Product quality in developing countries agrifood supply chains : a survey of theory*

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November 13, 2018

Abstract

Keywords: certification, contract farming, quality assurance

JEL Classification: L15, O13.

*The author acknowledges the support received from the *Agence Nationale de la Recherche* of the French government through the program "*Investissements d'avenir*" (ANR-10-LABX-14-01). The usual disclaimer applies

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1 Introduction

Ten years after the publication of the World Development Report ([58]) on agriculture for development, agriculture is still underused for development purposes, especially in subsaharan Africa. However, agrifood global value chains are witnessing rapid and profound changes, inlcuding a strong increase in agrifood trade and a consolidation of supply chains (see Maertens and Swinnen [37]). These changes will have a huge impact on smallholder farmers : positive if they are able to participate to the global value chain and exploit the opportunities it offers in terms of access to new markets for inputs and/or products; negative if they are excluded from global value chains because they are unable to meet the requirements for entry . In developing countries, the middle segment of the supply chains is transforming rapidly (see Reardon, [43]), supermarkets become pivotal actors on the downstream segment and large scale foreign direct investments target the agroindustry sector. Governments and institutions realize the a modern financing of agricultural supply-chains is crucial for Africa (see Banque Africaine de Développement ([5]).

The recent changes in agrifood value chains have led to an increased attention paid on product quality. Meeting quality requirements including phytosanitary standards seem to be a condition for participating in the global value chains and to get access to high-value markets in developped countries. It becomes also a condition for serving local urban consumers that are increasingly supplied by supermarkets and consume more agro-processed food.

Quality attributes of agrifood products in the global value chains shall not be studied in isolation. A focus on quality should highlight the fact that attributes of products are related to the organization and the structure of the whole supply chain and to the type of contractual agreements between actors. This is a common theme of the industrial organization literature.

The objective of this paper is to offer a literature review on product quality in markets. It focuses mostly on the theoreticall industrial organization literature and the applied game theory literature. It highlights the following features that are particularly interesting for the understanding of the changes in agrifood supply chains in developing countries. First, an increased focus on quality will necessary have a deep impact on the structure of the supply chain because it increases the number of dimensions along which competition and/or cooperation takes place ; it exacerbates

informational problems between actors and give a potentially more important role to intermediaries and third-parties ; it may also modify economies of scale. Second, the importance given to quality in the supply chain may be demand driven but may also be strategic. In the latter case, it serves at distorting the bargaining power of actors and modifying the surplus sharing along the supply chain. Third, contracts and certification of quality should be considered as complements in order to guarantee the production of high quality goods. While contracting arrangements are necessary to tackle a number of organizational and informational issues along the supply chain, their functioning can be smoother if third-party certification of quality is available.

The review is organized in three sections. In section two, we review the literature on quality attributes of goods, quality standards and quality disclosure mechanisms. In section three, we survey the industrial organization literature on quality differentiation in markets, with a focus on the production of quality products, the revelation of quality attributes and the market for certification. In section four, we extend the analysis to supply chains and survey quality provision in vertically related markets.

2 Quality attributes of agri-food products

2.1 Search, experience and credence goods

Following Lancaster's [32] insight that, more precisely than from goods, consumers derive utility from characteristics or attributes of goods, the standard classification of quality attributes of goods relies on the distinction between search, experience and credence goods, developped by Nelson [42] and Darby and Karni [12].

Search goods are those for which the consumer can learn the quality attributes, presumably at a non-zero cost, before purchase. Markets for search goods are characterized by frictions and the relevant modeling must go beyond perfect competition. Salop [45] is an early contribution emphasizing that market equilibrium, in that case, may involve multiple prices. The information possessed by a given buyer depends on his past consumption path which may give rise to dynamically captive markets. Buyers may also adopt strategies according to which they visit in sequence a restricted number of sellers before buying. On the sellers' side, search deterrence strategies such as exploding offers (e.g. price offers that will not last) or deposits seem to be common. Armstrong and Zhou [2] offer a model and an up-to-date discussion of search

deterrence in markets.

Experience goods are those for which the consumer can discover the quality attributes via experience, i.e. after having consumed them. In markets for experience goods, reputation of sellers is a central element. Under the reasonable assumption that sellers have a better information on quality attributes than buyers, spot markets for experience goods are plagued by asymmetric information giving rise to the Lemons' problem (Akerlof, [1]). Quality signalling via different price offers in a separating equilibrium becomes possible once one takes into account the repeated interaction between buyers and sellers (Riordan, [44]). Gale and Rosenthal [20] provide a model according to which sellers build a reputation by selling high quality products at low price, then enjoy the benefits of their reputation by selling high quality at high price before running down their reputation by selling low quality at high price. Quality cycles may appear in a steady state equilibrium. The incidence of market structure on quality provision is also a central theme in the literature, following Schumpeter [46] and Swan [52] whose focus on innovation parallels concerns about quality. In markets for experience goods, incentives to maintain a reputation for high quality or to increase quality in order to steal business from rivals are stronger if margins are higher. Monopolists generally have higher margins but the threat of a rival stealing their business is small. Dana and Fong [11] develop a model according to which the incentives to produce high quality may be highest in an oligopoly where players are in a tacit collusion equilibrium.

Credence goods are those for which the quality attributes cannot be discovered by the consumer neither before or after purchase. In credence goods markets, the seller usually knows the quality of the good or service needed by the customer and therefore plays an expert role in addition to being the seller. The literature, surveyed in Dulleck and Kerschbamer [14], has shed light on overcharging (the good or service is sold at a high price despite its low quality) and overtreatment (the customer is offered a high quality-high price good while a low quality-low price one would suffice) phenomena in these markets. Whether market forces can discipline sellers of credence goods depends on the precise information available on those markets (see Emons, [15]).

2.2 Quality standards, observability and traceability along the supply-chain

Quality attributes of agricultural products encompass a variety of elements such as appearance, taste, nutritional value, chemical composition, ingredients, methods of production, origin or safety and health related characteristics (see for instance European Commission Fact Sheet [16]). These attributes may be relevant all along the supply chain or solely at a given stage, on a specific market where they may give rise to differentiation strategies. The classification of agrifood quality attributes according to the search-experience-credence grid is instructive but one has to keep in mind that it may be market specific and not constant for a given product as one moves along the supply chain.

Appearance is a search attribute that may necessitate some sampling to be correctly assessed. Taste is clearly an experience attribute that is subjective and may vary across consumers. Nutritional value could be considered as in-between experience and credence attribute. Chemical composition could be a credence attribute on the final market but a search atribute on wholesale markets where buyers may have access to the technology necessary to discover the chemical composition of what they buy.

Driven by final consumers demand, markets have put a recent emphasis on quality attributes related to the geographical origin of production, to the use of organic methods of production, to the fulfillment of fair trade standards or to the absence of child labor. Those attributes are generally analyzed as credence attributes.

The variety of quality attributes that consumers value as well as the increasing importance of food safety give a central role to quality standards, verifiability and traceability along the supply chain (see Hobbs [24]).

Quality standards can limit the risk borne by final consumers, they can also guarantee some minimum level of a desirable attribute. Their role in trade and industrial organization has been largely studied in the literature, with a debate opposing those who view standards as barriers to international trade and those who view standards as catalysts limiting informational asymmetries along the supply chain (see Jaffee and Henson [27] for an overview).

Traceability is a core component of the European Union regulatory framework of

the food sector. It is also being used as the basis of competitive product differentiation strategies by food firms that want to assure consumers of the presence of some credence attribute in their product. A traceability system has three main functions: 1) to allow an efficient traceback of products and inputs and therefore minimize the treatment cost of a problem (e.g. public health problem), 2) to identify credence attributes related to production processes and therefore to limit information costs, 3) to strengthen liability incentives and minimize free-riding along the supply chain.

Traceability systems often seem to be a prerequisite for the efficiency of the diverse quality assurance mechanisms that we will detail below.

2.3 Quality disclosure : brands, warranties, licensing and labels

There are many mechanisms for informing consumers about product non-observable attributes. Some mechanisms necessitate public intervention, some emerge from market forces alone.

Branding may be the most common. Due to the fixed costs associated with advertising campaigns, brands may credibly signal quality to consumers prior to purchase. They may also guide consumers making repeat purchases based on their recall of the good experiences thay had (see Bagwell [4] for a survey on brands and advertising in the economics literature).

Warranties limit the risk borne by consumers when the quality of purchased goods is uncertain. They may also be offered to buyers to signal quality (see Grossman [22]). In a separating equilibrium, warranties will only be offered jointly with high-quality products for which the exercise of the warranty is unfrequent. Such an assurance mechanism is quite demanding in terms of liability and verifiability because consumers must be able to unambiguously link product defect to quality attributes and to prove it. Liability of producers can also be imposed by public intervention when private incentives to offer warranties are not sufficient (see Spence [49]).

Licensing is usually performed by a government agency to ensure some minimum level of inputs (e.g. training or staffing) or minimum quality standard. While offering some indirect guarantee on the quality of the product, this type of mechanism is criticized for its role as a barrier to entry. Leland [34] analysis of licensing and

minimum quality standards support this view as he shows that if the standard is set by the industry itself, it will be too high from a social welfare perspective.

Consumers may also be informed about product quality by diverse direct disclosure mechanisms. From a producer's perspective, disclosure can be voluntary (and generally in that case industry-sponsored), or mandatory (and generally in that case government-enforced). Dranove and Jin ([13]) offers a recent survey of the theoretical and empirical literatures related to quality disclosure and certification. They highlight three distinctive features of disclosure: First, disclosure systematically measures and disseminates information about product quality; second, disclosure is usually performed via third-party certifiers; third, disclosure standardizes quality assessment so that results are readily comparable across sellers. With disclosure mechanisms, consumers are empowered with information and their behavior should discipline producers and provide the right incentives for producing quality products.

Labels are one example of voluntary disclosure mechanisms. Whether private labels provide sufficient information to consumers is studied in Bonroy and Constantatos [10], while Giraud-Héraud et al. [21] compare the performance of private labels and minimum quality standards in supply chains.

3 Quality differentiation on markets

3.1 Producing quality

Suppose first that quality attributes are perfectly observable by consumers. In that case, diverse quality levels of the same good might be offered on the market, reflecting diversity in production costs and consumers' tastes as well as strategic or informational considerations.

Under perfect competition, optimal product differentiation is analyzed by Lancaster [33]. In that setting, vertical differentiation is driven by the marginal cost of quality and the heterogeneity in consumers' marginal rates of substitution (between quality and money). Increasing returns to scale on producers' side may limit the optimal scope of qualities that are offered to consumers.

Consider the polar case of a monopoly that does not observe consumers' tastes. Quality differentiation is a tool to perform second-degree price discrimination. The

pioneer analysis in this vein is due to Mussa and Rosen [41]. Compared to the situation where the monopolist could perfectly price discriminate, the scope of qualities offered to consumers is larger. Here quality differentiation plays an informational screening role.

Vertical differentiation in an oligopoly is studied by Shaked and Sutton [47] in a model where firms first choose the quality they will produce and then, having observed the quality choice of their competitors, fix the price they charge.Quality differentiation is strategic here as it relaxes price competition in the last stage. The equilibrium of this game is asymmetric and several qualities are offered on the market. Tirole [54] has established the principle of maximum differentiation, according to which duopolistic firms choose in equilibrium the maximal scope for quality differentiation.

In a model motivated by field work conducted among tea producers in Nepal, Mohan [40] link the quality level of production to the rejection rate of product by consumers in the final market. In such a situation, adopting a higher quality standard decreases the risk of rejection and is more valuable to more risk averse producers.

3.2 Revealing quality

Suppose first that quality of goods is a private information of producers that can be costlessly and credibly revealed to consumers. Whether consumers benefit from quality revelation depends on the price they pay and on their risk aversion with respect to quality attributes. From the sellers' viewpoint, revealing quality has an impact on the demand they face. The basic result emphasized in the literature is an *unraveling* result, first obtained by Viscusi [56]. The firm producing the highest quality as a clear incentive to reveal it to the consumers since this will increase their expectations about this firm's product quality and therefore increase their propensity to pay for the good. Then by the same argument the second-highest quality producer as an incentive to reveal its product quality, and so on... So that consumers end up with perfect information on product quality in the market. Behavioral models with a fraction of boundedly rational consumers provide an example of failure of unraveling : in Hirshleifer et al. [23] and Fishman and Hagerty [19] a fraction of consumers misinterpret disclosure or non-disclosure decisions and continue to believe non-disclosing firms produce average quality ; in such models, some firms rationally do not disclose in equilibrium.

Quality of goods sometimes cannot be credibly revealed but only signalled to consumers. On spot markets, prices alone are generally not a good signalling device (see Akerlof [1]). Sellers might use bundled services such as warranties as mentioned in section 2 above ; they may also signal quality through labels that are costly to obtain (labels may not necessarily perfectly reflect quality ; a standard sorting condition would then be that the label is more costly to obtain for a low-quality producing firm than for a high-quality producing firm). When interaction with consumers are repeated, reputation for producing high quality items can be built up by firms. Elaborating on Klein and Leffler [29], Shapiro [48] provides a model of a market with free entry in which reputation allows firms to charge a price above marginal cost and serves as a reward on maintaining high quality production. Kranton [30] revisits such an analysis in a model where firms can increase their market share by lowering their price ; quality-assuring prices may be undercut by firms willing to increase their market share, leading to suboptimal quality levels in the subgame-pefect equilibrium.

A literature has focused on situations where the quality of goods can be revealed to consumers at a cost : the cost of certification by a third-party. We first discuss that literature, leaving aside the problem of certifiers' incentives to be honest. With costly disclosure, Jovanovic [28] establishes that sellers will voluntarily disclose information when their quality is above a threshold. There may be too much disclosure in equilibrium compared to the socially optimal level. Considering both the monopoly and oligopoly settings, Levin et al. [35] build a model where disclosure is higher under monopoly than under duopoly but where welfare comparisons depend on the disclosure cost. In either market structure, disclosure is excessive in terms of total surplus but insufficient in terms of consumer surplus.

3.3 Certifying quality

While certification by a third-party is a mechanism that facilitates truthful revelation of product quality information to consumers, the certificate itself is a credence, or at best an experience, good and the relationship between certifiers, producers and consumers is plagued with multiple asymmetric information problems.

The central concern in the economics of certifiers is whether certifiers will truthfully reveal information. This literature has been focusing mostly on certification in financial markets but its insights can be easily transposed to other markets. Moral haz-

ard and conflicts of interest problems, reputation mechanisms or competition among certifiers are scrutinized.

One first question is related to the financing of certification. It is difficult to imagine a business model according to which consumers directly pay for certification because of private benefits dispersion and free-riding issues. So certification could be financed by a regulator or by producers. Another question relates to the initiator of certification. Stahl and Strausz [50] distinguish seller induced and buyer induced certifications and argue that seller induced certification reveals more information to consumer since non-certification can be interpreted as the willingness of the seller to conceal (bad) quality information.

If certification involves a contractual agreement between the producer and the certifier, potential biases have been identified in the literature. It is usually assumed that the information learned by the certifier is hard and cannot be manipulated, however it can be concealed, raising the issue of collusive behavior between the producer and the certifier at the expense of the consumers (see Strausz [51]). Considering contracts that specify monetary transfers and a disclosure probability both contingent on quality, Faure-Grimaud et al. [18] have studied the renegotiation incentives once quality is learned by the certifier and the distortion induced by renegotiation-proof contracts, raising the issue of the ownership of certificates.

Notice that revolving doors between producers and certifiers may well create conflicts of interest due to career concerns, even in the absence of financial transaction between certifiers and producers at the time of certification.

Reputation of certifiers among consumers is clearly a disciplining device when certification targets some experience attributes of goods (see Benabou and Laroque [7], and Biglaiser and Friedman [8]). Its efficiency may be challenged if consumers are naive (see Bolton [9] for an analysis of credit rating along these lines). Reputation among producers plays a more ambiguous role. For instance, Hubbard [25] documents how smog check inspectors may pass a failing car if reputation for being lenient increases future business.

As analyzed by Lizzeri [36], a monopolistic certifier generally has incentives to only partially reveal information to consumers in order to extract more rent from producers. The analysis of competition among certifiers is complexified by the fact that certifiers often compete in prices as well as certification criteria, this leads to a

type of monopolistic competition outcome with quality ordered certificates (see Hvide and Heifetz [26]). Farhi, Lerner and Tirole [17] explore three related strategic dimensions of the certification market : the publicity given to applications, the coarseness of the rating patterns and the sellers' dynamic strategies. Auriol and Schilizzi [3] model certification of credence attributes in market equilibirum, with an application to agricultural seed certification in developing countries.

4 Quality provision along the supply-chain

4.1 Global value chain and the access to high-quality markets

As an effect of globalization in the agri-food sector, farmers in developing countries can target high-quality markets, in the North and increasingly in cities in the South. However, reaching those markets is often not direct and necessitates intermediaries that are somehow gatekeepers of the global value chain. In that sense, vertical relations between producers and retailers (or other intermediaries) are a sine qua non condition for selling high-quality production. Vandemoortele et al. [55] propose a simple model of inclusion of small scale farmers in the global vlaue chain along these lines. Their model assumes costlessly observable search attributes, and free entry and competition at the intermediary stage. It provides a useful framework and benchmark ; it allows them to perform comparative statics exercises with respect to a set of parameters including transaction costs, average wealth of consumers, taste for quality, cost of capital, etc. Their main focus is on the emergence and the size of the high-quality economy in developing countries.

Elaborating on the idea that value chain intermediaries are necessary to reach a demand for high-quality production we can analyse quality production, revelation and certification in supply chains along the same lines as we did in section 3 above. Supply chain vertical relations possess some specificities : for instance on intermediate markets, repeated interactions among a small set of well-identified actors facilitate the functioning of reputation mechanisms and should limit free-riding issues. Market power is also likely to be an important aspect : in the agrifood sector, the rise of supermarkets or the concentration in the seed sector are leading to market power upstream and/or downstream.

It should also be stressed that global value chains introduce an international trade

dimension into the picture. As a consequence, political economy arguments can be invoked and studied when one analyses the barriers to trade effects of instruments like minimum quality standards (see Swinnen and Vandemoortele [53] for a model).

4.2 Vertically related markets and quality choices

An important insight of the IO literature focusing on quality standards is that a taste of final consumers for quality is not necessary for standards to emerge. Quality requirements can be imposed at various stages of production for strategic reasons (see McCluskey [38] for a summary discussion).

In this vein, von Schlippenbach and Teichmann [57] develop a nice illustrative model. The supply chain involves a duopoly downstream and multiple suppliers upstream. In this model quality standards on the downsteam market may be driven by the willingness to strengthen the bargaining position vis-à-vis suppliers. It is in the duopolists' interest to use quality standards to force exclusive dealing with suppliers and reinforce their market power upstream. Indeed in their model upstream suppliers must choose the quality they produce early with limited possibility of switching; duopolists choose to sell different qualities on the downstream market so that a given supplier is stuck in his relationship with the duopolist that sells the quality he produces.

Yu and Bouamra-Mechemache [59] model supply chains that rely on wholesale prices on intermediate and final markets and abstract from bilateral contractual relationships. Standards may emerge from collective bargaining that involves the different stakeholders because they may have an impact on the size of the industry surplus as well as on the shares that the different stakeholders obtain. For instance, under perfect competition at the intermediary stage, diseconomies of scale at the upstream stage and for a fixed number of upstream producers, a minimum quality standard may affect marginal costs of production in a way that increases the equilibrium agregate producers' surplus. With oligopolistic competition at the intermediary stage, the latter effect remains and is complemented by a surplus sharing effect which depends on how the wholesale price on the intermediate market is modified with the introduction of the quality standard. The authors establish that the interests of upstream producers and intermediaries are generally not aligned with respect to the choice of the quality standard.

4.3 Contracting and vertical integration

When quality of agrifood products raises some informational problems linked to the experience or search nature of the attributes, or linked to asymmetric information at various stages of production, bilateral contracts between upstream and downstream actors might be needed. Barrett et al. [6] offers a conceptual framework to analyse the different issues tackled by bilateral contracts in agrifood supply-chains in developing countries.

It should be stressed that quality issues are one aspect of contractual relationships in supply-chains. Contracts can be relied upon to safeguard supplies, to mitigate hold-up problems, to trade-off incentives and insurance in case of moral hazard with a risk-averse party, or to bundle financial services, to list a few aspects. Quality issues can interact with other aspects, or can inherently bring other dimensions into the contractual relationship. To illustrate, suppose that quality provision in a fruit or vegetable market requires a specific investment by the upstream small-scale farmers; an efficient contractual agreement would therefore give attention to hold-up of the investment by the downstream processors, to the provision of credit by the processor if it has a better access to the financial markets, to free-riding and side-selling by the upstream small-scale farmer, etc.

Kuijpers and Swinnen [31] build a simple model of contractual relationship between producers and processors to study technology adoption in agrifood supply-chains related to the emergence of a high-quality economy. Their model takes into account limited access to credit and hold-up opportunities.

Multiple moral hazard problems have been largely studied in the theoretical literature on vertical contracting. With respect to quality provision, multiple moral hazard siutations arise when the quality of the final good is impacted by several unobservable efforts all along the supply chain. Mitchell [39] offers a nice model of vertical contracting motivated by observations in milk, cocoa, chillies and rice supply chains in developing countries. Her model offers a very nice framework for understanding the respective roles of contracting and certification in agrifood supply chains.

There are two stages of production, each undertaken by a different agent and each involving an unobservable effort impacting quality. Achieving high-quality of the final good necessitates high effort at the two stages ; however, high efforts do not guarantee high quality, it only increases the probability of high quality. After the

first stage of production is performed, a signal on quality is obtained from which the downstream agent can update his beliefs concerning the effort undertaken upstream. Once the second stage of production is performed, quality becomes observable by final consumers and market clears.

Several features of the model are worth mentioning. The nature of the good's attributes varies along the supply chain as quality is unobservable afeter the first stage and observable on the final market. The signal obtained after the first stage is akin to a quality certificate. It helps the downstream agent manage the moral hazard upstream but does not solve alone the quality provision issue.

Mitchell derives the minimum price difference between low and high quality final good for which the supply chain is able to produce the high-quality good despite the multiple moral hazard problem. Comparative statics is performed with respect to the precision of the signal, the cost of effort and the cost of production. Mitchell also studies the situation in which the supply chain is integrated with a single agent performing the two stages and analyzes the conditions under which vertical integration outperforms vertical contracting.

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