

# Incentive Payments in Danish Cooperative Creameries\*

Morten Hviid

School of Economic and Social Studies  
and  
Centre for Competition and Regulation  
University of East Anglia

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## Abstract

Following the formation of the first cooperative creamery in Denmark in 1882, this particular organisational form grew rapidly over the next 20 years. During the same period, private dairies which has emerged somewhat earlier, decline in numbers. This paper contrasts these two organisational forms to understand why one was so much more successful than the other and suggests that the legal environment with ready enforcement of contractual obligations and in particular the extensive use of incentive pay for managers were important reasons for the success of the cooperative organisational form.

Preliminary - comments welcome

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# 1 Introduction

In the late 19 century, there was in Denmark a move from farm to factory production of butter. Denmark had at that time a large number of small farms and although they did produce butter, the quantity was too low to ensure high prices from the wholesalers, who preferred large homogeneous shipments such as those they could get from the manor farms. While collecting the milk from a large number of small farms enabled the production of larger batches of butter, transportation costs were high and, in more importantly, transportation itself reduced the amount of cream which could be extracted and hence increased the important milk per pound of butter ratio as compared to farm production. The invention of the continuous cream separator in the later 1870ies and its rapid improvement changed that, making factory production from the collection of small quantities of milk potentially profitable. This lead to a rapid growth first in the number of private creameries and then an even more rapid expansion in the number of cooperative creameries. The development of this is described in Bjørn (1982) from which the following table is extracted:

**Table 1. Development in the number of creameries.**

Year	Cooperatives	Private
Mid 1880ies	< 50	> 500
1888	388	468
1894	907	215
1898	1013	260
1901	1067	209
1905	1087	207
1909	1163	255

Although the precision of the data in table 1 could be challenged,<sup>1</sup> they do show two interesting trends. Firstly, they demonstrate the very rapid growth in the number of cooperative creameries, in particular in the decade 1885-1895 and secondly, they show the decline in the number of private creameries. What table 1 thus demonstrates is the dominance of one particular organisational form over another. The aim of this paper is to add to our understanding of why this occurred.

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<sup>1</sup> There are two reasons for this. Firstly, some creameries have been missed out. Secondly, classification is sometimes difficult as for example some private dairies are owned by milk producers and often look very similar to the cooperatives. If anything, the data understates the growth of cooperatives and the decline of private creameries.

Given this aim, it is important to be precise about what the two organisational forms are. One, which we shall refer to as the cooperative, is really a (milk) supplier owned organisation in which a manager is hired to run the creamery. The other is a private creamery, which is managed by the owner and purchase its supply of milk from neighbouring farms. The former can be interpreted as a vertical integrated organisation where the same individuals own the cows and the creamery, whereas the latter involves vertical separation, with one set of individuals owning the cows and another individual owning the creamery and trading taking place via the market, possibly using contracts.

To evaluate the potential performance of the two organisational forms, it is important to understand the incentive problems which might arise in the production of butter. These are discussed more extensively in section 2 and centre around the production and delivery of quality milk and the efficient transformation of this milk into butter and in many cases also cheese. Whereas some argue that cooperatives are better able to monitor and police members and hence might have had an advantage in securing milk of high quality, they suffer from a separation of ownership and control over the creamery and one would expect a private owner of the creamery to have the strongest incentive to produce butter efficiently. There may thus have been a trade-off between the two broad incentive problems.

We will argue in section 3 that, because of the contractual environment, the private creamery could potentially solve all the incentive problems that is faced. This makes the success of the cooperatives more startling, especially when one keeps in mind that the farmers are consistently argued to maximise the yield from their milk. In section 4 we then turn to how the cooperatives ensured the efficient production of butter. One of the interesting, but so far overlooked,<sup>2</sup> features of the early phase of the Danish cooperative movement in general is that managers of the cooperatives were in the majority of cases paid according to some measure of performance.<sup>3</sup> These incentive contracts took many forms and varied not only across sectors such as the dairies, the bacon factories and grocery retail, but also within these sectors. For a survey of incentive provision in firms, see Prendergast (1999) and for specific empirical analyses of whether incentives work, see e.g. Lazear (2000) and Paarsch and Shearer (2000).

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<sup>2</sup> Although one can find brief discussions of managers pay in the bacon factories in Just (1989) and for grocery retail in Just (1984, 120-134), there appear to have been little explicit discussion about the form of incentive schemes as well as their effects in the literature.

<sup>3</sup> For a recent survey of the provision of incentives, see Prendergast (1999).

In reaching our conclusions, we rely partly on the extensive debated about pay in the creameries at that time, particularly in *Mælkeritidende*, a weekly magazine for the dairy industry published by the Danish Association of Dairymen. Similar, but less passionate discussions are found in another magazine, *Ugeblad for de Samvirkende Jydske Mejeriforeninger*, the weekly journal of the Dairy Association of Jutland. Moreover, statistical information collected in 1892 and 1895 can be used to shed some empirical light on the use and form of incentive schemes. Finally, information extracted from the minutes of the meetings of the cooperative creameries, which in many cases have survived to this date, has been used to provide information about the type and popularity of different incentive schemes.

Existing theoretical literature on cooperatives has focused on particular aspects of the cooperative to highlight strengths and weaknesses of this organisational form. Bannerjee et al. (2001) and Hart and Moore (1998) focus on the problems caused by asymmetric members, something which we shall argue was less of an issue for our case as the members were not too dissimilar in size. Rey and Tirole (2000) focuses on the instability of a cooperative which is prone to members defecting, identifying a problem related to bank-runs. The solution, which is to make exit from cooperatives harder is something which we do observe in the creameries, but for example, the assumption that the cooperative has neither debt nor retained earning is violated in our case. As the number of creameries in Denmark during the period of interest was high and growing, the literature on imperfect competition, either among cooperatives or in mixed markets, such as Albæk and Schultz (1998), Bru and Ordonez (2001), Madhavan et al. (1996) and Sexton and Sexton (1987) are less relevant for our discussion.

## **2 Incentive problems in butter making**

The raw milk was produced by the farmers and transported to the creamery where, with the help of labour and other inputs, the dairy man transformed this into butter. Occasionally, the creamery also produced cheese, either from the raw milk or more commonly from the skimmed milk.<sup>4</sup> The creamery consisted of the manager and staff. The latter might for example consist of an assistant dairyman, a dairy maid, a trainee and a stoker. In the production, the main non-labour inputs are: Coal (energy), cleaning and packaging material, and capital in the shape of buildings and machinery. A final important cost to the creamery is the transport of milk from the

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<sup>4</sup> The main waste products from this, skimmed and/or butter milk, was most often sold back to the farmers to be used as a feed for pigs and calfs. Some of the early creameries, in particular the private ones, had a piggery attached

farms to the creamery (as well as the skimmed milk returned to the farmer). This cost was often substantial and varied greatly from creamery to creamery, depending on the density of farms and the number of cows on each farm.<sup>5</sup>

The following incentive problems which might affect the effectiveness of a particular organisational form could potentially arise:

1. Farmers could affect the quality of the milk they deliver to the creamery.

There are three broad reasons for this. Quality is affected by any lack of hygiene. Secondly, the taste of the milk and consequently the butter can depend on what the cows were fed. Finally, by either skimming cream from the top of the milk or by adding water or skimmed milk, the farmer can reduce the butter fat content of the raw milk. The first two affect the quality of the butter, whereas the latter affect the amount of milk which had to be used to produce one pound of butter.

2. Farmers could affect the amount of milk they deliver to the creamery.

The minimum efficient scale of a creamery required milk from approximately 400 cows. As the average herd was somewhere between six and fourteen, Henriksen (1999, p. 61), the creamery needed milk from a large number of farmers. Sufficiently large farmers might be able to hold-up a creamery by refusing to deliver.

3. The amount of milk delivered to the creamery had to be accurately measured and its quality monitored.

The farmer has an incentive to over report and the creamery manager to under report the amount of milk delivered. In terms of monitoring, rejecting milk because it was of too low quality, may have been problematic either because the creamery was close to its minimum efficient scale or for fear of future repercussions.

4. The dairy man could affect both revenues and costs.

The dairy man through his own efforts as well as the efforts of the workforce affect the quantity as well as the quality of the butter and hence the revenue from butter

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to the creamery as an alternative way to make use of the waste products, but this tradition did not last, mainly due to fairly obvious hygiene problems.

<sup>5</sup> From a sample of 487 creameries for 1903, the transportation costs on average accounted for about a third of total costs, but this share varied between a quarter and a half. Nor is this variance related to the size of the creameries.

production. Similarly the dairy man can affect the costs of producing butter, not just through monitoring the workforce, but also by ensuring that the machinery is working well.

Broadly speaking, we can think of two classes of incentive problems, one associated with the suppliers of milk, 1 and 2, and one associated with the management of the creamery, 3 and 4. The success of an organisational form would then depend on how well they would solve these problems.

### **3 Organisational responses to incentive problems**

In order to understand the success or not of organisational forms, we need to know what motivates the various actors. A private owner of a creamery could safely be assumed to maximise the return on the creamery since he would be the residual claimant and this would be his main source of income. There seems to be broad agreement that the farmers aimed to maximise the return on the raw milk, and hence the main driving force behind the cooperative was to make money, see Henriksen (1999, p. 59, note 3). As a first approximation, we will assume that the choice of organisational form depended on which could ensure the largest returns to the investments and hence depended on which organisational form best solved the incentive problems identified in the section above.

#### ***3.1 Contracts and transactions costs***

A second issue which needs to be addressed is the extent to which contracts could have been used to create incentives. For contracts to be a powerful tool, it must be the case that the terms which the parties wish to use are enforceable, that the parties are willing to enforce them and that public enforcement is relatively cheap. In Denmark, long-term contracts which include exclusivity clauses and heavy penalties for breach or non-performance are and were enforceable. This implies in particular that a contract of the following form would be enforceable by the courts:

*For the next X years, farmer Y delivers all the milk not consumed on the farm to creamery Z. If specified levels of hygiene and feeding are not observed or the milk is in any way adulterated, the farmer will be fined x per cow, has in addition to*

*pay compensation for any losses incurred as a consequence and will be banned from supplying to Z in the future.*

Enforceability of such a contract is not generally available in other countries, with many jurisdictions neither allowing the exclusivity clause because it is a restraint of trade nor the fines if they are deemed to be penalties.<sup>6</sup>

In terms of the costs of enforcement, very little information about the cost of using the court system in Denmark is available, but there is a general presumption that access to justice must be cheap and ready. A few cases regarding the cooperatives did reach the Danish High Court which in its judgement also include the costs borne by the two parties. In one case from 1895,<sup>7</sup> the Board of the cooperative had to pay costs of 10 Kroner and the other party (a member of the cooperative) nothing. In a second case from 1895,<sup>8</sup> the Board of the cooperative also had to pay 10 Kroner and the other party (a member of the cooperative) 2 Kroner. As the price of a pound of butter was approximately 1 Kroner, it is evident that the direct costs of using the legal system was very low indeed. Similarly, legal bills, mentioned in the minutes of the Board meetings of the cooperatives, are generally low.

Turning to actual use of the legal system to enforce contractual agreements, all the evidence we have stem from cooperatives and may therefore leave us with a biased picture. However, from those sources, it is clear that the cooperatives were always ready to use the legal system when necessary for contractual enforcement.

Similarly, evidence about the cost of monitoring and enforcing contractual obligation come from the cooperatives. Although the majority of the creameries, who's minutes we have read,<sup>9</sup> have cases of breach of contractual obligations either by members or suppliers, and so cheating did manifestly occur, the response from the cooperative is in all but a very few cases, swift, decisive and harsh. Those found guilty of adulterating the milk are fined, forced to pay compensation, to pay their share of any out-standing debt and excluded from the cooperative with the loss of any

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<sup>6</sup> In Ireland, the *McEllistrem v. Ballymacelligott cooperative*, [1919] A.C. 548, case went to the House of Lords, which deemed a exclusive dealing agreement between a member and a cooperative dairy unreasonable hence unenforceable.

<sup>7</sup> Sag no. 14/1895 smed Frederik Frederiksen contra Bestyrelsen for Interessentskabet "Fuglekilde Andelsmejeri". The former is a blacksmith, the latter party the board of the cooperative Fuglekilde.

<sup>8</sup> Sag no. 20/1895 Gaardejer Christen Bertelsen contra Sønner Farup Andelsmejeri ved dets bestyrelsesformand. The former is a farm owner, the latter party the chairman of the board of the cooperative Sønner Farup.

<sup>9</sup> The number of creameries from which minutes have been read to date is approximately 70.

rights to the assets of the creamery. The monetary value of the penalties vary considerable from cooperative to cooperative and case to case, but they are typically in excess of 200 Kroner, with one fine as high as 7000 Kroner. To get a feel for the magnitude, the revenue from the butter produced from an average annual yield of a cow was in the region of 120 - 150 Kroner.<sup>10</sup> Added to these monetary costs, there were clear social costs. It would have been widely know if somebody had been caught cheating and one would expect at least some amount of ostracism to occur.

It is clearly not sufficient that individuals are willing to enforce contractual terms, these must also be monitored for breach. Some monitoring occurred at the creamery, where the milk in many cooperatives was measured for fat content and this form of monitoring accounts for a little over half the cases (55%) where we know the origin of the information. A low reading would lead to an inspection and test milking at the farm and an analysis by a third party. Other important sources of monitoring was servants(20%) and members (15%). In a few cases, we observe that small prizes are being paid for information.

Judging by the behaviour of the cooperatives, we would argue that the transactions costs of using contracts were relatively small, especially where reasonably complete contracts could be written. One naturally has to be careful when extrapolating the ease with which the cooperatives enforced contractual terms to what a private creamery owner could have done. Maybe enforcement was cheaper and more ready in the cooperative and maybe local people would have been more willing to inform on others to a local cooperative than a private enterprise.

### ***3.2 Private creameries***

The private creamery is owned by the manager, who purchases the raw milk from surrounding farmers and transforms it into butter. As the manager of the creamery is the residual claimant, there should be no incentive problems either with respect to the running of the creamery, including the monitoring of the work force, nor the monitoring of supplied milk. The potential incentive problems relate to the behaviour of the farmers' supply of sufficient raw milk of a sufficiently high quality and the managers willingness to impose sanctions. If the private creamery has similar transactions costs of using contracts as did the cooperative creameries, these incentive problems could have been solved by entering long-term contracts specifying the

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<sup>10</sup> For 1898, a typical annual yield of a cow was 3500 pound milk and it took on average 27 pounds of milk to produce a pound of butter, yielding about 130 pounds of butter. Butter sold at approximately 1 Kroner per pound.

way in which the milk had to be handled, the way in which the cows should be fed and the penalties in case of breach. Many of the cooperatives entered supply contracts with farmers who were not members of the cooperative and these contracts were enforced where necessary.<sup>11</sup> It is thus more than a theoretical possibility that a private creamery owner could write and enforce such contracts with farmers.

Although it was possible, and customary for the cooperatives, to write fairly comprehensive contracts, the contracts were not complete and hence there must have been scope for some hold-up. The biggest threat to the creamery would be if some individual farmers were so big that their individual refusal to supply dragged the creamery substantially below the minimum efficient scale. This could be countered by ensuring that enough cows had been signed up on long-term contracts before the start-up of the creamery and by making the start-up contingent on the number of cows sign up before a given date.<sup>12</sup> By ensuring that no farmer was pivotal in terms of achieving minimum efficient scale, the danger of strategic hold-up could be minimised.

It would appear that a private creamery could solve the majority of the incentive problems it faced and hence should be able to generate sufficient rent that it could offer the farmers the highest possible return on their raw milk. The only remaining issue is whether those skilled in running a private creamery could raise sufficient capital to build it.<sup>13</sup>

There are several reasons to think that raising the finance was not a general problem. Firstly, we find several cases where the manager of a cooperative lends the cooperative substantial sums of money, in some cases up to 20% of the cost of building a creamery, which suggest that there were skilled individuals who would have been able to put up a substantial part of the capital themselves. Secondly, both Bjørn (1982) and Buch (1960) suggest that the cooperative creameries were never constrained in terms of raising capital. One could argue that the cooperative had the advantage here in being able to post more substantial collateral through each member having unlimited liability. However, it is also the case that the cooperative had the status of an association rather than a business and hence did not itself have any legal status so that the financial institution would have to pursue each member individually, making the collection of any debt potentially very costly. This also implies that the cooperative really is

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<sup>11</sup> In one case, two men were caught at the same time adulterating milk. Although one was a member and the other a supplier, they were dealt with in exactly the same way by the cooperative.

<sup>12</sup> It is clear from other contracts entered into by the cooperative that contingent contracts were well known and used when necessary.

borrowing on the back of the contract each member has with all other members. There is no reason to think that a private individual could not borrow on the back of a number of long-term contracts agreed with potential suppliers. Finally, although the dairy men had no track record in the 1880ies, once the cooperative had been running for some time, they should readily have been able to convince savings banks to lend them money to buy out the suppliers. A small number of cooperatives did convert to private ownership or leased the creamery to the manager after their initial period, but the vast majority did not. Thus there is no compelling evidence that private individuals, skilled in running a creamery, could not raise the necessary capital to finance a restructuring to a supposed more efficient organisational form.

As a conclusion, these does not seem any substantial barriers to entry for a highly able private dairy man to construct a successful creamery, enabling the payment of high prices if necessary for raw milk and still remain profitable.

### **3.3 Cooperative Dairies.**

The cooperative can be interpreted as the team production of an important input combined with the vertical integration between the team of input producers and the creamery. As illustrated in tables 2A and 2B, the number of members at the formation of the cooperative as well as the number of cows per creamery vary considerably. For the 382 creameries who supplied relevant information about size for the 1903 annual dairy statistics, the average was 83 members with a minimum of 4 and a maximum of 333. The average number of cows per creamery was 482. In 1903, the average number of members had grown to 158 and the average number of cows to 918. At their formation, more than 3/4 of creameries had less than 100 members. In 1903, when these had on average been running for 13 years, more than 3/4 had more than 100 members. Similar trends are observed for cows per creamery. The best estimate of minimum efficient scale is about 400 cows, suggesting that at formation, 45% of creameries were below this size. In 1903, this had dropped sharply to 6%.

**Table 2A. Size distribution of cooperatives: members**

Number of members	0-50	51-100	101-150	151-200	201-250	over 250
Initially in % of total	23.8	52.1	16.5	5.0	2.4	0.3
In 1903 in % of total	3.4	19.9	30.6	21.2	13.6	11.3

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<sup>13</sup> Alternatively, a group of financiers could build the creamery and hire the manager. This would appear to combine the worst of both worlds, having to rely on contracts with both farmers and the manager.

**Table 2B. Size distribution of cooperatives: cows**

Number of cows	0-200	201-400	401-600	601-800	801-1000	over 1000
Initially in % of total	8.9	36.4	29.8	16.8	5.8	2.4
In 1903 in % of total	0.8	5.2	18.1	17.8	22.5	35.6

Moreover, in 1903, on average half the members of the cooperatives had three or fewer cows. In terms of teams and team production, these cooperatives were thus substantial in size, leading to the common concern about collective decision making.

The format of the cooperative was typically a 10 year agreement to adhere to a set of laws where these defined the cooperative in legal terms.<sup>14</sup> The laws could be changed by the General Meeting, usually requiring more than simple majority and occasionally that the changes were accepted at two consecutive General Meetings, and could moreover be revised after each 10 year period, but in reality they changed very little over time. Looking across creameries, the laws are broadly similar, with some regional variations, particularly with respect to voting.<sup>15</sup> The laws of the cooperative are formally equivalent to a set of 10 year contracts which commits each signatory to deliver all his milk to the cooperative, to observe certain specified standards of cleanliness, observe certain standards of feeding the cows, to share in the profits according to a specific formula, typically the amount of milk delivered in the year, to share in any losses which might arise according to a formula, possibly how much milk the individual had supplied in the most recent years.<sup>16</sup>

The highest authority was the General Meeting (Generalforsamling), a body consisting of all the members of the cooperative, which took all long-term decisions such as investments. The General Meeting elected the Board, the (internal) auditors, the control men who oversee the control of the milk, and any delegates to other associations to which the creamery may belong. Of these the Board, which typically consisted of 5, 7 or 9 members,<sup>17</sup> was the most important. The Board elected a Chairman, Deputy-chairman and Secretary from within it membership. The role of the Board was to monitor, to take whichever short- to medium-term decisions were delegated to them by the General Meeting and to provide recommendations to the General Meetings on medium- to long-term decisions. How heavily the Board or its chairman got

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<sup>14</sup> The length of the agreement almost always matched the length of the loan financing the cooperative.

<sup>15</sup> The norm is one man one vote, but in some cases large members, either in terms of number of cows or amount of milk delivered get more votes.

<sup>16</sup> The latter essentially implied that each member had potentially unlimited liability. This is important because it explains not only why the cooperative could borrow money, but also why the members had strong incentives to enforce the law.

involved in the day-to-day running of the creamery varied considerably from cases where the manager had almost total freedom to run the creamery to cases where the manager was little more than an administrator.

The most important role of the board and the chairman is arguable their monitoring role, which partly involve monitoring the manager and partly monitoring the members. As an example of the latter, a member of the Board was often required to be present when milk was delivered milk, not only to ensuring that measurements were correct, but also to ensure that the quality was assessed and to back up any decisions to reject below par deliveries. The separation of ownership and control raises questions about the incentives to monitor. According to Bjørn (1982), the Boards in the early period had a disproportionate number of larger farmers, but we must remember, that even in this case, most individual members would have had a small fraction of the total number of cows.<sup>18</sup> The following table, taken from Bjørn (1982, p. 103) illustrates this. It gives the percentages of members and Board members with a particular number of cows for the first elected Board of dairies founded 1887-89 on the island of Zealand.

**Table 3: Distribution of cows.**

Cows	1 - 5	6 - 9	10 - 14	15 - 29	30 or over
Members	49.8	18.7	36.2	4.9	0.4
Board	17.7	20.3	48.2	12.6	1.2

With that distribution, the Board would on average own about 20% of the cows and hence have approximately that share in the surplus of the creamery, while the chairman would have a share closer to 3%. When we add the reputations of the individuals as stake as well as the potentially unlimited liability for losses, this may well have given the Board and chairman strong incentive to monitor to the best of their ability without having to make them the residual claimants.<sup>19</sup>

Monitoring together with the enforcement of the rules of the cooperative could have ensured that large quantities of high quality raw milk was delivered. More difficult, given that the Board members were not expert butter makers, would have been ensuring that the production of butter from the raw milk was efficient. We see the latter as a core problem for the cooperative to overcome to be successful. As with any other problem they faced, the members could and did

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<sup>17</sup> From a sample of 382 cooperatives from 1906, 93% had Boards with from 5 to 9 members, with 51% of the boards having 7 members, but Boards with from 2 to 15 members was observed.

<sup>18</sup> The share in the surplus was determined by partonage and hence a farmer with more cows would on average also get a larger share of the surplus. However, the share in the surplus of the largest farmer was rarely above 5%.

<sup>19</sup> See Hansmann (1996) for a discussion of the incentive of farmers to monitor agricultural cooperatives in general.

attempt to solve this through written contracts. However, specifying a complete contract governing the behaviour of the manager is a much harder task than writing a complete contract with respect to the supply of raw milk. The way in which many of the cooperatives solved this problem was through offering the manager (in some cases quite intricate) incentive contracts, linking pay to performance. As this, given the success of the cooperative must have worked, it is interesting to study these incentive mechanisms more closely and we turn to this next.

## 4 Managerial Incentives

Paying the manager and other staff a fixed salary could give rise to serious moral hazard problems. Without a link between performance and pay, the manager might put in insufficient effort, both in terms of monitoring the input and producing efficiently. With regards to the latter, problems might also arise because the manager was the supervisor of the staff of the creamery, as the manager might collude with these to cover over poor performances, a problem identified by Tirole (1986).

It is possible to create incentives for the manager when the salary is fixed, either through efficiency wages or short term contracts, in both cases coupled with monitoring by the cooperative either through the Board or its chairman. There is no evidence that the cooperatives used efficiency wages. On the contrary, the cooperatives were, in particularly early on, often accused by observers such as Professor Bøggild, of trying to press wages of managers down, with some cooperatives going as far as putting the job of manager up for tender.<sup>20</sup> The use of short term contracts, on the other hand, was customary. Typically, managers were hired for one year at a time with their contract renegotiated annually. The fear of losing ones job may obviously create incentives, at least for a good short-run performance. For this to work, it would have to be the case that evaluation of performance either through monitoring or by comparisons across dairies was possible. Both was indeed attempted. The Board and in particular the chairman would be in the creamery regularly and the creameries were quick to publish their annual results in various weekly publications such as *Mælkeritidende* and after 1897 in a national collection of statistical information, *Mejeri-Drifts-Statistikken* providing measures of performance. However, monitoring was made difficult as the farmers were not experts in butter making and comparisons across creameries were problematic due to important heterogeneities.<sup>21</sup>

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<sup>20</sup> There is a particularly heated debate in *Mælkeritidende* during the early 1890ties concerning this practise.

<sup>21</sup> The distribution and quality of the cows as milkers as well as the distance the milk had to travel and the state of the local roads are among the most important reason for heterogeneity, making even local comparisons potentially

The threat of dismissal was credible, but not costless to the creamery.<sup>22</sup> Adverts for jobs attracted a large number of qualified applicants and the Board never seemed to find it difficult to draw up a shortlist. Especially early on, we do see a large turn-over in managers. One analysis from 1896 of 96 dairies over a period of 10 years report 121 changes of manager of which more than half was caused by dissatisfaction with the manager or disagreements over pay.

Using short term contracts alone to motivate the manager may store up future problems. The most obvious is that the manager may be too focused on short-term performance. As the manager often appears to be the driving force behind not just the maintenance of the capital equipment, but more importantly innovation and investment in the rapidly improved technology of cream separation, this may lead to underinvestment by the cooperative and hence poor long-term results. Where the manager was the only or the main monitor of the quality of the milk, rejecting low quality raw milk when contract renegotiation was near, may also have been difficult.

If the staff are all hired and paid by the cooperative, the manager merely becomes the supervisor of the work force rather than their direct principal. As pointed out by Tirole (1986), this can give rise to the potential problem of collusion between manager and staff, where the manager protects the staff from the consequence of poor performance. For the creameries, there was a very simple solution to this problem, which was indeed adopted in the vast majority of cases. The manager not only hired and fired creamery staff, but also paid for it out of his own pocket. The payment to the staff was a mixture of wages and their accommodation and food, both of which were paid for by the manager.<sup>23</sup> The latter might have been in order to avoid the manager paying a low wage, but offering the staff high quality accommodation and food, the cost of which would be met directly by the creamery. Thus, the cooperative creameries solved one of the incentive problems by making the manager behave towards the staff in the same manner as would an owner/manager. There appear to have been an additional reason for this arrangement, namely that the manager had more authority over a staff which he had hired and could fire.

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misleading. This does not imply that the creameries never used relative performance measures. Some of the incentive schemes did involve these.

<sup>22</sup> Hiring a new manager in many creameries involved the majority of the members meeting the short-listed candidates.

<sup>23</sup> The only exception was the stoker who was in a number of cases hired and paid for by the creamery. One possible motivation for this is that, unlike all other staff of the creamery, the activities of the stoker is of such a nature that the board members are just as qualified as the manager to judge the performance of the stoker.

Even paying the manager an amount unrelated to effort may require careful design in order to ensure that the manager's participation constraint was not too slack. There were reported returns-to-scale in managing a creamery in the sense that the required effort and necessary staff increased less than linearly with size (the amount of milk processed).<sup>24</sup> This clearly creates problems where the creamery grows rapidly over time so that even annual adjustments to the wage based on the size of the creamery was insufficient to ensure that the manager was not on average overpaid. The solution to this, adopted by some creameries, was to make the wage a (non-linear) function of either the amount of milk processed or the number of cows from which the creamery was supplied.

A short-term fixed wage contract in which the manager paid for the necessary staff still left a number of potential incentive problems unresolved. These could at least potentially be addressed by direct incentive schemes, although some care must be taken when drafting these to avoid problems arising from the manager being involved in several tasks, see e.g. Holmstrom and Milgrom (1991). As we shall see in the next subsection, the large majority of cooperative creameries used some form of direct incentive pay. Such incentive schemes also places additional risk on the manager and hence the allocation of risk also becomes an issue, in particular if the reason for the poor performance of the private creameries was that there was not enough skilled dairy men who would take the full residual risk. At the present time it is not possible to say much about attitudes towards risk.<sup>25</sup>

#### ***4.1 Common incentive systems***

Most of the contracts with managers had a few common features, one of which have been mentioned above, that the manager hired and paid for the necessary staff. Another common feature was that the manager was given a number of in-kind payments. The typical ones were free accommodation, free disposal of an adjoining garden, free skimmed milk and other dairy products for the household, including staff and in some cases an amount of cream and or butter.<sup>26</sup> Thirdly, in the large majority of the cases the manager paid at least some part of costs, although his share of these varied considerable. Interestingly, the cost of transportation of milk to the creamery, a cost which depends solely to the location and size of the farms of the

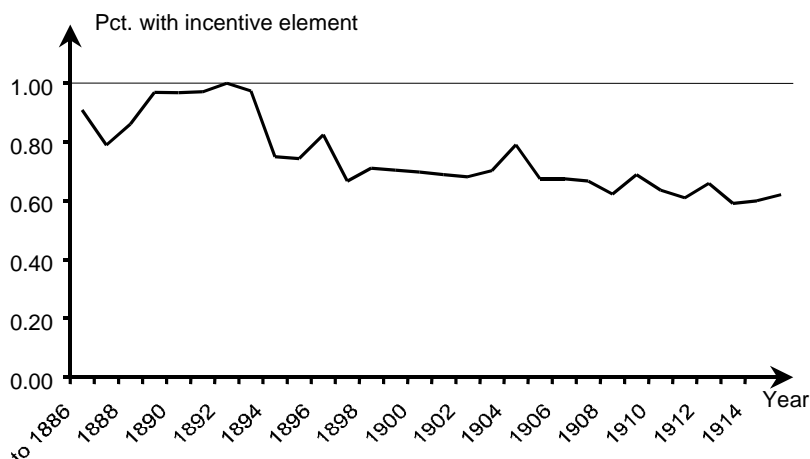
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<sup>24</sup> The most direct evidence of this is the nationally negotiates pay scale for managers from 1908, revised 1919 and 1923 which is concave in the size of the creamery.

<sup>25</sup> When we have a more extensive sample of dairies for which we know both the salary structure and the actual pay, we may be able to identify any possible risk premium attached to particularly risky incentive schemes.

members, was almost always excluded. Finally, especially in the period before 1908, part of the total remuneration for the manager was independent of performance<sup>27</sup> and where incentives were used a lot, the contract occasionally specified a minimum and maximum level of pay, thus attempting to mitigate large variations in pay and thus reduce the manager's exposure to risk.

From our own (as yet relatively small) sample of cooperatives, we find the following development of incentive pay over the period 1882-1915.



**Figure 1. Percentage of contracts which include some explicit incentive element.**

It is clear that incentive pay is very popular, although this appears to have been dented in 1894. What the figure does not reveal is the considerable variation in how the manager was paid, not only across cooperatives but also over time.

We can divide these incentive schemes into three broad categories.

1. Schemes using relative performance measures.

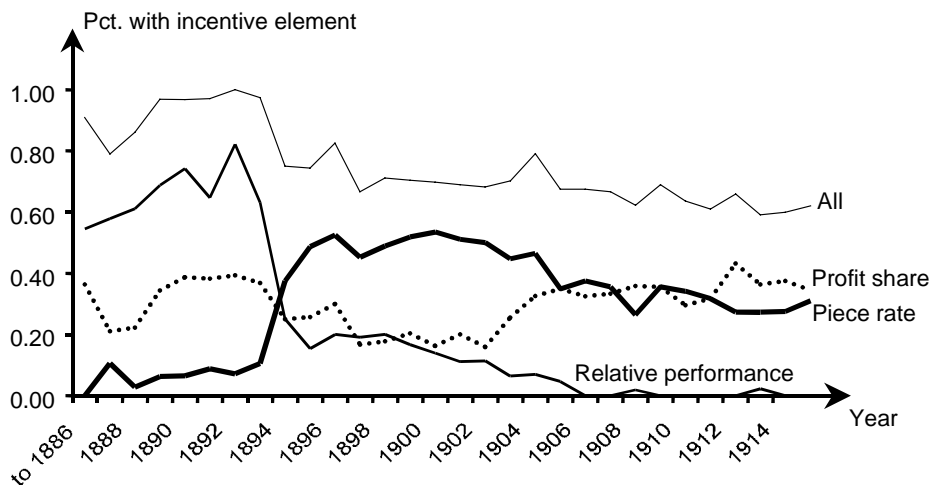
These typically focus on the revenue side. Using the following notation,  $P^B$  is the actual price fetched by the butter,  $P^*$  the target price of butter,  $\mu = \frac{m}{b}$  is the actual milk,  $m$ , per pound of butter,  $b$ , produced and  $\mu^*$  the standard industry norm for  $\mu$ , we can illustrate two of the most common forms of relative performance schemes:

<sup>26</sup> The latter creates a particular problem in assessing the pay of the manager, because an entitlement to a particular amount of cream was at least in some cases converted to money.

<sup>27</sup> The part of pay which was independent of performance was in many cases a fixed annual salary, but in some cases it depended on the number of cows or amount of milk delivered to the dairy and as such was linked to the size of the dairy. Moreover, in some cases, the salary was not linear in the number of cows or pounds of butter.

- (a) Payment relative to a target price, typically a fraction of  $(P^B - P^*) \cdot b$ .
  - (b) Payment relative to a target level of productivity, typically a fraction of  $\left(b - \frac{m}{\mu^*}\right) \cdot P^B$ .
2. Schemes using piece rates.
- These either related to the quantity of butter or cheese or both and typically offered an amount per pound produced. Occasionally a threshold level of quality was included, so that for example only first class butter was included in the measure of quantity.
3. Schemes using profit or revenue sharing.
- The two most popular versions of this were:
- (a) A share of the net surplus of the creamery.
  - (b) The property rights to the returns to a particular amount of milk. The entitlement was usually expressed as the rights to a number of pounds per 1000 pounds raw milk delivered.

From our sample, we can graph the development in the use of incentives based on these three categories.



**Figure 2. A breakdown of the three types of incentive elements.**

We are able to detect the following broad developments in the incentive schemes. Prior to 1894, most schemes involved relative performance measures with the most prevalent one being scheme 1(a) A revision to the commonly used reference price shattered the confidence in relative performance evaluation and a large proportion of creameries moved to piece rate. The

popularity of piece rate decline over time. The schemes based on profit sharing were popular early on, declined in the period from 1894 to 1903 and then increased to overtake piece rate.

Other studies at the time looked at the use of incentive schemes as well as their development over time. The investigation by Jens Johansen in *Mælkeritidende* (vol 6, 1893) into the number of creameries who paid for the milk according to the content of butter fat, carried out for Ribe and Vejle county and containing 104 creameries, also contains information about the managerial incentive schemes used. Of the 87 creameries, who supplied the relevant information, 68 (78%) included some incentive element.

A more diverse geographical analysis was carried out in 1895 looking at the incidence of incentive schemes before and after the reform to the butter quotation. The results regarding incidence is reported in table 4 below:

**Table 4: The incidence of incentive pay, Jutland 1895.**

Association	Replies	Incentive pay before 1895	Incentive pay in 1895	Share in costs
Sydjysk	19	95%	79%	58%
Aarhus & Randers	16	87%	75%	27%
Midtjysk	16	94%	56%	60%
Viborg	11	91%	64%	36%
Aalborg	4	100%	75%	50%
Ringkøbing	14	57%	43%	7%
Ribe	11	73%	55%	0%
Thisted	4	75%	75%	25%
Total	95	84%	64%	34%

As we can see from table 4, although the fraction of dairies using some kind of incentive mechanism did fall from 84% to 64%, in all but one local association more than half of the dairies still use some form of incentive system. Looking at figure 1, we get a similar result from our sample, that incentive pay drop to about 68% after 1894. The 1895 survey also contains a breakdown according to the method of payment. Aggregating to make it comparable to figure 2, we can construct the following table:

**Table 5. Methods of incentive pay before and after 1894.**

Method	Number of creameries before	Number of creameries after
Relative performance measure <sup>28</sup> }	41	6
Piece rate	16	47
Share of surplus	20	17

As in figure 2, we see a shift from relative performance measures to piece rate, with less of an impact on shares of surplus. Our sample thus confirm previous findings about the incidence of incentive pay. However, the aggregate nature of the data hides some further information and the next subsections will discuss our sample contracts in greater detail.

#### **4.1.1 Pre 1894 - Relative Performance Evaluation**

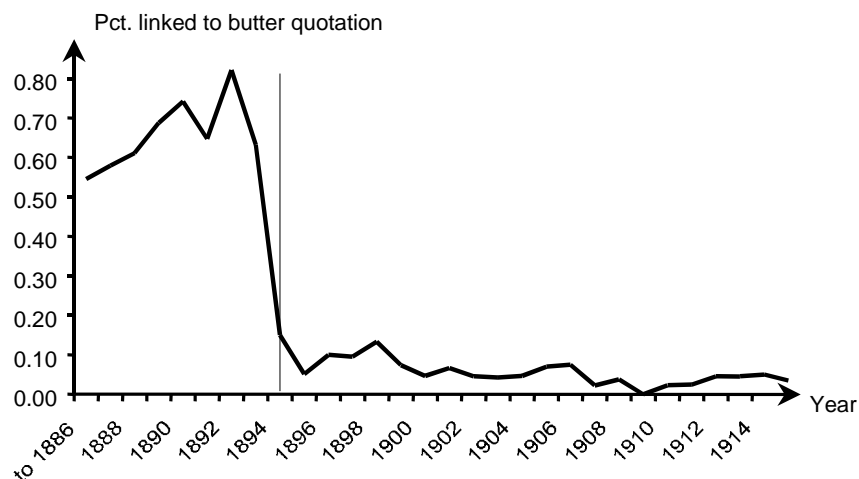
The target or reference price of the most popular relative performance scheme, 1.a, was based on the price quotation provided by the Copenhagen Butter Merchants, a weekly quotation known as “The Copenhagen quotation” or the “The Danish butter quotation”. An intriguing feature of this quotation prior to 1894 was that the quoted price for first class butter, commonly referred to as the “top quotation”, was consistently below actual prices of first class butter and in particular below the prices which the cooperatives achieved. The top quotation was revised in 1894 to ensure that top really meant top, something which appeared to shattered the confidence in this measure.<sup>29</sup> From figure 3 below, we see that the use of this scheme almost entirely stopped after 1894. In 1893, about 80% of the creameries in our sample used this incentive and by 1895, this had fallen to below 10% and never recovered its past popularity.

The relative performance measure 1(a) has the advantage that it rewards both quantity and (relative) quality. It does have two possible downsides. Firstly it is solely focused on the revenue side, something which could and often was dealt with by making the manager pay a \ fraction of a pre-specified part of the costs. Secondly, the gap between quotation and reality was increasing up to 1894, giving the manager an annual windfall. The cooperatives were keen to claw back this windfall and this lead in many creameries to a endless rows between the manager and the Board, in some cases culminating in a change of manager.

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<sup>28</sup> After 1894, all but one relate to the consumption of milk per pound butter

<sup>29</sup> For a period after 1894 this was indeed the case, but as noted in Henriksen and O'Rourke (1999) there was subsequent slippage.



**Figure 3. Incentives linked to the butter quotation.**

One can observe three interesting reactions to the reform to the butter quotation. Firstly, and most important for this paper, there is an almost total loss of confidence in the use of this as a reference price for a relative performance evaluation, with all but a very few creameries abandoning linking pay to the top quotation. Secondly, in 1893 with rumours of a reform of the quotation rife, many dairies entered contingent contracts with their manager, showing a strong reliance on contractual measures to deal with future uncertainties. Finally, some contracts with managers included a penalty for prices below top and some contracts with wholesalers were based on prices above the top quotation. If such a contract spanned the period of the reform, managers or wholesalers could find themselves in considerable financial difficulties. In the cases we know of, the cooperatives renegotiated the contracts fairly rather than take advantage of the situation. Thus incompleteness did not lead to hold-up even where the short-term gains were potentially large.<sup>30</sup>

#### **4.1.2 Post 1894 - Piece Rate or Profit Share**

The reform to the butter quotation triggered a lively debate about pay schemes. In a meeting of the Jutland Farmers Association in September 1894, the question of managers pay was debated extensively. One suggestion, based on discussion between the South Jutland Creamery Association and Vejle county Dairymen Association proposed that the manager was paid: (a) a fixed salary of 1200 Kroner, (b) a part contingent on the amount of butter, (c) a certain percentage of the price of butter, (d) a certain percentage of the net surplus, (e) 5% of revenue

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<sup>30</sup> One dairy which renegotiated their contract with a wholesaler might have been able to gain as much as 20% on almost a whole years sale of butter

from sale of cheese. In addition to this, in-kind payments in the form of house, garden, firewood, lighting and skimmed milk, cheese, butte and cream for daily household consumption (including staff). Thus there was no move here to abandon incentive pay from either the employer nor employee side, but the suggestion contained both piece rate and profit (or surplus) sharing.

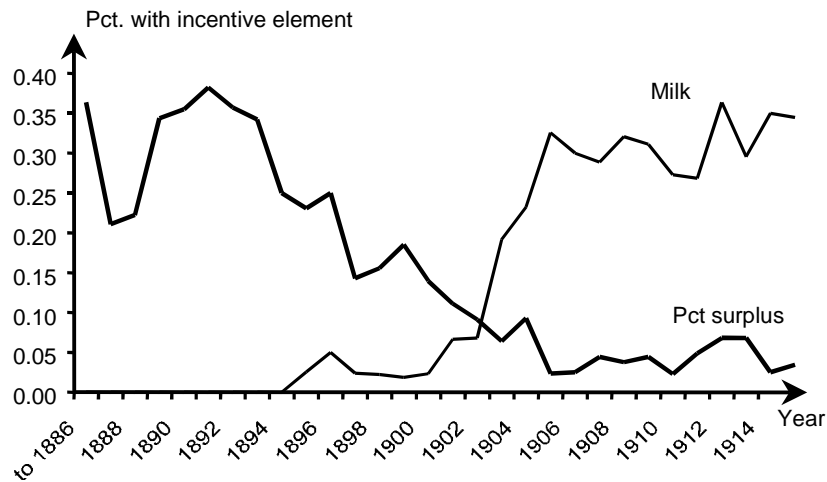
The debate about manager pay culminated in the offer of a prize (25 Kroner) for the best new pay scheme in the industry magazine, Mælkeritidende. Of the many suggestions which were received, two got a prize. The first prize was awarded to the following scheme (where the method rather than the actual amounts mentioned are important):

1. Fixed salary 600 Kroner.
2. 2.5% of revenue from butter up to a revenue of 100,000 Kroner and 1.5% of the rest. (The manager pays for salt, colour and “renkultur”)
3. 6% of revenue from Cheese (The manager pays for salt, cumin, colour and rennet)
4. At the end of each year, the average consumption of coal, oil, soda and other polishing and cleaning goods per 100 pound butter for the dairy association is computed. Those above this average pays 50% of the excess, whereas those below the average are paid 50% of the saving.
5. Every week, the average price for butter for all dairies in the association (preferable the national one, otherwise the local) In creameries where the price was above average, the manager is paid 10% of the amount above the average. In creameries where the price was below average, the manager pays 10% of this to the creamery.
6. If the milk is paid according to fat content, the manager is given an extra amount a year, depending on the size of the creamery, 100-200 Kroner.

Clearly this is a fairly intricate system, but the author offers arguments for why each point are important. From his discussion, it appears that he was well aware of the various incentive problems which arise in the cooperative dairy sector. He also points out that some of the components favour the larger dairies, but also that this is counteracted by other components which penalise size. By contrast, the suggestion which got the second prize, is extremely simple.

1. The manager is paid with a certain number pounds of milk from the milk delivered to the creamery.

Recall that figure 2 suggested a fairly steady appeal of including some share of the surplus in the pay scheme. As figure 4 makes plain, using this broad category hides some important information.



**Figure 4. Contracts with some form of profit sharing.**

From figure 4 we see that schemes involving a specific percentage share in the net surplus of the creamery, though very popular early on, fell dramatically after 1890. Schemes based on property rights to amounts of milk grew in popularity from about 1902. Note that this coincides roughly with the time when the use of piece rate starts to decline. Thus we have identified a second and third phase in the evolution of incentive pay in the creameries. From 1894 to about 1902/3 piece rate is the dominant form and from 1902/3 onwards, profit related pay starts to dominate, getting almost global dominance by 1919 when it becomes part of a national pay scale.

Why then profit share in terms of milk? A manager with property rights to 2% of the milk of the creamery would get a 2% share of the surplus of the creamery, so why not just offer 2% of the surplus? As was pointed out at the time, using percentages of net surplus is problematic. To see why, we need to look at how the net surplus of the cooperative is derived.

Let  $P^B$ ,  $P^S$  and  $P^M$  be the price of butter, skimmed milk and milk respectively. Let  $m_i$  be the supply of farmer  $i$  and  $m$  be the total amount of milk supplied. Let  $b$  be the amount of butter produced and  $\delta \cdot m$  the total amount of skimmed milk produced given the amount of milk. Finally, let  $C$  be the cost of production excluding the manager's pay. Net surplus is then given by

$$NS = b \cdot P^B + \delta \cdot m \cdot P^S - C - m \cdot P^M$$

Let the manager's pay be given by  $S(\lambda) = w + \lambda \cdot NS$ . The total income of farmer  $i$ ,  $Y_i$ , derives from the amount he gets for his milk, the price he has to pay for the skimmed milk and his share of the surplus. This share is the fraction of the total amount of raw milk which this farmer has supplied, i.e.  $\frac{m_i}{m}$ . Thus  $Y_i$  can be written as:

$$\begin{aligned} Y_i &= m_i \cdot \left( P^M - \delta \cdot P^S + \frac{1}{m} \cdot (NS - w - \lambda \cdot NS) \right) \\ &= \lambda \cdot m_i \cdot (P^M - \delta \cdot P^S) + \frac{m_i}{m} \cdot ((1 - \lambda) \cdot (b \cdot P^B - C) - w) \end{aligned}$$

and the wage of the manager is

$$S(\lambda) = w + \lambda \cdot (b \cdot P^B + \delta \cdot m \cdot P^S - C - m \cdot P^M)$$

Whereas  $b$ ,  $P^B$  and  $C$  are at least to some extent affected by the efforts of the manager and hence  $\lambda > 0$  creates some incentives for the manager, he affects neither  $P^M$  or  $P^S$ . Moreover, these prices are not set by the market but by the annual general meeting of the cooperative. It is clear that, unless  $\lambda = 0$ , each member of the cooperative prefer to extract the surplus of the cooperative through a high  $P^M$  or a low  $P^S$  or a combination of this. At the same time, if  $\lambda > 0$ , the manager want a low  $P^M$  and/or a high  $P^S$ . Thus for  $\lambda > 0$  the members and the manager have opposing views about the values of the transfer prices  $P^M$  or  $P^S$ . For the manager to accept a contract with  $\lambda > 0$  is has got to be the case that not only  $P^M$  and  $P^S$  but more generally the precise definition of the net surplus has to be defined explicitly. Indeed in a large number of the cooperatives where the manager was paid a share of the net surplus, this was the case. The possibility for opportunistic behaviour is not the only drawback. It also makes a number of the strategic variables of the cooperative inflexible of the duration of the contract with the manager. This may go some way towards explaining its lack of universal support.

The alternative, giving the manager property right to a particular amount of the raw milk supplied to the creamery, has better properties. Let the share of the share of milk be  $\xi$ , so that the manager would then enter the cooperative with the amount of milk  $\xi \cdot m$ , yielding the following payoffs to farmer  $i$  and the manager:

$$Y_i = (1 - \xi) \cdot m_i \cdot \left( P^M - \delta \cdot P^S + \frac{1}{m} \cdot NS \right) = (1 - \xi) \cdot \frac{m_i}{m} \cdot (b \cdot P^B - C)$$

and

$$S = \xi \cdot m \cdot \left( P^M - \delta \cdot P^S + \frac{1}{m} \cdot NS \right) = \xi \cdot (b \cdot P^B - C)$$

Paying the manager in raw milk generate the same outcome as paying a share of net surplus, but with a considerable simpler contract, which neither needs to specify how net surplus is defined, nor what share the manager has in which parts of costs. This may help explain the increased popularity of this payment scheme.

## 4.2 Variety of measures within a contract

In our sample, we find that 16% of contracts specify more than one incentive measure.<sup>31</sup> An article in *Mælkeritidende* (1890) discussing theoretical and practical issues of running a creamery, drew up a suggested model contract, of which paragraph seven is relevant for the pay of the manager. In translation it states:

*In return for his services, he receive: in fixed annual salary of Kroner . . . , 25% of what is achieved above the top quotation for the butter, 5% of the sales value of the cheese, 5%, 10% or 15% (depending on the size of the fixed annual salary and how the creamery pay for milk) of the net surplus when these are based on paying the milk according to the top quotation (for butter) per 28 pound milk and charging 3 or 4 Øre per kilo of the returned (skimmed) milk.*

*In addition he gets in all cases a free abode (with garden) for himself, his family and the staff, firewood, lighting, one pægl cream daily, 3 pound butter a week and the necessary cheese and skimmed milk for the housekeeping.*

*Mælkeritidende (1890, 377-8)*

Similarly the winning entry from the 1895 competition outlined above include several measures. The survey by Johansen in 1895 mentioned above found that for the before 1895 case, although the majority, 53, used only one incentive measure, 18 used two and 4 used three, painting a similar picture to the one found in our sample.

The use of several measures together suggest that the manager is involved in several tasks and than one measure alone would have biased the manager's allocation of time and effort between these tasks. Lafontaine (2000) considers this for a sample of contracts from the USA trucking industry, where piece rate (pay per miles) which focuses on one task, is more likely to be

accompanied by other incentive measures, whereas surplus sharing is not. With a larger sample, we will be able to test which measures are used together.

From our sample, not only are many of the contracts complex in that they include several performance measures and/or non-linearities, they also vary over time within each creamery. Unlike Lafontaine and Shaw (1999), who for franchising find that contract terms within a franchise rarely change, many of the creameries in our sample used the annual renegotiation of the contract to vary terms. Moreover, contract terms are not just altered when a new manager is employed, existing managers may either be offered a contract with different measures, or \ a contract with the same measures, but different amounts attached to these. Although we cannot test for this, it is as if the creameries are trying to keep the manager to his participation constraint every year. Our findings of a high degree of variety in contract terms is also at odds with the literature on retail contracting surveyed by Lafontaine and Slade (1997), who highlight the large degree of within-firm contract uniformity found in the existing empirical literature, see also Lyons (1996).

**4.3 Risk**

The use of incentive contract transfers risk from the farmers to the manager. The creameries did occasionally take measures to ensure that the manager was partially ensured by specifying a minimum total wage.<sup>32</sup> The incidence of this is illustrated in figure 5 below, where insurance appears to peak just after 1894, the year the largest number of contracts were revised. Over the full sample, 10% include this insurance explicitly.



**Figure 5. Contracts explicitly specifying a minimum salary.**

<sup>31</sup> This does not include incentives relating directly to costs and is hence an understatement.

<sup>32</sup> Equally they occasionally specified a maximum wage.

From the data, it would appear that the insurance is more likely if the performance measure is piece rate (related to butter production) or share of surplus. This would not be surprising, since following the revision to the quotation, the price of butter was uncertain. This has a direct effect on a manager on piece rate and an indirect effect on a manager with a share in the surplus. The latter arises because the internal transfer price for milk delivered to the creamery followed the butter price quotation<sup>33</sup> so that if it was too high, the farmers would be paid too much for their milk and hence the net surplus would be smaller.

## 5 Conclusion

The paper has argued that two features in particular helped the cooperative organisational form to thrive. One was the legal system, which was ready to enforce contractual terms necessary to the success of the cooperative. In particular, the legality of restraints of trade which locked the member into supplying only to the cooperative for a considerable period of time, ensured that the cooperative could be sure to control sufficient milk to produce butter efficiently. The second was the manner in which the manager was remunerated. The use of incentive schemes together with the delegation of paying for staff and extensive monitoring may have ensured that the goals of the manager was more closely aligned to those of the members.

From the contemporary debate as well as the minutes of Board and general meetings, the participants in the cooperatives were relatively sophisticated users of contractual solutions and understood the potential incentive problems very well, including problems which might arise due to multi-tasking.

When looking at the incentive schemes used in the initial phase (pre WW1) of the cooperative movement, one is struck by a number of features. The schemes are often complex containing several performance measures, they may be non-linear and even state contingent. Moreover, the terms of the incentive schemes varied considerably not just across cooperatives, but also over time within cooperatives. Any convergence to what one might term a national scheme occurs very late and as a result of central negotiations between associations of cooperatives and dairy men. This is somewhat surprising since there is throughout the period a lively debate about payment methods with several prominent proposals of best practice. Thus the variety is not

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<sup>33</sup> The typical transfer price was the price of one pound of butter per 28 pounds of milk delivered.

caused by ignorance alone. A future aim is to link incentive schemes to measures of performance to test whether these actually worked as intended.

We have identified three phases of incentive pay. Pre 1894, relative performance evaluation dominates, often complemented with shares in the net surplus. From 1894 to 1902/3 the dominant form is piece rate, while from 1902/3 virtually to the present the dominant form has been profit sharing. This development in the incentive schemes is intriguing and we aim to explore this more fully in future work.

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