The Role of Monetary Policy in Setting the Natural Rate of Unemployment

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Workshop Quantitative Prognosen realwirtschaftlicher Effekte der Geldpolitik


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A widely accepted view amongst economists and policy makers represents unemployment as the sum of structural component called the natural rate and a cyclical component reflecting short-run business cycle fluctuations. The secular rise in European unemployment in the 1980s and 90s, but also more recently in Japan, is usually explained by shifts in the natural rate. Not surprisingly, most policies combating unemployment are dominated by demands for ‘structural reforms’ in goods and labour markets. Yet, reforms seem difficult to put into practice and when attempted the results are rarely as convincing as expected (Blanchard and Wolfes, 2000). There seems to be a gap between theory and practice that usually indicates faults in the theory. In this paper I will review the ‘natural rate hypothesis’ (NRH) and its complement the Phillips Curve as the theoretical foundation for orthodox explanations of unemployment. It will appear that the distinction between structural and cyclical unemployment is dependent on a partial equilibrium in the Labour market. By introducing capital markets into the model, the labour market has multiple equilibria and monetary policy selects one out of many possible general equilibria. As a consequence it can also play an active role in reducing unemployment.

1. The natural rate hypothesis

∗ London School of Economics and CEP. I dedicate this article to the memory of Franco Modigliani, who encouraged me to think about these issues and died while I was working on this paper.
The ‘natural rate hypothesis’ was first developed\(^1\) by Friedman (1968) and Phelps (1967, 1968). It became the precursor of new classical economics and the Anti-Keynesian counter-revolution, which was completed by Sargent and Wallace’s (1975) conjecture that monetary policy was ineffective for anything other than the economy’s nominal side. Friedman defined the natural rate:

\[\text{[T]here is some level of unemployment which has the property that it is consistent with equilibrium in the structure of real wages. At that level of unemployment, real wage rates are tending on average to rise at a “normal” secular rate, i.e. at a rate that can be indefinitely maintained so long as capital formation, technological improvements etc remain on their long-term trends. A higher level of unemployment is an indication that there is an excess supply of labour that will produce downward pressure on real wage rates. The “natural rate of unemployment”, in other words is the level that would be ground out by the Walrasian system of general equilibrium equations, provided there is imbedded in them the actual structural characteristics of the labour and commodity markets, including market imperfections, stochastic variability in demands and supplies, the cost of gathering information about job vacancies and labour availabilities, the costs of mobility and so on.}\]

Thus, the natural rate corresponds to a unique level (or path) of real wages and the economy behaves as if markets were determining real (i.e. relative) prices all the time (Tobin, 1995). Lucas (1972) has perfected the argument by the ‘misperceptions’ supply curve in the context of the rational expectations hypothesis. The fundamental consequence in both models is that unanticipated monetary policy and inflation can raise employment only temporarily by fooling workers, employers or price setters although effects on nominal prices are permanent.

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\(^1\) 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. I have discussed the NAIRU model in Collignon, 2002.
Friedman derived the ‘natural rate hypothesis’ from Wicksell’s (1936/1962: 102) concept of a ‘natural’ rate of interest:

[a] rate of interest on loans which is neutral in respect to commodity prices, and tends neither to raise nor to lower them. This is necessarily the same as the rate of interest which would be determined by supply and demand if no use were made of money and all lending where effected in the form of real capital goods

At the natural interest rate, the interest in the capital market is equal to the return on physical capital and at this point actual unemployment is at its ‘natural’ level. Thus, in equilibrium money is neutral as both labour and capital markets seem to balance with respect to ‘real’ variables. Money seems to disappear when the ‘veil’ is lifted. It can only be a disturbance, causing temporary deviations from the natural level, modelled by the expectations-augmented Phillips curve. Yet, this view also implies complementarity between capital and labour markets. The natural rate of unemployment is an equilibrium concept that links the labour market to interest rates. But this fact must also assign a role to monetary policy, as the central bank influences interest rates as the marginal supplier of liquidity in the money markets.

It is frequently argued that political authorities may be tempted to exploit the transitory effects of monetary policy by choosing “time inconsistent behaviour”. For example, Cukierman, (1992, p. 17) claimed that "Government normally inflates in order to achieve real objectives". It can do so by causing a surprise inflation that lowers real wages, to which confused producers respond by employing more labour. In the long-run, workers realize their real wages have fallen and demand compensation, thereby pushing wages and prices up and bringing employment back to its natural level. In the Lucas model producers cannot distinguish between relative and absolute price levels and therefore respond to inflation by a temporary increase in output. Thus, the strategic interactions between nominal wage and price setters and a monetary authority which cares about both employment and price stability create excessive inflation without having any effect on the level of employment in the long-run (Barro and Gordon, 1983). By delegating authority to an

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2 I have never fully understood why governments concerned with reelection would find that voters like higher employment more than they dislike lower real wages. After all the whole population is entitled to vote, not only newly employed workers.
independent central bank which cares "primarily" about price stability, the inflation bias can be reduced without having an effect on average employment. Such arrangement would therefore be welfare improving (Rogdoff, 1985).

This view raises questions about the link between price inflation and real economic activity and about the monetary transmission mechanism: how will a change in interest rates by the central bank affect inflation and output? In the early days of Phillips-curve-economics a stable trade-off between nominal wages, prices and unemployment was widely assumed. The transmission mechanism was modelled by the real-balance effect, whereby economic agents aim at holding a given amount of money relative to the general price level. Milton Friedman (1968) consequently argued that monetary policy was neutral in the long run and the trade-off had to be described by the expectations-augmented Phillips curve where real wages or, taking into account productivity, the wage share respond negatively to unemployment. This neutrality assumption is a consequence of the ‘axiomatic construction’ of the natural rate, (see Phelps, 1995) or as Friedman (1975:25) put it:

“The purpose of the concept [of natural rate] separates the monetary from the non-monetary aspects of the employment situation – precisely the same purpose that Wicksell had in using the word ‘natural’ in connection with the interest rate.”

Yet, while for Wicksell there was no guarantee that the credit market would always reflect the ‘natural’ interest rate, the anti-Keynesian counter-revolution assumed that real wages would always return to the level corresponding to natural unemployment, perceived as the status quo ante. Despite Friedman’s vague reference to the Walrasian ‘general equilibrium’, this reduction was made possible by decomposing the system of general equilibrium equations and treating the labour market as a partial equilibrium, which can be solved in isolation. But if the labour market equilibrium is simultaneously determined with the capital market equilibrium – which after all is the defining property of capitalism – the dynamics of adjustment become richer and multiple ‘natural’ equilibria are possible (see also Dixon, 1995). Hence, policies to combat unemployment

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3 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.
that focus exclusively on the labour market ("structural reforms") are unlikely to pareto-improve sub-optimal equilibria, unless the corresponding new equilibrium in the capital market is established.

This raises questions for the role of monetary policy, because the natural rate (or the NAIRU) is often seen as a benchmark when monetary policy is aiming at price stability. For, if the capital market adjusts to labour market equilibrium, assuming a natural rate of unemployment will determine the natural rate of interest at which price stability is maintained. But if labour and capital market equilibria are determined simultaneously, this anchor for monetary policy disappears. Monetary developments in the 1990s have also shed some doubt on the NRH (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 rise. This fact has led to the construction of time-varying NAIRU models (Gordon, 1996). But, although a fairly stable non-accelerating rate of unemployment may still appear reasonable in the US case (Smyth and Easaw, 2000), the large fluctuations in Europe seem hardly compatible with the stable NRH, (Blanchard and Summers, 1988; Solow and Taylor; 1998 Collignon, 2002). It seems implausible that the secular rise in unemployment over two or three decades was due to expectational errors, or other adjustment dynamics leading to a progressive divergence from equilibrium (Karanassou and Snower, 1997). Karanassou et al (2003) show that the rise in EU unemployment in the 1970s and early 1980s was largely due to permanent shocks such as the decline in capital formation, while the increases of the early 1990s resulted from temporary shocks such as rising interest rates. Henry et al. (2000) observe for the UK that the natural rate has remained reasonably stable over time, while the medium-run swings in unemployment are due to very prolonged persistent (transitory but long-lasting) shocks. Haldane and Quah (1999) observe a similar pattern for the Phillips curve.

Karanassou and Snower (1997) have pointed at two alternative characterisations of the natural rate: (a) the stable, long-run equilibrium and (b) the equilibrium « at which there is no tendency for this rate to change at any time, given the values of the exogenous variables at the time. » In my model the Wicksellian equilibrium interest rate is such an ‘exogenous variable’, which prevents the natural rate of unemployment to be a reference point for monetary policy. However, I do not assume, as they do, that the capital stock is continuously increasing. My model therefore relies on the stronger characterisation of the natural rate (a), often used in theoretical models.
Shifting natural or time-varying NAIRU models pose two difficulties for monetary policy: 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 interest level to be targeted by the central bank? Secondly, if the average rate of unemployment can be shown to be 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 dependent on monetary policy.

In this paper I focus on the medium term effects of monetary policy for employment and the mechanism through which monetary policy is transmitted to the real economy over the long run. I will start with a narrow orthodox approach and then introduce capital into the natural rate model. Section 2 discusses the concept of the long-run equilibrium rate in the labour market. Section 3 shows how the mark-up and therefore price level is determined by the capital market. Section 4 describes the monetary policy objective function based on a wage feedback mechanism. Section 5 concludes.

2. Labour market equilibrium and the natural rate of unemployment

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, the NRH is "classical" in the sense that real wages are assumed to equate the quantities of labour supplied and demanded. Nominal wages have no role on their own, because wage earners are only interested in what money can buy. Because unemployment is exclusively determined by labour markets, goods’ prices and interest rates, i.e. the other markets in the Walrasian general equilibrium, cannot influence output and

5 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.
unemployment systematically. Hence, the long-run aggregate supply curve is vertical and money is neutral. Yet, this result depends entirely on the way the labour market is modelled.

The labour market equilibrium

In all standard models the demand for labour is derived from companies seeking to maximise profits. Firms operate with a standard homogenous production function depending on the input of labour (L) and capital (K) at a given technology (τ)

\[ Y = \tau F(L, K) \quad \text{with } F_L > 0, F_K > 0, F_{LL} < 0, F_{KK} < 0, F_{LK} > 0 \]

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

\[ \Lambda = \tau f(k) \quad f'(k) > 0, \quad f''(k) < 0 \]

with \( \Lambda = Y/L \) and the capital intensity \( k = K/L \). \( f'(k) \) is the marginal product of capital per unit of labour. \( \tau \) reflects Hicks-neutral technology, where the capital intensity remains constant.

Firms maximise short term profits defined as revenues minus the wage bill:

\[ \max \: \Pi = PY - WL = P \tau F(\bar{K}, L) - WL \]

where \( W \) is the nominal wage, \( P \) the price level and \( \bar{K} \) the given capital stock. For future reference we also define the capital share as the part of aggregate income that goes to capital. It is the complement of the wage share.

\[ \frac{\Pi}{PY} = \frac{PY - WL}{PY} = 1 - \sigma_w = \sigma_k \quad \text{(capital share)} \]

Short term maximisation yields:
(2b) \[ \frac{d\Pi}{dL} = 0 \Rightarrow PF_L(L, K) - W = 0 \]

and 6

(2c) \[ F_L(L, K) = \frac{W}{P} \]

Hence short-term profits are maximised by equalling the marginal product of labour at a given capital stock \( K \) to real wages. The demand for labour is a function of the real wage and the capital stock.

(2d) \[ L^0 = \Phi \left( \frac{W}{P}, K \right) \]

Changes in the demand for labour depend on changes in the real wage and the capital stock. By totally differentiating (2d) we get:

(2e) \[ dL^0 = (1/F_{LL})d(W/P) - (F_{LK}/F_{LL})dK \]

The economic definition of the short-run is that the capital stock remains constant; hence short run demand for labour falls with rising real wages, because \( F_{LL} < 0 \). However, it is also clear that in the long-run an increase in the capital stock will increase labour demand.

Next we look at labour supply. Because workers face a trade-off between leisure and consumption, labour supply is assumed to be an increasing function of the real wage and a vector of shift parameters \( X \):

(2f) \[ L' = \varphi \left( \frac{W}{P}, X \right) \quad \text{with} \quad \varphi_{w/p} > 0 \]

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 which are institutionally determined.

6 The second order condition describes a maximum, because \( PF_{LL} < 0 \)
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 the price-output space. Because of search costs, efficiency wages, and other microeconomic distortions, equilibrium employment (L*) and output levels maybe lower than full employment of the labour force (N) so that a given "natural" rate of unemployment (U*) is associated with a specific level of potential output.

(3) \[ U^* = N - L^* \]

actual unemployment is

(3a) \[ U = N - L^D \]

and excess demand for labour is

(3b) \[ U^* - U = L^D - L^* \]

Unemployment can result from distortions or short term misperceptions of the real wage that lead to temporary (although possibly persistent) disequilibria from the natural rate or from ‘structural’ shifts of the labour supply and demand curve. We will assume in this paper that the labour supply curve is fixed, not because the structural changes in the shift vector X are negligible, but because I believe the discussion on structural reforms of the labour market has unduly neglected the shifts in the labour demand curve. Assuming the usual supply and demand elasticities, any deviation of output or employment from equilibrium would bring about wage and price adjustments, pushing
the real wage back in line with the marginal product of labour. In this static model, the natural rate is constant. However, the adjustment process may take a long-time when the costs of adjustment such as search costs of entry and exit from the labour force or insider membership effects are high. These so-called structural factors create unemployment persistence, although the natural rate remains fixed.\(^7\)

A complement to the natural rate is the expectations-augmented Phillips curve. It assumes workers are interested in real wages, i.e. the purchasing power of their money wages. When bargaining for wage increases, they therefore take into account inflation expectations, secular productivity increases and actual unemployment relative to equilibrium (as a measure for labour market tightness). The idea is that it is real and not nominal wages and given productivity, also the labour share that rise with excess demand for labour:\(^8\)

\[
\Delta w = \alpha_1 \Delta p^e + \Delta \lambda + \alpha_2 (u^* - u),
\]

were \(\Delta w\) stands for the proportional rate of wage increases and \(\Delta p^e\) for the expected rate of inflation; \(\Delta \lambda\) is the secular growth in labour productivity and \(u^* - u\) is excess demand for labour. The coefficient \(\alpha_1\) is a parameter for wage indexation or nominal wage rigidity. \(\alpha_2\) measures the elasticity by which wages respond to excess demand in the labour market. The value of \(\alpha_1\) is controversial. Friedman assumed \(\alpha_1 = 1\), but Sargent showed that under the rational expectations hypothesis this must always hold. Yet, with adaptive expectations or staggered wage setting (Taylor, 1979; Fischer, 1977) \(\alpha_1\) may be less than 1. In the very short term \(\alpha_1\) may even be zero.

Assuming \(\alpha_1 = 1\) the bargained real wage increases above productivity growth and the expected wage share rises when actual unemployment is below the natural rate.\(^9\) \(\alpha_2 \geq 0\) is the slope of a log-linear short-term Phillips-curve and is a parameter for real rigidity in the labour market. The

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\(^7\) Natural unemployment would only shift, if there is hysteresis. See below and footnote 38.

\(^8\) Small letters denote logs, unless otherwise specified.

\(^9\) (4a) \[\Delta w - \Delta p^e = \Delta \lambda + \alpha_2 (u^* - u)\] (bargained real wage)

(4a’’) \[\Delta w - \Delta p^e - \Delta \lambda = \alpha_2 (u^* - u)\] (expected wage share)
natural rate hypothesis would imply a unique and stable real wage path following secular productivity growth and a vertical long-run Phillips curve that shifts upward with rising inflation.

At this point it is useful to remember that the real wage is always identically equal to the rate of average labour productivity times the wage share in income. \( W/P = \Lambda \sigma_w \) or in logs:

\[
(5) \quad w - p = \lambda + s_w
\]

where \( s_w = \ln \sigma_w = \ln(1 - \sigma_k) \)

Equation (5) will also be useful for the definition of the price level in the next section. We will use a simple model, where prices are determined by a mark-up on unit labour cost,

\[
(5a) \quad p = w - \lambda + c \quad \text{(price equation)}
\]

So that the mark-up is the inverse of the labour share, i.e.

\[
(5b) \quad c = -s_w
\]

We also define the targeted mark-up from the price level firms seek to achieve.

\[
(5c) \quad c^T = -s^T_w = p^T - (w - \lambda) \quad \text{(targeted mark-up)}
\]

Inserting (4) into (5c) shows that if price setters target the expected rate of inflation, a change in the targeted mark-up is a function of labour market disequilibria.\(^{11}\) Only at the natural rate will the targeted mark-up be constant.\(^{12}\)

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\(^{10}\) With a Cobb-Douglas production function the wage share is determined by technology. In reality a stable wage share implies that real wages are increasing at the same rate as labour productivity.

\(^{11}\) In fact, it would be more precise to say that our modified Phillips curve is the property of a bivariate joint distribution between the targeted mark-up and unemployment « and nothing more », as Haldane and Quah (1999 :263) emphasise. In this interpretation a projection of the targeted mark-up on unemployment makes as much sense as one of unemployment on the targeted mark-up.
An increase in the targeted mark-up would require that unemployment rises above the natural rate and a fall in unemployment implies a fall in the targeted mark-up. However, there is a question of causality. If the natural rate is exogenously given by labour supply and demand, as assumed by the natural rate hypothesis, then a surprise inflation would increase realised mark-ups above the level targeted by wage bargainers. Real wages would fall, labour demand increase and unemployment falls below equilibrium. At that point real wages will increase again, as workers seek to restore the purchasing power of their wages (adaptive expectations) or try to increase the wage share (the ‘justice motive’ – see Hahn and Solow, 1995). If price setters target a constant mark-up, prices will increase with rising wage costs, but the labour market returns to its ‘natural’ equilibrium. Surprise inflation will only reduce unemployment temporarily, while the actual mark-up is the adjustment variable. The only permanent effect would be an increase in nominal variables or a vertical shift of the Phillips Curve.

The story is different if we take the targeted mark-up as the exogenous variable and the labour market adjustment as endogenous. Assume for a moment that firms will increase their targeted mark-up permanently. I will discuss the reasons in the next section. An initial increase in $c^T$ will require, according to (5d), that unemployment rises above the natural rate. There is no other way to lower real wages. But once mark-ups have achieved their targeted new level, they will not come down. The higher actual rate of unemployment will become the new natural rate. But how will the labour market adjust to this new equilibrium? The endogeneity of the labour market requires in this case that the labour demand curve shifts downward. According to equation (2e), this is only possible if firms reduce their capital stock. I will provide an explanation for this below. Here we simply note that the new (higher) natural rate is a long-term consequence of a permanently higher required mark-up by firms.

\begin{equation}
\Delta c^T = -\alpha_2 (u^* - u) \tag{modified Phillips curve}
\end{equation}

12 Note that for Friedman the relation was between the actual mark-up (real wage at given productivity) and excess demand of labour, while in this model it is the targeted mark-up. As we will see this makes a crucial difference.
We can picture this relationship in Figure 2. The upper part reproduces Figure 1, the lower part shows the modified Phillips curve.

Figure 2

If the targeted mark-up changes only in the short-run and returns to the initial position, we move on the $c_o^T$ curve, which cuts through the zero-line at the natural rate $u_o^*$. The slope of the $c^T$ curve is identical to the slope $\alpha_2$ of the Phillips curve. However, if the targeted mark-up changes permanently, a permanently lower real wage is required (given productivity), which can only be obtained by shifting the labour demand curve to the left i.e. by lowering the capital stock. At the new equilibrium ($L'$) the $c^T$ curve has also shifted to the left. In this new position the
increase in the initial mark-up is stabilised because the lower capital stock has reduced unemployment. *The natural rate of unemployment has permanently increased and the Phillips curve has shifted horizontally.*

The difference between the two explanations for monetary policy is fundamental. If the natural rate is exogenously given, a fall in the real wage (an increase in the mark-up) by orchestrating a surprise inflation can temporarily stimulate employment,\(^{13}\) as postulated by the NRH. But if the mark-up is exogenous, the labour market has a continuum of equilibria and the natural rate (or the NAIRU) does not provide any guidance for monetary policy. We therefore need a theory for explaining the exogenously set mark-up.

3. Capital market equilibrium and the mark-up

In this section, I will provide a theory where the mark-up is determined by the capital market. I define the capital market as the market where financial claims for real assets are traded. The net wealth of an economy consists of all real assets. Because ownership and possession of real assets do not necessarily coincide, the financial assets of one are the liabilities of another. To make things simple we assume that the private non-banking sector (PNB) has a choice of holding its wealth in the form of financial claims, i.e. currency and deposits and as possession of real assets, called private capital.\(^{14}\) Hence, money (i.e. a claim) is not net wealth in the economy (see also Dullien, 2003). Deposits are created by banks lending to firms at the prevailing interest rate. Interest rates may be fixed over the entire period of the loan like in the case of bonds, or variable as for overdraft facilities. As we will see below, this has consequences for the conduct of monetary policy. Firms pay their workers and suppliers with deposits or with currency (an asset swap within the PNB). Currency is created by the central bank lending to commercial banks.\(^{15}\) Currency is the reserve asset that extinguishes debt contracts. It therefore has the utility of being a liquid store of wealth and this is the motive to hold currency. The price for this liquidity is the

\(^{13}\) Note that this is a consequence of the axiomatic definition of the short-term, i.e. the notion of “temporarily”. Because the capital stock does not change, employment can only change temporarily.

\(^{14}\) I borrow the concept from Tobin and Golub (1998:135)

\(^{15}\) In the American tradition of modelling money creation through open market operations, currency is created by making payments for these transactions, so that the creation of currency is an asset swap within the financial sector.
interest rate controlled by the central bank. Financial claims held by the central bank, like all financial claims, earn interest that needs to be serviced by currency repayments. This fact creates a structural shortage for liquidity in the money market, i.e. in the market between financial institutions, that allows the central bank to set their interest rate as the marginal price for currency. To simplify even further, we abstract from default risk, and let banks operate without profit, so that they lend to firms at the same rate at which they borrow from the central bank.

Firms borrow from banks if they expect to earn a profit at least sufficient to service their liabilities. With the borrowed funds they buy capital equipment (real assets), which they use together with labour in the production of goods and services, thereby creating income. We will call the excess of profits over the cost of capital entrepreneurial profits. As a consequence, the capital share of income must be sufficient to service at least the interest and repayment cost of the aggregate capital stock, which is equal to the outstanding liabilities (Gross Monetary Assets). In aggregate we may call entrepreneurs the receivers of entrepreneurial profits and rentiers the class of financial asset holders who are remunerated by interest payments.

An important implication of this model of the monetary economy is that increases in wealth and the creation of income depend on capital, i.e. monetized real assets rather than resource endowment. In this simplified economy money is endogenously generated by firms’ demand for loans or financial institutions’ demand for liquidity (base money). The central bank is therefore a price setter for liquidity and not a quantity setter. It uses interest rates to conduct monetary policy and steers money supply by affecting the conditions for money demand. How is the aggregate price level determined in such a model?

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16 The theoretical implication is that the real interest rate has to be positive in a functional monetary economy, for otherwise currency is not a store of wealth and has no utility. In practice a low negative interest rate is compatible with a monetary economy as real assets also have some carrying costs. See Keynes, 1936: Chap 17.

17 In our simplified world there is no government. If we introduced government, which borrows money by issuing bonds, the debt service would have to be covered by future taxes. If these future tax liabilities match the NBP’s claims against the government (Ricardian equivalence), financial assets issued by the government are not private wealth. Tobin and Golub (1998:135) have recognised this by subtracting them from Gross Monetary Assets (GMA) and calling Private Wealth the sum of Net Monetary Assets (NMA) plus Private Capital (PC). Without government GMA and NMA are the same and private wealth is the sum of GMA plus PC, which equals the value of real assets.

18 Firms also do not hold liquid assets in equilibrium.

19 The firm’s own capital is a liability against the shareholders and as such part of GMA. Firms are run by manager’s who earn a wage.

20 This distinction is analytical, given that share capital combines both types of revenue empirically.
Determining the price level

For Keynes, it was the wage unit that anchored nominal values to the real economy (Keynes, 1936:41; Desai, 1995). In early Keynesian models, prices were linked to wages by a fixed mark-up. In recent years micro-based models of monopolistic competition have provided a rational of more or less fixed mark-ups (Blanchard and Fischer, 1989; Carlin and Soskice, 1990; Coricelli, Cukierman and Dalmazzo, 2003). However, Keynes' own theory of the mark-up, as developed in the Treatise of Money (1930), derived the mark-up from macroeconomic conditions.21 For simplicity I will use Keynes’ model, although the monopolistic model is not incompatible with it (see Dullien, 2003).

The link between the wage unit, prices 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 "entrepreneurial income",22 or aggregate excess profits, a term called Q, 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 can also be expressed in the form of Tobin’s q so that q = 1 when entrepreneurial income is zero.23 Tobin's q 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 cost of capital.

\[
q(i) = \frac{1+i_k}{1+i} = \frac{1+i_k - E(\Delta p)}{(1+i - \Delta p)} \approx \frac{R}{r}
\]

21 In the General Theory Keynes hid his mark-up theory behind the concept of user cost. Riese (1986) has reformulated the theory to a fully-blown theory of inflation. See also Collignon, 1997.
22 Keynes, 1930, p. 53. For his explanation of the link between the Treatise’s entrepreneurial profits and the General Theory’s aggregate income, see Keynes 1973: 424-437.
23 The Q-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.
where \( i_K \) is the internal rate of return, \( R \) the expected real return on investment and \( r = i - \Delta p \) the real short-term interest rate. \( \Delta p \) is the current rate of inflation and \( E(\Delta p) \) is the expected average inflation rate over the life of the capital equipment.\(^{24}\) Thus, \( q \) is the shadow price of capital that expresses windfall profits. \( q(i) \) is a function of the interest rate \( i \), which is controlled by the central bank.\(^{25}\) The effect of monetary policy on \( q \) is:\(^{26}\)

\[
(6a) \quad q_i = \frac{\partial q}{\partial i} = \frac{R_i - R}{r^2} < 0
\]

\( R_i \) measures the degree by which expectations on the return on capital are affected by variations in interest rates. In a strictly neoclassical world, where \( R \) reflects the marginal product of capital \( R_i = 0 \) and \( R = r \), so that \( q_i = -\frac{1}{r} \). Normally the expected rate of return would be negatively influenced by higher interest rates \( (R_i < 0) \)\(^{27}\), and \( q_i \) should be smaller than the factor \(-\frac{1}{r}\). Thus, in general, \( q_i \) is negative and its absolute value rather large.\(^{28}\)

\(^{24}\)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 of interest, the marginal efficiency of capital has to be higher under disinflationary conditions. Equation (9) below shows that this will lead to a lower capital stock, so that natural unemployment rises in disinflations.

\(^{25}\)In more complex models, \( q \) is also related to the real exchange rate and fiscal policy (Collignon, 1997). Because we have taken \( i \) as exogenously given by monetary policy, our model implies that the marginal product of capital \( F_K = R \) will adjust to \( r \) - and not the other way round. 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.

\(^{26}\)Starting in equilibrium and taking the total differential of (6) yields (6b): \( dq = \frac{1}{r} dR - \frac{R}{r^2} dr \). In the very short-run, the inflation rate is fixed so that \( dr = di \). In equilibrium \( q = 1 \) and therefore \( R = r \), for \( r \neq 0 \) Inserting these values into (6b) and dividing by \( di \) yields: \( q_i = \frac{dq}{di} = \frac{1}{r} [R_i - 1] < 0 \), which is a reduced version of (6a).

\(^{27}\)This might be the case when the central bank follows an aggressive interest rate policy to combat inflation as in Goodfriend (1998)

\(^{28}\)In a neo-classical model, the cost of capital match the marginal product of capital. Q-profits can then be interpreted as the macroeconomic producer surplus, which can be positive or negative. In models with imperfect competition, the price mark-up is added to total marginal cost. In my definition, the mark-up is added to the labour cost and covers the cost of capital plus \( q \)-profits. Either way the mark-up would vary with \( q(i) \).
Building on Tobin’s formulation for entrepreneurial income and splitting the costs of production into wage costs (i.e. unit labour cost \( W/\Lambda \)) and the (rental) cost of capital per unit of output \((i*b)\), Keynes' fundamental equation can be reformulated as:

\[
P = \frac{W}{\Lambda} + i*bq(i) = \frac{W}{\Lambda} \left( 1 + \frac{i*b}{W/\Lambda}q \right)
\]

Or in logs:

\[
p = w - \lambda + \ln \left( 1 + \frac{i*b}{W/\Lambda}q \right)
\]

Prices are determined by unit labour costs and the mark-up, which has to cover the cost of capital and entrepreneurial income. The value of capital equipment purchased is equal to the value of loans \((P_0K=B)\) and \(b\) is the ratio of outstanding loans \((B)\) to output \((Y)\) or the historic value of capital per unit of output. Furthermore, we assume that B can be divided into two kinds of credit contracts: fixed rate contracts freeze the interest rate over the entire life of the loan and flexible rate contracts vary the cost of borrowing with the marginal interest rate set by the central bank. Capital equipment is purchased by a combination of fixed and flexible rate finance agreements, where \(\phi\) is the share of loans financed by fixed rates. The cost of capital per unit of output is:

\[
(7a) \quad i*b = [(\phi i^{fix} + (1-\phi)i^{flex})] \frac{B}{Y}
\]

We assume all capital equipment is purchased at the beginning of the period. The cost of capital, which also represents the required rate of return, is then dependent on the capital-output ratio and financial structure in the economy. The larger the share of flexible rate contracts \((1-\phi)\), i.e. the more the financial system operates as a spot economy (Riese, 1997), the higher will be the volatility of the required rate of return. By contrast, in economies which operate like coordinated market economies dominated by long-term contracts (Hall and Soskice, 2001), volatility should be lower.

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29 At the firm level the cost of capital consists the interest paid for the loan and of the depreciation \(\delta\) of and the capital stock \((i^*+\delta)b\). However, if we look at net value added in the economy it is net investment that matters and we can ignore depreciation.

30 If we were dealing with gross capital, a term \(\delta\) for depreciation would have to be added into the square bracket.

31 Equation \((7a)\) could also be reformulated as a model of overlapping credit contracts over time, where \(i^{fix}\) and \(i^{flex}\) represent different interest rates at different points in time and the cost of capital is a moving average. However, we will stick here with the fixed/flexible model as it allows us a simpler modelisation of the effects of monetary policy.
Equation (7) and (7a) formulate an explicit theory for the mark-up, which is determined by the cost of capital and the margin of entrepreneurial profits, given unit labour costs. It makes no assumptions about degrees of monopolistic competition or the monetary aggregates, which dominate the neoclassical IS-LM model. From (6) we know that when the actual return on capital is equal to the required return \( i^* \), there are no entrepreneurial profits: \( q(i^*) = \bar{q}(i^*) = 1 \). The market value of the investment project is then equal to its replacement costs and its net present value is zero. This reflects therefore the "normal" or natural capacity utilisation of the firm, at which the mark-up is just sufficient to cover the cost of capital. Thus, \( i^* \) is Wicksell’s natural rate of interest when \( q(i^*) = \bar{q}(i^*) = 1 \). We then also have the equilibrium price level \( P^* \) determined by unit labour costs \((W/\Lambda)\) and the “normal” cost of capital per output.

\[
(7') \quad P^* = \frac{W}{\Lambda} + i^* b \quad \text{or} \quad P^* = w - \lambda + c^{r*}
\]

where \( c^{r*} = \ln(1 + \frac{i^* b}{W/\Lambda}) \).

Because \( i^* \) is the required rate of return, \( c^{r*} \) is the minimum mark-up, which firms need to target in order to service their debt liabilities and stay in business. This explains why the mark-up is the exogenous variable and not real wages. Firms must set prices so that they cover their cost of capital, and real wages will adjust, which has consequences for employment (see equation 5d).

The Walrasian system clears by adjustment in the labour market, as Franco Modigliani never ceased to remind us (Modigliani 1997).

**The mark-up and interest rates**

We now look at how monetary policy affects inflation and the mark-up. Taking first differences of (5a) gives us the inflation rate. Using \( \Delta c = \frac{d\mu}{\mu} \), where \( \mu = \frac{i^* b q}{W/\Lambda} \) we get the elasticity by which the mark-up responds to an interest variation:
We can then write the inflation equation:

\[ \Delta p = (\Delta w - \Delta \lambda) + \beta \Delta i \]

Inflation is determined on the supply-side by unit labour cost increases and on the demand-side by monetary policy. An interest rate increase \( \Delta i \) operates through two transmission channels: higher interest rates increase capital costs, as shown by the second part of the RHS in (7c) and therefore raise equilibrium prices. At the same time higher interest rate reduce demand (because \( q_i < 0 \)). In general, a rise in rates by the central bank will lower the actual mark-up and prices if the demand effect \( \frac{i^* q_i}{q} \) dominates the cost effect \( (1-\phi) \frac{q}{i^*} \). And cutting interest rates will stimulate demand. We assume that this is generally the case, so that \( \beta < 0 \). However, the larger the share of flexible rates \( 1-\phi \) in the economy, the lower will be the elasticity \( \beta \) by which prices respond to monetary policy.

If the central bank wishes to reduce inflation, it must increase interest rates. But by doing this, it also increases the targeted minimum mark-up \( c^T^* \) as long as there are some flexible rate credit contracts. When firms try to recover the mark-up required to service their debt, they have to target an increase:

\[ \Delta c^T = \Delta c^T^* - \beta \Delta i \]

\[ \phi < 1 - r - 2\Delta p - \frac{\Delta p^2}{r} \).

\[ (7c^c) \quad \frac{\partial e^*}{\partial i} = \frac{\partial \mu^*}{\partial i} \mu \frac{1}{i} = \phi \frac{1}{i} \]
An increase in interest rates will unequivocally raise the targeted mark-up of firms, and, according to (5d), this will push unemployment up. If all loans were fixed rate contracts ($\phi=1$), monetary policy would only have a direct impact on profit inflation but not on capital cost: a rise in interest rates ($\Delta i$) would lower $\Delta p$, because lower effective demand will reduce profits ($q_i < 0$). Thus, the price level would fall below its expected equilibrium level ($p < p^*$), reducing the actual mark-up below the targeted level. In order to survive and service their debt obligations, firms will now target a higher mark-up, which can only be achieved by higher unemployment. \footnote{In fact, lower employment may simply be the consequence of the bankruptcies of marginal firms and that may accelerate productivity growth.} If the lower mark-up leads to a reduction of the capital stock, the labour demand curve will shift to the left until the mark-up has attained the level necessary to service capital. The natural rate of unemployment will have risen as a consequence of a persistent one-off increase in interest rates. The opposite movement occurs when the central bank cuts interest rates. By setting the marginal interest rate $i^{\text{flex}}$, the central bank affects the required mark-up, but the impact of its action $\Delta i$ is determined by the financial structure represented by $\beta$. When credit contracts have a high share of flexible rates, the targeted mark-up will be higher than in the fixed rate economy, so that unemployment becomes more volatile. A spot economy therefore requires more “flexible labour markets” (in terms of hire and fire) than a contract economy.

**Determining the capital stock**

In this model, monetary policy determines the equilibrium towards which the capital market will converge. To this Wicksellian natural interest rate corresponds one out of a continuum of many possible labour market equilibria. Hence, it is indeed the capital market and Wicksell’s natural rate of interest that establish the natural rate of unemployment. How the labour market adjusts to this capital market equilibrium can be modelled by using Tobin’s investment function for explaining changes in the capital stock. This shifts our focus to the impact of monetary policy on entrepreneurial profits.
Profit-seeking entrepreneurs compare the rate of return from productive investment to the cost of borrowing monetary assets. Unless investing in capital equipment yields at least as much as the cost of capital, there is no incentive to increase the capital stock. If the return is less, firms go bankrupt and this reduces the value of the capital stock. In neo-classical models, $R$ 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 ($F_K = R$) is equal to $r$. Thus entrepreneurial profits (quasi-rents) tend to disappear as the capital stock increases. The capital stock is in equilibrium at Wicksell’s natural rate, when all opportunities for entrepreneurial profits have been exhausted and the return on capital reflects the costs of borrowing so that Tobin’s $q(i^*)=1$. The economy consists then only of workers and rentiers. The speed of convergence to equilibrium after an interest shock depends on the cost of adjustment: if these costs were zero, $q$ would instantaneously jump to $\bar{q}$. As long as adjustment costs are positive, transitory disequilibria following policy measures may be long-lasting.

The rate of investment is determined as a function of Tobin's $q$:

$$dK = a_0 + \varphi\left[q(i) - \bar{q}(i^*)\right]$$

Because our model deals with net capital and abstracts from depreciation, investment at the natural rate ($a_0$) equals zero. In order to stimulate net investment, expected entrepreneurial profits must be larger 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 additional

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35 Tobin’s model of $q$ was about portfolio allocation between holding different financial assets (money and bonds). However, given our simplified financial system, the same argument can be made by comparing the return on capital with the cost of capital.

36 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).

37 This euthanasia of entrepreneurs is due to the fact that we model share capital remunerated at the cost of loans as rents.

38 In a steady state growth model à la Solow, it would reflect the growth of the labour force. See Collignon 2002.
output covers excess demand and the capital stock has adjusted to the new equilibrium \((q(i) = \bar{q} = 1)\). At that point the price level will have returned to \(P*\). Keynes’ price equation (7) implies that 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 to equilibrium. Hence, the demand-induced acceleration of inflation is transitory - unless it spills over into wage bargaining. Monetary policy affects simultaneously both prices (on the demand side via \(q\), and on the supply side via \(i^*\), the borrowing costs) and output quantities (via investment and demand). But the effects cease once \(q\) has returned to the level of \(\bar{q}\). Because the capital stock grows (or falls) during the entire adjustment period, the effects of a persistent interest variation are transitory on demand but permanent on the capital stock, output and employment. Aggregate demand has hysteresis effects, although monetary policy does not. Nevertheless, monetary policy is not neutral, as it causes the demand effects. This analysis sheds some light on the empirical findings by Karanassou et al. (2003), Henry et al. (2000) as well as by Haldane and Quah (1999). These authors found an apparent stability of the natural rate and the Phillips curve in the very long-run, although in the medium term there is an ambivalence between the very prolonged after-effects of persistent shocks and structural shifts in the natural rate. My reading would be that in the very long-run interest shocks are i.i.d. with zero mean, while in the medium term persistency in interest rates causes shifts in the natural rate. We therefore need to explain this persistency in interest rate variations.

4. Monetary Policy and Inflation Dynamics

We can now describe the role of monetary policy for the inflation process. Starting in equilibrium, let us cut interest rates. Additional investment opportunities become available, firms borrow funds to buy capital equipment, thereby expanding monetary supply. This causes a (transitory) profit inflation \((q\) increases). As the capital stock grows and more labour is employed, the supply of goods and services grows and extra profits are competed away. Prices return to their

\[39\text{Remember that } P^* \text{ reflects capital costs which may have been affected by the interest variation, so that } P^* \text{ is not necessarily constant.}\]

\[40\text{Hysteresis is defined as the response of a system when there is permanent effect on output after the value of input has been modified and brought back to its initial position. Amable et al. 1995:155.}\]
cost level. However, labour cost may also rise in the process, as the labour market tightens and workers try to recuperate their lost purchasing power. The interaction between profits and wages will create the inflation process.

Because the profit inflation is a transitory shift in the price level, sustained inflation is driven by the supply side cost push in unit labour costs \((\Delta w - \Delta \lambda)\), although it is sparked off or restrained by an exogenous demand effect. Monetary policy aiming at maintaining price stability will use interest rate variations to achieve this objective. However, as equation (8) shows, monetary policy can only affect the mark-up directly, not unit labour costs. Its success therefore depends on the indirect effects of demand on prices and on the response function of wage bargainers’ inflation expectations.

*The central bank’s reaction function*

Assuming an exogenous inflationary shock, let us first look at the central bank’s reaction function. From (8) we can formalise the extent of an inflation-stabilising interest rate move by:

\[
\Delta i = \frac{\gamma}{\beta} [\pi_m - (\Delta w - \Delta \lambda)]
\]

\(\pi_m\) is the inflation target of the central bank. Monetary policy will remain neutral as long as the increase in unit labour costs is exactly equal to the inflation target. But if wage increases rise above the inflation target, the central bank will put rates up. The extent of the rate response to excessive wage increases depends on the financial structure parameter \(\beta\) and the parameter \(\gamma\) for central bank conservatism. Given our discussion of the elasticity parameter \(\beta\) above, we would expect that the interest rate reaction by the central bank is higher in spot economies than in contract economies. However, the full extent depends on the parameter \(\gamma\), which indicates the

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41 In a flexible rate (spot) economy the equilibrium price level falls after an interest rate cut.
42 In our model the demand shock is caused by an interest shock. In a more complex model we have a whole range of exogenous shocks, such as exchange rates, oil prices, productivity etc.
43 Remember \(\beta < 0\).
degree of conservativeness by which monetary authorities respond to inflationary pressures. In principle a central bank could vary interest rates sufficiently aggressively to hold inflation always down to a desired path. With $\gamma = 1$, equation (10) simply indicates how large an interest rate variation would be required, in order to counterbalance the inflationary cost-push effect of wage settlements by a reduction of demand in order to achieve the inflation target. If wage pressure is high and/or $\beta$ low, this may lead to unexpectedly high interest rates (destabilising the financial system) or unexpectedly high unemployment (destabilising society). The central bank will then smooth interest rates (Goodhart, 1997) and it will have a reaction function that takes other factors than price stability into account. Therefore a “normal” conservative central bank would have a reaction parameter between zero and one but at the higher end. A $\gamma = 0$, the central bank is ultra-liberal or populist, as it would accommodate any wage settlement (Coricelli et al, 2003). In this case monetary policy would peg a given interest rate, but the price level would be indetermined (Sargent and Wallace, 1975), or rather exclusively determined by unconstrained wage bargains. In this case the targeted mark-up would be constant (or at least stationary) and the natural rate of unemployment an arbitrary constant corresponding to the pegged interest rate. Yet, for all $0 < \gamma < 1$ the time path of interest rates reflects the persistence of inflationary pressure and this persistence is higher, the lower $\gamma$. The consequence of a low $\gamma$ will be a relatively slow process of disinflation and a rising level of natural unemployment. A highly conservative central bank would therefore contribute to lower unemployment. An ultra-conservative central bank with $\gamma \geq 1$ would exhibit high volatility in interest rates, given the distribution of inflation shocks. However, because central bank conservatism may be reflected by wage settlements, the nature of the shocks may be significantly lower in conservative regimes, so that the time path of interest and natural unemployment could remain fairly stable (see next section).

Equation (10) brings out an interesting feature: because central banks need to maintain price stability in order to preserve the functionality of the monetary system (or simply because it is their mandate), it is the development of nominal wages (unit labour costs) that causes the long run level of interest rates. But because interest rates have consequences for firms’ required mark-
ups, wage bargainers determine in final consequence the time-varying natural rate. This shifts responsibility for unemployment, but also for price stability, back to wage bargainers.

*Labour markets and the central bank’s reputation*

Given the inflation target and the secular rate of productivity growth, the extent by which monetary authorities should move interest rates will depend on the increase in nominal wages. If unit labour costs remained stable, monetary policy could stay neutral. We will now look at the potential interactions between wage bargainers and monetary authorities enabling low natural rates of unemployment. A full explanation would require modelling the institutional structure of the labour market which is beyond the scope of this paper. There exists now a vast and diversified literature on the relationship of institutional structures of wage bargaining and economic performance (see Flanagan, 1999 for an overview). The focus is on collective bargaining structures and mechanisms to internalise the externalities of pursuing moderate wage demands. In an early paper Calmfors and Driffill (1988) conjectured a “hump-shaped” curve between the degree of centralised wage bargaining and the real wage. Subsequent research has shown that it is the coordination of wage contracts, rather than the institutional level of bargaining, that matters (Soskice, 1990) and Hancke and Soskice (2003) observe national wage competition taking hold in European labour markets creating an inflationary bias. Most of these models explain the *time-path of nominal wages as the result of relative wage changes* and relative bargaining power. However, institutional features like contract periods and indexation duration, both a function of negotiating costs, must also be taken into account. Overlapping labour contracts can be an important reason for nominal wage rigidity, affecting the efficiency of monetary policy (Fischer, 1977). I will argue below that, at least partly, the length of wage contracts will reflect the length of credit contract. However, important as these institutional features may be, the outcome of the *nominal* wage bargain will fundamentally be determined by inflation expectations. This fact assigns a crucial role to monetary policy.

Hall and Franzese (1998) have argued that the central bank’s disinflationary policies send a signal to wage bargainers that will induce them to settle for lower wage increases, if they are credible. This effect may well dominate the structural effects of wage bargaining. Dullien (2003)
points out that the optimal response by wage bargainers to the central bank’s signals may fail due to signal uncertainty, lack of coordination (insufficient information) or non-cooperation between monetary authorities and wage bargainers. I will not discuss theories of labour market behaviour in detail here. Instead I will distinguish two aspects of the wage bargaining process: the nominal rigidity/flexibility of wage settlements that are set by the institutional structures, and the credibility of the central bank’s commitment to its inflation target.

We will assume that nominal wage rigidity is reflected in the parameter $\alpha_i$ in our wage equation (4). On the other hand, the literature on wage bargaining and central bank independence deals with the credibility of monetary policy in the context of rational expectations. A fairly general synthesis would model expected inflation as the weighted average of the central bank’s inflation target and its record of past inflation:

(11) \[ E(\Delta p_t) = (1 - \vartheta)\pi_m + \vartheta \Delta p_{t-1} + \varepsilon_t, \]

where $\vartheta$ is the weight attached to past inflation and $\varepsilon_t$ is a white noise disturbance. The long run mean or steady state of the series is $\pi_m$, the central bank’s inflation target. The autoregressive coefficient $\vartheta$ is an indicator for the central bank’s commitment to price stability. If $\vartheta$ is high, price and wage setters attach little weight to monetary authority’s inflation target and therefore are backward looking in the formation of their price expectations. Hence, deviations from the steady state inflation target may become long-lasting. A low $\vartheta$ implies high credibility of the central bank's commitment to achieve its target, so that the persistence of inflation shocks is less.

To formulate the wage equation, we insert (11) into (4):

(11a) \[ \Delta w = \alpha_1[(1 - \vartheta)\pi_m + \vartheta \Delta p_{t-1}] + \Delta \lambda + \alpha_2(u^*-u)_{t-1} + \varepsilon_t, \]

as discussed above, $\alpha_i$ is the coefficient for nominal wage rigidity. If $\alpha_i = 0$, we have no indexation and perfect nominal wage rigidity; if $\alpha_i = 1$, nominal wages are perfectly flexible, as assumed by the rational expectations hypothesis. Nominal inertia (sticky wages) may arise from
staggered wage and price setting, from the cost of changing wages and prices, and from adaptive expectations. However, our analysis of credit contracts reveals an additional motive: risk averse firm managers would conclude long-term wage agreements if they have contracted fixed-rate loans and stable price expectations, as such wage settlement would increase the visibility and stability of their profit expectations. A contract economy would therefore exhibit a larger degree of price and wage stickiness than a spot economy. Finally, under simplifying assumptions \( \alpha_2 \) is the slope of the short term Phillips-curve and a measure of labour market flexibility. There are good theoretical reasons, supported by empirical evidence, to think that both \( \alpha_1 \) and \( \alpha_2 \) are regime dependent (Coricelli et al, 2003; Collignon, 2002). They are low in a low inflation regime with infrequent nominal contract changes and high if price stability is uncertain. However, for our argument here we may assume that \( \alpha_2 \) is constant.  

45 Substituting (11a) into (10):

\[
\alpha_2 \beta \int (1 - \alpha_1) \pi + \alpha_1 \kappa (\pi - \Delta p) - \alpha_2 (u^* - u) + \epsilon \]

Assuming that shocks are i.i.d with \( \text{E}(\epsilon) = 0 \), monetary policy could ignore short-term inflation shocks. We can then distinguish four idealised policy regimes: a perfect contract or a spot economy, each operating with either a perfectly credible or ill-reputed central bank where wage contracts are either forward or backward looking. Table 1 indicates the optimal interest variation, given the central bank’s reaction function (10). Assuming the degree of conservativeness \( \gamma \) and the financial structure \( \beta \) as given, the time path of the interest rate is not the same under each regime.

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45 Empirical estimates of wage equations show that \( \alpha_2 \) is normally much lower than \( \alpha_1 \). See De Grauwe, Micossi, Tullio, 1996
Table 1: Interest variations under different regimes

<table>
<thead>
<tr>
<th>Labour Market</th>
<th>Central Bank reputation</th>
<th>Sticky (\alpha_i = 0)</th>
<th>Flexible (\alpha_i = 1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(\vartheta = 0) Forward</td>
<td>(\frac{\gamma}{\beta} [\pi - \alpha_2 (u^* - u)])</td>
<td>(\frac{\gamma}{\beta} [-\alpha_2 (u^* - u)])</td>
<td></td>
</tr>
<tr>
<td>(\vartheta = 1) Backward</td>
<td>(\frac{\gamma}{\beta} [\pi - \alpha_2 (u^* - u)])</td>
<td>(\frac{\gamma}{\beta} [\pi - \Delta p_{-1} - \alpha_2 (u^* - u)])</td>
<td></td>
</tr>
</tbody>
</table>

With perfect nominal wage rigidity, it obviously makes no difference how credible the central bank’s future inflation target is. Monetary policy will then have to rely on Phillips curve dynamics (excess supply of labour) to reach its inflation target, although also shifting the natural rate of unemployment in the process. However, interest rates will only be moved, if labour market pressures exceed the inflation target. A relatively generous target and a flat Phillips curve would stabilise or even allow lower interest rates and natural unemployment. With nominal wage flexibility, the central bank’s reputation matters. If it is high, so that wage settlements are forward looking, monetary policy must be more active: because wage bargainers anticipate the inflation target, any tightening in the labour market leads to an overshooting of the central bank’s inflation objective and requires an immediate reaction. However, if restrictive monetary policy overshoots, so that actual exceeds natural unemployment and wages fall, interest rates will be cut again. Hence, in an economy with flexible labour markets, rational expectations and forward looking wage bargainers, the natural rate of unemployment will only be stable when the central bank is ultra-conservative. Finally, in an economy with flexible nominal wages but backward looking wage indexation, monetary policy is most restrictive, as it will not only have to react to wage pressure from labour market tightness, but also to deviations of past inflation from the inflation target. As a consequence interest rate variations may become quite persistent, causing significant shifts in the natural rate.
These four idealised regimes provide some indication for the interaction between monetary policy and unemployment. If society values both, high employment and high price stability, a flexible labour market with backward looking wage indexation is the least attractive regime. However, this is the most likely outcome if the degree of central bank conservatism ($\gamma$) is low. On the other hand, if central bank conservativeness is high, but not excessive, and pursuing a moderate inflation target, then it is likely that wage bargaining becomes forward looking and long-term wage contracts create both monetary stability and low equilibrium unemployment.

5. Conclusion

The natural rate hypothesis of stable equilibrium unemployment and the related claim of long-term neutrality of money are dependent on the axiomatic assumptions of a partial equilibrium in the labour market to which the capital market adjusts. A complement to this theory is the idea of exogenous money supply injected by central banks and the real balance motive for holding monetary assets in the non-banking private sector. However, in a world where central banks set interest rates as the marginal price for liquidity, money supply is endogenous to the demand for credit. In this case monetary policy will have long-term consequences, because the demand for credit depends on the rate of investment into capital goods. Monetary policy then affects simultaneously prices, and via capital also output and employment. The mechanisms by which monetary policy is transmitted to these variables depends on the financial structure of the economy (the mix between fixed and flexible rate credit contracts) and the institutional structures of the labour market. Monetary policy, which guarantees the sustainability of a monetary economy by maintaining price stability, will respond to inflationary shocks by raising interest rates, thereby increasing the required mark-ups for firms to service their financial liabilities. This leads to a reduction in the capital stock which will increase natural unemployment. Inversely, a
cut in interest rates will lower required mark-ups, increase entrepreneurial profits and investment and therefore employment. However, whether such stimulating policy is feasible depends on the sensitivity of wage bargainers to central bank objectives. We found that regimes of highly credible but also moderately conservative central banks together with nominal wage stickiness are preferable to inflation-accommodating authorities with flexible labour markets. The solution to bringing down unemployment is therefore less the structural reform of labour markets, but the establishment of a credible inflation fighting reputation by the central bank and long-termism in credit and wage contracts. This model seems to reflect Euroland’s reality
Bibliography


