THE NON-LINEAR LONG-RUN PHILLIPS CURVE: THE IMPLICATIONS FOR MONETARY POLICY

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1 INTRODUCTION

Since Friedman (1968) and Phelps (1967, 1968), the vertical long-run Phillips curve (LRPC) has held a pre-eminent position in macroeconomic theory. This position has not been seriously questioned. Empirical evidence which contradicted the notion of a vertical long-run Phillips curve was explained in a series of papers which can be loosely grouped as "hysteresis theories", which left the original long-run result intact.[1] Given the dominance of the theoretical view that there is no long-run trade-off between inflation and unemployment, an important question is why the actions of policy makers indicate a belief that the LRPC is not vertical. By arguing that low inflation is preferable to moderate inflation, policy makers indicate a belief that the LRPC has a positive slope over this range of inflation. Furthermore, by not attempting to eradicate the last few percentage points of inflation, policy makers also indicate they believe that the cost outweighs the benefits and that the LRPC has a negative slope over a range of low

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1 "Hysteresis theories" include: the insider-outsider theories of Lindbeck and Snower (1988a, 1988b) and Blanchard and Summers (1986); Layard and Nickell's (1986) argument that the relationship between unemployment and inflation is affected by the mix of short and long-term unemployment in total unemployment; and the impact of capital scrapping on inflation by Sneessens and Dréze (1986).

inflation. This paper argues that there are theoretical reasons why the long-run curve may indeed display this shape.

The paper begins by deriving an imperfect competition macroeconomic model in the Layard and Nickell tradition.[2] The standard Layard-Nickell model assumes that the desired real wage of firms is constant in the long-run and that unemployment adjusts to bring the real wage desires of employed labour into line with the real wage desires of firms. However, this assumption is not valid when the profit share of firms and inflation are inversely related in the steady-state. And yet, such an empirical regularity exists in the data of many economies.[3] The existence of a negative correlation between the profit share and inflation in the steady-state implies that the real wage and inflation are positively correlated for a given level of productivity. So unlike in the standard model, the data indicates the long-run real wage is not constant but is conditioned by the steady-state inflation rate. In a more general model derived in this paper, unemployment adjusts until the desired real wage of labour equals the desired real wage of firms as in the standard model, *but the real wage is also dependent on the rate of inflation in the long-run*. As a result, the LRPC is unlikely to be vertical.

Russell (1995) explains the steady-state correlation between inflation and the profit share by highlighting the missing information and uncertainty aspects of price setting. It is argued that non-colluding price-setting firms face a coordination problem as they

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[2] See Layard and Nickell (1985, 1986) or for a textbook treatment see Layard *et al.* (1991) or Carlin and Soskice (1990).

[3] Using US retail sector data, Bénabou (1992) finds that expected and unexpected inflation have a significant negative impact on the markup. Russell (1994a, 1994b, 1995) shows inflation and the markup of price on unit labour costs are negatively correlated in the steady-state for the United Kingdom, the United States, Japan, Germany and Australia. Cockerell and Russell (1995) estimate a price and wage system for Australia and find the same negative correlation in the steady-state.

adjust prices in response to changes in demand and costs.[4] They solve their coordination problem by taking a "gradualist" approach to price adjustment. The cost of overcoming the missing information in an inflationary environment is represented by the lower profit share in the steady-state.

The idea that inflation is associated with a lower profit share is straight forward. Information is a "real" variable and its absence should have real effects in the long-run. If following a shock, missing information causes problems for firms when coordinating price changes on the path back to maximum profits, then the real impact will be on the profit share. At zero inflation, there is no need to adjust prices; profits are at a maximum and the missing information imposes no costs on the firm. With steady inflation, firms need to regularly adjust prices and incur costs so as to insure against the repercussions of poor price coordination which leads to lower profits. Hence, profits are reduced not due to the missing information, but due to the interaction of inflation with the missing information.

The next section derives the LRPC for the imperfect competition model. In the general model when price adjustment is not costless to the firm and inflation and the profit share are negatively correlated in the steady-state, the LRPC is not vertical. The conditions necessary for the LRPC to be consistent with how policy makers behave are explored. It is shown that the policy rule followed by policy makers of *low but not zero* steady-state inflation is supported by the general model. Section 3 considers the long-run implications for inflation, unemployment and real wages of demand and real wage shocks within this analysis. Finally, section 4 looks at the implications for monetary policy and concludes.

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[4] A number of authors highlight the coordination problems faced by firms when adjusting prices. For example, see Ball and Romer (1991) Eckstein and Fromm (1968), Blinder (1990), Chatterjee and Cooper (1989).

2 THE LONG-RUN PHILLIPS CURVE

Assume a closed economy where capital and labour are the only inputs to the production process and there is exogenous trend productivity growth given by δ_p. Assume also that the economy is in general inflationary and the level of competition within the economy is given. Let the firm's desired long-run markup of price on unit costs, $\overline{\Pi}$, be given by[5]

$$\overline{\Pi} = \Pi_0 - \delta_C\left(\frac{\overline{\Delta p}}{\overline{\Delta p} + \delta_p}\right), \tag{1}$$

where Π_0 is the maximum desired markup of firms at zero inflation, Δp is inflation, δ_C is the inflation cost coefficient and the bar over a variable indicates its long-run value.[6] In the standard model $\delta_C = 0$ and the markup is constant in the long-run. In the general model where $\delta_C > 0$, the term $\delta_C\left(\frac{\overline{\Delta p}}{\overline{\Delta p} + \delta_p}\right)$ represents the cost of overcoming missing information when adjusting prices in an inflationary environment.[7] The desired markup, therefore, is at a maximum at zero inflation and converges in a non-linear fashion on $\Pi_0 - \delta_C$ as steady-state inflation tends to an infinite rate, giving rise to the inverse relationship between the profit share and inflation. The minimum markup

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5 Russell (1995) sets out an imperfect competition model of price adjustment with incomplete information which conforms with (1). For exposition purposes the terms "markup" and "profit share" are used interchangeably. The terms are related as: $\text{Markup} = 1/(1 - \text{Profit Share})$.

6 Lower case variables are in logs. The "Δ" signifies the change in the variable and, therefore, for small changes it is approximately the proportional change in the variable. The markup, Π, is the ratio of two levels.

7 An alternative explanation of the long-run relationship is that competition increases in customer markets as inflation increases because the more frequent price changes increase the search undertaken by customers. As a result, the markup falls with increasing inflation and competition. See Bénabou (1992).

must not be less than unity as firms cannot systematically make losses in the steady-state.

Consider now a simple imperfect competition desired real wage function for employed labour for a given level of productivity, Φ,

$$W = P^e \Phi (Z_0 - Z_1 U), \tag{2}$$

where U is the unemployment rate and W and P^e are the wage rate and expected price level respectively, Z_0 is employed labour's excess real wage demands over productivity at zero unemployment and Z_1 is the sensitivity of labour's desired real wage with respect to the unemployment rate.[8] One interpretation of the wage function is that wages are determined by collective bargaining at the firm or industry level. Employed labour is concerned with the expected real wage and their bargaining position depends on conditions in the labour market which are represented by the unemployment rate.[9] Low unemployment corresponds to a strong bargaining position for labour and implies a high desired real wage relative to a given level of productivity. From (2), labour's desired expected markup function is

$$\Pi_L^e = \frac{P^e \Phi}{W} = \frac{1}{Z_0 - Z_1 U}. \tag{3}$$

In the long-run, inflationary expectations are met with $P = P^e$ and the markup desired by labour and firms must be equal. By eliminating the markup from (1) and (3) we can derive the long-run relationship between inflation and unemployment as

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8 Rearranging (2), labour's excess real wage demands at zero unemployment are $Z_0 = \left(W / P^e\right) / \Phi$. If unemployment exists in the steady-state, Z_0 is presumably greater than unity. For simplicity and so as to concentrate on the long-run relationship, the wage function excludes a hysteresis term.

9 This wage function can be interpreted as the bargained real wage function of the conflicting claims model. See Layard *et al.* (1991), Carlin and Soskice (1990). For an extensive theoretical and empirical examination of the wage function see Blanchflower and Oswald (1994).

$$\overline{\Delta p} = \frac{\Pi_0 \delta_p (Z_0 - Z_1 \overline{U}) - \delta_p}{1 - (\Pi_0 - \delta_c)(Z_0 - Z_1 \overline{U})} = \left[\frac{\Pi_0 - \overline{\Pi}}{\overline{\Pi} - (\Pi_0 - \delta_c)} \right] \delta_p, \qquad (4)$$

or equivalently

$$\overline{U} = \frac{1}{Z_1} \left[Z_0 - \frac{\overline{\Delta p} + \delta_p}{\overline{\Delta p}(\Pi_0 - \delta_c) + \Pi_0 \delta_p} \right] = \frac{1}{Z_1} \left[Z_0 - \frac{1}{\overline{\Pi}} \right], \qquad (\Pi_0 - \delta_c \geq 1). \qquad (5)$$

Equation (5) shows that unemployment in the long-run depends on the interaction of the excess real wage demands of labour, Z_0, and the profitability of firms, $\overline{\Pi}$. If the markup, $\overline{\Pi}$, is constant in the long-run and $\delta_C = 0$ (ie. $\overline{\Pi} = \Pi_0$) then the general model reduces to the standard Layard-Nickell imperfect competition model with a vertical LRPC.[10]

Alternatively, consider the general model set out here where the long-run markup is dependent, in part, on the rate of steady-state inflation and $\delta_C > 0$.[11] We now find unemployment in the long-run is that necessary to reduce the real wage demands of labour to equal the desired real wage of firms net of the cost of inflation. Equation (4) shows that, when $\delta_C > 0$, stable inflation in the long-run depends on the balance

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[10] In this case, unemployment in the long-run is that necessary to reduce the real wage desires of labour (given by (2)) to equal the constant real wage desires of firms which is equivalent to the inverse of the markup $1/\Pi_0$. If we substitute the expression for long-run unemployment into (4), we find the standard result that inflation is undefined in the long-run and can hold any constant value.

[11] It may be that some firms benefit from inflation which will reduce δ_C. For example, in an inflationary environment, firms may be able to hide an increase in their profit share. If overall, firms benefit from inflation then $\delta_C < 0$. However, given that the empirical relationship indicates a negative correlation between the profit share and inflation, it would appear that the costs outweigh the benefits (if they exist), and it is legitimate to assume $\delta_C > 0$. Further evidence that inflation imposes costs and not benefits on firms is the frequently expressed desire of firms through business associations for low inflation.

between the firms inflationary pressures due to the markup, and the inflationary pressures from labour. As long as the long-run markup lies between its minimum and maximum values, such that $\Pi_0 - \delta_C < \overline{\Pi} < \Pi_0$, then there exists a stable positive rate of inflation in the long-run. By rearranging (4), we also see that higher growth in trend productivity is consistent with a higher markup for given inflation in the long-run.[12]

Turning now to the slope of the LRPC which can be seen most clearly by differentiating (5), which provides

$$\frac{\partial \overline{U}}{\partial \overline{\Delta p}} = \frac{1}{Z_1}\left[\frac{\partial Z_0}{\partial \overline{\Delta p}} - \frac{\delta_c \delta_p}{\left[\overline{\Delta p}(\Pi_0 - \delta_c) + \Pi_0 \delta_p\right]^2}\right] = \frac{1}{Z_1}\left[\frac{\partial Z_0}{\partial \overline{\Delta p}} + \frac{1}{\overline{\Pi}^2}\frac{\partial \overline{\Pi}}{\partial \overline{\Delta p}}\right]. \qquad (6)$$

For the general model where $\delta_C > 0$ the slope of the LRPC depends on the relative impact of changes in inflation on the real wage demands of labour $(\partial Z_0 / \partial \overline{\Delta p})$ and on the steady-state markup of firms $(\partial \overline{\Pi} / \partial \overline{\Delta p})$. If the excess real wage demands of employed labour are independent of steady-state inflation, and $\partial Z_0 / \partial \overline{\Delta p} = 0$, then the LRPC has a negative slope as $\partial \overline{\Pi} / \partial \overline{\Delta p} < 0$. This is shown in Figure 1 as $LRPC_1$. At low inflation, the firm's long-run markup is high which implies a low real wage. To restrain the real wage demands of labour so they are consistent with the firm's high markup, unemployment must also be high.

However, it is likely that the excess real wage demands of labour are not independent of inflation in the long-run. If capital markets are imperfect then investment may be positively related with the steady-state profit share.[13] It follows, therefore, that higher

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[12] Rearranging (4): $\overline{\Pi} = \Pi_0 - \overline{\Delta p}\,\delta_c / \left(\overline{\Delta p} + \delta_p\right)$.

[13] This may be because firms have to resort to retained earnings to fund investment in imperfect capital markets and these funds are more available with a larger profit share. Alternatively, past profitability may be used as an indicator of the profitability of future projects in a world where information is missing. Fazzari *et al.* (1988) discuss why the cost of internal funds may be less than

steady-state inflation and the resulting lower profit share will reduce the rate of investment. This in turn may lead to a lower capital-labour ratio and a lower level of productivity. If the real wage demands of employed labour lag actual productivity then, as productivity falls, the real wage demands relative to productivity will rise.[14] That is, the excess real wage demands of labour will rise with steady-state inflation and $\partial Z_0 / \partial \overline{\Delta p} > 0$.

The degree to which excess real wage demands rise will depend on the sensitivity of investment to the profit share, the lag between productivity and the real wage demands of labour, and the initial level of steady-state inflation. At very low rates of inflation it is likely that $\frac{\partial Z_0}{\partial \overline{\Delta p}} < \frac{1}{\overline{\Pi}^2} \frac{\partial \overline{\Pi}}{\partial \overline{\Delta p}}$ in (6), as $\overline{\Delta p}$ is small and the impact on the markup is large. If $\partial Z_0 / \partial \overline{\Delta p} > 0$ but is always less than $\frac{1}{\overline{\Pi}^2} \frac{\partial \overline{\Pi}}{\partial \overline{\Delta p}}$ then the LRPC is always negatively sloped but steeper than $LRPC_1$. This is shown in Figure 1 as $LRPC_2$.

However, if as steady-state inflation rises, the impact on the real wage demands of labour eventually outweighs the impact of inflation on the markup, and $\partial Z_0 / \partial \overline{\Delta p} > \frac{1}{\overline{\Pi}^2} \frac{\partial \overline{\Pi}}{\partial \overline{\Delta p}}$, then the LRPC has a positive slope. Furthermore, if the impact on productivity and labour's real wage demands are large enough then the maximum rate of unemployment in the long-run may be greater than U_0, the maximum unemployment rate for $LRPC_1$ and $LRPC_2$. This case is shown as $LRPC_3$. Finally, at very high inflation rates, the LRPC is vertical in all cases as the impact of changes in steady-state inflation on the markup approaches zero.

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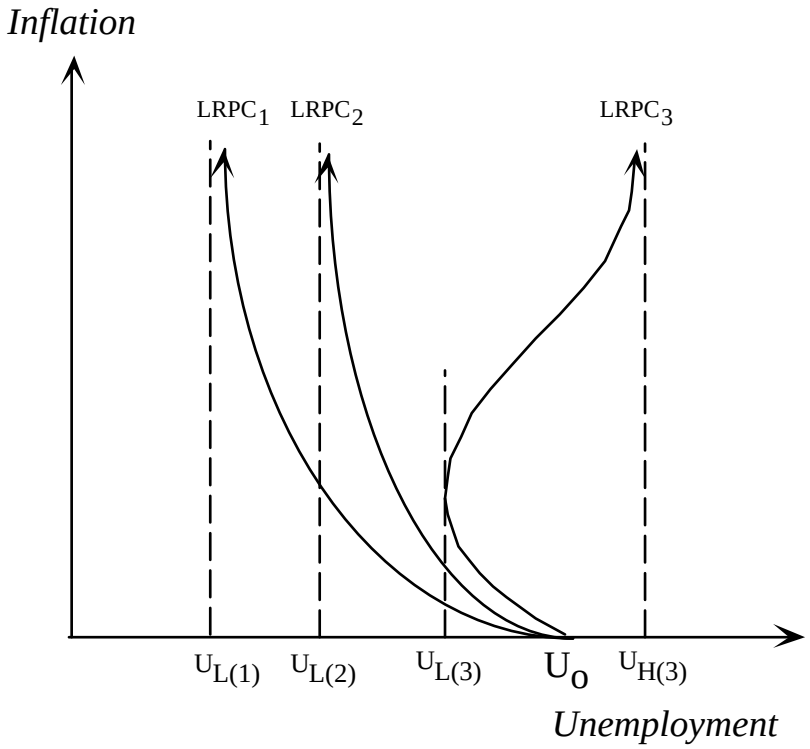
external finance and then show empirically that investment is sensitive to the availability of internal finance.

[14] A number of studies have highlighted the persistently high growth in labour's desired real wages as a major explanation of European unemployment following the slowdown in productivity growth after the first oil price shock. See Bruno and Sachs (1985), Grubb *et al.* (1983).

Figure 1: The Long-Run Phillips Curve



The position of the maximum and minimum rates of unemployment in the long-run depends on competition in the labour market which affects z_0 and z_1 and competition in the goods market which influence Π_0 and δ_C. It is easily shown that for the non-vertical LRPC, increased competition in either market, or an incomes policy which reduces z_0 or increases z_1, unambiguously reduces unemployment in the long-run for given inflation and shifts the LRPC to the left.[15] Furthermore, the range of possible unemployment rates in the long-run decreases with increasing goods market competition or an increase in the sensitivity of the real wage to the unemployment rate.

The general model can be interpreted as focusing on four time horizons. The first is the short-run where the markup, inflation and unemployment are all changing. This is reflected in the desired markup equations (1) and (3) of firms and labour respectively.

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[15] More formally, this proposition follows as $\partial\overline{U}/\partial\overline{\Pi}$ and $\partial\overline{U}/\partial z_0$ are positive and $\partial\overline{U}/\partial z_1$ is negative where increased competition serves to reduce $\overline{\Pi}$ and z_0 and increase z_1 for a given steady-state rate of inflation.

The second is still a relatively short time horizon where productivity has yet to be affected by the change in the profit share. With no change in productivity it follows that the excess real wage demands have also not been affected. This corresponds with $LRPC_1$ in Figure 1. The third time horizon is the medium term. Productivity has been affected and the economy has partially adjusted towards its new long-run equilibrium. This results in $LRPC_1$ being bent back on itself through curves such as $LRPC_2$ until it reaches its "full" long-run at $LRPC_3$ where the impact on productivity and the excess real wage demands is complete.

2.1 Comparison of the General and the Standard Imperfect Competition Models

The general and standard models can be compared in a number of ways. First, there exists a range of unemployment rates where inflation can be stable and non-negative in the general model. Below some unemployment rate U_L for each of the LRPCs there is no stable inflation rate and inflation is rising.[16] In this region, labour believe their real wage is too low and, simultaneously, firms believe their markup is too low. This leads to inflationary pressures from both labour and firms, and inflation rises. In contrast, above some high rate of unemployment, inflation is falling. If nominal wages do not fall as fast as prices in a deflationary environment then the markup will attain its maximum desired level quickly and firms will have no desire to further change prices. A distinct asymmetry is introduced. Inflation is rising at low rates of unemployment while it falls to zero at very high rates of unemployment. Between these two extremes in unemployment, inflation may be stable.

This result contrasts with the standard model where inflation is rising when unemployment is below the NAIRU and falls when above the NAIRU. Developed economies seem not to display this characteristic of "disequilibrium" from the NAIRU. Inflation may be lower as unemployment rises but inflation does not continue to fall.

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[16] In Figure 1 this is $U_{L(1)}$, $U_{L(2)}$ and $U_{L(3)}$ for $LRPC_1$, $LRPC_2$ and $LRPC_3$ respectively.

Indeed, the absence of this characteristic of the standard model in the real world has led to the "hysteresis" explanations of why the NAIRU is unstable.[17] While inflation may increase with expansions lasting many years, it does not appear to continue to rise. Following the tightening in macroeconomic policies in many economies in the 1970s and 1980s, inflation appeared to stabilise when unemployment increased. Furthermore, inflation did not fall continuously as unemployment rose. During these periods of high stable inflation however, expansionary policy had little impact on the real economy and a large impact on inflation. The general model is consistent with these "real world" observations. When inflation is high and the markup is low, the trade-off between unemployment and inflation is indeed very poor in the long-run. However, the analysis suggests inflation would stabilise at the new setting of monetary policy unless unemployment is less than its lower boundary.

Second, the LRPC in the general model collapses to a vertical LRPC in two special cases. The first is the standard model when the long-run markup is constant and $\delta_C = 0$. The second case is when the labour market is perfectly competitive and Z_1 is infinitely large. Irrespective of the competitive nature of the goods market the LRPC is again vertical but this time at zero unemployment with $\overline{U} = 0$.[18]

Third, unlike the standard model, there is an upper and lower boundary for the long-run markup in the general model which is delineated by the range over which monetary policy is set. Similarly, the general model indicates there are upper and lower boundaries for unemployment in the long-run for given competition in the goods and labour markets.

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[17] See the "hysteresis" references in footnote 1.

[18] For the full competitive market long-run equilibrium, no excess profits in the goods market is also required.

Fourth, the dominance of the low, but not zero, inflation rule among policy makers can be understood in terms of $LRPC_3$ in the general model but not by the standard analysis. Reducing moderate inflation in the general model leads to a higher markup, investment and productivity as well as reducing unemployment. However, to eliminate the last few percentage points of inflation requires an increase in unemployment in the long-run. Irrespective of the slope of the LRPC over moderate inflation, all the possible LRPCs in the general model have a negative slope over the range of low inflation and the curve becomes flatter as it approaches zero inflation. This may explain the findings of Ball *et al.* (1988) and DeFina (1991) that the aggregate supply curve is flatter at lower rates of inflation.[19]

3 SHOCKS AND THE LONG-RUN PHILLIPS CURVE

3.1 The Impact of Changes in Monetary Policy

For the analysis which follows it is assumed that policy makers are indeed correct and that $\partial Z_0 / \partial \overline{\Delta p}$ is large enough so that the LRPC is positively sloped over some range of inflation. Figure 2 sets out diagrammatically the above analysis for a given level of goods market competition and no trend growth in productivity.[20] The negative correlation between inflation and the markup is shown in quadrant Q1. In quadrant Q3 the relationship between real wages and unemployment is shown for a given level of excess real wage demands. The model displays an appealing symmetry. Quadrant Q1 represents claims by firms on total output which is curtailed by inflation. In contrast,

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[19] The findings relate to the short-run Phillips curve. However, if the LRPC is misspecified and assumed vertical, it would be difficult to identify separately the short and long-run curves .

[20] More specifically, the diagrams are "normalised" for the trend growth in productivity as it is necessary for $\delta_p > 0$ so that the profit share and inflation are negatively correlated in the steady-state (see (1)).

Q3 represents labour's claims on output which is curtailed by unemployment. In the long-run, therefore, we find the combinations of inflation and unemployment which balance the claims of firms and labour on total output. This is represented as LRPC in Q2.

If we assume the monetary authorities set the growth in money balances at $\mu + \delta_p$ then from the quantity equation, and assuming a constant labour supply, we can expect in the long-run that $\mu = \overline{\Delta p}$. The impact of changes in monetary policy depends on whether the change in policy occurs over the negative or positively sloping sections of the LRPC. Consider first the impact of a loosening in monetary policy from μ_A to μ_B in the negative sloping section of the LRPC. This will shift the economy from A to B in the long-run with unemployment and the markup lower and inflation higher. While the lower markup implies the real wage has risen *relative* to the level of productivity, in the new long-run it is not clear if the real wage is higher in *absolute* terms following the loosening. If productivity is unaffected by the profit share then Z_0 does not change and the real wage curve RW_A in Q3 does not shift and the real wage increases to A´ in Q3.[21]

Alternatively, if productivity falls and we assume the increase in the excess real wage demands Z_0 do not outweigh the fall in productivity then the real wage curve shifts upwards towards the origin.[22] Depending on how far the curve shifts, the real wage may rise or fall in the long-run relative to its starting value. As shown, the real wage curve shifts to RW_B and the economy converges on B in Q3 where real wages have fallen absolutely but have risen relative to productivity. However, a smaller shift in the

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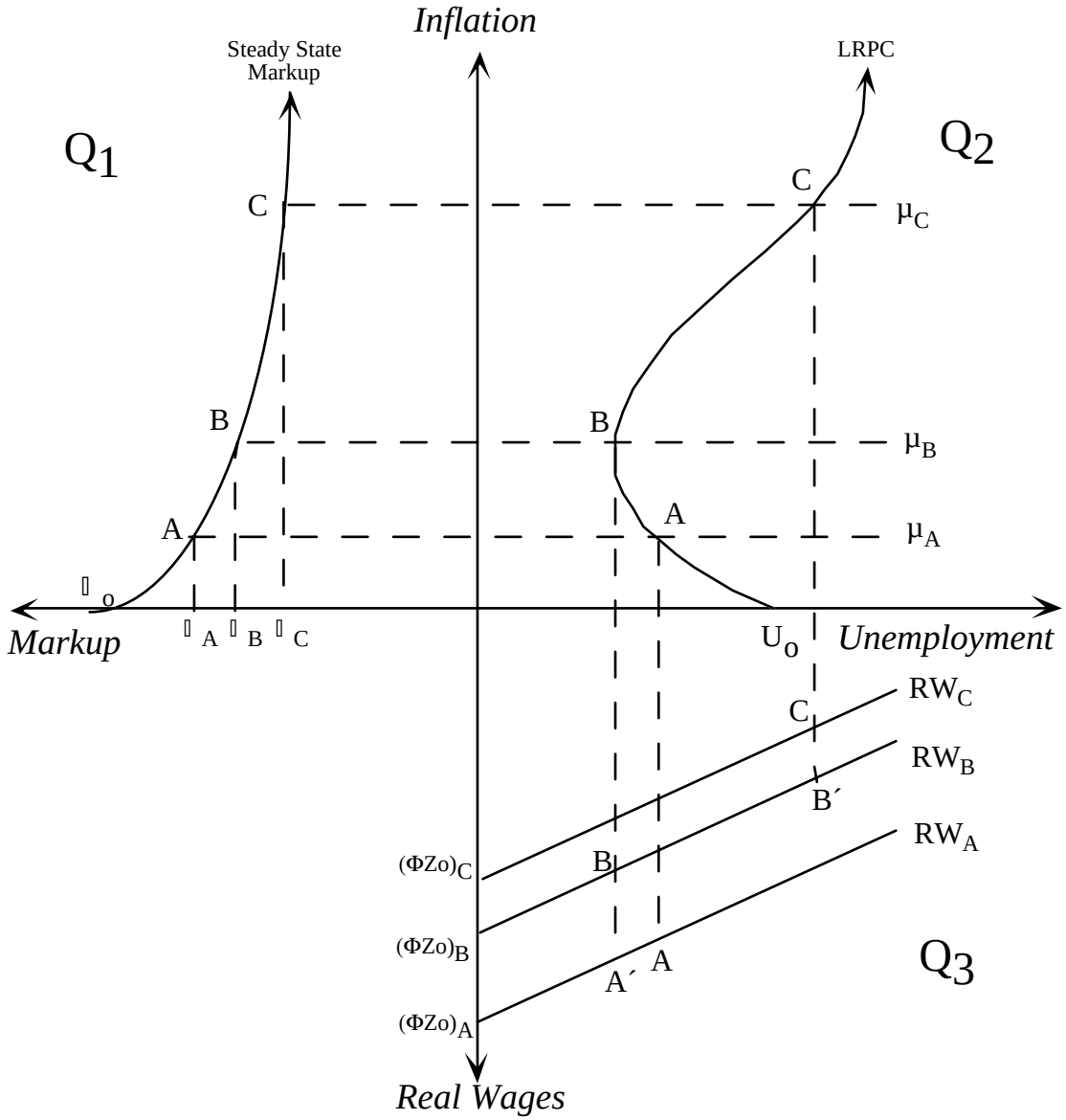
[21] In this case the LRPC will be identical to $LRPC_1$ in Figure 1 and not that which is assumed here.

[22] This assumption is not too ambitious. It implies that a percentage point fall in the level of productivity does not lead to a more than 1 percentage point rise in the excess real wage demands of labour. That is, labour's real wage demands are not greater than if the fall in productivity had not occurred.

curve may see real wages rise absolutely following the loosening in policy in the long-run.

Figure 2: The Long-Run Impact of Changes in Monetary Policy



The effect of a loosening in monetary policy from μ_B to μ_C in the positively sloping section of the LRPC is more clear. The economy will shift from B to C in the long-run with the markup falling from Π_B to Π_C. If there is no shift in the unemployment/real wage curve in Q3 then the real wage falls absolutely from B to B´. If the real wage curve shifts towards the origin (such as to RW_C) then this accentuates the absolute fall in

real wages. As a result, real wages rise relative to productivity but fall relative to before the loosening in policy.

3.2 The Impact of Real Wage Shocks

Figure 3 examines the impact of a real wage shock within this analysis. Starting at A on $LRPC_X$ the shock is interpreted as an exogenous increase in the excess real wage demands of labour and shifts the unemployment / real wage curve down from RW_X to RW_Y in Q3. As a result, $LRPC_X$ shifts to $LRPC_Y$. Before unemployment increases, the economy shifts to A´ where real wages are higher. If monetary policy is unchanged and remains at μ then the economy converges in the long-run on B where inflation and the markup are unchanged and unemployment is higher. As the markup is the same in the long-run then it follows investment and the level of productivity are the same and, therefore, real wages have not changed. With no change in monetary policy the real wage shock falls entirely on the unemployed. Alternatively, if monetary policy is loosened in response to the rising unemployment then the analysis for a change in monetary policy must overlay this analysis of a real wage shock.

The continuous game between labour and the monetary authorities is highlighted by this analysis. If the wage shock is not accommodated and monetary policy is unchanged then the real wage and productivity return to their pre-shock levels and unemployment is higher. If the welfare function of employed labour incorporates only real wages and unemployment with their usual signs then employed labour will be unambiguously worse off after the shock.[23] If the shock is accommodated then the real wage of the employed in the new steady-state is higher relative to productivity (because the markup is lower) but may be higher or lower than the pre-shock level. Whether employed labour consider themselves better off following the shock depends on the

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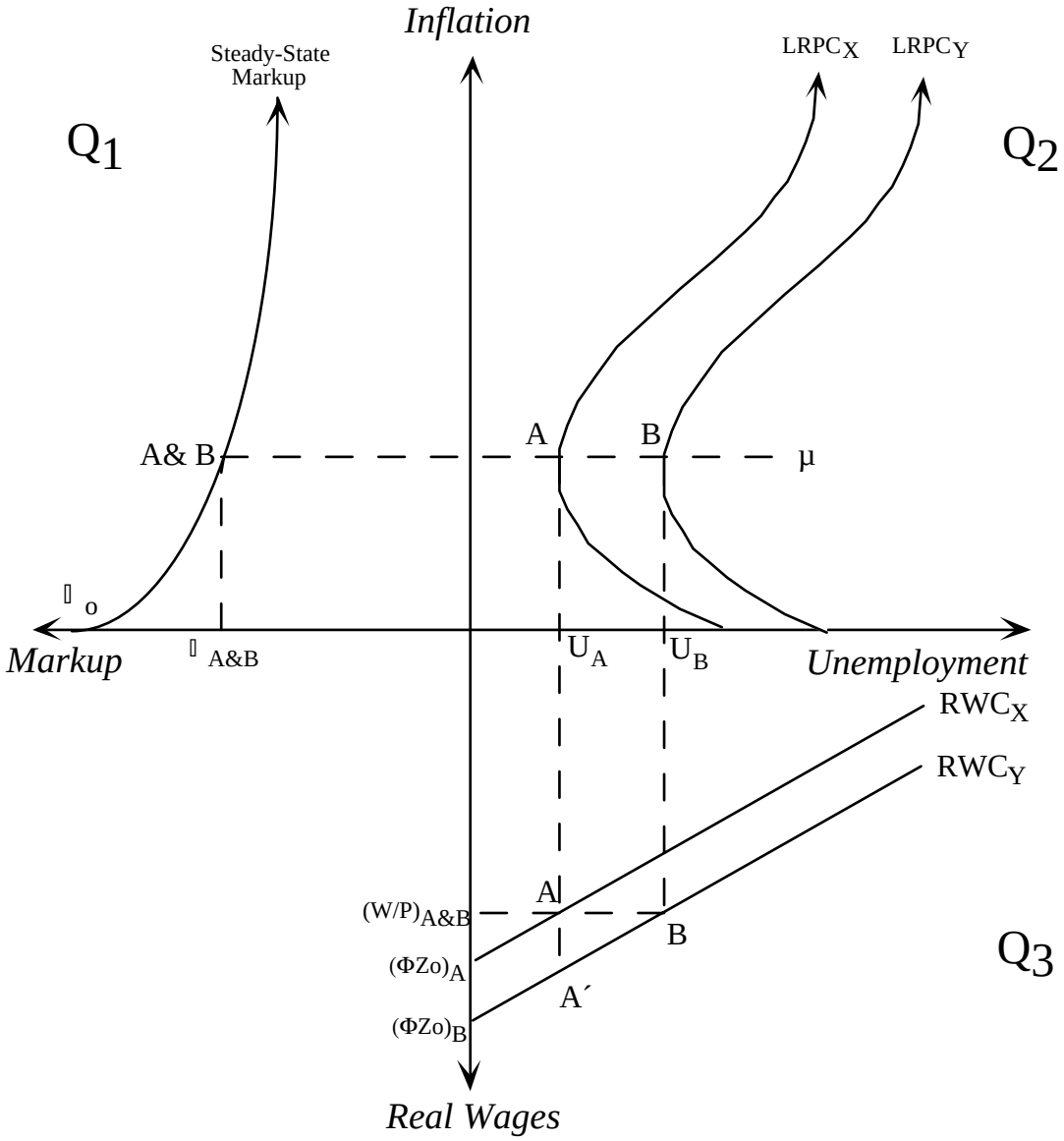
[23] This is not to say that during the transition when real wages are above their long-run level, labour's welfare may be greater.

relative weights on real wages and unemployment in their welfare function and whether they perceive real wages in absolute terms or relative to the level of productivity. *However, for labour to believe that a real wage shock will in any way be beneficial in the long-run they must expect the monetary authorities to at least partially accommodate the shock.* Presumably, this expectation is based on the past behaviour of the monetary authorities.

Figure 3: The Impact of a Real Wage Shock on the Long-Run Phillips Curve



4 THE IMPLICATIONS FOR MONETARY POLICY AND CONCLUSION

The "breakdown" of the Phillips curve and the "stagflation" of the 1970s can be explained by the general model. If the excess real wage demands (Z_0) are small then the LRPC may be close to or touching the vertical axis as shown in Figure 4 as $LRPC^*$. In this economic environment, the monetary authorities have no incentive to loosen policy to such an extent that the economy moves past B on $LRPC^*$ and experiences the positive sloping section of the LRPC. That is, with very low unemployment there is no incentive to further inflate the economy. The economy in the steady-state, therefore, lies between A and B on $LRPC^*$ and there exists a stable negative sloping LRPC. Phillips' (1958) seminal article showed that a stable inverse relationship existed between wage inflation and unemployment for the UK between 1861 and 1957. Given the stability of the relationship, the original Phillips curve could be interpreted as the negative sloping section of the LRPC over this period.

We can characterise the oil and real wage shocks in the late 1960s and early 1970s as an increase in the excess real wage demands of labour (Z_0) which would cause $LRPC^*$ to shift outward to $LRPC^{**}$.[24] In response to rising unemployment, and unaware of the backward bending section of the LRPC (which they had never experienced), the monetary authorities loosened policy. This resulted in higher inflation *and* higher unemployment in the long-run as the economy converged on some point on the positive sloping section of the LRPC. The "breakdown", therefore, was partly due to an outward shift in the LRPC but also due to experiencing the positive sloping section of the LRPC. The former is consistent with the standard view of the "breakdown" of the Phillips curve while the latter is not. Furthermore, the standard view usually emphasises that labour became more sophisticated during the 1960s and came to focus

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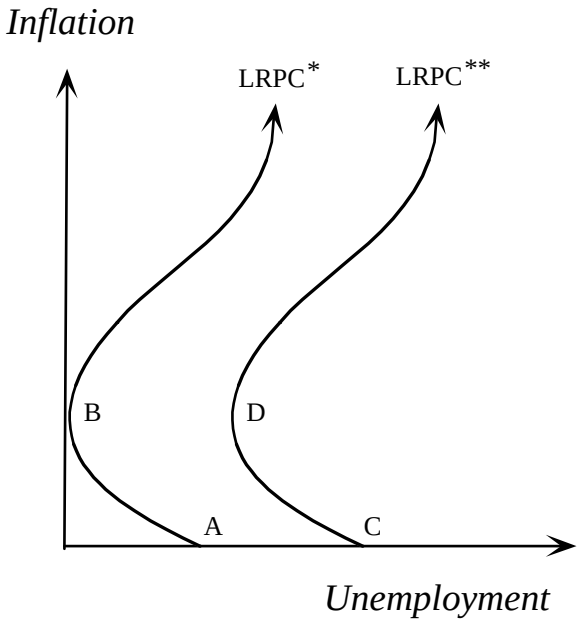
[24] This characterisation of the "breakdown" as a shift in the LRPC is more applicable to Europe than the US. See footnote 25 for how the "breakdown" in the US curve might be characterised.

more on expected real wages rather than nominal wages.[25] Resort to such an explanation of the "breakdown" is not necessary in the general analysis outlined here.

Figure 4: The "Breakdown" of the Phillips Curve



Under the general model, the higher inflation in the 1970s following the "breakdown" of the Phillips curve would result in a lower long-run markup, lower investment and slower productivity growth. The lower markup and higher inflation would move the economy onto the positive sloping section of the LRPC, increasing the inflationary impact of expansionary policies and leading to the "stagflation" of the 1970s and early

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[25] Following Friedman (1968), the "breakdown" of the US Phillips curve is attributed almost entirely to the increased sophistication of agents rather than a shifting of the LRPC. If we consider $LRPC^{**}$ between C and D to represent the US curve prior to the "breakdown", then the loosening in fiscal and monetary policies in response to the US commitment to the Vietnam war and the first OPEC oil price shock would see the economy experience the positive sloping section of the LRPC. Consequently, standard empirical analysis of data drawn from both the negative and positive sloping sections of the LRPC would conclude that the curve is vertical even if $LRPC^{**}$ is the "true" long-run curve.

1980s. Eventually monetary policy was tightened in most economies so as to reduce inflation. However, the shocks which served to increase the excess real wage demands of labour during the 1960s and 1970s, and thereby shift the LRPC outward, have yet to be fully reversed and so the LRPC has not shifted back to its original position.

One result of the general model is that the profit share is inversely related to the rate of inflation in the steady-state. Hence we can understand with this model why labour might systematically desire a higher inflation rate than that desired by firms. However, as real wages fall absolutely as we move up along the positive sloping section of the LRPC (even though they rise relative to productivity), labour will still desire an inflation rate in the steady-state which is low enough for the economy to remain on the negative sloping section of the LRPC.

The general model highlights the difficulty that policy makers face in distinguishing between the short and medium term impact of a loosening in monetary policy where unemployment falls and the long-run impact where unemployment may rise. In the confusion, it may well be that a rigid low inflation target is the best way to proceed. However, irrespective of the slope of the LRPC over a range of moderate inflation, the analysis indicates that the eradication of low inflation will be costly in terms of increased unemployment.

A number of clear policy conclusions can be drawn from the general model. First, if the welfare function of the monetary authorities includes inflation and unemployment then the general policy rule of "low but not zero inflation" is appropriate. To try to eradicate the last few percentage points of inflation over the negative sloping section of the LRPC would be costly in terms of higher unemployment.

Second, increased competition faced by firms or labour unambiguously reduces the rate of unemployment associated with a given rate of inflation in the steady-state. Equivalently, income policies which reduce the excess real wage demands of the

employed unambiguously shift the LRPC towards the origin. Finally, on an operational level, the analysis suggests that monetary policy should not be loosened following a real wage shock as this leads to a higher steady-state real wage relative to productivity (ie a lower markup) and provides the motivation for labour to seek further increases in real wages.

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