



## Inflexible Prices and Procyclical Productivity

Julio J. Rotemberg; Lawrence H. Summers

*The Quarterly Journal of Economics*, Vol. 105, No. 4. (Nov., 1990), pp. 851-874.

Stable URL:

<http://links.jstor.org/sici?sici=0033-5533%28199011%29105%3A4%3C851%3AIPAPP%3E2.0.CO%3B2-0>

*The Quarterly Journal of Economics* is currently published by The MIT Press.

---

Your use of the JSTOR archive indicates your acceptance of JSTOR's Terms and Conditions of Use, available at <http://www.jstor.org/about/terms.html>. JSTOR's Terms and Conditions of Use provides, in part, that unless you have obtained prior permission, you may not download an entire issue of a journal or multiple copies of articles, and you may use content in the JSTOR archive only for your personal, non-commercial use.

Please contact the publisher regarding any further use of this work. Publisher contact information may be obtained at <http://www.jstor.org/journals/mitpress.html>.

Each copy of any part of a JSTOR transmission must contain the same copyright notice that appears on the screen or printed page of such transmission.

---

The JSTOR Archive is a trusted digital repository providing for long-term preservation and access to leading academic journals and scholarly literature from around the world. The Archive is supported by libraries, scholarly societies, publishers, and foundations. It is an initiative of JSTOR, a not-for-profit organization with a mission to help the scholarly community take advantage of advances in technology. For more information regarding JSTOR, please contact [support@jstor.org](mailto:support@jstor.org).

# INFLEXIBLE PRICES AND PROCYCLICAL PRODUCTIVITY\*

JULIO J. ROTEMBERG AND LAWRENCE H. SUMMERS

Hall has shown that, with perfect competition and price flexibility, total factor productivity measured using labor's share either in revenues or in costs will be acyclical regardless of the level of labor hoarding. We show that if firms producing a homogeneous good under constant returns must pick their prices before demand is known, both measures of productivity become procyclical. The model implies that productivity should be more procyclical the more important is labor hoarding. Empirically, productivity is more procyclical in industries and in nations where labor hoarding appears more important.

## I. INTRODUCTION

Productivity, no matter how it is measured, is procyclical.<sup>1</sup> Leaving aside trend growth, output rises by about 1.25 percent when man-hours employed rise by 1 percent. This relationship is robust—holding even in cases like wars where increases in employment are the result of changes in the demand for output. The apparent contradiction with the basic principle of diminishing returns has long troubled economists.

Output per man-hour is a very crude indicator of productivity. For the purpose of measuring changes in the economy's technology, a somewhat more sophisticated method is appropriate.<sup>2</sup> Under constant returns and ignoring changes in capital, "total factor productivity" goes up when the rate of growth of output exceeds the product of the rate of growth in employment and the labor share. The share of labor income in total industry revenues is fairly stable and, in the United States, equals roughly 0.75. Because economic profits (profits in excess of the cost of capital) are trivial, the share of labor income to total costs is almost the same. Since 1.25 (the

\*This is a revised version of our 1988 paper entitled "Labor Hoarding, Inflexible Prices and Procyclical Productivity." We wish to thank Olivier Blanchard, Mark Bils, Tim Bresnahan, Dennis Carlton, Bob Hall, Garth Saloner, and Louise Sheiner for helpful discussions and John Little for leading us to *Progressive Grocer*. Louise Sheiner also provided able research assistance. Michael Woodford greatly clarified our thinking by suggesting Figure I. Bob Gordon generously shared his data on man-hours and output with us. We also acknowledge the financial support of the NSF and the Sloan Foundation.

1. See Solow [1964] and Hall [1987, 1988]. After we completed our analysis, we became aware that Eden [forthcoming] takes a similar approach to the analysis of productivity fluctuations. His analysis differs somewhat from ours, as we explain in the text.

2. See Solow [1957].

elasticity of output with respect to demand-induced changes in employment) exceeds 0.75, increases in demand that raise employment by 1 percent raise total factor productivity whether it is measured using labor's cost or revenue share.

Hall [1987, 1988] offers challenging interpretations of these facts. Hall [1988] argues that increases in total factor productivity following demand increases are probably due to the existence of a wedge between price and marginal cost. Denoting output by  $Q$ , the labor input by  $N$ , the initial wage by  $W$ , and the initial price by  $P$ , total factor productivity rises from one period to the next if  $\Delta Q/Q$  exceeds  $[WN/PQ]\Delta N/N$ . Therefore, it rises if  $P\Delta Q$  exceeds  $W\Delta N$ . This requires that the value of the increased output evaluated at the initial period's prices exceeds the value (at initial wages) of the increased labor. In other words, productivity rises if an increase in output at the initial prices would have been profitable. This is tantamount to having price exceed marginal cost.

By measuring the extent of procyclical productivity, Hall [1988] finds that price equals more than twice marginal cost in over half of U.S. two-digit manufacturing industries. He regards the "most obvious explanation" to be "monopoly power in product markets." The absence of economic profits then implies that average cost is over twice marginal cost in many industries [Hall, 1987]. Either there must exist long-run increasing returns to scale, or firms must be wasting resources in unnecessary investments. As he puts it: "The data strongly refute the combination of two hypotheses: Constant returns to scale and a capital stock that maximizes expected profit."

In traditional discussions of productivity fluctuations monopoly power and increasing returns play a much smaller role. Cyclical changes in productivity are attributed principally to labor hoarding, i.e., to the quasi fixity of the labor input.<sup>3</sup> Productivity falls in recessions because firms retain their workers. This can explain why, as the economy enters a recession, the percentage fall in output exceeds the percentage fall in labor input. However, Hall demonstrates that this is, at best, an incomplete explanation for the procyclicality of total factor productivity. Firms whose workers are not fully utilized have very low marginal costs, so under standard assumptions, their prices should be low. As a result of these low prices, the reduction in the value of output equals the reduction in

3. See Oi [1962] for the view that there are constant returns in the long run and labor fixity in the short run. See also Solow [1964] and Fair [1969].

cost, and both the cost and revenue-based measurements of total factor productivity should be acyclical.

In this paper we show that, with rigid prices at cyclical frequencies or even at much higher frequencies within periods of weak and strong demand, labor hoarding also leads total factor productivity measures to behave procyclically. The reason is that firms which must set prices before demand is known cannot afford to charge as low a price as is required for the reduction in the value of output to equal the reduction in cost. They must charge instead a price that covers average costs. As a result, those firms whose labor is mostly quasi-fixed will charge a price further in excess of marginal cost than will those whose labor is largely variable. Therefore, firms (or industries) that hoard more labor also have more procyclical total factor productivity.

Labor hoarding thus plays a double role in our model; it explains why total hours worked fall less than output in recessions and also the extent to which total factor productivity falls. In contrast, Hall [1987, 1988] treats labor hoarding, which can be present as well, is less important; even the fact that the labor input falls less than output in recessions is attributed in part to long-run increasing returns to scale.

While these distinctions are important, it is worth stressing that both theories imply that changes in demand affect total factor productivity. They both therefore cast doubt on Kydland and Prescott's [1982] method for computing the fraction of economic fluctuations due to changes in technology. That methodology treats all fluctuations in total factor productivity as being the result of changes in technology.<sup>4</sup>

Our paper is organized as follows: the next section shows informally how price-rigidity can give rise to prices that on average exceed marginal cost—thus leading to procyclical total factor productivity. We also discuss the role of labor hoarding. By labor hoarding, we mean that certain workers who are hired *ex ante* cannot be dismissed when demand drops. We have in mind situations where these workers have no alternative occupation within the firm and where their disutility from being at the firm does not depend on the amount they actually work. When output is

4. This point is also emphasized by Lucas [1989] whose dynamic general equilibrium model allows him to analyze the effects of changes in the money supply in a setup that, like ours, is based on Prescott [1975].

low, firms that hoard large quantities of labor thus have lower marginal costs than those that do not. With rigid prices, the wedge between price and marginal cost is larger, and productivity is more procyclical.

Section III presents a formal model based on Prescott [1975]. The model features atomistic firms producing a homogeneous good and facing stochastic demand in each period. When these firms must pick prices before demand is known, productivity becomes procyclical. Periods with higher expected demand will have higher productivity even though this increased demand is fully foreseen at the time firms set their prices. This result holds as long as there are variations in demand within boom and bust periods caused by seasonal or other factors. Our results do not hinge on price rigidity at cyclical frequencies.

Section IV presents several fragments of evidence that seem consistent with our labor-hoarding-price-rigidity-theory of productivity fluctuations. In particular, productivity is more procyclical in those manufacturing industries where labor turns over less. It is also more procyclical in Japan where several institutions reduce the flexibility of the labor input. Section V concludes.

## II. AN INFORMAL MODEL

This section illustrates our points with a somewhat informal model. We show how price rigidity can explain why total factor productivity is procyclical. It can also explain why the extent of procyclical movements in total factor productivity depends on the extent of labor hoarding.

Consider an industry (or firm) whose marginal cost of producing output  $Q$ ,  $c'(Q)$  slopes as in Figure I. Let there be two levels of demand given by the inverse demand functions  $D_1(Q)$  and  $D_2(Q)$ . Suppose that only one price  $P^*$  can be charged in this industry. Under a variety of assumptions,  $P^*$  exceeds the price  $P_1$  that clears the market when demand is low. This will happen even if entry is relatively unrestricted since the industry does not recover its fixed costs if it charges  $P_1$ . Price rigidity generally implies that price exceeds marginal cost in the low states of demand.

Next, we must determine the quantity sold at  $P^*$  when demand is high. If  $P^*$  is very high, the quantity sold is simply the quantity demanded. But, if entry is relatively unrestricted, we expect the price  $P^*$  to be smaller than  $P_2$ —the price that clears the market when demand is high. We assume that, even then, firms sell only the

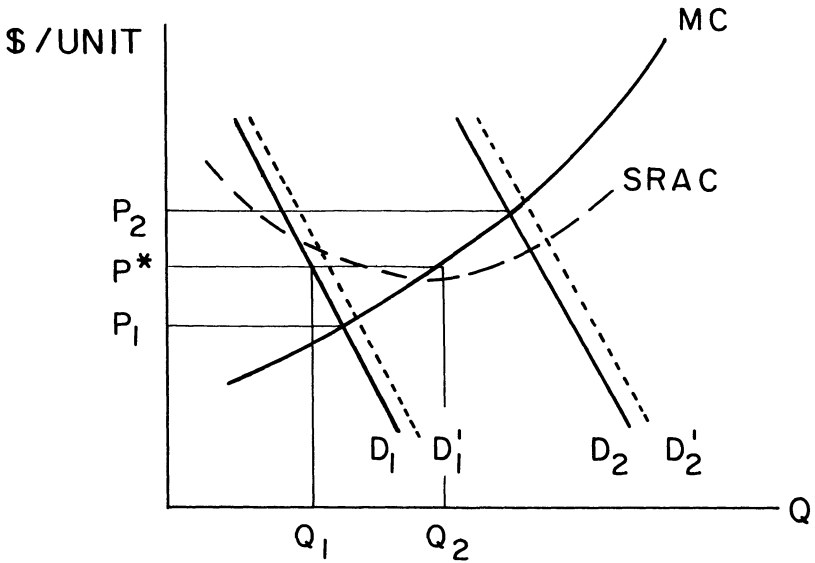


FIGURE I  
The Effect of Price Rigidity

quantity that maximizes profits. In other words, they sell no more than the quantity that equates marginal cost  $c'(Q)$  to the price  $P^*$ .

An alternative assumption would have firms sell the quantity demanded  $D_2^{-1}(P^*)$ . Hall [1988] shows that, under this alternative assumption, total factor productivity does not become procyclical as a result of price rigidity. This occurs because, under that assumption, marginal cost is larger than the price when demand is high. By contrast, under our profit-maximizing assumption, price either equals or exceeds marginal cost.

There are two ways of viewing the price rigidity we just described. An extreme Keynesian viewpoint would have  $D_1$  and  $D_2$  represent the demand in different phases of the business cycle, and prices would be constant over that cycle. It is apparent that, under this interpretation, total factor productivity rises as the economy goes from having the demand  $D_1$  and quantity  $Q_1$  to having the demand  $D_2$  and quantity  $Q_2$ . The reason is that price exceeds marginal cost at  $Q_1$ . Therefore, the value of the increased output  $P^*(Q_2 - Q_1)$  exceeds the cost of the increased inputs. Productivity and profits are higher in booms than in recessions.

There is substantial debate over the extent of price rigidity

over the business cycle. The evidence surveyed in Rotemberg [1987] suggests that some prices do indeed remain constant for several years, lending credence to the possibility that price rigidity accounts for the appearance of procyclical productivity. Discussions of the inflation process inevitably emphasize the role of shortages in precipitating inflation. Moreover, delivery lags, which can be viewed as a form of rationing in that customers are not getting the product they really want—namely instant delivery at the posted price—, lengthen during booms. This suggests that at least some rationing is observed at cyclical peaks. Okun [1981, p. 277] feels that actual shortages of this type matter: “In boom periods, many specific shortages last sufficiently long . . . that buyers make behavioral adjustments . . . (though) shortage phenomena are widespread only in periods . . . like 1966 and 1973.”

Whatever the empirical merits of this Keynesian price rigidity, much less is needed to induce procyclical total factor productivity. Suppose that  $D_1$  and  $D_2$  represent demand at different times of the day (or different stochastic states of demand). We refer to departures from flexible pricing that arise because firms must set their price before the state of demand is known, or are unable to continuously vary prices as “micro” price rigidity. Such “micro” rigidity implies that the same price  $P^*$  prevails whether demand is  $D_1$  or  $D_2$ . The rigidity of prices is weaker than the Keynesian variety because price responds to shifts in aggregate demand. Suppose that an increase in aggregate demand shifts the two demand curves to  $D'_1$  and  $D'_2$ . The question is whether this increase in aggregate demand accompanied by the optimal price readjustment raises average total factor productivity.

Insofar as  $P^*$  changes, sales in state 2 will change as well. Since price equals marginal cost in state 2, the increased revenues (evaluated at base period prices) equal the additional costs. Thus, changes in  $Q_2$  do not contribute to changes in total factor productivity. On the other hand, as long as  $P^*$  changes little,  $Q_1$  rises unambiguously. Since price in state 1 exceeds marginal cost, total factor productivity rises as a result of the increased sales in state 1.

The following is an intuitive interpretation of the result. Consider the 2 P.M. and the 6 P.M. New York-to-Boston flights, and suppose that the fare is the same for both. The 6 P.M. flight is generally full, while the 2 P.M. flight has empty seats. As demand increases for both the 2 P.M. flight and the 6 P.M. flight, the 2 P.M.

flight fills up with passengers. Since the 2 P.M. flight has a price in excess of marginal cost, total factor productivity rises.

One attractive feature of the story in Figure I is that the excess of price over marginal cost in states of excess capacity is consistent with free entry and constant returns; the industry need not be profitable. In Figure I we have drawn an industry U-shaped short-run average cost curve (SRAC) such that the industry suffers losses in state 1 which are roughly compensated by the profits in state 2.<sup>5</sup> This suggests that procyclical total factor productivity and the absence of extraordinary profits are perfectly consistent with long-run constant returns to scale.

We finally turn to the effect of labor hoarding. By labor hoarding we mean the unwillingness to fire workers when demand is  $D_1$  instead of  $D_2$ . We have in mind situations where the workers must continue to earn their original wages to remain with the firm even though they are less productive. Since these workers need not be paid more to become productive, marginal cost at  $Q_1$  is lower for a given marginal cost at  $Q_2$ . In Figure II we thus draw a dashed line to represent the marginal cost curve when there is extensive labor hoarding.

One way of thinking about this is to imagine that marginal cost at  $Q_2$  is the same with and without labor hoarding. In both cases new workers must be hired (or the existing workers must put in more effort which they dislike). Labor hoarding means that at  $Q_1$  there are workers around who must be paid (because they dislike being there) and who could be made productive at relatively small cost. In the absence of labor hoarding, workers must actually be brought in to increase production so that marginal cost is higher.

Once this interpretation of labor hoarding is accepted, it is apparent that it implies a bigger wedge between price and marginal cost in state 1. It therefore implies more pronounced procyclical movements in total factor productivity.

5. An individual firm would prefer to shift its short-run average cost curves to the left (by cutting capacity) if it remained able to sell the same amount in the low state of demand. Firms are indifferent with respect to such shifts if either of two conditions is met. First, sales in the low state might fall in the same proportion as capacity if customers in situations of low demand get allocated on the basis of capacity. Second, there might exist a (small) minimum efficient scale below which production is very costly. Then, firms operating this minimum efficient scale are indifferent between producing and leaving the industry. In the formal model of Section III neither of these conditions is necessary because firms selling only in the low state of demand receive a lower price.

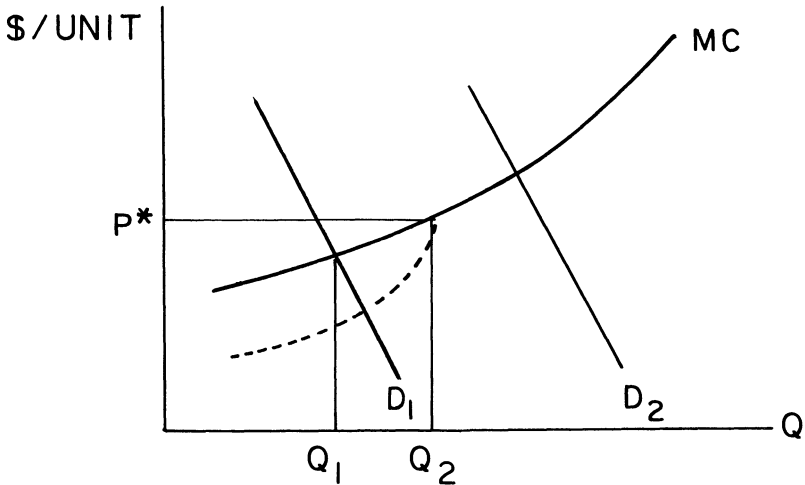


FIGURE II  
The Effect of Labor Hoarding

When output is low, labor hoarding reduces marginal cost because the firm has access to free labor. The costs of adjusting capital have a similar effect, firms with excess capital have low marginal cost. Thus, with rigid prices, capital intensity and the costs of adjusting capital also affect the ratio of price to marginal cost. For simplicity we concentrate only on labor and ignore these effects in this paper. A more realistic model would have to treat capital explicitly.

The model we have sketched is obviously incomplete. First, we have not derived the equilibrium price  $P^*$ . Second, we have been imprecise concerning labor hoarding and have ignored its possible effects on the level of  $P^*$ . We thus present a more complete model below.

### III. THE PRESCOTT MODEL

#### A. The Setting

We consider a setup due to Prescott [1975] in which demand for a homogeneous product is uncertain. There are an unlimited number of firms with access to the following constant returns technology. For each unit that the firm wishes to produce with

certainty, the firm must hire  $c + v$  workers at a wage that we normalize to equal one.

These workers differ in the way the firm can adjust employment in response to unexpected changes in production. In particular, the  $c$  workers are a variable input in that firms can avoid the cost  $c$  if they choose not to produce *ex post*. By contrast, the  $v$  workers are a quasi-fixed input. If the firm wants to have the capability of producing one unit *ex post*, it must hire  $v$  workers *ex ante* and keep paying them even if it later decides not to produce. Formally, we let each firm choose an initial capacity  $Y$ . Then, if the firm decides later to produce  $Q$  (where  $Q \leq Y$ ), its cost is  $(cQ + vY)$ .

Quasi-fixed labor inputs of this kind are present in several settings. For instance, some workers may be overhead workers; the need for their services is independent of the amount produced. Aircraft pilots fall in this category, since the amount of work that they perform in any given flight is essentially independent of the number of passengers on that flight. Firms also fail to lay off some workers whose efforts fall as output declines. If their compensation falls as their output falls, the services of this labor are a variable input.<sup>6</sup> By contrast, if their compensation remains constant as their output falls, they constitute a quasi-fixed input.

Compensation would be independent of effort if workers experience disutility only from their presence at the firm and not from the intensity of their work. It would also be independent if, as in Grossman and Hart [1986], contracts are incomplete so that contracts which let compensation depend on actual effort are unenforceable. In this latter case compensation could still depend on the expected level of effort.

Let consumers' reservation price, which does not depend on the state of demand, equal  $r$ . What varies across states is the amount  $Q$  they want to buy at this reservation price; in state  $s$  they are willing to purchase  $g(s)$ , where  $g$  is an increasing function.<sup>7</sup> The states of nature  $s$  can be taken, without loss of generality, to be uniformly distributed between zero and one.

6. Obviously it does not matter whether the firm changes the workers' current or future compensation in response to a fall in their current output.

7. The assumption of a fixed reservation price that does not vary is not necessary for our results about the behavior of productivity. It does simplify the exposition and as stressed by Prescott allows the market optimum to be attained even when prices must be set before demand is revealed.

### B. Flexible Prices

Firms must pick their capacity before demand is known. However, they choose price afterwards. With a continuum of firms the equilibrium is Walrasian. The price equals  $c$  in states where demand is less than capacity and equals  $r$  in states where demand exceeds capacity. This is the standard peak-load pricing solution. Let  $s^*$  be the state in which demand  $g(s^*)$  equals capacity. Since the firms must break even in equilibrium, the capacity level satisfies

$$(1) \quad (1 - s^*)(r - c) = v.$$

We now consider the effect of a change in demand on productivity. Since we are studying flexible prices, the results here parallel Hall's [1987, 1988]. Suppose in particular that the maximum consumers are willing to buy at  $r$  is now given by

$$(2) \quad Q = g(s) + \epsilon.$$

An increase in aggregate demand raises the demand by the same infinitesimal amount  $\epsilon$  in each state. We assume that capacity does not change when demand changes. Sales then increase by  $\epsilon$  for all excess capacity states, i.e., for all states below  $s^*$ . The change in the value of labor inputs,  $dL$ , is thus equal to  $cs^*\epsilon$ .

Let  $R$  be the usual index of real output. This index is the average over all states  $s$  of the value (at base period prices) of sales in that state. In the states where sales increase by  $\epsilon$ , the price is  $c$ . Therefore, the change in  $R$ ,  $dR$ , also equals  $cs^*\epsilon$ .

The standard Solow residual is procyclical if  $dR/dL$  is greater than one so that the value of output increases more than the value of labor input. In the case of flexible prices this ratio equals one independently of the number of workers  $v$  who must be kept around when output is low.

Another contrast with the case of rigid prices is obtained studying the response of the Solow residual based on cost rather than on revenue shares. This is of some interest because Hall [1987] argues that the procyclical movements in the cost-based residual are evidence of long-run increasing returns to scale (or excess capacity). Since labor is the only factor of production here, its cost share is one. Thus, Solow residuals measured in this way will be procyclical if  $dR/R$  exceed  $dL/L$  or if the naive measure of labor productivity,  $R/L$ , is procyclical. Since there is free entry and constant returns, profits are zero, and the initial value of  $R/L$  is one. Since  $dR/dL$  is also one,  $R/L$  is also acyclical with flexible prices. This conclusion does not depend on the size of  $v$ .

### C. Micro Price Rigidity

We now assume that, after the firms pick capacity but before demand becomes known, firms must choose their prices. Since the good is homogeneous, customers always buy the cheap items first. They turn to high-priced items only when the cheaper ones are exhausted.<sup>8</sup> If there are free entry and constant returns, not all the various units of the good for sale will have the same price tags. Suppose that they did. Given that demand is random, some units would sometimes remain unsold. Therefore, a firm would gain by undercutting the going price slightly and thereby sell with certainty.

This model thus differs from that of Figure I which had only one price in all states of demand. For there to be only one price, it must be impossible for another firm to enter, undercut the price, and sell with certainty. For completeness we therefore also developed a differentiated products model in which each good can have only one price. The results are analogous to those derived here and are available in an Appendix available from the authors upon request. Even when monopoly power is low because the elasticity of demand for each good is very high, price rigidity can lead to substantial procyclical movements in total factor productivity.

In the equilibrium of the current model, there is a continuum of producing firms charging a variety of prices. Those whose price is low sell often; those whose price is high sell only when realized demand is high. For ease of presentation we think of each as charging only one price, though this is unessential. A given firm may charge low prices to its first customers, and higher prices to subsequent customers as is common in the post-deregulation U. S. airline industry.

To describe this equilibrium, we let  $s(P)$  be the state such that for all states equal to or higher than  $s(P)$  a firm charging  $P$  sells up to capacity. This definition implies that an amount  $g(s(P))$  is supplied by firms charging  $P$  or less. Since  $s$  is uniformly distributed, it also implies that firms charging  $P$  can expect to sell all that they can produce with probability  $(1 - s(P))$ . Therefore, the expected unit profits of a firm charging  $P$  are

$$(3) \quad [1 - s(P)][P - c] - v.$$

8. For a related model in which goods are perfect substitutes before "A", the customer chooses which firm to purchase from but where purchasing from a second firm is impossible if the chosen firm has run out; see Carlton [1978].

In equilibrium firms must break even. If losses are realized by a firm charging  $P$  so that expression (3) is negative, the firms would prefer not to build capacity. If expression (3) is positive instead, more firms would build capacity and charge  $P$ . A firm contemplating such entry can neglect the effect of its entry on the probability of selling because it can enter supplying only an infinitesimal amount. Therefore, in equilibrium expression (3) must be zero for all prices actually charged. Of course, no price below  $(c + v)$  is charged, for that would lead to losses; nor is a price above  $r$  charged, for there would be no demand at this price.<sup>9</sup> Note that the lowest price charged also is the unique price if demand is certain so that  $g(s)$  is constant.

To complete the demonstration that this is an equilibrium, we now show that deviations at the pricing stage are unprofitable. Obviously, nothing is gained by charging less than  $c + v$  or more than  $r$ . For prices between  $c + v$  and  $r$ , the proposed equilibrium in which (3) equals zero has all firms making equal profits. So unless a deviating firm affects the probability of selling at any particular price, firms are indifferent to the price they charge. Yet, the fact that there is a continuum of firms ensures that this distribution is essentially unaffected by single-firm deviations.

The equilibrium requirement that (3) be zero for all prices charged implies that the price charged by each firm equals its average cost. So this model is consistent with the claim of Hall and Hitch [1939] that firms charge "full average" cost. It is also consistent with the notion that price equals "long-run" marginal cost where long-run marginal cost is appropriately defined to recognize that the firm will not always be able to make use of its capacity.

The highest price charged is  $r$ . From (1) and (3) it is apparent that firms charging this price sell with probability  $(1 - s^*)$ . Since these are the firms charging the highest price, total industry capacity is, as in the flexible price case,  $g(s^*)$ .<sup>10</sup>

9. This model is formally almost identical to Butters [1977]. In the Butters model unit production costs equal  $c$ , whereas  $v$  corresponds to the cost of sending an ad to a single customer. Equilibrium then requires that an expression such as (3) be zero for prices between  $c + v$  and the reservation price  $r$  where  $[1 - s(P)]$  is the equilibrium probability that an ad with a price  $P$  will be the ad with the lowest price received by the customer and will thus lead to a sale.

10. This equivalence of flexible and rigid prices was originally demonstrated by Prescott [1975]. As argued in Rotemberg [1988], it depends on the assumed functional form of demand.

*D. Demand Shocks and Measured Productivity*

We now consider the effects on various productivity measures of an increase in aggregate demand that is accompanied by price changes but not by changes in capacity. This differs from Eden [forthcoming] because he considers the effect on productivity of changes in demand which occur during the interval over which prices are preset. Thus, Eden studies the effects of changes in the realization of  $s$ . By contrast, assuming demand is given by (2), we study the effect of changes in  $\epsilon$ . After  $\epsilon$  becomes known, the firms set prices, and only then is  $s$  realized.

Then, for an infinitesimal  $\epsilon$ , the increased demand will be met in all states below  $s^*$  whether prices change in response to the increased demand or not. The reason is that, since  $r$  exceeds  $c$ , rationing by high-priced firms is never optimal, so the amount firms are willing to sell remains  $g(s^*)$ .

If firms are free to readjust prices, the equilibrium equates the unit profits of firms charging different prices. These unit profits given by (3) are equated to a number that differs from zero. This number can be computed as follows. Let  $s'(\epsilon)$  be the highest state for which demand is fully met so that  $g(s'(\epsilon))$  equals  $g(s^*) - \epsilon$ . Since  $r$  is the highest price charged, it is charged by firms that sell only when the state equals or exceeds  $s'$ . These firms earn unit profits equal to  $(s^* - s'(\epsilon))(r - c)$ , and these must also be the unit profits of firms charging other prices.

The increased labor costs ( $dL$ ) associated with the increased sales are again equal to  $cs^*\epsilon$ . We now compute  $dR$ , the change in the value of output computed at base period prices. In any state  $s$  below  $s^*$ , output rises by  $\epsilon$ . If such an additional sale had taken place at base prices, the volume of sales in this state would have risen by  $\epsilon$  times the price of the marginal unit in state  $s$ ,  $P(s)$ . The price of this marginal unit equals the price charged initially by firms that sell in states greater than or equal to  $s$  and can be obtained by equating (3) to zero. Therefore, the change in  $R$  is

$$(4) \quad dR = \epsilon \int_0^{s^*} P(s) ds = [(c - k) \log(1 - s^*) + cs^*] \epsilon,$$

where  $k$  equals total marginal cost ( $c + v$ ). From (4),

$$(5) \quad \frac{dR}{dL} = 1 - \left(\frac{v}{c}\right) \frac{\log(1 - s^*)}{s^*},$$

which exceeds one. So, unlike the flexible price case, total factor productivity is procyclical. The magnitude of  $dR/dL$  in (5) should

equal the markup of price to marginal cost measured by Hall. In his study the typical markup equals 2. This can easily be reconciled with (5). If  $s^*$  equals 0.9,  $dR/dL$  in (5) equals 2, as long as  $c$  equals about 0.3 of total cost  $c + v$ .

Total factor productivity computed using labor's share in cost is procyclical as well. Because this cost share is one, this productivity is procyclical if  $R/L$  rises with  $\epsilon$ . Since entry is free and there are no returns to scale, profits are zero, and the initial value of  $R/L$  is one. So  $R/L$  rises if  $dR/dL$  exceeds one and  $R/L$  is also procyclical.

We finally turn to the role of labor hoarding. Labor hoarding becomes more important as more of the tasks are performed by workers whose quantity is fixed, even though they are not productive in low demand states. In our model this can be captured by increasing  $v$ , while letting the labor input per unit produced with certainty,  $k$ , be constant. The effect of this on  $dR/dL$  is

$$\frac{d[dR/dL]}{dv} = \frac{(c - k) \log(1 - s^*)}{rs^*(r - c)} - \frac{(k/c) \log(1 - s^*)/s^* + 1}{c}.$$

The term  $(k/c) \log(1 - s^*)/s^*$  is negative both because  $(k/c)$  exceeds one and because  $\log(1 - s^*)/s^*$  is smaller than minus one for  $s^*$  between zero and one. Thus,  $dR/dL$  rises with  $v$ . As costs become more congealed and as labor becomes less variable, the extent of procyclical productivity rises. At the other extreme, when  $v$  is zero and all labor is variable, price equals  $c$  and productivity is acyclical.

We have stressed the role of labor fixity in generating productivity increases when demand rises. Suppose that the increase in demand given by (2) persists. Firms will then eventually adjust their capacity. This tends to raise  $L$  without commensurate increases in  $R$ . Complete adjustment requires that profits equal zero and that  $R$  again equal  $L$ , at least in current prices. Since GNP deflators have no reason to change from before the change in demand to after the adjustment is complete,  $R/L$  in constant prices also ought to come back to its normal value of one. Thus, our theory predicts that productivity increases driven by demand expansions tend to be reversed over time.

The model developed in this section demonstrates that procyclical productivity, and the appearance of price in excess of marginal cost when demand is low can arise in a setting with atomistic firms, free entry, and constant returns. We want to stress that these results follow merely from the need of firms with rigid prices to recover some of their capacity costs in low states of

demand and do not depend on the precise formulation of our model. We have focused on genuine price rigidity. There is also the possibility of artificial price rigidity arising from the failure of the National Account statistics to take full account of price variations.

#### IV. EMPIRICAL EVIDENCE

In this section we discuss how various empirical features of both rationing and productivity relate to our theory.<sup>11</sup> We consider in turn the evidence on rationing, the behavior of productivity across industries and across nations, and the dynamic behavior of productivity when output changes.

##### *A. The Importance of Rationing*

Notice that the model considered in Section III also exhibits the rationing that the analysis of Section II suggests is necessary to overturn Hall's results. With many different prices charged by different firms, some firms are always running out. Individuals are rationed in the sense that they are unable to buy goods on the good terms that have been obtained by others and must turn to more expensive suppliers. It is important to stress that this form of rationing (which is all that is required) is very mild and widespread. For instance, when an item is on sale, some individuals are often unable to obtain it on demand at the sale price. Indeed, "limited quantity" sales can be seen advertised in any Sunday newspaper.

The prevalence of this sort of rationing becomes apparent once it is recognized that in many settings consumers who buy first get a higher quality product, which is tantamount to paying a lower price. Take the case of airplane reservations. Aisle and window seats are more desirable, and they fill up first. Latecomers are rationed in that they must content themselves with middle seats. In other words, even when the prices of all seats are the same, the pattern of prices bears some resemblance to that predicted by our equilibrium in which the marginal price is higher when demand is high. Similarly, those who come earlier to a movie theater get better seats.<sup>12</sup>

While rationing can take these very mild forms in the model we have described, the more traditional form of rationing—customers

11. See Bernanke and Parkinson [1990] for relevant evidence from the Interwar period.

12. Admittedly, having to arrive earlier can be seen as an additional cost.

actually unable to buy the good they wish at any price—would emerge if reservation prices rose when demand rose (or alternatively if demand curves sloped down throughout). Does this form of rationing actually take place? At an informal level, seats on airplanes are unavailable at the last minute on holiday weekends, rooms in hotels are unavailable during graduation week, and not all customers get in when hit movies have their first run. It is generally felt that those who do their Christmas shopping early have access to a better selection. In the case of industrial goods, early-comers get relatively flexible delivery terms, while later customers may have to wait longer. Carlton [1989] gives several examples of such rationing between firms. He points out that firms are so concerned with the reliability of their supplies that the purpose of vertical mergers is sometimes to ensure access to the product.

More quantitative evidence is presented in *Progressive Grocer* [1968] which reports that, on average, 12.2 percent of major brand items carried by supermarkets are out-of-stock at any point in time. The Nielsen study which forms the basis for this calculation also indicates that 30 percent of customers at the typical store are unable to purchase all the items on their shopping lists. It also reports that the rate of stockouts varies significantly over the course of the week. A Chicago study found that 17 percent of frozen food items were not available to consumers on Monday, 12 percent were missing on Wednesday, and 11 percent on Friday. Interestingly, while the article devotes considerable attention to the problem of minimizing stockouts, the idea of raising prices on items that are in short supply is never mentioned. The article also mentions that one fifth of the individuals who find the item they want missing, refuse to substitute.

### *B. Productivity Across Industries*

Our theory implies that the extent to which an industry's total factor productivity is procyclical is higher the more labor the industry hoards in recessions. That is because, with rigid prices, price exceeds marginal cost by more than the more average cost exceeds marginal cost. One alternative view is that price exceeds marginal cost only in industries where barriers to entry ensure that only a few firms share the market. To gauge the relative importance of these two explanations, we study whether, across industries, the procyclicality of total factor productivity is related more to traditional indicators of market power or to indicators of labor hoarding.

As a crude indicator of market power, we use the four-firm

concentration ratio. We use two indicators of the extent to which the labor input is quasi-fixed. The first is the ratio of nonproduction workers to total employment. Since employment of nonproduction workers varies much less, industries where this ratio is high have more labor hoarding. The second indicator is the rate of turnover measured as the number of separations per year per 100 employees.

One difficulty is that both these indicators of labor hoarding may be related to the extent to which firms in the industry have increasing returns. The fixed costs in increasing-returns industries may involve a large number of nonproduction workers. Insofar as the ratio of nonproduction workers to employment is a proxy for increasing returns, it is probably related to the presence of market power as well. It is also possible that industries where the fixed costs take the form of nonproduction workers have lower turnover because, for some reason, nonproduction workers turn over relatively little. Consistent with these possibilities, turnover and concentration are negatively related across our industries, while the ratio of nonproduction workers is positively related to concentration.

The procyclicality of productivity is measured either by Hall's [1988] measures of price over marginal cost for 18 two-digit manufacturing industries or by the conceptually similar numbers reported in Domowitz, Hubbard, and Peterson [1988] for 19 manufacturing industries. The two differ mainly in their treatment of materials costs.

As is clear from Table I, the two measures of labor hoarding are significantly related to the procyclicality of productivity, while our measure of market power has the wrong sign and is not statistically significant.<sup>13</sup> This is consistent with our model. It is also consistent with the view that the fixed costs which lead to increasing returns and monopoly power take the form of nonproduction workers who turn over relatively little.

However, there is a slight amount of evidence that this latter view cannot fully explain our results. Suppose that only true market power  $m$  affects the procyclicality of productivity  $p$ , i.e., that

$$p = am + \epsilon,$$

where  $a$  is a coefficient and  $\epsilon$  is a residual. Suppose also that both our labor hoarding indices and the four-firm concentration are simply noisy proxies for market power. Letting  $c$  denote the concentration

13. The lack of importance of concentration is confirmed by the much larger study of Domowitz, Hubbard, and Petersen [1988].

TABLE I  
INDUSTRY CHARACTERISTICS AND THE EXTENT OF PROCYCLICAL TOTAL FACTOR  
PRODUCTIVITY

Indep. var./Depend. var.	Hall's $P/MC$					
	OLS			2SLS		
Constant	-0.95 (3.29)	13.43 (4.85)	-2.33 (2.64)	12.2 (3.7)	5.20 (12.9)	0.59 (36.1)
Nonproduction/employment	29.5 (11.1)		27.5 (10.7)		-5.51 (56.4)	
Separations/100 employ.		-1.97 (0.86)		-1.92 (0.82)		0.78 (8.39)
Concentration	-4.77 (6.43)	-2.63 (1.00)				
$R^2$	0.32	0.26	0.29	0.25	-0.12	-0.25

Indep. var./Depend. var.	DHP's $P/MC$					
	OLS			2SLS		
Constant	1.45 (0.13)	1.99 (0.17)	1.33 (0.11)	1.87 (0.13)	2.04 (0.96)	0.09 (5.73)
Nonproduction/employment	12.0 (4.10)		1.06 (0.4)		-1.94 (4.09)	
Separations/100 employ.		-0.073 (0.031)		-0.070 (0.031)		0.36 (1.38)
Concentration	-0.39 (0.25)	-0.29 (0.25)				
$R^2$	0.36	0.29	0.27	0.23	-1.87	-8.55

Standard errors are in parentheses.

ratio and  $h$  either of our labor hoarding indices,

$$c = bm + u$$

$$h = cm + v,$$

where  $b$  and  $c$  are parameters while  $u$  and  $v$  are residuals. Suppose that  $u$ ,  $v$ , and  $\epsilon$  are uncorrelated. Then, ordinary least squares regressions of  $p$  on  $h$  yield downward biased and inconsistent estimates of  $a/d$ . Regressions of this type are reported in the third and fourth column of Table I.<sup>14</sup> In principle, two-stage least squares

14. Note that the coefficient on our labor hoarding variables is smaller in absolute value when the concentration ratio is excluded as a regressor.

regressions of  $p$  on  $h$  using  $c$  as an instrument yield consistent estimates. Therefore, under our assumptions the two-stage least squares estimates ought to have greater absolute value but be of the same sign as the ordinary least squares estimates. By contrast, the last two columns of Table I show that using concentration as an instrument leads our labor hoarding variables to have the wrong sign.

To give an idea of the magnitudes involved, recall that our left-hand-side variable is the ratio of price over marginal cost. In the case of Hall's estimates, our parameters imply that an industry with concentration equal to the sample mean and with nonproduction workers equal to 9.5 percent of employment would have price equal to marginal cost. By contrast, an industry where nonproduction workers are a fifth of employment would have price equal to almost three times marginal cost. For comparison, actual ratios of nonproduction workers to employment vary from 9.7 percent to 38.4 percent in our sample.

If one takes the estimates in the second column, we estimate that an industry with average concentration and 6.3 separations per 100 workers would have price equal to marginal cost. In our sample the separations range from 2.1 to 6.8 per 100 workers. The Domowitz, Hubbard, and Petersen [1988] estimates yield smaller, though statistically more significant, effects of labor hoarding on the procyclical movements of productivity.<sup>15</sup>

### *C. Productivity Across Nations*

It is well-known that output per man-hour is more procyclical in Japan than in the United States. Table II shows that the same is true for total factor productivity. The difference between the two sets of estimates is both economically and statistically significant. These regressions are obtained by using output growth in the United States and Europe as instruments to obtain the estimates for Japan, while output growth in Japan and in Europe are used as instruments to obtain estimates for the United States.

It is conceivable that this result obtains because Japan is more monopolistic (and has more increasing returns) than is the United States. We prefer to attribute this finding to more extensive labor hoarding in Japan. Given the dependence of Japanese manufacturing on export markets, it seems unlikely that it is far more heavily

15. In part, this is due to the fact that the Hall estimates range much more widely and, having been obtained with less data, are less precise.

TABLE II  
 PROCYCLICAL MOVEMENTS OF TOTAL FACTOR PRODUCTIVITY IN MANUFACTURING

(a) Regressions of output growth on labor share times man-hour growth					
Specification	1	2	3	4	5
Sample period	1962-84	1962-84	1962-84	1962-72	1973-84
Additional regressors			trend	dum73	
U. S.	1.70 (0.24)	1.78 (0.29)	1.85 (0.31)	3.48 (3.01)	1.68 (0.22)
Japan	3.75 (0.82)	3.49 (0.86)	3.13 (0.80)	-10.05 (25.71)	3.21 (0.44)
(b) Regression of labor share times man-hour growth on output growth					
Specification	1	2	3	4	5
Sample period	1962-84	1962-84	1962-84	1962-72	1973-84
Additional regressors			trend	dum73	
United States	0.59 (0.08)	0.63 (0.10)	0.66 (0.11)	0.24 (0.25)	0.57 (0.07)
Japan	0.20 (0.05)	0.23 (0.05)	0.21 (0.05)	-0.04 (0.14)	0.30 (0.04)

*Note.* Dum73 is a variable that takes the value of zero before 1973 and one thereafter. Data are provided by Robert Gordon and are described in Gordon [1987].

monopolized than American manufacturing. On the other hand, institutional differences promoting lifetime employment, and pressuring firms to retain workers during recessions are widely recognized.

#### *D. Dynamic Response of Productivity to Demand*

Our theory emphasizes labor hoarding and short-run increasing returns as opposed to long-run returns. The response of productivity over time to changes in output suggests that procyclical physical productivity is due at least to some extent to labor hoarding and that increasing returns to scale cannot be the whole story. In the two studies where output data are measured in physical units [Hultgren, 1960; Fair, 1969], there is evidence that as output expands productivity first rises and then, at least for many industries, falls. This is consistent with the idea that it takes time to change the quasi-fixed labor inputs. On the other hand, it would seem that with pure increasing returns to scale, productivity would keep rising (as it does for some individual industries). This would not necessarily be true if entry by new firms occurred in response to

the expansion but the amount of time it takes for productivity to start falling makes this particular explanation difficult to believe.

More evidence along these lines is obtained by Sims [1974] and Gordon [1979], who use aggregate data on manufacturing output and labor input to describe the time series properties of conventional labor productivity. They conclude that expansions raise productivity but that productivity tends to revert toward its normal level. Gordon [1979], in particular, shows that this reversion is more prevalent at the end of expansions.

Figure III uses monthly data on U. S. manufacturing over the period 1962 to 1985 to evaluate the response of productivity to demand impulses as proxied either by increases in man-hours or in output.<sup>16</sup> The results which appear robust to whether the equation is estimated using first differences or levels, confirm earlier results suggesting that productivity rises and then falls following demand impulses as would be expected if labor was hoarded.

## V. CONCLUSIONS

The results in this paper suggest that traditional analyses emphasizing the costs of adjusting capacity and labor hoarding capture important aspects of productivity behavior. In conjunction with plausible degrees of price rigidity, labor hoarding can account for the observed cyclical behavior of various productivity measures. This implies that Keynesian analysis which emphasizes the rigidity of prices and attributes most fluctuations in aggregate output to changes in aggregate demand is in principle consistent with important fluctuations in productivity. The appropriateness of Kydland and Prescott [1982]'s methodology that treats all fluctuations in observed productivity as being due to changes in technology has yet to be demonstrated.

Even leaving aside the possibility that technology fluctuates stochastically at business cycle frequencies, it is difficult to gauge at this point the relative importance of the labor-hoarding-price-rigidity story that we have stressed and the increasing-returns-monopoly-power story stressed by Hall. In future research it would be valuable to extend our comparison of the United States and Japan to embrace other countries. The variables constructed by

16. The figures are obtained by first running regressions of productivity either on man-hours or on output. Then, we simulate how productivity would respond to a permanent change in either man-hours or output.

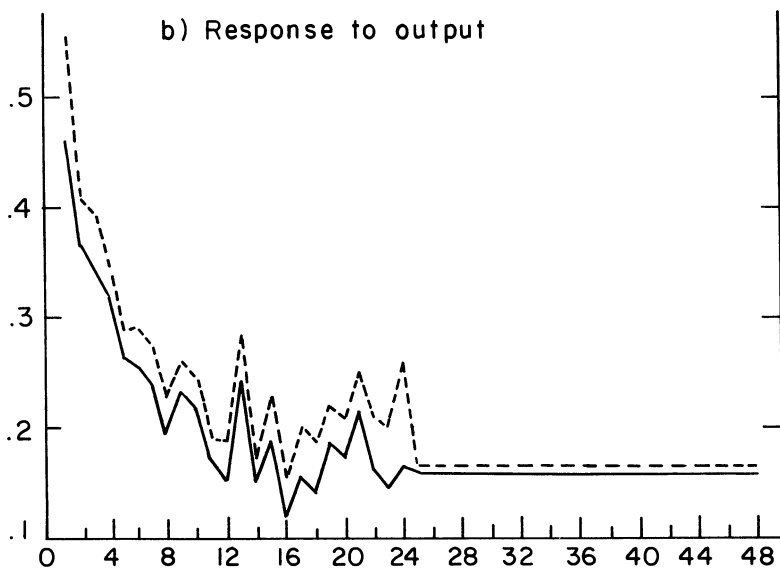
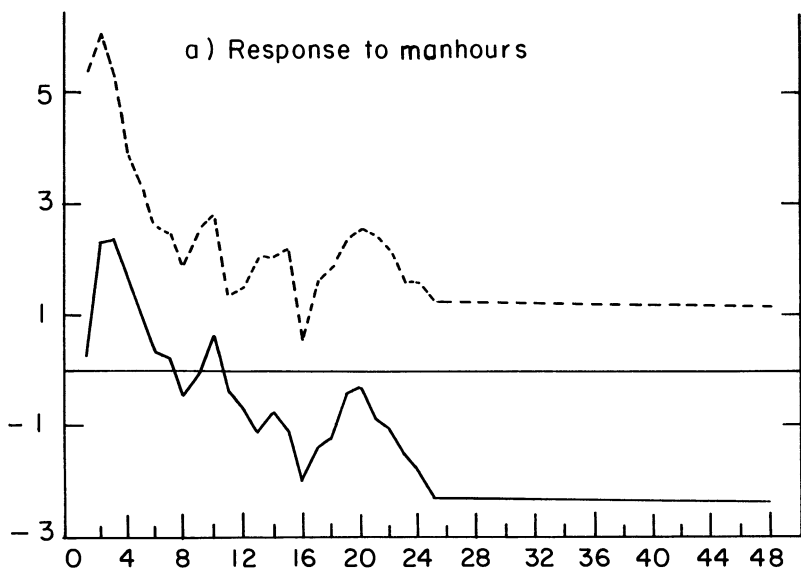


FIGURE III  
Productivity Over Time  
Solid lines are for differenced specification. Broken lines for levels specification.

Lazear [1987] in his study of employment security rules might be useful proxies for the costs of labor adjustment. Measuring monopoly power is likely to be more difficult. One plausible strategy would involve studying the cyclicity of productivity in different countries for industries that produce for world markets. This would at least crudely hold the degree of monopoly power constant.

A different approach would involve more detailed investigation of the dynamics of productivity movements. Any satisfactory resolution of the productivity and pricing paradoxes should account for the dynamic pattern of productivity's response to labor input—rising sharply then falling as labor input increases. This seems more naturally consistent with the labor hoarding view, though rationalizations involving increasing returns are probably possible.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY AND NATIONAL BUREAU OF ECONOMIC RESEARCH

HARVARD UNIVERSITY AND NATIONAL BUREAU OF ECONOMIC RESEARCH

#### REFERENCES

- Bernanke, Ben S., and Martin L. Parkinson, "Procylical Labor Productivity and Competing Theories of the Business Cycle: Some Evidence from Interwar Manufacturing Industries," mimeo, 1990.
- Butters, Gerald, "Equilibrium Distributions of Sales and Advertising Prices," *Review of Economic Studies*, XLIV (1977), 465–91.
- Carlton, Dennis W., "Market Behavior with Demand Uncertainty and Price Inflexibility," *American Economic Review*, LXVIII (1978), 571–87.
- , "The Theory of Allocation and its Implications for Marketing and Industrial Structure," in R. Schmalensee and R. Willig, eds. *Handbook of Industrial Organization* (Amsterdam: North-Holland, 1989).
- Domowitz, Ian, R. Glenn Hubbard, and Bruce C. Petersen, "Market Structure and Cyclical Fluctuations in US Manufacturing," *Review of Economics and Statistics*, LXX (1988), 55–66.
- Eden, Benjamin, "Marginal Cost Pricing When Spot Markets Are Complete," *Journal of Political Economy*, forthcoming.
- Fair, Ray C., *The Short Run Demand for Workers and Hours* (Amsterdam: North-Holland, 1969).
- Gordon, Robert J., "The 'End-of-Expansion' Phenomenon in Short-Run Productivity Behavior," *Brookings Papers on Economic Activity* (1979), 447–63.
- , "Productivity, Wages and Prices Inside and Outside Manufacturing in the US, Japan, and Europe," *European Economic Review*, XXXI (1987), 685–733.
- Grossman, Sanford J., and Oliver D. Hart, "The Costs and Benefits of Ownership: A Theory of Vertical and Lateral Integration," *Journal of Political Economy*, XCIV (1986), 691–719.
- Hall, Robert E., "Investment under Uncertainty, Theory and Tests with Industry Data," NBER Working Paper #2264, 1987.
- , "The Relationship Between Price and Marginal Cost in US Industry," *Journal of Political Economy*, XCVI (1988), 921–47.
- Hall, R. L., and C. J. Hitch, "Price Theory and Business Behavior," *Oxford Economic Papers*, II (1939), 13–45.
- Hultgren, Thor, "Changes in Labor Cost During Cycles in Production and Business," NBER Occasional Paper #74, 1960.
- Kydland, Finn E., and Edward C. Prescott, "Time to Build and Aggregate Fluctuations," *Econometrica*, L (1982), 1345–70.

- Lazear, Edward, "Employment Security Rules and Unemployment," mimeo, 1987.
- Lucas, Robert E., Jr., "The Effects of Monetary Shocks When Prices Are Set in Advance," mimeo, 1989.
- Oi, Walter Y., "Labor as a Quasi-Fixed Factor," *Journal of Political Economy*, LXX (1962), 538-55.
- Okun, Arthur, *Prices and Quantities* (Washington, DC: Brookings Institution, 1981).
- Prescott, Edward C., "Efficiency of the Natural Rate," *Journal of Political Economy*, LXXXIII (1975), 1229-36.
- Progressive Grocer* "Growing Problem of Stockouts Verified by Nielsen Research" (Part II of Out-of-Stock Study), (November 1968), 17-32.
- Rotemberg, Julio J., "The New Keynesian Microfoundations," *Macroeconomics Annual*, II (1987), 69-104.
- \_\_\_\_\_, "Rationing in Centrally Planned Economies," mimeo, 1988.
- Sims, Christopher A., "Output and Labor Input in Manufacturing," *Brookings Papers on Economic Activity*, III (1974), 695-737.
- Solow, Robert M., "Technical Change and the Aggregate Production Function," *Review of Economics and Statistics*, XXXIX (1957), 321-20.
- \_\_\_\_\_, Draft of Presidential Address to the Econometric Society on the Short-Run Relation between Employment and Output, 1964.

## LINKED CITATIONS

- Page 1 of 4 -



You have printed the following article:

### **Inflexible Prices and Procyclical Productivity**

Julio J. Rotemberg; Lawrence H. Summers

*The Quarterly Journal of Economics*, Vol. 105, No. 4. (Nov., 1990), pp. 851-874.

Stable URL:

<http://links.jstor.org/sici?sici=0033-5533%28199011%29105%3A4%3C851%3AIPAPP%3E2.0.CO%3B2-0>

---

*This article references the following linked citations. If you are trying to access articles from an off-campus location, you may be required to first logon via your library web site to access JSTOR. Please visit your library's website or contact a librarian to learn about options for remote access to JSTOR.*

### **[Footnotes]**

#### <sup>1</sup> **The Relation between Price and Marginal Cost in U.S. Industry**

Robert E. Hall

*The Journal of Political Economy*, Vol. 96, No. 5. (Oct., 1988), pp. 921-947.

Stable URL:

<http://links.jstor.org/sici?sici=0022-3808%28198810%2996%3A5%3C921%3ATRBPAM%3E2.0.CO%3B2-G>

#### <sup>3</sup> **Labor as a Quasi-Fixed Factor**

Walter Y. Oi

*The Journal of Political Economy*, Vol. 70, No. 6. (Dec., 1962), pp. 538-555.

Stable URL:

<http://links.jstor.org/sici?sici=0022-3808%28196212%2970%3A6%3C538%3ALAAQF%3E2.0.CO%3B2-L>

#### <sup>4</sup> **Review: Efficiency of the Natural Rate**

Edward C. Prescott

*The Journal of Political Economy*, Vol. 83, No. 6. (Dec., 1975), pp. 1229-1236.

Stable URL:

<http://links.jstor.org/sici?sici=0022-3808%28197512%2983%3A6%3C1229%3AEOTNR%3E2.0.CO%3B2-I>

#### <sup>8</sup> **Market Behavior with Demand Uncertainty and Price Inflexibility**

Dennis W. Carlton

*The American Economic Review*, Vol. 68, No. 4. (Sep., 1978), pp. 571-587.

Stable URL:

<http://links.jstor.org/sici?sici=0002-8282%28197809%2968%3A4%3C571%3AMBWDUA%3E2.0.CO%3B2-C>

**NOTE:** *The reference numbering from the original has been maintained in this citation list.*

## LINKED CITATIONS

- Page 2 of 4 -



### <sup>9</sup> **Equilibrium Distributions of Sales and Advertising Prices**

Gerard R. Butters

*The Review of Economic Studies*, Vol. 44, No. 3. (Oct., 1977), pp. 465-491.

Stable URL:

<http://links.jstor.org/sici?sici=0034-6527%28197710%2944%3A3%3C465%3AEDOSAA%3E2.0.CO%3B2-7>

### <sup>10</sup> **Review: Efficiency of the Natural Rate**

Edward C. Prescott

*The Journal of Political Economy*, Vol. 83, No. 6. (Dec., 1975), pp. 1229-1236.

Stable URL:

<http://links.jstor.org/sici?sici=0022-3808%28197512%2983%3A6%3C1229%3AEOTNR%3E2.0.CO%3B2-I>

### <sup>13</sup> **Market Structure and Cyclical Fluctuations in U.S. Manufacturing**

Ian Domowitz; R. Glenn Hubbard; Bruce C. Petersen

*The Review of Economics and Statistics*, Vol. 70, No. 1. (Feb., 1988), pp. 55-66.

Stable URL:

<http://links.jstor.org/sici?sici=0034-6535%28198802%2970%3A1%3C55%3AMSACFI%3E2.0.CO%3B2-B>

## References

### **Equilibrium Distributions of Sales and Advertising Prices**

Gerard R. Butters

*The Review of Economic Studies*, Vol. 44, No. 3. (Oct., 1977), pp. 465-491.

Stable URL:

<http://links.jstor.org/sici?sici=0034-6527%28197710%2944%3A3%3C465%3AEDOSAA%3E2.0.CO%3B2-7>

### **Market Behavior with Demand Uncertainty and Price Inflexibility**

Dennis W. Carlton

*The American Economic Review*, Vol. 68, No. 4. (Sep., 1978), pp. 571-587.

Stable URL:

<http://links.jstor.org/sici?sici=0002-8282%28197809%2968%3A4%3C571%3AMBWDUA%3E2.0.CO%3B2-C>

**NOTE:** *The reference numbering from the original has been maintained in this citation list.*

## LINKED CITATIONS

- Page 3 of 4 -



### **Market Structure and Cyclical Fluctuations in U.S. Manufacturing**

Ian Domowitz; R. Glenn Hubbard; Bruce C. Petersen

*The Review of Economics and Statistics*, Vol. 70, No. 1. (Feb., 1988), pp. 55-66.

Stable URL:

<http://links.jstor.org/sici?sici=0034-6535%28198802%2970%3A1%3C55%3AMSACFI%3E2.0.CO%3B2-B>

### **The "End-of-Expansion" Phenomenon in Short-Run Productivity Behavior**

Robert J. Gordon; William Poole; Robert Hall; Charles Holt

*Brookings Papers on Economic Activity*, Vol. 1979, No. 2. (1979), pp. 447-461.

Stable URL:

<http://links.jstor.org/sici?sici=0007-2303%281979%291979%3A2%3C447%3AT%22PISP%3E2.0.CO%3B2-T>

### **The Costs and Benefits of Ownership: A Theory of Vertical and Lateral Integration**

Sanford J. Grossman; Oliver D. Hart

*The Journal of Political Economy*, Vol. 94, No. 4. (Aug., 1986), pp. 691-719.

Stable URL:

<http://links.jstor.org/sici?sici=0022-3808%28198608%2994%3A4%3C691%3ATCABOO%3E2.0.CO%3B2-F>

### **The Relation between Price and Marginal Cost in U.S. Industry**

Robert E. Hall

*The Journal of Political Economy*, Vol. 96, No. 5. (Oct., 1988), pp. 921-947.

Stable URL:

<http://links.jstor.org/sici?sici=0022-3808%28198810%2996%3A5%3C921%3ATRBPAAM%3E2.0.CO%3B2-G>

### **Price Theory and Business Behaviour**

R. L. Hall; C. J. Hitch

*Oxford Economic Papers*, No. 2. (May, 1939), pp. 12-45.

Stable URL:

<http://links.jstor.org/sici?sici=0030-7653%28193905%291%3A0%3A2%3C12%3APTABB%3E2.0.CO%3B2-K>

### **Time to Build and Aggregate Fluctuations**

Finn E. Kydland; Edward C. Prescott

*Econometrica*, Vol. 50, No. 6. (Nov., 1982), pp. 1345-1370.

Stable URL:

<http://links.jstor.org/sici?sici=0012-9682%28198211%2950%3A6%3C1345%3ATTBAAF%3E2.0.CO%3B2-E>

**NOTE:** *The reference numbering from the original has been maintained in this citation list.*

## LINKED CITATIONS

- Page 4 of 4 -



### **Labor as a Quasi-Fixed Factor**

Walter Y. Oi

*The Journal of Political Economy*, Vol. 70, No. 6. (Dec., 1962), pp. 538-555.

Stable URL:

<http://links.jstor.org/sici?sici=0022-3808%28196212%2970%3A6%3C538%3ALAAQF%3E2.0.CO%3B2-L>

### **Review: Efficiency of the Natural Rate**

Edward C. Prescott

*The Journal of Political Economy*, Vol. 83, No. 6. (Dec., 1975), pp. 1229-1236.

Stable URL:

<http://links.jstor.org/sici?sici=0022-3808%28197512%2983%3A6%3C1229%3AEOTNR%3E2.0.CO%3B2-I>

### **Output and Labor Input in Manufacturing**

Christopher A. Sims; Michael C. Lovell; Robert M. Solow

*Brookings Papers on Economic Activity*, Vol. 1974, No. 3. (1974), pp. 695-735.

Stable URL:

<http://links.jstor.org/sici?sici=0007-2303%281974%291974%3A3%3C695%3AOALIIM%3E2.0.CO%3B2-S>