

“To the taste and fancy...”

Quality control in the value chain

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One of the crucial innovations in 19th dairying was the steam-driven cream-separator . It allowed milk to be skimmed immediately after it had been transported – an important feature in countries with many small or medium-sized dairy farms. The flipside of the coin was that modern dairies became a hotbed for the spread of microbes, among them tuberculosis bacteria that could infect humans with the disease. The paper demonstrates how Danish dairies while pursuing their interest in hitting the exact taste of British consumers inadvertently saved the same consumers from contaminated dairy products. Private grocers as well as state subsidized research and extension services played an important role in the story

Introduction

Recent research has offered further opportunities for the comparison of value chains in various agricultural products during the first wave of globalization (see, for example, Simpson 2005 and 2011 on the wine trade). The focus of research in this field has been the examination on how the various steps in the chain were organized and to what extent the organization furthered competition in domestic and foreign trade and thereby limited dead weight losses. Part of the prerequisite for competition is the establishment of a reliable quality control in every link of the chain to make full information available to all transacting parties.

The chain consists of several important links. In earlier papers we have tracked the path from primary producer to the processor. We have analyzed the Danish trade in milk between the dairy farmer and the dairy (in this case a cooperative) (Henriksen and Hviid 2005, Henriksen, Hviid and Sharp 2012). One of our findings is that the dairies fairly effectively handled one dimension of the quality problem, that of adulteration of the product. First, perpetrators of the contracts faced harsh consequences when detected, secondly, when the technology had been developed, by rewarding quality directly. The emphasis of this paper is the trade between the processor and the middleman or grocer.

Obviously, there was the more subtle dimension of quality, which was more difficult to deal with when grading. In the case of dairies the rules of cleanliness and temperature presented a problem. On the one hand the observation of these rules was crucial for the smell and flavor of the butter processed. Besides, a growing concern for animal health played a role towards the end of the century. On the other hand, the producers accused of transgressing the rules would claim that the judgment made by the dairy manager and his staff was purely subjective (in the absence of bacteriological control). The manager in the Danish case was in a predicament when refusing bad consignments, since his contract was renewed annually. Consequently, it did not pay to make enemies in the local community. Efforts by dairy farmers themselves to put up control organs were not uniformly successful. In this dilemma the purchasers of the product, the butter grocers, came to play an important role as a check of quality. In our archival material covering the minute books of 215 dairy cooperative creameries we found 33 explicit references to complaints from grocers about the poor quality of the product. Some dairies responded by trying their luck with

another purchaser. More importantly, however, were the cases in which the dairy called in the state sponsored extension service in order to detect the root of the evil. The consultant rarely found faults with the dairy staff, while it appeared that a lot of the milk supplied was “labeled bitter, old, sickly and sour and with the taste of stable” (a quotation from 1890). Along with the provision of the extension service the state worked actively in its first research laboratory from 1883 to better the understanding and measurement of bacteria. We claim, however, that without the outspoken feedback on poor quality from many private grocers, who punished the dairies with rejection or lower prices, the state effort might not have borne fruit. In Section 2 we describe how the export trade was organized. Section 3 offers some detailed case stories.

Figure 1. The value chain in Danish dairying 1882 to 1914

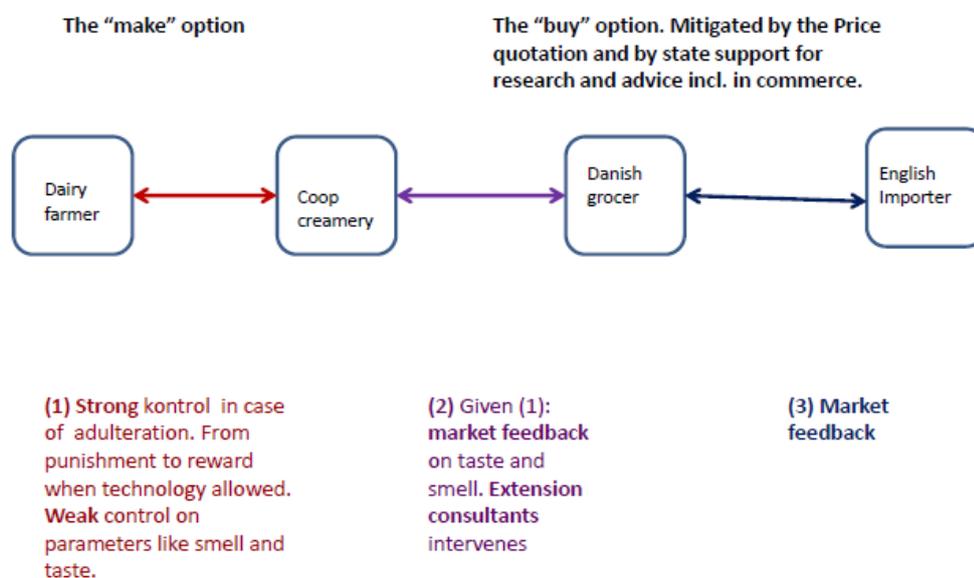
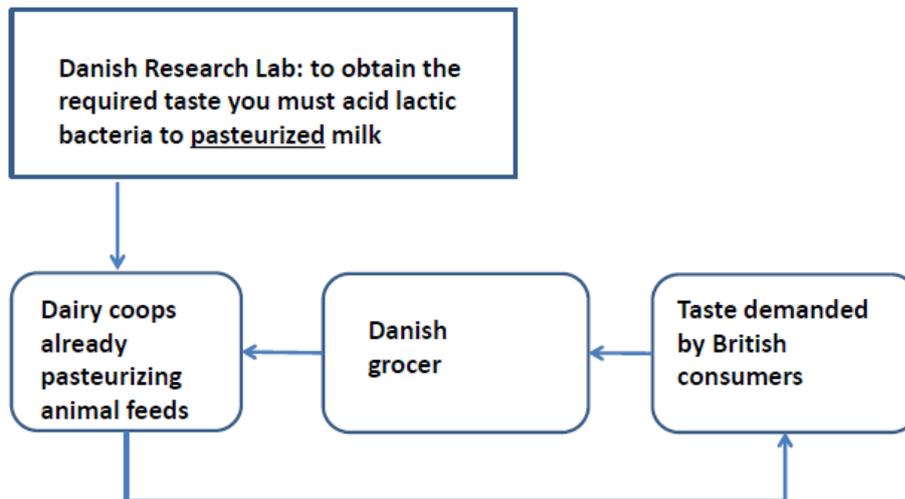


Figure 1 sketches the links in the value chain described above. The links are labeled according to the typology suggested by Klein (2005). In this paper the focus will be on (2) and (3). It is a central allegation that the market feedback in both links was working. These markets had features that can be characterized as monopolistic competition.

Furthermore, given that market forces worked, our paper challenges the claim by Easterlin (1999) that the market did not contribute in a positive way to the improvement in public health. “The classic sources of market failure – information failures, externalities, public goods, principal agent

and free-rider problems have been pervasive.” We intend to add a twist to this allegation. Our line of reasoning can be illustrated in a simplistic way.

Figure 2: The feedback mechanism and its outcome



The paper is organized as follows. First, we review the efforts by the coops themselves and by invited dairy consultants to raise the level of hygiene of the raw milk supplied to the creameries. This typically happened as a response to complaints from the butter grocers.

We then go on to describe the effects of micro biological research results on the health of the members’ herds of cows. Bovine tuberculosis could cause a reduction in milk production by 10-25 per cent and problems in breeding (Olmstead and Rhode 2004, pp. 737-738). Why would these facts be of increasing concern to the cooperatives in particular? The cooperatives had often been praised for the practice of returning the skimmed milk to the members to use as feed for their calves. As it dawned on Danish scientists that one of the main conveyors of the disease was that of drinking contaminated milk it caused an almost immediate reaction (Faber 1900-01, p. 254).

Finally, we explore a different source of bad tasting butter. It could surface even when clean and fresh milk was delivered to the dairy. Thus, clean milk is but one part of the story of quality. The other important role is played by the processes adopted in the creamery. Recent works by two Danish historians of science (Nielsen 2004 and 2010, Leisner 2005) review the early history of bio-science in the Danish dairy industry. Nielsen, in particular, underlines the advent of ‘rational

agriculture' in the late 19th century, where "rational implied modern, *based on market economy and based on science.*" [my italics]. The results from state-subsidized research could not have been exploited effectively without market based incentives.

The solution to the problem was to add a pure starter culture to the cream. This process could, however, only be effective after the indigenous micro-flora in the cream had been killed through heating, i.e. pasteurization.

It ought to be emphasized that pasteurization in itself could not remove the deficiencies in taste that originated in dirty milk. At the same time, there was no way in which the addition of a pure starter culture to non-pasteurized milk could improve the taste of the butter.

In conclusion, market forces in the form of consumer demands transmitted through English and Danish butter merchants led not only to a more palatable but also to a healthier product.

1. Own control of quality

We know that adulteration of the milk in the early days of the creameries was uncovered by other coop members or by members of the general public. To an increasing degree the detection was taken over by technology applied by the staff of the creameries. (see, Henriksen and Hviid 2005 for the development and application of a technology that made control of the fat or cream per cent available).

A system of formal peer monitoring of supplies arriving at the creamery was set up in a majority of coops. It is apparent from the minutes that control was directed mainly at 'thin' milk. It was executed in two ways. Originally, in most places it was left to one or two board members to supervise the creamery manager testing samples of the day's consignments. The board was the highest authority in the day-to-day management of the plant. In a few cases the participation of the board member was limited to the second test, taken at the stable door, in case the test taken at the creamery was suspiciously low fat.

For various reasons monitoring by board members was supplemented or superseded. The obvious explanation is the growing workload when tests became more frequent. In a small number of cases a paid assistant assisted the manager. We found two cases where professional dairy

consultants were hired for this purpose but most often it was a local man elected for the job by the general assembly.

In a large number of cooperatives monitoring was carried out by a control committee of members elected by the general meeting. Sometimes this committee is set up from the very beginning and in some cases even written into the statutes. The control commission members would then take turns, usually one or two at a time, to go to the creamery and supervise the testing of the fat per cent measured by the manager. In some cases a member of the board would also be present. Very likely the incidence of control commissions in the sample in Table 1 is underestimated. We do not have the minutes from the start of the creamery in 15 cases. It is equally possible that we have recorded the establishment of some committees too late. If the establishment is not mentioned although the committee was quite important we typically detect them when fines are mentioned, i.e. fines to committee members for not showing up at the creamery. The board members were not alone in finding control - a time consuming task. In a single small creamery they had to give up the committee after just a year since "people rarely show up".

Table 1. Formal control organization in 134 creameries

| | | |
|--|----|-----|
| Committee from start | | 31 |
| Later than first year but less than 10 years | 29 | |
| Later than ten years from start | 10 | |
| Year not recorded | 14 | |
| Total with a control committee | | 84 |
| Monitoring by board and/or paid assistant only | 12 | |
| No committee recorded | | 38 |
| Of which no minutes from start | 15 | |
| Total sample | | 134 |

Source: Minutes from board meetings and general assemblies of 134 Danish dairy cooperatives, 1884-1915

In at least 72 per cent of the creameries for which this question was examined systematic peer monitoring was organized. What is perhaps more interesting is that in at least 63 per cent the consignments were monitored by an elected control committee. The committees often had 10-12 or more members, or a number of members that represented various local communities. At any rate the mode of election ensured an annual or biannual replacement of members. The actual control or rather supervision of control was usually carried out by two members at a time and the members would, of course, take turns. This procedure points to an awareness of the problem of regulatory capture. That would have happened if a regulatory agency (committee) formed to act in the interest of all cooperative members, eventually acted in the interest of the committee members only. Board members were, of course, up for election or re-election once or twice a year but in practice re-election, especially of the chairman was rather common. Had it only been a problem of work load one would believe that a paid help had been hired early on. This rarely happened. Instead monitoring was carried out by a perpetually changing set of two members.

It would have been obvious to charge the control committee or the board members with the task of controlling the cleanliness and taste of the individual consignments supplied. In most statutes we find one or more paragraphs on quality that prescribe the proper hygienic standards. The milk should be supplied fresh and strained in a clean bucket and milk from sick cows or cows which had recently calved was under no circumstances allowed. In addition to this certain feeding rules should be observed limiting feeds that would affect the taste such as turnips. Some statutes went to the length of threatening perpetrators with a visit to the stable by the coop board in order to raise the standard. Nevertheless, we find examples of lenient treatment of perpetrators. "Because the member B.S. has supplied a lot of un-clean milk to the coop he came forward [to the board] to negotiate claiming that it had only been dirty once. The board agreed to let him off with a warning for the first incidence." This happened in October 1893.

Why would some coop members shirk when it came to stable hygiene and feeding? Basically, their motive was the same as that of members adulterating the milk. Compliance with the statutes was costly in time and sometimes in money as well. Even if the shirking members suspected that un-

clean milk might influence butter quality and, eventually, prices, they believed that their share of total loss would cost less than the value of their diminished effort.

Why were the formal bodies, control committees or board members, so inadequate when it came to this important dimension of quality? We claim that the organizational arrangements of quality control were insufficient as long as there was no clear cut scientific method of proving the faults in milk consignments. A method for detecting milk that had been adulterated by water or skimmed milk had existed from the mid-1880s. Quite apart from technology in a number of cases the fraudulent behaviour of some dairy farmers had simply been detected by visual observation in the local community. Bacteriology, however, was only in its infancy in the early 1890s. This was partly the reason why it took considerable effort by butter grocers and dairy consultants to persuade the suppliers to observe the rules on hygiene. The reductase test, to test for the bacterial content of milk products, was not introduced in Danish creameries until the 1920s and was only made obligatory by law in 1931.¹

One may legitimately ask why the invention, by a Danish veterinary, of the tuberculin test for bovine tuberculosis in 1890 did not have an immediate effect on disease control in the coops. As we shall see it happened when the treatment of milk was concerned. What was sorely lacking was the other measure to prevent tuberculosis from spreading - that of isolating and destroying infected animals. Even though we find examples of coops investing in veterinary control they did not act effectively on the challenge. One such example is from the coop of Gjesten that pays a veterinary to inspect the herds of the members in June 1891. In that and the following year he finds 10 respectively 13 sick cows. The only reaction according to the coops was to forbid the owners from supplying the milk from these cows. In a later report it says that one of the infected cows had been slaughtered while some others had been sold. In fact, the trade in tuberculous animals was one of the main culprits when it came to spreading the disease among herds.

¹ Methylene blue is added to the milk and the time determined for decolorization of the dye by the reducing action of bacteria is measured, the more bacteria the faster the process.

2. Private grocers as the harbingers of British taste

Going back to Figure 1 one may well ask why the dairy cooperatives did not opt for cooperative export associations from an earlier date. The first such association was set up in 1889 and the diffusion of the cooperative export business was slow compared to processing coops in Denmark. On the Eve of WWI the export coops only catered for about one third of the export trade. Why were the dairy coops not quicker to integrate with the trade link? In this section we argue that 1) the cooperatives were not yet equipped with the knowledge to enter the export business, and 2) the idea of the private grocers 'exploiting' the dairies was not backed up by the facts.

The advantages of vertical integration has, once more, been forcefully extolled by Klein and Murphy (2011, p. 418). They find that "vertical integration can be explained as a particular contractual arrangement that often facilitates self-enforcement." The reason for this is that "integration minimizes inefficiencies by allocating all contractually unspecified or residual cost to the owner." On a more prosaic note we have argued that Danish dairy farmers were aware of these benefits and that they induced them to form cooperative dairies (Henriksen 1999). So why did they not go on to establish cooperative export businesses?

Simpson's work on overseas and European wine gives us a living illustration of the importance of distance to the market for the organization of distribution.² The demand by the British consumers was well known to Danish butter grocers. Because of the geographical proximity and the long term experience with the export trade, mainly in grain, the merchants had their ears to the ground.³

Boje (1977) in his account of Danish provincial merchants' trade 1815-1847, records no less than 30 local custom houses from which agricultural goods were shipped to England, The Netherlands, Norway, Altona, Slesvig⁴ and Copenhagen. What might have triggered the discontent among minor producers was simply the well-known effect of economy of scale. Exports, to the Dutch and, not least, the English market demanded more capital in larger ships and stores. This favored large

² Simpson (2011, pp. 40-41)

³ One of the small signs is the swift communication in 1908 of the British announcement of a 16 per cent maximum content of water in butter. In our archival material we find several references in the minutes to letters from the grocer in question to the creamery demanding this rule to be observed and only a few creameries that did not take the message seriously.

⁴ Holstein with Altona and Schleswig with the town of Schleswig were then part of the kingdom of Denmark. That is the 30 custom houses covered about the area of present Denmark which is 44.000 square KM.

producers or the joint supply of many producers. Boje goes on to demonstrate some early concentration in export goods and export markets among a selected group of traders but he concludes that 'The concentration was not stronger than it allowed the existence of grocers with a more limited export.' (p. 100).

As the dairy sector on estates and large farms progressed through the 1860s and as focus grew on the British market⁵ buying butter for export became more professionalized. That is to say trade specialized in butter rather than in grain or a mix of products and it removed superfluous intermediates between the dairies and themselves and between British retailers and themselves. (Bjørn1982, p. 36)

The arguments for the market power of grocers is often high on the list of explanations why agricultural coops were established, whether in industrial countries in the nineteenth and early twentieth century or in developing countries half a century later. Monopsony redistributes profits to the detriment of sellers and creates a dead weight loss to the economy. If this is the case it would induce the dairies to form bargaining cooperatives

Taking a closer look at the Danish background the claim by farmers, including dairy farmers, that they were "exploited" by townspeople⁶ is hardly justified by reality. Excellent logistics with many isles and natural harbors prevented local monopsony for any longer period of time even before the advent of a nationwide railway system in the 1860s and 1870s. Furthermore, the acceleration in the number of creameries during the latter half of the 1880s formed the basis for an increase in the number of regular steam ship services between Danish ports and the eastern British ports beginning with Copenhagen-Leith in 1865, Randers-Newcastle in 1866, Aarhus-Newcastle in 1868, Copenhagen-Newcastle in 1870, Aalborg-Newcastle in 1874, and Esbjerg-Newcastle, Esbjerg-Harwich, Esbjerg-Grimsby and Copenhagen-Hull in 1875.

On the basis of the evidence put forward below we argue that no Danish butter merchant had absolute market power, not even locally, when it came to buying the produce from the dairies. Turning, however, to the subsequent link in the value chain, from exporters to British buyers,

⁵ The opening of the first direct steamship line between Western Jutland and Southern Scotland (Esbjerg-Leith) in 1865 was symptomatic for this.

⁶ See, for example, Hansen (1984 p.218)

grocers or retailers, we claim that there was, at last for a period of time, a *monopoly of information*. From 1878 to 1894 a committee set up by Copenhagen grocers published weekly benchmark prices, so-called quotation prices. This quotation like similar examples in Europe was a way to lower transaction costs in international or interregional trade. For the argument, see for example North and Thomas (1976). Traded prices could, of course, deviate from the benchmark. The benchmark published for the upcoming week, nevertheless, facilitated the transactions between Danish exporters and British grocers. Export trade from the mid-1880s was to an increasing degree organized as "free on board after order" based on the Copenhagen quotation. This means that British orders would come in by telegraph from the beginning of the week, to be priced fob in a fixed relation to the quotation for the following Thursday (i.e. the quotation served as a benchmark). Apparently most British importers placed great trust in their Danish counterparts during this period.⁷ In case an importer refused a consignment the exporter's only option was to leave it to a commissioner to sell on the open market with an unavoidable loss.

At the same time the Copenhagen quotation serves as a benchmark for the fixing of prices in the half-yearly price contract between the dairies and the butter grocers. This monopoly of information almost broke down in November 1894 and never regained its former importance. External circumstances, partly some misunderstandings regarding a reform of the benchmark and partly the flooding of the British market with butter from Australasia at that particular time, triggered a hard blow to the Copenhagen Quotation. First, the British importers refused to buy any Danish butter under the circumstances. Second, the episode provoked a spurt in the process of establishing butter export cooperatives in Denmark to replace private grocers. The latter had started in 1889 albeit much more slowly than the dairies. This is interpreted as sign of the special knowledge or information about the British market by Danish private grocers –something that had, after all been recognized, by the cooperative dairies.⁸ It took much longer for the export coops to gain their ground and they did not become as dominant as other sorts of coops. One other significant outcome of the 1894 clash between Danish exporters on the one side and their antagonists, the Danish dairies and the British importers, on the other was a loss of profit for the

⁷ Thomsen and Thomas 1966

⁸ Thus, a former successful private grocer, Kraunsøe in the town of Randers was appointed managing director of a new butter export cooperative in 1904. It was clearly a recognition of his professional skills. We have examples of coops that followed him to do business with the new cooperative.

Danish grocers. This we regard as proof of a breakdown of the market power in information held by the Danish grocers.

The bargaining that did take place between the individual dairy and the individual grocer both before and after the heyday of the quotation was the trade price *relative* to the benchmark price. Danish creameries in Schleswig, then in Germany, bargained for prices relative to the Hamburg quotation. In a single case the quotation in Berlin is mentioned.

We have in our archival material 112 coops that recorded their transaction with a butter grocer. Some entries are very detailed while others barely mention a “grocer in Copenhagen”. Altogether 19 transactions are recorded of businesses with an export cooperative⁹ at any time.

Table 2. Number of dairies contracting with a named export coop or grocer at least once.¹⁰

| Danish export coop | English private | English Wholesale | English Maypole | Cream to Germany | Butter to Germany | Alberti |
|--------------------|-----------------|-------------------|-----------------|------------------|-------------------|---------|
| 19 | 15 | 13 | 8 | 8 | 4 | 17 |

| Kraunsøe | Noack | Klitgaard | Carøe | Plum | Petersen & Jensen | Kjær | Maegaard | Schnakenburg |
|----------|-------|-----------|-------|------|-------------------|------|----------|--------------|
| 13 | 10 | 9 | 8 | 7 | 5 | 5 | 4 | 4 |

| Keller & Co. | Hansen Holbæk | Kirchoff | Andrev ¹¹ | Meyer Esbjerg | Folkman & Berthelsen | Caspersen |
|--------------|---------------|----------|----------------------|---------------|----------------------|-----------|
| 4 | 4 | 4 | 4 | 3 | 3 | 3 |

Source: Excerpts of the minutes from the board meetings and general assemblies of Danish dairy cooperatives, 1884-1915

⁹ Alberti, cf. below footnote 13 below is counted as a private grocer.

¹⁰ For each creamery we entered the buyer only once. It was not unusual for a creamery to return to the old buyer after it had tried its luck by dealing with another. This has been counted as one transaction. The Table is to be read that, for example, Kraunsøe had at least one dealing with 13 dairies.

¹¹ It does not say whether Andrev is an agent for an English merchant

The purpose is to show the potential for dealing with a large number of grocers so as not to be stuck with one local player. With the possible exception of Andrev these are all independent grocers. In addition to the 16 (or 17) private buyers recorded above, 42 names are listed as firms that had bought from one or two creameries. Unfortunately, we do not know to what extent they were independent grocers or agents for others, Danish or English grocers. Still, the presence of local or regional agents was important for competition. In general we are looking at an environment in which awareness of the demands of the British market was growing. The competition between buyers was keen at times. One sign of this is that no fewer than 28 left their grocers after the tumultuous event in November 1894 that made prices drop dramatically. It seems like many coops tended to blame their current grocer at that time.

Another way of observing the availability of alternatives is the number of shifts to a new grocer wherever this is recorded. In 69 cases of the 111 that mention a grocer the cooperative dealt with more than one firm. 23 took their business to two grocers, 18 to three and 28 to four or more grocers.¹²

3. Feedback on butter quality from the grocers

As stated in the introduction we argue that market forces represented by the butter grocers stepped in as a controlling link between the dairies and the export market. In our sample of 215 coops we find 33 explicit references to complaints from the grocers to their suppliers about quality. Most frequently the butter is referred to as having a 'bitter' taste. In half of the cases the coop sends for a dairy consultant to learn how to obtain a better price. A couple of examples will serve to illustrate the course of events:

The dairy coop of Ullerslev is a case of a drawn-out learning process. It starts with a board meeting on 16.01.1890. One of the most experienced and influential butter grocers, Esmann, from the town of Odense, had telegraphed to complain about the quality of the butter indicating that he

¹² It ought to be mentioned that 9 export grocers went bankrupt during the period. Notorious among them was *Smørekøbsforeningen* led by P. C. Alberti. It was a cooperative by name but Danish cooperative historians like Bjørn (1982) do not acknowledge it as a true part of the cooperative movement. The firm was led by an autocratic and, as it turned out, highly fraudulent character who, in the same manner, ran a large savings bank. Of the dairies in our sample 17 had dealings with the firm at some point in time and when it went bankrupt in 1908 eight dairies currently dealing with the firm was hit hard, both in their capacity as sellers and as depositors in the adjoining savings bank *Den Sjællandske Bondestands Sparekasse*. None of these dairies, however, went under.

could not pay more than top price for the product.¹³ The board of the coop decided to contact a dairy consultant in order to raise the quality. On his arrival on 24.01.1890 the consultant found that no less than 40 members had supplied bad milk or milk from unclean buckets (which may amount to the same thing) of these 40 the milk from 26 members is totally 'unfit for use' in butter production. The day after that the quality was deemed 'good'. It took but a month for the grocers to complain again. The head of the coop board admonished the members to feed well and not supply 'old milk'. Less than a month later the consultant was back again. By now only 5 consignments of milk was found to be useless and returned to the members. After a lull in the complaints Esmann sent a new telegram on 06.11.1890. The board decided on a testing of the milk. It appeared that 'a lot of bad milk had been supplied, labeled bitter, old, sickly and sour and one with the taste of stable.' On the following general assembly on 25.11.1890 the members were informed about the result. A member suggested that the dairy manager could be blamed for the low quality of the butter. This suggestion, wisely, "fell to the ground on the lack of evidence." After yet another complaint from the grocer on 03.12.1890 the dairy consultant returned on 08.12.1890 on which occasion 56 members got bad marks for their milk. Finally, from the minutes from 1892 it appears that Esmann found the quality satisfactory and raised the price on more than one occasion.

As mentioned already a dairy expert was often consulted. He then had to deal with the delicate problem that bad quality often, if not always, fell back on the members. The dairy manager and his or her staff were hardly ever to be blamed and, clearly, the manager was in a predicament to refuse bad consignments, since the manager's contract was renewed once a year. It did not pay to make enemies in the local community. Instead, the members had to learn the hard way when the butter grocers acted as a useful end check on quality.

There are economies of scale in expert advice. Given the good logistics of Denmark at the time and the organization of dairies, be it coops or private, a relatively small staff of consultants, only 6 in dairying before WWI, could serve the whole country.

¹³ 'Top price' at the time was by far the highest obtainable price at the time. It served rather as a benchmark price.

Another way of reacting to a discontented grocer was to try another grocer. Some dairies found, much to their disappointment, that the change did not help them to achieve a better price.¹⁴

A fruitful outcome of a conflict on price and quality between a dairy and a grocer was some specific advice mostly on refrigeration but also on pasteurization. A grocer even went as far as lending a coop the money to build an icehouse.¹⁵

4. Bio-science, animal health and butter quality

Applied dairy science in Denmark was substantially strengthened in 1883 by the establishment of the Agricultural Research Laboratory, attached to the Royal Veterinary and Agricultural College, founded in 1858. One of the creators of modern micro-biology, the French scientist Pasteur, had demonstrated that the growth of micro-organisms was responsible for spoiling beverages such as milk. He then invented a process by which liquids were heated to kill most bacteria. The earlier results by Pasteur dating back to the 1860s inspired the Laboratory's head of research, N.J. Fjord, to develop an apparatus for steam pasteurization of milk in the late 1880s. The practical experiments in the Danish dairies lead to the recommendation that the milk be heated to about 73 C (165 F) for about 40 seconds and quickly cooled thereafter. The adoption of pasteurizers in Danish dairies was fast. The share of dairies and factories which had introduced the methods grew from 11 per cent in 1892, to 86 per cent in 1895 and 97.5 per cent in 1897 (Faber 1901, p. 257).

The original motivation for buying the apparatus was purely veterinarian, however. Another contemporary microbiologist, the German scientist Koch, had in 1882 discovered the tubercle bacillus. The Danish veterinarian Bang was a pioneer in using the tuberculin test to detect *Mycobacterium tuberculosis* in 1890. Earlier research had already established that the disease was highly contagious through milk from infected cows, but was not hereditary. This led to the recommendation of removing the new-born calves from their infected mothers and to feed them by milk that had been boiled or pasteurized. In a short span of years the creameries, as we have seen, acquired steam pasteurizers. These were used for the treating of the skimmed milk returned

¹⁴ Ranum in Jutland went through this process 1891-97.

¹⁵ The coop Hejnsvig 1901.

to the members as feed for their calves. In 1898 the pasteurizing of returned milk was made mandatory. Not until 1911 was pasteurization made obligatory for all dairy products for human consumption exported from Denmark.

This order of priority may seem strange. According to Olmstead (2009, p. 332) it was, however, no anomaly. Explorations in human physiology had been held back by the taboo against using human cadavers for medical training and research. Consequently, knowledge was forthcoming at a slower pace. In addition to that, the quest for new knowledge was not as eager when it came to humans.

“Livestock owners had an interest to invest individually to protect their animals and to organize to demand that governments use the police power of the state to combat animal plagues. Employers of wage labour did not have a similar incentive. The concentration of wealth and political power in the hands of the elite contributed to entitlement failures whereby the health requirements of the masses went unheeded.”

In the particular case of bovine tuberculosis the danger of spread to humans was debated around 1900.¹⁶ In 1902 Ravenel isolated the bovine microorganism from a child with tuberculosis meningitis (Olmsted and Rhode 2004, p. 736).

At this point in time, however, market forces in the Danish case had overtaken government legislation. The demand of the English butter market was mediated to the dairy coops through the grocers, as we have seen, but also by the Danish state consultant in London. This market called for an acidified butter with a mild flavour (Leisner 2005, p. 424). The consultant Faber, educated as an engineer, had been employed by an English company, the Dairy Supply Company in 1884-88. The business dealt with wholesale of liquid milk and dairy machinery. Through his work he got in contact with the private Royal Danish Agricultural Society and was subsequently, in 1888, appointed by the Danish government as a dairy consultant with the task of promoting exports by following the British market. He was to hold the position until 1931 and won according to biographers respect as “a considerable authority both in Great Britain and in Denmark.” In

¹⁶ Koch derailed the debate in 1901 by arguing that bovine tuberculosis posed no threat to humans.

numerous communications in journals and dailies he was often critical towards Danish dairies and, thus, supportive of the efforts made by the private grocers to improve the quality of the product.

The opportunity to get the taste right, presented itself when a research result from the Agricultural Research Laboratory was published in 1890. The head chemist Storch had succeeded in isolating several lactic bacteria to grow pure strains with specific flavouring properties. “He concluded that tasty butter could be produced simply by adding agreeable bacteria during souring, while suppressing the growth of undesirable species. This resulted in a new practice for producing butter at the creameries: the milk was separated, then pasteurized to limit the number of germs before a locally or commercial starter¹⁷ was added to sour the cream before churning. The starters contained one or a few lactic bacteria with documented flavouring effects. This [combined] application of pasteurizers and standardized starters in butter production were indispensable elements in obtaining a product with a uniform flavour and texture, a long shelf-life (an added benefit of pasteurization) and no pathogenic germs.”(Nielsen 2004 pp.169-170).

Faber, keen in his effort to sell Danish butter to English costumers, praised the latter aspect in an article published in Public Health in 1900, titled *Compulsory Pasteurization of Milk in Danish Dairies as a precaution against the Spread of Tuberculosis*. He admits that

“For the purpose of combating tuberculosis in cattle, at the same time as in man, it was highly desirable to require all factories to heat all the milk, and to compel them by law to do so. But was it reasonable to lay such restrictions on a great industry? Could, indeed, the manufacture of high-class butter be carried on, and economically carried on, when both separated milk and butter-milk [to be returned] should be heated to such a degree?”

As it turned out, the answer was affirmative. According to Faber the opportunity to use starter cultures, and thereby improve quality and price, outweighed the costs of larger steam boilers and pasteurizers. The first commercial starter cultures made in laboratories were marketed in Denmark already in 1891 (Leisner 2005, p. 421)

¹⁷ Commercial starter cultures were rapidly introduced into the market from 1891 to 1892 as a result of the initial research by Storch (Leisner 2005, p. 423).

Faber, in his eulogy in 1900, came close to alleging that bovine tuberculosis had been nearly exterminated by the 1899 law on pasteurizing the return milk. We argue that the spread of the disease through dairy products for human consumption had already come a long way towards being extinguished by that time. Danish dairies in their own interest had made the products much healthier.

Later literature admits that bovine tuberculosis still existed in Danish dairy herds in the 1930s.¹⁸ The most plausible explanation was the propagation from herd to herd when cattle with an undetected infection were traded. The even more unfortunate effect of that was the spread of this strain of tuberculosis, not to consumers but to humans in close contact with the animals. Children in rural areas were especially susceptible to catching tuberculosis of their bones. This is in contrast to the successful American eradication of bovine tuberculosis around 1917 (Olmstead and Rhode 2004, p. 734). Olmstead and Rhode explain the US success by a scientific breakthrough that allowed for the earlier detection of the disease¹⁹ combined with a radical programme by the US Department of Agriculture to inspect and slaughter sick animals.

Conclusion

We show a case in which market forces with profit maximizing agents²⁰ achieved a result with unanticipated positive externalities. It belongs to the story, however, that the process was supported by state subsidized research and extension services.

Private Danish grocers dealing in agricultural goods since the 1830s had a long established relationship with their British counterparts when the export trade in butter took off from the late 1860s. The free-on-board trade from the 1880s, when British imports accepted the benchmark set by the Copenhagen butter quotation, was an advantage to the Danes. At the same time it forced

¹⁸ The updated version of the Danish National Encyclopedia says as much as 30 per cent of the cattle were still infected.

¹⁹ Reading Faber one would have believed that testing was no big problem. He claimed that the veterinarian Bang had performed tuberculin tests on as many as 66,000 heads of cattle by 1898. Olmstead and Rhodes (2004, pp. 738-739), however describes the earliest technology as very time consuming.

²⁰

Danish grocers to focus keenly on a products quality that lived up the expectations of British consumers.

The message on quality and a specific taste in butter was transmitted to Danish dairies through their grocers. In the case of cooperative dairies we see a living illustration of this ongoing process in the minutes from their board meetings.

A breakthrough in micro-biology led by scientists in the state subsidized Agricultural Research Laboratory in 1890 speeded up the progress. In order to obtain the desired taste, 'beneficent' lactic bacteria should be added, but only to milk than had been pasteurized. This had the very favorable side-effect of forcing the dairies to pasteurize milk for human consumption and thereby guaranty a product that was free of tuberculosis bacteria.

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