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Robert Eisner, M. I. Nadiri


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NEOCLASSICAL THEORY OF INVESTMENT BEHAVIOR: A COMMENT

Robert Eiser and M. I. Nadiri *

In our "Investment Behavior and Neo-Classical Theory" [14], we pointed out that major, purportedly empirical findings of Dale W. Jorgenson and James A. Stephenson (J-S) [24, 25] depended critically upon their assumptions. We focused primary attention on what they now call their "maintained hypothesis," tied in part to the Cobb-Douglas production function, which constrains investment behavior to entail identically distributed lagged responses to changes in relative price and in output in accordance with long run elasticities of capital stock demand equal to unity. Utilizing a model which permitted separate, unconstrained estimation of price and output effects, we found that their own data for all manufacturing yielded results which contradicted their assumptions and conclusions. Recent comments by J-S [26] and by Charles W. Bischoff [1], which have offered varied but not entirely consistent responses to our findings, merit some further comment.

I Compatibility of Jorgenson and Eiser-Nadiri Models

J-S argue that our log-linear model contradicts Jorgenson's model and that "evidence predicated on the validity of either model is not relevant to the validity of the other." There is, however, no validity to this charge. First, as already pointed out, shifting from arithmetic to log-linear relations is convenient but makes no substantial difference. Since J-S have again raised the question, we now offer in table 1 comparable results of estimates from logarithmic and arithmetic relations. Critical estimated price elasticities are 0.147 from the logarithmic relation and 0.153 from an arithmetic relation for one rental price of capital, and 0.052 versus 0.058 for another, all contrasting sharply with the value of unity assumed by J-S.

<table>
<thead>
<tr>
<th>Relation</th>
<th>Constraints</th>
<th>$E_p$ Using $c_3$</th>
<th>$E_q$ Using $c_3$</th>
<th>$E_p$ Using $c_3$</th>
<th>$E_q$ Using $c_3$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Log.</td>
<td>$E_p = E_q$, $\gamma_p = \gamma_q$</td>
<td>.201</td>
<td>.201</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Arith.</td>
<td>$E_p = E_q$, $\gamma_p = \gamma_q$</td>
<td>.197</td>
<td>.197</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Log.</td>
<td>None</td>
<td>.1470</td>
<td>.6889</td>
<td>.0525</td>
<td>.5974</td>
</tr>
<tr>
<td>Arith.</td>
<td>None</td>
<td>.1552</td>
<td>.6811</td>
<td>.0583</td>
<td>.5962</td>
</tr>
<tr>
<td>Arith.</td>
<td>$\gamma_p = 0$</td>
<td>—</td>
<td>.5585</td>
<td>—</td>
<td>.5585</td>
</tr>
<tr>
<td>Arith.</td>
<td>$\gamma_q = 0$</td>
<td>—</td>
<td>—</td>
<td>.5585</td>
<td>.5585</td>
</tr>
<tr>
<td>Log.</td>
<td>$\gamma_q = 0$</td>
<td>.1084</td>
<td>—</td>
<td>.0780</td>
<td>—</td>
</tr>
<tr>
<td>Arith.</td>
<td>$\gamma_q = 0$</td>
<td>.1306</td>
<td>.5873</td>
<td>.0555</td>
<td>.6273</td>
</tr>
<tr>
<td>Arith.</td>
<td>$\gamma_p = 0$, $\gamma_q = 0$</td>
<td>.1314</td>
<td>.6455</td>
<td>.0493</td>
<td>.6459</td>
</tr>
<tr>
<td>Arith.</td>
<td>$\gamma_p = 0$, $\gamma_q = 0$</td>
<td>.2083</td>
<td>—</td>
<td>.2388</td>
<td>—</td>
</tr>
</tbody>
</table>

Note: As in previously published work, $E_p$ = estimated elasticity with respect to relative prices, $\beta/c$, $E_q$ = estimated elasticity with respect to output, the $\gamma_p$ and $\gamma_q$ are the individual distributed lag price and output parameters respectively and $\gamma$ is the constant term. Jorgenson’s rental price of capital variable, $c_3$, includes as the cost of capital "the ratio of corporate profits after taxes and net monetary interest to the value of all outstanding securities" [24, p. 17, fn. 7]. Jorgen-son’s $c_3$ takes the United States Government long term bond rate as its measure of the cost of capital.

Beyond this, our model would appear clearly to be a generalization of the Jorgenson model, with the latter the special case relating to unitary price

* [26, p. 346].
* Our "lengthy footnote 19" in [14], cited by J-S [26, p. 347].
NOTES

elasticity, such as might be forthcoming from a Cobb-Douglas production function and perfect competition, and identically lagged output and substitution effects. It is difficult to understand whether J-S really wish to reject our model, since they welcome Bischoff’s application of it insofar as they see in certain of Bischoff’s findings support for their own assumptions (while ignoring other findings by Bischoff which conflict with Jorgenson’s special case). 4

II The Issue of Increasing Returns

J-S charge us with a “theoretical lapse; [we] combine increasing returns with competitive equilibrium” [26, p. 346]. But it is J-S who assume competitive equilibrium, which raises some questions about the relevance of their model as an explanation of postwar investment in the United States. We make no such assumption. 5 The implication of increasing returns relates to the evidence of the Jorgenson data, not our theory. Rather than reshape our theory they might try to reinterpret the evidence, taking a cue from the delineation by Jorgenson and Griliches of factors contributing to upward bias in estimates of returns to scale. 6

It is of course true that increasing returns are generally incompatible with competitive equilibrium. Introduction of oligopoly and monopolistic competition into the Jorgenson model means that investment should be related not to prices and costs but to marginal revenues and marginal costs. This makes perilous any estimates of investment response with respect to the “relative prices” which are specified in Jorgenson’s model. It means as well that only under special assumptions about relations among changing marginal and average revenues and costs will direct estimates of elasticities of substitution be possible. But all this would imply further, grave errors of specification in the Jorgenson model and make all the more inappropriate conclusions based directly on those specifications. If capital demand is to respond with non-unitary elasticity to changes in relative prices because of less-than-perfect and changing elasticity of demand as well as non-unitary elasticity of substitution, it is at least better to find this out from the data than to rule out the facts by insistence on a contrary assumption.

III ExTRANeous Estimates of the Elasticity of Substitution

Apparently in response to our criticism, J-S seek support for their crucial assumption of unitary price elasticity in a scattering of extraneous estimates of elasticities of substitution, generally from cross-section studies involving vastly different kinds of data. 7 They choose to focus, however, on those studies and reports which fit their assumption of unitary elasticity and ignore or reject the very substantial body of conflicting estimates, particularly from time series, which do not. In his monumental survey article [32, pp. 93–94], Nerlove reports the following time series estimates of elasticities of substitution for the “U.S. Aggregate Production Function”: Kravis, .64; Arrow et al., .57; Diwan, .37 and .068; Kendrick-Sato, .58; Brown-de Cani, .35, .08 and .11, short run, and .55, .31 and .47, long run; Kendrick, .62; Ferguson, .67 and 1.16, assuming constant returns to scale, and .49 and .64, allowing nonconstant returns to scale; and David-Van de Klundert, .11 short run and .32 long run and .16 in a regression without distributed lags. Nerlove himself, referring to both cross-section and time series studies, declares, “The major finding of this survey is the diversity of results” [32, p. 58]. Gary Fromm, in his analysis of a number of papers relating investment and tax incentives writes, “Hall and Jorgenson justify the assumption of a unitary elasticity on the basis of empirical evidence. Unfortunately, much of this evidence is weak or contradictory.” [16, p. 80]. Most recently, Lucas finds “time series estimates of elasticities of substitution . . . well below cross-sectional estimates” and concludes “that for time series applications of substitution elasticities, time series estimates should be preferred” [29, p. 265, p. 267]. Harberger, summarizing the Lucas study, points to “Strong biases in the direction of an estimated elasticity of unity” in cross-section estimates 8 and adds, “Lucas

4 This relates, as will be seen below, both to Bischoff’s analysis of the Jorgenson data and to support for a putty-clay model which he offers in evidence from his own data of different speeds of adjustment to price and output changes.

5 What we did say was, “... If one could really accept the marginal condition $OQ/OK = c/\rho$, one could use this investment function to estimate the degree as well as the elasticity of substitution of the CES production function.” [14, p. 373, fn. 20.]

6 See [18] and [19], in particular.

7 J-S ignore the fact that even unitary elasticity of substitution is a sufficient condition for unitary price elasticity of the demand for capital only under conditions of perfect competition; the existence of these conditions is of course assumed and not established empirically.

8 See also Eisner [11], but contrary to J-S’ assertion, Eisner nowhere, in work on investment or growth models, “maintains” that the elasticity of substitution is zero. Indeed, the major point of Eisner’s [10] which J-S see as “a spirited defense of perfect complementarity” was precisely the opposite, that the Harrod-Domar-Hicks “growth models did encompass variable factor proportions” [10, p. 178, italics in original].
conclusion is that rather than ranging around unity, as the cross-section studies suggest, the elasticities of substitution between labor and capital in most manufacturing industries are probably well below unity, with 0.4 or 0.5 as a regression measure of their central tendency” [22, pp. 7, 8]. Other recent papers reporting various estimates of elasticities of substitution distinctly less than the value of unity assumed by Jorgenson and Stephenson include Chetty [4], Coen [8] and Evans [15].

There are indeed many problems in estimating parameters from time series of particular sets of data with the use of extraneous estimates of some of the parameters from cross sections of entirely different sets of data. On which parameters, for example, should extraneous estimates be imposed? Extraneous estimates for one parameter may well be inconsistent with those for another. Witness the common Cobb-Douglas estimates of $\alpha$, the elasticity of output with respect to capital, in the neighborhood of 0.23 and 0.33 and their inconsistency with the elasticity of 0.05813 reported by Jorgenson and Stephenson on the basis of their assumed elasticity of substitution of unity [24, p. 215, table 9].

IV Stochastic Specification

J-S accept with acclivity Bischoff’s suggestion that our estimating equations are asymptotically biased because of improper stochastic specification. This bias would stem from serial correlation of disturbances in equations including lagged values of the dependent variable.

Now, first, it should be made clear that the stochastic specification is not ours but Jorgenson’s. In the effort to keep our model as comparable to his as possible we did not think to alter the stochastic specification implicit in J-S [24] and all other previous, published reports of Jorgenson’s work.

But second, the possibility of an inconsistent estimator does not establish the existence of substantial bias, as might have been recalled from Koyck’s pioneering work [27] in which point estimates were shown to be relatively invariant with regard to first order autoregressive transformations of the disturbances. We find precisely the same results with the Jorgenson data.

Following Bischoff’s suggestion, we explored

* Dipping into an extensive literature on the use of extraneous estimates, the interested reader may begin with Kuh [28]. Most recently, Chetty has reminded us, in his analysis of the introduction into time series of estimates of parameters from cross-section data, “... It seems desirable not to introduce the estimate of a parameter as known with certainty when one is not really so certain about it” [3, p. 289].

See also Cochrane and Orcutt [5 and 6], Hildreth the entire range of possible first order autoregressive transformation, $1 - \rho L$, for $0 \leq \rho \leq 1$ at intervals of one-tenth or less, using equations with seven lagged values for the price and output variables and two lagged values of the dependent variable, corresponding to the best-fitting equations on which attention was focused in our original paper. The essential and characteristic results are presented in table 2.1. Using the rental price of capital $c_t$, our estimated price elasticity of 0.1470 conditional upon $\rho = 1$ (the first difference form corresponding to the J-S equations and our original ones) is relatively unaffected by the autoregressive transformations. Estimates vary only between 0.2120, for $\rho = 0.9$, and 0.0334, for $\rho = 0.6$. For $\rho = 0.0$ (the “level” form of the relation), the price elasticity is 0.1740.

The maximum likelihood estimates are $\hat{\rho} = 0.925$ and $\hat{\rho}_p$, the estimated price elasticity, = 0.1470. For most values of $\rho$, and particularly for the maximum likelihood value, the t-statistics based on the difference between unity and the sum of the $\gamma$’s and $\omega$’s indicate clear statistical rejection of the hypothesis of unitary elasticity.

<table>
<thead>
<tr>
<th>Table 2. — Maximum Likelihood Estimation of Autoregressive Parameter, Jorgenson-Stephenson Data, Manufacturing Structures and Equipment, 1949–1 to 1962–IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\rho$</td>
</tr>
<tr>
<td>(1)</td>
</tr>
<tr>
<td>A) Using $c_t$ as Rental Price of Capital</td>
</tr>
<tr>
<td>0.0</td>
</tr>
<tr>
<td>0.9</td>
</tr>
<tr>
<td>0.925</td>
</tr>
<tr>
<td>1.0</td>
</tr>
<tr>
<td>B) Using $c_t$ as Rental Price of Capital</td>
</tr>
<tr>
<td>0.0</td>
</tr>
<tr>
<td>0.1</td>
</tr>
<tr>
<td>0.32</td>
</tr>
<tr>
<td>1.0</td>
</tr>
</tbody>
</table>

* Not readily available. (Equations for $\rho = 0$ had to be estimated with Robert Hall’s Time Series Processor Regression Program for IBM 7094, dated Aug. 15, 1968. Standard errors of appropriate sums of regression coefficients were not calculated.) The two-tailed .05 probability level value in the t-distribution is 2.07 and the 0.01 level value is 2.31. t-values are conditional on indicated values of $\rho$.

With the rental price of capital, $c_t$, estimates range from the 0.0525 originally reported, and here listed for $\rho = 1.0$, to 0.1036 for $\rho = 0.0$ and 0.1068 for $\rho = 0.1$. The maximum likelihood estimates are $\rho = 0.32$ and $\hat{\rho}_p$, the estimated price elasticity, = 0.0859. Again, t-tests conditional on assumed

and Lu [23, cited by Bischoff, 1, p. 357.], and Malinvaud [30, pp. 492–494].

10 More complete versions of this and other tables may be secured from the authors.
values of $\rho$ indicate elasticities significantly less than unity, at least at the 0.05 probability level and usually at the 0.01 level. In Table 3, we present the F-tests of significance of departures of elasticities from unity suggested by Bischoff on the basis of a maintained hypothesis that errors are a first order autoregressive process. It may be seen clearly that the hypotheses which include unitary price elasticity are rejected.\textsuperscript{12}

Much of what we have just observed on re-examination of the Jorgenson data is indeed to be found in the Bischoff article. Bischoff’s Table 1, (2) [1, p. 358] offers a striking confirmation of the original Eisner-Nadiri findings relating to the rental price of capital variable, $c_2$. Bischoff unaccountably extended the number of lagged values of the independent variables to eight each instead of setting the upper bound at seven as had Jorgenson and Stephenson as well as Eisner and Nadiri. Nevertheless, the elasticity of capital stock with respect to price defined as $p/c_2$ varied only between 0.037 and 0.117 in the estimates Bischoff presented. His maximum likelihood estimate of the price elasticity is 0.072, hardly distinguishable from the Eisner-Nadiri estimate of 0.0525.\textsuperscript{13}

\textbf{V Bischoff’s Data}

While neither we nor Bischoff, in re-analyzing Jorgenson’s data find any significant support for J-S critical assumptions, Bischoff presents price and output elasticities close to unity when utilizing his own data. And in so doing, Bischoff contradicts a fundamental dynamic specification of the Jorgenson model, that the lag patterns of response to changes in relative prices and of output be identical. Indeed, if results of the Bischoff data are to be believed, the policy conclusions presumed to flow from the Jorgenson model are perhaps even more seriously vitiates than by the Eisner-Nadiri findings. For Bischoff’s results suggests that responses to relative price changes such as might be introduced by varying tax parameters and interest rates are so substantially lagged\textsuperscript{14} as to offer more danger of destabilizing effects than if the role of relative prices were merely quite weak as suggested by Eisner and Nadiri.

Re-examination of the Bischoff data, however, yields some interesting further findings. First, going back again to the original Jorgenson relation with no more than seven lagged values of dependent variables, we discovered that estimated price elasticities are uniformly less than unity for conditional values of $\rho$ at one-tenth intervals from 0.0 to 1.0. They ranged from 0.0476 for $\rho = 1.0$ to 0.8047 for an apparently best-fitting $\rho = 0$. Estimates were generally similar to Koyck-type equations with one lagged value of the dependent variable; here, the estimated price elasticities vary from 0.0367 for $\rho = 1$ to 0.6524 for $\rho = 0$, with a maximum estimated elasticity of 0.7153 for $\rho = .3$ and approximate maximum likelihood estimates of $\rho = .4$ and $E_p = .6815.\textsuperscript{15}$

But second, Bischoff’s results are found to de-

\begin{table}[h]
\centering
\caption{Test Statistics for Alternative Models of Demand for Manufacturing Capital, Jorgenson Data, Maintaining the Hypothesis that Errors Are A First Order Autoregressive Process}
\begin{tabular}{|c|c|c|c|c|c|}
\hline
Model & Test & Critical & Result of & Test & Value of $F$ \\
& No. & & $F$-Statistic & & Value of $F$ \\
& Restriction & & for $H_0$: & & of Model \\
& & & Model 1 & & Model 1 \\
\hline
A) Using $c_3$ as price of capital services & & & & & \\
1. None & 0.925 & & 0.6935 & & Reject \\
6. $E_p = 1$ & 0.20 & & 0.5798 & & 4.91 & 4.09 & Reject \\
9. $E_p = E_q = 1$ & 0.27 & & 0.6041 & & 3.46 & 3.23 & Reject \\
\hline
B) Using $c_3$ as price of capital services & & & & & \\
1. None & 0.32 & & 0.5706 & & Reject \\
6. $E_p = 1$ & 0.38 & & 0.6936 & & 8.41 & 4.09 & Reject \\
9. $E_p = E_q = 1$ & 0.38 & & 0.6938 & & 4.32 & 3.23 & Reject \\
\hline
\end{tabular}
\end{table}

\textsuperscript{12}Estimated elasticities with respect to output are found to be uniformly higher than price elasticities, corroborating our original article, regardless of the value of $\rho$. Some markedly low estimates of output elasticity with $\rho < 1$, when $c_3$ is taken as the rental price of capital, may relate to the capture of an output effect in the measure of the value of outstanding equity which enters into the definition of $c_3$.

\textsuperscript{13}Bischoff’s results when using $c_1$ are, as he indicates, “very peculiar” [1, p. 358]. When he specifies $\rho = 0$ he manages to obtain a price elasticity of .525, at the cost of an output elasticity of -.434! For his preferred value of $\rho = .2$, he offers an estimate of price elasticity of .358 and an output elasticity of .028. It is rather difficult to account for the differences between these estimates and those we have presented now in Table 2; some of the difficulty may relate to the awkward relation between $c_3$ and output cited above, the effects of which may be exacerbated by Bischoff’s addition of still another set of lagged values of these highly autocorrelated and intercorrelated price and output variables.

\textsuperscript{14}The total effect of relative price changes on capital stock over the first four quarters are estimated to be slightly negative by Bischoff, and over the first eight quarters the total price elasticity of capital response is given as only 0.1158. Bischoff’s results with his data would have fully half of the price effects after a four-year lag. [1, p. 556, table 5.]

\textsuperscript{15}It may also be noted that the Bischoff series extends through 1966 and that restriction of the observations to the years 1949–1962 does tend to lower the estimated price elasticities for low values of $\rho$. Further, it is conceivable that Bischoff’s capital spending, which is for equipment, may tend to have less of a lead time and be more sensitive to fluctuations in relative prices than J-S\textsuperscript{16} spending for equipment and structures.
pend critically on his own definition of the rental price variable. This is a trend-adjusted, weighted average of earnings-price ratios and bond yields, which enter separately into Jorgenson's $c_1$ and $c_0$, respectively. It may be further recalled that the weights and the trend were estimated as part of a minimization of residual sums of squares in previous investment regressions with very similar data. In an effort to ascertain the special contribution of Bischoff's version of the price of capital variable to his relatively high estimates of the price elasticity, similar regressions were run using Jorgenson's rental price variables instead of Bischoff's. The results are striking. Taking values of $p$ at one-tenth intervals from 0.0 to 1.0, and using $c_1$ as the rental price of capital services, we find the estimated price elasticity never higher than 0.2202. For the best fitting value of $p = 0.3$, the estimated price elasticity is 0.1606. Using the preferred $c_2$ as the price of capital service, we secure a range of estimates of price elasticity never higher than 0.2827, with a figure of 0.2608 for the best fitting value of $p = 0.3$. The $t$-test indicates this estimate differs very significantly from unity $(t = 3.23)$, although, in the poorer fitting estimates involving $c_1$, the $t$-test does not indicate rejection at the 0.05 level of the hypothesis of unitary price elasticity.

Thus, on the major substantive question of price elasticity, our original paper is fully sustained. As far as the Jorgenson data go, the statistical question of autocorrelation of disturbances, on the basis of which J-S seek to dismiss our findings, proves irrelevant. Re-estimates of price elasticity prove uniformly low and comparable in magnitude to those presented on the basis of the original Eisner-Nadiri and Jorgenson stochastic specification.

Results with the Bishop data are somewhat different, but the difference can be fully accounted for in Bischoff's price-of-capital variable which is itself a series of values fitted to similar investment data. When the Jorgenson rental-price-of-capital variables are used with the other Bischoff data, our original results with the Jorgenson data are reconfirmed.

### VI Conclusion

We do not pretend to have the last word on the question of elasticity of response to changes in

\[ \text{Some further question may be raised as to Bischoff's generalization of Jorgenson's stochastic specification. J-S were quite explicit in specifying an exact relation determining desired capital stock. They then introduced "a stochastic specification in which a random term $\epsilon_t$ is added to the final form of the distributed lag function" in net investment. It is this error in their "difference equation in net investment" which was assumed to be "distributed independently and identically over time and distributed independently of all values of changes in desired capital stock." [25, pp. 180-181.]} \]

The appropriate generalization of Jorgenson's specification to meet the danger of first order autoregressive correlation in the error terms would hence involve estimating $p$ in a $[1 - pL]$ transformation of an equation in net investment, not capital stock. We have in fact re-estimated our relation and found estimated price elasticities proved quite insensitive to such a transformation. With the relative price variable $p/c_0$, they fell within the narrow interval $[-0.111, 0.013]$ for trial values of $p$ between $-1$ and $+1$. The maximum likelihood estimates were $p = .23$, $\hat{E}_p = .0606$, $\hat{E}_\epsilon = .5848$. For Bischoff's data including his relative price variable, the range of estimates was similarly narrow and the approximate maximum likelihood figure for elasticities were $\hat{E}_p = .09$ and $\hat{E}_\epsilon = .92$.

Whether the J-S specification that errors arise only in the investment relation as opposed to the underlying capital demand relation is correct is uncertain, however. A general neo-classical theory of investment behavior may well imply disturbances related to each of two underlying relations, one determining desired capital and the other the adjustment or path of change of capital. If we specify either a capital stock equation or an investment equation, the disturbances thus may prove to be a complicated function of the error terms in both relations. We see no a priori ground for deciding which components of such disturbances would be dominant or even whether the same components would be dominant in all circumstances. These issues may relate in part to basic questions of theoretical specifications and possible reconciliations of the assumption of perfect competition and an exogenous role for output, which may imply nonequilibrium values for desired capital stock, as pointed out by Coen [7, 8 and 9] and Gould [23]. The whole matter may well merit further, systematic investigation which would take us beyond the framework of the Jorgenson model and the limited scope of this paper.
relative prices and the broader issues of the determinants of business investment. In this perplexing area, all of us make assumptions for purposes of simplicity and elegance which may prove useful as we who are blind in proverbial fashion investigate the shape of the elephant. It is important, however, that we confuse neither ourselves nor our readers as to what is assumption and what are empirical findings. We hope that our original article and this further comment have contributed to reducing the possibilities of such confusion.

REFERENCES


[22] Harberger, A. C., and M. J. Bailey (ed.), The

One problem not taken into account in this paper or any of those under discussion relates to interaction among various productive inputs and their rates of utilization. Nadiri and Rosen [31] have developed a general model of interrelated factor demand which allows disequilibrium in the employment and rate of utilization of one factor to affect the demand functions for other factors. It may be pointed out that application of this model to a body of data very similar to Jorgenson's yielded estimates of long run price and output elasticities very similar to those reported originally by Eisner and Nadiri.

Space limitations prevent more than the briefest reference to "peripheral issues" disputed by J-S.

a) J-S did constrain at least the first lag coefficient to be zero in all of the "eighteen possibilities [they] considered" and standard errors of estimate are lower when this constraint is removed. Indeed, the J-S claim that there is no capital expenditure response except after four or more quarters is further contradicted by Bischoff [1, p. 366, table 6] and by Hall and Jorgenson [20] and, most recently, [21].

b) That all coefficients are non-negative and partial sums less than unity is better ascertained, if that is possible, from the data than from the so-called "defining characteristics of a distributed lag function" [26, p. 350].

c) Replacement proportional to capital stock remains a hypothesis—sometimes convenient but not always very reasonable in view of the cyclical nature of capital expenditures. It is contradicted, for the all manufacturing data within the framework of the Jorgenson model, by the significant difference between the regression estimate of the rate of replacement and the estimate derived from the "perpetual inventory" calculations.


