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#### Seminar Paper No. 403

#### TRANSMISSION MECHANISMS FROM THE PRODUCT TO THE LABOR MARKET

by

## Assar Lindbeck and Dennis J. Snower

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#### TRANSMISSION MECHANISMS FROM THE PRODUCT TO THE LABOR MARKET

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#### <u>Introduction</u>

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How are product demand shocks transmitted to the labor market? In particular, how can demand-management policies affect employment?

These questions, which are the focus of our attention here, have received a variety of answers in the macroeconomic literature. In some Keynesian models, where prices are more responsive than wages to demand shocks, an increase in product demand reduces the real wage and consequently raises employment (assuming that firms make their employment decisions unilaterally under diminishing returns to labor). In some New Classical macroeconomic models, product demand shocks lead to a temporary outward shift of the labor supply curve and thereby reduce the market-clearing real wage and raise the corresponding level of employment. In both these approaches, demandmanagement policies move the economy along a downward-sloping relation between aggregate labor demand and the real wage - which we will call the "aggregate labor demand relation", for short.

This transmission mechanism is bound to be significant in practice (particularly in the short run, say over one or two years), but we do not believe that it tells the whole story. For if it were the only channel whereby product demand affected employment, then the real wage would always move countercyclically in response to demand shocks - a prediction which appears to be in conflict with a large body of evidence (particularly on U.S. real wages). In order to allow for procyclical real wage movements, it is necessary to show either (a) that the "aggregate labor demand relation" is not

always downward-sloping or (b) that this relation shifts outwards when product demand rises and inwards when product demand falls. The aim of this paper is to investigate both possibilities.

The transmission mechanism of the "Reappraisal-of-Keynes" models, (e.g. Barro and Grossman (1976) and Malinvaud (1977)), where both the nominal wage and the price level are rigid and there is excess supply in both the product and labor markets, operates through "intermarket spillovers": firms face product demand constraints which are exogenous to their decision-making and thus their labor demand depends directly on the demand for their products. In this context, a rise (fall) in product demand leads to a rise (fall) in employment, at any given real wage. The underlying assumption of sluggish wages and prices may be rationalized by appealing to long-term wage contracts, government price fixing, or price- and wage-setting under adverse selection or moral hazard conditions.

By contrast, the analysis below examines the transmission mechanism under <u>flexible</u> wages and prices and imperfect competition. As we will show, the assumption of imperfect competition yields a larger menu of transmission mechanisms from the product market to the labor market than does the assumption of perfect competition. In Section 1 we analyze the behaviour of firms which make pricing, production, and employment decisions under perfect information<sup>1</sup> in order to maximize their profits, given their product demand function, production function, and the nominal wage. For such firms, we derive an important negative result, whose radical implications still remain largely unexplored: A shift in the aggregate product demand function (in price-quantity space) does not necessarily imply a shift in the "aggregate labor demand relation". More specifically, demand shocks have no influence on the relation between aggregate labor demand and the real wage, as long as these shocks do not change the price elasticity of product demand, the number

of firms in the economy, or the marginal product of labor. We show in an appendix that this negative result is robust under a wide variety of alternative model specifications.

The flip side of our negative result is that fiscal policy shocks <u>can</u> shift the aggregate labor demand relation by affecting

(a) the number of firms,

(b) the marginal product of labor, or

(c) the price elasticity of product demand.

The marginal product may, for instance, be influenced through industrial infrastructure investment or by changes in the rate of capital utilization. We examine the transmission mechanisms (a) - (c) in Section 2-4.

The transmission (a) suggests that the entry or exist of firms may have an important role to play in channelling product demand shocks to the labor market. Thus, "supply-side" policies which facilitate the emergence and growth of new firms may be an important complement to demand-management policies. This emphasis on the creation of firms squares well with the empirical finding that much of the employment increase in the United States from the mid-seventies to the mid-eighties appears to have occurred in new firms. Our analysis also implies that cross-country differences in barriers to entry by firms may help explain why U.S. employment recovered more speedily from the recession of the early eighties than did European employment.

Another empirical conjecture, suggested by the transmission mechanism (b), is that the massive investment in industrial infrastructure which Western governments undertook in the fifties and sixties may have contributed to the successful employment growth records during these periods, whereas the less ambitious infrastructure investment since then may have contributed to the subsequent slow-down of employment growth.

We also suggest that when there is substantial excess capital capacity,

expansionary demand management polices may stimulate the labor market by raising the rate of capital utilization and thereby increasing firms' use of plant and equipment, which - in the above cyclical context - is usually complementary to labor. Then, by transmission mechanism (b), increases in product demand shift the aggregate labor demand relation outwards.

The transmission mechanisms which operate via the entry of firms, infrastructure investment, and capital utilization have an important thing in common: in each case, demand management policies work through their supply-side effects on labor productivity. In this respect, our analysis has a somewhat non-Keynesian flavor, though without generating laissez faire policy conclusions. In particular, we are led to avoid making a sharp distinction between demand-side and supply-side policies. Rather, we argue that demand-side policies in the product market may have a particularly large impact on the labor market when they enchance the economy's supply-side capacity to produce goods.

Naturally, the standard Keynesian inter-market spillovers are operative when there are variations in spending on goods which are sold exclusively to the government and which have prices fixed by contract. This policy option may indeed explain the surges in employment which commonly follow the implementation of armaments programs. Equally naturally, the government is always free to shift the aggregate labor demand relation by varying the number of government employees. Yet our analysis leads us to suppose that the multiplier effects of such policies (via changes in income and consumer spending) may be rather small unless the real wage, the entry of firms, or the marginal product of labor is thereby affected.

#### 1. Firms' Behaviour under Imperfect Competition

To identify the channels whereby product demand shocks affect the

aggregate labor demand relation, we construct a simple model of the production,  $e^{\sigma}$  ployment, and pricing decisions of imperfectly competitive firms.

Suppose that there are a fixed number (M) of identical firms, producing a homogeneous product. Let the (inverted) aggregate product demand function be

(1) 
$$P = P(Q, A)$$
  $P_Q < 0, P_A > 0$ 

where P is the product price, Q is aggregate product demand and A is a shift parameter (changes of which represent product demand shocks). The production function of a representative firm is

(2) q = h(n), h' > 0, h'' < 0,

where q is the firm's output and n is its labor input.

We depict the firm's imperfectly competitive behaviour by the simple device of postulating that the firm expects its rivals to respond to its production decisions in the following way: [d(Q-q)/dq] = v - 1, where (Q-q) is the total production by all the firm's rivals and v is a constant. In short (dQ/dq) = v. The associated conjecture function may be written as:

(3)  $Q = a + v \cdot q$ ,

where "a" is a constant. This formulation has the advantage of simplicity, without removing our analysis from the domain of conventional bargaining games, on account of the following special cases:

- Under "cartel behaviour", v = M, the firm expects each of its rivals to make the same production decision as it does itself and, as result, all firms behave as if they were joint profit maximizers.

- Under "Cournot behaviour", v = 1, the firm expects its production decision to have no effect on the production decisions of its rivals.

- Under "Bertrand behaviour", v = 0, the firm expects its production decision to have no effect on aggregate output (Q) and, given the product demand function (1) on the price level (P). Thus, all firms behave like perfect

competitors.

Let W be the nominal wage, which is exogenously given to the firm (say, by an already negotiated contract), and let B be an exogenous fixed cost of production (which will have a role to play in Section 3). The firm's objective is to maximize its profit

 $(4) \quad \pi = P \cdot q - W \cdot n - B$ 

subject to the product demand function (1), the production function (2), and the conjecture function (3). The first-order condition for an interior optimum is

(5) 
$$\frac{\mathrm{d}\boldsymbol{\pi}}{\mathrm{d}\boldsymbol{n}} = \mathbf{P} \cdot \mathbf{h}' + \mathbf{q} \cdot \frac{\mathrm{d}\mathbf{P}}{\mathrm{d}\boldsymbol{n}} - \mathbf{W}$$

$$= \mathbf{P} \cdot \mathbf{h}' \cdot \left[ \mathbf{1} + \left( \frac{d\mathbf{P}}{d\mathbf{Q}} \cdot \frac{\mathbf{Q}}{\mathbf{P}} \right) \cdot \left( \frac{d\mathbf{Q}}{d\mathbf{q}} \right) \cdot \frac{\mathbf{q}}{\mathbf{Q}} \right] - \mathbf{W}$$

$$= \mathbf{P} \cdot \mathbf{h}^{*} \cdot \left[ 1 - \frac{\mathbf{v}}{\eta \cdot \mathbf{M}} \right] - \mathbf{W},$$

where  $\eta$  is the "price elasticity of aggregate demand".<sup>2</sup> In contrast to the price elasticities of microeconomic theory, this elasticity covers the relation between aggregate product demand and the economy-wide price level which emerges after all the feedback effects within the product-demand side of a macroeconomic system have worked themselves out.

Let e be a Lerner-type index of monopoly power, i.e. the proportional price-cost margin: (P-C)/P, where C is the marginal cost. By the first-order condition (5), C = W/h' = P  $\cdot \left[ 1 - \frac{v}{\eta \cdot M} \right]$ . Thus (6)  $e = \frac{v}{\eta \cdot M}$ .

Consequently, condition (5) reduces to the formally familiar expression,

(7)  $(1-e) \cdot h' = (W/P),$ 

## with the real marginal product of labor being equal to the real wage.<sup>3</sup> Inverting condition (7), we obtain the firm's "labor demand relation":

(8)  $n = \ell(\frac{W}{P} \cdot \frac{1}{1-e}), \qquad \ell = (h')^{-1}, \ell' < 0.$ 

Since n and P are endogenous to the firm's decision-making whereas W is exogenous, equation (8) is not a labor demand curve in the traditional, perfectly competitive sense (where the real wage (W/P) is exogenous). Rather, it must be interpreted as the profit-maximizing relation between the real wage and the firm's labor demand.<sup>4</sup> Letting N be aggregate labor demand, the "aggregate labor demand relation" becomes

(9)  $N = M \cdot \ell \left( \frac{W}{P} \cdot \frac{1}{1-e} \right)$ .

Although this type of demand relation is commonplace from a microeconomic perspective, it has important (and as yet largely unrecognized) implications for the transmission of product demand shocks to the labor market. Specifically:

<u>Proposition 1</u>: Given firms' imperfectly competitive behaviour described above,<sup>5</sup> the relation between the real wage and aggregate labor demand depends exclusively on the following three variables:

(i) the price elasticity of aggregate product demand  $(\eta)$ ,

(ii) the number of firms (M), and

(iii) the marginal product of labor (h').

In particular, this relation does <u>not</u> depend on the level of product demand at any given price (independently of the three variables above), i.e. it does not depend directly on the shift parameter (A) of the aggregate product demand function.

In other words, an elasticity-preserving demand shock, in the absence of "supply-side" influences on the number of firms or the marginal product of labor, has <u>no</u> effect on the aggregate labor demand relation. This means that a standard formulation of the aggregate labor demand relation in much of the macroeconomic literature,  $n = A \cdot \ell(W/P)$ ,  $\ell' < 0$ , where labor demand is a function

of the real wage and a shift parameter (A) in the product demand function, is misleading. More specifically, the Reappraisal-of-Keynes's "intermarket spillovers" from the product market to the labor market do not survive when we replace the assumption of price-taking with sales rationing by that of price-setting by imperfectly competitive firms.

At first sight, this negative result may appear surprising; we might expect that increased demand for products automatically leads to an increase in the demand for labor. However, the intuition underlying our result is straightforward: Rewrite the firm's marginal condition (7) as

(7')  $W = P \cdot (1-e) \cdot h' = P \cdot [1 - (1/\eta_F)] \cdot h'$ 

where  $\eta_{\rm F} = (\eta \cdot M/v)$  is the representative firm's individual price elasticity of product demand (taking into account its expectations about its rivals' responses to its activities). Now suppose that, given the aggregate product demand function P = P(Q, A), the shift parameter (A) rises so that a higher price P is now associated with any given level of Q, but the firm's individual elasticity  $(\eta_{\rm F})$  remains unchanged. Then, the marginal revenue product curve  $(P(Q, A) \cdot [1 - (1/\eta_{\rm F})])$  rises in P-Q space. To examine how the rise in A affects production (and therefore also employment) <u>at any given real wage</u>, we ask what happens to Q when the marginal cost (W) rises proportionately with the price (P). As equation (7') shows, if the elasticity  $\eta_{\rm F}$  remains constant, then the marginal revenue product curve rises by the same amount as the marginal cost curve, and thus production remains unchanged. Consequently the relation between the real wage and production (and therefore also employment) also remains unchanged.

Figure 1 illustrates this point in another way. Here, the firm's marginal revenue in wage units is  $(1-e) \cdot (P/W)$ , where  $(P/W) = P[(a+v \cdot q), A]/W$ ; and the marginal cost in wage units is (1/h'). The intersection of the marginal revenue and marginal cost curves (in wage units) yields the firm's

profit-maximizing level of production (q\*) and (P\*/W). The figure shows that, given the marginal product of labor (h'(n)), the relation between the firm's production q\* and (P\*/W) depends solely on the index of monopoly power, e (which depends on  $\eta$ , n, and v). Then, the relation between the profitmaximizing level of employment n\* and the real wage (W/p\*) also depends only on e. The same holds at the aggregate level, too, since the aggregate labor demand relation is simply the horizontal sum of all firms' individual labor demand relations.

Our negative conclusion (that the aggregate labor demand relation does not depend on the shift parameter of the aggregate product demand relation) and our positive conclusion (that the labor demand relation does depend on the price elasticity of product demand, the number of firms, and the marginal product of labor) are surprisingly general. In Appendix A, we show that the negative and positive conclusions continue to hold when the model is extended to cover differentiated products, durable output which may be held as inventory for production-smoothing reasons, stochastic product demand, firms which are not of identical size, and efficient bargaining over real wages and employment.

We now proceed to examine how the three transmission mechanisms above work.

#### 2. Transmission via the Price Elasticity of Product Demand

According to this transmission mechanism, demand management policies in the product market affect the price elasticity of product demand and thereby shift the aggregate labor demand relation. There is a broad literature on how this may come about. Pigou (1927), Kalecki (1938), and Keynes (1939) argued that firms' market power may vary counter-cyclically (thereby imparting a pro-cyclical influence on each firms' price elasticity of product demand).





More recently, Stiglitz (1984) has argued that the price elasticity of product demand may move pro-cyclically if the real interest rate moves countercyclically and customer search for heterogenous products is costly. Rotemberg and Saloner (1986) constructed a model in which oligopolists have an incentive to behave more competitively as product demand rises. Bils (1987) argued that the mark-up of prices of durable goods over wages may be pro-cyclical since poor customers tend to buy these goods primarily in boom periods.

Here we take a different tack. We note that demand management policies in the product market may change the composition of public versus private expenditures and/or the composition of domestic versus foreign expenditures, and thereby the overall price elasticity product demand may be affected. Let us examine each of these composition effects in turn.

#### 2a. The Composition of Public versus Private Expenditures

To fix ideas, let real aggregate product demand in our economy consist of real private-sector consumption demand (c) and real government demand (g). As above, the product is homogeneous and nondurable.

Let the aggregate consumption function be

(10) 
$$c = c(Y, P),$$
  $c_1 > 0, c_2 < 0,$ 

where Y is real disposable income. (For example, the consumption function could have the following familiar form:  $c = c \cdot [Y + (M_{-1}/P)]$ , where c is the constant marginal propensity to consume and  $(M_{-1})$  are nominal money balances carried forward from the past.) Let the price elasticity of aggregate consumption demand,  $\epsilon_c = -(\partial c/\partial P) \cdot (P/c)$ , be a constant:

 $(11) \quad 0 < \epsilon_{c} \leq 1.$ 

We express real government demand as follows:<sup>6</sup>

(12) 
$$g = \frac{G_0}{P} + \frac{G_1(P)}{P}$$
,

where  $G_0$  is "autonomous" nominal expenditure and  $G_1$  is endogenous nominal expenditure as a function of the price. The price elasticity of government demand is  $\epsilon_{\sigma}$ :

$$\epsilon_{g} = -\frac{\partial g}{\partial P} \cdot \frac{P}{g} = 1 - \frac{G}{g} 1 .$$

This elasticity depends on the degree to which the government changes its nominal expenditure when the price level changes. If the government faces a "non-accommodating cash constraint" (viz, it has a fixed amount of cash available to be spent), then  $G'_1 = 0$  and thus  $\epsilon_g = 1$ . Yet if it has an "accommodating cash constraint" (viz, its cash balance available for spending rises when the price level rises), then  $G'_1 > 0$  and thus  $\epsilon_g < 1$ . In short, we assume that

(13)  $0 < \epsilon_g \leq 1.$ 

Aggregate product demand is the sum of consumption and government demand:

(14) Q = c[(Q - T), P] + g,

by (10) and (12), where disposable national income (Y) is equal to national product (Q) minus lump-sum taxes (T). (Inverting the aggregate demand function (14) yields the relation P = P(Q,A), Equation (1).) From equation (14) we may derive the price elasticity of aggregate demand:

(15)  $\eta = \alpha \cdot \left[ \left( \frac{c}{c+g} \right) \cdot \epsilon_c + \left( \frac{g}{c+g} \right) \cdot \epsilon_g \right],$ 

where  $\alpha = 1/(1 - c_1)$  is the standard Keynesian multiplier.

Now consider how a fiscal shock can shift the aggregate labor demand relation by affecting the aggregate elasticity  $\eta$ . We take our fiscal shock to be dG<sub>0</sub> > 0 (in equation (12)), i.e. an increase in autonomous, nominal government expenditure (financed through money creation). The effects of this shock on the labor market are derived in Appendix B and may be summarized as follows:

#### Proposition 2a

(a) If  $\epsilon_g > \epsilon_c$ , then an expansionary fiscal shock  $(dG_0 > 0)$  has an ambiguous effect on the price elasticity of aggregate demand, so that the aggregate labor demand relation may shift outwards or inwards.

(b) If  $\epsilon_g \leq \epsilon_c$ , then an expansionary fiscal shock shifts the aggregate labor demand relation inwards.

Intuitively, it is easy to see what is happening. As illustrated in Figure 2, the fiscal shock affects the price elasticity of aggregate demand directly (shown by the arrow from the "dG<sub>0</sub>" box to the "dq" box) and indirectly via the price level (shown by the arrow from the "dG<sub>0</sub>" box to the "dP" box and from there to the "dq" box). A change in the elasticity  $\eta$ , in turn, affects the monopoly power index e, which shifts the aggregate labor demand relation.

The <u>direct effect of the fiscal shock</u> (i.e. the effect in the absence of a price change) works in the following way. By equation (15), we see that the aggregate elasticity  $(\eta)$  is a weighted average of the public- and private-sector elasticities  $\epsilon_g$  and  $\epsilon_c$  (respectively), where the share of public expenditures in the national product [g/(c + g)] weights  $\epsilon_g$  and the share of private expenditures in national product [c/(c+g)] weights  $\epsilon_c$ . Now suppose that the public-sector elasticity exceeds the private-sector elasticity  $(\epsilon_g > \epsilon_c)$ . Then the larger elasticity  $(\epsilon_g)$  receives more weight through the fiscal shock and therefore the aggregate elasticity  $(\eta)$  must rise. As result, the index of monopoly power (e) falls. This is responsible for an outward shift of the aggregate labor demand relation. Conversely, if  $\epsilon_g < \epsilon_c$ , then the fiscal shock shifts the labor demand relation inwards.

The indirect effect of the fiscal shock (i.e. the effect that works





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through a change in the price level) operates as follows. Suppose that  $\epsilon_g > \epsilon_c$ . Provided that the fiscal shock raises the price level (P), this price increase must reduce public expenditures (g) by more than private expenditures (c). Thus the public share [g/(c+g)] falls while the private share [c/(c+g)] rises. Then the smaller  $(\epsilon_c)$  elasticity receives more weight and therefore the aggregate elasticity  $(\eta)$  must fall.

Now suppose instead that  $\epsilon_g < \epsilon_c$ . Then the rise in the price level (P) raises the public share [g/(c+g)] and reduces the private share [c/(c+g)]. Then the smaller elasticity  $(\epsilon_g)$  receives more weight and hence the aggregate elasticity  $(\eta)$  falls in this case as well.

In short, the indirect effect of the expansionary fiscal shock is always to reduce the aggregate elasticity, thereby shifting the aggregate labor demand relation inwards. Adding the direct and indirect effects, yields the results in Proposition 2a.

It is worth noting that public- and private-sector shocks have different effects on the aggregate labour demand relation. In terms of direct effects, an autonomous increase in public-sector expenditures pulls the aggregate elasticity  $(\eta)$  in the opposite direction from an autonomous increase in private-sector expenditures (generated, say, through increased transfer payments financed through money creation). In terms of indirect effects, public- and private-sector shocks pull in the same direction (viz, an expansionary shock reduces the aggregate elasticity  $(\eta)$ .

Thus, we obtain the private-sector counterpart to Proposition 2a. <u>Proposition 2b</u>

(a) If  $\epsilon_g \geq \epsilon_c$ , then an expansionary private-sector shock shifts the aggregate labor demand relation to the left (in real wage-employment space).

(b) If  $\epsilon_g < \epsilon_c$ , then an expansionary private-sector shock has an ambiguous effect on the position of the aggregate labor demand relation.

In practice, the relative magnitudes of  $\epsilon_g$  and  $\epsilon_c$  are likely to vary through time and from country to country. This leads us to believe that variations in the price elasticity of aggregate product demand, arising from changes in the relative sizes of the private and public sectors, are probably not a reliable medium for the consistent and systematic transmission of product demand shocks to the labor markets.

#### 2b. The Composition of Domestic versus Foreign Expenditures

Another way in which policy variations in aggregate product demand may shift the aggregate labor demand relation is by changing the composition of domestic versus foreign expenditures. This, too happens only under special conditions.

Clearly, it does <u>not</u> happen when firms produce goods for sale in <u>either</u> the domestic or the foreign markets, but not in <u>both</u>. In that event, each firm's employment decision would be such that the nominal wage is equal to the marginal revenue product of labor, which would depend on either the domestic elasticity of demand facing the domestic firms or the foreign elasticity facing the foreign firms. Then, assuming that each elasticity is constant, the composition of domestic versus foreign expenditures would not affect the firm's labor demands. This is true regardless of whether domestic and foreign goods are substitutes or complements on the demand side.

Even if firms produce goods for simultaneous sale in domestic and foreign markets, the composition of domestic versus foreign demand will not shift the aggregate labor demand relation if these firms can practice price discrimination between these markets (on account of, say, trade restrictions or inter-country transportation costs). In that event, once again, each firm would set the marginal revenue product of labor in each market (the domestic

and the foreign one) equal to the given nominal wage, and its labor demand relation (in real wage-employment space) would not be affected by elasticity-preserving changes in the relative levels of foreign and domestic product demands.

However, supposing that firms sell to the domestic and foreign markets simultaneously but do not price discriminate, our composition-of-productdemand argument is analogous to that presented in the previous section 2a. Now the price elasticity of aggregate product demand may be expressed as follows:

(16) 
$$\eta = \left(\frac{Q_d}{Q_d + Q_f}\right) \cdot \epsilon_d + \left(\frac{Q_f}{Q_d + Q_f}\right) \cdot \epsilon_f$$
,

where  $Q_d$  and  $Q_f$  are the quantities demanded in the domestic and foreign markets (respectively) and  $\epsilon_d$  and  $\epsilon_f$  are the corresponding price elasticities of demand.

As in Section 2a, our expansionary fiscal shock  $(dG_0 > 0)$  has a direct effect and indirect effect via the price level. The direct effect works as follows: Provided that the fiscal shock raises the domestic share of national product  $[Q_d/(Q_d + Q_f)]$ , then the weight on  $\epsilon_d$  rises relatively to the weight on  $\epsilon_f$ . If we suppose - quite plausibly - that  $\epsilon_d < \epsilon_f$ , then the aggregate elasticity  $(\eta)$  will fall.

The indirect effect operates in the same direction. If  $\epsilon_d < \epsilon_f$ , then a rise in the price level (P) (induced by the fiscal shock) will lead to a smaller reduction in domestic demand  $(Q_d)$  than in foreign demand  $(Q_f)$ . Thus, the domestic share  $[Q_d/(Q_d + Q_f)]$  rises relatively to the foreign share  $[Q_f/(Q_d + Q_f)]$ . Then the weight on  $\epsilon_d$  (the smaller elasticity) rises relative to the weight on  $\epsilon_f$  (the larger one). By implication, the aggregate elasticity  $(\eta)$  will fall.

Taking the direct and indirect effects together, we obtain the following

result:

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<u>Proposition 3</u>: If  $\epsilon_d < \epsilon_f$  then the expansionary fiscal shock shifts the aggregate labor demand relation inwards (in real wage-employment space).

If  $\epsilon_d > \epsilon_f$  then the effect of the fiscal shock on the position of the aggregate labor demand relation is ambiguous.

Once again, we arrive at predictions without much empirical support. It appears that the elasticity transmission mechanism which works through changes in the composition of product demand is a "weak reed" on which to anchor a theory of demand management.

#### 3. <u>Transmission via Entry or Exit of Firms</u>

Let us now examine how a product demand shock may lead to the entry or exit of firms and thereby affect the aggregate labor demand relation. We make the standard assumption that if positive profits are earned,<sup>7</sup> then new firms will enter the economy, and if profits are negative, then existing firms will exit. This process continues until profits are reduced to zero.

Suppose that in the short run the number of firms is exogenously given and in the long run it is determined by the following zero-profit condition:

$$(17) \quad \pi = P \cdot q - W \cdot n - B$$

=  $P[(a + v \cdot h(n), A] \cdot h(n) - W \cdot n - B = 0,$ 

by equations (1) - (4). (Our assumption that the fixed cost B is positive ensures that the long-run equilibrium number of firms is finite and positive, given that h(0) = 0, h'>0 and h'' < 0). We also assume that in the long run each firm's conjecture about its rivals' production decisions is correct, so that  $Q = a + v \cdot q = M \cdot q$ . Given that the conjectural variations coefficient is a constant, this equilibrium condition determines the constant a: (18)  $a = (M - v) \cdot q$ 

Combining the long-run equilibrium conditions (17) and (18), we obtain

(19)  $\mathbf{I} = P[\mathbf{M} \cdot \mathbf{h}(\mathbf{n}), \mathbf{A}] \cdot \mathbf{h}(\mathbf{n}) - \mathbf{W} \cdot \mathbf{n} - \mathbf{B} = \mathbf{0}.$ 

Let the economy initially be in a long-run equilibrium, corresponding to an arbitrarily given real wage  $\overline{w}$  and real fixed cost  $\overline{b}$ . Each firm's employment is given by n\*, specified implicitly by the profit maximization condition  $(1-e) \cdot h'(n*) = \overline{w}$ . The number of firms M\* is obtained by substituting  $\overline{w}$ ,  $\overline{b}$ , n\* into the long-run equilibrium condition (19):

 $P[(M* \cdot h(n*), A] \cdot h(n*) - W \cdot n* - B = 0.$ 

The associated price level is

 $P* = P[M* - v) \cdot h(n*), A].$ 

Now suppose that an expansionary product demand shock occurs, raising the shift parameter A in the product demand function (but leaving the price elasticity of product demand and the marginal product of labor unchanged). How can this shock be transmitted to the labor market via the entry or exit of firms?

Observe that the entry-exit transmission mechanism does <u>not</u> work unless the product demand shock has at least a short run influence on the real wage (w = W/P) or the real fixed cost of production (b = B/P). To see why this is so, suppose that w and b were rigid:  $w = \overline{w}$  and  $b = \overline{b}$ . Then each firm's real profit would be

 $(\pi/P) = h(n*) - \overline{w} \cdot n* - \overline{b} = 0$ 

in the initial equilibrium. Here it is clear that a change in the parameter A has no effect on this condition. Profits remain at zero and thus the number of firms remains constant. When the expansionary product demand shock raises the price level, it leads to a proportionate rise in the nominal wage W and nominal production cost B. Thus, if the real wage (w) and real production cost (b) remain constant, then the product demand shock cannot be transmitted

to the labor market through entry of firms.

Now suppose, by contrast, that the nominal wage W and cost B are sluggish in the short run; in fact, for expositional simplicity, take W and B to be rigid. Then the short-run effect of an expansionary product demand shock (viz. a rise in A) is to yield positive profits  $((d\pi/dA) = (\partial\pi/\partial A) = P_A \cdot h > 0,$ by the envelope theorem) and to raise employment in each firm  $((dn*/dA) = (\partial\pi/\partial A) > 0,$  by the profit maximization condition (7)).

Eventually, the opportunity to earn positive profit leads to an increase in the number of firms<sup>8</sup> which, in turn, leads to an incremental rise in employment.<sup>9</sup>

The entry of firms leads to an outward shift of the aggregate labor demand relation. To see this, suppose that after the new firms have entered, the real wage w and the real fixed cost b return to their initial equilibrium levels ( $\bar{w}$  and  $\bar{b}$ , respectively). Then each firm's employment must return to its initial equilibrium level n\* as well (as implied by the profit maximization condition (7)). However, the new equilibrium differs from the initial one since the increase in the number of firms has two effects on aggregate labor demand:

(a) a direct effect, whereby new firms create new employment, and
(b) and indirect effect, whereby entry influences the firm's individual
price elasticity of product demand and thereby affects labor demand.

Differentiating the aggregate labor demand function (9) with respect to M, we obtain:

(20) 
$$\frac{\mathrm{dN}}{\mathrm{dM}}^{\mathrm{D}} = \ell - \mathrm{M} \cdot \ell' \cdot \frac{\mathrm{W}}{\mathrm{P}} \cdot \frac{\mathrm{v}}{\eta} \cdot \frac{1}{((1-\mathrm{e})\cdot\mathrm{M})^2} > 0,$$

where the first right-hand term is the direct effect and the second is the indirect effect.<sup>10</sup>

Note that both effects are positive (as illustrated in Figure 3b). The

indirect effect works because new firms, in our model, compete with the old firms. A rise in the number of competing sellers in the product market makes each seller's product demand relation more elastic (i.e.  $\eta_F = [v/(\eta \cdot n)]$  rises when n rises), which reduces the measure of monopoly power e and induces all firms (both the existing and entering ones) to demand more labor than they otherwise would. Clearly, if new firms would not compete with old firms in selling products (say, on account of sufficient product differentiation), then entry of firms would have a direct effect on labor demand, but no indirect effect.

The entry-exit transmission mechanism is summarized in Figures 3a-c.

#### 4. Transmission via the Marginal Product of Labor

In this section, we first examine the direct effect of a fiscal policy shock on the marginal product of labor - say, in the form of improvements in industrial infrastructure - which causes the aggregate labor demand relation to shift. Next, we examine the indirect effects on the marginal product of labor, via changes in the demand for factors which are complements or substitutes for labor. In particular, we focus on how changes in the degree of capital utilization and in the prices of non-labor factors may affect the position of the aggregate labor demand relation.

#### 4a. Direct Effects: Improvements in Industrial Infrastructure

An expansionary product demand shock may shift the aggregate labor demand relation outwards by stimulating the use of factors which are complementary with labor or by curtailing the use of substitutes for labor. Perhaps the simplest example of this transmission mechanism is an increase in the availability of particular government goods and services to the private production sector - such as roads, railways, harbours, sewage systems, police



Figure 3: Transmission via Entry of Firms

19a

and fire services.

To fix ideas, suppose that each firm uses the services of two factors of production: labor (L) and another factor (I). To begin with, let (I) be government spending on industrial infrastructure that has a direct, positive effect on the marginal product of labor. Let the representative firm's production function be q = h(L, I), where  $h_L$ ,  $h_I > 0$ ,  $h_{LL}$ ,  $h_{II} < 0$ , and  $h_{LI} > 0$ . The level of I is exogenous to the firm's decision making (I =  $\overline{I}$ ) and thus we express the firm's labor demand relation as  $(W/P) = h_L(L, \overline{I})$ . The effect of a change in  $\overline{I}$  on labor demand (at any given real wage) is  $(\partial L/\partial \overline{I}) = -h_{LI}/h_{LL}$ . Here it is obvious that when L and I are complements  $(h_{LI} > 0)$ , then a rise in government spending (I) shifts the firm's labor demand relation outwards. (Conversely, when L and I are substitutes  $(h_{LI} < 0)$ , then it is a fall in government spending that leads to an outward shift of the labor demand relation.)

Infrastructure investment is a potentially important means for affecting the relation between real wages and employment, though over a longer period of time than that relevant to the business cycle.

#### 4b. Indirect Effects: Changes in Capital Utilization

Now consider a fiscal stimulus which induces firms to increase their purchase of factors (or intermediate inputs) which are complementary to labor, or to reduce their purchase of substitute factors. It is tempting to argue that any such change in factor demand leads to a shift in the relation between aggregate labor demand and the real wage, in the same way as the change in government spending did in Section 4a. For instance, an expansionary product demand shock may lead to an increase in the demand for intermediate products and raw materials which, in turn, raises the marginal product of labor and shifts the aggregate labor demand relation outwards (e.g. Solow (1986)).

However, the temptation to argue along these lines should be resisted, since complements and substitutes for labor obviously do not fall like "manna from heaven", but rather depend on variables - e.g. factor prices - which may or may not be influenced systematically through fiscal policy. Thus, whereas government spending is exogenous to firms' decisions, the demands for non-labor factors and intermediate inputs are generally endogenous and may, in turn, be influenced by government policy.

Thus, an analysis of the transmission mechanism must indicate how product demand shocks affect the relation between aggregate labor demand and the real wage after endogenous variations in the demand for other inputs has been taken into account. In other words, the labor demand relation which is relevant to our analysis of the transmission mechanism is not the "conditional" one (i.e. the relation between labor demand and the real wage, holding all other input use constant), but rather the "unconditional" one (i.e. that relation, allowing other variable inputs to change).

To derive a simple unconditional labor demand relation, we suppose (as above) that the representative firm uses two factors, L and I; but we now interpret I as a complement or substitute to labor whose availability is endogenous to the firm's decision-making. Given the marginal condition for employment,  $(1-e) \cdot f_L(L, I) = (W/P)$ , we find that the slope of the unconditional labor demand relation is

(22)  $d(W/P)/dL = \frac{\partial [(1-e) \cdot f_L(L, I)]}{\partial L}$ 

Holding the real price  $(P_I/P)$  of input I constant and inverting the marginal condition for the input demand,  $(1-e) \cdot f_I(L, I) = (P_I/P)$ , we obtain

(23) I = I(L, 
$$\frac{P_I}{(1-e)\cdot P}$$
).

Thus (by (22) and (23)) we find that the unconditional labor demand relation may be upward or downward-sloping:<sup>11</sup>

(24) 
$$\frac{\partial((1-e)\cdot f_{L}}{\partial L} = (1-e)\cdot \left[f_{LL} - f_{LI}\cdot\frac{\partial I}{\partial L}\right] = (1-e)\left[f_{LL} - \frac{f_{LI}^{2}}{f_{II}}\right] \geq 0,$$

holding the real price of the input  $(P_I/P)$  constant.

Equation (24) shows how the relation between the real wage and labor demand depends on the degree of factor interdependence. When L and I are interdependent ( $f_{LI} \neq 0$ ) - <u>regardless of whether they are complements or</u> <u>substitutes</u> - the slope of the labor demand relation is <u>greater</u> than it is when L and I are independent. (The two factors are independent when  $f_{LI} = 0$ , so that  $d(W/P)/dL = (1-e) \cdot f_{LL} < 0$ ). Furthermore, the greater the independence (measured by the absolute value of  $f_{LI}$ ), the greater the slope.

The intuitive rationale underlying this conclusion is straightforward. When L and I are Edgeworth complements  $(f_{LI} > 0)$ , a rise in labor demand is associated with a <u>rise</u> in the demand for the factor I  $((\partial I/\partial L) = -(f_{LI}/f_{II}) >$ 0). The increase in I, in turn, <u>raises</u> the marginal product of labor (since  $f_{LI} > 0$ ). In short, as employment increases, the marginal product of labor either rises or falls by less than it does in the absence of factor complementarity. Thus the slope of the labor demand relation must also be greater.

When L and I are Edgeworth substitutes  $(f_{IL} < 0)$ , a rise in labor demand is associated with a <u>fall</u> in the demand for the other factor  $((\partial I/\partial L) = -(f_{IL}/f_{II}) < 0)$ . The fall in I, in turn, <u>raises</u> the marginal product of labor (since  $f_{IL} < 0$ ). Consequently, as employment increases, the change in the marginal product of labor (and thus also the slope of the labor demand relation) must be greater than it is in the absence of factor substitutability.

Whenever the degree of factor interdependence is sufficiently large (in particular, when  $(f_{LI}^2 > f_{II} \cdot f_{LL})$  in equation (24)), then the labor demand relation is upward sloping. Otherwise, it is flat or downward sloping. Thus,

product demand shocks which affect the employment and the use of the non-labor input, but leave the real price of that input unchanged, may cause the real wage to move either pro-cyclically or counter-cyclically.

A potentially important practical example of this transmission mechanism can occur when product demand shocks affect the degree of capital utilization. When firms hold excess capital capacity, the effective (shadow) price of capital services is zero; thus the product demand shocks can change the utilization of capital but leave the effective price of capital services unchanged at zero, so long as some excess capacity remains.

The conditions under which firms in our model carry excess capital are given in Appendix C. Under these conditions, suppose that there is an increase in product demand which induces the firms to use more of their capital. This capital brought into operation in the course of a cyclical upswing - occurring in practice when workers are recalled to man empty machines, restart assembly lines, etc. - tends to be complementary to labor.

As we have seen above, the greater is this complementarity, the greater is the slope of the unconditional labor demand relations. If the complementarity exceeds the upper bound  $\sqrt{f_{II} \cdot f_{LL}}$ , then a rise in product demand leads to an expansion in employment accompanied by an increase in the real wage; yet if the complementarity falls short of this upper bound, the real wage moves counter-cyclically.

Once full capacity is reached, a rise in the demand for capital services obviously cannot be accompanied by a rise in the stock of capital in use, and thus (given diminishing returns to labor) the labor demand relation becomes downward-sloping:  $d(W/P)/dL = (1-e) \cdot f_{LL} < 0$ . It is interesting to observe that, in the model above, the possibility of experiencing an expansion of employment without a drop in the real wage depends on the existence of

underutilized capital, rather than unemployed labor.

#### 4c. Indirect Effects: Changes in Factor Prices

The indirect effects of Section 4b are not likely to work through nondurable inputs, such as raw materials and energy, since the real prices of these inputs generally do not remain constant in the face of product demand shocks. The same may be said, as we have seen, of durable inputs which are used to capacity. With regard to all these inputs we must examine how a product market shock changes the real input prices and thereby changes the firm's input demand and, in turn, the marginal product of labor.

Suppose that a rise in product demand leads to a rise in the real factor price  $(P_I/P)$ . Holding the real wage (W/P) constant, the effect of this factor price change on labor demand is

(25) 
$$\frac{\partial L}{\partial(P_{T}/P)} = \frac{\partial[(1-e) \cdot f_{L}]/\partial(P_{I}/P)}{\partial[(1-e) \cdot f_{T}]/\partial L}$$

$$= \frac{\mathbf{f}_{\mathrm{LI}}}{(1-e) \cdot [\mathbf{f}_{\mathrm{LL}} \cdot \mathbf{f}_{\mathrm{II}} - \mathbf{f}_{\mathrm{LI}}^2]},$$

by the marginal employment condition  $(1-e) \cdot f_{L}(L, I) = (W/P)$  and Equation (23).

The intuitive meaning of condition (25) is this: when factor I is a complement to labor ( $f_{IL} > 0$ ), then a rise in  $P_I/P$ ) reduces the real marginal value product of labor:

$$\frac{\partial [(1-e) \cdot f_{L}]}{\partial (P_{I}/P)} = (1-e) \cdot f_{LI} \cdot \frac{\partial I}{\partial (P_{I}/P)} = \frac{f_{LI}}{f_{II}}$$

and thus, at any given real wage, employment falls when the interdependence between L and I is "low" (i.e.  $f_{LI}^2 < f_{II} \cdot f_{LL}$ ) and rises when the interdependence is "high" (i.e.  $f_{LI}^2 > f_{II} \cdot f_{LL}$ ). Conversely, when factor I is

a substitute for labor, then a rise in  $(P_I/P)$  raises the real marginal value product of labor (by reducing the demand for factor I). Consequently, the firm must raise employment if the interdependence between L and I is "low" and reduce employment when the interdependence is "high". The effect of a rise in the real factor price  $(P_I/P)$  on L is summarized in the following table:

<u>Table 1</u>: The Effect of a Rise in the Real Factor Price  $(P_{T}/P)$  on Employment

Degree of Interdependence	Type of interdependence	
between L and I	between L and I	
	Complements	Substitutes
Low	Negative	Positive
High	Positive	Negative

This transmission mechanism, however, has greater relevance for supply-side than demand-side policies. Unfavourable supply-side shocks (like the rise of energy prices in the mid- and late seventies) usually have an immediate, positive effect on the real factor price  $(P_I/P)$ : and conversely for favorable supply-side shocks. Demand-side policies, however, do not have such a predictable effect on the real prices of factors working in conjunction with labor.

Finally, it is worth noting that, in a stochastic context, there may also be search-related transmission mechanisms which are akin to the ones described in this section (Diamond (1982), Drazen (1986), Howitt (1985)). In particular, suppose that firms face stochastic product demand functions and that they make decisions on how intensively to search in the product market (e.g. by varying their advertising expenditures). Then a deterministic rise

in product demand (at any given product price) reduces the firm's per unit search costs in the product market and thereby raises the real marginal revenue product of labor (inclusive of product market search costs) at any given level of employment. As result, the labor demand relation shifts outwards.

We suspect that although this transmission mechanism, in principle, may give product demand shocks more punch than they would otherwise have, it appears unlikely that variations in the effectiveness of product advertising (and related expenditures) on jobs would be a main pillar on which the effectiveness of fiscal policy rests.

#### 6. <u>Conclusions</u>

This paper has explored how product market shocks may be transmitted to the labor market. Taking for granted the transmission mechanisms which arise on account of wage and/or price rigidity, we have investigated what channels of transmission are operative under flexible wages and prices under imperfect competition. We have found that the scope for short-term demand-management policy is more complex, but also more limited than the traditional Keynesian theory indicates.

Leaving aside some highly unreliable transmission mechanisms discussed above, we are left primarily with a short-run, a medium-run, and a long-run mechanism. The short-run mechanism operates via changes in capital utilization, and the medium-run mechanism works through entry and exit of firms, and the long-run mechanism operates through changes in industrial infrastructure. This suggests that, in the absence of nominal wage or price sluggishness, product demand management policies may be promising tools for the achievement of short-run employment goals primarily when there is substantial excess capacity of capital goods. There may be more latitude for

demand management policies to be effective over a period of several years. By contrast, supply-side shocks (like those associated with the sudden rises of energy prices in the 1970's) may affect the labor market more directly and promptly.

#### APPENDIX A

We show that the positive and negative conclusions of Proposition 1 hold under much more general conditions than those specified by the assumptions in Section 1. In particular we consider the following extensions:

#### (a) **Differentiated Products**

Suppose that the M firms in our economy produce differentiated products, whose price elasticities of demand are given by  $\eta_i$ , i = 1, ..., M. Then the labor demand relation for the i'th firm is

$$n_i = \ell \left( \frac{W}{P_i} \cdot \frac{\eta_i}{\eta_i - 1} \right)$$

where  $\eta_i$  might depend on the number of firms in the economy. Here the relation between firm i's labor demand and its real wage does not depend on the level of product demand at any given price, independently of the elasticity  $\eta_i$ .

#### (b) Stochastic Product Demand

Let  $\rho$  be the expected price level associated with a particular aggregate product demand Q and shift parameter A. The "expected aggregate product demand function" is  $\rho = \rho(Q, A)$ . The firm's decision making problem is to maximize its expected profit subject to its production function, conjecture function, and expected product demand function:

Maximize  $\pi = \rho \cdot q - W \cdot n - B$ subject to q = h(n),  $Q = a + v \cdot q$  $\rho = \rho(Q, A)$ 

Consequently, the firm's labor demand relation is

$$n = \ell \left( \frac{W}{-} \cdot \frac{1}{1-e} \right),$$

where  $e^{e} = - \frac{v}{M \cdot (\partial \rho / \partial Q) / (Q/\rho)}$ .

Given the firm's imperfectly competitive interactions (summarized by v), the position of the labor demand relation depends exclusively on the number of firms, the marginal product of labor, and the inverse of the expected price elasticity of aggregate product demand  $((\partial \rho)/\partial Q)/(Q/\rho))$ .

#### (c) Firms of Different Sizes

Suppose that  $\sigma_i = (q_i/Q)$  is the market share of firm i. Then the firm's labor demand relation is

$$\mathbf{n}_{\mathbf{i}} = \ell \left( \frac{\mathbf{W}}{\mathbf{P}} \cdot \frac{1}{1 - \mathbf{e}_{\mathbf{i}}} \right),$$

where  $e_i = (v \cdot \sigma_i)/\eta$ . Here the relation between the firm's employment and the real wage depends exclusively on the price elasticity of aggregate product demand, firm i's market share, and the marginal product of labor.

#### (d) Efficient Wage-Employment Bargains

Suppose that the real wage and employment are the outcome of an efficient bargain between the firm and a union comprising its employees. The union has a utility function U = U(w, n) (where w is the real wage) and the firm's profit function is  $\pi = h(n)-w\cdot n$ .

In an efficient wage-employment bargain, the slope of the union's indifference curve is equal to the slope of the firm's corresponding iso-employment locus (in w-n space):

$$-\frac{U}{U_{w}} = \frac{h'(n) - w}{n} .$$

We call this the "efficiency locus".

The division of the available economic rent among the firm and the union is given by the "equity locus", which may be specified as follows. Let  $(\pi - \tilde{\pi})$ and  $(\tilde{U} - \tilde{U})$  be the rent captured by the firm and the union, respectively (where  $\tilde{\pi}$  and  $\tilde{U}$  may be interpreted as the disagreement points of the firm and the union). Then the equity locus may be expressed as

where the function  $\alpha$  may depend on the number of firms in the economy. (In a generalized Nash bargain,  $\alpha$  is a nonnegative constant).

The outcome of the bargain is the intersection (in w - n space) of the efficiency locus and the equity locus. In this context, it is clear that the relation between employment and the real wage does not depend on the shift parameter (A) of the product demand function, independently of the marginal product of labor, the union's marginal rate of substitution (in w-n space) and the number of firms.

#### (e) <u>Durable Goods</u>

Suppose that firms sell durable goods and that they may hold inventories of these goods for production-smoothing reasons. For expositional simplicity (but without loss of generality), we assume that each firm produces a differentiated product, that the production functions and product demand functions are all identical, and that each firm has a two-period time horizon. Then the decision making problem of a representative firm is

Maximize  $\begin{aligned} & 2 \\ t = 1 \\ \text{subject to} \quad d_t = q_t + (1 - \delta) \cdot x_{t-1} \\ & q_t = h(n_t), \end{aligned}$ 

with respect to sales  $(d_t)$ , production  $(q_t)$ , employment  $(n_t)$ , and inventory stocks  $(x_t)$ . (The inventory depreciation rate is 5.)

On account of the two-period time horizon, the optimal inventory stock in the second period is  $x_2^* = 0$ . Consequently, the first-order conditions for profit-maximization are

h' 
$$(n_t) \cdot (1 - \frac{1}{\eta}) = \frac{W}{P_t}$$
  
P<sub>1</sub> -  $(1 - \delta) \cdot P_2 = 0$ 

where the firm's elasticity of product demand  $(\eta)$  may depend on the number of firms in the economy.

Here it is obvious that the relation between the firm's employment and the real wage does not depend on the shift parameter (A) in the product demand function, independently of the marginal product of labor, the price elasticity of product demand, and the number of firms.

#### APPENDIX B

The total effect of an expansionary fiscal shock  $(dG_0 > 0)$  on the price elasticity of aggregate demand is

(B1)  $\frac{d\eta}{d\overline{G}_0} = \frac{\partial\eta}{\partial\overline{G}_0} + \frac{\partial P}{\partial\overline{G}_0} \cdot \frac{\partial\eta}{\partial\overline{P}}$ 

The two right-hand terms stand for the "direct" and "indirect" effects of the fiscal shock.

The direct effect is

(B2)  $\frac{\partial \eta}{\partial G_0} = \alpha \cdot \frac{\partial g}{\partial G_0} \cdot (\epsilon_c - \epsilon_g) \cdot \frac{\partial r}{\partial g}$ 

where r = c/(c + g) is the share of consumption spending in national product.

Observe that

(B3)  $\frac{\partial g}{\partial G_0} = \frac{1}{P} > 0$ 

and

(B4) 
$$\frac{\partial r}{\partial g} = - (\frac{1}{c+g})(1 - \alpha \cdot c_1) \cdot r,$$

which we (quite plausibly) assume to be negative.

Consequently (by (B2) - (B4)),  
(B5) 
$$\operatorname{sgn}\left(\frac{\partial \eta}{\partial \gamma_{0}}\right) = \operatorname{sgn}\left(\epsilon_{g} - \epsilon_{c}\right)$$

The indirect effect is

(B6) 
$$\frac{\partial P}{\partial G_0} \cdot \frac{\partial \eta}{\partial P} = \frac{\partial P}{\partial G_0} \cdot \alpha \cdot (\epsilon_c - \epsilon_g) \cdot \frac{\partial r}{\partial P}$$

Observe that

(B7) 
$$\frac{\partial \Gamma}{\partial P} = \frac{1}{(c+g)^2} \cdot \left[ \frac{\partial c}{\partial P} \cdot g - \frac{\partial g}{\partial P} \cdot c \right],$$

$$=\frac{1}{\overline{p}}\cdot r(1-r)\cdot(\epsilon_{g}-\epsilon_{c}).$$

Thus

(B8) 
$$\frac{\partial \eta}{\partial P} = -\alpha \cdot (\epsilon_g - \epsilon_c)^2 \cdot \frac{1}{P} \cdot r \cdot (1 - r) < 0$$

The total effect (by (B2) - (B4) and (B8)) is

(B9) 
$$\frac{d\eta}{dG_0} = \frac{\alpha}{P} \cdot (\epsilon_g - \epsilon_c) \cdot \frac{(1 - \alpha > c_1) \cdot r}{c + g} - (\frac{\partial P}{\partial G_0}) \cdot (\epsilon_g - \epsilon_c)^2 \cdot \frac{r \cdot (1 - r)}{P}$$

Given (B5) and (B8) and assuming that  $(\partial P/\partial dG_0) > 0$ , we obtain Proposition 2a.

#### APPENDIX C

In this appendix we examine what conditions the imperfectly competitive firms described above may hold excess capital capacity. The input "I" is interpreted as the firm's stock of capital in use. We assume that the firm seeks to maximize its profit over two periods. The current period capital stock ( $I^1$ , where the superscript refers to the time period) is exogenous, given at whatever level is carried forward from the past.

To examine why a firm may find it worthwhile to hold excess capacity, we suppose that there is currently a business downturn, so that the constant  $(A^1)$  in the current demand function is sufficiently low to rob the firm of any incentive to invest in the current period. Hence, the capital stock in the next period is  $I^2 = (1-\delta) \cdot I^1$ , where  $\delta$  is the depreciation rate. Furthermore, we assume that the firm expects a business upturn in the next period, i.e.  $A^2 > A^1$ . Finally, for simplicity, we let the nominal wage remain constant over the two periods  $(W^1 = W^2 = W)$ .

Now consider the alternative ways in which the firm can dispose of a marginal unit of this existing capital in the two periods, given that it is profitable to use this capital in the second period:

(a) it can be used in both periods, and

(b) it can be sold in the first period and repurchased (and used) in the second.

The profit per marginal unit of capital from Strategy (a) is (Cla)  $\pi_{a} = (\frac{1-\delta}{1-r}) \cdot p^{2} \cdot f_{I}^{2} \cdot (1-e)$ 

where r is the rate of time discount. (Differentiating the profit function, we obtain

$$\pi_{\mathbf{a}} = (\frac{1}{1-\mathbf{r}}) \cdot \{\mathbf{P}^2 \cdot \mathbf{f}_{\mathbf{K}}^2 \cdot (1-\delta) \ [1 + \mathbf{q}_2 \cdot \frac{\partial \mathbf{P}}{\partial \mathbf{K}}] + (\mathbf{P}^2 \cdot \mathbf{f}_{\mathbf{L}}^2 - \mathbf{W}) \cdot d\mathbf{L}^2\}$$

where dL<sup>2</sup> is the profit-maximizing amount of labor cooperating with the

marginal unit of capital in the second period. Optimal employment in the second period is given by the marginal condition  $P \cdot f_L^2 = W$ . Further more (by analogy with (5)),  $q_2 \cdot (\partial P_2 / \partial K) = -(v/q \cdot n) \cdot f_K^2 \cdot P^2$ . Thus the equation above reduces to equation (Cla)).

We assume that capital's rate of depreciation (5) depends on the rate of capital utilization, with 5' being the change in the depreciation rate resulting from the use of a marginal unit of capital. Then the marginal profit from Strategy (b) is

(Clb)  $\boldsymbol{\pi}_{b} = P^{1} \cdot f_{I}^{1} \cdot (1-e) + (\frac{1+\delta}{1+r}) \cdot P^{2} \cdot f_{I}^{2} \cdot e$ 

(Once again, we let employment be at its optimal levels in the first and second periods.)

In order for the firm to find it worthwhile to keep a marginal unit of its existing capital idle, the marginal profit from Strategy (a) must exceed that from Strategies (b) and (c) .

(C2a)  $\pi_a > \pi_b$ , which implies that  $(1+r) \cdot \frac{P^1}{P^2} \cdot f_1^1 - f_1^2 \cdot I' \cdot s' < 0$ 

by (Cla) and (Clb) and

(C2b)  $\pi_a > \pi_c$ , which implies that  $\rho_B^2 - (1+r)\rho_S^1 > 0$ conditions (C2a) and (C2b) show that the firm will keep its marginal unit of capital unused in the current period when

the rate of time discount (r) is sufficiently low;

- the severity of the current business downturn, measured by the ratio  $P^2/P^1$  is sufficiently large;
- the current capital stock (I<sup>1</sup>), the depreciation rate (5), and the effect of capital utilization on the depreciation rate (5') are sufficiently large;
- the complementarity between labor and capital, measured by  $f_L^t$ , is sufficiently large (since (W/P<sup>1</sup>) > (W/P<sup>1</sup>) which implies that  $L^1 < L^2$ ,

ceteris paribus, and the larger  $f_{LI}^1$ , the smaller the value of  $f_I^1$  relative to  $f_I^2$  in equation (C2a)).

#### Footnotes

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- 1. We do not consider asymmetric information which prevails under conditions of adverse selection or moral hazard.
- 2 We assume that the parameters of the problem are such that the second-order condition is satisfied.
- 3 Under perfect competition, the number of firms (n) is infinite, so that e = 0; hence, the real wage is brought into equality with the marginal product of labor: (W/P) = h'. Under monopoly, n = v = 1, so that condition (5) reduces to the well-known condition that the mark-up of the price (P) over the marginal cost (W/h') is  $[1 - (1/\eta)]$ .
- 4 Traditionally, a demand curve relates the quantity demanded to variables which are exogenous to the demanders. In this sense, the firm's labor demand curve is a function of the nominal (rather than the real) wage:

 $n = \zeta^{-1}[W/(1-e)],$  where  $\zeta(n) = P[(a + v \cdot h(n)), A] \cdot h'(n),$ 

by Equations (2), (3), and (7).

- 5 In particular, firms' imperfectly conpetitive intentions are assumed to be such that v = (dQ/dq) is a constant. See, however, Rotemberg and Saloner (1986).
- 6 Note that we cannot assume, as the traditional macroeconomic models do, that consumption and government demands are given in real terms. The reason lies in the nature of our imperfectly competitive product market. If the consumption elasticity ( $\epsilon_c$ ) or the government elasticity ( $\epsilon_g$ ) were zero, then firms would be able to earn infinite profit by charging an infinite price.
- 7 Recall that all existing firms are assumed to be identical. Thus all firms (existing and potential ones) earn equal profits.
- 8 By the zero-profit condition (17) and equation (18),

$$(dM/dA) = -(P_n)/(P_Q \cdot h) > 0$$

9 Substituting equations (1), (2), (3) and (19) into the profit maximization condition (7), we obtain

$$(1-e) \cdot h'(n*) \cdot P[(M-v) \cdot h(n*), A] = W.$$

10 Let  $\mu = - [\partial N^D / \partial (W/P)] \cdot [(W/P) / N^D]$  be the elasticity of aggregate labor demand with respect to the real wage. Then the indirect effect may be simply expressed as  $\mu \cdot e \cdot \ell$ .

11 When the firm is a price taker, the second-order conditions are  $\pi_{LL}$ ,  $\pi_{II}$ < 0 and  $\hat{\pi}_{LL} \cdot \pi_{IL}^2 > 0$  and these imply that  $f_{LL} < 0$  and  $\hat{f}_{LL} \cdot f_{II} - f_{IL}^2 > 0$ for any positive price P. Thus, the labor demand curve must be downward sloping. Yet this is not so, in general, for a price-setting firm.

#### References

- Barro, R.J. and H.I. Grossman (1976), <u>Money, Employment, and Inflation</u>, Cambridge: Cambridge University Press.
- Bils, M. (1987), "Cyclical Pricing of Durable Luxuries", Working Paper No. 83, University of Rochester.
- Diamond, P. (1982), "Aggregate Demand Management in Search Equilibrium", Journal of Political Economy, 90, 881-94.
- Drazen, A. (1987), "Reciprocal Externality Models of Low Employment", <u>European Economic Review</u>, Papers and Proceedings, 31, 436-44.
- Howitt, P. (1985), "Transactions Costs in the Theory of Unemployment", <u>American Economic Review</u>, 75(1), 88-100.
- Kalechi, M. (1938), "The Determinants of the Distribution of the National Income", <u>Econometrica</u>, 6, 97-112.
- Keynes, J.M. (1939), "Relative Movements of Real Wages and Output", <u>Economic</u> <u>Journal</u>, 49, 34-51.
- Lindbeck, A. and D.J. Snower (1987), "Transmission Mechanisms from the Product to the Labor Market", Seminar Paper, Institute for International Economic Studies, University of Stockholm.
- Malinvaud, E. (1977), <u>The Theory of Unemployment Reconsidered</u>, Oxford: Basil Blackwell.
- Pigou, A.C. (1927), Industrial Fluctuations, London, Macmillan.
- Rotemberg, J. and G Saloner, "A Supergame-theoretic Model of Business Cycles and Price Wars during Booms", <u>American Economic Review</u>, 1986, 76, 390-407.
- Stiglitz, J. (1984), "Price Rigidities and Market Structure", <u>American</u> <u>Economic Review</u>, Papers and Proceedings, 350-55.
- Solow, R. (1986), "Unemployment: Getting the Questions Right, <u>Economica</u>, 53, S23-S34.