Market structure and voluntary product standards

By: Albert N. Link

Link, A.N. "Market Structure and Voluntary Product Standards," *Applied Economics*, 1983, 15(3): 393-401. https://doi.org/10.1080/00036848300000009

Abstract:

A voluntary standard is an agreement intended to facilitate communication within an industry. Specifically, it is a technical document to describe design, material, processing, safety or performance characteristics of a product (US Federal Trade Commission, 1978). Standards serve to meet various functions: 1. to provide information such as consistent terminologies or measurement methods; 2, to ensure physical compatability between related products produced by different manufacturers; 3. to establish minimum acceptable levels of product quality; or 4. to restrict product variety so that production economies can be realized.

Keywords: voluntary product standards | market structure | consumer products

Article:

I. INTRODUCTION

A voluntary standard is an agreement intended to facilitate communication within an industry. Specifically, it is a technical document to describe design, material, processing, safety or performance characteristics of a product (US Federal Trade Commission, 1978). Standards serve to meet various functions: 1. to provide information such as consistent terminologies or measurement methods; 2, to ensure physical compatability between related products produced by different manufacturers; 3. to establish minimum acceptable levels of product quality; or 4. to restrict product variety so that production economies can be realized.[1]

[1] Standards are not homogeneous with regard to their function in the market. Standards perform various functions. Because of their heterogeneity in purpose, several classificatory schemes have been noted in the literature. These functional categories were designed by Putnam, Hayes, Bartlett Inc. (1981b); however, other classificatory schemes have been used in the literature. Hemenway (1975), for example, dichotomizes standards into those for uniformity and those for quality. The American Society of Testing and Materials uses five categories: standard definitions, standard recommended practices, standard test methods, standard classifications, and standard specifications. No scheme is perfect since any one standard can often be placed in more than one category.

Standards have existed in one form or another in almost every society.[2] Today, there are more than 30000 voluntary product standards (as opposed to mandatory product standards, which entail a legal obligation to comply) in effect within the United States. There is preliminary evidence, based on selected case studies, that voluntary standards influence the rate of growth and direction of innovation in firms and in industries to which the standard applies (Putnam, Hayes, Bartlett Inc., 1981a; Tassey 1981). However, there has not been, to my knowledge, an economic analysis of the factors influencing the adoption of voluntary standards.[3] This paper attempts to fill that void.

In Section II a conceptual model of standards activity is presented. Then, in Section III one aspect of the model is tested empirically; namely, the influence of the seller's market structure on the probability of a product being standardized. Finally, in Section IV, some concluding remarks are offered.

II. A MODEL OF VOLUNTARY STANDARDS ACTIVITY

At least two groups of individuals can influence the promulgation of a voluntary standard; the buyers and the sellers of the product to which the standard applies. As with any economic activity, incentives will determine the level of effort exhibited by either group in the voluntary process. In other words, buyers and sellers will participate in the standards process to the degree that they can appropriate net benefits.

Buyers have an incentive to favour a voluntary standard in order to decrease their transaction costs and thus increase their purchasing efficiency. These transaction costs arise in several ways. One way is as a result of an asymmetry in information between buyers and sellers regarding the quality of a product (Akerlof, 1970). If a standard could improve the consumer's information about the quality of the product (for example, by promoting an interchangeable design) then the consumer may benefit in at least two ways. First, his uncertainty about the usefulness of the product may be reduced and thus the effective price of the product would fall due to lower search costs. Second, if the consumer's increased buying confidence about the product increases overall demand, then the price may fall and the quality may increase owing to competition for the marginal demand.

The degree to which consumers can influence the adoption of a particular standard, and thus internalize the pecuniary benefits from the new knowledge that results, is hypothesized to be negatively related to the competitiveness of the buyer's market. In a market where buyers are atomistic, no one will willingly incur the organizational costs associated with participating in the voluntary standards process since no one can fully appropriate the resulting informational

---

[2] For example, standardized weights and measurement scales have been dated as far back as 3500 BC (Verman, 1973). For example, in 1477 bricks in England were standardized to an after-firing size of 9 inches long, 44 inches wide, and 24 inches high: this voluntary standard eventually became mandatory by an Act of Parliament in 1567 (Verman, 1973). Of more contemporary interest is the sizing of a two-by-four piece of lumber. In the early days of the lumber industry variations in dimensions of wood depended on how sizes were quoted-green or dried, uncut or planed. By 1920, however, regional lumber associations voluntarily agreed upon the dimensions of a two-by-four as 1 5/8 inches by 3 5/8 inches (Hemenway, 1975).

[3] Watson (1980) has analysed standards organizations. those bodies influential in the final promulgation of a voluntary standard, and their role over time in formulating standards.

benefits. When buyers are concentrated, perhaps, say, in an intermediate rather than a final goods market, they may more readily realize the benefits from cooperative action.[4]

Producers may also have several reasons for promoting a voluntary standard. Standards may reduce their production costs by limiting the variety of dimensions of a product (for example, mattresses are sold in only four standard sizes). Hence, it is potentially feasible for firms to benefit from production economies in standardized lines to the extent that previous purchasers of the nonstandardized product shift their demand into the standardized product. In that case the standard would be fulfilling the function of variety reduction. Variety reduction may not only encourage larger scale production, but may stimulate process innovations (automation for example) which may further reduce cost. Or, as noted above, a standard may increase the confidence of buyers and thus increase their demand for the product. Again, an enlarged market may afford a firm the potential for internalizing the cost-related benefits from economies of scale.[5]

Firms may promote voluntary standards for reasons other than those related to economies of scale. One, a standard may act as a barrier for new firms seeking to enter the industry. These entry barriers often function when the standard in question exhibits a quality or compatibility related function. Two, a standard may act as a form of nonprice competition to eliminate firms from the industry. Consider a situation where a group of firms is selling an inferior product in the market. Since consumers do not have perfect information on quality, these firms may be profitable. Firms producing the higher quality good may favour a quality standard to eliminate this competition. Three, a variety reduction standard may facilitate oligopolistic coordination, for example, by eliminating alternative (and competitive) versions of the underlying technology. Tacit collusion is more difficult to monitor the more complex the product. An accepted product standard may reduce one dimension for possible cheating.

As was the case for consumers, the extent to which producers participate in the voluntary standards process is proportional to the net benefits they receive. Since most standards organizations use a consensus rule for decision making, the probability that firms will cooperate in establishing a particular standard depends on their ability to cooperate (Watson, 1980). This ability, it is hypothesized here, decreases (increases) as the output market becomes atomistic (concentrated). In a perfectly competitive environment, where benefits are nonappropriable, consensus is unlikely: no firm would have the incentive to incur the costs of initiating the voluntary process. As the product market tends toward the monopolistic end of the market structure spectrum, cooperation is more likely since firms would realize their interdependence.

---

[4] The early efforts of the Society of Automotive Engineers to regulate oil viscosity are one example where concentrated buyers were instrumental in the adoption of the voluntary standard (Thompson, 1954); however, regarding most consumer goods buyers have little influence. A case in point was the inability of consumerist groups in the 1960s to influence voluntary labelling and packaging standards: only with political intervention did mandatory standards, such as the *Fair Labelling and Packaging Act 1966,* become effective (Hemenway, 1975).

[5] This economic value of a production standard was perhaps first realized by Eli Whitney by using interchangeable parts in the production of muskets in 1800. However, Veblen (1936, p. 12) first theorized about the economics of standards: 'standardization means economy at nearly all points of the process of supplying goods, and at the same time it means certainty and expedition at nearly all points in the business operations involved in meeting current wants. . . The standardization of goods means that the (variability) of industrial processes is reduced to more definite terms. . .'

And, if standards did serve as a means of coordinating tacit agreements, their benefits would increase with market concentration. Theoretically, the relationship between market structure and the probability that firms will initiate the voluntary standards process may be like that described in Fig. 1. As drawn, the probability of firms initiating standards activities remains zero until some threshold level of market concentration, A, is realized. Beyond that level, the probability increases as market power increases owing both to the ability of firms to cooperate and to the increased benefits they expect to receive, *ceteris paribus.*

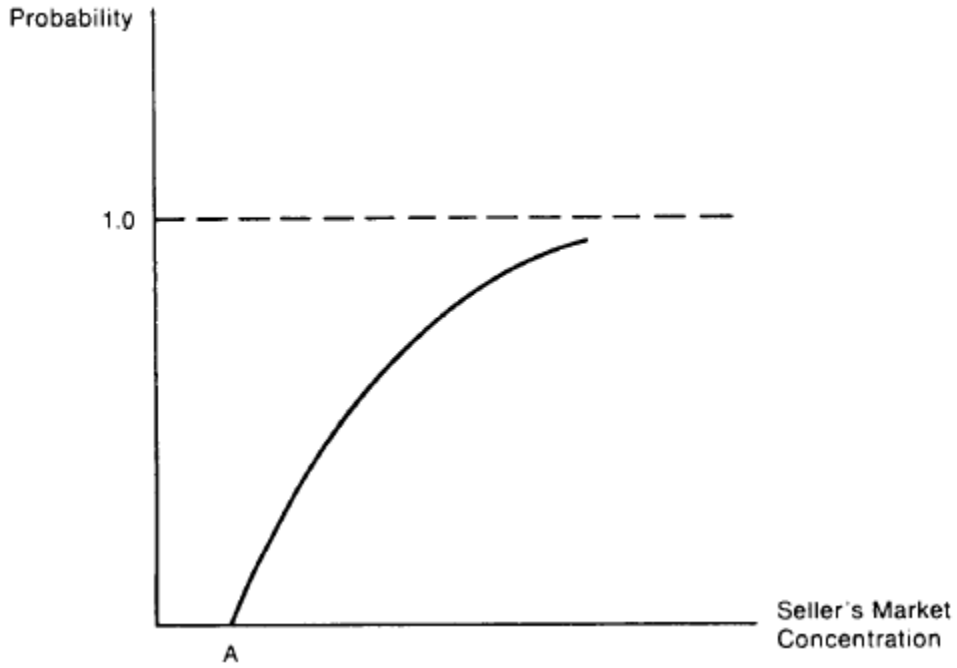

Fig. 1. Relationship between market structure and the probability of initiating voluntary standards.

At least two other industry characteristics may influence the adoption of standards. The first is the technological complexity of the industry's production process. The more complex the production process, the more difficult it is for buyers and sellers to agree on the performance attributes of products; therefore, the greater the demand for standards by both parties, *ceteris paribus.* In addition, the associated reduction in information costs may allow the market to grow faster. The second characteristic is the degree of unionization within the industry. The management of firms where the collective bargaining strength of unions is strong may favour production-related standards as a form of labour-saving technology (Hemenway, 1975). Generally, unionized workers' wages rise faster than the price of capital inputs; accordingly, firms may pursue their profit-related calculus by increasing their capital-to-labour ratio. One avenue to this end may be to adopt, or at least to initiate, standards, *ceteris paribus.*

III. THE EMPIRICAL FRAMEWORK AND ANALYSIS

To provide some quantitative support for these hypotheses an industry index of voluntary standardization needed to be formulated. Information from the US National Bureau of Standards in *Tabulation of Voluntary Standards and Certification Programs for Consumer Products* (US

Department of Commerce, 1977) and from the unpublished documentation to this publication was used to identify and classify 881 consumer product areas (generally seven-digit SIC classifications) as 'standardized' or 'not standardized' on the basis of whether at least one voluntary standard existed as of 1976.[6] Since these data do not disaggregate standards by their functional use, the following empirical analysis is constrained to view standards as homogeneous in function as well as form. Still, this index represents, to my knowledge, the first empirical attempt to quantify standardization activity within US manufacturing.

Of the consumer product areas considered, 53.8% were defined as standardized, that is, they had at least one voluntary product standard in effect as of 1976. Since the primary data source was specific to consumer products, certain industries are better represented than others: five two-digit industry groups contained more than 50 different product areas.[7]

The model presented in the previous section was based on the hypothesis that buyers as well as sellers may have an incentive, depending on their market structure, to promulgate voluntary standards. Since the data here apply only to consumer products, it is assumed that the buyer's market is atomistic and that the market structure impetus for voluntary standards comes only from the producer's side.

The following regression model is intended to test the propositions posited in the previous section:

$$STAND = \alpha_0 + \alpha_1 CR + \alpha_2 CR^2 + \alpha_3 TECH + \alpha_4 UNION + \varepsilon. \qquad (1)$$

The dependent variable, *STAND*, represents the probability that the voluntary standards process will be initiated for a particular product. It is estimated using the dichotomous standardization index described above. *STAND* takes on the value 1 if a product area has at least one voluntary standard in effect, and takes on the value 0 otherwise.

The variable *CR* represents the degree of seller market power in the four-digit industry associated with each consumer product area. It is measured by the 1972 four-firm concentration ratio as reported by the US Department of Commerce (1975).

The variable *TECH* represents the technological complexity underlying the industry's production process. Here, it is assumed to be a function of the research and development (R & D) activity in the industry in which each product area is classified. This variable is quantified in two ways. First, it is measured by the process R & D intensity (process R & D expenditures per unit of sales), *PROCRD*, of the two- or three-digit industry corresponding to each consumer product area. R & D activity encompasses a myriad of activities: one possible dichotomy is to distinguish between process- and product-related innovations. Link (1982) and Terleckyj (1982) have shown that the fraction of total R & D allocated to process innovations is more highly correlated with the underlying level of technological change in a firm or industry than the fraction allocated to

[6] About 1000 product areas are listed; however, many could not be uniquely associated with a particular seven-digit or even four-digit SIC industry and hence were deleted since they would not be compatible with other data used in the empirical analysis.

[7] Summary statistics, by industry, are available by request from the author.

product innovations. Total 1976 R & D expenditures per unit of sales estimates (National Science Foundation, 1979)[8] were weighted by the 1976 percentage of R & D allocated to process innovations (McGraw-Hill, 1977). Second, R & D expenditures per unit of sales estimates were weighted by the 1976 percentage of R & D allocated to basic research, *BR.* Although basic research represents only a small fraction of total R & D, about 5% for the entire manufacturing sector, it may be that the activities near the basic end of the R & D spectrum are also a good approximation of the relevant inputs into a firm's or industry's underlying level of technical advance.[9] The empirical research of Mansfield (1980) and Link (1981) lends some support to this hypothesis.

The variable *UNION* is the percentage of each two-digit industry's labour force that is unionized. These data come from Freeman and Medoff (1979).

Equation 1 was estimated by probit analysis owing to the dichotomous nature of the dependent variable. The regression results. using both measures of *TECH,* are reported in Table 1. Each of the estimated equations is significant at the 0.01 level or better as measured by the likelihood ratio test (Silberman and Durden, 1976).

Table 1. Probit results from Equation 1 (asymptotic *t*-statistics in parentheses)

	Probit coefficients		**Partial derivatives**	
Independent variables	**(1)**	**(2)**	**(1)**	**(2)**
Constant	–0.970 (–4.49)	–1.030 (–4.76)	—	—
CR	–0.928 (–0.69)	–1.156 (–1.27)	–0.349	–0.459
CR^2	2.001 (2.80)	2.083 (2.85)	0.797	0.826
PROCRD	—	1.022 (5.22)	—	0.406
BR	1.338 (2.69)	—	0.530	—
UNION	2.011 (5.63)	1.804 (5.09)	0.798	0.715
–2 × log likelihood ratio	81.55	106.26	—	—

In both versions of Equation 1, the reported probit coefficient on *CR* is not significantly different from zero, whereas the coefficient on CR^2 is positive and significant at the 0.01 level or better. These findings suggest that levels of concentration less than, say, 0.23[10] have no statistical importance in influencing standards activities. After that threshold level, the influence remains positive.

[8] R & D data are not published at a more disaggregated level. The Federal Trade Commission's Line of Business Summary Statistics reports only averages on R & D intensity for selected four-digit SIC industries, and hence was not considered to be a superior data source.

[9] The National Science Foundation (1979) defines basic research as the original investigation for the advancement of scientific knowledge that does not have a specific commercial objective.

[10] The mean value for *CR* is 0.344. The threshold level based on the estimates in column 2 of Table 1 is 0.28.

As hypothesized, the technological complexity variables are positively related to *STAND,* and are significant at the 0.01 level or better. Similarly, the estimated coefficient on *UNION* is positive, as predicted, and significant at the 0.01 level or better.

Probit coefficients cannot be interpreted directly as partial derivatives. The calculated (evaluated at the mean) partials are also reported in Table 1.[11] Of particular interest are the partials associated with the two alternative measures for the technology variable. A one percentage point increase in the per cent of sales allocated to process innovations (basic research) increases the probability of voluntary standardization by about 41 (53) percentage points, *ceteris paribus*.

The impact of market structure on standardization may, however, not be independent of this technology effect. For example, it was suggested above that standards may be promulgated as a form of an anti-competitive strategy. This motive for standardization may not be uniformly strong across all industries. In particular, if technological advance within an industry is positively related to aspects of inter-firm competition within that industry, then the strength of the statistical relationship between standardization and market structure may too be industry specific.

To test empirically for this possibility, the sample of 881 product areas was subdivided into two broad groupings, high and low technology industries. This dichotomy was based on relative levels of process and basic R & D intensity. High technology industries were defined here as chemicals (SIC 28), machinery (SIC 39, electrical equipment (SIC 36), transportation (SIC 37) and scientific instruments (SIC 38).

For the high technology group (379 product areas), the probit estimates, with asymptotic *t*-statistics in parentheses and calculated partial derivatives in brackets, are

$$\begin{array}{lllll} STAND = & -0.440 - & 0.069\ CR + & 1.461\ CR^2 + & 1.549\ UNION \\ & (-0.95) & (-0.04) & (3.78) & (2.36) \\ & & [-0.022] & [0.476] & [0.505] \end{array} \qquad (2)$$

$-2 \times$ log likelihood ratio = 47.12

and for the low technology group (502 product areas), the results are

$$\begin{array}{lllll} STAND = & -0.679 - & 1.996\ CR + & 1.715\ CR^2 + & 1.837\ UNION \\ & (-2.34) & (-1.054) & (0.89) & (4.28) \\ & & [-0.766] & [0.658] & [0.705] \end{array} \qquad (3)$$

$-2 \times$ log likelihood ratio = 23.86.

Each of these equations is significant at the 0.01 level or better as measured by the likelihood ratio test. The influence of unionization on standardization is not technology group specific; but, as suspected, the influence of market power is. It appears that concentration is a significant determinant only in industries characterized by relatively more complex underlying technologies.

IV. CONCLUSIONS

[11] The sample means are: *PROCRD*: 0.391, *BR*: 0.054, *UNION*: 0.457.

This analysis represents, to my knowledge, the first attempt to study the economic dimensions of voluntary standards. The empirical findings broadly support the hypothesis that market structure positively influences the incentive of producers to promulgate voluntary standards, especially producers of consumer products in industries with relatively more complex technologies underlying the production process.

Since this study is exploratory in nature, the empirical results should be interpreted cautiously. First, there are no other studies with which to compare the results. Second, some of the assumptions implicit in the empirical analyses may be too strong. For example, a standardized industry was defined as one for which at least one voluntary standard existed: no distinction could be made in this definition for the type of standard (for example, design versus performance versus safety) or for the age of the standard. And third, the other independent variables held constant in the regression model may themselves be dependent on the extent of standardization in the industry. The technology structure of the industry may determine whether standards are promulgated and, if they are, the function they may perform. This issue of simultaneity was not considered here. In addition, certain variables may have been omitted from the estimation procedure. For example, we know that the existence of a standard is not independent of the industry's technological lifecycle. When technologies are fluid and firms' market shares are volatile, voluntary standards are less likely because agreement on which standard to adopt is itself a competitive decision.

Still, even with these caveats, this study may be useful in providing some first insights into the economics of standards and for identifying a seemingly important, yet unresearched, area of industrial activity.

ACKNOWLEDGEMENTS

This research was supported by the Planning Office of the US National Bureau of Standards. I am grateful to Greg Tassey and to James A. Dalton for their encouragement and many helpful suggestions at various stages in the preparation of this paper. Also, the comments from John Lunn, Alison Masson and John T. Scott have been useful. An earlier version of the paper was presented at the Industrial Organization Society session of the 1981 Allied Social Science Associations meetings in Washington, DC.

REFERENCES

Akerlof, G. (1970) The market for 'lemons': quality uncertainty and the market mechanism, *Quarterly Journal of Economics,* **84,** 489-500.

Freeman, R. B. and Medoff, J. L. (1979) New estimates of private sector unionism in the United States, *Industrial & Labor Relations Review,* **32,** 143-74.

Hemenway, D. (1975) *Industrywide Voluntary Product Standards.* Ballinger. Cambridge, Mass.

Link, A. N. (1981) Basic research and productivity increase in manufacturing: some additional evidence, *American Economic Review,* **71,** 1111-2.

Link, A. N. (1982) A disaggregated analysis of industrial R & D: product versus process innovation, in *The Transfer and Utilization of Technological Knowledge,* (Ed.) D. Sahal, DC Heath, Lexington, Mass, pp. 45-62.

Mansfield, E. (1980) Basic research and productivity increase in manufacturing. *American Economic Review,* **70** 863-73.

McGraw-Hill Publishing Company (1977) *22nd Annual McGraw-Hill Survey : Business' Plans for Research and Development Expenditures,* 1977-1 980, McGraw-Hill, New York.

National Science Foundation (1979) *Research and Development in Industry,* 1977, Government Printing Office, Washington, DC.

Putnam, Hayes, Bartlett, Inc. (1981a) *A Preliminary Report on the Effect of Standards on Innovation in the Semiconductor Equipment Manufacturing and Materials Industries,* US National Bureau of Standards, Washington, DC.

Putnam, Hayes, Bartlett, Inc. (1981b) *Impacts of Voluntary Standards on Industrial Innovation and Growth,* US National Bureau of Standards, Washington, DC.

Silberman, J. and Durden, G. (1976) Determining legislation preferences on minimum wages: an economic approach, *Journal of Political Economy,* **84,** 31 7-29.

Tassey, G. (1981) The Role of Government in Voluntary Measurement Standards, paper presented at the Society for Engineering Standards, Washington, DC, September.

Terleckyj, N. E. (1982) R & D and the US industrial productivity in the 1970's, in *The Transfer and Utilization of Technological Knowledge,* (Ed.) D. Sahal, DC Heath, Lexington, Mass., pp. 63-100.

Thompson, G. V. (1954) Intercompany technical standardization in the early American automobile industry, *Journal of Economic History,* **14,** 1-20.

US Department of Commerce, Bureau of the Census (1975) *Concentration Ratios in Manufacturing,* Government Printing Office, Washington, DC.

US Department of Commerce, National Bureau of Standards (1977) *Tabulation of Voluntary Standards and Certification Programs for Consumer Products,* Government Printing Office, Washington, DC.

US Federal Trade Commission (1978) *Standards and Certification,* proposed rule and staff report, Bureau of Consumer Protection, Washington, DC.

Veblen, T. (1936) *The Theory of Business Enterprise,* Charles Scribner's Sons: New York.

Verman, L. C. (1973) *Standardization,* Anchor Books, Hamden, CT.

Watson, H. (1980) The economics of private standards organizations, mimeographed, University of Chicago, Chicago.