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JEL Classification: E24; E31; E51; E62

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30 June 2008

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1 Introduction

The aim of this paper is to shed light on the inflation-unemployment relationship and, in this context, explore the driving forces underlying the "roaring nineties" in the US: the dream combination of low inflation, low unemployment and strong growth.[1] We will examine how these conditions were generated by a combination of money growth, productivity growth, the budget deficit, and the trade deficit. In this context, we will investigate long-lasting effects of monetary policy on real macroeconomic activity.

Our analysis centers on "frictional growth," a phenomenon arising from the interplay between growth and frictions. In particular, we examine the interaction between money growth and various nominal frictions. In this context we show that monetary policy has not only persistent, but permanent real effects, giving rise to a long-run inflation-unemployment tradeoff.

The orthodox view that there is no long-run relationship between inflation and unemployment has led to a compartmentalisation in macro-labour economics: one branch of the literature examines the real variables driving unemployment, and another branch explores inflation dynamics.[2] In recent years, this orthodoxy has been weakened somewhat through the microfoundations of the New Phillips Curve (NPC), which can be expressed as $\pi_t = \beta E_t \pi_{t+1} - a(u_t - u^n) + \varepsilon_t$, where π_t is the inflation rate, u_t is the unemployment rate, u^n is the natural rate of unemployment, and β is the discount factor. The implied long-run relation between inflation and unemployment ($d\pi/du = -a/(1-\beta)$) can be shown to arise from the interactions between money growth and nominal frictions in the presence of time discounting.[3] Under staggered price setting, the discounting effect causes current prices to depend more heavily on the past price level than on the future price level. The faster the money supply grows, the greater is the spread between future and past price levels, and since the past price level has a stronger influence than the future price level on current prices, the current price level falls relative to the money supply. This interplay between money growth and nominal frictions has been called "frictional growth" (see Karanassou, Sala and Snower, 2005 and 2008a).

Since the discount factor is close to unity, the long-run Phillips curve above is still presumed to be approximately vertical. This presumption may of course be disputed when the coefficient a, in the NPC above, is sufficiently low. Macro estimates of this coefficient[4] are commonly much lower than those used in calibrated New Keynesian models,[5] and Karanas-

[1] For some background to the performance of the US economy, see for example Blinder and Yellen (2002), and Stiglitz (2003).

[2] As Mishkin (2006) puts it, the absence of a long-run inflation-unemployment tradeoff is one of 'six ideas that are now accepted by monetary authorities and governments in almost all countries of the world'.

[3] See, for example, Ascari (1998), Graham and Snower (2008), and Karanassou and Snower (2008).

[4] For example, Galí and Gertler (1999) estimate it to be between 0.007 and 0.047; Sachs (1980) finds it in the range 0.07 and 0.1; and Taylor (1980) estimates it to be between 0.05 and 0.1.

[5] For example, Huang and Liu (2002).

sou, Sala and Snower (2005) show that the long-run Phillips curve can be far from vertical under the former.

Further reasons for calling the vertical long-run Phillips curve into question include interactions between multiple nominal frictions. The standard microfoundations of the NPC above is based on either price- or wage-staggering; but when price- and wage-staggering mechanisms occur side-by-side, they can be shown to have a complementary influence on monetary persistence (see Merkl and Snower, 2008) and this can have important implications for the long-run inflation-unemployment tradeoff, as explored below.

Beyond that, there are of course a host of other theoretical considerations (dating back to Sidrauski, 1967) indicating that the superneutrality of money rests on special, strong assumptions, such as the separability of consumption and leisure in utility and the role of money in the economy (see, for example, Orphanides and Solow, 1990, for a survey). Thus, the long-run inflation-unemployment tradeoff becomes an empirical issue.

The purpose of this paper is (i) to explore the empirical issue by estimating a system of macroeconomic equations with several growing variables and several nominal frictions and (ii) to outline a simple analytical model that provides useful insights for our empirical results.

The rest of the paper is structured as follows. Section 2 presents a dynamic model of frictional growth and derives the implications for the Phillips curve. Section 3 estimates an extended multi-equation model with spillover effects between real and nominal equations for the US. This empirical model is used in Sections 4 and 5 to derive the Phillips curve, and reappraise the performance of the US economy during the roaring nineties, respectively. Finally, Section 6 concludes.

2 Frictional Growth and the Phillips Curve

We illustrate the effects of frictional growth on the Phillips curve through a simple, stylised macro model containing several growing variables and nominal frictions.

While a full microfoundations lies beyond the scope of this paper, our model captures the essential relationships to describe frictional growth and derive its implications for the effects of monetary policy. A fully microfounded model, with both wage and price staggering is developed in Merkl and Snower (2008); it provides a theoretical background to the analysis of this section. As is well known, when wages and prices are temporarily rigid, current wages and prices depend on past and expected future wages and prices, and the expected future values, in turn, can be expressed in terms of current and lagged variables (once agents' information sets and the underlying stochastic processes have been specified).[6] For the

[6] For example, Karanassou, Sala and Snower (2005, 2008a) derive the rational-expectations solution of wage-price staggering models by expressing the expected future values of the variables in terms of current and past values.

sake of simplicity and brevity, the equations of our model are reduced forms in which the expected lead variables are expressed in terms of the current and past variables. Specifically, our model comprises the following nominal wage (W_t), price (P_t), labour demand (n_t), and labour supply (l_t) equations:

$$W_t = \alpha_W W_{t-1} + (1-\alpha_W) M_t + \alpha_b b_t - \alpha_u u_t, \quad (1)$$
$$P_t = \alpha_P P_{t-1} + (1-\alpha_P) M_t, \quad (2)$$
$$n_t = \beta_k k_t - \beta_w w_t + \beta_m (M_t - P_t), \quad (3)$$
$$l_t = \gamma_z z_t + \gamma_w w_t, \quad (4)$$

where the autoregressive parameters ($0 < \alpha_W$, $\alpha_P < 1$) capture wage and price staggering effects, and α_b, α_u, the βs and the γs are positive constants. $w_t \equiv W_t - P_t$ is real wage, M_t is the money supply, b_t are real unemployment benefits, k_t is the real capital stock, and z_t is the working-age population (constant and error terms are ignored for expositional ease). In the labour demand equation (3), product demand-side influences are captured through real money balances ($M_t - P_t$), while product supply-side influences are captured through the capital stock. All variables are in logs, except for the unemployment rate (u_t), which is approximated by the difference of (log) labour force and (log) employment:

$$u_t = l_t - n_t. \quad (5)$$

Observe that the nominal equations (1)-(2) satisfy the "*no money illusion* (or money neutrality) restriction" in the long-run, since the steady-state elasticities of wages and prices with respect to money are unity. However, as we will show below, unemployment does not depend on inflation in the long-run if $a_W = \alpha_P$ and $\beta_m = 0$, or $a_W = \alpha_P = 0$ (see equation (19) in Section 2.1). In other words, money neutrality requires either (i) identical wage and price dynamics, and a labour demand independent of real money balances, or (ii) static wage and price equations. It is also worth pointing out that α_u, β_w, β_m and γ_w generate spillover effects, since changes in an exogenous variable, say benefits, can also affect labour demand and supply equations (via β_w and γ_w). In the presence of spillover effects, the short-run elasticities of the dependent variables with respect to the exogenous ones can no longer be adequately captured by α_b, β_k and γ_z. We refer to the latter as the short-run "local" elasticities, to distinguish them from the "global" elasticities that result from the interactions in the system.

In this context, we derive the unemployment rate as a function of its own lags and the exogenous variables. Subtracting (2) from (1) and further algebraic manipulation leads to the following real wage equation:

$$(1-\alpha_W B)(1-\alpha_P B) w_t = \alpha_b (1-\alpha_P B) b_t + (\alpha_P - \alpha_W) \mu_t - \alpha_u (1-\alpha_P B) u_t, \quad (6)$$

where B is the backshift operator, and $\mu_t \equiv M_t - M_{t-1}$ is the money growth rate. Note that (i) money growth affects real wages in all horizons when $\alpha_P \neq \alpha_W$, and (ii) the real wage is procyclical when price inertia exceeds wage inertia ($\alpha_P > \alpha_W$).

Algebraic manipulation of the price (2) gives the following dynamics for real money balances:

$$(1 - \alpha_P B)(M_t - P_t) = \alpha_P \mu_t. \tag{7}$$

Substitution of real wage (6) and real balances (7) into the demand (3) and supply (4) equations, and further algebraic manipulation, gives

$$\begin{aligned}(1-\alpha_W B)(1-\alpha_P B)\, n_t &= \beta_k (1-\alpha_W B)(1-\alpha_P B)\, k_t \\ &\quad +\beta_m \alpha_P (1-\alpha_W B)\, \mu_t - \beta_w (\alpha_P - \alpha_W)\, \mu_t \\ &\quad -\beta_w \alpha_b (1-\alpha_P B)\, b_t + \beta_w \alpha_u (1-\alpha_P B)\, u_t,\end{aligned} \tag{8}$$

and

$$\begin{aligned}(1-\alpha_W B)(1-\alpha_P B)\, l_t &= \gamma_z (1-\alpha_W B)(1-\alpha_P B)\, z_t + \gamma_w (\alpha_P - \alpha_W)\, \mu_t \\ &\quad +\gamma_w \alpha_b (1-\alpha_P B)\, b_t - \gamma_w \alpha_u (1-\alpha_P B)\, u_t,\end{aligned} \tag{9}$$

respectively.

We obtain the *reduced form* dynamics of the unemployment rate by subtracting (8) from (9):[7]

$$\begin{aligned}(1-\alpha_P B)\left[(1-\alpha_W B) + \gamma_u (\beta_w + \gamma_w)\right] u_t &= \left[(\alpha_P - \alpha_W)(\beta_w + \gamma_w) - \beta_m \alpha_P (1-\alpha_W B)\right] \mu_t \\ &\quad + (1-\alpha_P B)\left[\gamma_z (1-\alpha_W B)\, z_t - \beta_k (1-\alpha_W B)\, k_t + \alpha_b (\beta_w + \gamma_w)\, b_t\right].\end{aligned} \tag{10}$$

This equation is also referred to as the univariate representation of unemployment, since no other endogenous variables appear on its right-hand side. The term "reduced form" relates to the fact that the parameters of the equation, instead of being directly estimated, are some nonlinear function of the parameters of the underlying macro model (1)-(4).

Recall that α_W and α_P are associated with price and wage staggering, respectively, α_u reflects the downward pressure of unemployment on wages, β_w depicts the wage elasticity of labour demand, β_m is the elasticity of labour demand with respect to real money balances, γ_w is the wage elasticity of labour supply, and α_b, β_k, γ_z measure the "local" elasticities of the exogenous variables.

The univariate representation of the unemployment rate (10) highlights the following features of our model.

[7] Note that (10) is dynamically stable since (i) products of polynomials in B which satisfy the stability conditions are stable, and (ii) linear combinations of dynamically stable polynomials in B are also stable.

First, if $\alpha_W > \alpha_P$, an increase in money growth (μ_t) reduces both unemployment (by eq. (10)) and real wages (by eq. (6)). Put it differently, the real wage is countercyclical when prices adjust faster than nominal wages. On the other hand, if $\alpha_W < \alpha_P$, an expansionary monetary policy reduces unemployment[8] and increases real wages. That is, the real wage is procyclical when prices adjust slower than wages.

Second, the transmission mechanisms of monetary policy are (i) the direct channel of real money balances in the labour demand equation ($\beta_m \neq 0$), and (ii) the indirect channels of real wage in labour demand and supply ($\beta_w \neq 0$ and $\gamma_w \neq 0$, respectively).[9]

Third, if $\alpha_u = 0$, changes in capital stock (k_t) and working-age population (z_t) do not spillover to the system. This is because labour demand and labour supply shocks are transmitted to the rest of the system via wages. If changes in the capital stock (working-age population) do not influence wages ($\alpha_u = 0$) , they cannot spillover from labour demand (supply) to the other equations. Therefore, the effects of these variables on unemployment can be adequately captured by the individual labour demand (3) and supply (4) equations, respectively, and there is no value added from the reduced form unemployment rate eq. (10).

Finally, if $\beta_w = \gamma_w = 0$, changes in benefits (b_t) do not spillover to either labour demand or supply, and, thus, do not affect unemployment.

We can reparameterise the univariate representation of the unemployment rate (10) as

$$\begin{aligned} u_t = {} & \phi_1 u_{t-1} - \phi_2 u_{t-2} - \theta_\mu \mu_t + \beta_m \phi_2 \mu_{t-1} + \theta_z z_t - \theta_z \left(\alpha_W + \alpha_P\right) z_{t-1} + \theta_z \alpha_W \alpha_P z_{t-2} \\ & - \theta_k k_t + \theta_k \left(\alpha_W + \alpha_P\right) k_{t-1} - \theta_k \alpha_W \alpha_P k_{t-2} + \theta_b b_t - \theta_b \alpha_P b_{t-1}. \end{aligned} \tag{11}$$

where $\phi_1 = \frac{\alpha_W + \alpha_P + \alpha_P \gamma_u (\beta_w + \gamma_w)}{1 + \alpha_u (\beta_w + \gamma_w)}$, $\phi_2 = \frac{\alpha_W \alpha_P}{1 + \alpha_u (\beta_w + \gamma_w)}$, $\theta_\mu = \frac{(\alpha_W - \alpha_P)(\beta_w + \gamma_w) + \beta_m \alpha_P}{1 + \alpha_u (\beta_w + \gamma_w)}$, $\theta_z = \frac{\gamma_z}{1 + \alpha_u (\beta_w + \gamma_w)}$, $\theta_k = \frac{\beta_k}{1 + \alpha_u (\beta_w + \gamma_w)}$, and $\theta_b = \frac{\alpha_b (\beta_w + \gamma_w)}{1 + \alpha_u (\beta_w + \gamma_w)}$.

The above equation shows that the unemployment rate is the outcome of the interactions of the wage and price staggering adjustment processes, α_W and α_P, and the feedback mechanisms of the macro model, i.e. α_u, β_w, β_m and γ_w. Note that the θs are the short-run "global" elasticities of unemployment with respect to the exogenous variables. The univariate representation of unemployment (11) can be understood as an autoregressive moving average (ARMA) process with the lags of the exogenous variables being the moving-average terms.

[8] This holds when

$$\beta_m \alpha_P \left(1 - \alpha_W\right) > \left(\alpha_P - \alpha_W\right)\left(\beta_w + \gamma_w\right).$$

[9] Indirect in the sense that monetary policy first affects nominal wages ($\alpha_W \neq 0$) and prices ($\alpha_P \neq 0$), and then transmits to unemployment via real wages in the labour demand and supply equations.

2.1 The Long-run

Another key feature of the univariate representation (11) is that trended variables, like capital stock and working-age population, influence the time path of the nontrended unemployment rate. This controversial result can be explained as follows. Recall from eq. (3) and (4) that the trended series of employment and labour force are determined by the trended variables of capital stock and working age population, and the real wage. According to (8)-(9), labour demand and supply remain balanced after substituting in the real wage equation (6) since they are dynamically stable ($|\alpha_W, \alpha_P| < 1$).[10]

Therefore, the reduced form unemployment rate equation (10) is itself dynamically stable, since (by (5)) it is the difference of the dynamically stable labour supply and demand equations. Karanassou and Snower (2004) show that equilibrating mechanisms in the labour market and other markets jointly act to ensure that the unemployment rate is trendless in the long-run (see, also, Karanassou, Sala, and Salvador, 2008b). These mechanisms can be expressed in the form of restrictions on the relationships between the long-run growth rates of capital stock and the other growing exogenous variables.

First differencing (10), setting $B = 1$, recognising that money growth (μ_t) stabilises in the long-run, and assuming that the exogenous variables are characterised by nonzero long-run growth rates, gives the following equation for the long-run change in unemployment:

$$(1-\alpha_P)\left[(1-\alpha_W)+\alpha_u\left(\beta_w+\gamma_w\right)\right]\Delta u^{LR} = (1-\alpha_P)\begin{bmatrix} \gamma_z\left(1-\alpha_W\right)\Delta z^{LR} \\ -\beta_k\left(1-\alpha_W\right)\Delta k^{LR} \\ +\alpha_b\left(\beta_w+\gamma_w\right)\Delta b^{LR} \end{bmatrix},$$

where Δ is the difference operator and $(\cdot)^{LR}$ denotes the long-run value of the variable. The above equation shows that the unemployment rate stabilises in the long-run, i.e. $\Delta u^{LR} = 0$, when the long-run growth rates of the exogenous variables satisfy the following restriction:

$$\beta_k \Delta k^{LR} = \gamma_z \Delta z^{LR} + \frac{\alpha_b\left(\beta_w+\gamma_w\right)}{(1-\alpha_W)}\Delta b^{LR}, \tag{12}$$

where Δk, Δz, Δb are the growth rates of capital stock, working-age population, and benefits, respectively.

We should point out that the specification of real wage (6) is a manifestation of frictional growth. Thus, one implication of frictional growth is that the interplay of wage/price staggering and the growing money supply generates real effects of the monetary policy in both the short- and long-run, despite the no money illusion restriction imposed on the wage and price setting eq. (1)-(2).[11] That is, the classical dichotomy evaporates in the

[10] Note that (8) and (9) are dynamically stable since the products of polynomials in B which satisfy the stability conditions are also stable.

[11] For a discussion of the concepts of the short-run, steady-state, and long-run, see Karanassou, Sala, and

presence of frictional growth.

In particular, the long-run solution of the price eq. (2) is

$$\begin{aligned}\underset{\text{long-run}}{P_t^{LR}} &= M_t^{LR} - \frac{\alpha_P}{1-\alpha_P}\Delta P^{LR} \\ &= \underbrace{M_t^{LR}}_{\text{frictionless steady-state}} - \underbrace{\frac{\alpha_P}{1-\alpha_P}\mu^{LR}}_{\text{frictional growth}},\end{aligned} \tag{13}$$

where the subscript t signifies that the variable does not stabilise in the long-run. Note that, even in the absence of money illusion, the growing price level does not catch up with the growing money supply in the long-run due to frictional growth. However, due to no money illusion (money neutrality) inflation equals money growth in the long-run:

$$\pi^{LR} = \mu^{LR}. \tag{14}$$

Furthermore, the long-run solution of the wage eq. (1) is given by

$$\begin{aligned}\underset{\text{long-run}}{W_t^{LR}} &= M_t^{LR} + \frac{\alpha_b}{1-\alpha_W}b_t^{LR} - \frac{\alpha_u}{1-\alpha_W}u^{LR} - \frac{\alpha_W}{1-\alpha_W}\Delta W^{LR} \\ &= \underbrace{M_t^{LR} + \frac{\alpha_b}{1-\alpha_W}b_t^{LR} - \frac{\alpha_u}{1-\alpha_W}u^{LR}}_{\text{frictionless steady-state}} - \underbrace{\frac{\alpha_W\alpha_b}{(1-\alpha_W)^2}\Delta b^{LR} - \frac{\alpha_W}{1-\alpha_W}\mu^{LR}}_{\text{frictional growth}}.\end{aligned} \tag{15}$$

By subtracting (13) from (15) we get the following long-run real wage equation:

$$\underset{\text{long-run}}{w_t^{LR}} = \underbrace{\left(\frac{\alpha_b}{1-\alpha_W}b_t^{LR} - \frac{\alpha_u}{1-\alpha_W}u^{LR}\right)}_{\text{frictionless steady state}} + \underbrace{\frac{(\alpha_P-\alpha_W)\,\mu^{LR}}{(1-\alpha_W)\,(1-\alpha_P)} - \frac{\alpha_W\alpha_b}{1-\alpha_W}\Delta b^{LR}}_{\text{frictional growth}}. \tag{16}$$

It is clear from the above equation that money growth (μ) affects real wages in the long-run. Consequently, by (14) and for $\alpha_W \neq \alpha_P$, the above equation implies that the Phillips curve is not vertical in the long-run since unemployment depends on real wages.

A second important implication of frictional growth is that under quite plausible conditions the natural rate is not an attractor of the unemployment trajectory. We derive this result below.

The long-run solutions of labour supply (4) and demand (3) are

$$\begin{aligned} l_t^{LR} &= \gamma_z z_t^{LR} + \gamma_w w_t^{LR} \text{ and} \qquad (17)\\ n_t^{LR} &= \beta_k k_t^{LR} - \beta_w w_t^{LR} + \beta_m (M-P)^{LR}, \qquad (18)\end{aligned}$$

respectively. Subtraction of (18) from (17), and further algebraic manipulation, leads to the

Snower (2008b).

following long-run unemployment rate equation:

$$\begin{aligned} u^{LR} &= \underbrace{\xi\left[\gamma_z z_t^{LR} - \beta_k k_t^{LR} + \frac{\alpha_b\left(\beta_w+\gamma_w\right)}{\left(1-\alpha_W\right)} b_t^{LR}\right]}_{\text{frictionless steady-state (NRU)}} \\ &\quad \underbrace{+\xi\left[\frac{\left(\alpha_P-\alpha_W\right)\left(\beta_w+\gamma_w\right)-\left(1-\alpha_W\right)\beta_m\alpha_P}{\left(1-\alpha_W\right)\left(1-\alpha_P\right)}\pi^{LR} - \frac{\alpha_W\alpha_b\left(\beta_w+\gamma_w\right)}{\left(1-\alpha_W\right)}\Delta b^{LR}\right]}_{\text{frictional growth}}, \end{aligned} \tag{19}$$

where $\xi = \frac{1-\alpha_W}{1-\alpha_W+\alpha_u(\beta_w+\gamma_w)}$. Note that the frictional growth term is constant, while the steady-state term stabilises in the long-run under (12). Thus, condition (12) ensures that the unemployment rate is constant in the long-run.

In single-equation unemployment rate models the natural rate of unemployment (NRU) is obtained by the steady-state solution of the equation, and it easy to show that actual unemployment gravitates towards its natural rate. In sharp contrast, eq. (19) predicts that in the context of dynamic macro models with lagged adjustments and growing exogenous variables, unemployment may deviate substantially from what is commonly perceived as its natural rate, even in the long-run.[12] The long-run value $\left(u^{LR}\right)$ towards which the unemployment rate converges reduces to the NRU only when frictional growth is zero, i.e. when the exogenous variables have zero growth rates or there are no lags in the system.

2.2 Persistence and Elasticities

The effects of shocks to dynamic models persist for much longer than the duration of the shocks and eventually die out long after the shocks are over. The impulse response function of unemployment describes its responses through time to a one-off shock (impulse), and persistence measures the after effects of the shock.

For a temporary shock occurring at period t, we define unemployment persistence (σ) as the sum of its responses for all periods $t+j$ in the aftermath of the shock ($j \geq 1$):[13]

$$\sigma \equiv \sum_{j=1}^{\infty} R_{t+j}, \tag{20}$$

where the series R_{t+j}, $j \geq 0$ is the impulse response function (IRF) of unemployment.[14] We can distinguish the following cases: (i) $\sigma = 0$, i.e. the shock is absorbed instantly, when the unemployment rate model is static, (ii) $\sigma \neq 0$, i.e. the effects of the shock gradually

[12] See also Karanassou and Snower (1997), and Karanassou, Sala, and Salvador (2008a).

[13] Other measures of persistence are the half life of the shock, the sum of the autoregressive parameters, and the largest autoregressive root. The virtues and faults of these measures are pointed out in a recent application by Pivetta and Reis (2007).

[14] In other words, R_{t+j}, $j \geq 0$, denotes the coefficients of the infinite moving average representation of unemployment with respect to the shock.

dissipate through time, when the model is dynamically stable, and (iii) $\sigma = \infty$, i.e. the temporary shock has a permanent effect, when the model displays hysteresis.

Note that when we view the shock at period t as a change in one of the explanatory variables over that period, the immediate response (R_t) is simply the short-run "global" elasticity (slope) of unemployment with respect to that variable, while the sum of the current impact (R_t) and persistence (σ) gives the long-run "global" elasticity (slope) of unemployment with respect to the variable. In other words, the long-run elasticity (e_{LR}) can be decomposed into the short-run elasticity (e_{SR}) and our measure of persistence (20):

$$e_{SR} + \sigma = e_{LR}. \tag{21}$$

The above relation essentially uses the IRF of the shock to obtain the short- and long-run elasticities of the model, and thus offers an additional diagnostic tool for the estimated macro-labour system. In a large model with inter-equation spillovers, mere inspection of the individual equations only gives the "local" (direct) short-run elasticities of the exogenous variables. The "global" short-run elasticity is influenced by the feedback mechanisms of the system and can be effectively measured by the contemporaneous response. Furthermore, the sum of the short-run elasticity and the "future" responses (i.e. persistence) gives the "global" long-run elasticity. The economic plausibility of the signs and magnitudes of the elasticities of the various exogenous variables serves to diagnose the model in hand. We believe that a crucial factor that led to the demise of the large macro-econometric models, very popular in the past, was the lack of such a diagnosis.

3 An Empirical Model of the US Economy

Along the lines of the analytical model in the previous section, we capture the phenomenon of frictional growth by estimating a dynamic model for the US economy comprising wage/price setting and labour market equations. This model is an expanded version of the three-equation system in Karanassou, Sala, and Snower (2005) as it endogenises productivity and financial wealth, and derives the unemployment rate from labour supply and demand equations. Thus, our empirical model consists of a six-equation structural system (plus the definition of the unemployment rate). Our model can jointly explain the evolution of unemployment and inflation. At the same time, the interplay of money growth and nominal frictions gives rise to a downward-sloping Phillips curve (PC) in the long-run.

We should emphasize that, although the wage and price equations depend only on lags (and not leads), they derive from staggering equations that contain backward- and forward-looking components. Karanassou, Sala, and Snower (2005, 2008a) show that the rational expectations solution of wage/price staggering models translates the expected future values of the variables into their current and past values.

3.1 Data and Estimation Methodology

We use annual data, over the 1960-2005 period, obtained from Bloomberg (S&P's 500 index), Datastream (oil prices) and the OECD (rest of the variables). Table 1 provides the definitions of the variables used in the estimated model.

Table 1: Definitions of variables.

M_t	money supply (M3)	π	price inflation ($P_t - P_{t-1}$)
P_t	price level (GDP deflator)	μ	money growth (ΔM_t)
W_t	nominal compensation	fw_t	financial wealth (real S&P's 500)
w_t	real wage ($W_t - P_t$)	k_t	real capital stock
pr_t	real labour productivity	oil_t	real oil prices
n_t	employment	imp_t	real import prices (goods & services)
l_t	labour supply	z_t	working-age population
u_t	unemployment rate ($l_t - n_t$)	$cons_t$	private consumption, % of GDP
tax_t^{ss}	social security contributions, % of GDP	gov_t	public expenditures, % of GDP
tax_t^{i}	indirect taxes, % of GDP	fd_t	foreign demand: exports-imports, % of GDP
tax_t^{d}	direct taxes paid by households, % of GDP	t	linear time trend
		c	constant

All variables are in logs except for the unemployment rate u_t and the ratios.
Source: Bloomberg, Datastream and OECD.

Our econometric methodology is based on the autoregressive distributed lag (ARDL) approach developed by Pesaran (1997), Pesaran and Shin (1999) and Pesaran, Shin and Smith (2001). These authors argue that the ARDL is an alternative to the cointegration error-correction methodology with the advantage of avoiding the pretesting problem implicit in the standard cointegration techniques (i.e. the Johansen maximum likelihood, and the Phillips-Hansen semi-parametric fully-modified OLS procedures). In fact, they show that the ARDL yields consistent short- and long-run estimates, and can be reliably used in small samples for hypothesis testing irrespective of whether the regressors are I(1) or I(0).

Our empirical macro model is given by the following system of nominal and real equations:[15]

$$\mathbf{A}_0\mathbf{y}_t = \sum_{i=1}^{2}\mathbf{A}_i\mathbf{y}_{t-i} + \sum_{i=0}^{2}\mathbf{D}_i\mathbf{x}_{t-i} + \boldsymbol{\varepsilon}_t, \tag{22}$$

where $\mathbf{y}_t$ is a (6×1) vector of endogenous variables (prices, wages, financial wealth, employment, labour force and productivity), $\mathbf{x}_t$ is a (10×1) vector of exogenous variables, the $\mathbf{A}$s and $\mathbf{D}$s are (6×6) and (10×10) coefficient matrices, respectively, and $\boldsymbol{\varepsilon}_t$ is a (6×1) vector of strict white noise error terms. (Constants and trends are omitted for ease of exposition.)

[15] The dynamic system (22) is stable when, for given values of the exogenous variables, all the roots of the determinantal equation

$$\left|\mathbf{A}_0 - \mathbf{A}_1 B - \mathbf{A}_2 B^2\right| = 0$$

lie outside the unit circle. Note that the estimated equations given below satisfy this condition.

The ARDL methodology is applied to each equation of the model (22), and the selected equations pass the standard diagnostic tests for structural stability, linearity, serial correlation, heteroskedasticity (and autoregressive conditional heteroskedasticity), and normality. (The tests are available upon request.) In the next section we discuss the estimation results and provide an overall evaluation of our empirical macro-labour model.[16]

3.2 Estimated Equations

Tables 2 and 3 display the results on the estimated equations. The price equation exhibits a persistence coefficient of 0.65, as in Karanassou, Sala and Snower (2005), with supply-side influences captured via nominal wages, with a positive sign, and productivity, with a negative sign. The restriction of no money illusion in the long-run is imposed so that the price equation is homogeneous of degree zero in the nominal variables.[17] With respect to productivity, the long-run elasticity of -0.71 indicates that almost three quarters of productivity gains are translated into price reductions. This price setting curve can be interpreted as the outcome of price-staggering, where the demand conditions are captured by investment (proxied by the growth in capital stock, Δk), consumption, government expenditures, and foreign demand, all with the expected upward pressure on prices. Since the latter three variables are expressed as a percentage of GDP, their estimated coefficients show how prices change in response to increases in these variables *relative to output*. Note that prices are more sensitive to fluctuations in the trade surplus/deficit than to changes in either consumption or government expenditures.

The nominal wage equation is quite standard and satisfies the restriction of no money illusion.[18] The persistence coefficient of 0.51 implies that wages adjust faster than prices (similarly to Karanassou, Sala and Snower, 2005). The long-run elasticity of wages with respect to productivity is 0.65, indicating that about two thirds of productivity gains are translated into wage increases. Unemployment puts downward pressure on wages, while oil prices push them up.

The dynamics of the stock market are determined by a combination of inflation, money and productivity growth, and real wages.[19] In particular, while the growth rate of real money balances ($\mu_t - \pi_t$) affects positively the stock market, an increase in money growth depresses it. Note that since prices satisfy the money neutrality condition, inflation equals

[16] Note that we only report the OLS estimates - 3SLS estimation is not feasible as we run out of degrees of freedom due to the large number of instruments required in the context of such a big model.

[17] The restriction that the long-run elasticity of prices with respect to wages is unity cannot be rejected by the Wald test at the 2.3% significance level.

[18] The restriction is imposed by setting equal to unity the long-run elasticity of wages with respect to its nominal determinants (i.e. prices and money supply). The restriction cannot be rejected at the 5% significance level using the Wald test.

[19] Although the equation was initially estimated having these variables as separate regressors, the signs and magnitudes of their coefficients eventually led to the selected specification given in Table 2.

money growth in the long-run. Thus, our equation implies that an increase in inflation has a negative impact on the performance of the stock market.

Furthermore, the (financial wealth) equation includes the growth in productivity rather than its level. This implies that productivity does not influence the stock market in the long-run, which is consistent with the finding by Madsen and Philip Davis (2006, p. 791) that 'productivity advances can only have temporary effects on the fundamentals of equity prices.' Finally, the disparity between productivity and real wages, the so called wage-gap, has a positive effect on the stock market. Our interpretation is that this variable proxies the profit rate so that the more real wages lag behind productivity, the higher is the firm's profitability and the higher its market value.

Table 2: Prices, wages and financial wealth. US, 1963-2005.

Dependent variable: P_t		Dependent variable: W_t		Dependent variable: fw_t	
	coef. [probs.]		coef. [probs.]		coef. [probs.]
c	-0.80 [0.024]	c	0.46 [0.000]	c	-1.95 [0.000]
P_{t-1}	0.65 [0.000]	W_{t-1}	0.51 [0.000]	fw_{t-1}	0.72 [0.000]
ΔP_{t-1}	0.41 [0.001]	ΔW_{t-1}	0.31 [0.016]	Δfw_{t-1}	-0.20 [0.148]
ΔP_{t-2}	-0.15 [0.067]	ΔW_{t-2}	0.32 [0.012]	$\mu_t - \pi_t$	2.79 [0.000]
W_t	0.35 [*]	P_t	0.45 [0.000]	μ_{t-1}	-1.93 [0.011]
pr_t	-0.25 [0.000]	M_t	0.04 [*]	Δpr_t	4.14 [0.020]
Δpr_t	-0.21 [0.023]	u_t	-0.65 [0.001]	$pr_{t-1} - w_{t-1}$	4.90 [0.000]
Δpr_{t-1}	-0.27 [0.004]	Δu_t	0.20 [0.214]		
Δk_t	0.79 [0.002]	Δu_{t-1}	0.42 [0.032]		
$cons_t$	-0.35 [0.158]	pr_t	0.32 [0.001]		
$cons_{t-1}$	0.80 [0.000]	oil_t	0.01 [0.018]		
gov_t	0.29 [0.054]				
fd_t	0.52 [0.029]				

(*) restricted coefficient for no money illusion in the long-run.
p-values in brackets; Δ denotes the difference operator;

The employment equation reflects a standard downward sloping labour demand curve with a long-run wage elasticity equal to -0.72. Since this is below unity in absolute value, wage increases are not fully translated into employment reductions. Real balances, capital stock and productivity shift the labour demand outwards and enhance employment, at a given wage, with long-run elasticities ranging from 0.32 to 0.40. Finally, indirect taxes have the expected negative influence.[20]

In the labour force equation, wages have an overall negative influence on labour supply decisions, while the tax variables display a positive coefficient. The traditional justification of the influence of wages via the relative weight of the income and substitution effects is

[20] Although this variable is not statistically significant at conventional levels, it improves the overall specification and diagnosis of the equation.

unsatisfactory at the macro level. Nevertheless, Lin (2003) shows that when working hours and work effort are treated as different variables (unlike in the textbook classical model) two substitution effects may arise and explain a backward-bending labour supply. This is related with the impact of taxes on labour supply decisions in a labour market, such as the US one, where a large share of workers possess a slim income share. In this case, better wages allow a reduction in the supply of labour, while higher taxes harden the economic conditions of households and force them to supply more work.[21]

The performance of the stock market enters the labour force equation with a small coefficient and the expected negative sign. This is along the lines of Phelps (1999), who was the first to draw attention to the role played by financial wealth in the US labour market. Finally, unemployment discourages participation, while working-age population (capturing demographic and migration influences) indicates that population has a positive effect on labour supply.

Table 3: Labour demand and supply, and productivity. US, 1963-2005.

Dependent variable: n_t	coef. [probs.]	Dependent variable: l_t	coef. [probs.]	Dependent variable: pr_t	coef. [probs.]
c	2.89 [0.004]	c	-1.52 [0.014]	c	3.11 [0.167]
n_{t-1}	0.75 [0.000]	l_{t-1}	0.69 [0.000]	pr_{t-1}	0.64 [0.000]
w_t	-0.18 [0.033]	w_t	0.05 [0.299]	n_t	-0.21 [0.062]
$M_t - P_t$	0.09 [0.001]	w_{t-1}	-0.10 [0.009]	k_t	0.19 [0.107]
k_t	0.10 [0.058]	τax_t^{ss}	-0.21 [0.452]	Δk_t	1.38 [0.000]
Δk_t	1.66 [0.000]	τax_{t-1}^{ss}	0.74 [0.009]	Δk_{t-1}	-1.50 [0.000]
Δk_{t-1}	-1.33 [0.000]	tax_t^d	0.15 [0.011]	Δk_{t-2}	0.54 [0.055]
pr_t	-0.16 [0.112]	tax_t^i	-0.55 [0.034]	oil_t	-0.01 [0.005]
pr_{t-1}	0.24 [0.034]	tax_{t-1}^i	0.61 [0.026]	t	-0.07 [0.896]
tax_t^i	-0.50 [0.353]	fw_t	-0.01 [0.001]	t^2	0.007 [0.065]
		u_t	-0.27 [0.000]		
		z_t	0.40 [0.000]		
		Δz_t	0.47 [0.004]		
		Δz_{t-1}	-0.23 [0.061]		

p-values in brackets; Δ denotes the difference operator.

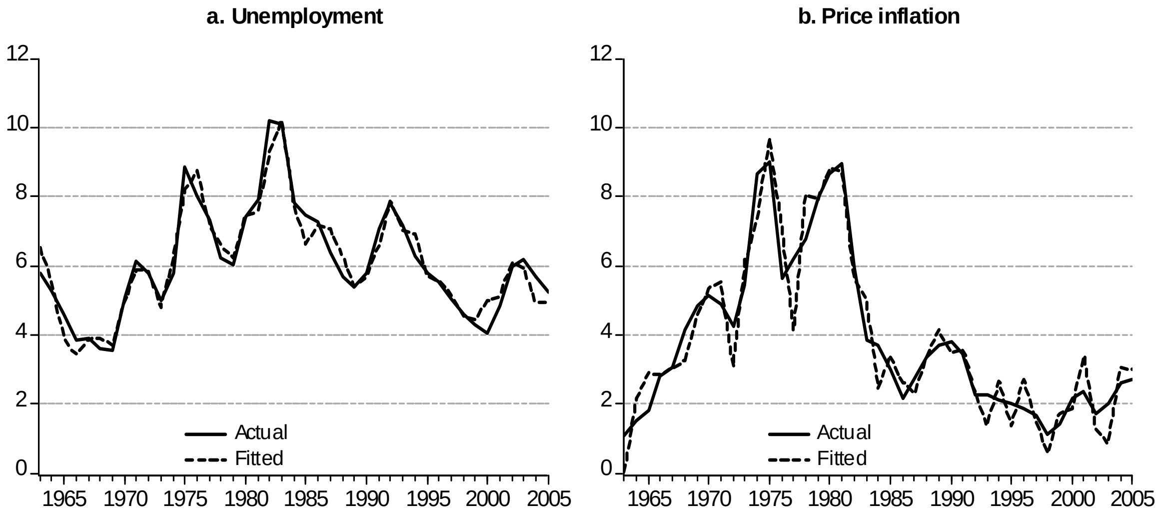
The last equation models productivity as a function of the standard production factors. Thus, labour productivity depends negatively on employment, and positively on capital stock availability and quicker technological change (proxied by time trends). The negative elasticity of oil prices accounts for the influence of raw materials, an often overlooked production factor. The "global" long-run semi-elasticity of unemployment with respect to oil

[21] This situation of regressive taxation fits with the evidence provided by Hamermesh (2006) on low paid employees and over-time work. In particular, he points to the disproportionately amount of work performed in the US 'by low-wage workers, at unusual times - evening/nights and weekends.'

prices, obtained by the IRFs of the system, is 0.014 - a 1% increase in oil prices leads to a 1.4 percentage points increase in the unemployment rate.

Figure 1 displays the actual and fitted values of the unemployment and inflation rates. Note that our estimated model tracks the data very well, despite its relatively large size and the plethora of feedback mechanisms.

Figure 1. Actual and fitted values



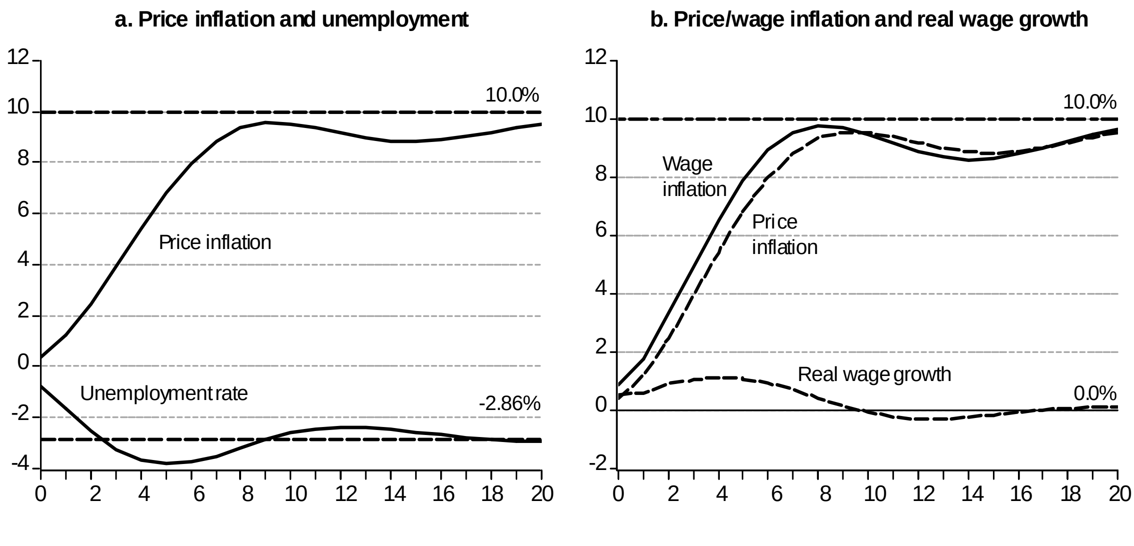
4 The Long-run Phillips Curve Tradeoff

In what follows, we describe monetary policy in terms of the growth rate of the money supply (μ_t). This has an obvious advantage when examining the long-run Phillips curve: to identify different points on the long-run Phillips curve, we need to identify different long-run inflation rates and these are associated with different long-run money growth rates. In the literature, for example, Cooley and Hansen (1989), Cooley and Quadrini (1999), Chari, Kehoe, and McGrattan (2000), and Mankiw and Reis (2002) assume that the monetary policy shock is the error in the time series representation of money growth.

We regard money growth as a better indicator of the overall monetary conditions than the federal funds rate, since it reflects not only the level of the yield curve (i.e. short-term interest rate), but also its slope (i.e. spread) and curvature (i.e. relative spread). It is widely accepted that the shape of the yield curve is influenced by expected future spot rates which, in turn, are influenced by monetary policy. For example, the higher spreads of the 1980s were accompanied by a monetary contraction (a decrease in money growth). In the second half of the 1990s the funds rate was relatively stable, while the flattening of the yield curve was associated with a monetary expansion. Furthermore, increases (decreases) in the short-term rate do not always translate to monetary contractions (expansions). For example, the increase in the fund rate from 3% in 1993 to 6% in 1995 was associated with an increase in money growth from 1.5% to 4%, and robust economic growth. Finally, money growth captures the fluctuations in the liquidity of the market. For example, after the 1987 stock market crash, the Fed provided additional reserves to the banking system to prevent a liquidity squeeze (Taylor, 1993). Following the 1988-89 crisis in the savings and loan (S&L) industry, banks restricted their lending to conform to new regulations that would minimise the chances of another crisis and bailout in the future. The Fed's decision to treat long-term government bonds as if they were perfectly safe (despite their high sensitivity to interest rate changes) encouraged banks to invest in these bonds rather than lend to business, and thus further precipitated the 1991 recession (Stiglitz, 2003, p. 40).

In accordance with the aim of this paper we evaluate the effects of monetary policy on unemployment and inflation. In particular, we evaluate the slope of the Phillips curve by introducing an unanticipated permanent shift in money growth, say from 0 to 10% at $t = 0$, and simulating the empirical model until the variables stabilise in the long-run.[22] The inflation and unemployment IRFs are plotted in Figure 2a. In accordance with stylised facts (see, among others, Mankiw 2001), the responses are delayed and gradual, with unemployment adjusting faster than inflation. Furthermore, as shown in Figure 2b, wage inflation adjusts faster than price inflation and the real wage growth rate is procyclical.

Figure 2. Impulse response functions to a permanent increase in money growth



Due to money neutrality, price (and wage) inflation stabilises at 10% in the long-run. The only unconventional feature of the IRFs is that the unemployment effects of the monetary shock do not dissipate with the passage of time. Instead, unemployment decreases by 2.86

[22] Since the residuals of our structural model are uncorrelated with changes in money growth, we are justified to assume that there are no other shocks to the model. Note that this is the counterpart of the standard assumption in vector autoregressions (VARs) of zero covariances between the structural innovations.

percentage points in the long-run, implying that the long-run slope of the PC is $\frac{10}{-2.86} = -3.5$. This is in line with the long-run slope of -3.66 that Karanassou, Sala, and Snower (2005) found using a three-equation model for the US from 1966 to 2000.

We should also point out that Karanassou, Sala and Snower (2007) demonstrate the robustness of the finding of a downward-sloping PC in the long-run by assessing the popular alternative methodologies of the generalised method of moments (GMM) and structural vector autoregressions (SVARs) vis-à-vis the above econometric methodology of structural modelling. They apply the GMM and SVAR econometric techniques to a semi-annual dataset covering the same period (1963-2005) and find that the long-run inflation-unemployment tradeoff is close to the one obtained via our structural modelling methodology.

5 A Reappraisal of the Roaring Nineties

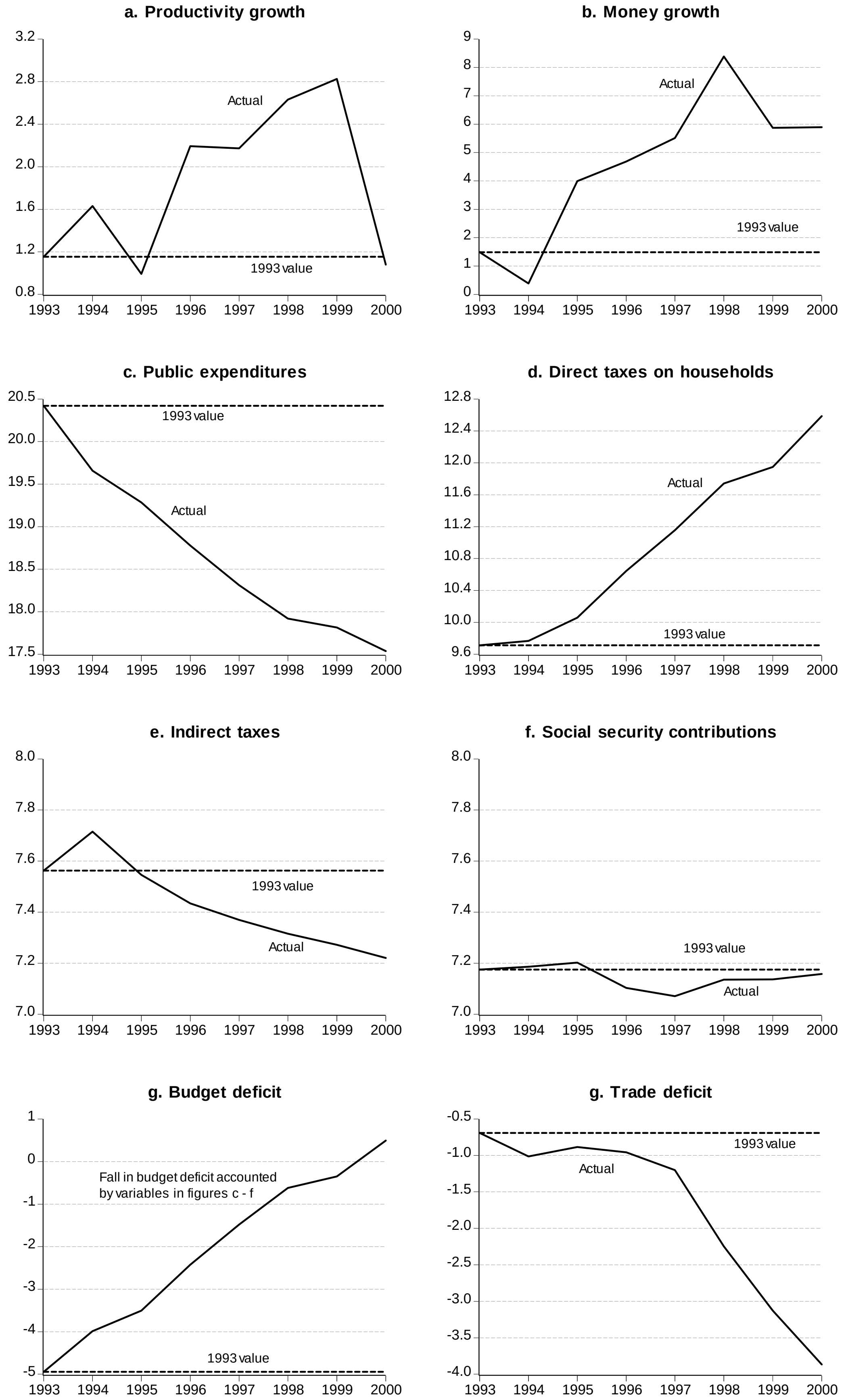
The literature has focused on two main explanations of the roaring nineties: (i) low inflation expectations (given the strong emphasis placed on inflation control by the Fed in the 1980s) together with a declining time-varying NAIRU; and (ii) the New Economy (i.e., the extensive and intensive development of information and communication technologies), that would explain the fast productivity growth witnessed in the 1990s and the resulting inflation deceleration.[23] In addition, the discretionary monetary policy by Alan Greenspan has been widely appreciated (see Friedman, 2006, and Phelps, 2006).

In this section we use the above estimated model to reappraise the roaring nineties and explain the absence of inflationary pressures (inflation was hovering around 2%) in the face of a rapid unemployment decline (unemployment fell from around 8% to 4%). In particular, our analysis examines the influence of higher productivity growth, increase in money growth, contractionary fiscal policy, and explosion of the trade deficit on the unemployment and inflation trajectories from 1993 to 2000. We evaluate the contributions of each of these factors by plotting the actual series of inflation (unemployment) against its simulated series obtained by fixing each specific factor at its 1993 value (see Figure 3). The disparity between the actual and simulated series of inflation (unemployment) measures the dynamic contribution of the specific factor to inflation (unemployment).

Our analysis indicates that higher productivity growth, the monetary expansion, a fiscal policy aiming at reducing the public deficit, and the rising trade deficit significantly contributed to prevent an inflation upsurge without seriously damaging employment.

[23] Along these lines, Gordon (1998) provides a list of candidates responsible for the decline in the NAIRU; Staiger, Stock and Watson (2002) discuss the right estimate of the NAIRU in the second half of the 1990s; Ball and Moffit (2002) focus on the effects of productivity growth on the Phillips curve; Greenspan emphasized on many occasions that the New Economy was bringing with it a new era of productivity increases (Stiglitz, 2003, p. 66).

Figure 3. Actual and 1993 values of the exogenous variables

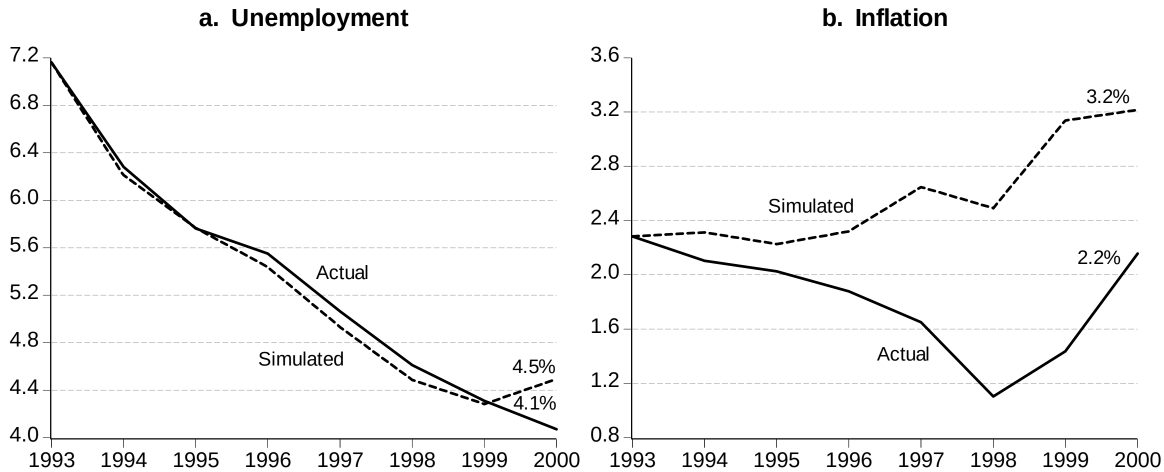


5.1 Productivity Growth

The role that the increase in productivity growth played on the positive performance of the US economy has received great attention in recent years. For example, Ball and Moffit (2002) argue that this increase caused a favourable shift of the Phillips curve. According to Blinder and Yellen (2002), the rise in productivity growth is a key supply-side shock. Although Staiger, Stock and Watson (2002) support the view that a declining NAIRU is the driving force of the roaring nineties, they also argue that the higher productivity growth led to a shift in the PC.

As Figure 3a shows, productivity growth increased from 1.1% in 1993 to 2.8% in 1999 with the break in its trend occurring in 1995-96.[24] According to Blinder and Yellen (2002, p. 62), the rise in productivity growth was mainly due to (i) the increased productivity of the computer industry, (ii) capital deepening, i.e. the expanded use of computers in the economy, and (iii) advances in information technology, boosting productivity in the computer intensive sectors of the market.

Figure 4. Contributions of productivity growth



Note: Simulated series are computed by keeping productivity growth constant at its 1993 rate.

Despite productivity being an endogenous variable in our model, we account statistically for the effects of productivity growth by holding it constant at its 1993 value in the simulated model and comparing the resulting time paths of inflation and unemployment with the time paths associated with the actual time series of productivity growth. Needless to say, this is simply an accounting exercise and it should be interpreted with caution. The actual and simulated series of unemployment and inflation are plotted in Figure 4. Observe that, the productivity increase put substantial downward pressure on inflation - had productivity

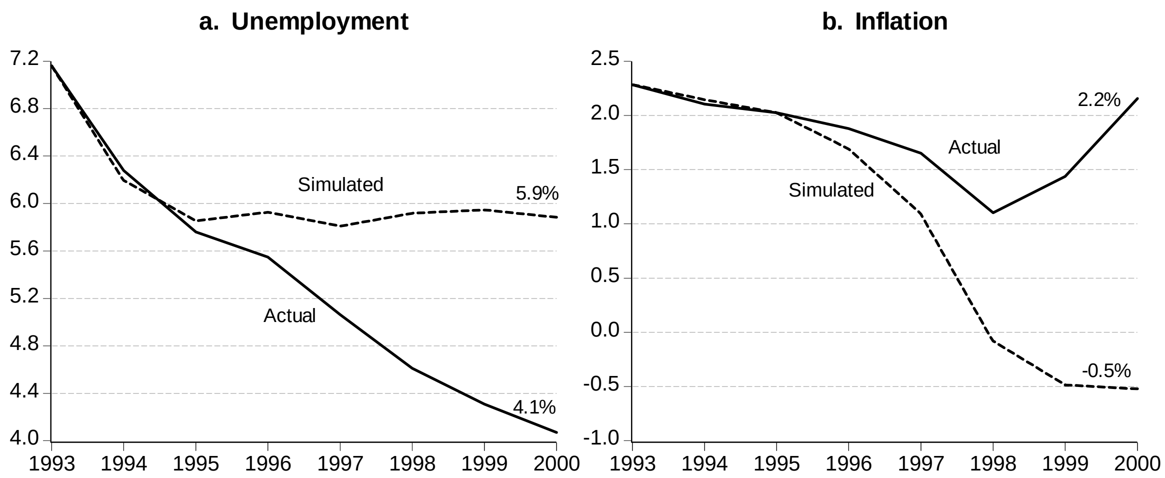
[24]See also Blinder and Yellen (2002, p. 59).

growth remained at its 1993 value, inflation would have reached 3.2% in 2000, instead of the actual 2.2%. In addition, a modest reduction in unemployment took place by the end of the decade (unemployment would have risen to 4.5% in 2000 instead of the realised 4.1%).

5.2 Monetary Policy

Money growth rose steadily from 1.5% in 1993 to 8.4% in 1998 to read almost 6% in 1999-2000 (see Figure 3b). The monetary expansion of the 1990s substantially reduced unemployment and put upward pressure on inflation.[25] As shown in Figure 5, had money growth stayed at its 1993 value, unemployment would have remained approximately constant and close to 6% 1995 onwards. In turn, the growth of prices would have declined attaining a situation of deflation at the end of the decade. In short, the contributions of money growth and inflation amounted to a fall of approximately 2 percentage points in unemployment, and a rise of around 3 percentage points in inflation.

Figure 5. Contributions of monetary policy



Note: Simulated series are computed by keeping money growth constant at its 1993 rate.

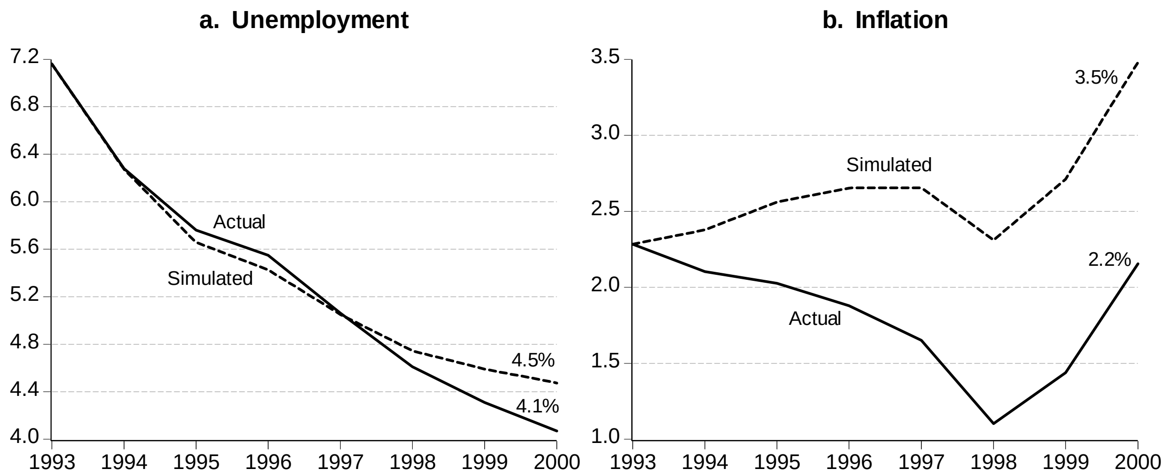
Conventional macro models - built on the assumption that the Phillips curve becomes vertical once inflationary expectations and nominal contracts have adjusted to actual inflation - have had difficulty explaining why monetary policy should have had a significatn influence on US unemployment in the 1990s. Our model does so by suggesting that the substantial influence stems in part from a long-run relation between unemployment and money growth. Yet the flip side of this favorable development, as mentioned, was an associated threat of increased inflation. Our analysis indicates that two powerful forces contributed to push inflation down: (i) fiscal policy aiming at reducing the public deficit and (ii) the rising trade deficit.

[25] Blinder and Yellen (2002, p.12-13) refer to the monetary expansion by saying that '...until February 1994...the real funds rate was kept around zero for about a year and a half - providing an extraordinary dose of easy money' and argue that this 'is important to understanding what made the 1990s roar.'

5.3 Fiscal Policy

The budget deficit was balanced in the Clinton years to increase again in the early 2000s. In 1993 it was 4.9% of GDP (it had reached a maximum of 5.8% in 1992) and continued to fall steadily, turning into a budget surplus by the end of the decade (see Figures 3c-g). The reduction of around 6 percentage points in the budget balance over the 1993-2000 period was achieved by reducing government expenditures and increasing direct taxes by approximately 3 percentage points each, so that, as Stiglitz (2003, p. 48) put it 'The cost of adjustment would be shared.' (Indirect taxes and social security contributions as percentage of GDP remained approximately constant during that period.) According to Blinder and Yellen (2002, p. 16), the deficit reduction program was put forward to prevent the occurrence of a financial calamity (mostly feared by Wall Street), and thus "saving jobs". The spirit of this policy was essential anti-Keynesian, since it aimed at increasing employment by cutting government expenditures and raising taxes.

Figure 6. Contributions of fiscal policy



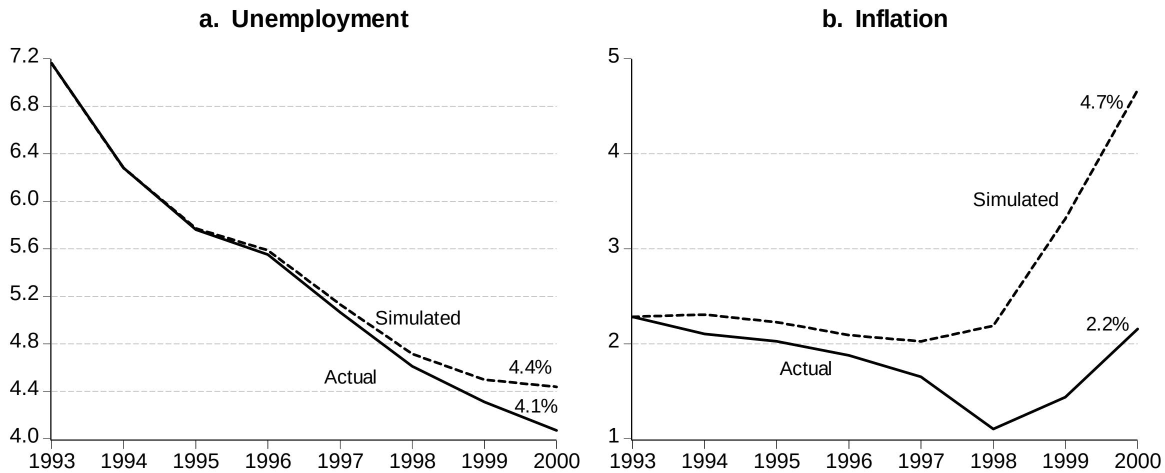
Note: Simulated series are computed by keeping direct taxes, indirect taxes, social security contributions and public expenditures constant at their 1993 values.

Our analysis shows (see Figure 6) that closing the budget gap put substantial downward pressure on inflation without leaving a heavy footprint on the unemployment rate. (Recall that the simulated series in Figure 6 were obtained by assuming that the budget deficit had remained at its 1993 value until 2000.) In other words, deficit reduction *per se* was not responsible for the economic recovery witnessed during the 1990s. However, it is widely accepted that the deficit reduction led to lower long-term interest rates which, in turn, contributed to the monetary expansion experienced throughout the decade. As shown in Figure 5, it was the resulting increase in money growth that paved the way for creating jobs. Our findings support Stiglitz (2003, p. 42) who argues that 'By lowering the deficit, the Clinton administration ended up recapitalizing a number of American banks; it was this inadvertent act, as much as anything, that refueled the economy.'

5.4 Trade Deficit

The trade deficit is a standard feature of the US economy: from 1960 to the mid 1990s the gap between exports and imports as a percent of GDP was fluctuating around -1% (see Figure 3h). In the second half of the nineties, however, and in particular after the 1997 East-Asian crisis, it started to increase steadily reaching 3.9% in 2000. As shown in Figure 7, the larger trade deficit, similarly to the budget deficit reduction, put substantial downward pressure on inflation without affecting much unemployment. Note that the substantial decrease in inflation essentially takes place after the 1997 East-Asian crisis. This result is in line with the perception of the average business person that the relatively low inflation rates experienced in recent years are due to cheap imports from the Far East and Eastern Europe (Bean, 2007). Furthermore, the negative relationship between openness (measured by the ratio of imports to GDP) and inflation is well documented in the literature (e.g. Temple, 2002).

Figure 7. Contributions of trade deficit



Note: Simulated series are computed by keeping exports minus imports as % of GDP constant at its 1993 value.

Overall, the simulations in Figures 4-7 indicate that the decrease in the budget deficit and the increases in productivity growth and the trade deficit kept inflation low while the economy was operating at relatively low unemployment rates. In contrast, several policy makers and academics have argued that this was due to higher levels of education, weaker unions, a more competitive marketplace, increased productivity, and a slower influx of new workers (see, for example, Stiglitz, 2003, p. 72).

6 Conclusions

In this paper we examined the implications of frictional growth for the inflation-unemployment tradeoff. In the context of a simple theoretical macro model, we examined how a long-run tradeoff can arise from the interaction between money growth and various nominal frictions.

Along these lines, we constructed an empirical macro-labour model for the US spanning the 1960-2005 period, and consisting of wage and price setting equations on its nominal side, and labour demand and supply, productivity, and financial wealth equations on its real side. Our approach jointly determines the driving forces of inflation and unemployment. The estimated model is used to evaluate the inflation-unemployment tradeoff, and appraise the performance of the US economy during the roaring nineties.

Our findings can be summarised as follows. First, a permanent shift in money growth generates hump-shaped IRFs, in line with stylised facts, and a downward-sloping long-run Phillips curve with a slope of -3.5.

Second, we carried out accounting simulations of our empirical model over the 1993-2000 period to measure the contributions of the various factors to the evolution of inflation and unemployment during these years. We found that, by 2000, (i) the increase in productivity growth was responsible for a 1 percentage point (pp) fall in inflation and a 0.4 pp fall in unemployment, (ii) the increase in money growth generated a 2.7 pp increase in inflation, and a 1.8 pp decrease in unemployment, (iii) the virtual elimination of the budget deficit led to a 1.3 pp fall in inflation and a 0.4 pp fall in unemployment, and (iv) the deterioration of the trade deficit decreased inflation by 2.5 pp, and unemployment by 0.3 pp. It is important to note that the impacts of productivity growth, budget and trade deficits on unemployment were only manifested after 1997.

In a nutshell, the increase in money growth put upward pressure on inflation and substantially lowered unemployment. On the other hand, the rise in productivity growth, the budget deficit reduction, and the increase in the trade deficit put downward pressure on inflation and had a modest impact on the unemployment rate. The resulting low unemployment and subdued inflation rates characterize the "roaring nineties". Although the New Economy played a role, it is not the sole - or even dominant - contributor to the fabulous performance of the US economy during the nineties. Our analysis can effectively explain what Stiglitz (2003, p. 44) describes as ‘a lucky mistake - a right decision made for the wrong reasons’, and Blinder and Yellen (2002, p. 23) call ‘an unusual coincidence of timing and policy...this is not a formula that can be repeated at will.’

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