

Does the Central Bank Set the Natural Rate of Unemployment?

Theoretical Considerations on Wage Policies for the Transmission Mechanism of Monetary Policy

by Stefan Collignon

Introduction

Will the first action of the European Central Bank consist in rising or lowering interest rates? In this paper I will not even try to guess. Instead I will set out a theoretical argument under what conditions an independent central bank which is committed to maintain price stability will be able to cut or be obliged to rise interest rates.

Monetary orthodoxy seems to agree today that "Government normally inflates in order to achieve real objectives" (Cukierman, 1992, p. 17) . The strategic interactions between nominal wage setters and a monetary authority that cares about *both* employment and price stability create excessive inflation without having any effect on the level of employment (Barro and Gordon, 1983). By delegating authority to an independent central bank which cares "primarily" about price stability, the inflation bias can be reduced without having an effect on average employment. Such arrangement is therefore welfare improving (Rogoff, 1985).

This theoretical approach has been translated into the Statute of the European System of Central Banks (ESCB) which stipulates in art. 2 and in art. 105 (1) of the Treaty on the European Union (TEU) that "the primary objective of the ESCB shall be to maintain price stability". Such prioritisation has occasionally been interpreted as precluding the ECB from addressing any other policy objectives (e.g. Crawford, 1996, p. 236). However, the same article of the ESCB statute insists that "without prejudice of the objective of price stability, it¹ shall support the general economic policies in the community with a view of contributing to the achievement of the objectives of the Community as laid down in article 2 of this Treaty." This latter article states that by establishing an economic and monetary union, the European Community shall have as its task "...sustainable and non-inflationary growth..., a high level of employment and of social protection, the raising standard of living and quality of life..."

Thus, the Treaty of Maastricht clearly sets real economy objectives for EMU, subject, of course, to the maintenance of price stability. An efficient monetary policy by the ECB would have to *maximise economic growth and employment under the constraint of stable prices*. Violating the constraint will be a disqualifying fault; but the bank's efficiency will be measured by real factors like economic growth and the unemployment rate. This is not exactly the same as the usual model

¹ the ESCB

where a central bank is concerned with *both* price stability and high unemployment and aims to minimise the cost of excess unemployment and excess inflation. In fact, if price stability is viewed as a binding constraint, there can be no trade-off between inflation and output, nor between their fluctuations.

This view of a central bank's tasks stands in the context of a familiar issue of economic theory: how are price inflation and real economic activity connected? A related question concerns the monetary transmission mechanism: how much will a tightening or relaxing of interest rates by the central bank affect inflation and output? Empirical studies usually produce large ideosyncratic variations between countries (Dornbusch et al. (1998) and they are often interpreted as obstacles to an efficient functioning of European Monetary Union. However, what is missing from the debate is a theory capable of explaining the structures within the "black box" of the monetary transmission mechanism. This paper attempts to contribute to such a theory.

In the early days of Phillips-curve-economics a trade-off between price stability and unemployment was widely assumed. Recently, evidence of an inverse connection between inflation and growth has emerged (Gylfason and Herbertson, 1996) although it is far from clear that this applies also to very low rates of inflation. However, since Milton Friedman's (1968) presidential address, the professional consensus has agreed that at least in the long run monetary policy is neutral. The average level of employment - or the natural rate - is determined by conditions in the labour market and other "structural" factors, while in the short-run there is a trade-off in output-inflation variability. The standard "accelerationist" doctrine claims that if the supply-demand balance in the economy deviates from the "natural" equilibrium, inflation will accelerate or fall depending on the economy's tightness or slack. Monetary policy can only choose between different amplitudes of inflation fluctuation versus fluctuations in real GDP (Taylor, 1979). The growth of monetary aggregates will have no impact on economic activity and employment, but only result in an increase of inflation.

From this orthodox point of view, the efficiency margins of the ECB's policy actions would be rather small. For if the objective to keep prices stable is interpreted to cover both, the level and the variance of the inflation rate, European output variability would have to be high and the level of *average* unemployment would be determined by the sacrifice ratio required to bring inflation down. This poses a dilemma for the ECB. High labour market "flexibility" is often cited as a necessary condition for a permanent reduction of average unemployment in Europe², and the suggested reforms focus on measures that reduce social benefits and real wages. However, such policies stand in conflict with the Treaty on European Union's (TEU) article 2 which requests "a high level of employment *and of social protection*". Under these circumstances, the European Central Bank may not be perceived as "efficient" and the European public may not develop the kind of consensus which backed the Bundesbank's commitment to price stability and which may have been the foundation of its success (Issing, 1997).

Yet, monetary developments in the 1990s have started to raise some doubt about the orthodox model (Galbraith, 1997). In the United States unemployment seems to have fallen below the natural rate for some considerable period of time without inflation having shown any significant

² See for example IMF, 1998.

rise. This fact can be interpreted as a fall in the natural rate and has led to the construction of time-varying NAIRU models (Gordon, 1996). Although moderate shifts in the non-accelerating rate of unemployment may still appear reasonable in the US case, the large fluctuations in Europe seem totally arbitrary (Collignon, 1998; Solow in: Solow and Taylor, 1998). Furthermore, for monetary policy time-varying NAIRU models pose two difficulties: First, if there is a rate of unemployment, below which inflation accelerates, and if the exact position of this natural rate is uncertain and moving, what would be the appropriate policy response by the central bank to a transitory increase in inflation? Could it not lead to an overly restrictive monetary policy which by itself would keep the average rate of unemployment higher than necessary? Secondly, if the average rate of unemployment is affected by monetary policy, then the natural rate cannot be posited as completely exogenous and the neutrality hypothesis would not even apply in the long run. These questions are important for the conduct of monetary policy, given that most monetary policy rules such as setting targets for money supply or following Taylor interest rate rules are based on the accelerationist model. They would break down if the natural rate is itself endogenous to monetary policy.

These difficulties are compounded in Europe by the uncertainties of the transition to European Monetary Union. Because of changes in the degree of openness, financial structure and wage bargaining institutions, the effects of a unified European monetary policy may be different from the simple weighted average of 11 national policies. (Dornbusch et al, 1998). I will not dwell on these transition problems in this paper. Instead, I wish to focus on the long term effects of monetary policy for economic growth and employment and the mechanism through which monetary policy is transmitted to the real economy over the long run. As Modigliani (1963) pointed out, changes in interest rates affect the economy through financial markets and wage settlements. In Collignon (1998b), I have taken a look at structural differences in European financial markets. In this paper I will focus on the wage setting channel of the monetary mechanism.

The rest of the paper is organised as follows: Section 2 establishes that the long-run equilibrium rate of unemployment is endogenous to monetary policy. Section 3 shows how the price level is determined by the nominal interest rate. Section 4 describes the monetary policy objective function based on a wage feedback mechanism. Section 5 concludes.

2. Determining the endogenous natural rate of unemployment

The idea of an equilibrium rate of unemployment at which inflation is stable has been derived from two strands of thought (Dixon, 1995). The older tradition of a "natural rate" originated in Chicago and focused on labour market equilibrium. The newer concept of a non-accelerating inflation rate of unemployment (NAIRU) has been developed by Layard, Nickell and Jackman at the LSE, putting the concept of non-accelerating inflation into the framework of labour markets with imperfect competition and focusing on wage bargaining. Although the latter version has permitted progress in empirical research, the theoretical implications of the two concepts are similar. They both work with an "accelerationist" model where imbalances of supply and demand in the economy as a whole, measured by the deviation of actual from potential output or actual minus

average unemployment, cause inflation to speed up or down. The equilibrium or neutral rate reflects a long run stationary state entirely determined by "real" factors like technology, population growth, preferences, labour market institutions etc. Monetary factors can cause temporary deviations from the long run equilibrium, but ultimately money is neutral in the system. This can be easily shown in the context of the Patinkin-Friedman-Phelps model of the natural rate³.

The natural rate reflects the equilibrium in the labour market where the real wage equals labour demand and supply. Contrary to Keynes who emphasized the role of nominal variables in the determination of equilibrium employment, Friedman's underlying idea is "classical" in the sense that *real* wages are assumed to adjust to equate the quantities of labour supplied and demanded⁴. But if the unemployment level is exclusively determined by labour markets, then goods prices and monetary policy, i. e. the other markets in the Walrasian general equilibrium, cannot influence output systematically. Hence, the aggregate supply curve is vertical and money is neutral. However, this result depends entirely on the way the labour market is modelled. To understand this, let us look at labour supply and demand curves.

The labour market equilibrium

The demand for labour is derived from companies seeking to maximise profits. Firms operate with a standard production function depending on labour (L) and capital (K) at a given technology (τ) such as:

$$(1) \quad y = tF(K, L) \quad \text{with } F_L > 0, F_K > 0, F_{LL} < 0, F_{KK} < 0, F_{LK} > 0$$

For further reference we also define labour productivity, i.e. the output per employee as:

$$(1a) \quad I = tf(k) \quad f'(k) > 0, \quad f''(k) < 0.$$

With $I = y/L$ and the capital intensity $k = K/L$. $f'(k)$ is the marginal product of capital per unit of labour. t reflects Hicks-neutral technology, where the capital intensity remains constant. Firms maximise short term profits by equalling the marginal product of labour at a given capital stock to real wages.

$$(2) \quad F_L(L) = \frac{W}{P}$$

So that,

$$(2a) \quad L_D = \Phi\left(\frac{W}{P}, K_t\right)$$

³ I have developed arguments similar to this paper in the context of the Layard-Nickell-Jackman (1991) model in Collignon, 1998

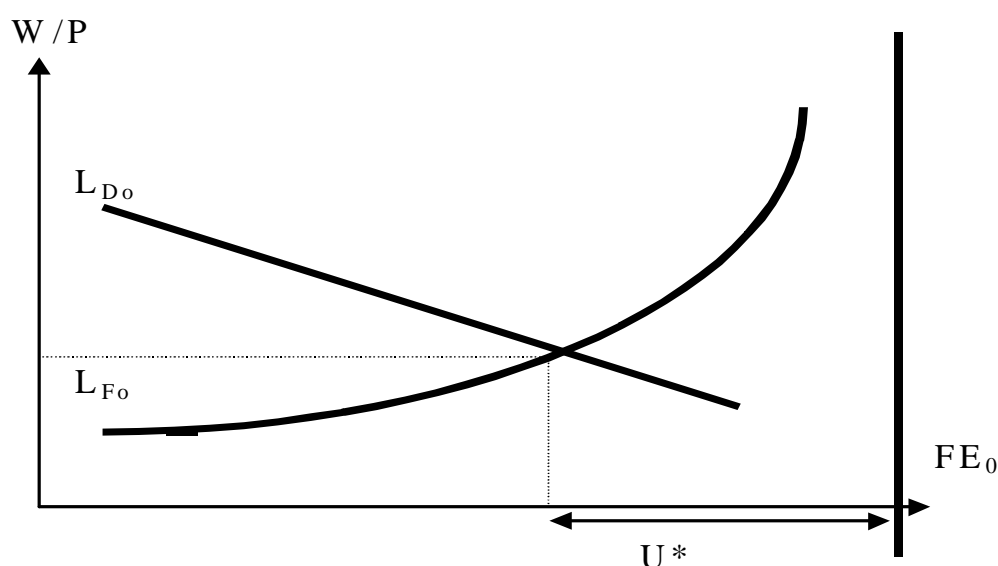
⁴ The idea of interpreting the real wage as the "price for labour" is, however, misleading. The real wage W/P is in fact the ratio of two nominal prices - that for labour and that for goods. Real wage flexibility with respect to employment would imply a systemic difference between the supply elasticity of labour and goods. This is not obvious. See also Flassbeck and Spiecker, 1998.

where W is the nominal wage and P the price level and K , the given capital stock. Equations (2) and (2a) define the quantity of labour demanded and the resulting demand curve is negatively sloped in the real wage-employment space. Next we look at labour supply. It is assumed to be an increasing function of the real wage and of a vector of shift parameters X :

$$(3) \quad L_s = j\left(\frac{W}{P}, X\right) \quad \text{with } \phi' > 0$$

The literature has produced a long list of factors which might shift the labour supply curve exogenously. Typically it includes population growth, the reservation wage, the replacement ratio, factors affecting the job match function, efficiency wages, trade union power, etc. Most of these items come under the name of labour market flexibility and are institutionally determined. The equilibrium rate of employment is where supply and demand meet as in **figure 1**. At that rate output is exclusively determined by technical factors and the aggregate supply curve is vertical in a price-output space. But because of search costs, efficiency wages, and other microeconomic distortions, the equilibrium employment and output level is supposed to be lower than full employment so that a given "natural" rate of unemployment is associated with a specific level of potential output⁵.

Figure 1



Unemployment can result from distortions or short term misperceptions of the real wage which would lead to temporary disequilibria from the natural rate or potential output. But any deviation of output or employment would bring about wage and price adjustments which push the real wage back into line with the marginal product of labour. Hence the natural rate is constant. This adjustment is described by the expectations-augmented Phillips curve, whereby workers are

⁵ Strictly speaking this natural unemployment is "involuntary" insofar as the labour supply curve reflects the part of the labour force that is willing to work. "Voluntary" unemployment could then be shown to the left of the Y-axis in figure 1.

interested in real wages and therefore take inflation expectations and unemployment (as a measure for labour market tightness) in consideration when bargaining for wage increases:

$$(4) \quad \dot{w}_t = \mathbf{a}_1 \mathbf{p}^e_t + f(u_{t-1}) \quad f_u < 0$$

were \dot{w} and \mathbf{p}^e stand for the rate of wage increases and the expected rate of inflation; u is unemployment. The coefficient \mathbf{a}_1 is a parameter for wage indexation which Friedman postulated to be equal to one.⁶ However, the actual real wage is identically equal to the rate of labour productivity (\mathbf{I}) times the wage share (\mathbf{s}) in income. Hence:

$$(4a) \quad \dot{w}_t - \mathbf{p}_t = \dot{\mathbf{I}}_t + \dot{\mathbf{s}}_{w_t}$$

where $\dot{\mathbf{s}}_{w_t}$ is the rate of change of the wage share. Inserting (4a) into (4) yields:

$$(4b) \quad \dot{\mathbf{s}}_{w_t} = f(u_{t-1}) - (\mathbf{p}_t - \mathbf{p}^e_t) - \dot{\mathbf{I}}_t$$

The natural rate hypothesis assumes that expected and actual inflation coincide and that the labour share (or its mirror the profit share) is constant. Thus, average unemployment is not related to the steady state inflation rate and no long term trade-off exists. Provided the labour share remains constant and productivity is exogenous, unemployment could only be reduced by "surprise inflation" which leads to accelerating inflation when expectations catch up. Under rational expectations, when the systematic prediction error is zero, unemployment could only fluctuate around the natural rate with the unanticipated price error (Sargent, 1973). Under these circumstances, there is a trade-off between inflation and unemployment only in the short run. If monetary policy would aim to reduce unemployment by raising inflation, it will be neutralised by compensating wage increases. Consequently, in the long run the real wage would return to the equilibrium level and unemployment returns to the natural level. The central bank's only objective can and must be to keep prices stable.

Two restrictions are crucial in order to obtain the natural rate hypothesis. First, the wage share must be constant. If it were not, natural unemployment would be inversely correlated with the wage share. However, from the identity (4a) it is obvious that the wage share only remains constant when unit labour costs ($\dot{w} - \dot{\mathbf{I}}$) change in exactly the same proportion as inflation. But if unit labour costs are set by firms and workers and inflation is set by monetary policy, then the labour share and unemployment are not determined independently of monetary policy, even if rational expectations prevail. Of course, it is true that the labour share cannot rise or fall indefinitely. But if deviations from the steady state can be shown to be persistent, "natural" unemployment may well be time-varying and endogenous to monetary policy. What we would need is a theory of policy-endogenous variations of the mark-up (or profit share or real wages).

⁶ In the 1970's there was a large debate whether $\mathbf{a}_1 = 1$ can be empirically verified. It turned out that this is always the case with rational expectations. We will return to this below.

Secondly, the model is based on the behaviour of short term profit maximising firms which implies a constant capital stock. Under this condition, the level of the natural rate depends crucially on the shift parameters X . If they shift the labour supply curve to the left, structural or "natural" unemployment would rise. However, a vast amount of evidence (see for example OECD, 1994; Blanchard and Jimeno, 1995; Ball, 1997, Solow in Solow and Taylor, 1998) shows that although institutional shifts may explain some variations in the natural rate in the USA, it is impossible to explain the rapid and large increases in European unemployment by exogenous, structural changes in labour market institutions.⁷ Thus, it is tempting to search for endogenous factors at least in European unemployment trends. These factors need to explain shifts in the equilibrium rate of unemployment.

One approach incorporates wealth effects into the labour supply curve. If wealth includes real balances, we are back into a Keynesian world where money makes a difference, because real balances depend on prices. According to new Keynesians, the real effects of monetary policy will then be due to slow and partial adjustment of prices. But ultimately full adjustment will be reached and we obtain again (long term) money neutrality.

An alternative route has been taken by real business cycle (RBC) theories which assume that all prices adjust instantaneously and fully. This implies that the economy always finds itself on the labour supply curve and any fluctuation in employment is voluntary. Observed correlations between nominal and real variables reflect the response of monetary variables to real output and not the other way round. These models have the advantage that they introduce capital accumulation and interest rates explicitly into the labour supply function. Work effort, i.e. the short term supply function, depends on intertemporal substitution in labour supply: if today's wages increase relative to future income, households increase today's labour relative to future supply. Similarly, a rise in interest rates increases the attractiveness of working today and saving relative to working tomorrow. Here, the interest rate is considered as the intertemporal rate of substitution and *not* as a monetary policy instrument. However, because this (real) rate of interest is dependent on thrift and productivity, higher savings will reduce the interest rate. Thus, despite households' willingness to substitute their labour supply intertemporally, movements in technology and/or capital have offsetting effects on labour supply. Consequently, the labour supply curve can be assumed to be constant (Romer, 1996; p.161). However, the labour demand curve is not necessarily constant because capital accumulation or technology shocks shift the marginal product of labour and therefore also the supply curve (McCallum, 1989, p.193). Hence, equilibrium employment is not fixed, and the natural rate of unemployment varies with productivity shocks. In this case the accelerationist model of monetary policy breaks down because *any* rate of unemployment is "natural", while monetary policy is ineffective in achieving any real effects.

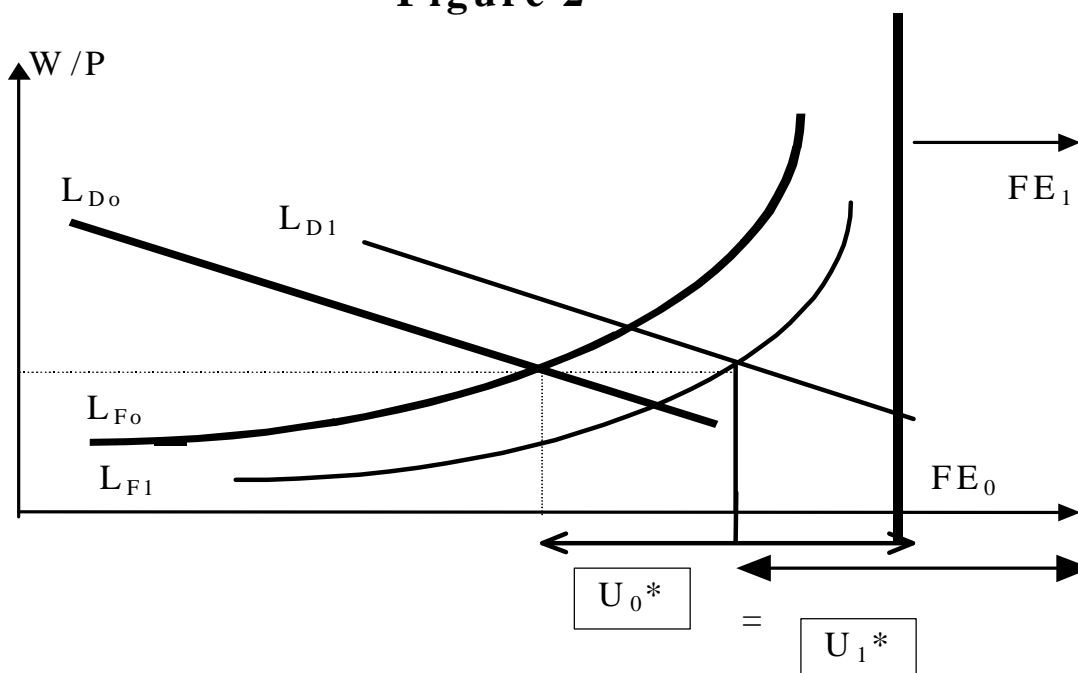
An important criticism of RBC-models is that technology shocks are postulated but not explained, and that observed evidence only conforms partially to theory, if at all (Mankiw, 1989). Furthermore, the intertemporal substitution of labour supply is a short term phenomenon, while

⁷ It has also been noticed that progress has been made with labour market reforms in Europe, but no significant impact on structural unemployment has been observed. Maybe this is so because action has not been sufficient, as the OECD (1998) and IMF claim. But it could also follow from an inadequate explanation model.

little is said about long term factors (Barro and Grilli, 1994). In fact, the so-called neutrality of money is often obtained because the short term production function is extrapolated into the long term. This is clear when we refer back to the production function (1). By definition the capital stock is constant in the short term and variable in the long term. Hence, over time the marginal product of labour and the real wage are a function of investment. Thus, explaining the "natural" rate requires an assessment of capital accumulation on labour supply and demand. In the following we will assume, in line with orthodoxy, that labour and profit shares remain unchanged in equilibrium. Changes in real wages therefore reflect changes in labour productivity. We also neglect exogenous shift parameters such as the reservation wage etc. The long term evolution of the natural rate depends now on the mode of capital accumulation. We can distinguish two polar cases where the natural rate of unemployment remains unchanged. The first pole is a Hicks-neutral steady state growth equilibrium, the second reflects growing capital intensity. However, in all intermediary cases, employment is constrained by investment and the natural rate is undetermined.

1. If the capital stock grows at the same rate as the labour force, capital intensity stays constant. Labour productivity and the real wage also remain unchanged (see equation (1a) and (2)), unless wage bargaining disturbs the income distribution (4a)⁸ Thus all three, the labour demand and the supply curve and the full employment level move to the right, because both the capital stock and the labour force grow at the same rate (see **figure 2**). Hence, the natural rate remains stable, despite rapid growth in the labour force and capital stock. This is the stylised fact of the US-labour market.

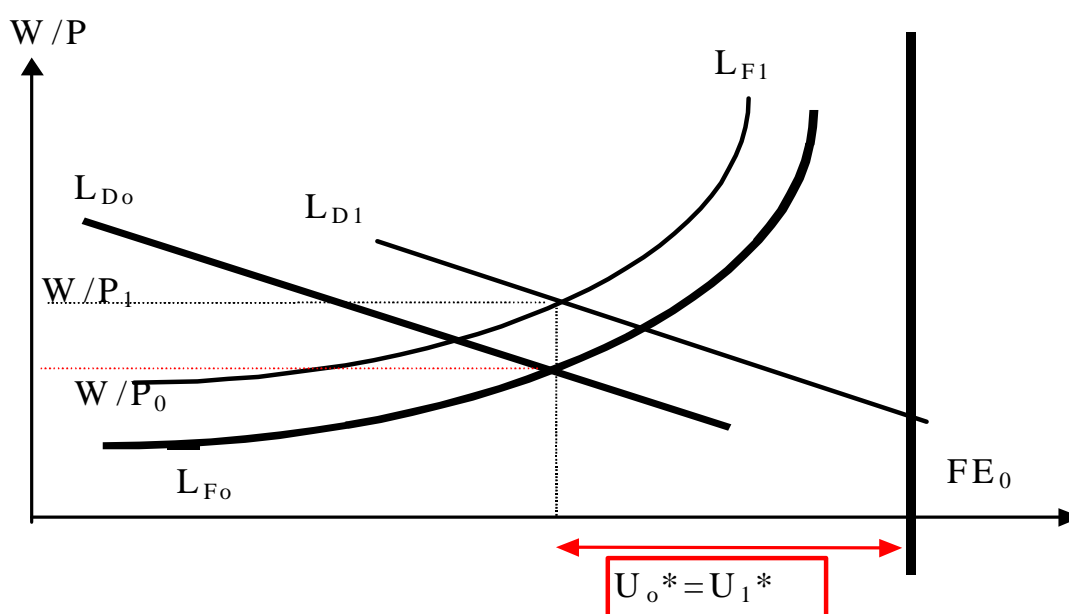
Figure 2



⁸ We abstract from Hicks-neutral progress, i.e. $\Delta t = 0$.

2. Alternatively, assume all investment is used to increase the capital intensity of production, while the labour force remains unchanged. Thus labour productivity and the real wage rise. The labour demand curve is shifted upward by the increase in the capital stock. Whether equilibrium unemployment is also affected depends on the labour supply curve. If labour productivity is expected to change permanently, as it would if the capital intensity increases, and the labour share remains constant, then the real wage would also increase for any amount of labour supply. In other words, as they get wealthier households prefer leisure to working and the L_S -curve shifts up. Thus again, the equilibrium rate of unemployment is unchanged (see **Figure 3**).

Figure 3



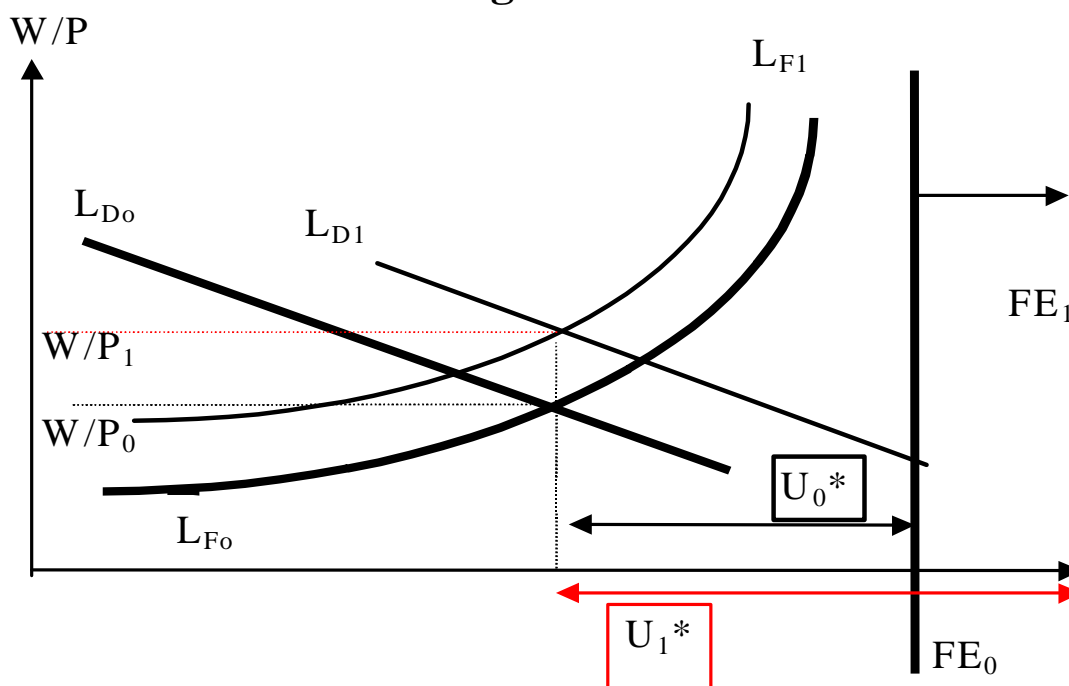
3. Next assume the intermediary case, where the labour force increases, but also capital intensity. In this case employment is constrained by investment. In order to keep the natural rate constant, investment would have to be sufficient to accommodate both, a growing labour force *and* a growing capital-labour ratio. Thus, employment growth depends on the investment function. We will formalise this idea below. **Figure 4** shows the marginal case, where all investment is used to rise capital intensity and productivity, while the labour force grows from FE_0 to FE_1 . The natural rate of unemployment increases by the same amount.⁹

Given that this case reflects a growth disequilibrium or non-steady-state, the question arises why the capital intensity increases. A simple answer is that the economy operates below the production-possibility frontier, so that catch-up growth to a higher capital stock per worker is

⁹ This statement does not imply that the rise in productivity is "bad" or responsible for unemployment, but simply that the rate of investment is insufficient for absorbing the growing labour force. In fact the productivity increase is "good", because Pareto-improving.

Pareto-optimising.¹⁰ It is sometimes argued¹¹ that capital intensity and productivity rise because of distorted incentives. Capital is substituted when wage costs are "too high" relative to capital costs. However, we have explicitly eliminated this argument by assuming that the capital and labour shares remain constant. Furthermore, it is hard to find any empirical evidence for the labour substitution model. If anything, the labour share has fallen in Europe since the early 1980, when unemployment started to rise. Also, in Collignon (1998a) I have not been able to verify the claim that wage pressure increases capital intensity. Therefore catch-up growth seems a better explanation for Europe's and Japan's rising capital intensity. **Figure 5** shows the important European convergence to US-levels of capital intensity between 1960 and 1990. The capital-labour ratio grew much more rapidly in Europe than in the United States, although the difference in capital per employee (converted into ecu at purchasing power parity) was still significant in 1990 - except in Germany and France. On the other hand, as **table 1** shows, the labour force grew more rapidly in the US than in Europe, but so did employment. In Europe capital accumulation was insufficient to absorb the growing labour force into production, so that unemployment rose. In Japan, on the other hand, both capital intensity and employment grew because investment was high.

Figure 4



It follows from this analysis that the mode of capital accumulation has far reaching implications not only for unemployment, but also for monetary policy. If the capital intensity remains fairly

¹⁰ At least it would be Pareto-optimising if a deterioration of the unemployed's living standard could be compensated by transferring some of the productivity gains from the employed. This is exactly what the European Social Model or Japan's life employment tend to achieve.

¹¹ See for example IMF (1998). For a critical analysis, see Flassbeck and Spiecker, 1998.

constant, as in the USA, the natural rate will vary only marginally. The central bank would not commit a major error by following an accelerationist model as we know from the Fed. However, if catch-up growth dominates and the capital intensity rises, as in Europe, then equilibrium employment is fixed, even if the labour force grows. Hence the natural rate of unemployment rises. But because new investment normally shifts the labour demand curve first and the supply curve only subsequently, actual unemployment will temporarily fall below the natural rate. An accelerationist central bank would now tighten monetary policy. As (real) interest rates rise, investment falls short of the expansionary effects which would be required to accommodate the growing labour force. An accelerationist response function of monetary policy would prevent an expansion of output and employment while the fault could be blamed on rising real wages and capital-labour substitutions. But if real wages would progress less than productivity, as they did over most of the post-Bretton Woods period (see **Figure 6**), they would lower the labour share which violates the assumption of distributional constancy. If, however, the rate of capital accumulation is higher than the increase in capital intensity, a growing labour force could be absorbed into employment.

In order to show the impact of capital accumulation on unemployment, we need a model that incorporates interest rates. If we assume, contrary to RBC-theory that interest rates are set by the central bank rather than by time preference, investment may exceed or fall short of planned savings, implying temporary disequilibria from the natural rate of interest. However, the "natural" rate of unemployment would become endogenous to macro-economic policy. Furthermore, if interest rates also affect prices, then the aggregate supply curve is no longer vertical in the price-output space and money cannot be neutral. Thus, integrating interest rates and capital accumulation into the model makes theory less simple than the traditional natural rate hypothesis¹².

Introducing capital accumulation

In order to show the impact of capital accumulation we start with a simple neoclassical growth model ‡ la Solow. The economy is on a balanced growth path when actual investment equals the (net) increase of the capital stock required to keep the labour force and technological progress growing at their natural rates. Output and capital grow at the same rate, and this rate is equal to the growth of the labour force plus technological progress. The capital-labour ratio is constant. Hence in the steady-state:

$$(5) \quad \dot{y} = \frac{I}{P_0 K} = \bar{n} + \frac{dt}{t}$$

¹² Sargent (1973) has shown that with adaptive expectations the Fisher equation whereby an exogenous jump of inflation leads to an equivalent jump in bond yields, will only hold under the very monetarist assumption that potential output is independent of current and past real rates of interest. With rational expectations it is the deviation of output from its normal level that is independent of the systematic parts of monetary policy, but also the real interest rate. Benjamin Friedman (in Solow and Taylor (1998), p. 56), raises the question whether the natural rate model has become so relevant for policy making precisely because it has been so simple: "we have plenty of theories, typically focusing on various kinds of either human or physical capital formation, according to which monetary policy plausibly has very long-lasting real effects. They are just not simple theories".

where \dot{y} is the GDP growth rate and \bar{n} the rate of growth of the labour force. I is the value of investment (capital equipment purchases) and P_0K is the capital stock valued at replacement costs.

In order to keep things simple, we will henceforth assume that $\frac{dt}{t} = 0$.

We now introduce an investment function into the model. The investment decision at firm level - and in aggregate - can be modelled by Tobin's q . This relation is defined as the ratio of the market value of the enterprise to capital replacement cost (Tobin and Brainard 1977), or simply the ratio of the internal rate of return of an investment project to the risk-free money market interest rate (Bofinger et al., 1996, p. 556). This definition implies abstracting from time-varying term premia and default risk, so that capital markets determine long term bond rates as the average expected level of the money market rate over the relevant horizon. The q -ratio is

$$(6) \quad q = \frac{1 + i_K}{1 + i} = \frac{1 + i_K - E(\mathbf{p})}{(1 + i - \mathbf{p}_t)} \approx \frac{R}{r}$$

where i_K is the internal rate of return, R the expected real return on investment and $r = i - \mathbf{p}_t$ the real short-term interest rate. \mathbf{p}_t is the current rate of inflation and $E(\mathbf{p})$ is the expected average rate over the life of the capital equipment¹³. Entrepreneurs compare the rate of return from productive investment to alternative investment opportunities in risk-free domestic monetary assets. Unless real capital yields at least as much as monetary assets, there is no incentive to increase capacities. q reflects the excess return or economic profit that productive investment would earn over and above the placing of funds in risk-free securities. Hence the equilibrium value is $q = 1$.¹⁴ In models with neo-classical production functions, R is equivalent to the marginal product of capital (F_K), a technical variable dependent on the size of the capital stock. Investment will then be determined by the growth of the capital stock to the point where the marginal product of capital ($F_K \circ R$) is equal to r and $q = 1$. Since investment will adjust to profitable opportunities, q represents profits as entrepreneurial quasi-rents which tend to disappear over time if interest rates remain unchanged. Once it has adjusted, the prevailing interest is the "natural rate of interest" (i^*) in the Wicksell-sense and $q(i) = \bar{q}(i^*) = 1$.¹⁵ The speed of this arbitrage depends on the cost

¹³ Note that q also depends on inflation acceleration. During periods of disinflation, when future inflation is expected to fall, q will be lower than in a stable inflation environment. This implies that for a given current real rate, the marginal efficiency of capital has to be higher under disinflationary conditions.

¹⁴ In reality, investment may already stop at an earlier rate, say \bar{q} , if a minimum profit rate is required for investment, but we will abstract from these complications here. Because R and r are not easily measured, empirical studies prefer the formulation whereby q is the ratio of the market value of an investment project to the replacement cost. Under certain assumptions the two formulations are identical, but what matters for investment is the q ratio on the margin, i.e. the increment of market valuation for the cost of the associated investment. Average q values for existing capital stock may be quite different from the supposed equilibrium value 1. But at the margin, q should be close to unity (Tobin and Golub, 1998).

¹⁵ Wicksell (1998) showed the adjustment process to go from the monetary interest rate to real capital via credit demand. If, however, the central bank sets the money market interest rate and keeps the discount window open,

of adjustment: if these costs were zero, q would instantaneously jump to \bar{q} . Therefore, as long as adjustment costs are positive, short-term monetary policy measures can have real effects by lifting or lowering q , thereby inducing an adjustment process in the capital stock. As a result, transitory disequilibria following policy measures could become long lasting¹⁶.

In our simplified model, q is a function of the interest rate i which we suppose to be controlled by the central bank. In reality, movements of q should reflect a weighted average of different rates for different maturities and risks, as determined in financial markets. However, this realism is not necessary for the argument I wish to make. Because prices move with some inertia¹⁷, we may also consider r also as exogenously given and can therefore assimilate i and r to monetary policy.¹⁸ In more complex models, q is also related to the real exchange rate and fiscal policy¹⁹ (Collignon, 1997). Because we have taken i as exogenously given by monetary policy, our model implies that the marginal product of capital ($F_K \circ R$) will adjust to r - and not the other way round (Riese, 1986). In a Keynesian environment, R must itself be a function of r , because an increase in real interest rates would have negative consequences for effective demand, which in turn would affect the future cash-flow of the firm as well as the internal rate of return.²⁰ We can now show, how monetary policy measures by the central bank will affect Tobin's q . Assuming we start in equilibrium, taking the total differential of (6) yields

$$(6a) \quad dq = \frac{1}{r} dR - \frac{R}{r^2} dr$$

In the short-run, the inflation rate is fixed so that $dr = di$. In equilibrium $q = 1$ and therefore $R=r$. Inserting these values into (6a) and dividing by di yields:

$$(6b) \quad q_i = \frac{dq}{di} = \frac{1}{r} [R_i - 1] < 0$$

R_i measures the degree by which expectations on the return on capital are affected by variations in interest rates. Normally, this value should be negative. In a strictly neoclassical world, where R

then the process must be inversed and real capital adjusts to the monetary rate. We will deal with the price consequences of the Wicksellian process in the next section.

¹⁶ They could even become very long lasting if capital accumulation incorporates technological progress, so that the marginal products of capital and labour increase (see equation (1))

¹⁷ This is not a necessary condition for our argument. Over the long run when the inflation rate changes, it is more useful for comparative purposes to use the real short term rate r , but for didactic reasons I prefer to focus on i .

¹⁸ This is a very simplified model of the transmission mechanism. A more appropriate description of monetary policy with interest rate targeting is given by Goodfriend (1998). I am aware that in reality, risk and uncertainty as well as the structure of the banking system and financial markets trouble the link between monetary policy instruments and capital costs significantly. For a study of how short term affect long term interest rates in Europe, see Gebauer, Müller *et al.*, 1994.

¹⁹ If Ricardian equivalence holds, fiscal policy will not affect q .

²⁰ In the General Theory, Keynes (1936, chap. 18) made great efforts to prove that R was independent from r . If all agents had absolute perfect foresight, including about the timing of interest rate increases, then this would indeed be the case.

reflects the marginal product of capital $R_t = 0$ and $q_i = -\frac{1}{r}$. This implies that monetary policy is only effective if real interest rates are positive. When the expected rate of return is negatively influenced by monetary policy ($R_t < 0$)²¹, q_i would be smaller than the factor $-\frac{1}{r}$. Thus, in general, q_i is negative and its absolute value rather large.

Finally, we can determine the rate of capital accumulation as a function of Tobin's q :

$$(7) \quad \frac{I}{P_0 K} = a_0 + \mathbf{j} [q(i) - \bar{q}(i^*)]$$

where \bar{q} is the "normal" value of Tobin's q (possibly 1) that defines the Wicksellian natural rate i^* , with $\mathbf{j}(+) = +$, $\mathbf{j}(0) = 0$, $\mathbf{j}(-) = --$ and a_0 the autonomous or natural rate of capital accumulation. Growth equilibrium occurs when the savings out of net income support net investment, so that:

$$(8) \quad a_0 + \mathbf{j} [q(i) - \bar{q}] = s \frac{Py}{P_0 K} = s \frac{f'(k)}{k}$$

with s as savings rate and Py as net income.²² If $q = \bar{q}$, our system is in equilibrium and *ex ante* savings equal investment. The capital-output ratio adjusts to savings and the natural growth rate of investment:

$$(8a) \quad \frac{K}{y} = \frac{s}{a_0}$$

As we saw in (5), to keep the unemployment rate constant, the capital stock will have to grow at the rate of the labour force (\bar{n}) plus the increase in the capital/labour ratio (dk/k) plus the rate of Hicks-neutral technological progress (dt/t). But the actual rate of employment growth (n) is constrained by the rate of accumulation:

$$(9) \quad \frac{I}{P_0 K} = n + \frac{dk}{k} + \frac{dt}{t}$$

Comparing (9) to (5) shows that for a given rate of capital accumulation an increase in the capital intensity would push the employment rate below the equilibrium level. This allows a neoclassical explanation of rising unemployment, where the capital labour ratio increases when labour is

²¹This might be the case when the central bank follows an aggressive interest rate policy to combat inflation as in Goodfriend (1998)

²²We also assume that the GDP-deflator is the same as the capital cost deflator, i.e. $\pi = \pi_0$.

substituted by capital. But this substitution also rises productivity. In fact, if we abstract from Hicks-neutral technological progress ($dt/t = 0$), an increase in the capital intensity k is the only way to increase productivity. This can be derived from (1a) which is a monotonically increasing function. Therefore, its inverse $k = f^{-1}(I)$ exists with the derivative

$$(10) \quad \frac{dk}{dI} = \frac{t}{f'(k)}$$

Hence, the rise in capital intensity depends on the increase in productivity:

$$(11) \quad dk = \frac{t}{f'(k)} \cdot dI$$

If productivity remains constant ($dI = 0$), the capital-labour ratio does not change and we have balanced growth where the rate of growth of the capital stock will be identical with employment growth. However, the neoclassical hypothesis only applies to the special case when $q = \bar{q}$, because only then would the rate of accumulation be given autonomously, say by "animal spirits". With Tobin's investment function, a cut in interest rates would increase profits and stimulate investment, thereby lifting the rate of capital accumulation. The capital-labour substitution argument then loses its force because the interest rate cut shifts the constraint outwards. But this has also important consequences for the determination of the natural rate. At the point $q = \bar{q}$ the actual rate of unemployment becomes the new "natural rate", because the deviation of the actual from the natural rate is only temporary. By substituting (11) into (9) and (7), we obtain the long term dynamic labour demand function:

$$(12) \quad n = a_0 + j \left(q - \bar{q} \right) - \frac{t}{f'(k)} \cdot \frac{dI}{k}$$

If we assume that long term labour supply is growing at the same rate as the labour force \bar{n} , we get the steady state equilibrium where labour demand and supply are in balance ($n = \bar{n}$), investment equals saving $q(i) = \bar{q}(i^*)$ and the capital-labour ratio remains constant (with $dI \dot{=} \dot{=} 0$). Hence $\bar{n} = a_0$.²³ Labour market flow-disequilibria are caused by discrepancies in savings and investment or by changes in the capital-labour ratio:

$$(12a) \quad n - \bar{n} = j \left(q - \bar{q} \right) - \frac{t}{f'(k)} \cdot \frac{dI}{k}$$

Next, we look at the evolution of stocks. We know that the labour force grows at the natural rate:

²³ This reflects a "Golden Age" (Robinson, 1965 p.99) or Harrod-equilibrium with (8a) as $\frac{K}{Py} = \frac{s}{\bar{n}}$ and Wicksell's

natural rate of interest as i^* .

$$(13a) \quad N_t = N_0(1 + \bar{n})^t$$

and the employment level at

$$(13b) \quad L_t = L_0(1 + n)^t$$

Thus the employment rate is

$$(13c) \quad \frac{L_t}{N_t} \approx \frac{L_0}{N_0}(1 + n - \bar{n})^t$$

and the rate of unemployment

$$(13d) \quad U_t = 1 - \frac{L_0}{N_0}(1 + n - \bar{n})^t$$

where L_0 and N_0 are initial values. Obviously, if employment grows at a rate faster than the labour force, the employment rate increases and unemployment falls. But from equation (12) we know that a deviation of employment growth from its natural rate is only possible if productivity changes due to a change in the capital intensity (*i.e.* $dI > 0$) or because planned investment deviates from saving ($q \neq \bar{q}$).

This allows an interesting insight. Let i_0 be the initial rate of interest at which $q(i_0) = \bar{q}(i^*)$, so that, the economy is in equilibrium with $n = \bar{n}$ and $i_0 = i^*$ and the initial rate of unemployment as a natural rate. Next, assume authorities raise interest rates. Thus, expected profits fall, $q(i_t) < \bar{q}(i_0)$ for $i_t > i_0$ and because of (12) employment grows less than the labour force ($n < a_0 = \bar{n}$). Hence, unemployment increases above the natural rate. However, this deviation of the actual from the natural rate is only temporary. Because q -profits are now negative, the capital stock will adjust to the new conditions of profitability. Disinvestment will take place until the expected marginal return on capital equals the higher interest rate. At this point, the actual rate of unemployment becomes the new "natural" rate, because it is the level of unemployment which corresponds - as in Friedman (1968) - with Wicksell's natural rate of interest. Thus, the new natural rate $i_t^* = i_t$ is higher than the previous equilibrium rate $i^* = i_0$, and the level of equilibrium unemployment is also higher.

In this model partial adjustment is due to the speed by which the capital stock changes. A variation of the interest rate will only cause a temporary deviation of the rate of employment *growth* from its natural level. However, this temporary deviation will cause a permanent shift in the employment *level*: while the unemployment rate rises above its natural level as long as $q < \bar{q}$, it will stabilise at

a higher natural rate when $q = \bar{q}$. The inverse logic applies to a cut in interest rates²⁴. Consequently, the natural rate of unemployment is a function of the interest rate.

This result is obtained by incorporating Tobin's investment function into a neo-classical Solow growth model. It allows us to explain why the natural rate of unemployment is closely related to the actual rate, as many hysteresis models claim. By implication there are multiple equilibria for the natural rate of unemployment. We could, however, obtain the same result in a neoclassical model where investment is always equal to savings if we made the savings ratio dependent on interest rates instead of using the investment rate as a function of q . As is well known, a change in the saving rate has a *level* effect and not a *growth* effect. Thus, the equilibrium unemployment rate would shift with savings/investment shocks and then remain stable.

So far we have established the fact that the equilibrium or natural rate of unemployment is a function of monetary policy.²⁵ By lowering interest rates, the central bank can achieve a permanent increase in the level of employment and potential output and the inverse when it rises interest rates. However, this may have consequences for inflation that we now need to discuss.

1. Determining the price level

From a monetarist point of view, output is fixed by the natural rate of employment and the described Wicksellian process would simply lead to an expansion of money supply and rising prices (Issing, 1990; p.92-94). However, in our model the additional money supply serves to increase investment above planned savings and the higher capital stock produces higher output. Hence, there are not only price but also output effects. The question is, how to separate the two. The accelerationist model claims that if actual GDP rises above (below) potential GDP, wage and price inflation will accelerate (decelerate), so that monetary policy must intervene to stabilize prices. This can be done by a policy rule for monetary aggregates which reflects the growth of potential output. Yet, given that central banks effectively use short term interest rates as their policy instrument, interest rate rules have recently gained more prominence. Best known are Taylor-rules where central banks adjust short term interest rates in response to deviations of inflation from a target and to the deviations of real GDP from potential output (Taylor in: Solow and Taylor, 1998, p. 50):

$$(14) \quad i = p + g(y - \bar{y}) + h(p - p^*) + r^*$$

where p^* is the target inflation rate and r^* is the implicit real interest rate in the central bank's reaction function which coincides with Wicksell's natural (real) rate of interest in our previous

²⁴ Wicksell claimed that the deviation of the actual from the natural rate set a "cumulative" process in motion. However, with diminishing returns to capital, the output tends to be stationary with shifting steady states dependent on interest rates. As for price movements, we will see in the next section that a cumulative process requires a price-wage spiral.

²⁵ As Solow (Solow and Taylor, 1998, p. 11) put it: "The long-run aggregate supply curve may be vertical, but its location is endogenous to macroeconomic policy."

section. g and h are positive. This rule effectively means that the central bank rises short term real interest rates above the implicit rate when it perceives inflation or output to exceed their average rates. Thus, as long as inflation is on target, it is impossible that the economy grows faster than the average (\bar{y}) which enters the central bank's reaction function. It has been observed that the Taylor-rules come close to mimicking the actual behaviour of central banks (Solow and Taylor, 1998, p. 94; Clarida and Gertler, 1997. IMF, 1998). This is not surprising, for they work as a self-fulfilling prophesy²⁶.

There are two problems with monetary policy feedback rules which incorporate explicit growth targets: first, they limit potential growth to the target. Secondly, they blur the distinction between profit and wage inflation. While the former represents a temporary shift in the price level, only the latter leads to the cumulative process which is correctly called inflation. With the output gap as an indicator for future inflation, a central bank wishing to keep prices stable is always justified to rise interest rates and kill economic growth. However, if we could distinguish between temporary increases in the price level and sustained inflation, it would be possible to limit restrictive monetary policies only to the latter. The analytical tool by which this distinction can be made is the price mark-up.

In early Keynesian models, prices were linked to wages by a fixed mark-up. This fitted the Phillips curve trade-off between inflation and unemployment. By focusing on the real wage, Friedman (1968) implicitly made the mark-up (the inverse of the real wage) a function of unemployment. Although fluctuating in the short run, it was supposed to be stable in the steady state where the natural rate prevailed. However, even Friedman's natural rate of unemployment would be variable if the steady state mark-up would shift in the long run. Keynes' own theory of the mark-up, as developed in the *Treatise of Money* (1930), was much more elaborate although in the *General Theory* he hid it behind the concept of user cost.²⁷

The link between the price level and profitability was shown by Keynes' (1930) fundamental equation. He split the price level into two terms: the first covers standard cost of production, the second reflects aggregate excess profits or "entrepreneurial income" (Keynes, 1936, p. 53) which "is positive, zero or negative, according as the cost of new investment exceeds, equals or falls short of the volume of current savings" (Keynes, 1930, p.122). These Q-profits are caught by Tobin's $q-1$.²⁸ Thus if we further split costs of production into wage costs (unit labour cost W/λ) and the (rental) cost of net capital ($i_o b$), then Keynes' fundamental equation can be reformulated as:

$$(15) \quad P = \frac{W}{I} + i_o b q$$

²⁶ At least this is true for the United States where the capital-labour ratio has stayed nearly constant over the last three or four decades. In Europe, the case is somewhat different, as the rising average unemployment shows.

²⁷ Riese (1986, 1994) has reformulated the theory to a fully-blown theory of inflation. See also Collignon, 1997.

²⁸ The concept is also found in Myrdal (1933). Tobin was apparently not aware of this link between q and Q . See Tobin and Golub, 1998, p. 150; Schmidt, 1995; Collignon 1997.

The aggregate mark-up over unit labour cost is now no longer a fixed or arbitrary empirical value. It depends on the financial structure of the economy and on the macroeconomic environment as determined by monetary policy. Let us assume for simplicity that all capital goods are financed by bonds (B) for which the nominal interest rate i_0 is to be paid. b is therefore the ratio of outstanding bonds (B) which are equal to (historic) value of capital (P_0K) per unit of output (y). As usual, q can also be interpreted as the shadow price of capital. Formulation (15) determines the price level as a function of interest rates without the simplifying assumptions about money demand that dominates the IS-LM model.

If $q(i_0) = \bar{q}(i^*) = 1$, the market value of the investment project is equal to its replacement costs and its net present value is zero. This reflects therefore the "normal" capacity utilisation of the firm, at which the mark-up is just sufficient to cover the cost of capital²⁹ or the debt service i_0b . Thus, when $q(i_0) = \bar{q}(i^*) = 1$, we have the equilibrium price level (P^*) determined by unit labour costs (W/I) and the normal (rental) cost of capital per output.

$$(15a) \quad P^* = \frac{W}{I} + i_0b$$

Prices are set as a mark-up on wages (unit labour costs) in order to cover capital cost and if possible to make a profit. Its size depends on the firms' financial structure at the microlevel, but also on interest rates which are set by monetary policy.³⁰ In order to stimulate new investment, expected profits must be higher than capital costs and interest rates need to be cut. Excess demand would then push the actual price level above the equilibrium P^* . Q-profits would last until the capital stock has adjusted to the new equilibrium ($q = \bar{q} = 1$). At that point excess demand has disappeared and the price level has returned to P^* . Hence, equation (15) implies that prices and profit margins rise in the early phase of an economic boom because $q > 1$, but fall subsequently when competition and additional supply push q back.³¹ Therefore, a demand induced acceleration of inflation is always transitory - unless it leads to further inflationary movements. Monetary policy affects simultaneously prices (via q and i_0) and output quantities (via investment and demand) - but only until q has returned to the level of \bar{q} . In line with equation (12) and (13), the output-effect permanently shifts income and employment levels, but not growth rates. The price effect has a temporary component related to the adjustment from one income level to another and a persistent element related to the cost structure of the firm.³²

²⁹ For simplicity we assume average equal marginal costs.

³⁰ In a neo-classical model, the cost of capital would match the marginal product of capital. Q-profits can then be interpreted as a kind of macroeconomic producer surplus which can be positive or negative. In models with imperfect competition, the price mark-up is added to total marginal cost, so that the mark-up would vary with $q(i)$. In our definition, the mark-up covers the cost of capital plus q-profits. The reason is that in a Keynesian framework quantities adjust to prices, so that the price of capital (= credit) is the independent variable and the stock of capital (including its marginal product) adjusts.

³¹ For evidence on time-varying mark-ups see Forsman et al., 1997, and Martins et al., 1996.

³² As we will see below, this could also explain Sims' famous price puzzle. Eichenbaum in a comment to Sims' (1992) price-puzzle stated: "I know of no business cycle theory which is consistent with the notion that monetary contractions lead to prolonged periods of inflation". Keynes' (1930) theory would not imply exactly this; but he

Equation (15) is a static description of the price level. With some auxiliary assumptions we can work out how a one-off shift in interest rate affects prices and unemployment. However, the *financial structure* of the economy matters for the transmission mechanism. We may distinguish two stylised polar cases: a spot market economy where the "bond" interest rate i_0 varies each time in the exact proportion as the central bank controlled money market rate, and a contract economy where bond interest rates and capital costs are fixed until the end of the capital goods' life (Riese, 1997).

We will at first assume a contract economy. Here, a variation in central bank rates has only consequences for demand, not for capital costs.³³ Assume we increase i above the natural rate i^* . This would lower $q(i)$ and also push realised prices below the anticipated "normal" level. The average firm makes a loss. Real wages should fall, but with wages being contract rather than spot prices the demand-induced fall in the price level increases the *ex post* real wage. As some firms will be liquidated, the capital stock will decrease, unemployment will rise and the marginal product of capital increases. The adjustment through the elimination of least competitive firms will continue until profitability (the marginal product of capital) has improved to the point where the mark-up is sufficient to cover the cost of the remaining capital. If real wages are sensitive to unemployment, this elasticity will accelerate the adjustment process, but the driving force is the change in capital stock. Alternatively, if interest rates are cut, excess demand pushes prices up, real interest rates and real wages fall. Profitable investment opportunities lead to additional investment and higher employment. Prices will first rise above the "normal" price level P^* at which $q=1$ and ultimately return to equilibrium.

In a spot-market economy, the increase in money market interest rates has two consequences: first, it will reduce effective demand and the *ex post* price level, as before; but secondly, it will also affect *nominal* capital costs because the debt service for the liabilities incurred when the capital stock was purchased is rising with interest rates. Thus, the cost of capital increases and the *equilibrium price level* P^* moves up. In order to attain equilibrium, real wages have to fall even more than in the contract economy. Similarly, a cut in interest rates reduces nominal capital costs and rises prices. Thus, prices, real interest rates and real wages are more volatile than in a contract economy, because a cut in interest rates reduces the cost of capital while stimulating also demand. Thus, the "normal" price level falls, even if demand pushes the actual level up. In the long run, when the capital stock has adjusted, prices will be lower. This leads to two interesting conclusions. First, the natural or steady state interest rate is positively correlated with the level of natural unemployment. Consequently, if monetary policy follows a Taylor rule which posits a steady state real interest rate r^* , equilibrium and output unemployment are fixed. Monetary policy is then

dealt with the puzzle in the form of the Gibson Paradox. As we will see below, in a spot market economy the cost-push effect of an interest increase can exceed the demand contraction effect for some considerable span of time.

³³ The transmission mechanism for such miracle might be credit rationing: when the central bank rises money market rates it might flatten or invert the yield curve and thereby reduce the profit margins of financial intermediaries. Therefore capital market rates may remain fixed, but lower credit supply reduces effective demand. The logic is less convincing in case of interest cuts: higher profit margins would only increase domestic credit if demand was rationed before. However, we could also construct the model so that new investment depends on lower interests, and old investment carries the higher old rate.

ineffective in combating unemployment. Secondly, as a consequence of their higher volatility, spot-market economies require more flexible labour markets. Otherwise, the spot economy will induce larger output and employment variations for a given elasticity of real wages to unemployment. But, if labour markets are not flexible, employment could also be stabilised by making credit contracts less flexible.

By affecting profits, demand and the capital stock, monetary policy does have an impact not only on short-term employment but also on the natural rate of unemployment. Thus, money is not neutral, neither in the short term nor in the long term. Demand induced price level shifts are transitory. Inflation will only start when wage bargainers recuperate the price change into wage settlements, i.e. when a profit inflation turns into wage inflation. If nominal wages are pushed up as soon as demand has pulled prices temporarily up, unit labour costs will rise and the price level will have increased permanently. Thus, a central bank that aims to maintain price stability must prevent the indexing of nominal wages to prices. However, it could accept temporary deviations from the low steady state inflation rate because, as equation (15) shows, the price level will come down when $q(i)$ returns to $\bar{q}=1$.

4. Monetary Policy and Inflation Dynamics

We can now describe the inflationary dynamics of equation (14) into demand or (transitory) profit inflation, when q increases after a cut in interest rates, and into wage cost push inflation, when nominal wages increase more than productivity.

From (15) we can derive, after some manipulation, the rate of change of the price level:

$$(15a) \quad \mathbf{p} = (\dot{w} - \dot{I})\mathbf{s}_w + \left(q_i \frac{i_0 b}{P} + q \frac{b}{P} \right) \Delta i$$

where \mathbf{p} the inflation rate, \dot{w} and \dot{I} the proportional rates of increase in nominal wages and productivity, \mathbf{s}_w the wage share in (net) national income, b/P the capital-output ratio or the ratio of real corporate debt to turnover (because $b = \frac{P_0 K}{y} = \frac{B}{y}$). $i_0 \frac{b}{P}$ is therefore the real capital cost per unit of output.³⁴ Δi is the variation of interest rates undertaken by the central bank and q_i is the partial derivative of q with respect to i , i.e. the elasticity by which profits respond to interest rates (see equation (6b)). In a pure contract economy the term $q \frac{b}{P} = 0$, because the interest rate change has no effect on capital costs.

³⁴ If $P = P_0 (1 + \mathbf{p})$ and $i_0 = r + \mathbf{p}$ than $i_0 \frac{b}{P} \approx r \frac{K}{y}$.

Equation (15a) shows inflation determined by unit labour costs and financial structure. Labour costs may change because of nominal wage dynamics or productivity shocks, but we will concentrate here on wages.³⁵

If monetary policy is to maintain price stability, its success depends on the transmission mechanism of interest rate changes to prices. It has two sides: a central bank reaction function if the central bank targets inflation and a wage response function which incorporates wage bargainer's inflation expectations. The mechanism works differently in contract and spot economies.

Let us first look at the central bank's response function. As we saw, in a contract economy, monetary policy has a direct impact on profit inflation but not on capital cost: a rise in interest rates (Δi) lowers \mathbf{p} because lower effective demand will reduce profits and prices ($q_i < 0$). But the effectiveness of monetary price stabilisation depends largely on labour cost developments. If the wage share in the economy (\mathbf{s}_w) is high, and nominal wages increase more rapidly than labour productivity, monetary tightening is unlikely to reduce inflation rapidly to zero. The central bank will then have to maintain a tight monetary stance until nominal wage increases fall to the level of productivity increases³⁶. Unemployment will rise persistently until monetary policy becomes neutral. Given that the effect of i on q is only transitory, repeated interest rate increases may be required until unit labour costs and inflation are stabilised.³⁷ We can formalise the extent of an inflation-stabilising interest rate move by:

$$(16) \quad \Delta i = \frac{1}{\mathbf{b}} \left[\mathbf{s}_w \left(\dot{w} - \dot{\mathbf{I}} \right) - \mathbf{p}_m \right]$$

\mathbf{p}_m is the inflation target of the central bank. Thus, monetary policy is neutral when the (weighted) increase in unit labour costs is exactly equal to the inflation target. The extent of required interest rate changes by the central bank depends on the parameter \mathbf{b} which reflects financial structure and on income inflation dynamics. In the *pure contract economy*, $\mathbf{b} = -q_i i_0 \frac{b}{P} > 0$. The parameter \mathbf{b} depends on the debt structure in the economy and reflects in our model the cost ratio of debt service to income³⁸ multiplied with the (negative) interest elasticity of Q -profits. Under very simplified neoclassical assumptions $\left(R_i = 0, \frac{B}{Py} = \frac{K}{y} \right)$, $\mathbf{b} = \frac{i}{r} \cdot \frac{K}{y}$. In general, we can assume that \mathbf{b} is positive and that the coefficient $\frac{1}{\mathbf{b}}$ before the bracket in (16) is higher, the lower the debt ratio in the economy and the lower the contracted interest rate on the outstanding debt and

³⁵ Throughout this paper, we abstract from wage gaps due to social benefits. Thus wage costs are inclusive of all labour charges.

³⁶ We define a tight monetary stance as an interest rate that yields $q(i) < \bar{q}(i^*)$.

³⁷ For a discussion of why central banks may not raise interest rates sufficiently aggressively to hold inflation to a desired path, see Goodhart (1997).

³⁸ On the firm level this is the inverse of the *interest cover* defined as the earnings/interest payable ratio.

the higher the real interest rate. The intuition behind this is clear: the lower the capital intensity of production, the stronger the shifts in capital cost must be in order to affect investment decisions. In a *perfect spot market economy*, the picture is more complicated. The coefficient \mathbf{b} in (16) changes to: $\mathbf{b} = -(q_i i + q) \frac{b}{P}$. Given that q_i is negative and rather large, while q is positive around 1, \mathbf{b} should normally be positive and higher than in a contract economy. Therefore, monetary policy can always stabilise inflation by rising interest rates but the required size in policy actions depends on financial structure and is larger in spot economies.

Equation (15a) reveals an interesting feature which might explain Sims' (1992) "price puzzle". Sims found that an increase in interest rates might first accelerate inflation and only later reduce it. Yet, in a spot market economy, any increase in interest rates has a cost-push element $\left(q \frac{b}{P} \cdot \Delta i \right)$.

If it takes time for the demand effect $\left(q_i \frac{i_0 b}{P} \right)$ to tickle down, then prices will first rise and then fall. This is what the VAR-models observe.³⁹

Finally, we can abandon the polar economy model and assume that our economy finances the purchases of capital goods by a mix of fixed and flexible interest rate contracts. If we design \mathbf{f} to the share of fixed interest bonds, then \mathbf{b} becomes:

$$\mathbf{b} = - \left[\mathbf{f} q_i i_0 + (1 - \mathbf{f})(q_i i_t + q) \right] \frac{b}{P}$$

where i_0 stands for the fixed and i_t for the flexible interest rate. Again, the stability condition

$$\left[\mathbf{f} i_0 + (1 - \mathbf{f}) i_t \right] q_i + (1 - \mathbf{f}) q < 0$$

is normally fulfilled under our simplifying assumptions⁴⁰ and the size of β stands between the two polar cases.

Next we look at income inflation dynamics. The extent by which the monetary authorities can move interest rates also depends on the increase in unit labour costs, weighted by the wage share, and the target inflation rate (\mathbf{p}_m). Obviously, the lower the inflation target, the sharper or longer drawn out will be the interest rate increase as a response to given wage cost developments. A fully accommodating monetary policy would keep interest rates constant and adjust its inflation target to the wage cost developments, such that in equation (16) the expression in brackets equals zero. But if monetary policy is committed to price stability, it would set \mathbf{p}_m close to zero and rise interest rates aggressively to fight inflation.

³⁹ For European evidence of the price puzzle, see Barran et al., 1997. Comparing their results with the ratio of enterprises gross interest payments to income in the table presented by Strauss-Kahn (1997, p. 118) seems to indicate a correlation between the extent of the price puzzle and this ratio, as our theory suggests. Further research would be desirable.

⁴⁰ Assuming $i = i_0 = i_t$ and $q_i = -\frac{1}{r}$, we get $(1 - \mathbf{f}) q < 1 + \frac{\mathbf{p}}{r}$

Our analysis yields the result that under normal circumstances, monetary policy is always capable to reduce or stabilise inflation by increasing interest rates. However, the speed and effectiveness of the stabilisation policy, and therefore also of the social cost involved, will depend on financial structure and on the wage setting process. We will now look at wage setting.

Wage setting

We are interested in the macroeconomic outcome of wage bargains. Models with microfoundations are of a complexity that does not help to elucidate point I wish to make here. Equation (16) makes clear that the evolution of unit labour costs is crucial for the interest setting margins of the central bank. Ideally, the aggregate wage increase is just equal to the average productivity gain in the economy. Unit labour cost would remain stable and monetary policy is neutral. The question is, how such settlements could be achieved. This requires modelling the institutional structure of the labour market which is beyond the scope of this paper. However, Calmfors and Driffill (1988) and others (e.g. Cukierman and Lippi, 1998) have shown that wage restraint is linked to the degree of centralised wage bargaining. In this context it would be reasonable that both high and low centralisation would produce wage settlements closer to productivity gains than intermediary forms. However, centralised wage bargaining would also produce higher average productivity gains, as innovative firms reap the benefit of Schumpeterian rents (Flassbeck, 1994). Thus, a more concerted approach to wage bargaining in EMU might be desirable.

Nevertheless, Europe is going to remain for some time on an "intermediary" degree of centralisation. We would then have to model the wage outcome differently. A simple approach is to assume that workers tend to defend their living standard against real wage reductions and that firms are more accommodating to nominal increases when profits are high. Such wage setting behaviour can then be modelled either by some kind of Phillips-curve dynamics where nominal wages rise when $q > 0$ either because the labour markets are tightening, or because workers focus on the distribution of income shares (the "justice" motive). Both lead to the cumulative process of profit (q) and income inflation ($\dot{w} - \dot{I}$) described by Riese (1986).

Let us assume that employment stands at the initial level E_0 and that the economy is in equilibrium with $q = \bar{q} = 1$, $P_0 = P^*$ and $dI = 0$. Next the central bank lowers interest rates once and for all. As a consequence, q will rise, investment will exceed planned savings and quasi-rents appear. This disequilibrium translates in an upward move of the price level ($P_t > P^*$). If we assume that unit labour costs do not change, then this is a transitory price level movement reflecting higher profit margins. Investment and employment would increase until the diminishing returns from the increased capital stock have pushed q back to 1, and competition has reduced prices back to the equilibrium level P^* . During the adjustment process, real variables change and the new employment level E_t is higher than E_0 , while real interest rates and the natural rate of unemployment are lower.

However, this is an unlikely story. Wages will respond to expected price changes, either because wage bargainers cannot distinguish between transitory price adjustments and continued inflation, or because workers tend to resist the new distribution of income in favour of profits. A fairly general model of price expectations assumes that expected inflation is a weighted average of the long run inflation target and past inflation:

$$(17) \quad E(\mathbf{p}_t) = (1 - \mathbf{J})\mathbf{p}_m + \mathbf{J}\mathbf{p}_{t-1} + \mathbf{e}_t$$

where \mathbf{J} is the weight attached to past inflation and \mathbf{e}_t is a white noise disturbance. The long run mean or steady state of the series is \mathbf{p}_m which we assumed to be set by the central bank as its inflation target. The autoregressive coefficient \mathbf{J} is an indicator for inflation persistence. If \mathbf{J} is high, deviations from the steady state are long lasting. A low \mathbf{J} implies high credibility of the central bank's commitment to achieve its target.

Next we formulate the wage equation. Assuming inflation expectation is formed rationally, we insert (17) into (4) and after specifying $f(u) = \mathbf{a}_2(u_{t-1} - u^*_{t-1})$ with $\mathbf{a}_2 < 0$ we get:

$$(18) \quad \dot{w}_t = \mathbf{a}_1[\mathbf{p}_m(1 - \mathbf{J}) + \mathbf{J}\mathbf{p}_{t-1}] + \mathbf{a}_2(u_{t-1} - u^*_{t-1}) + \mathbf{e}_t$$

where \mathbf{a}_1 is the coefficient for nominal wage indexation. If $\mathbf{a}_1 = 0$, we have no indexation and perfect nominal wage rigidity. If $\mathbf{a}_1 = 1$, nominal wages are perfectly flexible. Nominal inertia may arise from staggered wage and price setting, from the cost of changing wages and prices, and from adaptive expectations. However, adaptive expectations imply that wage earners are consistently proved wrong in their expectations. With rational expectations, workers would use all available information including the expected rate of inflation and, therefore, $\mathbf{a}_1 = 1$ with respect to $E(\mathbf{p}_t)$. Finally, under simplifying assumptions \mathbf{a}_2 is the slope of the short term Phillips-curve and a measure of labour market flexibility (see Collignon, 1998a). There are good theoretical reasons, supported by empirical evidence, to think that \mathbf{a}_2 is regime dependent. It is low in a low inflation regime with infrequent nominal contract changes and high if price stability is not expected to prevail. However, for our argument here we may assume that \mathbf{a}_2 is constant.⁴¹ Substituting (18) into (16):

$$(16a) \quad i_t = i_{t-1} + \frac{1}{\mathbf{b}} \{ (\mathbf{s}_w \mathbf{a}_1 - 1)\mathbf{p}_m - \mathbf{s}_w \mathbf{a}_1 \mathbf{J}(\mathbf{p}_m - \mathbf{p}_{t-1}) + \mathbf{s}_w [\mathbf{a}_2(u_{t-1}^* - u_{t-1}) - \dot{\mathbf{i}}_t] + \mathbf{s}_w \mathbf{e}_t \}$$

This equation gives the *monetary policy rule* at which the interest rate should be set, if the authorities pursue an inflation target. It is an alternative to the Taylor rule formulation (14), for it shows how short term rates must be adjusted to keep prices stable, without setting a rigid

⁴¹ Empirical estimates of wage equations show that \mathbf{a}_2 is normally much lower than \mathbf{a}_1 . See De Grauwe, Micossi, Tullio, 1996

preconceived "speed limit" to economic growth. This is because the expression in square brackets reflects unit labour cost dynamics with respect to excess demand and not the deviation from a *stable* natural rate or potential output. In our equation $(u_{t-1}^* - u_{t-1})$ is an expression for the *transitory* demand pull on prices and not a fixed, natural barrier for output. In fact $u_{t-1}^* - u_{t-1} > 0$ simply means average unemployment was larger than observed unemployment in the previous period. Thus, if we kept the interest rate unchanged at a lower level until the full adjustment process has taken place, excess demand is resorbed and $u_{t-1}^* > u_t = u_t^*$. The danger is rather, that the excess demand, reflected in improved employment levels, gives rise to nominal wage increases in excess of productivity. Yet, the lower the slope of the Phillips curve, the lower the probability for this to happen. If \mathbf{a}_2 is regime dependent and low or even zero in a low-inflation environment, then monetary policy influences also the flexibility of the labour market (Collignon, 1998a; Walsh, 1995).

What happens to the real economy ? In our model, growth and employment are determined by the investment function (12). An economic expansion and a reduction in unemployment requires that interest rates fall. But they will remain constant and growth-neutral at a natural rate ($i_{t-1} = i^*$), if the expression in the curly bracket is zero. They can only fall and start an economic expansion, if its value is negative. Thus, the monetary policy rule is dependent on four factors: the inflation target, the price adjustment speed, financial structure and excess demand. Under what conditions can it stimulate growth and employment?

First, if we assume rational expectations with $\mathbf{a}_1 = 1$ and $E(\mathbf{e}_t) = 0$, it is apparent that low inflation targets constrain the margin of possible interest rate cuts. Hence, for low levels there exists a trade-off between *inflation targets* and economic growth.

Second, the impact of past inflation deviation from target, i.e the price adjustment speed, depends on the central bank's credibility, measured by \mathbf{J} . If wage bargainers believe that the inflation target will be met, and if the justice motive of correcting past real wage distortions is absent, then $\mathbf{J} = 0$ and wage bargaining is forward looking. Therefore, the central bank would have less need to lean against inflation pressures and central bank credibility contributes to keeping high employment levels.

Alternatively, if wage bargainers do not believe authorities to be able to impose target inflation quickly, they may wish to give greater weight to correcting past inflation surprises. As a consequence, the central bank would have to raise interest rates more aggressively in order to reach its target. Unemployment would grow. There is, however, a link between inflation targets and central bank credibility. We may define price stability as expected changes in the price level that are small and gradual enough that they do not enter business or household decisions. The maximum inflation target which would keep wage bargaining forward looking must then conform to this definition, in order to maintain wide margins for central bank rate cuts.

Third, we have already dealt with financial structure; \mathbf{b} is higher in contract market economies, and when output is produced with capital intensive technology. Hence, less aggressive interest rate

movements are required in contract economies and output variations should be lower than in labour intensive spot economies.

Fourth, labour market flexibility counts. Excess demand reduces unemployment. When nominal wages respond flexibly to unemployment, i.e. when \mathbf{a}_2 is relatively large, then wage setting will support monetary policy objectives *during disinflations* and the sacrifice ratio is low. However, if the purpose is to reduce unemployment by *sustaining long term growth, high wage flexibility is counter-productive*, as a fall of actual unemployment below the average rate ignites wage increases which quickly require an increase in interest rates. We are then approaching the logic of a Taylor-rule, accelerationist model. There is, however, a countervailing force. If productivity gains are high, a steep slope of the Phillips-curve is less dangerous when the central bank cuts interest rates. Thus, we might expect that Taylor rules work better in moderate inflation environments than in very low inflation environments. In general, a low value of \mathbf{a}_2 that is low wage rigidity with respect to employment levels, is preferable, because productivity gains will then allow a larger scope for expansionist monetary policies.

Finally, we may consider a worst case scenario as a special case. Assume the central bank targets a zero inflation rate, expectations are formed rationally ($\mathbf{a}_1 = 1$), the central bank target enjoys no credibility $\mathbf{J} = 1$ and the labour market is perfectly inelastic with respect to unemployment ($\mathbf{a}_2 = 0$) which might be the case in a low inflation regime. The monetary policy reaction function (16a) then reduces to:

$$(16a') \quad i_t = i_{t-1} + \frac{\mathbf{s}_w}{\mathbf{b}} (\mathbf{p}_{t-1} - \dot{\mathbf{I}}_t)$$

Monetary policy could remain neutral ($\Delta i = 0$) only if this period's productivity increase makes up for last period's inflation ($\dot{\mathbf{I}}_t = \mathbf{p}_{t-1}$). This implies, because of (4), that inflation would only be constant if nominal wages increase exactly at the same ratio as labour productivity. Thus, as long as wage bargainers follows this "*iron rule*", monetary policy would remain at least neutral; under less rigid assumptions it could become expansionist. If, however, nominal wage settlements exceed the margins of productivity gains, monetary policy would have to rise interest rates. Assuming that we start in equilibrium, unemployment would move up until it ultimately stabilised at a higher natural rate. But if wage bargainers took the behaviour of the central bank into account and settled at $\dot{w}_t = \dot{\mathbf{I}}_t$, the central bank would not have to react and unemployment could remain at the previous level. This result implies that rational and forward looking behaviour by wage bargainers is more important than institutional labour market flexibility. With forward looking wage bargaining and a credible central bank, price stability is more probable and rising unemployment is less likely.

What about lowering unemployment? Could wage restraint reduce unemployment? Wage restraint alone, without supporting cuts in interest rates, will not create new jobs. For if $q = 1$ and $\Delta i = 0$

and $\left(\dot{w} - \dot{I}\right) < 0$, the price level will simply fall (see equation (15a)) without renewed investment and growth. Wage restraint then simply causes a deflation⁴².

5. Summary and Conclusion

We may now summarise our model:

1. We have seen that when monetary policy follows the accelerationist model, whereby the natural rate of unemployment is a "speed limit" for economic growth, it does not produce optimal results over the long term. If capital accumulation is introduced, money is not neutral. By setting interest rates in pursuit of an inflation target, the central bank also determines the incentives for investment.
2. With given technology, the level of employment is determined by the level of the capital stock. The growth of employment and, therefore, also the natural rate in unemployment are constrained by (net) investment and the change in labour productivity. Changes in labour productivity over and above Hicks-neutral technological progress may in theory result from catch-up growth in capital intensity and cost pressure. However, empirical evidence for Europe and Japan indicates that a rising capital-labour ratio results less from wage pressure but more from catch-up growth. In the United States, this ratio has grown little and investment was sufficient to absorb a growing labour force.
3. Investment depends on profit expectations and, therefore, on interest rates. Hence, interest rates determine the level of the capital stock and therefore the level of employment. The adjustment of the disequilibrium goes from interest rates (the independent variable) to investment (the dependent variable).
4. Interest rates are set by the central banks in response to inflation expectations in the context of a given financial structure. The required variation in interest rates for keeping prices stable is higher if debt contracts are *short term oriented (spot economy)*. Both, output and price volatility are reduced if *long term financial contracts* prevail.
5. The faster labour costs rise above the inflation target, the higher the interest rate increase required to maintain price stability. Also, the lower the central bank's credibility to fight inflation, the higher the interest rate rise.

⁴² Flassbeck and Specker (1998) have produced a model where a wage cut can produce an expansion in employment under the condition that money supply remains constant. However, using the quantity equation abstracts from the transmission process. In our model, money supply can only remain constant under conditions of falling unit labour costs, when $q > 1$ and therefore when interest rates are cut.

6. Non-inflationary employment growth is possible if, and only if, both *unit labour costs and interest rates fall* together, so that the price level stays constant and the profit margin increases. A reduction in unit labour costs without an interest rate cut would lead to deflation and not to price stability nor employment growth.

What evidence do we have that our model describes reality correctly? We stand at the frontier of research. It would be desirable to put at least some of our propositions into testable hypotheses. Nevertheless, some elements have been established in the literature: unemployment displays hysteresis effects whereby average follows actual unemployment and seems to be correlated with disinflation (Ball, 1997; Belke, 1996). Investment and growth provide reasonable explanations for Europe's high rates of unemployment (Morley, 1998; European Commission 1997). Interest rates matter for employment. Although the mechanisms are still rather unexplored, most studies focus on real interest rates (Newel and Symons, 1987; Phelps, 1994, 1995; Atkinson et al., 1993; Barrell et al., 1995). My own experiments with Granger-causality tests (not reported here) indicate that in the USA both nominal and real rates unequivocally Granger-cause changes in unemployment. In Germany, there is no evidence for real interest rates Granger-causing employment, but weak evidence for nominal rates. This might be evidence that the USA works as a spot economy and Germany as a contract economy. EMU-11 is likely to lean into the direction of Germany. Further research is required.

Some further sketchy evidence points in to the direction of our argument. According to our model, employment is constrained by investment. This feature is apparent from **figure 7a** (investments shares). In the high growth decade of the 1960s, the investment share in the EU 15 was high between 22 and 24 percent, and unemployment low at 2 percent. When the investment share fell after the first oil price shock, unemployment exploded. But during the period 1985-90, the investment share rose back to 20 percent and the European economy grew at 3-3.5 percent. Thus, unemployment can be seen as a mirror image of the investment share. This explanation of European unemployment is surprisingly simple. In order to check its robustness, I looked at Spain and Portugal. Blanchard and Jimeno (1995) called it "the biggest empirical challenge" to explain the dramatic difference in unemployment rates of these two countries. They found that there is no simple mapping from observable labour market characteristics (rules and institutions) to structural unemployment. Spain and Portugal are more similar in this respect than any other pair of EU countries, and yet their unemployment rates vary by 15 percent. Can investment shares provide a better explanation? **Figures 7 (b) and (c)** show the result: Spain's pattern is remarkably similar to the EU-15, but Portugal is different. While in Spain and Europe the investment share fell continuously after the mid 70s, it continued to rise in Portugal until the early eighties and stayed high even thereafter. It never fell to the low rates of Spain or Europe. Thus, even if a fall in the investment ratio in the mid-70s pushed unemployment rates up, these developments were much less harmful in Portugal than elsewhere. How can this unsatisfying investment performance in Spain be explained? Our model would suggest, that monetary policy expressed in short term real interest rates was crucial. **Figure 8** shows the relevant interest rate differentials. It appears that until the early 1990s, monetary policy was significantly tighter in Spain than in Portugal. Although we cannot try an in-depth assessment of the respective monetary policies in these two countries here, we find a strong indication that monetary policy provides a more significant explanation for

the differences in the employment performances of Spain and Portugal than supposed labour market rigidities.

What lessons can be learned from this analysis for the conceptualisation and implementation of monetary policy by the European Central Bank? It has sometimes been said that the ECB would benefit from inheriting the credibility of the Deutsche Bundesbank. Although there is some truth in this, we must not forget Lucas' critique: if everything changes, forget the past and think of the future! So this is how the future might work better:

1. By following an interest rate rule, the ECB should be able to maintain price stability, understood as the steady state inflation rate which is low enough not to enter business and household behaviours. It is likely that such target inflation is close to 2 %.
2. An efficient ECB would maximise output and employment under the constraint of maintaining price stability. This requires not to take output gaps or natural rate considerations into account when setting interest rates, but rather wage and income developments. Targeting monetary aggregates which are derived from potential output, or Taylor rules are likely to create unwarranted speed limits to growth.
3. An efficient monetary policy must steer interest rates between the Scylla of overrestrictiveness and the Charybdis of igniting an inflationary spiral by excess demand. This requires setting an inflation target as high as is possible without making wage bargaining backward looking, although allowing some flexibility for wage bargainers. It also would require to smooth interests downwards, so that excess demand deviations from the downward shifting natural rate do not ignite a cumulative price-wage spiral⁴³.
4. Wage bargainers also have to assume responsibility for the margins within which the central bank can lower interest rates. They must avoid that the ECB is obliged to rise interest rates because unit labour costs increase at a rate that is inconsistent with the bank's target⁴⁴. The "iron rule" which preserves this required coherence over the long term is to peg average wage increases to average productivity gains in the economy.
5. The interaction between wage setting by social partners and interest setting by the central bank is rarely direct. Nevertheless, it determines ultimately the level and evolution of employment and economic growth. In a large economy like European Monetary Union, labour market institutions will remain of significant heterogeneity. However, this does not prevent rules of good conduct to be followed by all, provided they are clear and well understood. The European Central Bank could help to make them transparent by taking earnings statistics as one of the intermediary policy variables when designing its monetary policy concept.

⁴³ The Bundesbank used to call this the policy of "Trippelschritte".

⁴⁴ German trade unions used to speak of the Bundesbank's interest bat (Zinskeule).

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Table 1 : Compounded Growth Rates 1960-1998

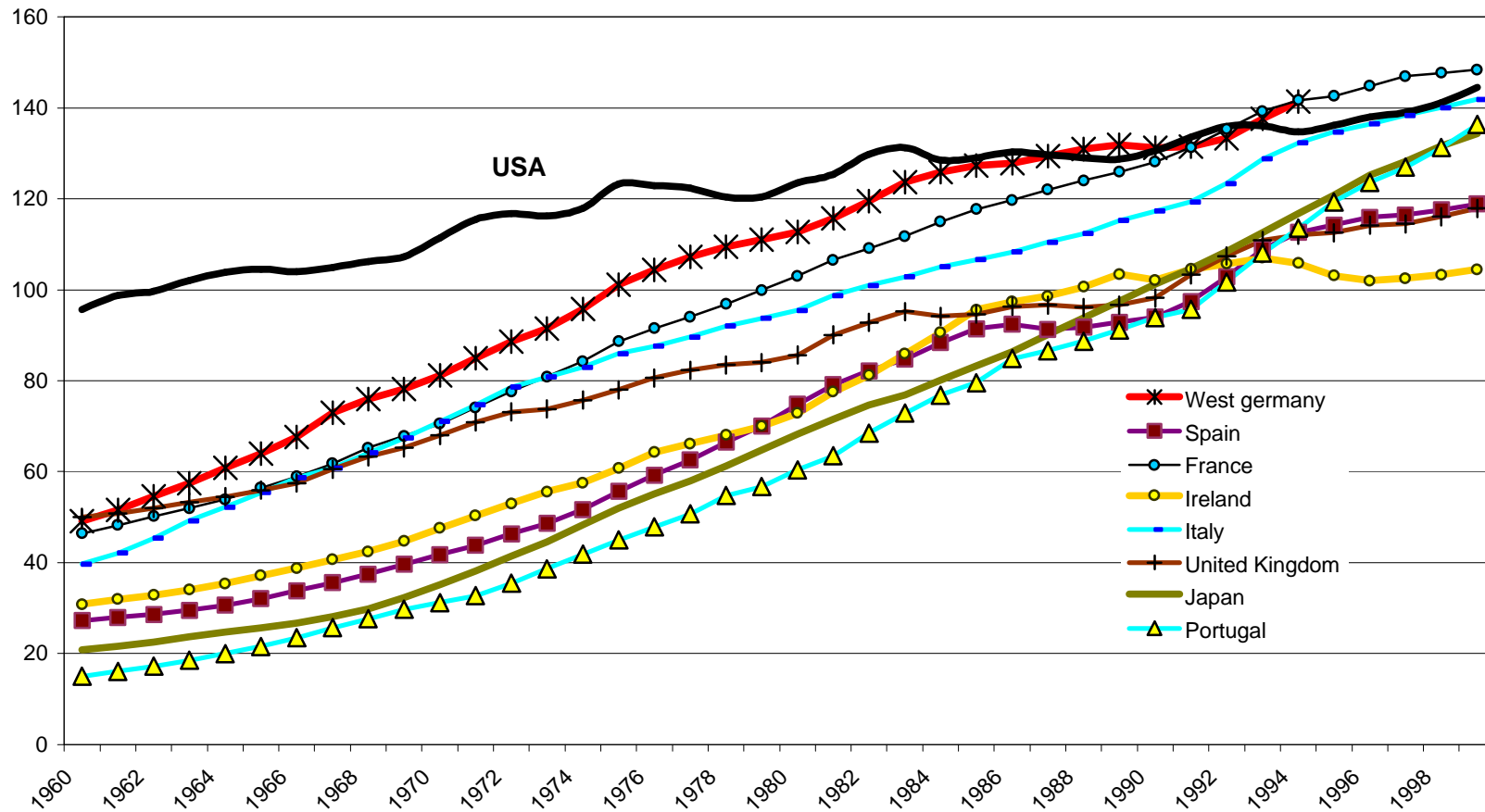
Variable	Capital Stock $\frac{I}{PK}$	Capital Intensity \dot{k}	Labour Force \bar{n}	Employment n	Steady State Unemployment $\bar{n} - n$
<i>Belgium</i>	3.35%	3.12%	0.36%	0.22%	0.14%
<i>Denmark</i>	2.29%	1.62%	0.84%	0.74%	0.11%
<i>Germany</i>	3.39%	3.28%	0.26%	0.11%	0.16%
<i>Spain</i>	4.25%	3.92%	0.84%	0.34%	0.51%
<i>Portugal</i>	6.02%	5.87%	0.63%	0.51%	0.12%
<i>France</i>	3.47%	3.09%	0.67%	0.37%	0.30%
<i>Ireland</i>	3.97%	3.23%	0.80%	0.72%	0.08%
<i>Italy</i>	3.56%	3.38%	0.16%	-0.02%	0.18%
<i>Luxemburg</i>	3.00%	1.51%	0.98%	1.47%	-0.48%
<i>Netherlands</i>	3.71%	2.92%	1.32%	1.26%	0.06%
<i>United Kingdom</i>	2.45%	2.24%	0.39%	0.25%	0.14%
<i>Finland</i>	3.46%	3.55%	0.42%	0.11%	0.30%
<i>USA</i>	2.85%	1.03%	1.75%	1.80%	-0.04%
<i>Japan</i>	5.97%	4.97%	1.07%*	0.95%*	0.12%

Source: European Commission

* Calculations based on Civilian Labour Force and Occupied Population data

Source : European Commission

Figure 5: Capital Intensity



Source : European Commission

Figure 6: Real Wage Position

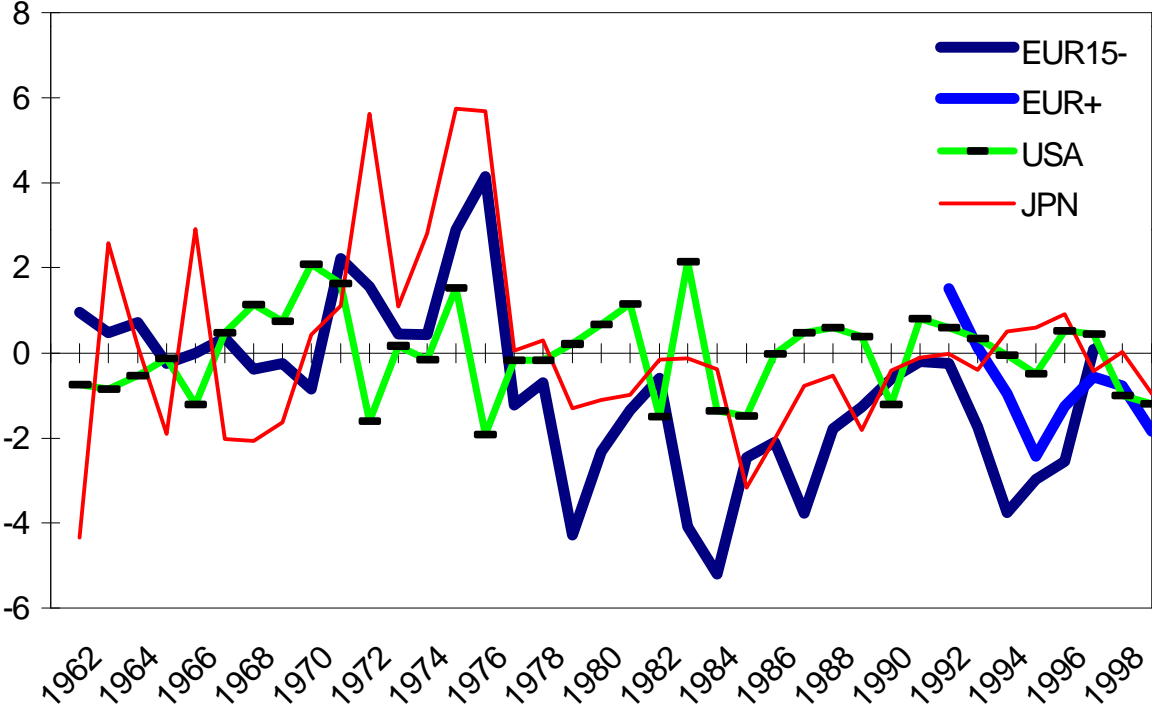
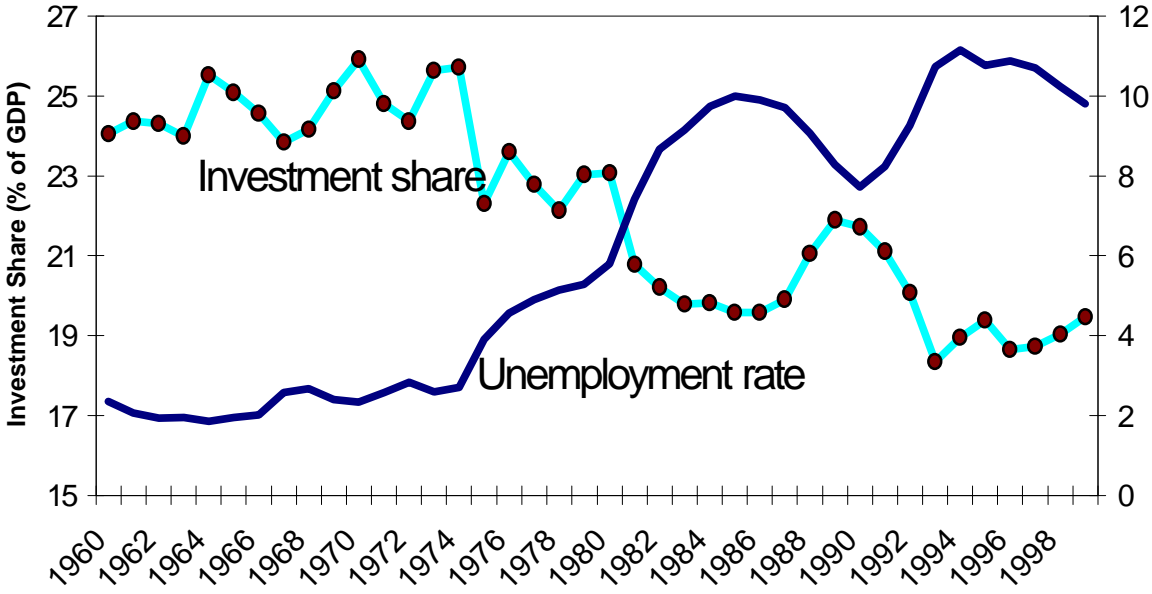


Figure 7a: Investment Share and Unemployment Rate - EU15



Source : European Commission

Figure 7b: Investment Share

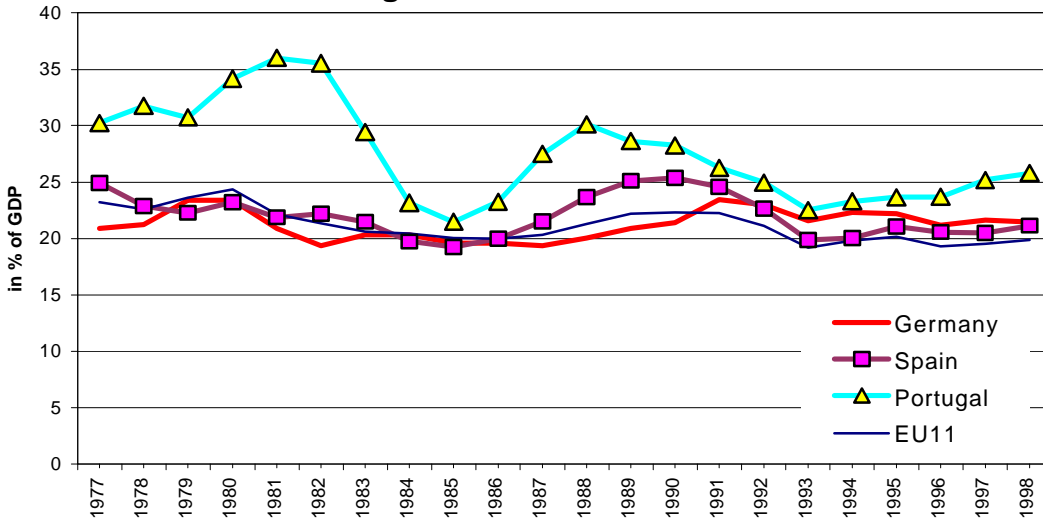


Figure 7c: Unemployment Rates

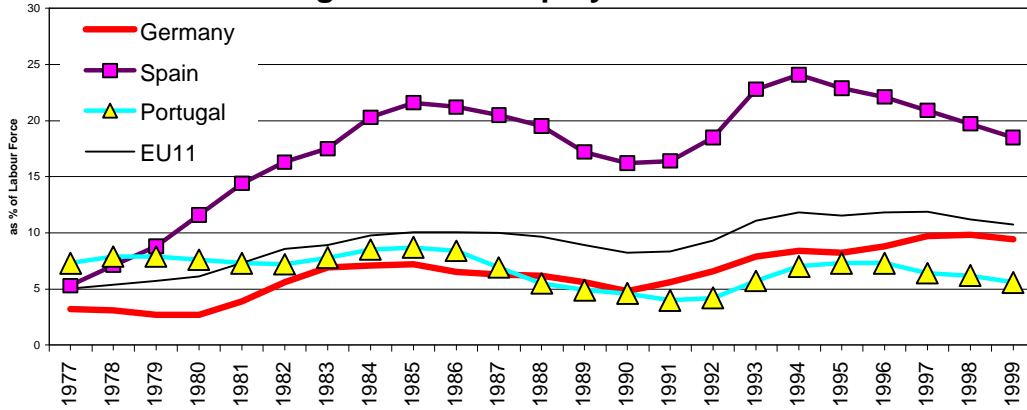
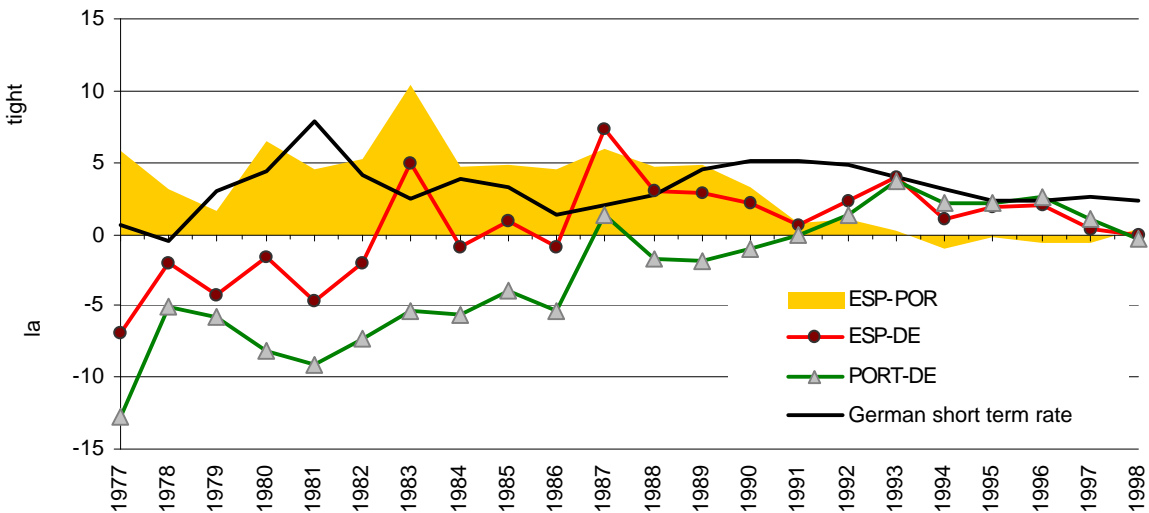


Figure 8: Short Term Real Interest Rate Differentials
Spain versus Portugal



Source : European Commission