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## How are product demand changes transmitted to the labour market?

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## DISCUSSION PAPER SERIES

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### HOW ARE PRODUCT DEMAND CHANGES TRANSMITTED TO THE LABOUR MARKET?

Assar Lindbeck and Dennis J Snower



**Centre for Economic Policy Research**

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## ABSTRACT

### How are Product Demand Changes Transmitted to the Labour Market?\*

In traditional Keynesian and neoclassical models, the transmission of product demand changes to the labour market generally involves wage-price sluggishness or counter-cyclical real wage movements. In practice, however, real wages are often acyclical or procyclical, and wages and prices are flexible in the longer run. This paper examines the main channels whereby product demand can affect employment under these conditions. The analysis suggests that the longer-term effectiveness of demand management policies depends significantly on the availability of a limited number of supply-side transmission channels.

JEL classification: E3, E6, J3, J4, L1

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imperfect competition, employment

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## NON-TECHNICAL SUMMARY

The issue of how demand management affects employment is a matter of urgent policy concern. Many economists believe that the recessions of the early 1980s and 1990s in many European countries were deepened by restrictive fiscal and monetary policies. Similarly, overheating of many economies in the late 1960s is often attributed to an over-expansion of demand. An understanding of how changes in product demand affect employment is crucial for the formulation of policies to deal with unemployment. This paper is motivated by the argument that standard macroeconomic theories tell far less than the whole story about how product demand changes are transmitted to the labour market.

In the Keynesian literature, there are two main channels of transmission: First, if prices are more responsive than nominal wages to product demand changes, then a rise in demand that raises the price level will reduce the real wage and thereby raise employment. Second, if prices are sluggish, a product demand shock has a direct effect on labour demand without any change in the real wage. (A firm that does not respond to a rise in demand by raising its prices may raise employment and production instead.)

In the New Classical Macroeconomics, an expansionary product demand shock may lead to errors in price expectations or to intertemporal substitution of labour, thereby leading to a temporary outward shift of the labour supply curve. When the labour market clears, this reduces the real wage and raises employment.

Both approaches have severe deficiencies. The Keynesian and New Classical channels of transmission that work via the real wage imply counter-cyclical real wage movements; in other words, employment rises when the real product wage falls and *vice versa*. In practice, however, real wage movements are often acyclical or even pro-cyclical (particularly in the US). Moreover, all the transmission channels above – those operating through the real wage and price inertia – are relevant primarily to the short run; they tell us little about how product demand changes can affect employment once wages and prices have responded fully, or intertemporal substitution effects and errors in price expectations have worked themselves out. This is a serious handicap if demand variations are to be seen as a possible cause of unemployment fluctuations, for periods of low unemployment (as in the 1960s) and high unemployment (as in Europe during the 1980s) may last for several consecutive years. For demand to have a significant role in explaining the prominent unemployment movements, the influence must extend beyond the short run.

In response to these deficiencies, this paper aims to identify channels whereby product demand changes are transmitted to employment, without: (a) assuming wage-price inertia, or (b) implying counter-cyclical movements of the real wage.

The underlying motivation is to provide a plausible account of how demand management policies and other demand changes can affect employment over a period long enough for prices to be flexible and for price surprises and intertemporal substitution to be insignificant. This issue is controversial and important: some economists believe demand-side policies to be effective only in the short run, while others assert that there are longer-term effects without explaining the various channels whereby these may occur. This paper focuses on both the medium run, when capital is roughly constant and there are diminishing returns to labour, and the long run, over which the capital stock adjusts fully.

It is common in many strands of macroeconomic theory to assume that the transmission of product demand changes to employment is automatic, in the sense that any type of product demand increase (whether it takes the form of road building, income tax reduction, or anything else) will invariably raise the demand for labour. Our analysis takes issue with this presumption. Furthermore, we show that the ability of any given type of product demand to shift the labour demand curve depends on whether a limited number of transmission channels are open. We argue that certain supply-side channels – operating through the degree of capital utilization, entry and exit of firms, and the productivity-enhancing effects of infrastructure investment – are particularly important in this regard.

The policy implications of this analysis are clear-cut and potentially important. Supply-side policies (such as the removal of barriers to the entry and exit of firms) which open a limited number of transmission channels may be expected to strengthen the longer-term impact of the demand-side policies on employment. Furthermore, government spending in the form of infrastructure investment may have a bigger impact on employment than tax reductions or increased transfer payments.

# HOW ARE PRODUCT DEMAND CHANGES TRANSMITTED TO THE LABOUR MARKET?

by Assar Lindbeck and Dennis J. Snower

## 1. Introduction

The question of how product demand changes are transmitted to the labour market has been the focus of unremitting interest in macroeconomics. In the Keynesian literature, there are two main channels of transmission: First, if prices are assumed to be more responsive than nominal wages to product demand changes, then a rise in demand reduces the real wage and thereby raises employment. Second, if prices are sluggish, a product demand shock has a direct effect on labour demand without any change in the real wage. In the natural rate models and intertemporal substitution models, a rise in product demand may lead to a temporary outward shift of the labour supply curve, reducing the real wage and raising employment.

The Keynesian and New Classical channels of transmission that work via the real wage imply counter-cyclical real wage movements, viz, the real product wage and employment move in opposite directions. In practice, however, real wage movements are often acyclical or even pro-cyclical (particularly in the US). Moreover, all the transmission channels above - those operating through the real wage and price inertia - are relevant primarily to the short run; they tell us little about how product demand changes can affect employment once wages and prices have responded fully, or intertemporal substitution effects and errors in price expectations have worked themselves out. This is a serious handicap if demand variations are to be seen as a possible cause of unemployment fluctuations, for periods of low unemployment (as in the 1960s) and high unemployment (as in Europe during the 1980s) may last for several consecutive years. For demand to have a significant role in explaining the prominent unemployment movements, the influence must extend beyond the short run.

In response to these deficiencies, this paper aims to identify channels whereby product demand changes are transmitted to employment, without (a) assuming wage-price inertia or (b) implying counter-cyclical movements of the real wage. The underlying motivation is to provide a plausible account of how demand management policies and other demand changes can affect employment over a period long enough for prices to be flexible and for price surprises and intertemporal substitution to be insignificant. This issue is controversial and important: some economists believe demand-side policies to be effective only in the short run, while others assert that there are longer-term effects without explaining the various channels whereby these may occur. This paper focuses on both the medium run, when capital is roughly constant and there are diminishing returns to labour, and the long run, over which the capital stock adjusts fully.

To fix ideas, let the labour market equilibrium be depicted by the intersection between a labour demand curve and a wage setting curve, as shown in Figure 1a.<sup>1</sup> Under

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<sup>1</sup>The labor demand curve (LD) may be interpreted as a relation between the real wage and

diminishing returns to labour, when the labour demand curve slopes downwards, it is clear that if changes in product demand do not shift the labour demand curve, then any employment effect must involve counter-cyclical real wage movements.

Thus, in order to explain how a change in product demand could affect employment without counter-cyclical real wage movements, we need to show how it could shift the labour demand curve, as illustrated in Figure 1a. Alternatively, we need to show why, in the presence of diminishing returns to labour, the labour demand curve may be flat or upward-sloping. Then a product demand shock that shifts the wage setting curve could generate acyclical or pro-cyclical movements in the real wage, as illustrated in Figure 1b.

These are clearly necessary, but not sufficient, conditions for the transmission of product demand changes to employment in the absence of counter-cyclical real wage responses.<sup>2</sup> By confining itself to these necessary conditions, this paper becomes manageable in scope, since it restricts our analysis to the position and slope of the labour demand curve. However, it is worth emphasizing that the paper thereby leaves out a number of conceivable interactions between imperfectly competitive product and labour markets, e.g. income effects on labour supply<sup>3</sup>, increasing returns<sup>4</sup>, and search with strategic complementarities<sup>5</sup>. It also does not consider what adjustment costs, labour immobilities, and aggregation across heterogeneous labour markets imply for the transmission of product demand shocks, since these have been covered in detail elsewhere.<sup>6</sup> Dixon and Rankin (1993) contains an excellent survey of these issues.

It is common in many strands for macroeconomics to assume that the transmission of product demand changes to employment is *automatic*, in the sense that any type of product demand increase (whether it takes the form of road building, income tax reduction, or anything else) will invariably raise the demand for labour, so that the

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labor demand that emerges when imperfectly competitive firms set prices and employment at predetermined wages. The wage setting curve (WS) could be either a labor supply curve (in a market-clearing model) or a relation between the real wage and employment that emerges from wage bargaining or efficiency wage minimization.

<sup>2</sup>Even if the labor demand curve shifts outwards in response to an increase in product demand, it is of course possible that the wage setting curve may shift further outwards, so that the real wage would still move counter-cyclically. And even if the labor demand curve is upward sloping, the real wage will not move pro-cyclically unless the wage setting curve shifts.

<sup>3</sup>See, for example, Dixon (1987), Mankiw (1988), and Startz (1989). These effects are relevant to the influence of product demand on the wage setting curve.

<sup>4</sup>See, for example, Cooper and John (1988) and Chatterjee and Cooper (1989).

<sup>5</sup>See, for example, Howitt (1985) and Pissarides (1985).

<sup>6</sup>For example, in Dixon (1988) unions reduce the degree of labor mobility and thereby make the employment level sensitive to the allocation of government spending across sectors. In Lindbeck and Snower (1988), an increase in product demand that temporarily reduces the real wage (on account of, say, a nominal wage rigidity) will raise employment even after the real wage returns to its initial equilibrium, because of unemployment persistence mechanisms.



level of product demand may be used as a shift parameter in the labour demand curve.<sup>7</sup> Our analysis takes issue with this presumption. Furthermore, we show that the ability of any given type of product demand to shift the labour demand curve depends on whether a limited number of transmission channels are open. We argue that certain supply-side channels - operating through the the degree of capital utilization, entry and exit of firms, and the productivity-enhancing effects of infrastructure investment - are particularly important in this regard. As we shall see, these results have potentially important policy implications.

The paper investigates the channels of transmission under three different sets of circumstances. Section 2 considers the case in which the stock of capital is given and there is full capital capacity utilization. Section 3 extends the analysis by including the possibility of excess capital capacity. Section 4 deals with the long run, when the capital stock is endogenous. Finally, Section 5 concludes by providing a brief overview and evaluation of the various transmission channels.

## 2. Channels of Transmission under Fixed, Full Capital Capacity

We begin by considering the employment behaviour of firms producing a homogeneous, nondurable product in the absence of risk and making their pricing, employment, production decisions simultaneously. The implications of our analysis for the transmission channels turn out to be surprisingly robust. As shown in the appendix, the channels identified here continue to hold for a very wide class of models, covering differentiated products, firms of different sizes, stochastic product demand, durable goods, efficiency wages, and simultaneous bargaining over wages and employment (so that a "labour demand curve" does not exist).

Consider a sector containing a fixed number (F) of identical firms and let the sectoral product demand function be

$$Q = Q\left(\frac{P}{\pi}, \frac{X}{\pi}, A\right) \quad (1)$$

where P is the product price,  $\pi$  is an aggregate price index, X stands for nominal endowments (e.g. money balances carried forward from the past), and A is a shift parameter representing the various other exogenous determinants of product demand (e.g.

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<sup>7</sup>Here are some examples: "... insert a parameter B (for business cycle) [into the labor demand function], with the convention that an increase in B increases the demand for labor at any wage." (McDonald and Solow (1981), p.899). "In the standard short-run case when labor is the only variable input, the demand for labor is  $F^{-1}\{AD(P(i)/P)\}$ , where  $Y(i) = F(N(i))$  is the short-run production function. (...) The employment offered by the representative firm is simply  $N\{w, AD(1)\}$  [where AD is aggregate demand]". (Solow (1986a), p.526). "In this case [i.e. when the goods markets are imperfectly competitive] a firm's labor demand depends on real aggregate demand as well as the real wage, because changes in aggregate demand shifts the firm's product demand." (Ball, Mankiw, and Romer (1988)).

government product demand). If all sectors are identical, the economy-wide product demand function may be captured by the special case where  $P = \pi$ .

Each firm is an imperfect competitor in the product market. To consider a broad spectrum of imperfectly competitive behaviors, extending from monopoly to perfect competition, we depict the firm's interactions with its rivals through the simple assumption that, when it increases its production ( $q$ ) by one unit, it expects its rivals to increase their production by  $c-1$  units:

$$\frac{d(Q^e - q)}{dq} = c - 1 \quad (2)$$

where  $Q^e$  is expected aggregate output,  $(Q^e - q)$  is expected output of the firm's rivals and  $c$  is a constant.<sup>8</sup>

The firm's production function is

$$q = h(n), \quad h_n > 0, \quad h_{nn} < 0 \quad (3)$$

where  $n$  is its employment, and we implicitly assume that the firm is operating under fixed, full capital capacity. The firm sets its employment ( $n$ ), production ( $q$ ), and pricing ( $P$ ) decisions so as to maximize its profit,  $z = P \cdot q - W \cdot n$ , subject to the product demand function (1), the conjecture function (2), and the production function (3), and a predetermined wage<sup>9</sup> ( $W$ ). For this problem, we obtain the standard first-order condition in which the real marginal value product of labour is set equal to the real wage:

$$(1-m) \cdot h_n = W/P = w \quad (4)$$

where  $w$  is the real wage and  $m = c/(\eta \cdot F)$  is the Lerner index of monopoly power<sup>10</sup>, with  $\eta$  being the price elasticity of product demand.<sup>11</sup> Inverting this function and letting aggregate (sectoral or economy-wide) employment be  $N = n \cdot F$ , we obtain the aggregate labour demand curve:

<sup>8</sup>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: (a) Under Cartel behavior ( $c = F$ ), the firm expects each of its rivals to make the same production decision as it does itself, and thus all firms behave as if they were joint profit maximizers; (b) under Cournot behavior ( $c = 1$ ), the firm expects its production decision to have no effect on the production decisions of its rivals; and under perfectly competitive behavior ( $c = 0$ ), the firm expects its production decision to have no effect on aggregate industrial output.

<sup>9</sup>This clearly does not imply that it is rigid. It could, for example, be the outcome of a bargain that takes place prior to the employment decision. Alternatively, it could be set simultaneously with employment, as in the efficiency wage models, where the optimal wage and employment decisions are determined by separate first-order conditions.

<sup>10</sup>In particular,  $m$  is the proportional price-cost margin:  $m = (P - MC)/P$ , where  $MC = W/h_n$  is the marginal cost.

<sup>11</sup>Under perfect competition, the number of firms ( $F$ ) is infinite, so that  $m = 0$ ; hence the real wage is brought into equality with the marginal product of labor:  $w = h_n$ . Under monopoly,  $F = v = 1$ , so that condition (4) reduces to the well-known condition that the markup of the price  $P$  over the marginal cost  $W/h_n$  is  $[1 - (1/\eta)]$ .

$$N = F \cdot L \left( \frac{w}{1 - m} \right) \quad (5)$$

where  $L = (h_n)^{-1}$ . Under diminishing returns to labour, this curve is downward sloping ( $L' < 0$ , since  $h_{nn} < 0$ ).

While this labour demand curve is commonplace in microeconomics, note that it has important implications for the transmission of product demand changes to the labour market and that these implications have largely been neglected in macroeconomics:

*Proposition 1: For the downward-sloping aggregate labour demand curve (5), an increase in product demand can raise employment without necessarily generating a counter-cyclical real wage movement only if the labour demand curve shifts outwards. This occurs only if*

- [i] the price elasticity of product demand ( $\eta$ ) increases,*
- [ii] the imperfectly competitive interactions among firms, described by  $c$ , become more competitive,*
- [iii] the number of firms ( $F$ ) increases, or*
- [iv] the marginal product of labour ( $h_n$ ) increases.*

Observe that since the shift parameter  $A$  of the product demand function is not an argument of the labour demand curve (5), the position of the aggregate labour demand curve does not depend on product demand independently of the transmission channels above. This insight is not compatible with a macroeconomic formulation of the labor demand curve: ( $N = A \cdot L(w)$ ,  $L' < 0$ ).

The intuition underlying Proposition 1 is quite straightforward. Suppose that there is an outward shift in the product demand function (1), as illustrated in Figure 2, but that the firm's individual price elasticity of product demand,  $\eta_f = (\eta \cdot F)/c = 1/m$ , remains unchanged. As result, the marginal revenue curve,  $MR = P \cdot [1 - (1/\eta_f)]$ , shifts out from  $MR$  to  $MR'$ . In the absence of a change in the marginal cost curve ( $MC = W/h_n$ ), the firm's output would rise from  $q^*$  to  $q'$  in the figure, corresponding to the intersection of the new marginal revenue curve ( $MR'$ ) with the old marginal cost curve ( $MC$ ). But then, of course, the real wage moves countercyclically, since the price  $P$  rises while the nominal wage  $W$  remains constant. But since we are concerned with how an outward shift in the product demand curve affects the firm's level of production and employment *at any given real wage*, we must ask what happens to  $q$  when the nominal wage  $W$  rises proportionately with the price  $P$ , shifting the marginal cost curve upwards. What the labour demand curve (5) implies is that if the elasticity  $\eta_f = 1/m$  is constant, then the marginal revenue curve ( $MR = P \cdot [1 - (1/\eta_f)]$ ) must rise by the same amount as the marginal cost curve ( $MC = W/h_n$ ), and thus production remains unchanged at  $q^*$ . Given the production function, employment also remains unchanged, so that there is no shift in the labour demand curve.

### 3. Channels of Transmission under Excess Capital Capacity

We now give this standard model a new twist by incorporating the possibility of excess capital capacity. This permits us to show why the labour demand curve may be flat or even upward-sloping even in the presence of diminishing returns to labour, and thus why changes in product demand that shift the wage setting curve can influence employment without pushing the real wage in the opposite direction.

We rationalize the existence of excess capacity by that firms make capital capacity and technological decisions prior to gaining full information about their product demands. Thus when demand is low and the resulting real wage is high, a firm may find itself with more capital than it is willing to use. Specifically, let the firm's decision making proceed in two stages. In the first stage, the firm makes its capital capacity and technological decisions, knowing the density,  $g(A)$ , of the demand parameter  $A$ . In the second stage, the realized value of  $A$  is revealed and the firm makes its employment, production, and pricing decisions, taking the parameter  $A$ , the capital capacity and technological decisions as given.

The firm's first-stage capital capacity decision involves choosing its capital stock ( $k=k^*$ ) so as to maximize its expected profit. Its technological decision involves choosing a limited range of technologies from the full range available in the first stage of decision making. In particular, given the first-stage production opportunities

$$q \leq h(n, k), \quad h_n, h_k > 0; h_{nn}, h_{kk} < 0 \quad (3')$$

then the technological decision is specified as the choice of a capital-labour ratio  $v^*$  such that, in the second stage, the firm's feasible range of capital-labour ratios becomes

$$[\underline{v}, \bar{v}] = [v^* - \beta, v^* + \beta] \quad (6)$$

where  $\beta$  is a nonnegative constant. (When  $\beta=0$ , the technology reduces to putty-clay.)

Figure 3a illustrates this technological decision for the case in which the first-stage production opportunities are bounded by a Cobb-Douglas production function so that the curve labeled  $q = h(n, k^*) = n^\alpha \cdot (k^*)^{1-\alpha}$  in the figure stands for the firm's ex ante production function, given the capital capacity decision  $k = k^*$ . For the upper and lower bounds on the capital-labour ratio ( $\underline{v}$  and  $\bar{v}$ ), the area  $OABC\bar{n}$  in the figure describes the firm's second-stage production opportunities.

In the second stage,<sup>12</sup> the firm sets its employment ( $n$ ), production ( $q$ ), and pricing ( $P$ ) decisions so as to maximize its expected profit  $z = P \cdot q - W \cdot n - R \cdot k^*$ , subject to the product demand function (1), the conjecture function (2), and the production function (3'), its first-stage capacity decision ( $k = k^*$ ), and the constraint that  $(k^*/\bar{v}) \leq n \leq (k^*/\underline{v})$ , the nominal wage ( $W$ ), and the nominal user cost of capital ( $R$ ).

<sup>12</sup>To analyze the labor demand curve under excess capital capacity, it is not necessary to specify the solution to the first-stage problem, which is omitted here for brevity.

Now define  $\underline{n} \equiv (k^*/\bar{v})$  and  $\bar{n} \equiv (k^*/\underline{v})$  as the minimum and maximum levels of employment, respectively, compatible with full utilization of the capital stock  $k = k^*$ . Similarly, define  $\bar{w} = h_n(\underline{n}, k^*)$  and  $\underline{w} = h_n(\bar{n}, k^*)$  as the corresponding maximum and minimum levels of the real wage. Now suppose that the demand parameter  $A$  turns out to be sufficiently low so that, at the given nominal wage, the profit-maximizing price is such that  $w > \bar{w}$  (i.e. the real wage is "high"). Then, even if the firm were to set the minimum level ( $\underline{n}$ ) of employment compatible with full utilization of the capital stock, the profit generated by a marginal employee would still be negative ( $(\partial z/\partial n) < 0$ ). Thus it employs less than  $\underline{n}$  and hold excess capital capacity, so that the binding portion of its second-stage production function is  $q = h(n, \bar{v} \cdot n)$ . The associated first-order condition for profit maximization is

$$\frac{dz}{dn} = P \cdot (1-m) \cdot [h_n + \bar{v} \cdot h_{kn}] - W = 0 \quad (7)$$

evaluated at  $h_n = h_n(n, \bar{v} \cdot n)$ ,  $h_k = h_k(n, \bar{v} \cdot n)$ , and  $P = \pi \cdot \psi\{F \cdot h(n, \bar{v} \cdot n), \frac{X}{\pi}, A\}$ , where  $\psi$  is the inverse of the product demand function (1). In other words, employment set so that the marginal value product of labour (under excess capital capacity) is equal to the nominal wage ( $W$ ).

When the demand parameter is such that  $\underline{w} \leq w \leq \bar{w}$  (the real wage is in the "intermediate" range), the firm utilizes its capital stock fully and sets employment so that the marginal employee generates zero profit ( $(\partial z/\partial n) = 0$ ). Thus the binding portion of its second-stage production function is  $q = h(n, k^*)$  and its first-order condition reduces to (4), evaluated at  $P = \pi \cdot \psi\{F \cdot h(n, k^*), \frac{X}{\pi}, A\}$  and  $h_n = h_n(n, k^*)$ .

Finally, when the demand parameter is such that  $w < \underline{w}$  (the real wage is "low"), then even if the firm were to set the maximum level ( $\bar{n}$ ) of employment compatible with full utilization of the capital stock, the profit generated by a marginal employee would still be positive ( $(\partial z/\partial n) > 0$ ). Then the firm faces "over-full capacity", the binding portion of its second-stage production function is  $q = h(\bar{n}, \underline{v} \cdot \bar{n})$ , and its employment is simply  $n = \bar{n}$ .

The value added of this extension of our model lies in the possibility of excess capital capacity. The slope of the labour demand curve under excess capacity is

$$(dw/dN)|_{(w > \bar{w})} = F \cdot (1-m) \cdot [h_{nn} + \bar{v} \cdot h_{kn}] \quad (8)$$

which, under imperfect competition, could be downward-sloping, flat, or even upward-sloping.<sup>13</sup>

<sup>13</sup>The second-order conditions for profit maximization is  $(d^2z/dn^2) = (1-m) \cdot [(dP/dn) \cdot (h_{nn} + \bar{v} \cdot h_{kn}) + P \cdot (h_{nn} + \bar{v} \cdot h_{kn})] < 0$ . Under perfect competition,  $(dP/dn) = 0$ , so that this condition reduces to  $(h_{nn} + \bar{v} \cdot h_{kn}) < 0$ . By (8), the labor demand curve must be downward-

Under excess capacity, an increase in employment is accompanied by an increase in capital utilization, and thus the slope of the labour demand curve depends not only on the response of the marginal product of labour to a rise in employment (as under full capacity), but also on the response of the marginal product of capital. Under diminishing returns to labour, the former response is negative; but when labour and capital are Edgeworth complements ( $h_{kn} > 0$ ), the latter response is positive. In practice, the excess capital that is brought back into use at the end of a recession - when workers are recalled to man vacant machines and to bring existing assembly lines back in operation - tends to be highly complementary with labour. Then the latter response ( $v \cdot h_{kn}$ ) may well be as large as, or even dominate, the former ( $h_{nn}$ ), so that the labour demand curve be flat or even slope upwards.<sup>14</sup>

Moreover, the excess capital capacity decision (7) yields a new channel of transmission, namely, an increase in product demand shifts the labour demand curve outwards if it raises the marginal product of capital ( $h_k$ ).

In sum,

*Proposition 2: For the model of excess capital capacity underlying (7),*  
*(a) when the degree of Edgeworth complementarity between labour and capital is sufficiently large,  $h_{kn} \geq -h_{nn}/\bar{v}$ , the labour demand curve is not downward-sloping, even in the presence of diminishing returns to labour;*  
*(b) an increase in product demand shifts the aggregate labour demand curve outwards only if channels [i]-[iv] in Proposition 1 are operative or if the marginal product of labour ( $h_k$ ) increases.*

*Under conditions (a) or (b), an increase in product demand can raise employment without necessarily implying a counter-cyclical real wage movement.*

#### 4. Long-Run Channels of Transmission

We now turn to the "long run", in which capital capacity is assumed flexible. For simplicity, consider the standard problem in which the firm maximizes the present value

of its profits,  $PV = \sum_t \delta^t \cdot [P_t \cdot q_t - W_t \cdot n_t - R_t \cdot k_t]$ , subject to the product demand function

(1),<sup>15</sup> the conjecture function (2), and the production function (3'). The first-order conditions are

sloping. Thus a flat or upward-sloping labour demand curve under excess capital capacity is possible only when competition is imperfect.

<sup>14</sup>The existence of an upward-sloping labor demand curve certainly does not imply that wage moderation in collective bargaining no longer has a role to play in stimulating employment. Firstly, an upward movement along such a labor demand curve can only be achieved by a reduction in the nominal wage, which leads to an even larger reduction in the price level. Secondly, as shown in Figure 1b, a rise in employment requires a fall in the wage setting curve, i.e. a reduction in the equilibrium real wage at any given level of employment.

<sup>15</sup>We assume full information, taking the product demand parameter  $A$  as a known constant.

$$(1-m) \cdot h_n(n_t, k_t) = w_t \quad (9a)$$

$$(1-m) \cdot h_k(n_t, k_t) = r_t \quad (9b)$$

for each period  $t$ , where  $r_t = (R_t/P_t)$  is the real user cost of capital. Letting  $N_t = F \cdot n_t$  be aggregate labour demand and  $K_t = F \cdot k_t$  be aggregate capital demand, and totally differentiating (9a) and (9b), we obtain

$$h_{nn} \cdot dN + h_{nk} \cdot dK = (F/(1-m)) \cdot dw_t \quad (10a)$$

$$h_{nk} \cdot dN + h_{kk} \cdot dK = (F/(1-m)) \cdot dr_t \quad (10b)$$

Holding the real user cost of capital constant, the slope of the aggregate labour demand curve is

$$(dw_t/dN_t) = F \cdot (1-m) \cdot [h_{nn} - (h_{nk}^2/h_{kk})] \quad (11)$$

where  $[h_{nn} - (h_{nk}^2/h_{kk})] < 0$  by the second-order conditions for optimality, so that the slope of the unconditional aggregate labour demand curve is negative. Then, in the absence of the four transmission channels of Proposition 1 and in the absence of an effect of product demand on the real user cost of capital, a change in product demand cannot affect employment without generating counter-cyclical real wage movements.

Note that the magnitude of these counter-cyclical real wage movements depends on the degree of factor independence, measured by  $h_{nk}^2$ . Equation (11) indicates that the labour demand curve is flatter, the greater is this degree of factor interdependence, *regardless of whether the factors are complements or substitutes*. The intuitive rational of this perhaps surprising result is straightforward. When  $n_t$  and  $k_t$  are Edgeworth complements ( $h_{nk} > 0$ ), a rise in labour demand is associated with a *rise* in the demand for capital ( $(\partial k_t/\partial n_t) = (h_{nk}/h_{nn}) > 0$ ) which, in turn, *raises* the marginal product of labour (since  $h_{nk} > 0$ ). Thus, the greater the degree of complementarity, the flatter the slope of the labour demand relation. On the other hand, when  $n_t$  and  $k_t$  are Edgeworth substitutes ( $h_{nk} < 0$ ), a rise in labour demand is associated with a *fall* in the demand for capital ( $(\partial k_t/\partial n_t) = -(h_{nk}/h_{nn}) < 0$ ) which, in turn, *raises* the marginal product of labour (since  $h_{nk} < 0$ ). Thus, the greater the degree of substitutability, the flatter the slope of the labour demand relation.

All this assumes, of course, that the real user cost of capital is constant. However, changes in product demand may affect the real user cost of capital via the real interest rate. The effect of an increase in the real user cost of capital on labour demand, for any given real wage ( $w_t$ ), is

$$\frac{dN_t}{dr_t} = - \frac{h_{nk}}{[h_{nn} \cdot h_{kk} - (h_{nk})^2] \cdot (1-m)} \quad (12)$$

by (10a) and (10b). When the second-order conditions for profit maximization are

satisfied (so that  $[h_{nn} \cdot h_{kk} - (h_{nk})^2] > 0$ ), we find that  $\text{sgn}(dn/dr) = -\text{sgn}(h_{nk})$ . This means that, for the standard case in which labour and capital are Edgeworth complements ( $h_{nk} > 0$ ), an increase in product demand that raises (lowers) the user cost of capital will shift the labour demand curve *inwards* (*outwards*).<sup>16</sup> An unconventional implication of this result is that, insofar as the interest rate is an empirically significant channel of transmission, monetary and fiscal policies pull the labour demand curve in opposite directions. When expansionary monetary policy depresses the real interest rate, it shifts the labour demand curve outwards; whereas when expansionary fiscal policy raises the real interest rate, the labour demand curve shifts inwards.

In sum,

*Proposition 3a: (a) For the flexible capital capacity model underlying (10a) and (10b), an increase in product demand shifts the labour demand curve outwards only if (1) channels [i]-[iv] in Proposition 1 are operative, or (2) the user cost of capital falls while labour and capital are Edgeworth complements, or (3) the user cost of capital rises while labour and capital are Edgeworth substitutes. Then an increase in product demand can raise employment without necessarily generating a counter-cyclical real wage movement.*

*(b) The greater is the degree of factor interdependence, the flatter is the labour demand curve. Hence, in the absence of the above transmission channels, the less pronounced will be the long-run counter-cyclical real wage variations associated with a given variation in employment.*

## 5. An Overview of Transmission Channels

The analysis above provides a unified framework for identifying a broad spectrum of possible channels whereby product demand changes can affect employment without assuming wage-price stickiness or necessarily implying counter-cyclical real wage responses. To give choice theoretic rationales for each of these channels would lie beyond the scope of this paper; in any case, many of these channels have already been rationalized elsewhere, albeit in a fragmented way. What remains to be done here is to provide a very selective overview and evaluation of the various channels, drawing on the existing literature.

*Transmission via the Price Elasticity of Product Demand ( $\eta$ ):* Various authors (surveyed by Dixon and Rankin (1993)) have shown that when public- and private-sector expenditures have different price elasticities, the aggregate elasticity will move in response to changes in the composition of demand. However, this is unlikely to be a reliable channel for the transmission of product demand variations to the labour market since the relative magnitudes of the public and private-sector price elasticities vary across sectors and through time. Furthermore, if the private-sector elasticity is plausibly

<sup>16</sup>Greenwald and Stiglitz (1988) argue that a rise in product demand may be able to shift the labour demand curve outwards by reducing the risk premium on investment. Yet it is far from clear that this effect invariably dominates the interest rate effect.



assumed to exceed the public-sector one, an exogenous increase in government spending shifts the labour demand curve *inwards*. Finally, government spending increases and tax reductions that raise private consumption would, through this channel, pull the labour demand curve in opposite directions! Changes in the composition of domestic versus foreign expenditures produce no plausible transmission channel either: indeed, for the plausible case when the foreign price elasticity exceeds the domestic one, an increase in domestic demand reduces the aggregate elasticity and thereby shifts the labour demand curve *inwards*.

*Transmission via Imperfectly Competitive Interactions (v)*: Pigou (1927), Kalecki (1938), and Keynes (1939) asserted that firms' market power may vary counter-cyclically, but provided no choice-theoretic rationale. More recently Rotemberg and Saloner (1986) have constructed a model in which implicitly colluding oligopolists behave more competitively as product demand rises. The effectiveness of this transmission mechanism depends on special circumstances and thus seems to be a weak reed on which to hang a theory of how product demand affects employment.

*Transmission via Changes in the number of firms (F)*: Pagano (1990), Snower (1983), and others have developed models in which an increase in product demand induces entry of new firms, which increases the degree of competition in the product market and thereby shifts the labour demand curve outwards. On a different tack, Lindbeck and Snower (1989) argue that, if nominal wages are sluggish relative to prices in the short run, then a rise in product demand (associated with a rise in the product price) will lead to a temporary fall in the real wage and a rise in profits, thereby encouraging the entry of firms. In the longer run, wages and profits fall to their original level and the entry of firms ceases. The recently entered firms, however, remain operative, and the long-run increase in the number of firms shifts the aggregate labour demand curve outwards.

*Transmission via Changes in the Marginal Product of Labour and Capital ( $h_n$  and  $h_k$ )*: Clearly, if an exogenous increase in government spending takes the form of industrial infrastructure investment the marginal product of labour may rise, thereby shifting the labour demand curve outwards. Over a shorter time span, our analysis of Section 3 has shown that the existence of excess capital capacity may make the labour demand curve flat or upward-sloping and thus product demand variations that shift the wage setting curve may affect employment without counter-cyclical real wage movements.

*Transmission via the real user cost of capital (r)*: For the common case where labour and capital are complements, our analysis of Section 4 indicates that an increase in product demand which raises (lowers) the real interest rate will shift the labour demand curve inwards (outwards).

To sum up, the transmission channels operating via the price elasticity of product demand, the imperfectly competitive interactions among firms, and the user cost of capital do not appear to represent consistently reliable ways in which product demand variations get transmitted to the labour market. That leaves us with three potentially significant channels: in the short run, the existence of excess capital capacity may make it possible for a rise in product demand to stimulate employment without reducing the real wage; in the medium run, transmission via changes in the number of firms may have an important role to play; and in the long run, transmission via the supply-side effects of infrastructure investment may be significant as well.

The policy implications of this evaluation are clear-cut and potentially important: Supply-side policies (such as the removal of barriers to the entry and exit of firms) which open a limited number of transmission channels may be expected to strengthen the longer-term impact of the demand-side policies on employment. Furthermore, government spending in the form of infrastructure investment may have a bigger impact on employment than tax reductions or increased transfer payments.

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## APPENDIX A

This appendix extends Proposition 1 to the case of differentiated products, firms of different sizes, and stochastic product demand, and inventories held for production- smoothing reasons. For brevity, we restrict our attention to part 1 of the proposition in the context of full capacity utilization; once that is done, the relevant extension to excess capacity and to part 2 will be obvious.

*A(i) Differentiated Products*

Suppose that the  $F$  firms in a sector produce differentiated products, whose price elasticities of demand are given by  $\eta_i$ ,  $i = 1, \dots, F$ . Then the labor demand curve for the  $i$ 'th firm is given by

$$(A1) \quad n_i = L \left( \frac{W}{P_i} \cdot \frac{\eta_i}{\eta_i - 1} \right),$$

(replacing the second equation of (12a)) where  $\eta_i$  depends on the number of firms in the sector as well as their imperfectly competitive interactions.

Again, the relation between a firm's labor demand and its real wage does not depend on the position of its product demand function, except indirectly via the variables  $\eta$ ,  $v$ ,  $F$ , and  $h_n$ .

*A(ii) Firms of Different Sizes*

Suppose that  $\sigma_i = (q_i/Q)$  is the market share of firm  $i$ . Then it may be shown that the firm's labor demand curve is given by

$$(A2) \quad n = L \left[ \frac{W}{1 - m_i} \right],$$

where  $m_i = (v \cdot \sigma_i) \eta$ .

Equation (A2) implies that the positive and negative results of the Transmission Proposition continue to hold, except that the position of the firm's labor demand curve depends on its market share rather than simply on the number of firms in the sector.

*A(iii) Stochastic Product Demand*

Let  $p$  be the expected price level and the aggregate expected product demand function be given by

$$(A3) \quad p = \Pi \cdot \Psi\left(Q, \frac{X}{\Pi}, A\right) + u,$$

(replacing equation 1') where  $\Pi$ ,  $X$ , and  $u$  may be random variables. Let the firm's decision making problem be the maximization of its expected profit ( $z = P \cdot q - W \cdot n$ ) subject to the production function (3c), the imperfectly competitive interactions (2), and the expected product demand function (A3). The first-order condition yields the following labor demand curve:

$$(A4) \quad n = L \left[ \frac{w}{1 - \tilde{m}} \right]$$

where 
$$\tilde{m} = \frac{v}{F \cdot (\partial p / \partial Q) / (Q/p)}$$

From equation (A4) it is obvious that Proposition 1.1 applies, with the market power parameter now depending on the price elasticity of the expected aggregate product demand function.

*A(iv) Inventories*

Suppose that firms sell durable goods and hold them for production-smoothing reasons. For simplicity of exposition, assume that the firm has a two-period time horizon. Let  $d_t$  be its sales,  $q_t$  its production,  $x_t$  its inventory stocks,  $\delta$  its discount factor, and  $\beta$  its inventory depreciation rate. Then its decision making problem may be expressed as the maximization of the present value of its profit

$\left( \sum_{t=1}^2 \delta^t \cdot [P_t \cdot d_t - W_t \cdot n_t] \right)$  subject to its production function (3c), the imperfectly competitive interactions (2), the product demand function ( $d_t = d[(P/\Pi), (X/\Pi), A]$ ), and the constraint that its current sales plus current inventory stock are equal to its current production plus the inventory stock carried over from the previous period ( $d_t + x_t = q_t + (1-\beta) \cdot x_{t-1}$ ). Due to the two-period time horizon, the optimal inventory stock in the second period is  $x_2^* = 0$ . Thus the first-order

conditions for an interior solution are

$$(A5a) \quad (1-m) \cdot h_n(n_t) = W_t/P_t$$

$$(A5b) \quad P_1 - (1-\beta) \cdot \delta \cdot P_2 = 0.$$

By condition (A5a) it is clear that Proposition 1.1 remains intact.

## APPENDIX B

In this appendix we extend Proposition 1 to two types of models in which wage and employment decisions are made simultaneously: one in which the firm makes these decisions unilaterally, and the other in which these decisions are the outcome of an efficient bargain between the firm and its employees. As in Appendix A, we restrict ourselves to part 1 of the proposition under full capacity; the corresponding extension to excess capacity and to part 2 is self-evident.

First consider the case in which the nominal wage, price, and employment decisions are all made simultaneously by the firm. As above, we assume that the firm has perfect information about its production opportunities and the aggregate demand for its product. Let the labor supply function facing the firm be

$$(B1) \quad n^s = n^s(W/\Pi), \quad n^s, > 0.$$

Let  $\xi = (n^s)^{-1}$ . Then the firm's profit may be written as

$$(B2) \quad z = P \cdot q - W \cdot n = \Pi \cdot \Psi \cdot h(n) - \Pi \cdot \xi(n) \cdot n,$$

where  $P = \Pi \cdot \Psi$  (by equation 1'). Then the first-order condition for an interior optimum ( $dz/dn = 0$ ) is

$$(B3) \quad (1 - m) \cdot h_n = w \cdot (1/\varepsilon),$$

where  $\varepsilon = [dn^s/d(W/\Pi)] \cdot [(W/\Pi)/n^s]$  is the elasticity of the labor supply function.

From condition (B3) it is clear that the position of the aggregate labor demand curve depends not only on the variables given in the Transmission Proposition (namely,  $\eta$ ,  $v$ ,  $F$ , and  $h_n$ ), but also on the elasticity  $\varepsilon$  of labor supply. Yet changes in product demand are unlikely to have a systematic effect on the elasticity  $\varepsilon$ , and thus this is probably not an important systematic channel of transmission. As in Proposition 1.1, the position of the labor demand curve does not depend on the level of product demand at any given price, in the absence of induced changes in the parameters above.

A similar result holds when the firm has imperfect information about productivity, and sets the nominal wage, product price, and employment, in an efficiency-wage context. In particular, suppose that the firm is unable to monitor perfectly the productivity of individual employees, but can infer that the average productivity ( $e$ ) of its

workforce. In line with most variants of the efficiency wage theory, let this average productivity depend positively on the real wage and on aggregate employment:<sup>1</sup>

$$(B4) \quad c = c[(W/\Pi), N], \quad c_1 > 0, c_2 < 0.$$

Furthermore, let the firm's production function be given by

$$(B5) \quad q = h(e \cdot n), \quad h' > 0, h'' < 0.$$

Then its profit is

$$(B6) \quad z = P \cdot q - W \cdot n = \Pi \cdot \Psi \cdot h(e \cdot n) - W \cdot n,$$

which it maximizes with respect to  $W$  and  $n$ . The first-order conditions are

$$(B7a) \quad (1-m) \cdot h_n \cdot c[(W/\Pi), N] = w$$

$$(B7b) \quad \Pi \cdot \Psi \cdot h_n \cdot c_W \cdot (1-m) = 1.$$

The first of these yields the labor demand curve, whose position does not depend directly on the shift parameters ( $(X/\Pi)$  and  $A$ ) of the product demand function, but rather on the variables identified in Proposition 1.1 under full capacity ( $\eta$ ,  $v$ ,  $F$ , and  $h_n$ ) as well as the productivity function (B4). The efficiency wage literature, however, does not suggest that changes in product demand have a systematic influence on the functional form of this productivity function.

Finally, suppose that the real wage and employment are the outcome of an efficient bargain between the firm and its employees. Specifically, let the employees be represented by a union, whose bargaining objective is  $[U(w, n) - U^0]$ , where  $U_w$ ,  $U_n > 0$  and  $U^0$  (the threat-point utility) is a constant. Let the firm's bargaining objective be  $[z - z^0] = [h(n) - w \cdot n - z^0]$ , where  $z^0$  (the threat-point profit) is a constant.

When the bargain is efficient, then an interior solution implies

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<sup>1</sup>In many versions of the efficiency wage theory, average productivity also depends inversely on the real wage offered by firms' competitors. But if this latter real wage is fixed (as in partial equilibrium efficiency wage models) or equal to the firm's real wage (as in symmetric general equilibrium models), the inclusion of this new variable leaves our qualitative conclusions unchanged.



that the slope of the union's indifference curve is equal to the slope of the firm's iso-profit locus (in  $w$ - $n$  space):

$$(B8a) \quad - \frac{U_n}{U_w} = \frac{h_n - w}{n}.$$

This describes the "efficiency locus".

The division of the available economic rent between the firm and the union is given by the "equity locus", which may be expressed quite generally as

$$(B8b) \quad \frac{z - z^0}{U - U^0} = \alpha(w, n, m, N).$$

(In a Nash bargain  $\alpha$  is a constant,  $0 \leq \alpha \leq 1$ .)

The outcome of the bargain may be depicted as the intersection of the efficiency locus and the equity locus in  $w$ - $n$  space. It is clear that the negative result of the Transmission Proposition holds in this context as well. The positive result also holds, but in addition to the variables  $\eta$ ,  $v$ ,  $F$ , and  $h_n$ , the position of the labor demand curve also depends on union's marginal rate of substitution ( $U_n/U_w$ ) - which, however, is not likely to be an important, systematic channel for the transmission of product demand changes to the labor market.

In sum, the positive and negative conclusions of the Transmission Proposition continue to apply when wage and employment decisions are made simultaneously, along the lines outlined above. As noted, wage-employment setting through firms or through efficient bargains also suggest some additional channels of transmission from the product to the labor market, but these are unlikely to be systematically significant in practice. As when employment decisions are made under predetermined wages, these conclusions also apply in the case of differentiated products, firms of different sizes, stochastic product demand, and inventories held for production-smoothing. This can be shown along the same lines as in the analysis of Appendix A but, for brevity, we do not do so here.

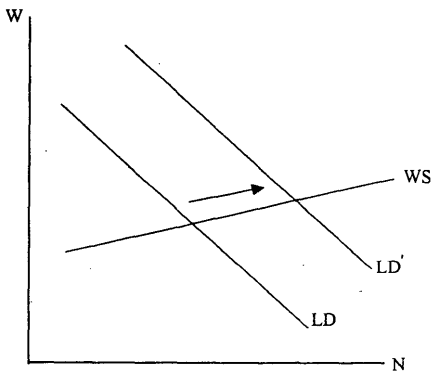


FIGURE 1a

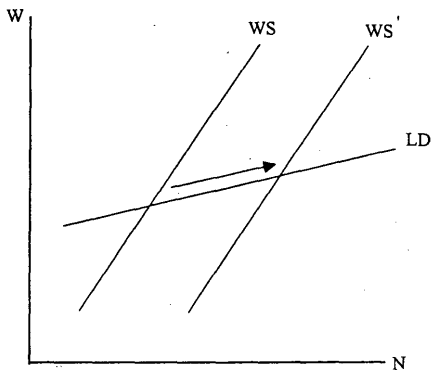


FIGURE 1b

FIGURES 1: The effect of Product Demand on Employment in the Absence of Counter-cyclical Real Wages

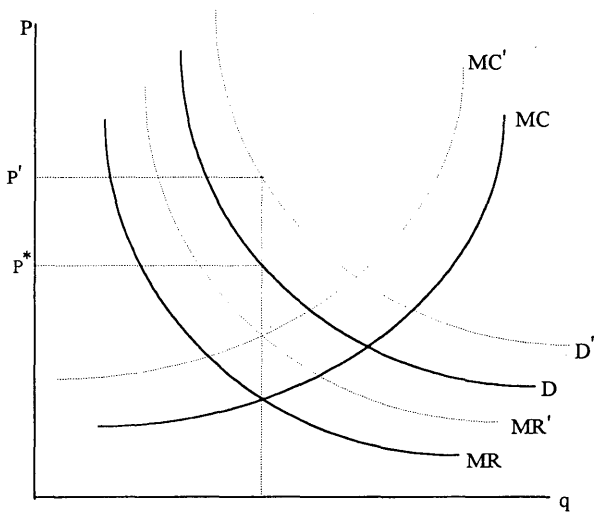


FIGURE 2: Transmission under Imperfect Competition

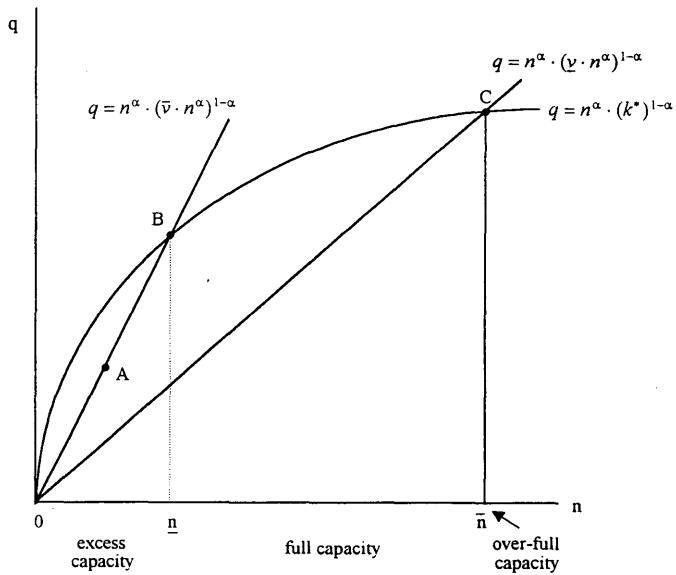


FIGURE 3: The Firm's Technological Decision