (3.2).

Lindé (2002) rearranges (3.3) by having future inflation on the left hand side and estimates the resulting equation by nonlinear least squares. He finds that the NPC does not perform well when either real marginal costs or output are used as forcing variables. Gali, Gertler, Lopez-Salido (2003) argue that nonlinear least

\footnote{Also, Gali and Lopez-Salido (2001) show that the NPC fits the Spanish data well over the disinflationary period 1980-1998.}
squares is inappropriate since the explanatory variables may be correlated with the error term.

GMM estimation of the NPC is also sensitive to the choice of instruments. One would expect that the test for overidentifying restrictions can detect invalid instruments, but it is widely accepted that this test has low power. In addition, Bardsen, Jansen and Nymoen (2002), and Rudd and Whelan (2001) argue that the results can be significantly biased by using variables as instruments that actually belong in a well-specified inflation regression. Furthermore, estimation is sensitive to the time span of the chosen instruments, i.e. whether the instrument list should be dated \( t \) and earlier or \( t - 1 \) and earlier.\(^{15}\)

Finally, the exogeneity/endogeneity of the driving variable \( x_t \) is of major importance. Bardsen, Jansen and Nymoen (2002) argue that the derivation of the dynamic properties of inflation require an analysis of a system that includes the forcing variable as well as the rate of inflation and conclude that “...as statistical models, both the pure and hybrid NPC\(^{16}\) are inadequate”.

In view of these unresolved empirical issues and the desirability of estimating the Phillips curve through an equation system in which both inflation \( \pi_t \) and the macroeconomic activity variable \( x_t \) are endogenous, it appears appropriate to align our empirical analysis closely to the empirical implications of our theory, noted at the beginning of this section. Accordingly, we proceed to construct an empirical model in which the Phillips curve is derived from an estimated system of real and nominal equations. These equations describe how monetary shocks affect the relative magnitudes of nominal variables and thereby affect the real variables.

\(^{15}\)For example, Gali and Gertler (1999) and Rudd and Whelan (2001) use instruments dated \( t \) and earlier, whereas Gali, Gertler and Lopez-Salido (2001) and Bardsen, Jansen and Nymoen (2002) use instruments dated \( t - 1 \) and earlier. The latter papers justify the use of lagged instruments on the basis of considerable error in the measure of the driving variable \( x_t \). The use of lagged instruments can also be motivated by an expectational error that arises when the NPC (3.1) is the outcome of wage staggering à la Taylor: \( \pi_t = \beta E_t \pi_{t+1} + \gamma x_t + \beta (E_{t-1}P_t - P_t) \). (See, for example, Roberts (1995)). Thus the inflation equation to be estimated is \( \pi_t = \beta \pi_{t+1} + \gamma x_t + \epsilon_{t+1} + v_t \), where \( v_t = \beta (E_{t-1}P_t - P_t) \). Note that \( v_t \) is a (rational) expectational error unforecastable at period \( t - 1 \) and thus uncorrelated with information dated \( t - 1 \) and earlier. In this case, for consistent estimation, the instrument list should contain lagged values of the variables involved.

\(^{16}\)In the context of the hybrid specification of the Phillips curve (3.2), much of the current literature is concerned with the question of whether the observed inflation autocorrelation results from backward looking behavior \( (\beta^f = 0) \) or forward looking behavior \( (\beta^b = 0) \) that is proxied by inflation lags.
4. Empirical Implementation

This section applies our analysis of the inflation-unemployment tradeoff to an empirical investigation of the Spanish economy. Spain is a particularly interesting country for such an analysis, since it has witnessed major institutional and policy changes over the past three decades - the transition to democracy, the advent of unionized collective wage bargaining, several waves of labor market reforms, entry into the EEC, and central bank independence, to name a few.\footnote{Appendix A presents a short account of these major events.} We attempt to capture shifts of policy regimes through the use of dummy variables in our empirical model. This is a transparently rough procedure, but difficult to refine in macroestimation.

We first present estimates of a structural model of the Spanish economy, in which context the long-run inflation-unemployment tradeoff can be derived. We then investigate how various important institutional and policy changes in Spain over the past few decades may have affected this tradeoff. Due to data limitations, however, our results should be seen as merely a tentative, first step towards a full-blown empirical reappraisal of the Phillips curve on the basis of frictional growth.

Finally, we endeavor to take seriously the common finding that productivity growth and capital accumulation play an important role in determining employment and unemployment. Thus productivity and the capital stock are not exogenous variables in our analysis;\footnote{Just as the costs of buying and selling (or depreciating) capital make investment decisions intertemporal, so the costs of hiring, training and firing labor make employment decisions intertemporal as well. Thus, we view firms as making their employment, investment, and production decisions together, with reference to broadly similar time horizons. On this account it appears inadvisable to hold the capital stock and productivity constant when estimating an employment equation.} rather, our empirical model includes an aggregate production function, relating output to employment and capital, and a capital stock equation, containing further lagged endogenous variables.

This leaves us with a sizable econometric model, comprising seven equations: employment, labor force,\footnote{Empirical macroeconomic models of the Spanish labor market have tended to focus on employment rather than the labor force. A significant exception is De Lamo and Dolado (1993).} wage, price, and capital stock equations, as well as a production function and the definition of the unemployment rate. This leaves us with fewer degrees of freedom than we might ideally wish for, but more than enough to identify well-specified structural equations. There is a well-known tradeoff between structural detail and the power of econometric tests and our empirical
model favors the structural detail.

Our theoretical analysis and attention to policy changes have led us to choose structural modeling rather than the VAR approach.\footnote{Both approaches have received ample attention in empirical labor market studies. Following Blanchard and Quah (1989), a number of the recent studies devoted to the Spanish labor market analysis opt for the structural VAR approach. For instance, Dolado and Jimeno (1997), Andrés \textit{et al.} (1998) or Dolado \textit{et al.} (2000) estimate VAR models. On the other hand, the structural modeling approach, in a partial equilibrium setting, has been followed by others, e.g. Andrés \textit{et al.} (1990) or Blanchard \textit{et al.} (1995).} The structural models are able to give more attention to policy variables and other exogenous variables outside the labor market, which tend not to be included in the VAR models.

Our estimation uses OECD annual data over a sample from 1966 to 1998.\footnote{1998 is the last year that data is available on the individual money supply series of the EMU countries.} The definitions of variables are given in Table 1.

\begin{table}[h]
\centering
\caption{Definitions of variables}
\label{tab:variables}
\begin{tabular}{llllll}
\hline
$M_t$ & money supply (M3) & $N_t$ & employment \\
$P_t$ & price level (GDP deflator) & $L_t$ & labor supply \\
$W_t$ & nominal wages & $u_t$ & unemployment rate \\
$w_t$ & real wage ($W_t - P_t$) & $Z_t$ & working age population \\
$m_t$ & real money balances ($M_t - P_t$) & $\tau_t$ & indirect taxes as a % of GDP \\
$\theta_t$ & real labor productivity & $b_t$ & real social security benefits \\
$y_t$ & real GDP & $P^I_t$ & import price level \\
$k_t$ & real capital stock & $c_t$ & competitiveness ($\frac{\text{import price}}{\text{GDP deflator}}$) \\
$t$ & linear time trend & \\
\hline
\end{tabular}
\end{table}

All variables are in logs except for the unemployment rate $u_t$ and the tax rate $\tau_t$. For any variable $x_t$ in our data set, slope dummies are given by $x^d_t = d^d_t x_t$.

\footnote{Pesaran and Shin (1995), Pesaran (1997), and Pesaran \textit{et al.} (1996), show that the traditional ARDL estimation procedure can be applied even when the variables follow I(1) processes. (See also Henry, Karanassou, and Snower (2000) for an application of this approach and a discussion of its merits.)}

We first estimated each of the equations in our model using the autoregressive distributed lag (ARDL) approach to cointegration analysis,\footnote{Pesaran and Shin (1995), Pesaran (1997), and Pesaran \textit{et al.} (1996), show that the traditional ARDL estimation procedure can be applied even when the variables follow I(1) processes. (See also Henry, Karanassou, and Snower (2000) for an application of this approach and a discussion of its merits.)} and used the Akaike and Schwarz information criteria to determine the optimal lag-length. The selected specifications are dynamically stable (i.e., the roots of their autoregres-}
sive polynomials lie outside the unit circle), and pass the standard diagnostic tests (for no serial correlation, linearity, normality, homoskedasticity, and constancy of the parameters of interest) at conventional significance levels. An important implication of the above methodology is that the long-run solution of the ARDL can be interpreted as the cointegrating vector of the variables involved (since an ARDL equation can be reparameterized as an error correction one).

Next, the following plausible restrictions were imposed on the model and accepted by the data: (i) constant returns to scale in production, (ii) the long-run elasticity of the labor force with respect to the working age population is unity, and (iii) absence of money illusion. Finally, we estimated the equations of our macro model as a system, using three stages least squares (3SLS), to take into account potential endogeneity of the regressors and cross equation correlation. Figures A2 in Appendix B picture the actual and fitted values of the unemployment and inflation rates. The plots indicate that our model tracks the data very well.

Tables 2a and 2b present the restricted 3SLS estimates of each equation. In the nominal wage equation, the explanatory variables have coefficients of plausible magnitudes and signs, e.g. wages are inversely related to the unemployment rate and positively related to productivity. The price equation has a similar structure to the wage equation. Higher wages contribute to rise prices, but with some delay, and with a substantially smaller effect than prices on wages. Money supply exerts a greater influence on prices than on wages in the short-run.

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23 See Tables A1-A6 in Appendix B.
24 The sum of the labor and capital coefficients in our Cobb-Douglas production function is unity.
25 That is, the equations in our model are homogeneous of degree zero in all nominal variables. This restriction was imposed and accepted in the wage and price equations, and it automatically holds in all other equations since the real endogenous variables only depend on real variables.
In the labor force equation, the size of the labor force depends on its own past values (due to, say, monetary and psychic costs of entry and exit from labor force participation). It also depends negatively on the real wage, implying that the income effect dominates the substitution effect. This negative sign appears plausible for Spain, where income sharing among adult members of families is common, so that a rise in the wage of the main bread winner reduces the need for the spouse and children to seek work. Finally, the labor force depends inversely on the change in the unemployment rate. This may be interpreted as a type of discouraged worker effect: the greater the increase in the unemployment rate, the

\[ (*) \text{ restricted coefficient for no money illusion in the long-run; } \Delta \text{ denotes the difference operator; } (+) \text{ coefficient is restricted so that the long-run elasticity with respect to } Z_t \text{ is unity.} \]

<table>
<thead>
<tr>
<th>Table 2a: Spanish model, 3SLS, 1966-1998.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dependent variable: $W_t$</td>
</tr>
<tr>
<td>coef.</td>
</tr>
<tr>
<td>-------</td>
</tr>
<tr>
<td>$Cn_1$</td>
</tr>
<tr>
<td>$W_{t-1}$</td>
</tr>
<tr>
<td>$W_{t-1}^{74}$</td>
</tr>
<tr>
<td>$W_{t-1}^{84}$</td>
</tr>
<tr>
<td>$W_{t-1}^{87}$</td>
</tr>
<tr>
<td>$W_{t-1}^{97}$</td>
</tr>
<tr>
<td>$W_{t-2}$</td>
</tr>
<tr>
<td>$P_t$</td>
</tr>
<tr>
<td>$P_t^{89}$</td>
</tr>
<tr>
<td>$M_t$</td>
</tr>
<tr>
<td>$\theta_t$</td>
</tr>
<tr>
<td>$P_t^{L}$</td>
</tr>
<tr>
<td>$P_t^{L,86}$</td>
</tr>
</tbody>
</table>

\( (*) \) restricted coefficient for no money illusion in the long-run; \( \Delta \) denotes the difference operator; \( (+) \) coefficient is restricted so that the long-run elasticity with respect to \( Z_t \) is unity.

This reduces the influence of the real wage channel, contained in the employment equation. This argument is supported by the fact that the unemployment rate of the main bread winners is half that of the second earner one and one third that of the corresponding child earners. These differences are largest in regions with the highest unemployment rates. Furthermore, data from the 1990 Household Budget Survey (Encuesta de Presupuestos Familiares, EPF) show that the net wage of the main bread winner was 1.390.091 pts. in that year, more than 40% higher than the one of the second earner (813.038 pts.) and twice the one of the child earners (684.700 pts.).
greater the level of long-term unemployment, *ceteris paribus*, and the greater the likelihood of exit from the labor force\(^\text{28}\).

<table>
<thead>
<tr>
<th>Table 2b: Spanish model, 3SLS, 1966-1998.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dependent variable: ( N_t )</td>
</tr>
<tr>
<td>coef.</td>
</tr>
<tr>
<td>( Cnt )</td>
</tr>
<tr>
<td>( N_{t-1} )</td>
</tr>
<tr>
<td>( N_{t}^{74} )</td>
</tr>
<tr>
<td>( N_{t}^{84} )</td>
</tr>
<tr>
<td>( k_t )</td>
</tr>
<tr>
<td>( k_{t-1} )</td>
</tr>
<tr>
<td>( k_{t-2} )</td>
</tr>
<tr>
<td>( w_t )</td>
</tr>
<tr>
<td>( \theta_{t-1} )</td>
</tr>
<tr>
<td>( \theta_{t-1}^{70} )</td>
</tr>
<tr>
<td>( \Delta L_t )</td>
</tr>
<tr>
<td>( c_t )</td>
</tr>
</tbody>
</table>

\((*)\) restricted coefficient for constant returns to scale.

In the employment equation, labor demand depends, among other things, on the real wage, the capital stock and productivity\(^{29}\). Restricting the long-run coefficient of the capital stock to unity is accepted by the data, implying constant returns to scale, which are also features in the production function. Employment also depends negatively on the real wage (representing the real wage channel, analyzed above), social security benefits per employee (reducing work effort by improving workers’ outside options) and the indirect tax rate. The capital stock

\(^{28}\)From 1986 to 1990, the 1.7 million newly employed reduced unemployment only by 0.5 million.

\(^{29}\)Note that employment also depends on the change in the labor force. A rationale is developed in Coles and Smith (1996), which argues that job matches depend more on new entrants to the labor force than on the level of the labor force, since firms’ search primarily for new job applicants, rather than review the old ones. Thus the greater the increase in the labor force, the greater the number of new job applicants, and the greater the consequent number of matches.
equation is analogous to the employment equation. Constant returns to scale is accepted: the long-run elasticity of capital stock with respect to labor can be restricted to one. Productivity has a positive influence on capital stock. Real wages, competitiveness, and the indirect tax rate have negative effects. Real money balances have a positive effect (working, say, via credit constraints and the real interest rate); they represent the real money balance channel analyzed above. Finally, the production function is standard, displaying constant returns to scale.

As noted, we endeavor to capture institutional and policy changes - henceforth called IPCs - through multiplicative dummy variables, as shown in Table 3. The introduction of unionized wage bargaining, beginning in 1973 (unions were not formally legalized till 1977), reduced wage persistence (as many of the Franco-era employment regulations were scrapped) and employment persistence. As is well known, after the first oil price shock Spanish production became less capital intensive. The Moncloa Pacts reduced domestic price persistence (by making prices more flexible) and increased the influence of productivity swings on employment (by reducing firms’ incentives to hoard labor). The first wave of labor market reforms reduced wage and employment persistence. Spain’s entry into the EEC in 1986 reduced wage and price persistence, and augmented the influence of money on prices (via increased credibility of monetary policy).

<table>
<thead>
<tr>
<th>Table 3: Institutional and Policy Changes (IPCs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Introduction of unionized wage bargaining: $W_{t-1}^{74}$ and $N_{t-1}^{74}$</td>
</tr>
<tr>
<td>2. Oil price shock: $k_t^{75}$</td>
</tr>
<tr>
<td>3. The Moncloa Pacts: $P_{t-1}^{79}$ and $Q_{t-1}^{79}$</td>
</tr>
<tr>
<td>4. First wave of labor market reforms: $W_{t-1}^{84}$, $N_{t-1}^{84}$, and $N_t^{84}$</td>
</tr>
<tr>
<td>5. Entry into the EEC: $W_{t-1}^{87}$, $P_{t-1}^{87}$, $M_t^{88}$</td>
</tr>
<tr>
<td>6. Entry into the EMS: $P_t^{89}$</td>
</tr>
<tr>
<td>7. Second wave of labor market reforms: $N_t^{93}$</td>
</tr>
<tr>
<td>8. Third wave of labor market reforms: $W_{t-1}^{97}$</td>
</tr>
</tbody>
</table>

In this way our structural model of the Spanish economy endeavors to capture the interplay between macro shocks and lagged adjustment processes that are central to our analysis of the inflation-unemployment tradeoff, as well as the influence of institutional and policy changes on this tradeoff.

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$M_t^{94}$ aims to serve a similar purpose with regard to central bank independence.
5. The Spanish Phillips curve

In the context of the empirical model above, given by the restricted 3SLS estimates, we now assess the slope of the long-run Phillips curve for Spain. We then examine how this tradeoff was affected by institutional and policy changes.

5.1. The Long-Run Inflation-Unemployment Trade-off

To derive the slope of the long-run Phillips curve, we begin with a change in the growth rate of the money supply and simulate the associated changes in the long-run inflation and unemployment rates. The change in money growth may be interpreted as realization of the stochastic process generating the money growth rates, and thus our analysis is not subject to the Lucas critique. In particular, the money supply may be treated as an I(2) variable,\(^\text{31}\) so that changes in the money growth rate are permanent. Since our empirical model is linear and thus the implied Phillips curve is linear as well, the size of the money growth change clearly makes no difference to our estimated slope of the long-run Phillips curve. We let our initial money growth rate be 15% and our final one be 5%. These values were derived by estimating the Kernel density function for the growth rate of the money supply (along the same lines as Bianchi and Zoega (1998), for example).\(^\text{32}\)

For the initial and final money growth rates above, we let all the endogenous variables in our system converge to their long-run steady state growth rates, given the dummy variables that obtain at the end of our sample period. We thereby find the change in the long-run inflation and unemployment rates associated with the change in the money growth rate, enabling us to derive the slope of the long-run Phillips curve at the end of our sample period.\(^\text{33}\)

The simulation exercise indicates that the above 10% reduction in money growth leads to a permanent increase of 3.70% in the unemployment rate, along with a permanent decrease of 10% in the inflation rate. Thus our model implies that the slope of the Spanish long-run Phillips curve is \(d\pi/du = -2.7\) (to the

\(^{31}\)The Dickey-Fuller (DF) and Phillips Peron (PP) tests indicate that we cannot reject the I(2) hypothesis for the money supply. In particular, for \(\Delta M_t\) we have \(DF = -0.26\) and \(PP = -0.41\); the 5% critical value is \(-2.95\). (For \(\Delta^2 M_t\) the DF and PP tests are \(-4.91\) and \(-7.96\), respectively.) However, as mentioned earlier, our analysis does not hinge on the random walk property of the money growth rate.

\(^{32}\)The results on this estimation are reported in Appendix C.

\(^{33}\)Since the model is linear, the evolution of the exogenous variables has no influence on the slope of the long-run Phillips curve. Thus these exogenous variables can be set to zero in the simulation exercise.
nearest two significant digits) at the end of our sample period. The influence of previous institutional and policy changes is examined below.

Of course this estimate of the slope pertains only to the range of observed variations in the inflation and unemployment rates. It is not permissible to extrapolate outside this observed range. Indeed, there are good theoretical reasons (lying beyond the scope of our theoretical model above) to believe that the long-run Phillips is nonlinear over a wider range and that the slope may turn vertical or even positive when the long-run inflation rate is sufficiently high.

5.2. The Influence of Institutional and Policy Changes on the Long-Run Phillips Curve

In our model, as we have seen, some of the institutional and policy changes (captured by the dummy variables above) affect the labor market adjustment processes, and these processes - interacting with money growth - affect the slope of the long-run Phillips curve. We now assess the magnitude and significance of this influence.

In the absence of all IPCs - at the beginning of our sample period - we find that the slope of the long-run Phillips curve is \( S_n = -1.89 \) (where the subscript \( n \) stands for "no IPC"). This is the base-run case.

Next, we add the first IPC to the base run, and we obtain the associated long-run Phillips curve slope. We call this slope \( S_1 \). We derive the contribution of first IPC \( (S^1) \) by subtracting \( S_n \) from \( S_1 \): \( S^1 = S_1 - S_n \).

Analogously, we add the second IPC to the previous system, and evaluate the slope of the associated long-run Phillips curve in the presence of the first and second IPCs, to be called \( S_2 \). The contribution of IPC 2 is then measured as \( S^2 = S_2 - S_1 \). Along these lines, we evaluate the individual contribution of each IPC to the long-run Phillips curve slope. The results are given in Table 4. The top section of the table shows the influence of a 10 percentage points decrease in money growth (\( \Delta M \)) on unemployment (\( \Delta u \)) and the slope of the long-run Phillips curve. The bottom section gives the individual contributions of each IPC.

---

34 Dolado et al. (2000) use a structural VAR model with quarterly data from 1964 to 1995 for Spain to estimate the long-run tradeoff between unemployment and inflation. They find that the long-run slope of the Phillips curve is -3.33 under a “Monetarist” identifying scheme, and -1.67 under a “Keynesian” identifying scenario.

35 Specifically, this is the slope in the presence of IPC 1 but in the absence of all other IPCs. After including the first IPC, we reimpose on the macro system the restrictions to ensure no money illusion and constant returns to scale.
to the slope \((S_i)\) and the percentage difference (%) in the slope implied by each IPC.\(^{36}\)

Observe that the IPCs which appear to have had the greatest impact are the introduction of the Moncloa Pacts and entry into the EEC and EMS. Our calculations show that these changes all made the Spanish long-run Phillips curve steeper.

| Table 4: The long-run Phillips curve slope. |

<table>
<thead>
<tr>
<th>Cumulative impact of IPCs</th>
<th>(\Delta u)</th>
<th>slope</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trade-off before 1973 ((S_n))</td>
<td>5.29</td>
<td>-1.89</td>
</tr>
<tr>
<td>IPC 1 ((S_1))</td>
<td>5.22</td>
<td>-1.92</td>
</tr>
<tr>
<td>IPCs 1+2 ((S_2))</td>
<td>5.25</td>
<td>-1.91</td>
</tr>
<tr>
<td>IPCs 1+2+3 ((S_3))</td>
<td>4.47</td>
<td>-2.24</td>
</tr>
<tr>
<td>IPCs 1+2+3+4 ((S_4))</td>
<td>4.38</td>
<td>-2.28</td>
</tr>
<tr>
<td>IPCs 1+2+3+4+5 ((S_5))</td>
<td>3.98</td>
<td>-2.51</td>
</tr>
<tr>
<td>IPCs 1+2+3+4+5+6 ((S_6))</td>
<td>3.74</td>
<td>-2.67</td>
</tr>
<tr>
<td>IPCs 1+2+3+4+5+6+7 ((S_7))</td>
<td>3.76</td>
<td>-2.66</td>
</tr>
<tr>
<td>All IPCs considered ((1+2+3+4+5+6+7+8) ((S_8))</td>
<td>3.70</td>
<td>-2.70</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Individual contribution of IPCs</th>
<th>(S_{\Delta i})</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Introduction of unionized wage bargaining ((S_{\Delta 1}))</td>
<td>0.03</td>
<td>-1.6</td>
</tr>
<tr>
<td>2. First oil price shock ((S_{\Delta 2}))</td>
<td>-0.01</td>
<td>0.5</td>
</tr>
<tr>
<td>3. Institutional changes associated with the Moncloa Pacts ((S_{\Delta 3}))</td>
<td>0.33</td>
<td>-17.3</td>
</tr>
<tr>
<td>4. First wave of labor market reforms ((S_{\Delta 4}))</td>
<td>0.04</td>
<td>-1.8</td>
</tr>
<tr>
<td>5. Entry into the EEC ((S_{\Delta 5}))</td>
<td>0.23</td>
<td>-10.1</td>
</tr>
<tr>
<td>6. Entry into the EMS ((S_{\Delta 6}))</td>
<td>0.16</td>
<td>-6.4</td>
</tr>
<tr>
<td>7. Second wave of labor market reforms ((S_{\Delta 7}))</td>
<td>-0.01</td>
<td>0.4</td>
</tr>
<tr>
<td>8. Third wave of labor market reforms ((S_{\Delta 8}))</td>
<td>0.04</td>
<td>-1.5</td>
</tr>
</tbody>
</table>

\(^{36}\) For example, entry into the EEC shifts the slope from -2.28 to -2.51 (in the top part of the table), which corresponds to a difference of -0.23 percentage points that makes the slope 10.1% steeper (in the bottom part of the table).
5.3. Monte Carlo Simulations

We now examine whether our point estimates of the long-run Phillips curve slope are significantly different from infinity. Accordingly, we conduct Monte Carlo experiments, each of which consists of 1000 replications. In each replication \((i)\), a vector of error terms \(\varepsilon_t^{(i)} = (\varepsilon_{1t}^{(i)}, \varepsilon_{2t}^{(i)}, \varepsilon_{3t}^{(i)}, \varepsilon_{4t}^{(i)}, \varepsilon_{5t}^{(i)}, \varepsilon_{6t}^{(i)})'\) (of the labor demand, nominal wage, price, labor force, capital stock, and production equations, respectively) was drawn from the normal distribution \(N(0, \Sigma)\). The vector \(\varepsilon_t^{(i)}\) was then added to the vector of estimated equations to generate a new vector of endogenous variables \(y_t^{(i)} = (N_t^{(i)}, W_t^{(i)}, P_t^{(i)}, L_t^{(i)}, k_t^{(i)}, y_t^{(i)}, u_t^{(i)} = L_t^{(i)} - N_t^{(i)})\). Next, the equations of the model were estimated using the new vector of endogenous variables \(y_t^{(i)}\), and the set of exogenous variables. Finally, the above simulation exercises for the computation of the long-run Phillips curve slope were conducted on the newly estimated system. In this way, each replication \((i)\) yielded a set of measures for the cumulative impact of IPCs on the long-run Phillips curve slope: \(x_i = \{S_0^{(i)}, S_1^{(i)}, S_2^{(i)}, S_3^{(i)}, S_4^{(i)}, S_5^{(i)}, S_6^{(i)}, S_7^{(i)}, S_8^{(i)}\}\). We grouped the values of each generated series \(x_i\) into class intervals of 0.5 units. In Table 5 we present the percentage count of slopes within specific class intervals. For example, in the presence of all IPCs, the probability that the long-run Phillips curve slope is below -50 is 1.3%. Using as a cut-off point a 2% count, there is no class interval below \([-6, -5.5)\) or above \([-1, -0.5)\) that contains at least 2% of the values of each \(x_i\). So in Table 5 we also give the probability that the long-run Phillips curve slope is greater than -6.0 and smaller that -0.5.

Observe that in the absence of all IPCs the probability that the slope of the Phillips curve \((S_n)\) is in the \([-6, -0.5)\) interval is 77.7%. The Phillips curve slope remains more or less unaffected by the introduction of unionized wage bargaining and the occurrence of the oil price shock (see columns \(S_1\) and \(S_2\), respectively, in Table 5). However, when the institutional changes associated with the Moncloa Pacts are introduced, the Phillips curve slope becomes steeper (column \(S_3\) in Table 5). In this case the probability that the slope lies between -6 and -0.5 drops to 72.3%. The Phillips curve slope does not change much when the first wave of labor market reforms takes place (column \(S_4\) in Table 5). But with the entry into the EEC the probability that the slope lies in the \([-6, -0.5)\) interval further decreases.

\(^{37}\)We used the normal distribution because the assumption of normality is valid in the estimated system of equations. Thus \(\varepsilon_t \sim N(0, \Sigma)\), where \(\Sigma\) is the variance-covariance matrix of the estimated model.
to 67.6%, thus the Phillips curve gets steeper (column $S_5$ in Table 5). Finally, the entry into the EMS, and the second and third waves of labor market reforms do not appear to have a significant impact on the Phillips curve slope (column $S_6$, $S_7$, and $S_8$ in Table 5).

<table>
<thead>
<tr>
<th>Table 5: Monte Carlo simulations, 1000 replications</th>
</tr>
</thead>
<tbody>
<tr>
<td>probability (%) that the PC slope is within a specific interval</td>
</tr>
<tr>
<td>$S_n$</td>
</tr>
<tr>
<td>---------</td>
</tr>
<tr>
<td>$(-\infty,-50)$</td>
</tr>
<tr>
<td>$(-\infty,-20)$</td>
</tr>
<tr>
<td>$[-6,-0.5)$</td>
</tr>
</tbody>
</table>

6. Conclusions

This paper has provided a theoretical rationale for a long-run tradeoff between inflation and unemployment due to the interplay between money growth and nominal frictions. In this context we have seen that the absence of money illusion and money neutrality does not prevent changes in money growth from having long-run effects on unemployment (as well as inflation, of course). Thereby our analysis avoids the counterfactual prediction of the NAIRU theory that inflation falls without limit when unemployment is high.

Our analysis suggests a significant role for monetary policy in combating Spanish unemployment in the long run. This role, however, has been reduced somewhat through successive policy changes, particularly the introduction of the Moncloa Pacts and Spain’s entry into the EEC and possibly the EMS.

Our empirical model yields a point estimate of -1.89 for the slope of the Spanish long-run Phillips curve at the beginning of our sample period (so that a 10% decrease in money growth leads to a permanent rise in unemployment by 5.3 percentage points) and a point estimate of -2.70 at the end of our sample period (so that a 10% decrease in money growth leads to a permanent rise in unemployment by 3.7 percentage points). Our Kernel density analysis captures two broad money growth regimes, one at 15% (predominantly at the beginning of the sample period) and one at 5% (predominantly at the end). In short, our analysis suggests that

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38The result concerning EMS contrasts with our finding in Table 4.
this policy regime change had a pronounced effect on Spain’s long-run employment rate.

Not surprisingly, the short- and medium-run effects on unemployment may be even more powerful. For instance, Spain experienced a precipitate fall in money growth over the 1990s, largely in response to the convergence criteria of the Maastricht Treaty (signed in February 1992), Spain’s EMS crisis (from September 1992 to August 1993), and the independence of the Bank of Spain (granted in June 1994). In the context of our empirical model, we can ask how much of the rise in Spanish unemployment since 1993 can be accounted for by the experienced changes in money growth. Although it is important to emphasize that our empirical model is merely illustrative, Figures 1 nevertheless tell an interesting tale.

Figures 1: Unemployment and Inflation Effects Attributable to Monetary Policy

Figure 1a gives the trajectory of the actual unemployment rate vis-a-vis the one the unemployment rate would have followed, in our model, if money growth had remained constant at its 1993 rate. The difference between the two trajectories stands for the extra unemployment, through time, that is attributable to the fall in money growth. Along the same lines, Figure 1b depicts the trajectory of actual inflation against the simulated inflation rate under money growth fixed at its 1993 rate, so that the difference stands for the fall in inflation, through time, that is attributable to the decline in money growth. In this simple accounting exercise, we see that, by 1998, the contractionary monetary policy accounts for a rise in the Spanish unemployment rate of about 4 percentage points and a fall in the inflation rate of also about 4 percentage points. In short, our model suggests that monetary policy has had a very substantial and prolonged effect on unemployment (and of course inflation). Our empirical analysis of Spain’s long-
run inflation-unemployment tradeoff indicates that some of this unemployment effect is permanent.

References


APPENDICES

Appendix A: An Overview of Inflation and Unemployment in Spain

The story of the Spanish economy over the past 25 years is one of declining inflation and persistent unemployment, as shown in Figures A1 and Figure 3a in the text. The rate of inflation has gradually declined from 24.5% in 1977 to 1.8% in 1998, permitting Spain to join the EMU in 1999. The unemployment rate started low - below 5% until 1976 - but reached more than 21% in 1985. After hovering near this peak for another decade, it has since fallen to less than 15%.

Figure A1. Inflation and unemployment rate. Spain. 1966-1998.

Within this broad picture, we can distinguish five different macroeconomic periods relevant to the Spanish Phillips curve.

The Period 1969-1977

From 1969 to 1974, Spain experienced a very strong expansion, with GDP growing at an annual rate of 6.6%. 1973 was the first year in the postwar period when inflation exceeded 10%, primarily on account of intense domestic demand pressure. In the following years, Spain had to deal with two severe macroeconomic shocks.
One was the first oil price shock, which had a pronounced effect on inflation and unemployment since Spanish industry was heavily dependent on oil imports. The other was the advent of unions in collective wage bargaining. Although unions were not legalized until 1977, their *de facto* influence was asserting itself already in 1973. The immediate implication in the period 1973-77 was a wage-price spiral, in which unions pushed up wages sufficiently to permit real wage growth after taking past inflation into account, while firms raised prices at an accelerating rate in order to recover their margins. This spiral was aggravated through accommodating macroeconomic policies. As a result, inflation rose above 15% during the period 1974-76 and reached 24.5% in 1977. However, the effects of the above shocks on unemployment were delayed; unemployment remained low, as shown in Figure A1 and Figure 3a.

**The Period 1978-1985**

This period featured the following further shocks. First, tight monetary policy was implemented in 1978 to control inflation, in accordance with the Moncloa Pacts. Next, the second oil price shock occurred in 1979. Together, these shocks reduced consumption, investment, and employment. As a consequence of the Moncloa Pacts, an incomes policy was implemented between 1978 and 1986, whereby the government set an inflation target, the unions agreed to accept moderation in wage increases, and firms agreed to price moderation.

In 1984 the government began a first wave of labor market reform by introducing fixed-term contracts to increase labor market flexibility and stimulate job creation. As a result temporary employment grew to one third of total employment over the second half of the 1980s.

As Figures A1 and 3a indicate, inflation came down during this period, but the unemployment rate rose dramatically, as a consequence of the lagged effects of the 1973-77 shocks as well as the 1978-1985 shocks.

**The Period 1986-1990**

Spain joined the EEC in 1986, and the resulting need for international competitiveness in what were previously highly protected product markets put downward pressure on wages and prices. Monetary policy was relaxed in 1986 and 1987,

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39These pacts consisted of a set of policy agreements between the government, firms and unions in response to the economic crisis. On the one hand, there was a very restrictive monetary policy; on the other, there were various structural measures, especially tax reform, incomes policy, and measures to promote competition, such as those in the financial market. The restrictive monetary policy was implemented right away; the structural policies took several years to apply.
in view of the previous fall in inflation. These developments, together with the lagged effects of the labor market reforms of 1984, led to a sharp increase in employment. GDP grew at a 4.5% annual rate, stoked by strong domestic demand. To prevent a resurgence of high inflation, monetary policies were tightened in the late 1980s, a move reinforced by Spain’s entry into the EMS in 1989.

The upshot of these developments was that the unemployment rate fell from 21.5% in 1985 to 16.3% in 1990, whereas inflation remained flat (the inflation rate, measured by the GDP deflator, was at 7.7% in 1985 and 7.3% in 1990).

The Period 1991-2000

A rise in household indebtedness, the Iraqi war of 1991, the upward pressure on interest rates due to German unification, and the EMS crisis of 1992 and 1993 together pushed the Spanish economy into a short-lived but deep recession. The unemployment rate rose from 15.9% in 1990 to 23.7% in 1994. This recession, together with the tight monetary policy implemented in accordance with the Maastricht Treaty signed in 1991, led to a decline in inflation from 7.3% in 1990 to 4.0% in 1994.

In 1994 the Spanish government implemented a second wave of labor market reform, and the Central Bank became independent, with a mandate to focus exclusively on inflation control. In 1997 there followed a third reform wave, in which firing costs on permanent contracts were reduced, thereby partially reversing the trend towards temporary employment.

These two labor market reforms played an important role in containing real wage growth and this influence, along with a new cyclical upturn, provided a strong stimulus to employment in the second half of the 1990s. In years 1995-99,

Whereas temporary contracts were a rarity before 1984, the ratio of fixed-term employment to dependent employment rose to 15.6% in 1987 (first year with official data), and further to 32.2% in 1991.

This second wave was a response to the first. The main fixed-term contract in the 1984 reform was the ‘employment promotion contract,’ which was used heavily by employers to cover both temporary and permanent tasks, and it gave Spain the highest rate of temporary employment in the EU. Thus, in the second wave of labor market reform of 1994, the government tried to restrict the use of this contract by attempting substitute it for other temporary contracts such as the ‘contract per task or service’ and the ‘contract for launching new activities’. These were originally targeted towards some groups of hard-to-place workers, but in fact they were used in the same way as the previous contract. As a result, the third wave of reform in 1997 was implemented to favor permanent contracts.

The share of temporary employment on total dependent employment had reached 33.7% in 1994, remained at 33.6% in 1997, and reduced to 32.1% in 2000.
the annual growth rate of GDP reached 3.5% with an annual increase of 3.3% in employment and around 1.8 million jobs created.

These developments were reinforced by the monetary policy run-up to Spain’s EMU entry in 1999, involving a sharp reduction in interest rates after 1995. In an attempt to keep inflation under control nevertheless, the government supplemented its labor market reforms by opening its product markets to foreign competition. Whereas this involved mainly the industrial sector in the second half of the 1980s, in the 1990s it included the service sector, particularly the financial, transport, communication and telecommunication sectors. Several important public companies were privatized, which helped reduce the public-sector deficit. As a result, the pronounced increase in employment in the second half of the 1990s was accompanied by a reduction in inflation. However, the labor force expanded and thus Spain’s unemployment rate responded only moderately; by the end of the 1990s, it was still above 15%.
Appendix B: OLS estimates and misspecification tests


<table>
<thead>
<tr>
<th>Dependent variable: $W_t$</th>
<th>Coefficient</th>
<th>t-stat.</th>
<th>Misspecification tests*</th>
</tr>
</thead>
<tbody>
<tr>
<td>$C_{nt}$</td>
<td>4.85</td>
<td>(4.11)</td>
<td>SC[$\chi^2 (1)$] 4.19[0.055]</td>
</tr>
<tr>
<td>$W_{t-1}$</td>
<td>0.68</td>
<td>(5.79)</td>
<td>LIN[$\chi^2 (1)$] 0.34[0.56]</td>
</tr>
<tr>
<td>$W_{t-1}^{74}$</td>
<td>-0.002</td>
<td>(-1.73)</td>
<td>NOR[$\chi^2 (2)$] 0.34[0.84]</td>
</tr>
<tr>
<td>$W_{t-1}^{84}$</td>
<td>-0.003</td>
<td>(-3.57)</td>
<td>ARCH[$\chi^2 (1)$] 0.89[0.35]</td>
</tr>
<tr>
<td>$W_{t-1}^{97}$</td>
<td>-0.005</td>
<td>(-5.41)</td>
<td>HET[$\chi^2 (14)$] 0.58[0.86]</td>
</tr>
<tr>
<td>$W_{t-2}$</td>
<td>-0.46</td>
<td>(-4.70)</td>
<td></td>
</tr>
<tr>
<td>$P_t$</td>
<td>0.66</td>
<td>(5.83)</td>
<td></td>
</tr>
<tr>
<td>$P_{t-1}^{89}$</td>
<td>-0.009</td>
<td>(-3.34)</td>
<td></td>
</tr>
<tr>
<td>$M_t$</td>
<td>0.16</td>
<td>(2.12)</td>
<td></td>
</tr>
<tr>
<td>$u_{t-1}$</td>
<td>-0.33</td>
<td>(-2.32)</td>
<td></td>
</tr>
<tr>
<td>$\theta_t$</td>
<td>0.44</td>
<td>(2.16)</td>
<td></td>
</tr>
<tr>
<td>$P_{t-1}^I$</td>
<td>0.07</td>
<td>(2.50)</td>
<td></td>
</tr>
</tbody>
</table>

+ LL=111.11, AIC=-5.95, SC=-5.36  
++ $[F (1, 20)] = 0.30 [0.59]$ 

* Probabilities in square brackets
  ✓ Structural stability cannot be rejected at the 5% size of the test
  + Log likelihood (LL), Akaike (AIC) and Schwarz (SC) criteria
  ++ Wald test for long-run no money illusion
### Table A2: Price equation, OLS, 1966-1998.

<table>
<thead>
<tr>
<th>Dependent variable: $P_t$</th>
<th>Coefficient</th>
<th>t-stat.</th>
<th>Misspecification tests*</th>
</tr>
</thead>
<tbody>
<tr>
<td>$Cnt$</td>
<td>-5.56</td>
<td>(-5.15)</td>
<td>$\text{SC}[\chi^2(1)]$ 1.51 [0.23]</td>
</tr>
<tr>
<td>$P_{t-1}$</td>
<td>0.78</td>
<td>(4.38)</td>
<td>$\text{LIN}[\chi^2(1)]$ 1.49 [0.24]</td>
</tr>
<tr>
<td>$P_{79}^{81}$</td>
<td>-0.012</td>
<td>(-2.74)</td>
<td>$\text{NOR}[\chi^2(2)]$ 0.18 [0.91]</td>
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<tr>
<td>$P_{87}^{81}$</td>
<td>-0.006</td>
<td>(-2.08)</td>
<td>$\text{ARCH}[\chi^2(1)]$ 0.26 [0.62]</td>
</tr>
<tr>
<td>$P_{t-2}$</td>
<td>-0.39</td>
<td>(-3.94)</td>
<td>$\text{HET}[\chi^2(22)]$ 0.60 [0.84]</td>
</tr>
<tr>
<td>$W_{t-1}$</td>
<td>0.32</td>
<td>(3.07)</td>
<td></td>
</tr>
<tr>
<td>$M_t$</td>
<td>0.24</td>
<td>(5.29)</td>
<td></td>
</tr>
<tr>
<td>$M_t^{88}$</td>
<td>0.002</td>
<td>(2.70)</td>
<td></td>
</tr>
<tr>
<td>$M_t^{94}$</td>
<td>0.000</td>
<td>(0.98)</td>
<td></td>
</tr>
<tr>
<td>$\theta_t$</td>
<td>-0.77</td>
<td>(-4.19)</td>
<td></td>
</tr>
<tr>
<td>$P_t^l$</td>
<td>0.06</td>
<td>(2.82)</td>
<td></td>
</tr>
<tr>
<td>$P_t^{l,77}$</td>
<td>0.010</td>
<td>(3.58)</td>
<td></td>
</tr>
<tr>
<td>$P_t^{l,86}$</td>
<td>0.015</td>
<td>(4.59)</td>
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</table>

+ LL=119.04, AIC=-6.43, SC=-5.84
++ $[F(1, 20)] = 2.56 [0.13]$

* Probabilities in square brackets
+ Log likelihood (LL), Akaike (AIC) and Schwarz (SC) criteria
++ Wald test for long-run no money illusion
### Table A3: Labor force equation, OLS, 1966-1998.

<table>
<thead>
<tr>
<th>Dependent variable: $L_t$</th>
<th>Coefficient</th>
<th>t-stat.</th>
<th>Misspecification tests*</th>
</tr>
</thead>
<tbody>
<tr>
<td>$Cnt$</td>
<td>-0.54</td>
<td>(-1.74)</td>
<td>SC[$\chi^2$ (1)] 0.12 [0.74]</td>
</tr>
<tr>
<td>$L_{t-1}$</td>
<td>0.84</td>
<td>(18.3)</td>
<td>LIN[$\chi^2$ (1)] 1.39 [0.25]</td>
</tr>
<tr>
<td>$\Delta L_{t-2}$</td>
<td>-0.34</td>
<td>(-2.16)</td>
<td>NOR[$\chi^2$ (1)] 0.46 [0.79]</td>
</tr>
<tr>
<td>$w_t$</td>
<td>-0.03</td>
<td>(-2.42)</td>
<td>ARCH[$\chi^2$ (1)] 1.74 [0.20]</td>
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<tr>
<td>$\Delta u_t$</td>
<td>-0.12</td>
<td>(-2.04)</td>
<td>HET[$\chi^2$ (1)] 1.42 [0.24]</td>
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<tr>
<td>$Z_t$</td>
<td>0.20</td>
<td>(3.76)</td>
<td></td>
</tr>
</tbody>
</table>

$^+$ LL=133.99, AIC=-7.76, SC=-7.48  
$^{++}$ [$F(1,27)$] = 3.34 [0.08]

* Probabilities in square brackets  
$^+$ Log likelihood (LL), Akaike (AIC) and Schwarz (SC) criteria  
$^{++}$ Wald test for unit long-run elasticity of $L$ w.r.t. $Z$
### Table A4: Employment equation, OLS, 1966-1998.

<table>
<thead>
<tr>
<th>Dependent variable: $N_t$</th>
<th>Misspecification tests*</th>
</tr>
</thead>
<tbody>
<tr>
<td>$Cnt$</td>
<td>SC[$\chi^2(1)$]</td>
</tr>
<tr>
<td>$N_{t-1}$</td>
<td>LIN[$\chi^2(1)$]</td>
</tr>
<tr>
<td>$N_{74}^{t}$</td>
<td>NOR[$\chi^2(1)$]</td>
</tr>
<tr>
<td>$N_{84}^{t}$</td>
<td>ARCH[$\chi^2(1)$]</td>
</tr>
<tr>
<td>$N_{93}^{t}$</td>
<td>HET[$\chi^2(1)$]</td>
</tr>
<tr>
<td>$k_t$</td>
<td>0.64 (2.94)</td>
</tr>
<tr>
<td>$k_{t-1}$</td>
<td>-1.35 (-4.33)</td>
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<tr>
<td>$k_{t-2}$</td>
<td>0.83 (3.64)</td>
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<tr>
<td>$w_t$</td>
<td>-0.15 (-4.50)</td>
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<td>$\theta_{t-1}$</td>
<td>0.34 (2.42)</td>
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<tr>
<td>$\theta_{79}^{t}$</td>
<td>0.02 (1.98)</td>
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<tr>
<td>$\Delta L_t$</td>
<td>0.65 (3.02)</td>
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<tr>
<td>$b_t$</td>
<td>-0.21 (-9.16)</td>
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<tr>
<td>$\tau_t$</td>
<td>-0.34 (-1.33)</td>
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<tr>
<td>$d_f$</td>
<td>0.01 (2.22)</td>
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</table>

$^+$ LL=141.97, AIC=-7.69, SC=-7.01
$^{++}$ $[F (1, 18)] = 0.35 [0.56]$

* Probabilities in square brackets
$^+$ Log likelihood (LL), Akaike (AIC) and Schwarz (SC) criteria
$^{++}$ Wald test for constant returns to scale
Table A5: Capital stock equation, OLS, 1966-1998.

<table>
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<th>Dependent variable: $k_t$</th>
<th>Misspecification tests*</th>
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</thead>
<tbody>
<tr>
<td>$Cnt$</td>
<td>$SC[\chi^2 (1)]$ 1.13 [0.30]</td>
</tr>
<tr>
<td>$k_{t-1}$</td>
<td>$LIN[\chi^2 (1)]$ 0.33 [0.57]</td>
</tr>
<tr>
<td>$k_{t-2}$</td>
<td>$NOR[\chi^2 (1)]$ 2.64 [0.27]</td>
</tr>
<tr>
<td>$k_{t-3}$</td>
<td>$ARCH[\chi^2 (1)]$ 0.75 [0.39]</td>
</tr>
<tr>
<td>$N_t$</td>
<td>$HET[\chi^2 (1)]$ 0.68 [0.78]</td>
</tr>
<tr>
<td>$N_{t-1}$</td>
<td></td>
</tr>
<tr>
<td>$N_{t-2}$</td>
<td></td>
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<td>$\theta_t$</td>
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<td>$\theta_{t-1}$</td>
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<td>$m_t$</td>
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<td>$w_{t-1}$</td>
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</tr>
<tr>
<td>$c_{t-1}$</td>
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<tr>
<td>$\tau_{t-1}$</td>
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</tr>
<tr>
<td>$d_{t-1}$</td>
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</tr>
</tbody>
</table>

$^+\text{ LL}=164.73, \ AIC=-9.13, \ SC=-8.50$

$^{++}[F (1, 19)] = 2.82 [0.11]$

* Probabilities in square brackets
+ Log likelihood (LL), Akaike (AIC) and Schwarz (SC) criteria
++ Wald test for constant returns to scale
Table A6: Production function, OLS, 1966-1998.

<table>
<thead>
<tr>
<th>Dependent variable: $y_t$</th>
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</tr>
</thead>
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<tr>
<td>coefficient</td>
<td>t-statistic</td>
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<tr>
<td>$Cnt$</td>
<td>$-1.78$</td>
</tr>
<tr>
<td>$y_{t-1}$</td>
<td>$0.36$</td>
</tr>
<tr>
<td>$y_{t-2}$</td>
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<tr>
<td>$k_t$</td>
<td>$0.45$</td>
</tr>
<tr>
<td>$k_{t}^{75}$</td>
<td>$-0.001$</td>
</tr>
<tr>
<td>$N_t$</td>
<td>$0.58$</td>
</tr>
<tr>
<td>$N_{t}^{84}$</td>
<td>$0.003$</td>
</tr>
<tr>
<td>$t$</td>
<td>$0.003$</td>
</tr>
<tr>
<td>$t^{78}$</td>
<td>$-0.001$</td>
</tr>
</tbody>
</table>

+ $LL=105.25$, $AIC=-5.83$, $SC=-5.42$
++ $[F (1, 24)] = 1.77 [0.20]$

* Probabilities in square brackets
+ Log likelihood (LL), Akaike (AIC) and Schwarz (SC) criteria
++ Wald test for constant returns to scale

Figures A2: Actual and Fitted Values of the Unemployment and Inflation Rates

a. Unemployment  

b. Price inflation
Appendix C: Kernel Density Analysis for Money Growth

Figure A3. Money supply growth Kernel density function. 1966-1998.

Figure A4. Money supply growth, Spain, 1966-1998.