

# THE NONNEUTRALITY OF MONETARY POLICY WITH LARGE PRICE OR WAGE SETTERS\*

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Monetary rules matter for the equilibrium rate of employment when the number of price-wage setters is small, even when assuming rational expectations, complete information, central bank precommitment, and absence of nominal rigidities. If the central bank is nonaccommodating, sufficiently large unions, bargaining independently, have an incentive to moderate sectoral money wages, and thereby expected real wages. The result is an increase in the real money supply, and hence higher demand and employment. This does not hold with accommodating monetary policy since unions' wage decisions cannot then affect the real money supply. A similar argument holds for large monopolistically competitive price setters.

## I. INTRODUCTION

Under a wide range of assumptions, the choice by a central bank of a monetary rule does not affect the equilibrium rate of employment. We show in this article, however, that with a finite number of wage or price setters this is no longer necessarily the case. In particular, we show that a switch by the central bank from an accommodating to a nonaccommodating monetary rule leads to an increase in the equilibrium rate of output or employment, and that this increase is greater the smaller the number of price or wage setters. The result does not challenge the weak neutrality of money theory; given the choice of monetary rule, a change in the money supply has no effect on real variables.<sup>1</sup> Rather, it shows that the *strategic interaction* of price-wage setters and monetary authorities can have important effects on the equilibrium rate of output and employment. In other words, with a finite number of wage or price setters, the character of the monetary rule is nonneutral. While it may appear at first sight counterintuitive that an *increase* in nonaccommodation should *increase* equilibrium employment, we show that this is consistent with data for seventeen OECD economies over the period 1973–1993.

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1. Bleaney (1996) shows this to be the case under a similar set of assumptions used here. This result is simply a restatement of the money neutrality thesis—a thesis we obviously do not challenge.

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A sufficient set of assumptions under which choice of monetary rule has no effect on equilibrium employment are (i) rational expectations, (ii) perfect competition, (iii) complete information, (iv) capacity for the central bank to credibly precommit, and (v) absence of nominal rigidities. A large literature on central banks has subsequently shown that the core conclusion is robust to changes in assumptions (iii), (iv), and (v).<sup>2</sup> We deliberately retain all these assumptions (in addition to (i)), and show instead what happens when assumption (ii) is dropped. In its place, we present two general equilibrium models, both based on Blanchard and Kiyotaki {1987} and Blanchard and Fischer {1989}, which assume that either prices are set by monopolistically competitive producers or wages are set by monopoly unions. The first, a “yeoman farmer” model of monopolistic competition in which each of  $N$  farmers produces unaided one product and consumes all  $N$  products, is simple, but gives the intuition of our argument. This is set out in Section II. The second model assumes a fully unionized multisector economy in which monopoly unions in each sector set wages independently and simultaneously. This is set out in Section III. In both cases, the economic agents care only about real variables, so there is no money illusion.<sup>3</sup>

The key to our argument is that price or wage setters with some monopoly power can affect the real money supply depending on the monetary rule used by the central bank. If the central bank fixes the nominal money supply, the effect of increased sectoral prices or wages on aggregate prices will translate into reduced real demand and hence lower output or employment. There is therefore an incentive for producers or unions to lower their nominal prices or wages relative to those expected in other

2. In Barro and Gordon, for example, inability of the central bank to credibly precommit to a monetary rule raises inflation, but has no effects on equilibrium unemployment (see also Kydland and Prescott {1977}). Other work has focused on the consequences of assuming incomplete information. For example, when voters do not know how competent governments are in producing public goods for a given fiscal revenue, governments may try to signal their competency by engaging in expansionary preelection fiscal and monetary policies (see Rogoff and Sibert {1988}, Cukierman and Meltzer {1986}, and Rogoff {1990}). Other models assume nominal rigidities in the presence of economic business cycles that create a trade-off between inflation conservatism (which reduces inflation) and flexibility to respond to exogenous shocks (which reduces employment variability). This has consequences of the optimal design of central bank contracts, but does not affect equilibrium employment. For examples of this approach, see Rogoff {1985}, Lohmann {1992}, Persson and Tabellini {1993}, and Svensson {1996}.

3. This contrasts with a recent paper by Cukierman and Lippi {1999} which assumes that the rate of inflation matters to unions. Absent this, the paper shows a nonneutrality result (in a different direction to ours) only when relative wages as well as real wages are added to the employment demand function.

sectors; and hence to increase production or employment. The smaller the number of independent monopoly price-wage setters, the greater the individual effect on the aggregate price level, and the greater the incentive for real price-wage restraint. In the case of unions, the standard trade-off between the real wage and the employment level along the sectoral employment demand curve is thus altered: greater real wage restraint lowers the relative price of the sector, and this raises the real money supply (given wage-price setting elsewhere). By contrast, if the central bank fixes the real money supply, the incentive to exercise restraint is absent since unions in this situation cannot affect real demand and hence employment. Because all unions reason similarly, real wage restraint and equilibrium employment are higher, the fewer the number of unions, and the more nonaccommodating the monetary regime.

Since wage-setting tends to be more monopolized than price-setting, the argument applies to all economies with a small number of independent unions. It does *not* apply to economies where there are a very large number of unions (or where individuals bargain wages), because here the aggregate price effects of individual unions are too small. Nor does it apply to economies where a single union sets wages, or where a small number of unions can coordinate their wage policies effectively enough to act as a single union, since the union(s) can then choose full employment independently of the monetary regime.<sup>4</sup> Rather, the argument is intended to solve, and is motivated by, a persistent empirical puzzle in comparative political economy: the capacity for good unemployment performance by some, but not other, economies with intermediately centralized systems of wage-setting. Such systems are often portrayed as institutional dilemmas where large unions are capable of inflicting great harm on the economy, yet incapable of solving their collective action problems (Olson 1982; Calmfors and Driffill 1988). But while it is true that some of these systems have performed poorly, it is frequently noted that others are among the most successful, and institutionally stable, economies in the world (see Soskice (1990), Hall (1994), and Iversen (1999)).

The purpose of this article is analytic rather than empirical, but the data in Table I help to illustrate the puzzle (the table is

4. The case of multilevel bargaining is more complicated; see Iversen (1998, 1999).

TABLE I  
LONG-RUN AVERAGE UNEMPLOYMENT RATES FOR 17 OECD COUNTRIES DEPENDING  
ON THE MONETARY RULE AND THE CENTRALIZATION OF WAGE BARGAINING,  
1973–1993 (*N*, IN PARENTHESES)

	Centralization			<i>Mean:</i>
	Very high	Intermediate	Very low	
Monetary rule				
Accommodating	3.9 (3)	7.6 (3)	7.1 (3)	6.2 (9)
Nonaccommodating	5.6 (2)	3.6 (4)	7.4 (2)	5.0 (8)
<i>Difference</i>	-1.7	4.0*	-0.3	5.6 (17)

\* Difference is significant at a .001 level (one-sided test).

Monetary rule refers to the independence of the central bank except in the case of Japan where a dependent bank has followed a nonaccommodating rule. Centralization refers to the prevalent level and concentration of wage setting. Very high centralization means that a small number of national unions or confederations bargain wages and routinely coordinate their wage demands. Very low centralization means that wages are predominantly bargained at the plant or firm levels by local unions or individuals. Intermediate cases are characterized by a limited number of bargaining areas, but without any effective coordination of union wage demands. Beginning with the top row, the countries in the table are from left to right (with brackets demarcating cells): {Finland, Norway, Sweden}; {Australia, Belgium, Italy}; United Kingdom, France, New Zealand}; {Austria, Denmark}; {Germany, Japan, Netherlands, Switzerland}; {Canada, United States}.

Sources: OECD (1996, 1997); Cukierman, Webb, and Neyapti (1992); and Hutchison, Ito, and Cargil (1997).

literally only illustrative). The table shows the equilibrium rate of unemployment in seventeen OECD countries characterized by different types of unions and monetary rules.<sup>5</sup> With one exception, we use Cukierman, Webb, and Neyapti's {1992} index of legal central bank independence as a proxy for the monetary rule, dividing the sample into an accommodating and a nonaccommodating category.<sup>6</sup> With regard to the number of unions, we use centralization of wage bargaining as a proxy. Although there is no consensus on the classification of every bargaining system, most industrial relations specialists agree on the ones that are either highly decentralized (Canada, France, New Zealand, the United Kingdom, and the United States), or highly centralized (Austria, Denmark, Finland, Norway, and Sweden). We treat the remainder

5. Equilibrium unemployment rates are proxied by OECD's {1996} estimates for the nonaccelerating wage rates of unemployment in the period 1973–1993 (i.e., post-Bretton Woods), except in the cases of Switzerland and New Zealand where these are not available (we use national definitions instead).

6. The exception is Japan where the monetary authorities began to adhere to an unambiguously nonaccommodating rule after 1973, even though the central bank remained legally dependent (see Cargil {1993}, Hutchison and Judd {1989}, and Hutchison, Ito, and Cargil {1997}). This is recognized by Cukierman, Webb, and Neyapti {1992} who attribute nonaccommodating monetary policies in Japan to the influence of an exceptionally "conservative" Ministry of Finance {1993, p. 372}.

(Australia, Belgium, Germany, Italy, Japan, Netherlands, and Switzerland) as intermediate cases.<sup>7</sup>

Note that monetary rule appears to be largely unrelated to unemployment when the number of unions is either very large or very small, but that nonaccommodating rules are associated with significantly *lower* unemployment than accommodating rules when the number of unions is intermediate.<sup>8</sup> Although data of this nature can only be suggestive, a number of more detailed empirical studies support the notion that monetary rules matter for unemployment when their interactive effects with the centralization of wage-setting are taken into account (see Iversen {1998, 1999}, Hall {1994}, Hall and Franzese {1998}, and Garrett and Way {1995}). Specifically, if our argument is correct, it would help us to understand why countries with intermediately centralized wage-setting systems are characterized by such widely divergent long-term unemployment performance.

## II. THE YEOMAN FARMER ECONOMY

To convey the basic logic of the argument, we begin by considering a simple “yeoman farmer” economy with monopolistically competitive producers who provide their own labor input. As in Blanchard and Fischer {1989, pp. 376–380} we assume, with one modification, that there are  $N$  identical monopolistic competitors each producing a single good indexed by  $i$  with price  $P_i$  and output  $Q_i$  ( $i = 1, \dots, N$ ). (The modification is that in each sector, while price and total output are decided by a single “marketing agent,” we assume that there are many identical producers whose production quota is set by the agent but who take individual consumption decisions; the agent maximizes their utility indirectly. This enables us to focus on strategic price-setting behavior when there are a small number of sectors, while avoiding the complications of strategic consumption behavior. It requires minor changes—set out in the Appendix—to the Blanchard-Fischer argument). Blanchard and Fischer conclude that the macroeconom-

7. The centralization of wage bargaining in different countries is reviewed in a recent OECD study {1997}. Our classification is consistent with the most frequently used classifications of centralization. See also Flanagan, Soskice, and Ulman {1983}, and Iversen {1998}.

8. Any attempt to capture these relationships in a simply additive model would fail, and it is not surprising that past studies employing a simple additive methodology have not found any strong employment effects of either central bank independence {Alesina and Summers 1993; Bleaney 1996}, or bargaining structure {OECD 1997}.

ics is unaltered as we move from perfect competition to monopolistic competition, and that “. . . money is neutral under monopolistic competition just as it is under perfect competition” (p. 381).

However, if the monopolistic competitor's price  $P_i$  has a finite effect on the general price level, changes in the monetary rule may be nonneutral. We assume that the central bank can precommit to a monetary rule, which we define by a parameter  $\alpha$ :<sup>9</sup>

$$(1) \quad M = P^\alpha \quad 0 \leq \alpha \leq 1.$$

Specifically, two limiting cases can be distinguished. When  $\alpha = 0$ ,  $M = 1$ , the monetary rule consists in fixing the nominal money supply equal to unity, and thus does not accommodate any price increases. When  $\alpha = 1$ ,  $M/P = 1$ , and the monetary rule consists in fixing the real money supply equal to unity, and thus accommodates all price increases.<sup>10</sup> It is convenient to assume that central banks are endowed with a fixed value of  $\alpha$  which might be thought of as the result of past reputation-building. In what follows, we assume a sequence of three moves: (1) the central bank precommits to setting  $M$  contingent on  $P$ . (2) The farmers' agents each set  $P_i$  simultaneously, in the knowledge of the monetary rule. (3) The central bank then sets  $M$  given  $P(P_1, \dots, P_N)$ . Since stage 3 is automatic, the game is in effect concentrated on stage 2. If  $U_i$  is the objective function of the  $i$ th agent, we show that the  $i$ th agent should choose  $P_i^*$  such that  $U_i(P_i^*, P_{-i}^*) \geq U_i(P_i, P_{-i}^*)$  for all  $i$ , where  $P_i^*$  is the equilibrium price of the  $i$ th agent and  $P_{-i}^*$  is the vector of equilibrium prices of the  $N - 1$  agents.

Using the Blanchard and Fischer model {1989, p. 433} with minor notational changes, the demand for good  $i$  is given by

$$(2) \quad Q_i = m/N \cdot p_i^{-\eta},$$

where  $p_i \equiv P_i/P$  is the relative price, and  $m \equiv M/P$  is the real money supply. (It is shown in the Appendix how (2) is derived from individual maximization behavior by farmers. This relies on the assumption that the agent can fix the supply of the farmer's output to equilibrium demand.) The aggregate price level  $P$  is defined as a constant elasticity of substitution (CES) index:

$$(3) \quad P = \left( \frac{1}{N} \cdot \sum P_i^{1-\eta} \right)^{1/(1-\eta)}.$$

9. We are indebted to Chris Allsopp for suggesting this form.

10. When  $\alpha = 1$ ,  $M/P$  could be set equal to any constant other than 1 without affecting the results (as we discuss below). Using 1 is for convenience.

Assuming that there are a fixed number of  $n$  farmers in each sector, with constant returns to scale production, it is shown (also in the Appendix) that maximization of the direct utility function of the farmer with CES preferences over the  $N$  goods, disutility of labor, and utility of real money balances, and who makes optimal consumption and real cash balance choices, is secured by maximization by the farmer's agent of the following indirect utility function:

$$(4) \quad \max_{p_i} U_i = p_i \cdot Q_i - (d/\beta) \cdot Q_i^\beta + m/N,$$

where  $d'/\beta \cdot (Q_i/n)^\beta$  is the individual farmer's utility cost in terms of own-labor of production  $Q$  ( $\beta > 1$ ),<sup>11</sup> with  $d \equiv d'/n^{\beta-1}$ , and  $n^{-1} \cdot (p_i \cdot Q_i + m/N)$  is the farmer's wealth.<sup>12</sup> Substituting (2) into (4) and differentiating with respect to  $p_i$  gives the first-order condition for utility maximization (see footnote 13). We focus on a symmetric equilibrium, implying that  $p_i = 1$  and hence  $Q_i = m/N$ , for all  $i$ . Together with the first-order condition this yields<sup>13</sup>

$$(5) \quad Q_i = Q^* = \left( \frac{\eta - 1 - 2\partial \ln m / \partial \ln p_i}{d\eta - d \cdot \partial \ln m / \partial \ln p_i} \right)^{1/(\beta-1)}$$

where  $Q^*$  is the equilibrium level of total output per sector (so the output per farmer is  $Q^*/n$ ). The crucial term in (5) is  $\partial \ln m / \partial \ln p_i$ ,

11. This is identical to equation (3) in Blanchard and Fischer (1989, p. 378).

12. We assume that a change in  $M$  (when the central bank's monetary rule is applied after prices have been set) is distributed across the farmers in proportion to their original holdings of  $M$ .

13. To see this, first substitute (2) into (4) to derive the first-order condition:

$$(1 - \eta) \cdot p_i^{-\eta} \cdot \left( \frac{m}{N} \right) + d\eta p_i^{-\eta\beta-1} \cdot \left( \frac{m}{N} \right)^\beta + (1 + p_i^{1-\eta}) \cdot \left( \frac{1}{N} \right) \cdot \frac{\partial m}{\partial p_i} - \left( \frac{d}{N} \right) p_i^{-\eta\beta} \cdot \left( \frac{m}{N} \right)^{\beta-1} \cdot \frac{\partial m}{\partial p_i} = 0.$$

Then divide through by  $(m/N)$  and impose the equilibrium conditions ( $p_i \equiv 1$  and  $Q_i = m/N$ ) to obtain

$$(1 - \eta) + d\eta Q_i^{\beta-1} + 2 \frac{\partial \ln m}{\partial \ln p_i} = \frac{\partial \ln m}{\partial \ln p_i} \cdot d Q_i^{\beta-1},$$

which can be reformulated as in (5). The second-order condition that  $d^2U/dp^2 < 0$  is satisfied; the proof is available from the authors upon request.

and we need to evaluate this. Since  $M = P^\alpha$ ,  $m = P^{(\alpha-1)}$ , and  $\ln m = -(1 - \alpha) \cdot \ln P$ . Hence,

$$(6) \quad \frac{\partial \ln m}{\partial \ln p_i} = -(1 - \alpha) \cdot \frac{\partial \ln P_{(i)}^E}{\partial \ln p_i} = -(1 - \alpha) \cdot \frac{\partial \ln P_{(i)}^E}{\partial \ln P_i} \cdot \frac{\partial \ln P_i}{\partial \ln p_i},$$

where  $P_{(i)}^E$  is the  $i$ th agent's expectation of  $P$ . Note that, if  $P_{j(i)}^E$  is the value of  $P_j$  expected by the  $i$ th agent,  $P_{j(i)}^E$  is independent of  $P_i$  since agents set prices simultaneously and independently. So from (3)

$$(7) \quad \frac{\partial \ln P_{(i)}^E}{\partial \ln P_i} = \frac{1}{N} \cdot \left(\frac{P}{P_i}\right)^{\eta-1} = \frac{1}{N}$$

given that  $P = P_i$  in equilibrium. Consequently,

$$(8) \quad \frac{\partial \ln P_i}{\partial \ln p_i} = \left(\frac{\partial(\ln P_i - \ln P_{(i)}^E)}{\partial \ln P_i}\right)^{-1} = \left(1 - \frac{\partial \ln P_{(i)}^E}{\partial \ln P_i}\right)^{-1} = \frac{N}{N-1}.$$

Substituting (7) and (8) into (6) yields

$$(9) \quad \frac{\partial \ln m}{\partial \ln p_i} = -(1 - \alpha) \cdot \frac{1}{N} \cdot \frac{N}{N-1} = -\frac{1-\alpha}{N-1},$$

and, substituting (9) into (5), the farmers' agent thus sets  $Q_i$  in equilibrium to satisfy

$$(10) \quad Q^* = \left(\frac{\eta - 1 + 2(1 - \alpha)/(N - 1)}{d\eta + d \cdot (1 - \alpha)/(N - 1)}\right)^{1/(\beta-1)}.$$

Note that if the monetary rule is completely accommodating,  $\alpha = 1$ , or if  $N = \infty$ , we get the Blanchard-Fischer result {1989 p. 380, equation 7}:

$$(11) \quad Q^* = \left(\frac{\eta - 1}{d\eta}\right)^{1/(\beta-1)}.$$

Comparing (10) and (11), we can see that the right-hand side of (10) is greater than that of (11) as long as  $((1 - \alpha)/(N - 1)) > 0$ .<sup>14</sup> Thus, we reach the following conclusion: *in the yeoman farmer monopolistic competition model, if  $\alpha < 1$ , so that monetary policy is*

14. Writing  $((1 - \alpha)/(N - 1))$  as  $K$ , the right-hand-side bracket of (10) becomes  $(\eta - 1 + 2K)/(\eta + K) = ((\eta - 1)/\eta) \cdot (((1 + 2K)/(\eta - 1))/(1 + K)/\eta)$  and this is greater than the right-hand-side bracket of (11) when  $2K\eta > K \cdot (\eta - 1)$ . Since by assumption  $\eta > 1$ , this requires  $K > 0$ .

*not completely accommodating, and  $N$  is finite (but greater than 1), equilibrium output will be higher than when monetary policy is completely accommodating; the difference will be larger the smaller is  $N$ , and the smaller (i.e., the more nonaccommodating) is  $\alpha$ .*

The reason for these effects is that monopolistic competitors will take into account their own effect on the aggregate price level, and hence the real money supply, when they set prices; and this effect is contingent on the monetary rule. Given  $\alpha < 1$ , if the  $i$ th agent is to reduce the aggregate price level  $P$ , that implies  $P_i$  must fall relative to prices in other sectors. Since all sectors are identical, the output, and thus marginal cost in terms of own-labor, of each farmer must be sufficiently large to eliminate the incentive to engage in further relative price-cutting. This will then be the equilibrium output and price level.

Another way of looking at this is in comparative static terms. Suppose that the central bank reduces  $\alpha$ , thus tightening monetary policy. With small enough  $N$ , each agent will now have an increased incentive to reduce his price (hence to undercut the others) to take advantage of the increased impact that this will have on the real money supply. In effect, the real marginal revenue curve has shifted out because the elasticity of the real money supply and hence demand with respect to the sector's relative price,  $\partial \ln m / \partial \ln p_i$ , has increased; this elasticity plays an exactly parallel role to the direct elasticity of demand. Competitive undercutting will thus continue until the equilibrium between marginal revenue and marginal costs has been restored at a higher level of output, with a higher real money supply and a lower aggregate price level.

This does not mean, however, that output is also nonneutral with respect to the nominal money supply. To see this, we can break the monetary rule into two parts: (a) the degree of accommodation of the central bank, and (b) the scale of the nominal money supply. The accommodation part of the rule is

$$(1a) \quad \frac{\partial \ln m}{\partial \ln P} = -(1 - \alpha).$$

Integrating (1a) gives us

$$(1b) \quad m = K \cdot P^{-(1-\alpha)}.$$

In the models of this article we have taken  $K = 1$  to simplify the

presentation. But in general  $K$  is the nominal scale part of the rule. Defining

$$(1c) \quad K = \mu^{1-\alpha},$$

we have that  $P = m^{*1/(1-\alpha)} \cdot \mu$  so that equilibrium output is neutral with respect to  $\mu$ , the nominal scale parameter.

But when  $N$  is finite, equilibrium output is nonneutral with respect to the degree of accommodation in the monetary rule ( $\alpha$ ), and the main objective of this section has been to show that the analysis of macroeconomics changes fundamentally as we move from a large number of monopolistic competitors to a small number; hence also from a perfectly competitive economy to a world of imperfect competition with a small number of price setters. It can be objected, however, that the practical significance of this insight is limited since price setting rarely occurs at a level that would make general price considerations relevant for individual pricing agents. But this objection need not apply to wage setting, which is frequently conducted at the industry, sector, or even national level. Indeed, relatively centralized wage setting is the rule rather than the exception in a majority of OECD countries {OECD 1997}. Because centralized wage setters exert an effect on the general price level, our argument has considerable practical importance for understanding real wage behavior and hence employment performance. In the following section we show this by introducing sectoral labor markets where each sectoral wage is set by the sectoral monopoly union. To ensure that our results do not depend on large price setters, we assume that there are two or more Bertrand competitors in each sectoral product market.

### III. A MODEL WITH MONOPOLY UNIONS

Nominal wages  $W_i$  are set in each of  $N$  identical sectors by a sectoral monopoly union; there are  $n$  workers in each sector, all of whom are union members, and there is no mobility between sectors. As before, the demand for the good in each sector is a constant elasticity function of the relative price of the sector's good multiplied by the real supply of money deflated by the number of sectors; this is equation (2). Hourly labor productivity is constant and equal to unity, and there are two or more Bertrand competitors in each sector; thus, the price in sector  $i$ ,  $P_i$ , is equal to the constant marginal cost  $W_i$ . Producers have to hire at the

union-determined wage, which determines total hours employed  $E_i$ , and each worker is hired for the same number of hours,  $E_i/n$ . Wages and prices in each sector are set independently of wage and price setting in other sectors. Finally, the aggregate price level is derived from a constant elasticity of substitution index of the individual sectoral prices, as in equation (3) in the last section.<sup>15</sup>

When analyzing this case, it is helpful to keep in mind the implied game of complete and quasi-perfect information. The game consists of four stages.

*Stage 1:* The CB precommits to the monetary rule implied by  $\alpha$ ;

*Stage 2:* unions simultaneously and independently choose  $W_i$  ( $i = 1, \dots, N$ );

*Stage 3:* producers simultaneously and independently set  $P_i$  and  $E_i$  ( $i = 1, \dots, N$ );

*Stage 4:* the CB sets  $M$  contingent on  $P$  as predetermined by  $\alpha$  (for all  $\alpha > 0$  since  $\alpha = 0$  is a noncontingent strategy).

The solution is found by backward induction, but in Stage 4 the central bank acts as an automaton in setting  $M$  equal to  $P^\alpha$  (as a result of the precommitment assumption); in Stage 3 Bertrand competitors in each sector  $i$  set  $P_i = W_i$ ; and in Stage 1 the CB precommits to a monetary rule ( $\alpha$ ) that it will subsequently adhere to. So we simply focus on union wage-setting behavior in Stage 2. All we need to retain from Stage 3 are the two constraints on union wage-setting. The first is

$$(12) \quad p_i = w_i,$$

which is implied by Bertrand pricing, using  $w_i \equiv W_i/P$ . The second provides the union with a trade-off between total hours employed and the real wage, and is found by substituting (12) into (2), and using the assumption of constant unit labor productivity,  $Q_i = E_i$ :

$$(13) \quad E_i = m/N \cdot w_i^{-\eta}.$$

Equations (12) and (13) hold as equilibrium results for any possible value of  $[W_1, \dots, W_N]$ , i.e., for each possible subgame starting at Stage 3. Just as the marketing agent in the yeoman farmer model sets production quotas for individual farmers, we assume here that the union sets the number of hours worked by its members. This assumption ensures that the union's supply of

15. Hence, if effective collusion occurs between several unions, this would alter the number of sectors as defined here.

labor always satisfies firms' demand for labor, and hence that there is an equilibrium for any value of  $\{W_1, \dots, W_N\}$ .<sup>16</sup>

As in the yeoman farmer model we assume that each union member has a utility function in which consumption and real money balances affect utility positively and directly and which is negative in hours worked. We show in the Appendix how the demand for labor schedules in each sector can be derived from utility maximization by individual workers. In addition, if the  $i$ th union maximizes the utility of the representative union member, this implies that the union should choose  $w_i$  to maximize the indirect utility function:

$$(14) \quad U_i = w_i \cdot E_i - (d/\beta) \cdot E_i^\beta + m/N,$$

where  $d \equiv (d'/n^{\beta-1})$  and  $(d'/\beta) \cdot (E/n)^\beta$  is the disutility of work and  $n^{-1} \cdot (w_i \cdot E_i + m/N)$  the wealth of the individual union member (see the Appendix). In Stage 2 unions choose their sectoral money wage simultaneously such that  $U_i(W_i^*, W_{-i}^*) \geq U_i(W_i, W_{-i}^*)$  for all  $i$ . This is equivalent to choosing  $w_i$  to maximize (14) subject to (12) and (13).

We focus on the symmetric equilibrium  $p_i = w_i = 1$ , for all  $i$ . Maximizing (14) subject to (13) then implies that the equilibrium number of hours of employment per sector is given by<sup>17</sup>

$$(15) \quad E^* = \left( \frac{\eta - 1 - 2\partial \ln m / \partial \ln w_i}{d\eta - d \cdot \partial \ln m / \partial \ln w_i} \right)^{1/(\beta-1)}.$$

Since  $P_i = W_i$ , since the aggregate price index is defined in the same way as in Section II above, and since  $p_i = 1$  in equilibrium, we can use the same reasoning as in that section to establish

$$(16) \quad \frac{\partial \ln m}{\partial \ln w_i} = -(1 - \alpha) \cdot \frac{1}{N} \cdot \frac{N}{N-1} = -\frac{1-\alpha}{N-1}$$

so that the equilibrium employment rate is given by

$$(17) \quad E^* = \left( \frac{\eta - 1 + 2 \cdot (1 - \alpha)/(N - 1)}{d\eta + d \cdot (1 - \alpha)/(N - 1)} \right)^{1/(\beta-1)}$$

with equilibrium hours per worker of  $E^*/n$ . Thus, exactly as output

16. One referee generously wrote out a formal proof of the existence of equilibria for all possible vectors of  $W_i$ , and pointed out that this is not the case in a standard model with market-determined wages. We will pass the proof on to anyone interested.

17. Recall that the number of workers per sector,  $n$ , is fixed, so the equilibrium number of hours worked per worker is simply  $E^*/n$ .

in the yeoman farmer model, if  $N$  is finite and greater than unity, the equilibrium rate of employment is higher when  $\alpha < 1$  (less than fully accommodating monetary policy) than when  $\alpha = 1$  (fully accommodating monetary policy); given  $N$ , the difference increases as  $\alpha$  falls to zero (fully nonaccommodating policy); and given  $\alpha$ , the difference is greater the smaller is  $N$ . Analogous to the yeoman farmer model, the reason is that unions have an incentive to take into account the effect of their own wages on aggregate prices and hence on the real money supply. The smaller is  $\alpha$  and  $N$  (for  $N > 1$ ), the greater is this incentive.

If  $N$  is very large—so that  $(1 - \alpha)/(N - 1)$  approximates 0—the equilibrium employment rate is independent of the central bank's monetary rule. If  $N = 1$ —when there is either a single encompassing union, or when a small number of unions are capable of acting as one—(17) is undefined, and our model does not cover this situation. However, we can sketch an Olson-type argument for expecting an encompassing union to act so as produce full employment for  $0 \leq \alpha < 1$ , (although a different argument is needed in the limiting case of a fully accommodating monetary policy). The encompassing union controls  $W$  hence  $P$ , and therefore can choose  $m$  (which is feasible if  $\alpha < 1$ ). The union will choose  $m$  to maximize utility function (14) subject to the equilibrium values  $w = 1$  and  $E = m$ ; this implies an equilibrium employment rate of  $E^* = (2/d)^{1/(\beta-1)}$ . It can be easily checked that this is greater than  $E^*$  for any other value of  $N$ . This argument does not apply in the special case of  $\alpha = 1$ , since the CB can set real money supply at any level, as long as it is less than or equal to  $(2/d)^{1/(\beta-1)}$ . But apart from this limiting case, when  $N = 1$ , it is reasonable to expect full employment in the sense that no worker could be made better off by working more. For all intermediate cases, however, when there is a small number of independently acting unions, the monetary rule of the central bank matters for equilibrium employment.

The results are illustrated in Figure I which plots the equilibrium rate of employment as a function of  $N$  for different values of  $\alpha$ .<sup>18</sup> Note that as the number of sectors decreases, employment rises (except in the limiting case of  $\alpha = 1$ ). For a finite number of sectors greater than one, the more nonaccommodating the central bank, the higher the equilibrium rate of employment; and this effect increases as  $N$  decreases. When  $N =$

18.  $N$  is treated as a continuous variable by assuming a continuum of sectors.

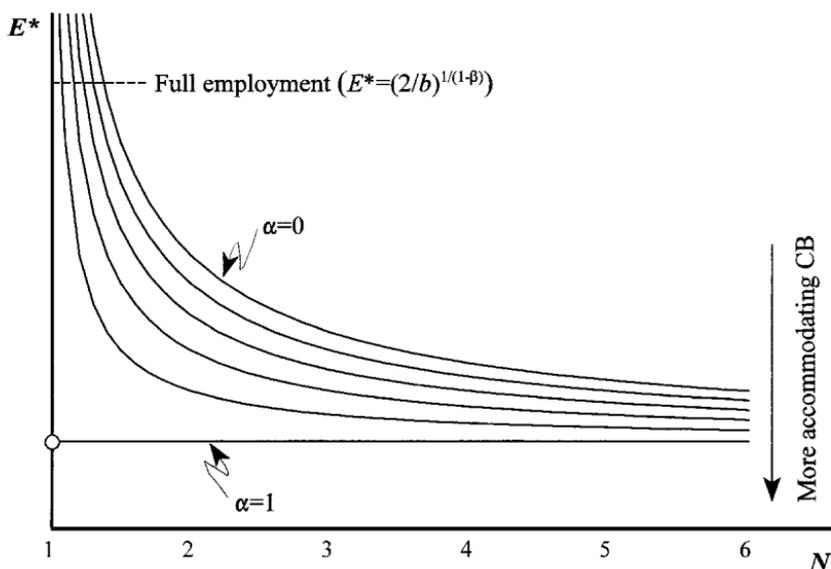


FIGURE I  
The Effects of  $N$  and  $\alpha$  on Equilibrium Employment

1, a single encompassing union can, and will, choose full employment. The special case of  $N = \alpha = 1$  is not covered by the model. Although the central bank *can* choose full employment in this case, we have not defined a CB objective function that ensures it *will*.

We can also interpret our main result in Layard-Nickell terms, in which equilibrium employment is determined by the intersection of the real wage imposed by business pricing behavior (the “Feasible Real Wage”) and the union-determined “Target Real Wage” (see Layard, Nickell, and Jackman {1991}; and Blanchard and Fischer {1989}). This is done in Figure II, where the union-determined real wage schedule is obtained from equations (13) and (17). Because unions have an effect on aggregate prices, they can influence the real money supply and hence employment. The less accommodating the central bank (the smaller  $\alpha$ ), and the smaller the number of unions (the smaller  $N$ ), the greater the effect of each union’s wage on the real money supply, and the greater the incentive to exercise restraint. This shifts the union-determined real wage schedule downward and raises the equilibrium level of employment.

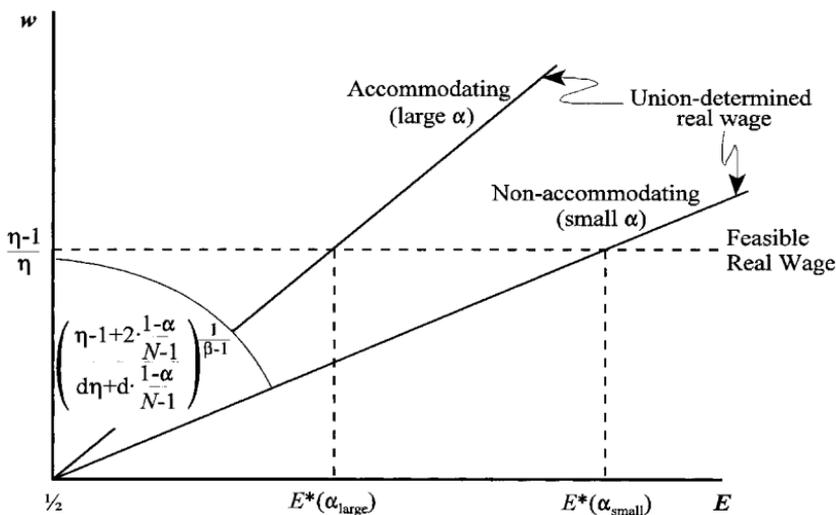


FIGURE II  
Layard-Nickell Interpretation of the Main Result

IV. CONCLUSIONS

The main result of this article can be summarized as follows: *under the assumptions of rational expectations, complete information, credible precommitment, and a finite number of price or wage setters, the accommodating or nonaccommodating nature of monetary rules affects the equilibrium level of employment.* The conventional result that the monetary rule is unrelated to the equilibrium rate of employment emerges as a special case in our model, when  $N \rightarrow \infty$ . In that case private agents are not engaged in a strategic interaction with the CB: very small unions or marketing agents cannot affect the general price level. We also sketched out a complementary model of the case of an encompassing union ( $N = 1$ ) and showed how monetary policy was also neutral in this case—apart from a set of measure zero. Here the lack of strategic interaction reflected the ability of the encompassing union to determine the price level. But whenever a limited number of unions or agents set wages or prices independently, the monetary rule of the CB affects the equilibrium employment (or output) rate since it determines the extent to which unions (or marketing agents) can affect the real money supply, and hence the level of demand and employment.

Although our model is deliberately based on a stringent set of

assumptions—rational expectations, complete information, credible precommitment, and absence of nominal rigidities—these ordinarily militate *against* finding employment effects of monetary policies. Ipso facto, we expect that if these assumptions are relaxed our basic result will remain. From a policy perspective only the union-determined wage assumption cannot be dropped, but this is a permissive one that enables us to theorize about a broad range of economies characterized by relatively centralized wage-setting systems. Thus, we expect our model to have something to say about the interaction between monetary policies and wage setting in a broad range of countries including Australia, Austria, Belgium, Denmark, Finland, Ireland, Italy, Japan, Germany, the Netherlands, Norway, Sweden, Switzerland, and several newly industrializing countries. It can also be used to understand the effects on the equilibrium rate of employment rate of changing the size of a currency area, as in the case of the European Monetary Union (see Soskice and Iversen {1998}).

Considering the simplicity of the model, one obviously has to be cautious in drawing strong policy implications. However, the results, which are at first blush paradoxical, strongly suggest that in countries with a small number of independently acting unions, a nonaccommodating central bank can have substantial benefits for long-term employment. In effect, such a bank alleviates the coordination problems between unions that are large enough to affect the welfare of all, yet too numerous to reach effective collusion. This is an important lesson for both countries where union fragmentation has undermined peak-level coordination (such as Sweden), and for transition economies where strong unions have reemerged in a setting of “weak” central banks. While there may be offsetting political or economic benefits from having accommodating central banks (especially in the short term), for the category of countries where our argument is most salient, the benefits we have described are likely to outweigh the costs.

#### APPENDIX: THE MICROECONOMIC BASES OF THE MODELS

In this appendix we show, first, how in the yeoman farmer model the demand function in sector  $i$  against which the  $i$ th “marketing agent” maximizes, and the indirect utility function which the agent maximizes, are derived from the individual maximization behavior of producers. Second, we show how the analogous propositions hold in the monopoly union model.

*The Yeoman Farmer Model*

In each sector  $i$  there are  $n$  farmers producing good  $i$  under constant returns to scale. The marketing agent sets the price  $P_i$  and hence total supply of good  $i$ ,  $Q_i$ , and each farmer is then required to produce  $Q_i/n$ .

The utility of the individual farmer,  $s$ , producing good  $i$  is

$$(A1) \quad U_{is} = \left(\frac{C_{is}}{g}\right)^g \cdot \left(\frac{M_{is}/P}{1-g}\right)^{1-g} - \frac{d'}{\beta} \left(\frac{Q_i}{n}\right)^\beta,$$

where  $C_{is}$  is aggregate consumption by  $s$ , given by

$$(A2) \quad C_{is} = N^{1/(1-\eta)} \cdot \left(\sum_j^N C_{jis}^{(\eta-1)/\eta}\right)^{\eta/(\eta-1)}$$

so the individual farmer's utility depends positively on consumption and real money balances and negatively on output.

$s$  chooses the  $N$  consumption levels  $C_{jis}$  and demand for nominal money balances  $M_{is}$  to maximize (A1) subject to the budget constraint:

$$(A3) \quad \sum_j^N P_j C_{jis} + M_{is} = P_i \left(\frac{Q_i}{n}\right) + \bar{M}_{is} \equiv I_{is},$$

where  $\bar{M}_{is}$  is initial cash balances. This yields

$$(A4i) \quad C_{jis} = \left(\frac{P_j}{P}\right)^{-\eta} \cdot \frac{g}{N} \cdot \frac{I_{is}}{P}$$

and

$$(A4ii) \quad \frac{C_{is}}{g} = \frac{M_{is}/P}{1-g} = \frac{I_{is}}{P}.$$

We can now derive the demand function for the  $j$ th good:

$$(A5) \quad Q_j = p_j^{-\eta} \cdot \frac{g}{N} \cdot \sum_i \sum_s \frac{I_{is}}{P},$$

where  $Q_j$  is demand for the  $j$ th good and  $p_j$  is its relative price.

We need to show finally that the double sum term in (A5) is proportional to initial real cash balances. Since  $C_{is}/g = I_{is}/P$ ,

$$(A6) \quad g \cdot \sum_i \sum_s \frac{I_{is}}{P} = \sum_i \sum_s C_{is} = \sum_j \sum_i \sum_s p_j C_{jis} \equiv Y,$$

where  $Y$  is aggregate demand. In equilibrium, aggregate demand is equal to output which is equal to  $\sum_i p_i \cdot Q_i$ . Hence, from (A3),  $Y + \bar{M}/P = \sum_i \sum_s I_{is}$ , where  $\bar{M} = \sum_i \bar{M}_i \cdot n = \sum_i \sum_s \bar{M}_{is}$  so from (A6)

$$(A7) \quad Q_j = p_j^{-\eta} \cdot \frac{g}{N \cdot (1 - g)} \cdot \frac{\bar{M}}{P}.$$

The marketing agent for the  $j$ th good is constrained by (A7); this is the same as equation (2) in the main text with  $\bar{M}/P \equiv m$  and  $g/(1 - g)$  normalized to unity.

Finally, substituting the optimal values of  $C_{is}$  and  $M_{is}$  from (A4ii) and (A3) into (A1), multiplying (A1) by  $n$  and defining  $d = d'/n^{\beta-1}$  yields the indirect utility function, equation (4) in the text, which the marketing agent for the  $i$ th good maximizes.

### *The Monopoly Union Model*

The argument in the monopoly union model is similar to the yeoman farmer model, with the following differences. The utility of the individual member,  $s$ , of union  $i$  is

$$(A8) \quad U_{is} = \left(\frac{C_{is}}{g}\right)^g \cdot \left(\frac{M_{is}/P}{1 - g}\right)^{1-g} - \frac{d'}{\beta} \left(\frac{E_i}{n}\right)^\beta,$$

so the individual member's utility depends positively on consumption and real money balances and negatively on number of hours worked  $E_i/n$  ( $E_i$  is the total number of hours worked in sector  $i$  and  $n$  is the number of union members; all workers are union members, and there is no mobility between sectors). Utility is maximized subject to the budget constraint:

$$(A9) \quad \sum_j^N P_j C_{jis} + M_{is} = W_i \left(\frac{E_i}{n}\right) + \bar{M}_{is} \equiv I_{is}.$$

The demand function in the  $j$ th sector is derived identically, noting that profits in the monopoly union model are zero (as a result of Bertrand pricing and constant marginal costs) so that  $Y = \sum_i^N W_i/P \cdot E_i$ .

Finally, substituting the optimal values of  $C_{is}$  and  $M_{is}$  from (A4ii) and (A9) into (A8), multiplying (A8) by  $n$  and defining  $d = d'/n^{\beta-1}$ , yields the indirect utility function in the text, equation (14), which the  $i$ th union maximizes.

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