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# INTRODUCTION

THE purpose of this volume is to present a systematic investigation of investment, employment, utilization rates, and inventories in manufacturing industries over the post-World War II period. The focus of the study is on the dynamic interrelationships among these variables that arise from changing demand and market conditions. Costs associated with changes of these variables, absent in a static world, significantly affect the outcome in a dynamic setting. These costs provide a link between present and future profits and consequently require firms to take explicit account of the effects of current decisions on future profits.

In a changing world, the firm is faced with three basic options regarding production and input. It can perfectly synchronize input and output decisions without holding any inventories. It can hold inventories of output to meet changing demand and stabilize employment of its capital stock and labor force. Finally, it can hold the equivalent of inventories of inputs, not smoothing production perfectly but changing the intensity of use of existing resources. The first strategy is unlikely to be pursued because there are natural delays in production and because rapid acquisition and change in the utilization of inputs is costly. The typical policy for most firms is to follow a mixed strategy of holding some inventories of output and some of input. The combination is determined by an interrelated set of implicit cost trade-offs which are, in turn, determined by the technological and market conditions under which the firm operates.

The forces underlying these trade-offs are very complex, and lead to a network of interrelated decisions. Changing the levels of output inventories, input utilization rates, or additions to input stocks all involve

costs which vary according to the type of adjustments, the length of time, and the decisions made about the other inputs and outputs. These events, in turn, lead to a pattern of intertemporal substitutions among these variables. Costs of altering input utilization rates include overtime wage payments to labor and accelerated depreciation of capital equipment because it is used more intensively. Finally, changing the labor force involves search, hiring, and training costs, and acquiring new capital goods entails order delays, installation costs, etc.

Some simple examples will illustrate the nature of the response mechanisms involved. Suppose a firm expects a permanent increase in sales, which will eventually make an expansion of its productive capacity advantageous. To meet new demand in the short run requires, because of adjustment delays in the acquisition of new capital goods, increasing utilization of existing capacity by adding overtime and additional labor and by running down existing inventories. Current costs are thereby increased temporarily. As capital expansion proceeds, these costs are slowly reduced to more normal levels. In certain cases, the firm may be additionally constrained by labor market conditions. Current unavailability of skilled labor at or near existing wage rates leads to the postponement of capital expansion plans and greater reliance on more intensive utilization of existing resources. In situations where increased sales are not considered permanent, costs of temporary changes of plant capacity may be so large that new investments are precluded. The firm increases utilization of existing stocks and may temporarily increase its labor force as well. As sales fall to their prior levels, utilization rates taper off, inventory-sales ratios slowly increase to their desired levels, and temporary labor acquisitions are reduced.

It is important to take account of these interrelationships and feedbacks in the adjustment process, both from a purely scientific point of view and also for policy prescriptions. The scientific contribution lies in a more complete description and analysis of production decisions. Taking account of these dynamic constraints provides an opportunity to predict more accurately the production and factor employment behavior of firms. This point is illustrated by a survey of the literature on investment and employment functions. Existing time-series employment studies assume fixed capital stock. Yet estimated labor stock adjustment periods are so long as to place this assumption in serious doubt. On the other hand, most investment studies treat labor as a completely variable factor even

though employment studies indicate otherwise. Furthermore, few of these investigations have made adequate allowance for variations in utilization rates of labor and capital, and the estimates often are difficult to interpret.[1]

The relationships among input and output decisions have important policy implications. For example, a policy designed primarily to influence investment behavior may have unintended spillover effects on employment and utilization decisions. Policies aimed at one market do not in fact remain confined to that market. An important consequence is that program monitoring of fiscal and monetary policies is rendered more difficult. Because of the complexity of the response networks involved, the immediate response and the evolution of the system can be very different from that intended. It therefore becomes very important to be able to predict how these response patterns will evolve. For example, as will be seen below, employment response to expansionary fiscal policy may exceed its ultimate equilibrium value for some period of time after the stimulus because of the feedback and cross-adjustment mechanisms involved. In terms of employment objectives, the policy temporarily may look better (or worse) than it will ultimately be.

An attempt has been made in this study to develop and estimate a model which takes explicit account of these interrelationships. The theoretical structure is based on the neoclassical theory of production in the presence of costs of changing input levels. The model and estimates of it provide a unified framework for analyzing input demand functions over time. The inputs considered are production and nonproduction labor, capital stock, and inventories. The role of utilization rates in these functions and variations in utilization rates are also analyzed. The model is estimated for total manufacturing and its component subsectors—durables, nondurables, and fifteen individual industries—using quarterly data over the 1947–69 period.

The main contribution of this study lies in four areas:

1. We have tested for the existence of cross-adjustment or feedback effects among input decisions and have found them to be present in all industries studied. Quarterly changes in each input are found to be

1. Some studies use man-hours rather than employment stock but do not determine the division between employment and hours of work. Two exceptions are Black and Kalejian [1970] and Kuh [1965a]. Nadiri [1969] explicitly takes into account capital utilization in his investment function, but it is exogenous to the model.

significantly affected by the position and adjustment response of other inputs. The results verify the generality of the model, which includes existing employment and investment models as special cases.

2. The existence of cross-input adjustment effects implies patterns of responses to changing conditions which are in marked contrast to results reported in previous studies. Two outstanding general features of the results are as follows: First, dynamic responses of utilization rate variables and, very often, employment variables overshoot their ultimate equilibrium values very soon after the adjustment process begins. These results cannot be obtained (by construction) in traditional employment and investment function studies, which exclude feedback effects from one input to the other. Second, there are systematic differences in the timing and speed of response among inputs. Utilization rates respond very quickly to changes in demand, followed by production employment and inventory variables. Nonproduction worker employment and especially capital stock respond very sluggishly. Moreover, the average lags in the system tend to be shorter than those found by previous investigators, who have ignored interaction effects. It should be emphasized that those variables which overshoot their ultimate equilibria are also the quickest to respond to external stimuli. They act as buffers, taking up the slack imposed by the slower-adjusting inputs such as capital. This result justifies the cross-adjustment specification of the model.

3. The analysis permits separation of sales and relative input price responses, and these are systematically different in all industries studied. The sales effects are much larger than the price effects, which tend to be very small in magnitude and often indiscernible in these data.

4. There are systematic differences across industries, both in speed of response of inputs to sales and prices and in the ultimate effects of these variables. Input responses are much more rapid in durable goods industries than in nondurables, and long-run responses are also smaller.

The material in this volume is presented as follows: Chapter 1 contains a discussion of the general setting of the problem and illustrations of some conceptual issues. The complete model is presented and elaborated in Chapter 2. The nature of the data and some preliminary observations are discussed in Chapter 3. Structural estimates, distributed lags, and long-run elasticities for total manufacturing and their interpretation are presented in Chapter 4. Results of various experiments with alternative

forms of the model for total manufacturing are found in Chapter 5. The complete results for individual industries are presented in Chapter 6. In Chapter 7, the empirical results obtained in this study are used to answer some heretofore unresolved questions about the estimation of short-run employment and investment functions, and a summary and conclusions are also given. Appendixes and references are included at the end of the volume.

For those readers interested only in the essential theoretical and empirical results of this volume, we recommend Chapter 2 for theoretical development and Chapters 4, 6, and 7 for empirical application.