A Transaction Cost Perspective on the Influence of Standards on Product Development

Examples from the Fruit and Vegetable Market

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Document Version
Final published version

Publication date:
1996

DANISH **R**ESEARCH **U**NIT FOR **I**NDUSTRIAL **D**YNAMICS

DRUID WORKING PAPER NO. 96-9

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June 1996

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May 6, 1996

Abstract

In this paper I argue that quality standards, products standards, and quality classes influence the priority that firms give to different product developments. These standards may be viewed as institutions in the sense of shared rules of behavior or codes. They have become shared because there are increasing returns to their use. These increasing returns apply both to their functions as means of reducing the costs of specifying and communicating product quality and to their functions as means of reducing buyers' costs of comparing the quality of different products - both of which are part of transaction costs. When reliable and extensively used standards exist, transaction costs are reduced. But these positive consequences to individual firms of adhering to the same standards create a sort of inertia in product development. This is because developments which are in line with existing standards will not introduce new transaction costs, while developments which break with the conformity of the standards will. In order for the latter kinds of product developments to be profitable, both development costs and transaction costs have to be overcome.

Keywords

Transaction costs, product development standards

JEL classification

D1, D23, D8, O3

ISBN 87-7873-009-0

Contents

1. Introduction

Product innovations offer the firm the potential of influencing market demand by meeting needs in new ways or in meeting new needs. One of the main challenges for firms in product development is to identify consumer preferences and market segments, since such information helps firms target their product development in profitable directions. But information on consumer needs is just one of the factors that influence product development. In this paper I argue that product development is also influenced by *quality standards, product standards* and *quality classes*. These standards serve the purpose of reducing information and transaction costs but they also direct firms' attention toward the development of some product characteristics rather than others.

The above mentioned standards may be viewed as institutions (shared rules of behavior) which are reinforced by their positive consequence on transaction costs when many adhere to the same particular standards. *The point I want to make is that the positive consequences in terms of reduced transaction costs from adherence to these standards create a sort of inertia in product development*.

One may distinguish between three kinds of product development: vertical, horizontal and complex (Hall, 1994)[1]. *Vertical product development* is the introduction of products with higher levels of quality characteristics while *horizontal product development* is the introduction of products with different ratios of characteristics. Finally, *complex product development* is the introduction of products which contain new kinds of characteristics. *I will argue that quality standards, product standards and quality classes exert different influence on vertical, horizontal and complex product development respectively*.

In order to understand the possible influence of quality standards, product standards and quality classes on product development, it is necessary to examine the economic rationale behind their continued existence in the market, and the positive externalities to firms from adhering to the same standards. For that purpose two different strands of theories are needed, namely the *measurement cost branch of transaction cost theory* and the theory of path dependence developed by Paul David (1987) and in particular the concept of *economies of system scale*.

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[1] In models examining vertical product differentiation it is assumed that products offered at same prices are ordered in preference in exactly the same way by every consumer whereas in models of horizontal product differentiation it is assumed that they are ordered differently at same price because of differences in consumer preferences (Krouse, 1990). To keep things simple, I shall make use of the assumtpion of same preference ordering by all consumers in the sections 3 to 5. However, the assumption is not needed to state may case.

The measurement cost theory indicates that transaction costs strongly depend on the cost of product information and on the variability in product quality. Both of these sources of transaction costs may be reduced by the existence of standards. System scale economies is the term David (1987) uses to describe the situation in which, for example, users of a particular type of car phone get more benefit from their phone the more subscribers they can use it to get in touch with -which in turn depends on other subscribers using the same type of phone. I use the concept of economics of system scale as referring to a situation where there are positive consequences to economic agents from an increased use by others of the same standards. Buyers experience increasing benefit in terms of reduced transaction costs (cost of comparing the offerings of different sellers) the more widely used a standard is and some of the reduction in transaction costs may be captured by the sellers.

In section 2, "*Standards*", I give a brief explaination of terminology and the nature of the standards in question. In section 3. "*Transaction costs and product information costs*", I introduce the measurement costs branch of transaction costs theory and discuss the relation between information costs, transaction costs. Section 4 ,"*Transaction costs and variation in product qualities*", provides a theoretical argument as to how standards reduce transaction costs. This argument serves as a basis for examining the influence of standards on product development. The sections 5 to 7 contain a discussion of the effect of quality standards, product standards, quality classes and production standards on firms' incentives to engage in different kinds of product development. Finally, in section 9, "*Changes in the hierarchy of sorting criteria in quality classes*", I provide some arguments as to the factors which might cause a change in the composition of quality classes.

2. Standards

Quality standards, product standards and quality classes are codes which, if both parties in the transaction know what the standard covers, make it less costly for sellers to communicate particular quality characteristics and for buyers to obtain product information and compare the offerings of different sellers.

Standards can be classified into technical and behavioral standards, according to whether they refer to an object's characteristics or human behavior (David, 1987). Technical standards often consist of well-known ordinal measurements, such as kg (lbs), mm (ins), or threshold values which state a minimum or maximum value, while behavioral standards consist of codes for specific routines or skills. Examples of the latter kind of behavioral standards are professional titles such as civil engineer, doctor, etc., while Integrated Production (IP) of fruit and vegetables or ISO standards

are examples of the former kind of behavioral standards[2].IP stands for integrated production which is a kind of production where the aim is to reduce the use of fertilizers and pesticides, for example, by developing alternative methods of growing. Where possible, standards will be indicated by means of technical standards rather than behavioral standards, since the latter are often ambiguous (David, 1987). This is due to the fact that the specifications which they contain often can be interpreted differently by different firms. This ambiguity implies that the information value of the standard is reduced.

In the following, the term *quality standards* is used to describe standards which indicate the level of a product's quality characteristics. For example, in fruit and vegetable markets quality standards such as brix are used as measure of the content of dry matter in fruit juice, and the more familiar reference standard from the metric system as indicators of the size of individual fruits and vegetables.

Product standards is the term used to describe the conditions a product must fulfil before it can be classified into a particular category of products. One example is "real juice", which is a designation that can only be used when the product contains pure fruit or vegetable juice. Another example is the set of criteria on which the recognition of a fruit or vegetable as a separate variety is based.

The term *quality class* is used in the classification of raw or final products into groups of similar levels of quality characteristics. Within each product category, individual products often vary in a lot of their characteristics. In principle, each measurable characteristic could result in a separate quality class. In practice, however, there seems to be a hierarchy of relatively few defining characteristics for sorting products into groups which are common for all producers.

Common to the above standards is that, as previously mentioned, they can function as a means of specifying and communicating valued characteristics of the product or deliveries. However, the reduction in transaction costs which can be achieved by using standards as a basis for specifying characteristics and classifying products or deliveries depends on whether buyers can trust that firms do not cheat.

Sellers can cheat on quality by disclosing wrong levels of quality characteristics, for example, by specifying wrong sizes of ingredients. If a seller discloses wrong product standards, production standards, or quality classes, buyers might become generally suspicious about their information value. These problems of trust must be presumed to be greatest when the standard includes

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[2] In fact, IP and ISO standards consists of a great number of specifications which are determined by means of both technical standards and behavioral standards of which the latter is in the form of a set of prescribed routines.

characteristics which the buyer has difficulty in controlling himself. One example of this is in the juice industry, where The International Juice Organization has developed a number of common European product standards. These standards distinguish between juice, nectar and fruit on the basis of specifications of the fruit juice and pulp content. The small profits involved in juice production, however, have tempted some producers to cheat by adding citric acid and other cheap ingredients to products which they still sell under the name of juice. This has led a number of firms in the Danish juice industry to jointly develop methods of measuring juice quality (especially its purity). The quality of the juice is to be further guaranteed through the development of a control programmed base on sampling juice products in shops and unannounced visits to firms. The program is financed by the firms themselves.

Some standards may be designed by organizations, while may have emerged form the general practice of buyers and sellers. For example, in the fruit and vegetable industry the establishment and diffusion of general quality classes for fresh fruit and vegetables are dominated by national and international organizations. Standards are drawn up by both the Danish food inspection agency and by EU and OECD agencies. International quality classes for fruit and vegetables have been in existence for more than 40 years. The first international standards were developed by UNECE (UN Economic Commission for Europe) and the OECD. Common EU norms have been established ever since the start of the Common Market in 1962. These norms are used in all stages of distribution, that is, from production to sale Within the EU, 34 of the most important fruits and vegetables are subject to EU quality norms. The EU requires that the country of origin, quality, and variation (within the given quality classes) of fruit and vegetables is clearly marked either on the packaging or on show cards. Fresh fruit and vegetables are classified into 4 quality classes, for example, extra class 1 and class 2. Extra class 1 products are of an excellent and specially selected quality, while class 2 products are of good quality without any serious defects. Class 2 products often have one or two defects in the form of size, shape, colour, or spots.

Processed fruits and vegetables also have their established quality classes. In jam production, for example, the percentage of berries and berry quality (their colour, and whether they are whole or not) are the prime criteria for classifying jam into high and low quality. For a number of intermediate products, for example, berries for stewed fruit, jam, and squash and squash concentrates, which are purchased in bulk, there are no quality classes in the proper sense of the word. However, there is general agreement in these forward markets transactions as to which characteristics are specified and which quality standards are used in the specification.

The industry's established quality classes appear to play an important role in how the processing firms define product quality and on the priority they give to the development of different characteristics of the products. In product development the identification of an optimal trade-off between these different quality characteristics was very much influenced by how the customs of

payment in the industry as regards the trade-off between content of brix, color and clarity. In the following section I bring in the measurement branch of transaction cost theory in order to examine why standards may exert an influence on product development.

3. Transaction costs and product information costs

Goods may be interpreted as bundles of characteristics. The word "characteristics" owes it use in economics to Lancaster (1966, 1971, 1979). A characteristic may be the quality, location, time and availability of a product. I restrict the analysis to product characteristics which in the case of fruits and vegetable could be taste, smell, colour, durability, nutritional value, and purity. The kind of product characteristics I have in mind may be divided into the categories of *search*, *experience*, and *credence* characteristics, depending on how easy it is for the consumer to experience the characteristic at the time of purchase (Tirole, 1988)[3]. Search characteristics can be observed directly. In the case of fruit and vegetables, this means size, shape and colour. Experience characteristics can often only be evaluated or measured after the product has been consumed or used in the production process. Consistency and taste are the two most important experience characteristics of fruit and vegetables. Finally, credence characteristics are characteristics which cannot be observed or experienced directly by looking at or inspecting the raw or final product. The use of crop sprays and ecological grown are such examples of credence characteristics.

The representation of goods as bundles of characteristics is in keeping with the property rights perspective (Coase, 1960) and the measurement cost tradition (Barzel, 1983, 1985, 1987). Goods may according to the property rights perspective be perceived as bundles of property rights where the property rights in question consists of the rights to use or consume valued attributes, i.e., charateristics of an asset, to obtain income or utility from the asset and to alienate the asset. Property rights in economics has most often been associated with so-called "intellectual property rights", that is, the securing of rights over intangible assets. Property right analysis has, however, a much broader application, since all transactions involve the exchange of property rights. For example, if one buys a can of marmalade, one is in fact buying the right to alienate, consume or obtain income from all the valued product characteristics of marmalade.

When assets/goods are traded the rights over valued attributes are transferred at a price from the seller of the good to the buyer. There are, however, costs to both parties of transferring the rights and these cost depends on the cost of obtaining rightful product informations.

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[3] The concept of search and experience goods was introduced by Nelson (1970), while the concept of credence goods was introduced by Darby and Karni (1973). In this paper, I regard a single product as having all three characteristics.

Product information is broadly defined as information about the level of a characteristic per unit, for example, the sweetness of a cherry, plus the number of products in a group with the same level (e.g., the number of sweet cherries in a basket). Product informations are in themselves valuable characteristics of products, since presumably a buyer is not willing to pay a price which equals its value to him unless he is convinced that the product has the characteristics that he values.

Then, on a general level transaction costs may be defined as costs which arise when individual agents want to exchange property rights over assets and thereafter enforce these rights. Such costs may consist of cost of searching for transaction parties, negotiation costs, cost of controlling products and monitoring parties in the transaction. If these transaction costs are sufficiently high potential traders may abstain from engaging in exchange. According to Barzel (1985), transaction problems arise precisely because it is difficult and costly to obtain precise information about all the characteristics of a product:

> "It is my contention that costly (intermediate and final) product information is the central problem of transacting, leading to all other transacting problems" (p.6).

Barzel (1982, 1989) has argued that costs from rent capture attempts are particularly predominant if the value that an asset can generate is variable and not fully predictable. Put another way transaction costs are particular predominant if products vary unpredictably with respect to those characteristics that are valued by buyers.

If product information was free, commodities with the same quality characteristics would be sold at the same price. Alternatively if product information was not free but all variation in quality was eliminated, buyers only needed to examine one product to know the quality of all products on offer, and the quantity purchased by a buyer would reflect his cost of examining one product, his preferences for the attributes of that product, and the price of the product (Barzel, 1982).

When products such as, for example, cherries vary with respect to the level of quality and if it is costly for a seller to precisely measure the quality of every single product, then high-quality cherries will probably be sold at the same price as cherries of a lower quality. Thus, the seller has placed some value of his product in the public domain that is for some of the cherries he charge a price which is lower than which (at least) some buyers would have paid[4]. Value in the public

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[4] Value in the public domain often occurs when rights to the use of an asset are shared by many. For example, the right to use the hallway in an apartment building is shared by all tenants. Each may pay some to the owner for that use. If no one has specified what this common space maybe used for by each of the tenant some of its value has been placed in the public domain. Some tenants may gain this value if they gain greater use of the space by for example, parking prams and childrens' toys in the hallway. They then gain more value for this common space than they pay for.

domain results in rent capturing attempt since one or both parties spend resources in their attempts to capture this value. Buyers for example confront an incentive to use resources to capture this wealth in the public domain, for example, by spending time in queues and to search for cherries of a higher quality than their price while sellers invest in sorting to avoid the gradual dissaperance of the higher quality products from their distribution of offers.

In the following I shall indicate more precise how variations in product quality give raise information costs and thus to transaction costs and how these costs may be reduced by the introduction of quality standards. First, I examine the relation between transaction costs and quality variation within one seller´s product offer and then how variation between differences sellers influences transaction costs and competition between sellers. The exercise form the basis for my argument that standards influence product development through their effect on those transaction costs that arise as a consequence of product information costs and variability in product quality.

4. Transaction costs and variation in product qualities

If product information costs are low while at the same time the quality of the products varies greatly from one unit to the next buyers face an incentive to sort among the products. This is because buyers expected utility from search depends on their sorting effort and the cost of sorting. Maximizing buyers will spend resources on such value capture until their marginal benefits equals their marginal costs. Buyers' costs of sorting consist of a cost of obtaining information of the valued attributes of a product and cost of competing against other consumers for access to the goods. These costs in turn depends whether the valued characteristics are search, experience or credence characteristics on the competition between buyers for the same underprices products[5]. Buyers' benefits from sorting depend on the mathematical expected level of quality from random search, their preferences for quality and their aversion toward risk

Now, maximizing buyers will choose to continue sorting (depending on their preferences for quality) whenever the expected benefit of another round of search is greater than the quality of the item in hand. The expected benefit may be expressed as the mathematical expected quality weighted by their preferences for high quality minus search costs[6]. In each round of search the distribution of quality changes since some buyers are lucky and finds an item of a level of quality sufficiently high that it does not pay for them to continue searching.

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5 Costs are opportunity costs. The competition between buyers then depends on their alternative costs of queuing and sorting and on the differences in their preferences for the same attributes of the products in the sample.

6 In each round of search the cost of previous searches are sunk cost and do not influence the decision to go on searching.

It is then possible to calculate the expected level of quality for different distributions. The expected utility will be greater the higher the variance, the more positively screwed the distribution of quality, and the lower the number of buyers that search per round compared to the number of items in the distribution. (The expected utility for the first group of buyers also depends on whether new buyers are allowed to perform search before the first group have finished searching). Preferences for quality and risk aversion influence buyers expected utility from search in different distributions. If buyers have high preferences for quality they favor those offerings which have a high mean, or, alternatively, if they face low cost of search a large variance (indicating a probability of finding a very high quality product). If buyers are risk averse their search will be influenced in favor of distributions with lower variability in quality.

Sellers may then increase their income if they can measure and grade products into uniform groups better and more cheaply than buyers, since then they can capture some of the resources buyers waist on such rent capture attempts[7]. Moreover, if sellers' can eliminate buyers searching they need not continually reduce their price as the higher quality products are sold. Maximizing sellers will sort until the point where their marginal costs equal their marginal gains of sorting. However, sellers' gains to sorting depend on buyers' gains and costs of sorting. This is because the dissipation of value depends on how many resources each buyer will spend on queuing and sorting. Now, if sellers indicate the level of quality by means of reliable quality standards, buyers' cost of sorting may be substantially reduced and buyers may find it worthwhile to sort more extensively, such that more value is dissipation relative to the situation in which quality standards were non existent. Quality standards may, however, also reduce sellers costs of sorting, such that this dissipation of value is avoided. Moreover, product information costs influence the price buyers are willing to pay for a product, since presumably for a buyer to pay the price reflecting his preference, he need some sort of confirmation about the quality of the product. In other words, product information may command a risk premium. Finally, by indicating the level of quality in each product, sellers may also make it easier for buyers to compare their distributions and prices.

Most often products contain a large number of valued characteristics which makes it impossible and too expensive for sellers to eliminate all variation in quality by sorting and some buyers may therefore still find in attractive to engage in sorting. In such a situation, sellers might be tempted to disregard quality standards in order to increase buyers' costs of sorting. But since product informations are valued attributes of products, the marginal benefits from avoiding dissipation of value may be less than the marginal cost in terms of a loss of a valued attribute[8]. Thus, some sellers

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7 Buyers on the whole will also win more from a better sorting of the products than they lose from not searching for underprices products.

8 If seller raise buyers costs of obtaining information about valued quality characteristics buyers may suspected sellers of cheating. The price (under competition) would fall to a level which reflected buyers' expectations of quality. Honest sellers would then be punished economically. To prevent such externalities honest sellers may have to signal their commitment to sell random selection of vegetables from an optimally sorted supply. Brands

may seek to avoid such dissipation of value by restricting consumers choice or by increasing buyers costs of determining the level of quality of those characteristics which do not enter as criterias of sorting. However, in either case the seller will have to convince the buyer that he does not take advantage of the asymmetry in information to perform an adverse selection of quality[9]. A brand, with which a sufficient number of buyers have accumulated trust, and for which they therefore are willing to pay a higher price can function as such a guarantee. Sellers who produce products of high quality but have not accumulated sufficient trust in their brand name, may prefer to indicate the quality of their products by means of quality standards, since by indicating the true level of product quality they reduce competition from producers of low quality products.

Normally buyers carry out their shopping for a product in two steps: first, they decide which seller to buy from, and second, then they select the products they want to buy from the sample of same products on offer. If buyers have no cost of identifying and comparing the quality distribution of all sellers' offers, sellers will have to charge a price reflecting the mean and variance of quality in their offers. Moreover, if all buyers have the same preferences for quality, the same opportunity costs of sorting and the same aversion toward variability, all sellers facing the same sorting costs would sort equally fine.

Now, different sellers may have different costs of sorting and thus attract buyers with different opportunities costs of sorting and aversion toward variation. However, as long as buyers can easily compare the quality distribution of the sellers, their prices will always reflect such differences[10]. If, however, buyers face costs of determining different sellers distribution and of comparing their offerings, the market may not be functioning well. Some sellers with offers of low mean and high variance may get away with charging a higher price than if such costs were non existent. Some of those costs which buyers face may arise because when products contain may valued characteristics, sellers may sort their product according to different criteria. Such a sorting practice implies that buyers have to spend more resources on determining the value of different sellers' offerings before purchase.

To sum up, I suggest that they are classified according to whether the information they contain helps reduce the transaction costs of:

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can function as such a signal, since systematic shortcomings in the seller's products undermine the value of the brand (see Klein & Leffler,1981).

9 If both buyer and seller use the same technical standards as units of reference, it also reduces the degree of asymmetrical information, since it creates the basis for a control of the deliveries. This also means that it is easier for the buyer to protect his rights in the transaction.

10 Provided that buyers have the same preference ordering regarding the different quality characteristics of the products.

1) Evaluating and ensuring a product's search, experience and credence characteristics;
2) Comparing the distribution of search, experience and credence characteristics in different sellers' offers.

Quality standards then help reduce buyers cost of evaluating and ensuring their rights over product quality characteristics and of comparing the quality distribution of different sellers.
Product standards likewise have two functions. First, they contribute to reduce buyers' costs of comparing different sellers' offerings of desired quality characteristics (consumers can just compare products in the same category), and second, they reduce a buyer's costs of evaluating a seller's distribution of quality characteristics over time[11]. Product standards should not be confused with registered titles of specific product classes within a product category, however, the main aim of which is to secure title owners an extra economic return (scarcity rent). One example of this is French wine, where the use of "titles", such as Bourgogne or Bordeaux, is reserved for wine growers within a strictly defined geographical area. The possibility that such titles can have a transaction cost function cannot be ruled out, however, since the "title's value" depends on the producers who use it not cheating on quality.

Finally, *quality classes* like product standards contribute to a reduction in transaction costs, since they make it easier for buyers to compare different sellers' products.

The economic benefits of using a particular standard (be it quality standards, product standards or quality classes) depends in part on how widely it is used in the industry (or economy). If it is widely used, then buyers can more easily compare the prices and quality level of different sellers' offerings, which is an advantage for sellers of high-quality products. This can be illustrated by the production of jam, where the proportion of berries is an important quality attribute. If, for example, Danish and American producers declare the weight of the berries in different units of weight, it will be harder for consumers to compare quality vis-à-vis price than if they had used the same units. This could make it easier for sellers of lower-quality jam to get consumers to buy their products, even though their price is high compared with the quality. If one standard is widely used buyers may altogether avoid buying from seller that do not comply to that standard. This is because the probability of finding a seller with an above average quality compared to price may be so little that it out-weights the extra cost of comparing his distribution with other seller. In that case the standard is self-enforcing even in markets with many low quality-producers.

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[11] Sometimes it is relatively easy for buyers to decide whether a product belongs to one product category or another; for example, it is easy to tell the difference between peas and other vegetables. It can be difficult for consumers to tell the difference between "real juice" and other juice, or between different kinds of carrots, however. In the former case, product standards are hardly likely to contribute much to a reduction in transaction costs but they still contribute to a reduction in communication costs.

Such "increasing returns to use" or "system scale economic" appear to be the case also for product standards and quality classes. For example, if only a few sellers grade their peas by size, buyers get much less out of it, because they will still incur costs of comparing graded peas with non-graded peas. If all sellers graded peas using size as the main criterion, however, buyers' costs of comparing mean and variation in quality relative to price would be much lower.

5. Quality standards and product development

The emergence of quality standards influences the number of product characteristics that can be specified. The extent to which quality standards and measurement methods exist may in particular influence sellers' incentives to invest in *complex* product developments. This is because, if no quality standards exists buyers face larger costs of determining the level of the new kind of product characteristics and may for that reason not be willing to pay a price that fully reflects the value they place on the characteristic. In particular, if the characteristic is an experience characteristic it may require substantial reduction in price (because of the risk of lower utility compared to the previous purchased goods) in order that a sufficient large group of consumers test and accepted the improved product[12]. With respect to credence characteristics the development of quality standards is the only way of communicating the new feature of the product.

The existence of widely used quality standards may also influence some sellers' incentive to perform *vertical* product development that is, increase the level (or rather the mean value) of all quality charateristics. This is especially true for seller who do not possess a brand name. The existence of widely used quality standards makes it easier for buyers to compare different sellers levels of product quality, making competition between sellers of high and low quality products function in favor of the former.

When looking at the whole chain of production it is possible that the extent to which there exists quality standards and measurement methods for the *raw* and *intermediate* products quality characteristics influence the costs of *vertical, horizontal* (the increasing of the mean value of some of the quality charateristics) as well as *complex* product developments (adding new quality charateristics) of the final product. The improvements or development of new quality characteristics of the final product often depend on changes in the raw product's quality characteristics. For example, it will be much more costly to improve the quality characteristics of

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[12] This argument is based on Schmalensee (1982). In his model of product differentiation and advantages of pioneering brands he agues that the is a risk-cost factor which influence consumers' valuation of the challenging product given pretrial uncertainty about its quality characteristics relative to the post trial valuation. In order to overcome this barrier to switching sellers may have to reduce price substantially for a period. The existence of reliable standards with which to indicate the true quality of a product may reduce the risk-cost factor of switching.

the final product if this means a lot of new demands on the raw product for which no quality standards exists. The opposite is also true: new quality standards for the raw product can make it easier to develop new characteristics in the final product. One example of this could be the spread of IP standards among growers. The formulation of technical and behavioral standards underlying the concept of IP, as well as a set of control procedures, is one of the ways in which growers can document the credibility characteristic "environmentally friendly". Under IP, everything about the crop is recorded, from before planting to final consumption - even storage conditions are controlled, because IP crops must not be mixed with other crops. If IP evolves into a credible standard, it reduces firms' needs to monitor and control the growing conditions of the raw products. Finally, it should be mentioned that the most widely spread quality standards also influence the technological development of the measuring equipment.

6. Product standards and product development

Product standards constitute the minimum threshold values for product categories which must be met before a product can be sold as a particular category of product. Product standards thus influence transaction costs in the sense that they narrow the range of products which the buyer regards as a relevant basis for comparing the relationship between price and quality.

The lack of product standards thus influences competition within an industry by increasing cost of comparing sellers offers, and can therefore result in a poorly functioning market for products with certain experience and credence characteristics. For example, if it is difficult for consumers to tell the difference between the various product categories, it can be necessary to introduce product standards to protect them.

The absence of product standards can, in turn, affect producers' incentives to develop new product lines. An imaginary example from the market for squash can help illustrate this. Imagine that there are several kinds of squash on the market: one which contains 100% pure fruit juice, one where the fruit juice is mixed with citric acid, and one where the fruit taste is synthetically produced. All these different products are sold as squash. Buyers who at a given price prefer a squash with 100% fruit content (which in this case is an experience characteristic) will have to tests several items in order to find the preferred one. Such costs will reduce the amount a buyer is willing to pay for the product compared to a situation in which he do not have to search. Since every buyer has to search, much value will be dissipated.

Also, without product standards variation is much greater with respect to all quality characteristics. This implies that more resources will be spent on comparing the quality and prices of different offerings. The more costly it is for buyers to compare different sellers' quality vis-à-vis

price, the easier buyers are persuaded to pay a higher price than the product's quality characteristics warrants. The market might even be distorted in favor of those producers who mixed in citric acid. Without registered titles, therefore, it can be difficult for producers to protect the value of the characteristic "real juice", which explains why economic incentives to develop real juice products are relatively limited. Finally, with high costs of comparing sellers' offers, buyers may only be willing to pay a lower price that which reflect their reservations price without such costs. This in turn could make the production of some high quality variants not profitable.

With the introduction of product standards, search is reduced to a search for juice which contains the highest possible level of valued quality characteristics other than content of fruit. In the above example, if a product standard for real juice emerged, then the various suppliers of juice would compete among themselves on search, experience, and credence characteristics, while juice producers as a group would compete with producers of various squash drinks. This is because the setting of standards for juice reduces buyers' costs of comparing sellers' products within a given product category, which at the same time increases price competition within this category, whereas competition between different product categories will, to a greater extent, develop into a struggle to persuade consumers to substitute one type of product for another.

Product standards have much influence on firms' development of entirely new product lines by *complex product development* since the kind of characteristic that a product possesses may place it in a very different product category. But product standards may also influence firms' *vertical product development* since also the level of quality characteristics may determine to which product category the product belongs and thus the basis for comparison with other sellers products.

Finally, I will mention a very different way in which product standards may influence the economic incentives to carry out product development. Sometimes appropriation possibilities in the form of patent rights can depend on whether product development takes account of the way in which a product's defining standards are determined. An example of this can be found in the production of new plant varieties, since, by law, a new variety of garden plant can only be defined as a variety if it can be proved to have stable, consistent, and separate phenotypical characteristics. This means that, if the development of a plant's functional characteristics (for example, resistance to disease) do not have a direct influence on the phenotypical characteristics which define the variety, it can not be patented as a new variety. In this case, the standard which defines a variety limits incentives to improve the plant through breeding.

7. Quality classes and product development

In many respects, quality classes have the same economic function as product standards, since they too lower costs of comparing sellers' quality distributions[13]. Now, imagine a buyer who has to choose between buying at a seller where he knows his expected utility from searching or at a seller where he does not know the distribution of quality characteristics and thus not his expected utility from searching. Such a buyer is put in a situation where he has to do some experimental search in the offering of the seller not known to him in order to determine which of the offers is better (in terms of expected utility). The cost involved in determining the expected utility from searching in different sellers offerings depends on the sampling necessary to determine the distribution (with some level of confidence) and the different sellers offers and the degree of variety (in terms of mean and spread of different quality characteristics) between different sellers offers. If sellers sort their products according to the same criterias this latter factor in the cost function is reduced. The ability of quality classes to reduce transaction costs appreciably therefore depends strongly on the number of sellers who classify their products after the same criteria. The more sellers who use the same quality classes, the fewer resources buyers have to use to compare different sellers' offerings. And the fewer the resources buyers use, the greater are sellers' advantage in sorting into quality classes.

Such "system scale economies" (David, 1987) can help in spreading specific norms for classifying products with different levels of quality characteristics into quality classes. At the same time, however, system scale economies lead to a certain reluctance to change the criteria by which quality classes are defined. It is especially thanks to this "inertia" that well-established quality classes and associated quality standards for trade are able to nudge *horizontal product development* in particular directions, since there will be far fewer transaction costs involved in selling products which have been developed according to the specifications laid down in the most widely-used quality classes.

If, for example, size is the prime criterion for dividing peas into quality classes and colour the secondary, then sellers will have a greater incentive to develop pea size rather than colour (assuming that buyers attribute all quality characteristics the same value).

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[13] Product standards can be necessary if the classification of products into quality classes is to reduce variations in quality characteristics, and thus also transaction costs. This is because, in the absence of product standards, it can be too easy to cheat on quality in a given quality class. One example of this - which, however, is from outside the fruit and vegetable industry - is the quality differentiation of English steak. Since there are no product standards for which cuts of meat can be called English steak, it is impossible to achieve any kind of credibility for a classification of English steak into a first or second class on the basis of the quality characteristics (for example, colour and tenderness) of the meat alone. An increased demand for English steak would merely result in them being taken from different cuts of meat, which in turn will increase the variations in all the quality characteristics not directly specified in the quality class.

The influence of quality classes on product development is obvious, if a seller's products are mixed with other sellers' products before they are sorted into quality classes. A seller who has developed peas with, on average, a better colour, but whose size places them in the class of medium-sized peas, must sell them as medium-sized peas. As it is impossible for buyers to identify any individual seller, he has no incentive to improve any characteristics other than those that places his product in a higher quality class. This is because the price his peas can command depends on buyers' expectations of mean and variance in quality of all the valued characteristics of the products. An improvement in some sellers product quality increases the mean implying a higher price. However, since individual sellers cannot be identified the innovator will have to share the profits with all other sellers.

In the above example the influence of quality classes on product development had nothing to do with the economic of system scale from increased use of a quality class. Now, buyers need not pull their products in a common offer. The innovator may sort his products according to the criterias set for different quality classes. A buyer will then compare his peas with other peas in the quality class "medium-sized". Within this class, he will have a quality advantage (the colour) which should fetch him a higher price for his peas (once buyers recognize the difference between the offerings). The price he can get will not reflect the full value of the improved colour, however. This is due to the fact that it is more costly for buyers to evaluate the colour of the peas compared with that of competitors' peas. If, instead, he had developed a production method which guaranteed him a pea size which matched that of class 1 peas, he would have realized a much larger part of the value of this effort, since buyers' costs are much lower for transactions involving this characteristic.

Alternatively, he could have chosen to protect the value of the "colour" of peas by grading after this characteristic. If a seller tries to grade his peas differently, so that colour, not size, is the main criterion, buyers will use more resources in trying to find out whether the seller's quality matches what they could get for the same price from other sellers. It thus seems reasonable to assume that the very hierarchical organization of quality classes can influence the *priority* sellers give to the development of different quality characteristics of the final product.

Quality classes may also influence *vertical* product development. This may be illustrated by continuing the imaginary example from the market for squash: Without the existence of quality classes, the total offering of juice will include both products with high levels of valued quality characteristics and products with low levels of the same characteristics. In the case where the valued characteristics were search characteristics, this would result in value dissipation through excessive sorting. In cases where the valued characteristics were experience characteristics, one could expect a "lemon effect". If, for example, consumers value fruit taste in juice and if juice with more or less fruit taste is sold at the same price, buyers would not know in advance which kind of juice they were buying. Gradually, however, they would develop a feeling for the likelihood of

getting a juice with fruit or synthetic taste. Since their demand depends on their expectations of quality, the price will gradually fall, and since at the same time the supply of juice with fruit taste must be presumed to depend on the price, this will also fall. After a certain period of time, therefore, buyers will adjust their expectations of quality downwards, and so on. The end result of this chain reaction can be that all production of real juice ceases, even though there is a demand for it (Akerlof, 1970).

In the above example, a declaration of contents of the various juices, combined with a producer's brand as a signal of credibility, could reduce the problem of asymmetrical information. It would still be very costly for buyers to compare different sellers' quality and distribution of many product characteristics. This is because the basis for comparison is much larger and much more varied than if there had been three different quality classes.

8. Changes in the hierarchy of sorting criteria in quality classes

Since quality classes appear to influence vertical and horizontal product development through the priority producers gives to product development efforts, it is pertinent to examine the possibilities for changes in the hierarchy of criteria for sorting into quality classes.

The question is which product characteristics form the basis for sorting along the criteria which make up a quality classes, and which factors could conceivably change the hierarchy of sorting criterias. On the face of it, it would seem reasonable to assume that those product characteristics which vary strongly in quality level from product to product, and which at the same time are valued most by the majority of buyers, will underlie the hierarchical organization in classes. This is supported by the presumption that maximizing buyers will use many resources in comparing sellers' products for the quality characteristics they value the most. Reducing the variation of precisely these characteristics in a seller's product range "saves" most resources in the transaction.

Precisely which characteristics will be in demand is often historically determined, however. When buyers come across a new product in the frozen food counter, for example, they are not likely to be able to make snap judgements on its price and quality compared with competing products. An important factor of demand is the development of buyers' concept of the product. Consider peas. The first time buyers come across frozen peas, they will try to evaluate them by placing them in the category "green vegetables". This doesn't give much indication of buyers' preferences for different qualities of peas, however. After buying them a few times, some buyers might develop the idea that colour is crucial to the taste. Other consumers make the same discovery. Gradually, buyers discover that peas of different size require different boiling times to get an optimal taste, or they develop a special liking for small peas in some meals and large peas in others. In time,

variations in pea colour and size become parameters after which they sort packets of peas or choose between different sellers' products. Only after a longer learning period will they develop an actual concept of the product which will enable them fairly quickly (and at less cost) to evaluate the product's quality (Clark, 1985). It is possible, therefore, that demand, and with it the value of different quality characteristics, changes over time as consumers gradually develop their concept of the product.

Variability and demand are not the only factors of importance for the economic benefit of sorting, however; sellers' costs of grading the peas after specific criteria are also important. Such costs depend in part on the development of quality standards and measurement methods for the characteristics.

These arguments lead to the hypothesis that the quality characteristics which form the basis for the hierarchical organization of quality classes are primarily:

> 1) the valued search (and possibly experience) characteristics which are easy and cheap for sellers to sort by, and
> 2) which at the same time are difficult for buyers to evaluate, because they vary widely from one unit to the next.

The sources of change in quality classes should thus be found partly in changes in buyers' preferences and partly in the development of better and cheaper measurement and sorting methods. It is reasonable to assume, however, that there is some difference in the way in which quality classes are changed for raw products and final products respectively, because firms' demand for particular quality characteristics in raw or input products is to a large extent also determined by production considerations. The diffusion of a new production technology can thus also be a source of change in a standard's specifications.

However, quality classes and standards' specifications seem to be quite stable. New product characteristics, for example, credence characteristics, are often just added to the hierarchies or they defined a new product standard. There are good reasons for such stability, since it would be costly for buyers to have to get to know new quality classes. The more often the criteria for class 1 peas are changed, the more resources buyers have to use, both in evaluating the individual seller's products and in comparing different sellers' products. Furthermore, it will take time for a new standard for sorting to spread to all firms. It will thus also take time for the same "system scale economic" benefits to emerge under the new standard as under the old standard.

While it may be difficult to change the order of priority of quality characteristics in quality classes without incurring new transaction costs, the characteristics themselves are not totally

unchangeable. Stricter criteria for first or second class quality can be introduced without this incurring significantly greater transaction costs. Such stricter criteria for sorting within fixed quality classes (standard variation) must be presumed to stem from competition, which forces firms to differentiate on quality by making tougher demands on the minimum level and maximum variation of quality. In time, these tougher firm-specific demands on the raw product can spread to other firms, and thereby end up as a change in the standard.

9. Conclusion

Quality standards, product standards, and quality classes can all serve a general cost-minimizing purpose, since they can be regarded as codes which make it easier for the economic agents to specify those product characteristics they want. As I have argued, thes standars may also exert an influece on product development. The influence of *quality standards* on product development is mainly due to their function as a means of specifying valuable product characteristics. Such standards make it easier for sellers to delineate and to protect the value of new characteristics. Quality standards may be particular important if the new charateristic is an experince and credencce charateristics since without quality standards experince[14] will be in the only way in which buyers can evaluate the charateristics. quality standard also makes it possible to sort products into more homogeneous categories, thus limiting value dissipation from searches.

The influence of *product standards* and *quality classes* on product development is first and foremost due to their ability to reduce buyers' costs of comparing different sellers' quality. This reduces sellers' incentives to cheat on quality, and makes it easier for honest sellers to realize an economic benefit from development efforts aimed at increasing the level of their products' search, experience, and credence characteristics. Quality classes, which consist of hierarchies of criteria for classifying products into groups, also influence the priority the firm gives to further development of particular product characteristics.

The relation between standards and product development is summarized in table 1 below.

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[14] In the case of credence charateristics investigations may be an more appropritate describtion of the kind of activities necessary for consumers to validate the charateristics.

Table 1: Standards and product development

Product development	**Standards**	**Influences**
Vertical	product standards quality classes	Influence which characteristics will be improved.
	quality standards	Improve competition in favor of those sellers with products of high mean quality.
Horizontal	product standards	Influence development efforts by setting threshold value for defining product categories.
	quality classes	Influence the ratio of characteristics.
	quality standars	Improve competition in favor of those sellers with products of high mean quality.
Complex	quality standards	Makes delineation of rights over new attributes possible.
	product standards	Influence development efforts by setting threshold value for defining product categories.

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Danish **R**esearch **U**nit for **I**ndustrial **D**ynamics

The Research Programme

The DRUID-research programme is organised in 3 different research themes :

- ***The firm as a learning organisation***
- ***Competence building and inter-firm dynamics***
- ***The learning economy and the competitiveness of systems of innovation***

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The theoretical perspective confronts and combines the ressource-based view (Penrose, 1959) with recent approaches where the focus is on learning and the dynamic capabilities of the firm (Dosi, Teece and Winter, 1992). The aim of this theoretical work is to develop an analytical understanding of the firm as a learning organisation.

The empirical and policy issues relate to the nexus technology, productivity, organisational change and human ressources. More insight in the dynamic interplay between these factors at the level of the firm is crucial to understand international differences in performance at the macro level in terms of economic growth and employment.

Theme B: Competence building and inter-firm dynamics

The theoretical perspective relates to the dynamics of the inter-firm division of labour and the formation of network relationships between firms. An attempt will be made to develop evolutionary models with Schumpeterian innovations as the motor driving a Marshallian evolution of the division of labour.

The empirical and policy issues relate the formation of knowledge-intensive regional and sectoral networks of firms to competitiveness and structural change. Data on the structure of production will be combined with indicators of knowledge and learning. IO-matrixes which include flows of knowledge and new technologies will be developed and supplemented by data from case-studies and questionnaires.

Theme C: The learning economy and the competitiveness of systems of innovation.

The third theme aims at a stronger conceptual and theoretical base for new concepts such as 'systems of innovation' and 'the learning economy' and to link these concepts to the ecological dimension. The focus is on the interaction between institutional and technical change in a specified geographical space. An attempt will be made to synthesise theories of economic development emphasising the role of science based-sectors with those emphasising learning-by-producing and the growing knowledge-intensity of all economic activities.

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