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A SIMPLE MODEL OF IMPERFECT COMPETITION WITH WALRASIAN FEATURES

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IMPERFECT competition is a pervasive part of modern industrial economies, where high levels of concentration in product markets often coexist with unionised labour markets. Most standard macroeconomic models, however, assume that markets are perfectly competitive. This paper provides a *simple* framework in which we are able to explore some of the implications of imperfect competition for the macroeconomy, and to evaluate the adequacy of competitive macroeconomic models as "convenient simplifications". The results of the paper suggest that whilst some general features of competitive macromodels do carry over to an imperfectly competitive framework, others do not. Imperfect competition in the labour and product market can have a significant impact on the level of employment and the effectiveness of macroeconomic policy. Imperfect competition provides an explicit account of price and wage determination, and thus gives us a far greater insight into the microeconomic structure of macroeconomic equilibrium than is possible in competitive models.

This paper presents a simple model of imperfect competition with Walrasian features. The model is "Walrasian" both in some of its assumptions,[0] and also in the properties of the model. What we have attempted to do is to take a standard neoclassical synthesis macromodel (e.g. Patinkin (1965), Branson (1979)) and introduce imperfect competition into the product and labour markets. We feel that this is a useful exercise for two reasons. Firstly, it provides a simple macro model of imperfect competition in which the causal mechanisms are very clear. In general, models of imperfect competition have tended to be rather complex, despite a recent trend towards simpler versions (e.g. Hart (1982), d'Aspremont *et al.* (1985)). Secondly, by adopting the standard neoclassical synthesis framework, it is easy to relate the model of imperfect competition to more familiar models.

Imperfect competition in the product is modelled using conjectural-variations Cournot equilibrium which captures a wide range of possible market solutions, encompassing perfect competition, Cournot, and joint profit maximisation as special cases. This approach contrasts with existing

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[0] These Walrasian assumptions include that of Leontief technology in Section 1. It is often forgotten that Walras made wide use of "coefficients de fabrication" in his work.

models which adopt a Chamberlinian framework with differentiated products and price-setting firms (Blanchard and Kiyotaki (1985), Layard and Nickell (1985), Svensson (1986)), and generalises Hart's (1982) assumption of Cournot competition. We explore the model with a competitive labour market in Sections 1-2, and with a unionised labour market in Section 3.

With an imperfectly competitive product market and competitive labour market, we can use familiar Aggregate Demand and Aggregate Supply analysis to evaluate the influence of the degree of imperfect competition on the level of employment, the government expenditure multiplier, and the neutrality of money. There are three main results. Firstly, equilibrium employment is inversely related to the degree of monopoly in the product market. With perfect competition employment is at its Walrasian level. Since the labour market is competitive there is no involuntary unemployment and this deviation of employment from its Walrasian level can be interpreted as underemployment. Secondly, if money is neutral the underlying Walrasian equilibrium then it will also be neutral in the imperfectly competitive equilibrium. This follows since the behavioural equations are all homogeneous to degree zero (Hodo) in money and prices. Thirdly, the government expenditure multiplier is in a very precise sense "Walrasian" in this model. By this we mean that the mechansims underlying the Walrasian multiplier are the same with imperfect competition. There will be crowding out, and the multiplier has the Walrasian value as its lower bound, is strictly less than unity, and strictly increasing in the degree of monopoly. In Section 1 the model is presented assuming constant returns to scale, a convenient simplification which enables us to derive an explicit solution to the model. In Section 2, however, we make the more orthodox assumption of diminishing returns: the analytical properties of the model are not affected by this.

In Section 3 we consider the impact of unions in an imperfectly competitive macromodel. A union may wish to set the wage above the market clearing level, so that there may be "excess supply" in both the labour and product markets.[1] In this sense the economy has a "Keynesian" equilibrium. However, we consider two alternative models of wage determination (bargaining, monopoly union) for which the equilibrium is very unkeynesian in its implications for macroeconomic policy. Both fiscal and monetary policy are neutral,[2] so that macroeconomic policy has even less impact here than in a Walrasian economy, despite the presence of excess supplies. The basic reason is that the equilibrium level of employment and

[1] The use of the terms "excess supply" and "market clearing" are the subject of disagreement. My own favoured uses are (a) market clearing means competitive—hence any non-competitive equilibrium is a non-clearing equilibrium, (b) excess supply means that at a given price suppliers would like to sell more than they do. Others who dislike this may translate into their own terminology.

[2] Throughout this paper we will use the term "fiscal neutrality" to mean that the fiscal multiplier is zero. We do not use the term in the technical sense of monetary theory, i.e. that no real variables are affected (although money is neutral in this sense too).

real wages are unaffected by government policy, so that changes in the money supply or government expenditure feed through entirely into nominal wage and price increases. The only role for macroeconomic policy in a unionised economy in the examples presented is in the presence of multiple equilibria: macroeconomic policy can be used to ensure that the equilibrium with the highest level of employment is attained rather than a low employment equilibrium. The results of this section relate most closely to Layard and Nickell's (1985) model of NAIRU. The main conceptual difference between the two models is that Layard and Nickell adopt an essentially partial equilibrium approach for the purpose of deriving a tractable econometric model. The model we present adopts an explicit—if simple—general equilibrium framework.

Whilst the models presented in this paper are very specific, and have no claim to generality, we believe that the results should not be dismissed as simply special examples. Most of the assumptions made are absolutely standard, and the originality of the paper consists not in the ingredients but the recipe. For this reason we believe the specific models presented have conceptual implications over and beyond their mathematical implications.

1. Imperfect competition with a competitive labour market

We shall first lay out the basic assumptions about households, firms, and the government.

(a) *The household*

There is one price-taking household which has initial endowments of money M^0 and leisure T and derives utility from consumption C, real money balances M/p and leisure l (money is being used as numeraire). The houlehold also receives all the profits from the two firms in the economy. The household has Cobb–Douglas utility:

$$U = \alpha \log C + \beta \log l + \gamma \log \frac{M}{p} \tag{1.1}$$

The household is a price-taker, and so maximises (1.1) subject to the budget constraint:

$$pC + lw + M \leqslant wT + M^0 + \pi \tag{1.2}$$

Where π are distributed profits, to be explained below. The solution to (1.1–2) yields the familiar Walrasian demand functions for money and consumption, and supply of labour $N = T - l$. Whilst (1.1) is assumed throughout the paper, we shall often write these demand functions in general form:

$$C = C\left(\frac{w}{p}, \frac{M^0 + \pi}{p}\right) = \alpha\frac{(wT + M^0 + \pi)}{p} \tag{1.3}$$

$$N = N\left(\frac{w}{p}, \frac{M^0 + \pi}{p}\right) = T(1 - \beta) - \frac{\beta p}{w}\left(\frac{M^0}{p} + \frac{\pi}{p}\right) \tag{1.4}$$

$$\frac{M}{p} = \frac{M}{p}\left(\frac{w}{p}, \frac{M^0 + \pi}{p}\right) = v\left(\frac{wT}{p} + \frac{M^0 + \pi}{p}\right) \tag{1.5}$$

As is clear from (1.3), the household's demand for consumption has a unit elasticity (as do (1.4) and (1.5)). Furthermore, all the demand functions are homogeneous of degree zero (Hodo) in prices, money balances and profits (p, w, M^0, π). This is because (a) the budget constraint (1.2) is unaffected by an equiproportionate change in (p, w, M^0, π) (b) utility is Hodo in (p, M). Of course, we might prefer to interpret the model as being a temporary equilibrium, in which case *nominal* rather than real money balances would enter the household's utility function. The condition for an indirect utility function to be Hodo in (p, M) are very restrictive (see Grandmont (1984)). However, it suits our purposes to have real money balances in the utility function because we aim to demonstrate that imperfect competition *per se* does not invalidate the "classical dichotomy": if the underlying competitive equilibrium is unaffected by the money supply M^0, then so will the imperfectly competitive economy. The treatment of profits in imperfectly competitive general equilibrium models is problematic (see Hart (1985)).

(b) *The firm*

There are two firms in the output market (this obviously generalises). They are price-takers in the labour market and there is a conjectural variations Cournot model in the output market. The assumption of price-taking in the labour market and price-making in the output market can be justified by the fact that the firm is "small" in the labour market (there are lots of firms from the many output markets), but "large" in its particular product market. Furthermore, the firms have no "general equilibrium" awareness: in taking their output decisions, they do not calculate the effects of this on the labour market (this contrasts with models such as Hart (1979) and Roberts (1980) where firms do calculate the full effect). However, the firms know the "true" household demand curve (taking w as given), which from (1.3) has unit elasticity. In this section it is assumed that firms have constant-return to scale production with one input—labour. This is a convenient simplification that enables us to derive explicit results; in Section 2 we show that the introduction of diminishing returns does not invalidate our analytical results. The output—labour ratio is normalised to unity:

$$y_i = N_i \tag{1.6}$$

where y_i and N_i are the i firm's output and employment respectively. Under (1.6) firms have constant marginal cost w. We further assume that firms have the same conjectural variations parameter ϕ. With two firms, unit elasticity demand, and constant marginal cost we have the equilibrium price-cost margin μ:[3]

$$\mu \equiv \frac{p-w}{p} = \frac{1+\phi}{2} \tag{1.7}$$

and hence real wage and profits:

$$\frac{w}{p} = 1 - \mu \qquad \frac{\pi}{p} = \mu \cdot N \tag{1.8}$$

For the competitive case with Bertrand conjectures $(\phi = -1) w/p = 1$ and $\mu = 0$; there are no profits, and all income is wages. In the Cournot case $(\phi = 0)$, $w/p = \mu = \frac{1}{2}$: wages are half of income. For ϕ close to 1, the equilibrium price-cost margin μ becomes close to 1 and real-wages close to 0 (note that for $\phi \geqslant +1$ no conjectural variation equilibrium exists with unit elastic demand). Following Lerner (1934), we shall call μ the "degree of monopoly".

(c) *Government*

Government expenditure can be in two forms: levels of *real* expenditure g are predetermined, or *nominal* levels ("cash limits"). Whether government expenditure is planned in real or nominal terms will have a big influence on the effects of that expenditure on the macroeconomy (this is discussed in more detail in Dixon (1986)). The results of this paper will apply to *real* government expenditure plans, as is standard in the macroeconomic literature. The simplest way to model g is to conceive of the government purchasing output at a price p_g determined by bilateral bargaining between the industry and government, the corresponding markup being μ_g. The important point is that the price which the government pays is not (directly) influenced by, and will not influence the price paid the household. This

[3] Those unfamiliar with the conjectural variations model of Cournot oligopoly are referred to Waterson (1984, pp. 18–19). The equilibrium condition that marginal revenue equals marginal cost is:

$$p\left(1 + \frac{1+\phi}{2}\right) = w$$

from which (1.7) comes directly. The markup μ is constant because with Cobb–Douglas preferences there is constant elasticity of demand. Alternatively, with Cournot competition, the markup can be seen as varying with the number of firms $(\mu = 1/n)$.

assumptions seems reasonable: the government is a big buyer, and does not enter the market as a price-taker.

Since p_g is determined independently of p, the conjectural variations equilibrium μ (1.7) will not be influenced by g (since the revenue gained from government contracts is fixed at $p_g g$, it does not enter into *marginal* revenue). Again, purely for simplicity, we assume that although independently determined, $p_g = p$: the price paid by government and households happens to be equal. This can easily be relaxed.[4] For a wide range of industrial products, bilateral contracts between firms and government is more realistic than the usual treatment of simply adding g to industry demand.

Lastly, there is the question of the governments budget constraint: how does it finance its expenditure? This is not analysed in any detail here. However, the results of this paper are consistent with a proportional profits tax. Alternatively, the government can be viewed as financing the expenditure by printing money, which appears in the next period's money balances. Neither of these possibilities is made explicit, since our main interest does not lie in the government's finance policy. In what follows, a change in government spending is analysed in its own right, independently of any monetary repercussions that could ensue.

(d) *Equilibrium and macroeconomic policy*

We have now outlined the assumptions underlying the model. Since the household is unrationed in all markets, consumption, employment and the demand for money are all given by notional demands (1.3–5). The equilibrium in the economy can be represented by four equations:

$$y = N\left(\frac{w}{p}, \frac{M^0 + \pi}{p}\right) \tag{1.9}$$

$$y = c\left(\frac{w}{p}, \frac{M^0 + \pi}{p}\right) + g \tag{1.10}$$

$$\frac{w}{p} = \frac{1 - \phi}{2} = 1 - \mu \tag{1.11}$$

$$\frac{\pi}{p} = \mu y \tag{1.12}$$

(1.9) is the equilibrium condition for the competitive labour market (y is total output); (1.10) is the equilibrium condition for output (output is demand determined); (1.11) is the real-wage determined by the equilibrium price-cost margin; (1.12) is total real profits determined by the equilibrium

[4] For example, a common form for government contracts is cost-plus, in effect a markup μ_g. The model would then simply require a different markup for government and private consumption. For example, profits would become: $\pi = \mu_g \cdot g + \mu(N - g)$ (see (1.12)).

price-cost margin and output. We omit the money market equilibrium condition, since (1.3–5) satisfy Walras' Law. The endogenous variables determined the equilibrium are $\{w, p, y, \pi, N\}$, and the exogenous variables are $\{M^0, \phi, g\}$.

The equilibrium in this economy can be represented by the usual aggregate supply and demand equations in (p, N) space. From the price-cost equation (1.7), the mark-up of price over the wage is fixed due to CRTS, hence things look the same in (w, N) and (p, N) space. The **Aggregate Supply** curve (AS) is derived by combining (1.9) and (1.12):

$$\text{AS} \qquad N = N\left(1-\mu,\ \mu N + \frac{M^0}{p}\right) \tag{1.13}$$

By total differentiation:

$$\left.\frac{dN}{dp}\right|_{AS} = \frac{-N_2 M^0}{p^2(1-N_2\mu)} > 0 \tag{1.14}$$

where $N_2 = dN/dW < 0$ from (1.4). If the price rises *given the real wage,* then the real balance effect will elicit an increased supply of labour (since with Cobb–Douglas preferences (1.1), leisure is normal). Note that the AS curve is upward sloping not due to the presence of "money illusion", but rather due to the real balance effect which operates in the labour supply (with leisure a normal good). In many received textbooks accounts, the labour supply depends only on the real wage w/p, which implicitly suppresses the real balance effect. The resultant vertical AS function is at best a misleading heuristic device (the origin of this "simplification" is probably Patinkin (1965, pp. 202–5)). Similarly:

$$\left.\frac{dN}{d\mu}\right|_{AS} = \frac{-(N_1 - N_2 N)}{1 - N_2 N} < 0 \tag{1.15}$$

At a given price, a rise in the markup μ will reduce the real wage and increase profits for any level of employment. Both of these effects lead to a reduction in the labour supply at a given price. Thus the AS function is upward sloping, and a rise in μ shifts it to the left, as in Fig. 1.1.

The analysis of aggregate demand is a little more complicated. The real balance effect will of course lead to a downward sloping **Aggregate Demand curve** (AD), which is defined by

$$\text{AD} \qquad N = C\left(1-\mu,\ \frac{M^0}{p} + \mu N\right) + g \tag{1.16}$$

Hence:

$$\left.\frac{dN}{dp}\right|_{AD} = \frac{-C_2 M^0}{p^2(1-c_2\mu)} < 0 \tag{1.17}$$

The effect of a change in μ on N given p is a little less obvious. A rise in μ

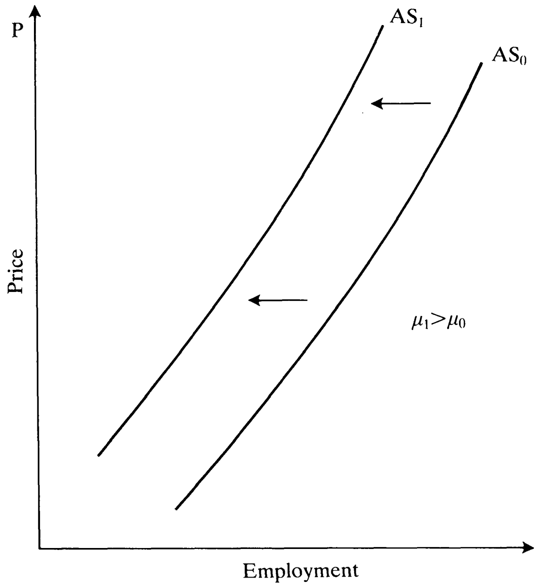

FIG. 1.1. Aggretate supply and the degree of monopoly

leads to a fall in the real wage, but a rise in profit income. If consumption is normal, these effects work in opposite directions. However, with Cobb–Douglas preferences the real-wage effect predominates:

$$\frac{\mathrm{d}C}{\mathrm{d}\mu} = -C_1 + C_2 N = \alpha(N - T) < 0 \tag{1.18}$$

Hence a rise in μ shifts the AD leftwards as in Fig. 1.2

$$\left.\frac{\mathrm{d}N}{\mathrm{d}\mu}\right|_{AD} = \frac{-(C_1 - C_2 N)}{1 - C_2 \mu} < 0 \tag{1.19}$$

(Note that $1 - C_2\mu > 0$, since from (1.3) C_2, the marginal propensity to consume from real balances is of course less than unity).

An equilibrium in this economy is represented by the intersection of the aggregate demand and aggregate supply functions. Inspection of (1.13) and (1.16) reveals that the classical dichotomy holds in this model since the equilibrium equations are homogeneous of degree zero (Hodo) in w, p, m. The classical dichotomy thus stems from homogeneity, and not a vertical AS curve nor the assumption of a competitive economy.

Proposition 1: Let $\lambda > 0$. If $\{w^*, p^*, \pi^*, N^*\}$ is an equilibrium given M^0, then $\{\lambda w^*, \lambda p^*, \lambda\pi^*, N^*\}$ is an equilibrium given λM^0.

Whilst the introduction of imperfect competition into this model does not upset the homogeneity of the economy, the level of equilibrium employment is decreasing in the degree of monopoly.

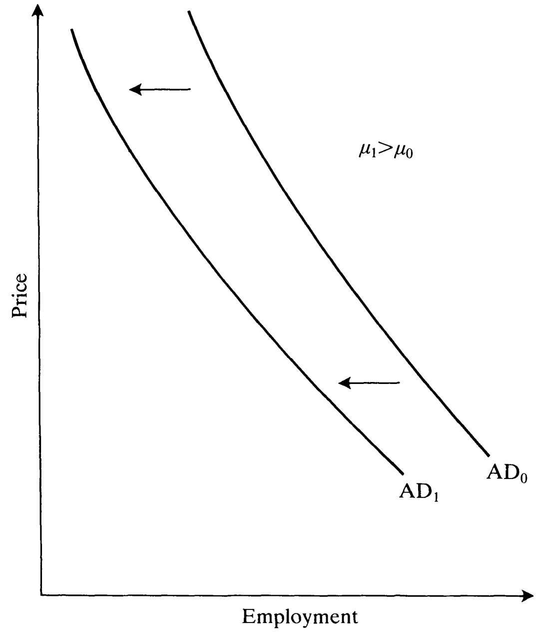

FIG. 1.2. Aggregate demand and the degree of monopoly

Proposition 2: Equilibrium employment is inversely related to the degree of monopoly μ.

Proof.
Total differentiation of (1.13) and (1.16) yields:

$$\frac{dN}{d\mu} = \frac{N_2C_1 - N_1C_2}{C_2 - N_2} < 0 \qquad \text{QED}$$

The maximium employment attained in this economy occurs at the Walrasian equilibrium, with $\mu = 0$. The labour market is of course competitive, so that there is no involuntary unemployment (in any possible sense of the word), merely underemployment. The presence of imperfect competition in the product market leads to a lower level of equilibrium employment in the competitive labour market.

What of the effectiveness of fiscal policy in this model? If we consider equations (1.13–16) which define the AS and AD curves, fiscal policy affects only the AS curve. The fiscal multiplier *taking μ and p as given* is a "Keynesian" multiplier:

$$\left.\frac{dN}{dg}\right|_{AD} = \frac{1}{1 - C_2\mu} > 1 \tag{1.20}$$

where C_2 is the marginal propensity to consume out of (real) income.

Essentially, what happens is that government expenditure increases profits initially by μg, this increases consumption, and this leads to a feedback from output to profits to increased consumption. The increase in output due to an increase in g in (1.20) is represented in Fig. 1.3 by a shift from initial position A to B. However, the increase in output at initial price p_0 leads to excess demand for labour, and hence wages and prices will rise to p_1. The full fiscal multiplier can be derived if we totally differentiate the AS and AD functions with respect to g:

$$\begin{bmatrix} 1-N_2\mu & N_2\dfrac{M}{p^2} \\ 1-C_2\mu & C_2\dfrac{M}{p^2} \end{bmatrix}\begin{bmatrix} \mathrm{d}N/\mathrm{d}g \\ \mathrm{d}p/\mathrm{d}g \end{bmatrix}=\begin{bmatrix} 0 \\ 1 \end{bmatrix}$$

Using Cramer's rule this yields:

$$\frac{\mathrm{d}N}{\mathrm{d}g}=\frac{-N_2}{C_2-N_2}>0 \tag{1.21}$$

$$\frac{\mathrm{d}p}{\mathrm{d}g}=\frac{p^2C_2(1-N_2\mu)}{M^0C_2-N_2}>0 \tag{1.22}$$

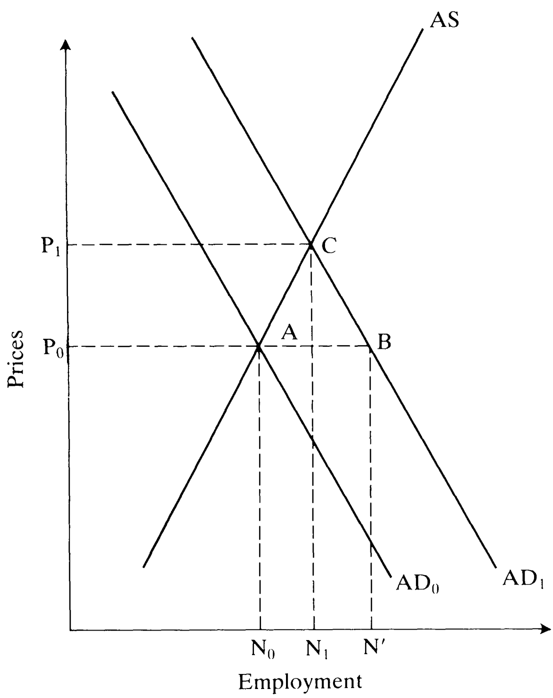

FIG. 1.3. Fiscal policy

Clearly, the fiscal multiplier is less than one and strictly positive. Using (1.3) and (1.4) the explicit solution is:

$$\frac{dN}{dg}=\frac{\beta}{\beta+(1-\mu)\alpha} \tag{1.23}$$

Using (1.7) we can relate firms' conjectures ϕ to the markup μ and hence the multiplier by (1.23). This is done in Table 1.

Recall that when $\phi=1$ there is no equilibrium in the product market: we include $\phi=1$ since from (1.23) as μ tends to 1 from below, the multiplier tends to unity. The cartel is then a limiting result. As is clear from (1.23) and Table 1, the greater the degree of monopoly μ, the more effective is fiscal policy. In general since $-1\leqslant\phi<+1$,

$$1>\frac{dN}{dg}\geqslant\frac{\beta}{\alpha+\beta} \tag{1.24}$$

Whilst the value of μ does influence the fiscal multiplier, there is always crowding out. Furthermore, the mechanisms underlying the multiplier are essentially the same—as indicated by the general formula (1.21). In this sense, the multiplier is basically "Walrasian" rather than Keynesian. We summarise the foregoing discussion in Proposition 3.

Proposition 3: for $0\leqslant\mu<1$ the fiscal multiplier is

$$\frac{dN}{dg}=\frac{-N_2}{C_2-N_2}=\frac{\beta}{\beta+(1-\mu)\alpha}$$

Hence

$$\frac{\beta}{\beta+\alpha}\leqslant\frac{dN}{dg}\leqslant 1$$

and is *increasing* in μ.

We shall now show that a profits tax will leave these results unaffected. This is important, since it shows that we are justified in not treating the

TABLE 1
Imperfect competition (Duopoly) and the fiscal multiplier

Conjecture	*Markup* μ	*Multiplier*
-1 (Bertrand)	0	$\frac{\beta}{\beta+\alpha}$
0 (Cournot)	$\frac{1}{2}$	$\frac{2\beta}{2\beta+\alpha}$
1 (Cartel)	1	1

government budget constraint explicitly. Suppose we assume that only a proportion t of profits appears in households budget constraints (1.2) (where $0 \leqslant t \leqslant 1$). In this case, AD and AS become:

$$N - C\left(1 - \mu, \frac{M_0}{p} + t\mu N\right) - g = 0 \quad \mathrm{AD}(t)$$

$$N - N\left(1 - \mu, \frac{M^0}{p} + t\mu N\right) = 0 \quad \mathrm{AS}(t)$$

Total differentiation of AD(t) on AS(t) with respect to t shows that $\mathrm{d}N/\mathrm{d}t = 0$. The equilibrium is unaffected by the proportion of profits distributed to the shareholder. Furthermore, total differentiation with respect to g yields the *same* fiscal multiplier as in (1.21) and (1.23). The effectiveness of fiscal policy is not influenced by the proportion of profits distributed. This is a surprising result given that the aggregate demand multiplier derived from AD(t) holding price constant is sensitive to t (e.g. if $t = 1$, then $\mathrm{d}N/\mathrm{d}g|\mathrm{AD} = 1$). The crucial point here is that if t increases, real distributed profits at the equilibrium output fall by $\Delta t\mu N$. The price level will fall so that real balances increase by $\Delta p M^0/p^2$. The increase in real balances exactly offsets the fall in real distributed profits, so that total wealth remains unchanged. Since the real wage remains constant, equilibrium output and employment are unaltered. In one sense, therefore, an ad valorem profits tax can be said to have no real effects, only nominal effects. Similar exercises can be conducted for an employment tax (which reduces the real wage and share of profits in income), a (real) lump sum tax (which increases equilibrium output via the wealth effect), and an income tax (which alters the real wage and the proportion of profits which households receive). The imposition of these taxes to finance government expenditure would alter the specific results stated in this paper, as they would in a Walrasian economy. However, we hope to have convinced the reader that the Walrasian features would still shine through.

2. Imperfect competition with diminishing returns

In the previous section, we made the simplest possible assumptions that enabled us to derive explicit formulae for policy multipliers. One of these—the "Walrasian" assumption of constant returns—is not standard in textbook macroeconomics. Since Keynes, it has been usual to view the macroeconomic equilibrium as occurring in the "short-run"; capital is fixed. This leads to the standard assumption that there are diminishing returns to labour—output is a concave function of employment; $y = f(N)$; $f' > 0 > f''$.

In this section we shall see that constant returns was merely a convenient simplification. Whilst we are unable to derive explicit formulae for the multiplier, the overall logic and conclusions of the previous section are not changed.

With diminishing returns, the only additional complexity is that the real wage becomes a function of employment as well as the degree of competition in the product market. The profit maximising duopolist chooses its output so that marginal revenue equals marginal cost. Rather than being constant, marginal cost increases with output, and is given by w/f';

$$\mu = \frac{p - w/f'}{p} = \frac{1+\phi}{2} \tag{2.1a}$$

$$\frac{w}{p} = f' \frac{(1-\phi)}{2} = f' \cdot (1-\mu) \tag{2.1b}$$

In the case of a perfectly competitive product market ($\phi = -1$), this simply means that the real wage equals the marginal product of labour. With imperfect competition, however, labour receives less than its marginal product. In the case of Cournot Duopoly ($\phi = 0$) the real wage equals only one half of the marginal product. Equation (2.1a) is often referred to as the "demand curve" for labour. This is misleading, as we shall discuss below. Rather, it simply tells us the relationship between nominal wages, prices and employment that must hold with imperfectly competitive product markets.

If we now define the real wage $\omega \equiv w/p$, our macroeconomic system becomes:[5]

$$Y = c\left(\omega, \frac{M^0}{p}\right) + g \tag{2.2}$$

$$Y = f(N) \tag{2.3}$$

$$\omega \equiv w/p = f' \cdot (1-\mu) \tag{2.4}$$

$$N = N\left(\omega, \frac{M^0}{p}\right) \tag{2.5}$$

Note that we are omitting profits from our analysis for simplicity.

Aggregate demand and supply analysis is still valid in this framework, so long as we include the real-wage equation (2.4). Turning first to aggregate demand (AD) in (N, p) space, we have the three equations (2.2)–(2.4). As the price increases, this reduces real balances as before, but also leads to an increase in the real wage. To see this, substitution reduces (2.2)–(2.4) to the AD relation

$$\text{AD} \quad f(N) = c\left(f'(N)1-\mu, \frac{M^0}{p}\right) + g \tag{2.6}$$

[5] There is an aggregation problem here which is skirted around, as is usual. In (2.1) the marginal productivity condition holds for the firm's production function. In (2.3) and (2.4) we have the aggregate production function. So long as firms are identical and the equilibrium symmetric, as here, there is no problem. Let the firm's production function be defined as $g(N_i)$, and the economies as $f = 2g(N/2)$: then $f' = g'$.

Total differentiation of (2.6) yields

$$\left.\frac{dN}{dp}\right|_{AD}=\frac{-c_2}{f'-f''(1-\mu)\cdot c_1}<0 \tag{2.7}$$

Note that since $c_1>0$ (leisure is normal) then the "real wage" effects of increases in price via the price cost equation (2.4) reinforces the real balance effect. As in the Walrasian model, an increase in monopoly μ shifts the AD curve to the left in (N, p) space.

Aggregate supply (AS) is defined by the two equations (2.4) and (2.5). For comparison with text-books, we can consider the AS relationship in real-wage/employment space. Equation (2.4) gives the real-wage as a function of employment, as in Fig. 2.1. The supply of labour is upward sloping in the real-wage. However, because of real balance effects, there are a family of labour supply curves which correspond to different price levels. The higher the price level, the lower are real balances, and the higher the labour supply at any given real wage (in terms of Fig. 2.1, $p_0<p_1$). Thus for price level p_0, the corresponding employment is N_0, and N_1 corresponds to p_1.

The AS function is upward sloping, as can be verified by total

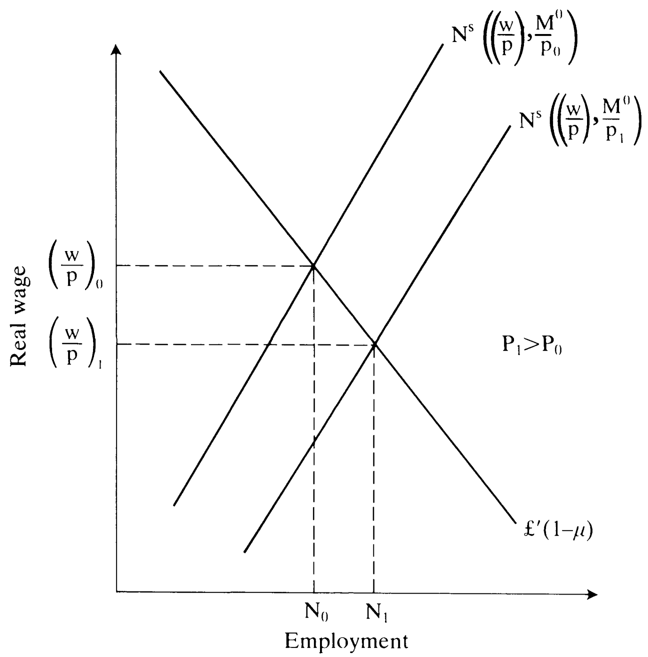

FIG. 2.1. Real wages, employment and the price level

differentiation of (2.4) and (2.5):

$$\left.\frac{\mathrm{d}N}{\mathrm{d}p}\right|_{\mathrm{AS}} = \frac{-N_2 \dfrac{M^0}{p^2}}{1 - N_1 f''(1-\mu)} > 0 \tag{2.8}$$

Note that an increase in the degree of monopoly (a decrease in ϕ) will shift the relationship between real-wages and employment to the left. In Fig. 2.2 we depict the relationship for $\phi = 1$ (perfect competition, $\phi = -1$) and $\phi = 1/2$ (Cournot). There is an inverse relationship between the degree of monopoly and employment.

The analysis of monetary and fiscal policy can be carried out analogously to the previous section. Equations (2.2)–(2.5) are Hodo in (w, p, M^0), so that the classical dichotomy holds and money is neutral. An increase in government expenditure shifts the AS curve to the right, leading to an increase in employment and prices. The fiscal multiplier is:

$$\frac{\mathrm{d}N}{\mathrm{d}g} = \frac{-N_2}{c_2(1 - N_1 \cdot (1-\mu) \cdot f'') - N_2(f' - c_1 \cdot f'' \cdot (1-\mu))} > 0 \tag{2.9}$$

Again, there is crowding out: $0 < \mathrm{d}N/\mathrm{d}g < 1$.

Note that as the degree of monopoly increases the multiplier increases. The "Walrasian" multiplier corresponds to the case when $\mu = 0$: again, the basic mechanisms underlying the expansionary effect of g are the same as in the Walrasian case.

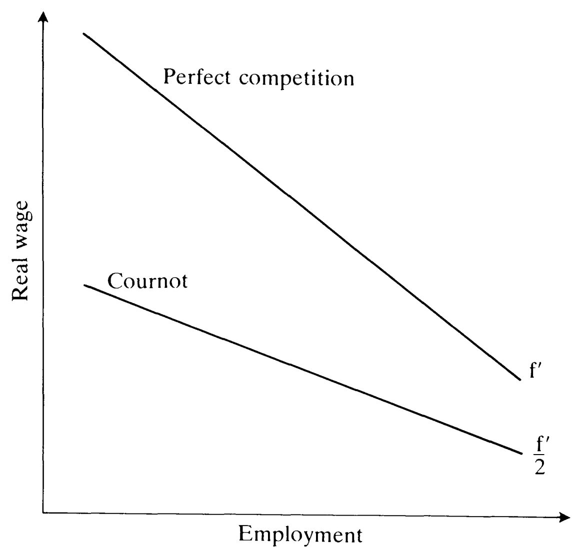

FIG. 2.2. Real wages and employment

3. Unions and the natural rate of unemployment

In this section, we relax the assumption that the labour market is competitive, and introduce a union which bargains with the firms over the nominal wage w. This introduces the possibility of an excess supply of labour: the union can push up the nominal wage, and hence the real wage, above the market clearing level. The resultant equilibrium will be "Keynesian" in the sense that there will be an excess supply in both the product and labour markets. However, as we shall demonstrate, the model is very un-Keynesian in that the classical dichotomy still holds (money is neutral) and fiscal policy can be less effective than in the Walrasian case. Indeed, we provide examples in which the fiscal policy multiplier is zero, and there is complete crowding out.

The model presented seems a good interpretation of Friedman's conception of the Natural Rate of Unemployment (NRH), (Friedman (1968), (1975)). Friedman's original article on the natural rate defined it as "the level ... ground out by the Walrasian system of general equilibrium equations, provided that there is embedded in them the actual structural characteristics of labour and product markets, including market imperfections, the cost of gathering information about job vacancies and so on" (1968, p8). Some economists have focussed on the word "Walrasian" in the above quote, and interpreted the NR as simply the Walrasian equilibrium (eg. Hahn (1980 p, 293)). Others focus on search models of unemployment (Mortensen (1970), Diamond (1985), Pissarides (1984), Lockwood (1985)). The model here focusses on imperfect competition in the labour and product market—the NR as a non-Walrasian equilibrium. At the end of this section we will show how the equilibrium can be interpreted as the Natural Rate.

How should unions be introduced into this model? A first point is that we can no longer think of there being one "representative" household. There will be two types of households in equilibrium: the employed and the unemployed. The union may act in the interests of its employed members, to maximise their welfare. Secondly, since there will be rationing in the labour market, the notional consumption function will have to be altered to become an *effective* demand function. We will first outline the model of the household and labour market, and then the union.

(a) *Households*

There is a continuum H of households with identical preference and money balances as represented by (1.1–5), except that for simplicity profits are not distributed. This corresponds to the idea that each household is very "small" and that to obtain market demand/supply you have to add up (in fact integrate) each household's demand/supply. If we look first at the labour supply, we integrate over the set H of households, so that market supply is given by:

$$N^s(\omega, M^0/p) = \int_H N^s(\omega, M^0/p, h)\,\mathrm{d}h \tag{3.1}$$

If there is insufficient demand for the labour supplied, we assume that the first households in the queue (or seniority system) are employed, and the rest are unemployed. Thus if labour demand is N, then the employment and unemployment rates are:

$$e = N/N(\omega, M^0/p) \tag{3.2a}$$

$$u = 1 - e \tag{3.2b}$$

Those households which are employed will receive income consisting of wages from employment plus money balances, the unemployed live off their money balances. Since households have Cobb–Douglas preferences, we can aggregate over employed and unemployed households. Consumer demand in the product market thus:

$$c^d\left(\omega, \frac{M^0}{p}, N\right) = e.C(w/p, M^0/p) + (1-e)\frac{\alpha}{\alpha+\gamma}\frac{M^0}{p} \tag{3.3}$$

The effective demand function still has unit elasticity of demand, so our analysis of the firm in Section 1 still holds good.

For a given level of (w, M^0) then, the macroeconomic equilibrium is determined by:

$$y = c^d\left(\omega, \frac{M^0}{p}, N\right) + g \tag{3.4}$$

$$y = f(N) \tag{3.5}$$

$$\omega \equiv w/p = f'(1-\mu) \tag{3.6}$$

plus (implicitly) the three equations (3.1–3) used to derive c^d. (3.4) tells us that output is determined by *effective* demand $c^d + g$, which takes account of the fact that some households may be rationed in the labour market. Using (3.4–6) we can determine output, employment and prices *given* the nominal wage, money balances and government expenditure. We will define the Aggregate Demand function as solving (3.4–6) for employment, AD(w, M^0, g). If we hold (M^0, g) as fixed, this yields the true "demand for labour" relationship. Total differentiation of (3.4–6) yields:

$$\left.\frac{\mathrm{d}N}{\mathrm{d}w}\right|_{\mathrm{AD}} = \frac{-c_2^d f'(1-\mu)M^0}{w^2(f' - f''(1-\mu))c_1^d + c_2^d f''(1-\mu)\dfrac{M^0}{w} + c_3^d} < 0 \tag{3.7}$$

Thus a higher nominal wage leads to a lower level of employment. This is because a higher nominal wage leads to higher prices, and a higher real wage. As in the previous section, a rise in the degree of monopoly μ leads to an inward shift in the AD curve. The AD curve is the union's real demand curve: it gives the level of employment that will result if a particular nominal wage is set. Equation (3.4–6) also tells the union the real wage that will result. As in the previous sections, the behavioural equations are all Hodo in (w, p, M^0), as is the AD function.

(b) *The union*

Given the relationships between nominal wages, real wages, and employment contained in the AD curve and equations (3.4–6), how is the equilibrium determined? We need a model of nominal wage determination. In this section, we shall consider two different models: the monopoly-union model where unions have the power to unilaterally set the nominal wage, and a model where firms and unions bargain over the nominal wage. Given the nominal wages set, firms choose outputs and thus prices. This seems very reasonable: in practice unions have a direct say only on the wages they get, not on the prices which firms set.

There are many alternative assumptions that can be made about the union's objectives in the wage determination process. In the bargaining model we adopt the simple yet plausible assumption that the union seeks to maximise the real wage. The rationale for this is that the union seeks to maximise the utility of those households which are employed—who presumably make up its membership. As Oswald (1984) argues, if there is a seniority system such as LIFO (Last In, First Out) which determines who get laid-off, then majority voting will lead to real-wage maximisation. In the context of the monopoly union model, however, the assumption of real wage maximisation is rather extreme (with diminishing returns, real wages are maximised with one employee), so we allow for a general utility function defined on employment as well as real wages (as is common—see Oswald (1985), Pencavel (1984)).

(c) *Bargaining over the nominal wage*

The firms and the union bargain over the nominal wage. The wage bargain is made at the industry level, so that the two firms act together. Given the nominal wage chosen, price is determined by the non-cooperative behaviour of firms in the product market. The firms' objectives are profits: the unions real wages. Out of the many possible bargaining solutions we will adopt the simple Nash-bargain. Thus the nominal wage is chosen to maximise the product of profits with real wages. Since (from the AD relation) there is a 1:1 relationship between nominal wages and employment, it is most convenient to represent the bargain as a choice of *employment*. Real wages are $f'(1-\mu)$: profits are $f - f'(1-\mu)N$. Hence the

TABLE 2
Equilibrium employment and the degree of monopoly: example

Equilibrium Employment	The degree of monopoly: Competitive $\mu=0$	$\mu=1/4$	Cournot $\mu=1/2$	Cartel $\mu=1$
N	$\frac{1}{3\delta}$	$\frac{1}{\delta\sqrt{12}}$	$\frac{1}{4\delta}$	$\frac{2-\sqrt{3}}{2\delta}$
% of $\mu=0$ (3.s.f.)	100	86.8	75.1	40.2

Nash-product is:

$$\max_N \, (f - f'(1-\mu)N)f'(1-\mu) \tag{3.8}$$

$$\text{s.t.} \quad N \leq N^s(f'(1-\mu), M^0/p) \tag{3.9}$$

Constraint (3.9) represents the notion that the union cannot force people to work, and p is given through (3.4–6). We will assume that (3.9) never binds, so that from the first order conditions for (3.8) we have for an inferior maximum:

$$N = \frac{f'^2\mu + ff''}{2f'f''(1-\mu)} \tag{3.10}$$

(the second-order condition will generally be satisfied—a sufficient condition is that $f''' \leq 0$). Given the equilibrium level of employment, the nominal wage is set so that AD yields N using (3.4)–(3.6). Of course an interior solution to (3.8–9) need not exist: however, that is not of interest here.[6] What is of interest is that the equilibrium level of employment defined by (3.10) is determined solely by the degree of monopoly μ, and the technology represented by the production function $f(N)$. If (3.9) is binding, then the labour market clears and we revert to the equilibrium examined in Section 2.

Suppose we consider a concrete example. Let $y = N - \delta N^2$, where we choose δ small enough so that $dy/dN = 1 - 2\delta N$ is positive for relevant N (e.g. $1/2\delta$ is greater than the Walrasian level of employment.) In this case we can solve (3.10) for the equilibrium employment level (assuming (3.9) is not binding). In Table 2 we have calculated the solution for different values of μ satisfied at these values, which give the global maxima over relevant ranges of N). In the second row we express the equilibrium employment levels as a percentage of the level when $\mu = 0$.

[6] No solution may exist at all, since the lower bound on N is given by the strict inequality $N > g$ (there is no upper bound on nominal wages). If a solution does exist, it may have (3.9) binding.

In this example, the degree of monopoly in the product market has a very strong influence on the equilibrium level of employment.

A generalisation of the classic Nash-solution is to allow for differential bargaining power, and have a *weighted* Nash-bargain. The objective function then becomes:

$$\max_N \,(f - f'N(1-\mu))^{\lambda}(f'(1-\mu))^{(1-\lambda)} \tag{3.11}$$

where a smaller λ represents greater union bargaining power, and $1 \geqslant \lambda \geqslant 0$. (3.11) yields the first order condition:

$$N = \frac{\lambda\mu f' + (1-\lambda)ff''}{f'f''(1-\mu)} \tag{3.11a}$$

Letting $\mu = 0$ a quadratic production function yields $N = \lambda/\delta(1+\lambda)$. Thus the greater the bargaining power of unions (the smaller λ) the lower the equilibrium level of employment.[7]

In the particular model of bargaining we have considered, there is no role for macroeconomic policy to influence the equilibrium level of employment. Unions and firms are locked into a bargaining process, the outcome of which is not influenced by monetary or fiscal policy.[8]

(d) *A monopoly union model*

An alternative assumption to a wage-bargain is that the union sets nominal wages. Thus the union sets (nominal) wages and firms set prices given the wages set. A higher nominal wage causes lower employment (through aggregate demand) and a higher real wage. The real wage equation (3.6) gives the feasible combinations of real-wage and employment. We could assume a general union utility function defined on the real wage and employment (see Oswald (1985) for a survey). In this case, the union maximises its utility subject to the real wage equation.

$$\max_N u(\omega, N) \tag{3.12}$$

$$\text{s.t.} \quad \omega = f'(1-\mu) \tag{3.13}$$

Should a solution to (3.12–13) exist, government monetary and fiscal policy will not effect the equilibrium level of employment. The impact of an increase in government expenditure is to crowd out the consumption of households, since the resultant price rise reduces the value of their real balances.[9]

[7] When $\lambda = 0$, $N = 0$ and the real wage is maximised: when $\lambda = 1$ then $N = 1/2\delta$ and profits are maximised. Clearly, we would expect the labour supply constraint to become effective for $\lambda < 1$, with the labour market clearing (as in Section 1).

[8] This is only true for an interior solution (3.10) and (3.11a), when (3.9) is not binding.

[9] Consumption by employed workers is $c(w/p, M^0/p)$; by the unemployed $(\alpha/(\alpha+\gamma))M^0/p$.

These strong results of fiscal neutrality stem from the assumptions made about the union's objective function. Although household utility depends upon consumption and leisure, it also depends upon real balances. In the two examples given above, the union's objective was expressed purely in *real* terms: the nominal price level played no direct role. This suppression of the real balance effect may seem a very reasonable step: after all, how many unions worry about the impact of wage settlements on their members real balances? However, the introduction of real balances to the union's objective function would undermine the fiscal neutrality result, although homogeneity and hence monetary neutrality still hold.

We have considered two models of nominal wage determination in a unionised economy. With a union influencing wage determination, and firms prices, the resultant equilibrium can have excess supply in both the output and labour markets. In this sense the equilibrium is very Keynesian. However, the policy implications for the economy are very unkeynesian: money is neutral, and the fiscal multiplier can be zero. The basis idea behind the classical dichotomy still holds in a unionised economy. The monopoly union case is depicted in Fig. 3.1. The equilibrium level of employment is determined in the labour market. Given the equilibrium level of employment, the nominal wage w^* is set to achieve this given AD. Since the AD function is Hodo in (w, M^0), an increase in M^0 to $M^{0\prime}$ will lead to an equiproportionate rise in the nominal wage set by the union, from w^* to w'.

To what extent do models of imperfect competition with unionised labour markets yield a model of the "natural rate"?. There are perhaps five crucial features of the NRH: (i) there exists a unique equilibrium in the economy, in which (ii) agents' expectations are confirmed and (iii) money is neutral, (iv) trade unions can influence the unique equilibrium[10] (v) the theoretical model is a general equilibrium model (this seems to be the import of Friedman's use of the phrase "Walrasian system"). Any equilibrium concept which has properties (i)–(v) will very much resemble Friedman's notion of the NRH.

Clearly, the model of imperfect competition in a unionised economy which we have presented satisfied (ii)–(v). Uniqueness is, however, rather less easy to guarantee. If we turn to the case of a Nash-bargain between firm and unions, over the nominal wage, uniqueness may or may not hold, depending on the nature of the production function. In the case of the monopoly union, uniqueness can only be guaranteed by fairly strong restrictions on both the production function and the union's utility function. For example, if the marginal product of labour is non-concave then there may be two or more "tangencies" with the union's indifference curve, as in Fig. 3.2. Recall that the concavity of the production function merely

[10] "Trade unions play an important role in determining the position of the natural level of unemployment" Friedman (1975, p. 30).

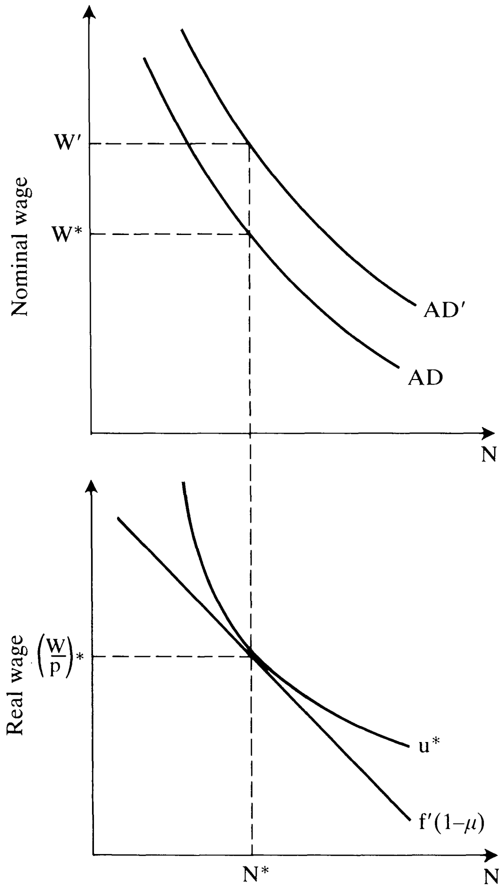

FIG. 3.1. The monopoly union: real wages, nominal wages and employment

requires the marginal product of labour to be decreasing, so for any shaped union indifference curve it is possible to construct multiple equilibria (a sufficient condition to ensure uniqueness given that the union utility is quasiconcave is $f''' \leqslant 0$).

Whilst non-uniqueness goes very much against the spirit of Friedman's NRH, it does not imply that the model is Keynesian, in the sense that there are multiplier effects. However, it is possible to conceive of macroeconomic policy causing the economy to switch from one equilibrium to another. Consider the following argument. In Fig. 3.2 there is a high-employment equilibrium at N_h, and a low-employment equilibrium at N_l. Suppose that the economy is at the low-employment equilibrium, and that wages are fixed in the short-run due to fixed-term contracts. Given initial government polict (M^0, g), the union has set wage w_1, as in Fig. 3.3. Given this wage, the

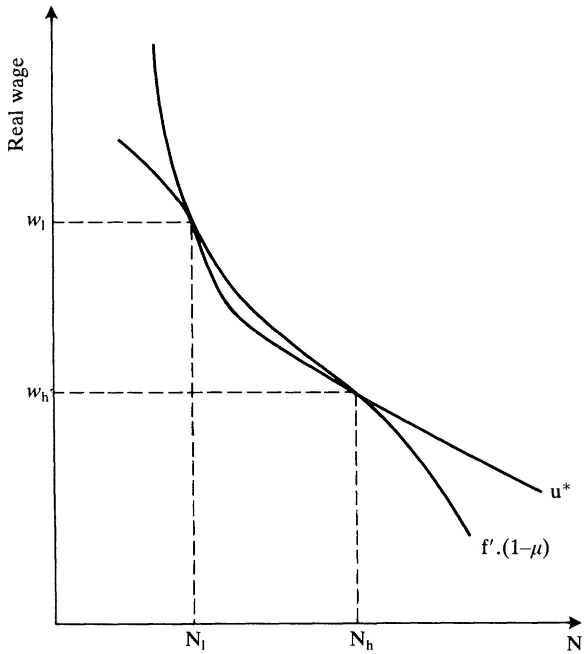

FIG. 3.2. Multiple Equilibria

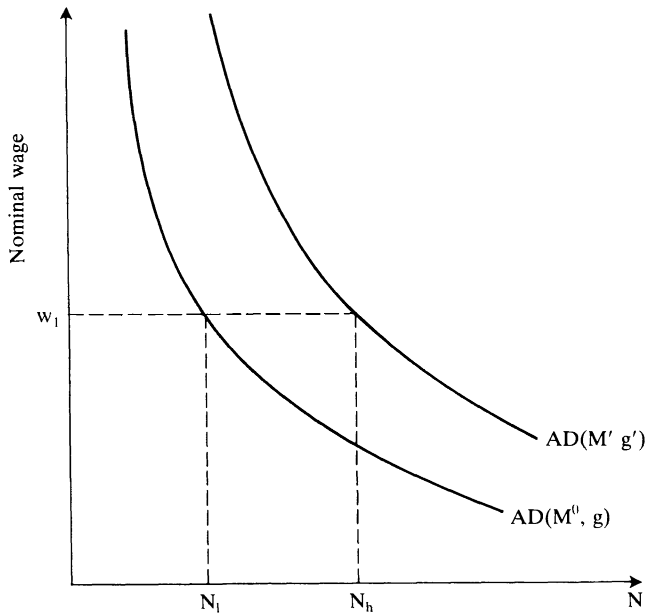

FIG. 3.3. Macroeconomic Policy with Multiple Equilibria

government can alter its macroeconomic policy to some (M', g'), such that:

$$N_h = \mathrm{AD}(w_1, M', g')$$

With the new policy, the union finds itself at the high-employment equilibrium, and has no incentive to alter the nominal wage. This story is very plausible, and indicates that in the case of multiple equilibria, macroeconomic policy can be used to ensure that the highest level of equilibrium employment is attained, avoiding the low employment equilibria.

If we put aside problems of uniqueness, it is possible to generate the long-run Phillips curve model if we assume that wage-bargains are fixed in the short run and unions (and firms) have rational expectations. We can impose the following two-stage temporal structure on the model. In the first stage, unions and firms bargain over the nominal wage, or the union chooses w. In the second-stage, the nominal wage is fixed: the government announces its money supply and firms choose their output and employment (this structure of moves is used by Nickell and Layard (1985)). The agents in the economy have point expectations about the governments policy (M^e, g^e). Given the desired level of employment N^*, w is chosen to attain this given expectations, so w solves:

$$N^* = \mathrm{AD}(w, M^e, g^e)$$

Given the wage set, actual employment is given by:

$$N = N^* + (M^0 - M^e)\partial \mathrm{AD}/\partial M + (g - g^e)\partial \mathrm{AD}/\partial g \tag{3.17}$$

Where the derivatives of AD are obtained by total differentiation[11] of (3.3–6), and will include standard multiplier effects. Thus if monetary or fiscal policy are more expansionary than expected, employment will be higher than the equilibrium where they are fully anticipated (this model can be seen as a theoretical justification for the econometric model employed by Nickell and Layard (1985) in which only surprises in fiscal policy are effective). From the price-cost equation (3.6), $p = w/f'(1-\mu)$. Hence an increase in employment will give rise to an increase in prices, due to diminishing marginal productivity:

$$\left.\frac{\mathrm{d}p}{\mathrm{d}N}\right|_w = -\frac{f'^2(1-\mu)}{f''w} > 0 \tag{3.18}$$

Hence it is possible to represent the deviation of actual from expected employment as a function of the deviation of the actual from expected prices:

$$N = N^* + \beta(p - p^e) \tag{3.19}$$

[11] (3.15) can be seen as a linear approximation if derivatives are evaluated at (M^e, g^e), or an exact expression by the Mean Value Theorem if derivatives are evaluated at some intermediate value.

or

$$p = p^e + (1/\beta)(N - N^*) \tag{3.20}$$

where

$$\beta = \frac{\mathrm{d}p}{\mathrm{d}N}\left(\frac{\partial \mathrm{AD}}{\partial M}(M - M^e) + \frac{\partial \mathrm{AD}}{\partial g}(g - g^e)\right)$$

Of course, the causality does not run from surprises in prices to deviations in employment: rather it runs from surprises in aggregate demand to deviations in employment and prices. Note that this neutrality result is much stronger than in a Walrasian economy where money is neutral, but even fully anticipated fiscal policy is not.

Given the basic set-up of fixed-wage contracts, we are able to provide a rigorous story of deviations from the "natural rate", which is in effect the short-run Phillips-curve. If we combine this with an appropriate model of expectations formation, then we can tell the usual stories. With rational expectations, surprises in government policy will be a white-noise error term, and hence deviations from the natural rate will be purely transitory. With adaptive expectations, there can be short-run deviations, but employment will tend back to the long-run equilibrium.

Conclusion

This paper has explored some of the implications of imperfect competition for macroeconomic policy within the simplest possible macroeconomic model with proper microeconomic foundations. In the product market there is a conjectural variations Cournot oligopoly model which allows for a wide range of competitive behaviour from perfect competition to joint profit maximisation. In the labour market we considered the case of perfect competition and two models of wage determination in a unionised labour market. Whilst it is dangerous to draw general conclusions from specific models, we feel that the following broad lessons can be drawn.

Imperfect competition matters. Not only does imperfect competition influence the equilibrium levels of employment and prices, it also influences the effectiveness of fiscal policy. With a competitive labour market the fiscal multiplier is larger the less competitive is the product market (though there is still crowding out). With a unionised labour market we presented two examples where there was complete crowding out. All three examples presented point towards "classical" conclusions about fiscal policy—there is partial or complete crowding out. Of course, it may well be possible that alternative assumptions might yield more Keynesian results.

Perhaps the most crucial assumption in the models presented is that there is a single sector. In Dixon (1986) we present a two-sector model of a unionized economy, which shares most of the assumptions of this paper. The union in each sector sets its wage, given the wage set by the other union. With two sectors, the unionized equilibrium does not have a unique natural rate of employment, but rather a "natural range" of employment. Hence macroeconomic policy is not ineffective, as in this paper. There is a limited range of feasible levels of employment which can be achieved by an appropriate policy.

There is one aspect of a perfectly competitive economy that can carry over to an imperfectly competitive economy: the neutrality of money. The basic justification for neutrality is the homogeneity of the underlying behavioural equations. This homogeneity is unaffected by imperfect competition per se. However, even in a perfectly competitive economy homogeneity is an extremely strong assumption (see Grandmont (1984)). Whilst we have adopted a basic framework that includes homogeneity for simplicity, it is no more plausible here than in competitive macromodels.

Imperfect competition has an ambiguous relationship to keynesian economics. If firms set prices, and unions wages, it is possible to have a macroeconomic equilibrium which is Keynesian in the sense that if agents were price-takers, they would like to sell more at equilibrium prices. Imperfect competition leads to a non-Walrasian equilibrium. The implications for macroeconomic policy are very non-Keynesian. In the examples presented of a unionised economy, fiscal policy had no effect on equilibrium employment, because an increase in government expenditure causes wages and prices to rise, crowding out private consumption by the real balance effect.

Certainly, the models of a unionised economy presented seem to have more affinity with Friedman's Natural Rate. We argued that the imperfectly competitive equilibrium can be seen as a natural interpretation of the Natural Rate, and one of which Friedman is aware. If we combine the model of the unionised economy with short run wage rigidity, the usual Phillips curve stories arise. The only scope for macroeconomic policy in this context appears to be in the case of multiple equilibria. If wages are fixed in the short-run, the government can ensure that the equilibrium with the highest level of employment is attained.

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