Durability of building materials, market structure and the economic development of the construction industry

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Proceedings, VTT Symposium 48. 3rd International Conference on the Durability of Building Materials and Components: Espoo, Finland, 1, pp. 178-88, 1984

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Presented at
VTT Symposium 48
Third international conference on the durability of building materials and components, Espoo, Finland
Vol. 1, 1984, p. 178 - 188

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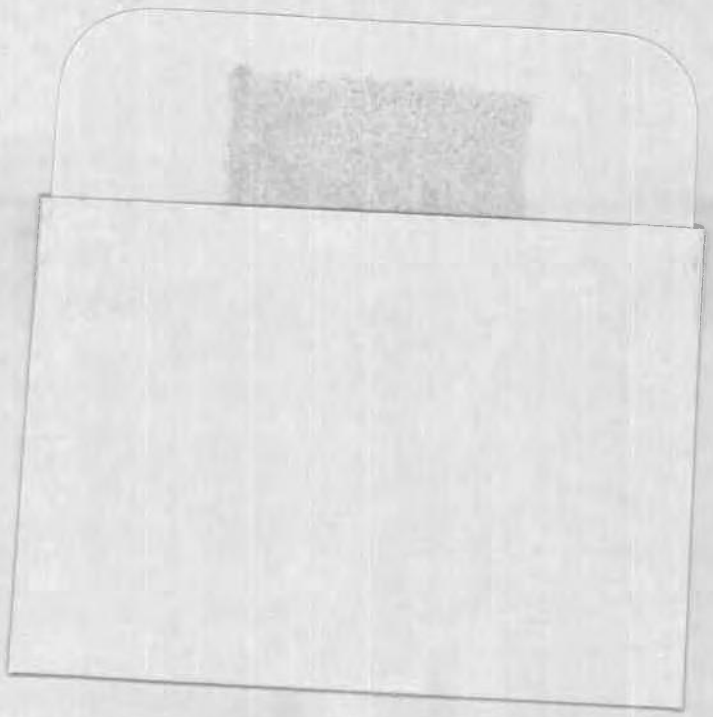

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DURABILITY OF BUILDING MATERIALS, MARKET STRUCTURE AND THE ECONOMIC DEVELOPMENT OF THE CONSTRUCTION INDUSTRY

Abstract

The present paper traces short- and long-term effects of enhancing durability on the construction sector and the rest of the economy. While short term effects may be negative, in the form of reduced output and employment levels in the material manufacturing industries, the long-term effects are expected to be positive. These effects will vary according to the market structure of material manufacturing firms, i.e., whether they are "competitive" firms or "monopolies".

Résumé

Cette communication décrit les effets à court et à long terme de l'accroissement de la durabilité des matériaux pour le secteur de la construction et le reste de l'économie. Bien que les effets à court terme puissent être négatifs (baisse de production et réduction de la main-d'oeuvre dans l'industrie de fabrication des matériaux), les effets à long terme devraient être positifs. Ces effets vont varier en fonction de la structure commerciale des entreprises de fabrication, selon qu'elles soient en situation de "monopole" ou de "concurrence".

1 ECONOMIC CONCEPT OF DURABILITY

As discussed elsewhere, the physical, chemical or mechanical concepts of durability may be different from the economic concept [1]. Materials may remain physically durable long after they have ceased to be economically attractive to use or operate. Another material may also become available, which has lower initial and operating and maintenance costs (life cycle costs) than the existing one; it thereby renders the latter cost-ineffective. Thus, the durability of a building material can be defined, in economic terms, as the time period over which it continues to meet the requirements of the building at less life-cycle costs than any other substitute. Materials competing for the same use can be ranked on the basis of their life-cycle costs and chosen accordingly.

In cases where there exists only one material to satisfy a given objective, the relevant question would be how durable it should be. Assuming that technical possibilities exist, a material's durability can be increased by using more resources. But, is it always economically efficient to manufacture goods that last, say, 100 years? The answer to this requires some knowledge of the cost structure of building materials or components for varying degrees of durability (see Fig. 1). The optimum level of durability will be reached at the point where the present value of total life-cycle costs is minimum (point L in Fig. 1). The present value of total life-cycle costs curve is the vertical summation of the initial cost and the present value of repair and replacement cost curves. As a material, or any structure made thereof, is made more durable, the initial cost rises, while the present value of repair and replacement cost falls. As a result, the total cost curve will first decline and then rise, as the rise in initial cost outweighs the fall in repair and replacement costs.

The diagram does not take into account the budgetary constraint on the user. The level of durability selected must satisfy the

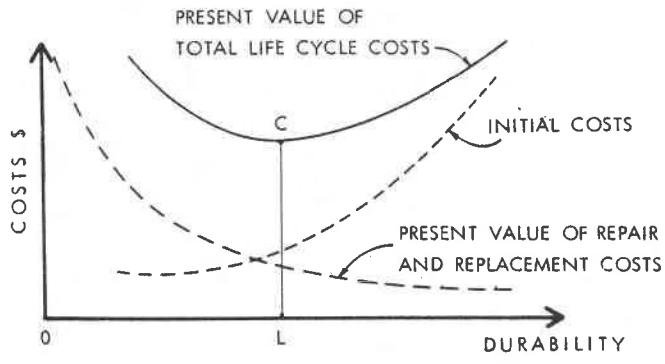

Fig. 1 Relation between durability of materials and costs

resources available to the user as illustrated in Figure 2. In this diagram, the horizontal axis represents present value of repair and replacement costs, the vertical axis denotes initial costs and the level of durability is represented by a family of curves (1, 2 and 3). The higher the curve, the higher should be the level of durability. For example, curve (1) denotes a durability of ten years, curve (2) of twenty years and curve (3) of thirty years. Any point on a curve provides the same level of durability with various combinations of initial costs and repair or replacement costs.

A user with a limited budget can spend it all either on initial costs (OI) or on maintenance, repair and replacement costs (OM). Usually, some part of the budget will be spent on initial costs and the remainder on maintenance and replacement. If more is spent on initial costs (i.e., more durability), less will have to be spent on maintenance and replacement. This trade-off between initial costs and maintenance and replacements costs is illustrated by curves (1) and (2). Curve (1) indicates that the user can obtain a ten-year level of durability by combining a given initial expenditure with the desired maintenance and replacement expenditure. Since every point on this curve will provide ten years of durability, it may thus be called an "iso-durability" or "indifference" curve. A point to the left (e.g. E2) will require him to spend more now and less later, and a point on the right will require him to spend less now and more

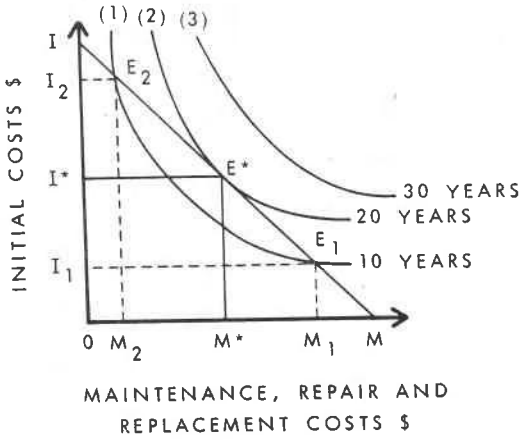

Fig. 2 User's equilibrium in the selection of durability

later on maintenance and replacement costs. Which point and which curve should be selected? It depends on the budgetary constraint given by the line IM. This budget in Figure 2 allows the user to go as far as indifference curve (2) and the equilibrium point is E. It is only at this point that the whole budget is spent, a prerequisite for equilibrium, and also at this point the maximum level of durability is obtained.

2 MACROECONOMIC EFFECTS OF DURABILITY OF BUILDING MATERIALS ON THE CONSTRUCTION AND OTHER INDUSTRIES

There is a generally held belief among manufacturers that enhancing durability of building materials or development of more durable materials will reduce the total or overall material requirements over the building's lifetime or over a given period of time. The argument runs like this - other things being equal, an increase in durability will result in a reduction in the consumption of materials for repair and replacement purposes. It will also reduce the consumption of less durable materials. This reduction in materials consumption will lead to a decline in output, employment, and price levels of firms, the demand for whose products has fallen, and through various linkages, will lead to a decline in output, income and

employment levels in other related industries. The initial effects of this decline will be amplified through "multiplier" and "accelerator" effects. Multiplier effects occur if an initial increase (or decrease) in a given level of building investment results in a series of secondary increases (decreases) in the level of income in the building or other related sectors. Accelerator effects occur when an increase (decrease) in income resulting from an increase (decrease) in investment causes a high (low) demand for housing and other consumer goods, the consumption of which induces capital investment.

2.1 Short Term Effects

The above viewpoint of a fall in employment and income caused by a reduction in demand for a less durable material is for the short run only. In the long run, there may not be any decline in income and employment levels; rather they may increase.

In Figure 3, the x-axis measures the amount of a fabricated polyethylene plastic material demanded by the construction industry, and supplied by the manufacturing industry, per period of time. The y-axis measures the level of material prices. Curve DD represents the amount of a material demanded at various price levels, "other things being equal". Curve SS shows the quantities of the material that all sellers are willing to sell

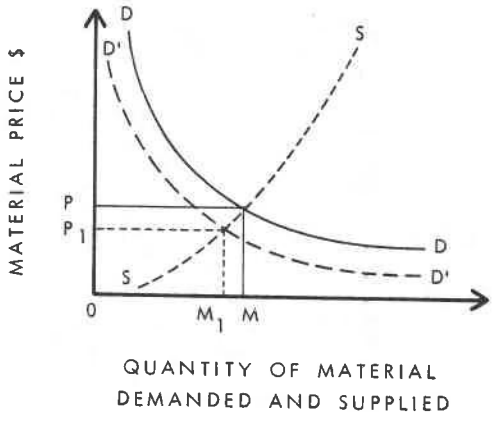

Fig. 3 Short-run consumption effects of reduction in demand for a less durable material

at alternative prices, other things being equal. In the case of the demand curve, other things include consumer income, consumer preference, consumer expectations and the prices of related goods or materials. In the case of the supply curve, other things comprise level of technology, prices of other resources, and producers' expectations. As a result of the consumer's preference for more durable plastic materials, the demand for the existing material, polyethylene, is decreased; this is reflected in the shift in the demand curve DD to D'D'. If the proportion of the old type of fabricated polyethylene consumed by the construction industry is quite large, the price level will decline from P to P_1 and so would the level of output from M to M_1.

Owing to the decline in the demand for the material, the demand curve (MRP) for labour used in the production of the old material will shift downward to the left (MRP'), as illustrated in Figure 4. Assuming the upward sloping supply curve for labour*, the downward shift in the demand curve for labour as a consequence of downward shift in the demand for material in which it is used as one of the inputs, will result in the

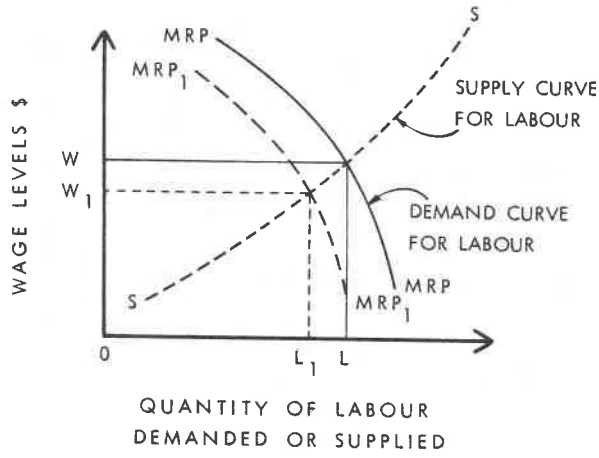

Fig. 4 Short-run employment effects of reduction in demand for a less durable material

* The upward sloping curve for labour implies that an incentive in the form of higher wages is needed to obtain more labour hours from a wage earner.

decline of employment from L to L_1 and the wage rate from W to W_1.

The extent of decline will depend on the market structure. Broadly speaking, a market structure could be perfect competition or imperfect competition.

Perfect competition is a market structure in which there are a large number of buyers and sellers of identical or comparable goods and services, and where the action of any single buyer or group of buyers or sellers cannot influence the market price of these goods and services. Imperfect competition, on the contrary, is a market structure characterised by a few sellers and buyers, differentiated goods and services, and monopoly power. Examples of imperfect competition are: monopoly (one seller or producer), and monopolistic competition (many producers producing several differentiated goods and competing among themselves by advertising their products or making them look different by using different labels).

In a situation where monopoly or imperfect competition prevails in the production of a material, the decline in employment and wages will be smaller than in the case where perfect competition exists. In the case of a monopoly, the MRP curve would be steeper than in the competitive situation, and hence an equal shift in it would cause more decline in employment level.

2.2 Long Term Effects

The above viewpoint is narrow and applies to short periods only. A decline in the consumption of a less durable building material may not be followed by a decline in the total activity of the economy, as the resources released by one industry can be absorbed by other industries. According to the basic principles of economics, resources of an economy are limited in relation to their alternative uses. For example, if iron and steel are required in lesser quantities than before as building materials,

there is a possibility that more may be demanded by another industry, say the auto industry, thus increasing the level of total economic activity.

In the long run, firms will have ample time to adjust their producing capacity to a changed situation. Firms suffering losses resulting from reduced material demand and prices will stop manufacturing, while others will reduce the manufacturing capacity to meet the reduced demand. The released workers will have enough time to look for jobs somewhere else; thus the situation of unemployment among the workers previously employed by the manufacturers of less durable material may not exist. The unemployed workers and other resources will move to other industries, resulting in increased levels of output and employment in those industries. The decline or slack in the output of less durable material may be picked up by industries producing more durable materials, where demand has gone up. Also, the less durable and, perhaps, cheaper material may be required in greater quantities by other industries that do not require durable products. In some industries where the rate of obsolescence is very high (i.e., the auto industry) due to certain technological and taste changes, it does not pay the manufacturer to increase the durability of materials. In summary, a reduction in the consumption of certain building materials may not lead to a decline in the national level of output and employment. This will be particularly true in the long run.

Figure 5a illustrates how a representative firm producing less durable material adjusts to reduced demand for its industry's product (illustrated in Figure 5b). The SAC and LAC curves represent the short run and long run average costs, while the SMC curve represents short run marginal cost (marginal cost curve denotes an addition to the total cost of a product as a result of producing an additional unit of output). These figures assume long run equilibrium (i.e., quantity of a material demanded is equal to quantity supplied at a given price

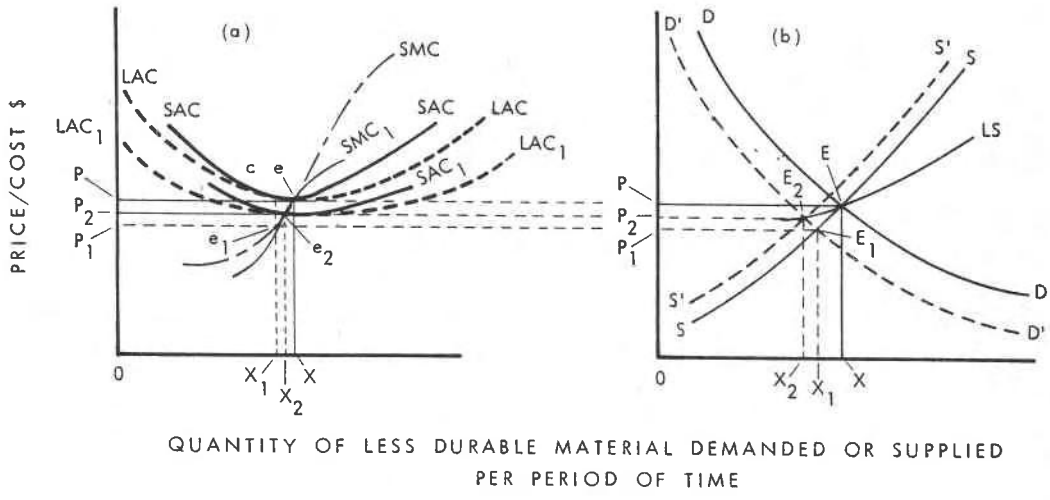

Fig. 5 Long-run adjustment process of a firm and an industry: less durable materials
(a) Representative firm (b) Industry

level and there is no incentive on the part of firms to enter or leave the industry), and trace the effects of reduction in durability by integrating short period with long period effects. The industry's demand curve for the less durable material (DD) shifts left to D'D' with the switch from the use of less durable material to more durable material. The supply curve SS remaining the same, the market price for the material is reduced from P to P_1. A firm producing the same material (Fig. 5a) has to lower the price for its products from p to p_1. Its sales are reduced to x_1 and it will suffer losses as it cannot now cover the average cost of production (cx_1). In a very short period, it cannot reduce its cost of production, either by lowering its production capacity or by laying off some workers such as managers or supervisors. But with the passage of time, the firm will have opportunity to adjust to the new situation. A firm which cannot cover the average cost of production will quit the industry. Consequently, the output share of a surviving firm will increase to x_2 from x_1, but will remain lower than the initial level of x. The supply curve for the industry will thus shift to the left (to S'S'), resulting in a lower price level of P_2 as compared to the initial price level P, and a lower output level of X_2. The new equilibrum point will be E_2, and

efficiency will be restored. The new or long run supply curve for the material will be LS.

On the other side of the picture the demand for a more durable material will increase, resulting in increased price levels (Figure 6). The increased use of more durable material will shift industry's demand curve to D'D' and the new equilibrum price and output levels would be, respectively, P_1 and X_1. Individual firms (Figure 6a) will start earning more than normal profits per unit of output (P_2-P_1, i.e. difference between the average cost and price of a unit of output). Encouraged by higher profits, the existing firms in the long run will expand their production capacity by hiring more workers and enlarging their plants. Also, some new firms will enter the market. As a result of these two changes, the supply curve of the industry will shift to S'S' and the final equilibrum price will be P_2.

Some resources that were rendered surplus by the decrease in demand for less durable materials may now be absorbed in the increased production of more durable materials, while others may be absorbed by other industries. Thus, the plant expansion of firms producing more durable materials may create additional demand for labour and other materials that may easily compensate

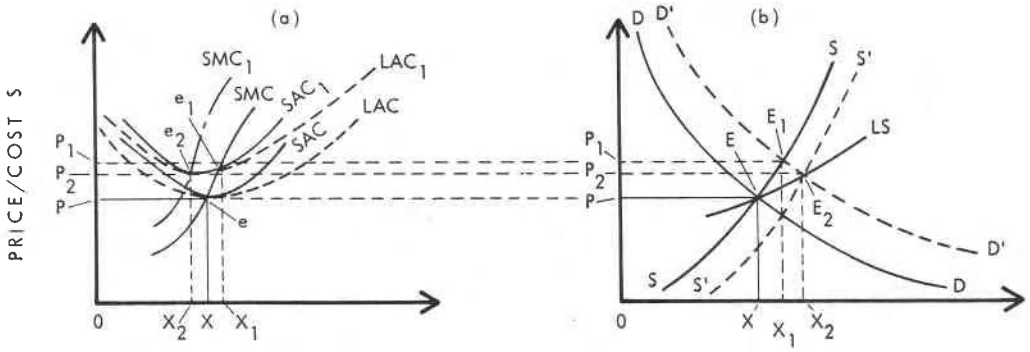

Fig. 6 Long-run adjustment process of a firm and an industry: more durable materials
(a) Representative firm (b) Industry

for the loss of jobs caused by the contraction of plants producing less durable materials. This all depends on the relative difference in size of the shift and the elasticity of demand for more durable material and less durable material.

3 CONCLUDING REMARKS

"Durability" both in technical and economic terms, is a relative concept and the selection of durability of building materials should be based on economic considerations along with technical possibilities.

Adoption of more durable materials may be accompanied by decline in output, price and employment levels in the short run. In the long run, however, through the process of adjustment and expansion, there may be more employment, income and output. The degree of employment generation or contraction will, of course, depend on the market structure. More employment will be generated in competitive firms than in monopolies.

4 REFERENCE

1. Rakhra, A.S., Economic aspects of the durability of building materials: an exploratory analysis, Durability of Building Materials, Vol. I, 1982, pp. 15-22. NRCC 20149.