Lags in Training Response to Changes in Economic Activity: An Update for Five Industries and an Addition of Two

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An expanded investigation of the time it takes training budgets in five, now seven, industries to respond to changes in market demand and productive activity. A serious question, this reflects directly on the ability of the American economy to respond to changes in economic environment. Results indicate that for three of the five initial industries studied, the length of lag between change in demand and median adjustment to it is far longer than previously measured.

Keywords: Training, Change, Strategic Human Resource Development

In their 2007 work, Azevedo, Park, and Akdere explored the time lags involved between changes in measures of demand and training expenditure response in five industries. The investigation concerned those five industries for which data were available and the time period for which those data were obtainable, 1989-1998.

The conceptual basis for these studies lies in the basic question of how quickly do industries respond when they experience a significant change in the demand for their outputs regardless of the output form. As the world has moved toward a just-in-time environment in which firms attempt to meet the needs of their customers just as those customers present them (Schroeder & Flynn, 2001); firms and industries now compete on the basis of response time more intensively than ever. Indeed, responding in time may be key to an organization's long term success or failure.

Since the earlier study, data have become available for two additional industries and for slightly longer time periods depending upon the particular industry involved. The availability of additional years of data is valuable for a number of reasons. First, it allows for testing stability of the approach; more data can tell you that the relationship is consistent through time. Second, and related to the first, more data will be able to tell you if the cycle is longer in time (i.e., span) than was possible to determine with the previously available data. Third, the additional data provide for a richer analysis of the behavior of training lags in individual industries.

Measuring Lags in Training—A Recognized Technique

There are a host of reasons why training may lag behind economic activity in the firm and industry. A firm may be unsure as to whether an increase in demand will "stick," delaying its training efforts until it is sure. A firm may hold back on training because it has insufficient capital in place and must delay until new technology arrives. A firm may be planning on/working toward expanding in other markets and be caught off guard when demand surges for an output it no longer believed to be an active participant in the market. A firm may find training materials in short supply and be forced to postpone its training effort.

While the above list is extendable, and it is impossible to assess each of the possible reasons for the lag individually, we are able to assess the combined effects as explained below. What is known about such "delaying causes" in the lags between output increases and response to them is that the wait generally follows a geometric lag (Koyck, 1954) particularly when measured on an aggregated basis. What this means is that those factors which move a firm to delay its investment in the training decision tend to have their greatest impact in the initial period and then trail off in successive periods. This trailing off is largely due to the other effects (some of which are mentioned above) which are working in the instant period(s) and the interactions of all effects from all time periods. While there may be some variation in the lag patterns of individual firms—and lag structures such as the Almon or adaptive expectation lags or the stock adjustment approach might be used--these tend to wash out when industry-wide data are assessed. What this means is that, while the geometric decline of Koyck provides the best assessment at the level of data utilized here, other approaches may work with individual firm data.

While the geometric lag is conceptually appropriate for this investigation, it also bespeaks an infinite lag. The advantage of the Koyck (1974) technique is that allows us to measure the impact over a limited period of time as will be evident below. The Koyck methodology specifically allows us to address the question of how the training expenditures of an industry respond to the shock of an increase or decrease in the demand for its output. As a stone thrown in a pond leads to circles radiating outward infinitely, any change in demand for an industry's output reverberates through the industry as subsequent changes in training programs, production procedures, and supply chains occur. The Koyck methodology allows assessment of how long those changes take.

What we need now do is consider the impact of any change in the level of economic activity on training as being measured by an equation of the following form:

$$(1) \qquad T_t = \alpha + \beta_0 O_t + \beta_1 O_{t-1} + \beta_2 O_{t-2} + \ldots + \beta_n O_{t-n} + \varepsilon_t$$

which simply says that the training in time t (T_t) is a function of the Output in time t (O_t) and Output in each of the previous time periods (e.g., t-1, t-2,…, t-n).

We then identify a weight, termed λ such that $0 < \lambda < 1$ which captures the geometric nature of the decline in the following form and allows us to use/assess a constant/stable coefficient:

$$(2) \qquad T_t = \alpha + \beta_0 O_t + \beta_0 \lambda O_{t-1} + \beta_0 \lambda^2 O_{t-2} + \ldots + \beta \lambda^n O_{t-n} + \varepsilon_t$$

The remaining difficulty with this equation/approach is that it is still one with an infinite time horizon which means that it is unobservable/unmeasurable in reality. The transformation by Koyck (1954), however, allows us deal with these infinite observations. We start with the equation/relationship noted above lagged one time period:

$$(3) \qquad T_{t-1} = \alpha + \beta_0 O_{t-1} + \beta_0 \lambda O_{t-2} + \beta_0 \lambda^2 O_{t-3} + \ldots + \beta_{n-1} \lambda^{n-1} O_{\tau-n-1} + \varepsilon_{t-1}$$

We multiply our third equation by λ and obtain:

$$(4) \qquad \lambda T_{t-1} = \lambda\alpha + \lambda\beta_0 O_{t-1} + \beta_0 \lambda^2 O_{t-2} + \beta_0 \lambda^3 O_{t-3} + \ldots + \beta_{n-1} \lambda^{n-1} O_{t-n-1} + \lambda \varepsilon_{t-1}$$

We now subtract (4) from (2) with the result:

$$(5) \qquad T_t - \lambda T_{t-1} = \alpha(1-\lambda) + \beta_0 O_t + (\varepsilon_t - \varepsilon_{t-1})$$

which becomes through reduction:

$$(6) \qquad T_t = \alpha(1-\lambda) + \beta_0 O_t + \lambda T_{t-1} + v_t \qquad \text{where } v_t = (\varepsilon_t - \varepsilon_{t-1})$$

The above algebraic treatment, which is called the *Koyck Transformation* (1954), leads to an equation which is measurable in current values of Output and previous values of Training, and allows for an empirical assessment of the lags associated with response to changes in demand….we now turn to such an assessment in an update of what has been done before.

Measuring Lags in Training—An Updated Assessment

Given this assessment technique, we need to note that the Azevedo, Park, and Akdere study of 2007 was somewhat constrained by the time period of data availability for the study. All of the years investigated were from 1989 to 1998, leaving one to ask what longer periods might show. We were able to obtain additional data for the period from 1982 to 1988 for some three of the previously studied industries as well as to add two industries—wholesale and retail trade and government—to the mix. These additions provide insight into the effects of expanded time periods on the patterns of expenditures on training by industry.

The data were taken from two major sources: *Training* Magazine and the Bureau of the Census, U.S. Department of Commerce. They were supplemented in some cases with data from the Bureau of Labor Statistics, U.S. Department of Labor. The advantage of these data is that they allow for a matching of the firms by both industry and firm size. The surveys involve firms larger than 100 employees and were matched to Standard Industrial Classification categories, allowing for rather unique comparability across data sources.

Table 1. *Comparison of β_0 , λ, and r^2 From Regressions Estimating Training Lag in Selected Industries, After Koyck Transformations Original Results & Update*

Industry	Sales / Gross Domestic Product						Production / Value Added					
	B_0	Λ	r^2	β_0	λ	r^2	β_0	λ	r^2	β_0	λ	r^2
		1989-1998			1982-1998			1989-1998			1982-1998	
Manufacturing	208.2	0.342	0.466	202.6	0.585	0.887	202.2	0.311	0.462	2223.1	0.778	0.877
Finance, Insurance and Real Estate	543.1	0.419	0.832	N/A	N/A	N/A	305.8	0.417	0.842	182.2	0.561	0.622
Transportation	-76834	0.493	0.562	N/A	N/A	N/A	-1277.8	0.271	0.605		N/A	
Business Services	-114.9	0.135	0.126	N/A	N/A	N/A	-86.2	0.159	0.135	39.3	0.793	0.840
Educational Services	15870.1	*0.321	0.418		N/A		626632	0.348	0.449		N/A	
Wholesale and Retail Trade				428.7	0.277	.967				7177.9	0.266	0.967
Government *, **				0.276	0.104	0.493				0.286	0.106	0.468

Table 2. *Comparison of Median Length of Response in Training Activity to Two Measures of Industry Output – Sales and Value Added; Using Koyck Transformation Regression Results, Original and Update*

Industry	Median Length of Response Time, In Months, Due to Change			
	Sales / Gross Domestic Product		Production / Value Added	
	1989-1998	1982-1998	1989-1998	1982-1998
Manufacturing	7.7 months	15.5 months	7.3 months	33.1 months
Finance, Insurance and Real Estate	9.6 months	N/A	9.5 months	14.4 months
Transportation	11.7 months	N/A	6.4 months	N/A
Business Services	4.5 months	N/A	4.2 months	36.0 months
Educational Services	7.9 months	N/A	7.8 months	N/A
Wholesale and Retail Trade		6.5 months		6.8 months
Government *, **		3.7 months		3.7 months

*, **: Based on unweighted and employee weighted total government outlays

Table 1 reports the results of the Koyck Distributed Lag analysis of Azevedo, Park, and Akdere (2007) with the inclusion of results encompassing the additional years 1982 through 1988 for three of the industries previously nvestigated (Manufacturing; Finance, Insurance and Real Estate, and Educational Services) as well as for two new industries: Wholesale and Retail Trade and Government.

We note that in general, the r^2 values for the longer time periods are higher/larger than they were for the original ten year period 1989-1998. This reveals the usually beneficial effects of extending the time period to allow the Koyck technique a fuller opportunity to exhibit its measurement capabilities. The industry where the new r^2 value was less than reported for the 1989 – 1999 period was Finance, Insurance and Real Estate is an industry with well-known dramatic changes in structure and/or definition during the period under consideration (U.S. Department of Commerce). Recall the savings and loan crisis and their disappearance from the market, the growth of interstate banking, and the number of bank and real estate mergers during this period, changing dramatically the nature of this industry—particularly its firm size—over the time period now possible in this study.

The two new industries for which data were obtained—Wholesale and Retail Trade and Government—reflect considerable different values of r^2, with the government values being about half those of the trade sector. This suggests training in government is much less tied to the level of fiscal activity that it is to business activity at both the wholesale and retail levels.

Because we know from Gujarati (2003) that

$$\text{Median Lag} = -(\text{Log } 2/\text{Log } \lambda) \tag{7}$$

we are able transition the analysis to the actual measured lags in Table 2.

Considering to Table 2, we find the additional yeas of data reveal longer lags than those described in the 2007 study by Azevedo, Park, and Akdere. In fact, in some cases the reported lags are dramatically longer. This is true for the sales lag in Manufacturing where the new results indicate almost twice the previously reported lag. Relative to production or value added, there were dramatic increases in the length of lag in Manufacturing and Business Services with only a slight increase in the case of Finance, Insurance and Real Estate. The new industries, Wholesale and Retail Trade and Government, show lags which are consistent with those reported in the earlier study by Azevedo, Park, and Akdere (2007). These shorter lags, over the longer measured time period (i.e., 1982 – 1998), suggest both of these industries are more flexible with their training capabilities and face their training needs much more quickly than do the other sectors of the economy studied.

It is interesting to note that the results were the same—3.7 months—regardless of how the economic impact of lags is measured in the government sector. Thus, although sales and value added are not generally attributed to government, when its output is as closely paralleled to these concepts as is possible, they make no difference to lags in training.

Implications for Human Resource Development

Scholars and practitioners in HRD need to be aware of the implications of these results. The field of training is one of the least regulated areas within the Human Resource Development (HRD) umbrella. Many trainers do not even go through a certification or a licensure process which would have the potential to make them aware of the industrial impact of what they do. This is largely due to the independent nature of the field where companies often decide for themselves about their training needs. One of the findings of this study is that U.S. companies generally do not respond to training needs in their industry in a timely fashion; thereby leading to lags in training. The problem is twofold. First, newer training needs do emerge during these lags; thus further complicating the issue. Second, such lags in training definitely put U.S. companies in a less advantageous position compared to their global competitors. Furthermore, these lags in training may become barriers in achieving learning in the workplace. HRD practitioners should continue their advocacy efforts at the top management level to emphasize the importance of investing in human capital through training to strategically position the organization in rapidly changing global markets. In doing so, HRD practitioners need to convey he findings of studies like this to the highest levels of management in their organizations as prime rationale for more timely and effective use of the training function.

Summary, Conclusions, and the Need For Further Work

When involved with a data intensive study of the type contained herein, more data are always of value for the additional enlightenment they may provide. Here we find that more years of data allow us to determine that the lag in training response by American industries is greater than Azevedo, Park, and Akdere (2007) were able to determine when limited to using data from the 1989 through 1998 period. This report is not meant to criticize that study but rather to build upon it due to the availability of new data, shedding a bit of additional light on this subject.

Once again we need to recognize the importance of these lags to an American economy which is becoming even more internationalized. Today, inflation, recession, boom and bust are ever more international in impact, touching virtually every nation at the same time. Much of the world speaks to operating on a "just-in-time" basis, with production, inventories, shipments, and, most importantly, trained workers available when needed to meet output demands. When, for example, U.S. manufacturing takes almost three years for the median firm to meet its production based training needs, this bespeaks falling behind countries of the world where training of workers takes on more primacy.

In sum, while those of us who study training are often advocates for more of it, it is not always without a quantum of altruism. More work needs to be done to make America a better competitor on the world scene. Indeed, creativity, invention and determination will help in such a venture. So too will the timely delivery of training ensure a strong U.S. competitive position worldwide. If the lags in training response get longer the America can do no better than slip backward in the hierarchy of world competitors.

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