

A Rationale of the Limitation Period in Sales Law*

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1. Introduction

Sales law of most countries regulates the length of the period after sale during which the buyer can claim remedies. After the expiry of what in common law is referred to as the limitation period and in civil law as the prescription period, the buyer can no longer claim a remedy for a defective good.¹ This means that although the buyer can prove the good to have been defective at the time of purchase, she does not hold a remedy. Generally, sales law stipulates both a default and a mandatory period where the default period limits the duration of the buyer's claim when the parties have not agreed otherwise, and applies to both consumer and interfirm sales, whereas the mandatory period applies only to consumer sales and only stipulates a minimum period in the sense that if the parties agree on a shorter period (or if a shorter period is part of the seller's standard terms) it will not be given effect by the legal system. In many EU countries, the minimum period has recently been lengthened through the implementation of a EU-directive (99/144).²

Both the default period and the mandatory period have been the subject of longstanding controversy. On one side of the controversy, consumer organizations have argued that the default period should be abolished altogether so that the buyer continues to hold a claim whenever she can prove that

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¹Some jurisdictions make an exception in the case of fraud on the part of the seller, as when the good sold is a forgery.

²In Denmark both periods were increased in 2002 from one to two years.

the good was defective at the time of purchase. They have pointed to cases where the producer acknowledged that the dysfunction was due to a manufacturing error, but where the defect arose after the expiry of the limitation period, and the buyer had to bear the expense of repair. For example, one case involved a yacht that cracked shortly after the expiry of the limitation period³. They have pointed to the unfairness of such an outcome but could also have argued in terms of the incentive for sellers to deliver performing goods. On the other side of the argument, producer organizations have argued that longer periods may be in the interest of neither the seller nor the buyer, since they increase the seller's cost, in part the cost of administering claims, and thereby raise the price of the good.

The debate has lacked a theoretical understanding of the advantages and disadvantages of allowing buyer claims. It may be thought that a rationale of the limitation period lies simply in the transaction costs of administering claims, broadly speaking, but it is not clear why a claim stemming from an 'older' purchase is administratively more costly than that of a more recent purchase, and so it is not clear why time passed since purchase is a relevant criterion. It has been argued in the law and economics literature that since claims arising over old purchases rely on evidence that is likely to be inaccurate due e.g. to the parties' imperfect memory, they are likely to be settled or adjudicated incorrectly.⁴ However, in the context of sales law, the relevant evidence typically concerns the state of the good at the time of the dysfunction, i.e. present rather than past circumstances.⁵ Second, it has been argued that as time passes the way in which a buyer uses a good becomes increasingly important for the probability of dysfunction, and hence cutting off claims increases the incentive for the buyer to use the good with care. However, also this answer is incomplete, for contrary to what is typical for warranties,⁶ sales law requires the buyer to prove that the good was defective at the time of purchase,⁷ and if the dysfunction arises due to

³The case is referred to in the Weekly Bulletin of Legal Affairs (Ugeskrift for Retsvæsen), by the reference U 1984.1077 H.

⁴This rationale is further discussed in the literature review below.

⁵However, a good is defective when it does not live up to the reasonable expectations of the buyer, and evidence concerning what the buyer could reasonably expect at the time of purchase might deteriorate. More on this below.

⁶See e.g. Cooper and John [3], Dybvig and Lutz [4].

⁷Although for the first six months, the burden of proof is on the seller (according to the Danish rule).

carelessness on the part of the buyer, the buyer cannot carry this burden of proof, so this already cuts off the claim.

Perhaps due to the unclear rationale behind the limitation period, several (Nordic) expert committees have advocated the abolishment of the default period⁸, but only in Finland has this been proposal been put into law.

This article suggests a rationale of the limitation period based on the simple observation that most goods tend to lose functionality over time, which implies that the number of dysfunctions or breakdowns that should not be considered defects (i.e. dysfunctions that cannot be said to disappoint the reasonable expectations of the buyer) will rise from some point in time onwards, while the number of valid claims will tend to fall. Hence, if only a fraction of the increasing number of breakdowns results in claims, administrative costs that have no incentive purpose will increase relative to the decreasing number of valid claims that do serve an incentive purpose. Moreover, due to wear and tear, those breakdowns or dysfunctions that should be regarded as defects will become only marginally worthwhile preventing over time, which means that at some point in time the administrative cost of allowing a claim will be likely to outweigh the positive incentive effect.

Two kinds of administrative cost will be emphasized. First, the cost of investigating the cause of the dysfunction, when one party holds a mistaken belief in this regard. This may require a costly inspection of the good. Second, the cost of discussion at the shop level, and the sense of aggrievement that one party may feel when his or her sense of entitlement is not given effect.

The suggested rationale may inform not only the general debate about the limitation period in sales law but also more specific issues that are currently under discussion. For example, it has been argued that the present limitation period is unworkable in markets for used goods (e.g. used cars). For such goods, many dysfunctions arise that cannot be considered defects. Perhaps under the influence of this argument, the EU-directive (99/44/EF) left open the possibility for member countries to implement a shorter minimum limitation period for used goods (though no shorter than one year). However, not all countries have done so. The Danish commission of experts that was constituted to advise the Danish Parliament on the implementation of the

⁸In Norway, the Committee report NOU 1993:27, in Denmark the report 1133/1988 (on services) and, though ambiguously, the report 1403/2001, while in Sweden the report SOU 1995:11 advocated a default period of five years.

EU-directive advised against differentiating between used and new goods⁹, arguing that when dysfunctions are not defects they do not give rise to claims (a good is only defective if it does not live up to the reasonable expectations of the buyer, and less can reasonably be expected of used goods). In the view of the commission, markets for used goods should therefore be able to function efficiently also with a longer minimal limitation period. We shall return to this argument and analyze it on the background of the model.

The remainder of the article is organized as follows. Section 2 presents an overview of the literature bearing on limitation periods. Section 3 presents and analyzes a model in which the rationale for a limitation period arises from a trade-off between incentives and administrative costs. Section 4 presents some empirical data, while section 5 discusses objections to the suggested rationale. Section 6 concludes.

2. The Literature

Statutes of limitations have received sparse attention in the law and economics literature. In the context of sales, what has been analyzed is the rationale of the limited duration of *warranties* (e.g. Dybvig and Lutz [4], Cooper and Ross [3], and Emons [5]). Dybvig and Lutz and Cooper and Ross argue that as time passes, defects become increasingly more likely to be caused by wrong usage, and increasingly less likely to be caused by original defects. Cutting off claims at some point then provides the best achievable (second-best) combination of buyer and seller incentives. Emons [5] explains the limited duration of warranties in terms of the producer's attempt to screen low-intensity users from high-intensity users. These theories, however, do not apply directly to the case in which the buyer bears the burden of proof of negligence (and of causation), as the buyer does under sales law¹⁰, and where wrong or high-intensity usage by the buyer therefore cuts off the buyer's claim.

Miceli [12] derives optimal statutes of limitations and statutes of repose¹¹ in product liability based on a trade-off between incentives and administrative costs¹². Longer duration increases the seller's incentive to exercise care, but

⁹In Commission report (bet nkning) 1403/2001, p. 149. It says: 'the existing definition of what constitutes a defective good is sufficiently flexible to be able to accommodate the specific circumstances of such sales'.

¹⁰with the exception, in some jurisdictions, of an initial period after purchase.

¹¹Statutes of repose run from when the good was sold while statutes of limitations (generally) run from the time the accident occurred.

¹²See also and Baker and Miceli [1] for an empirical analysis.

also increases the number of claims and hence administrative cost. On the critical question why the age of the claim is relevant for the trade-off between incentives and administrative cost, Miceli argues that a claim raised in period $t + \tau$ affects the injurer's incentives less than a claim raised at time t , because the injurer discounts future litigation costs when deciding the level of care. For this reason, the prospect of preventing a claim from arising at time $t + \tau$ is less important to the injurer than the prospect of preventing a claim from arising at time t .¹³ However, discounting future litigation costs is a more salient issue in product liability, where many years can pass from the time of the sale (or from the time of an accident) to when damages become apparent (as when a disease appears long after use of a medicament), than in sales law where limitation periods tend to be one, two or three years. Intuitively, the effect of discounting on future litigation costs can hardly provide a rationale for the limitation period in sales law given the rather short limitation period.¹⁴

Landes and Posner [9] emphasize that evidence deteriorates over time, and that trials occurring long after the sale of the good are therefore both more costly in terms of evidence production and more likely to result in error, as compared to trials occurring shortly after the sale, when memory is more fresh and more evidence is available. When error is more likely, the costs of litigation are harder to justify by their effect on deterrence. This explanation can account for the ubiquitousness of limitation periods in law (since many kinds of evidence deteriorate over time), but it suffers from two drawbacks in the context of sales law. First, an alternative is to raise the standard of proof for old claims; that could cut off dubious claims while allowing claims that are clearly valid. However, as will be discussed below, this may not be a realistic alternative. Second, as mentioned, and more importantly, deteriorating evidence does not seem to play a dominant role in the context of sales law, where the main issue to be resolved is whether the good has met reasonable expectations, a question that can often be answered without the use of historic evidence.

Finally, one finds various other rationales in the legal literature. It has e.g. been suggested by Martin [11], that cutting off claims allows businesses

¹³Note that the social costs of litigation should also be discounted back in time; Miceli's rationale holds when the incentive effect on incentives of the injurer's discounting of future litigation costs outweighs the discounting of total litigation costs.

¹⁴Miceli's result also seems to hinge (to some extent at least) on the assumption of the American rule for allocating litigation costs.

(and consumers) to ‘close their books’, i.e. to dispose of old files. Again, however, this concern does not seem very important in the area of sales contracts. Specific details about the product are typically not needed to assess a dysfunction, and it is the buyer who must keep proof of purchase. It has also been suggested that shifting risk from the seller to the buyer may be thought to justify limitation periods, but it has not been explained why the creditor (the buyer) bears the risk at lower cost. The seller may be a large firm while the buyer may be a consumer or a small firm averse to risk. Thus, it is difficult to account for the widespread use of limitation periods in private contracts on the basis of risk-allocation.

The model will now be presented to analyze under which conditions the rationale based on a trade-off between incentives and administrative costs can be maintained.

3. The Model

Consider a two-period model in which a limitation period may cut off the buyer’s claim after the first period. The model will balance the seller’s incentive to deliver goods of adequate quality against the administrative costs of handling buyer claims.

For simplicity, the market will consist of only one seller and one buyer. The seller produces a given level of quality q and sets the price. Thus, the seller’s strategy is (q, p) . The buyer’s strategy is either to accept or to reject the offer, as a function of (q, p) , i.e. the buyer’s strategy is a function $f(q, p)$, that takes on values of either 0 (reject) or 1 (accept). The buyer cannot observe the quality of the good but she attempts to guess it, and in Nash-equilibrium her guess is assumed to be correct. The cost to the seller of producing quality is $C(q)$, where $C'(0) = 0$, $C'(q) > 0$ and $C''(q) \geq 0$ for $q > 0$. The seller’s expected repair cost will be denoted $E(R)_s$ while the seller’s expected administrative cost will be denoted $E(A)_s$. The seller’s ex ante utility can then be expressed: $EU_s = p - C(q) - E(R)_s - E(A)_s$. The buyer’s utility from using the good in one period is an affine function of the quality of the good, i.e. the utility equals $\alpha + q$, and over both periods the buyer’s utility is then, with similar notation, given by: $EU_b = 2(\alpha + q) - p - E(R)_b - E(A)_b$. α will assumed to be so high that repair is worthwhile for the buyer, despite of both repair and administrative cost.

Note that the type of seller is known to the buyer, since the cost of producing quality is assumed to be common knowledge, so signaling of type is not an issue. The equilibrium concept will be Stackelberg equilibrium, i.e.

subgame perfect Nash-equilibrium, where the seller acts before the buyer. In equilibrium, the seller chooses (q^*, p^*) and the buyer chooses a function $f^*(q, p)$ such that for each (q, p) , $f^*(q, p)$ maximizes EU_b , while (q^*, p^*) maximizes EU_s given $f^*(q, p)$.

To formulate the idea that a good may be subject to more or less strain, states of nature will be indexed by the strain they impose on the product; a higher state signifies greater strain. Thus, the state space will be the interval $\Theta = [0, \infty]$ in both periods of the model, and the quality or endurance of the good will be indexed by the critical state it can withstand; if the state (and hence the strain) is higher than the critical state, the good will dysfunction. When the seller selects quality q , from the set $[0; \bar{q}]$, where for convenience and without loss of generality, an upper bound is set on quality, the good will be functional in the interval $[0, \sigma q]$ in period 1, where σ is some positive constant. The good will need repair, in contrast, in the interval $[\sigma q, \infty]$ in period 1. Wear and tear (decay) can then be introduced by assuming that the good will be functional in the interval $[0, \rho q]$ in period 2, and dysfunctional in the interval $[\rho q, \infty]$, where $\rho < \sigma$. For simplicity, the strain to which the good is likely to be exposed is the same in both periods; the density function of states (strains) in both periods will be $h(\theta)$. To avoid uninteresting mathematical complications, it will be assumed that h is bounded above. Thus, when quality is q , the probability of dysfunction will be $\int_{\sigma q}^{\infty} h(\theta) d\theta$ in the first period, and $\int_{\rho q}^{\infty} h(\theta) d\theta$ in the second period, since dysfunction will occur in states higher than σq in the first period and in states higher than ρq in the second period.

A judge will find the good defective if it is below some required quality level, q^r . The corresponding states which the good is expected to endure in the two respective periods are then $\theta_1^r = \sigma q^r$ and $\theta_2^r = \rho q^r$. The required level of quality will be assumed to be set by the court at that level which is socially optimal given the statute of limitations. The court is required to set the standard according to prevailing legal doctrine, which stipulates that a good must conform to the reasonable expectations of the buyer. This standard is assumed to be so broad as to enable the judge to set requirement at the socially optimal level. Naturally, this may in practice be difficult for the court, but it will bring out the forces at work to consider the case in which the court can do so.

Repair rather than replacement (or reduction in price) will be assumed to be optimal when the good breaks down. Thus, if the product becomes

dysfunctional in a state $\theta_1 < \sigma q^r$ in the first period, the product is defective (for it should only become dysfunctional in higher states), and the buyer can then require that the seller pays for the repair. By contrast, if the good becomes dysfunctional in a state $\theta_1 > \sigma q^r$, the buyer does not have a claim on the seller, but must pay for the repair herself, at a cost of R .¹⁵

The administrative cost of handling claims will be modeled as costly state verification (Townsend [16]). To fix ideas, the parties might incur administrative costs when the buyer underestimates the strain to which the good has been exposed. One can think of the case where the buyer has used a vacuum cleaner without properly switching filters; it may take an investigation of the dysfunction to realize that the unclean filter is likely to have caused the breakdown.

Thus, denote by $g(x)$ the probability for the buyer of thinking the state to be x higher than it really is, such that when the state of nature is θ' , the probability that the buyer perceives the state of nature to be $\theta' + x$ is $g(x)$ and the probability that the buyer underestimates the strain and believes the state of nature to be $\theta' - x$ is $g(-x)$, where $\int_{-\infty}^{\infty} g(x)dx = 1$ and $\int_{-\infty}^x g(x)dx \equiv G(x)$. Then, if the required level of quality is q^r such that the good should withstand strain up to the state of nature equal to $q^r\sigma$, then the buyer will perceive the good to be defective (and not only dysfunctional) when $\theta' + x < q^r\sigma$, i.e. when $x < q^r\sigma - \theta'$. The probability of this occurring is $G(q^r\sigma - \theta')$. Similar errors may be made by the seller (in reality, the seller is not always identical to the producer so the seller does not necessarily know the quality of the product), who cannot observe directly how the buyer has used the product, but for simplicity it will be assumed that mistakes are made by the buyer only. (The possibility of seller mistake should, however, be kept in mind when interpreting the results). Given these assumptions, when the buyer believes the good to be defective while the seller does not believe this to be the case, two kinds of costs can be incurred. As one source of administrative cost, the seller might instigate an investigation of the cause of the dysfunction (i.e. of the state of nature). Such an investigation will be assumed to cost the buyer τ_b and the seller τ_s . If $R > \tau_b + \tau_s$, and the parties are certain in their opposite beliefs about the nature of the dysfunction (to

¹⁵It may be noted that this way of modeling dysfunction and defect leaves out the possibility that the seller may deliver adequate quality yet be found liable due to a dysfunction that occurs for a stochastic reason and that cannot be distinguished from a defect. However, results are not sensitive to such an extension.

simplify), the parties will optimally choose to incur the costs of investigation rather than split the total cost of repair in some fraction ϑ for the seller and $1 - \vartheta$ for the buyer. Thus, the seller will believe to save $\vartheta R - \tau_s$ by the investigation and the buyer will believe to save $(1 - \vartheta)R - \tau_b$, and therefore the total expected savings from investigation is $R - (\tau_b + \tau_s)$, which is positive when $R > \tau_b + \tau_s$.¹⁶ As another potential source of administrative cost, the parties can incur a cost of disagreeable argument, of aggrievement and of a deterioration of their relationship, as in Hart and Moore [?]. Such cost of disagreeable argument is often mentioned by both sellers and buyers. Thus, in what follows, τ_b and τ_s may be thought of either as investigation¹⁷ or aggrievement (disagreeable conflict) costs.

Three cases will now be considered. In the first, state verification is costless.

3.1. The case of costless state verification

Consider the situation where claims are allowed in both periods, and denote the required level of quality in this situation by q^r . Then, when the seller delivers $q < q^r$, the seller will pay for the repair in the states $q\sigma < \theta < q^r\sigma$ in the first period and in the states $q\rho < \theta < q^r\rho$ in the second period. Thus, the repair cost to the seller will be $\int_{q\sigma}^{q^r\sigma} Rh(\theta)d\theta$ in period 1,

and $\int_{q\rho}^{q^r\rho} Rh(\theta)d\theta$ in period 2. Thus, the cost of delivering $q < q^r$ will be $C(q) + \int_{q\sigma}^{q^r\sigma} Rh(\theta)d\theta + \int_{q\rho}^{q^r\rho} Rh(\theta)d\theta$, while the cost of producing $q = q^r$ will be simply $C(q^r)$, since no claims will then be raised. The seller will choose q^r when (A) : $C(q^r) < C(q) + \int_{q\sigma}^{q^r\sigma} Rh(\theta)d\theta + \int_{q\rho}^{q^r\rho} Rh(\theta)d\theta$ for all $q < q^r$. (Note

¹⁶The incentive to raise a claim will be discussed more below.

¹⁷Note that when only the buyer makes mistakes, the seller could set up a system where the buyer pays the cost of the investigation when the investigation reveals that the good was not defective. In such a system, the seller would be indifferent between cutting off the buyer's claim or letting the buyer bear the cost of her own mistakes, and the limitation period would serve mainly the interests of the buyer. However, the seller can of course also make mistakes, and it is not always possible to let the buyer bear all costs of investigations (including the administrative trouble).

that it will be assumed not to be sufficient that $C(q^r) \leq C(q) + \int_{q\sigma}^{q^r\sigma} Rh(\theta)d\theta + \int_{q\rho}^{q^r\rho} Rh(\theta)d\theta$, in which case the seller might choose the lower level of quality).

Denote the first best level of quality by $q^{opt} = Arg \min C(q) + \int_{q\sigma}^{\infty} Rh(\theta)d\theta + \int_{q\rho}^{\infty} Rh(\theta)d\theta$

Proposition 1: When state verification is without cost for both parties, cutting off claims cannot be given a rationale, since when the court sets the required level of quality equal to the first best level, i.e. if $q^r = q^{opt}$, then the first best level of quality will be achieved in equilibrium when claims are allowed in both periods.

Proof: See Appendix A.

The point is that when there is no cost of verifying the state, when valid claims are handled without administrative expense, and when invalid claims do not arise, then allowing claims indefinitely can ensure optimal incentives at no administrative cost.

3.2. The case of costly state verification

Consider next the case where state verification is costly, and where claims are allowed in both periods. Denote the required level of quality by q_c^r , where the subscript c stands for cost of verification. Within the first period, there are three intervals for the seller to consider when producing a level of quality $q < q_c^r$: $\theta < q\sigma$; $q\sigma \leq \theta \leq q_c^r\sigma$, and $\theta > q_c^r\sigma$. In the first interval, there will not be a breakdown. In the second, the breakdown is legally a defect, but the buyer will not make a valid claim if she overestimates the state of nature by $q_c^r\sigma - \theta$ or more. The probability of this occurring equals $1 - G(q_c^r\sigma - \theta)$, so the probability of a valid claim will be $G(q_c^r\sigma - \theta)$. However, by the assumption that the seller can tell the state of nature, the seller will not incur the cost of verification, but will acknowledge the defect. Hence, the cost of valid claims to the seller will be $\int_{q\sigma}^{q_c^r\sigma} RG(q_c^r\sigma - \theta)h(\theta)d\theta$ in period 1. The same cost will be $\int_{q\rho}^{q_c^r\rho} RG(q_c^r\sigma - \theta)h(\theta)d\theta$ in period 2. In the states $]q_c^r\sigma; \infty[$ and $]q_c^r\rho; \infty[$, the

buyer will not hold a valid claim, but the buyer may raise a claim whenever she underestimates the state of nature by more than $\theta - q_c^r \sigma$, i.e when x takes on a negative value of $q_c^r \sigma - \theta$ or lower. This occurs with probability $G(q_c^r \sigma - \theta)$. The raising of an invalid claim will impose a cost τ_s on the seller, but the repair will eventually be paid by the buyer, since it will be discovered that (while the good broke down) the breakdown cannot be considered a defect. Thus, when state verification is costly to the buyer, the total cost for the seller of producing a level of quality, $q < q_c^r$ is:

$$C(q) + \int_{q\sigma}^{q_c^r \sigma} RG(q_c^r \sigma - \theta)h(\theta)d\theta + \int_{q\rho}^{q_c^r \rho} RG(q_c^r \sigma - \theta)h(\theta)d\theta \\ + \int_{q_c^r \sigma}^{\infty} \tau_s G(q_c^r \sigma - \theta)h(\theta)d\theta + \int_{q_c^r \rho}^{\infty} \tau_s G(q_c^r \rho - \theta)h(\theta)d\theta$$

On the other hand, when delivering q_c^r , repair will be paid by the buyer, and so the total cost to the seller becomes $C(q_c^r) + \int_{q_c^r \sigma}^{\infty} \tau_s G(q_c^r \sigma - \theta)h(\theta)d\theta$
 $+ \int_{q_c^r \rho}^{\infty} \tau_s G(q_c^r \rho - \theta)h(\theta)d\theta$

Thus, when claims are allowed in both periods and state verification is costly, the seller will conform to the required level when

$$(A_c) : C(q_c^r) < C(q) + \int_{q\sigma}^{q_c^r \sigma} RG(q_c^r \sigma - \theta)h(\theta)d\theta + \int_{q\rho}^{q_c^r \rho} RG(q_c^r \sigma - \theta)h(\theta)d\theta$$

for all $q < q_c^r$. Denote the set of q_c^r that fulfills (A_c) by Φ_c . That the court will choose an element in this set can be seen as follows (in the case of Φ_c but the proof applies also to Φ_l below). Consider the possibility that the court chooses $\hat{q} \notin \Phi_c$ as the required level of quality. The seller will then not choose \hat{q} as \hat{q} is not in the set. Assume then that the seller chooses $\tilde{q} < \hat{q}$ (the seller has no incentive to choose a higher level than required). If \tilde{q} is in the set Φ_c , the court might as well have chosen this level as the required level. If it is not in the set, the seller will optimally choose an even lower q , as a lower q dominates \tilde{q} even when \tilde{q} is the standard. But this contradicts that \tilde{q} is chosen by the seller in the first place when the standard is \hat{q} (QED).

Hence the court should solve the problem:

$$\text{Minimize w.r.t. } q_c^r : C(q_c^r) + \int_{q_c^r \sigma}^{\infty} (\tau_s + \tau_b)G(q_c^r \sigma - \theta)h(\theta)d\theta + \int_{q_c^r \rho}^{\infty} (\tau_s + \tau_b)G(q_c^r \rho - \theta)h(\theta)d\theta + \int_{q_c^r \sigma}^{\infty} Rh(\theta)d\theta + \int_{q_c^r \rho}^{\infty} Rh(\theta)d\theta$$

subject to : $q_c^r \in \Phi_c$

Given the court's choice, an equilibrium will emerge in the game between the seller and the buyer in which the seller chooses the required level of quality, and offers a price that is just worthwhile for the buyer to accept.¹⁸

Consider next the case where state verification is costly but claims are cut off after the first period. The subscript l will refer to claims being cut off after the first period. The cost to the seller of delivering less than q_l^r (the required level when state verification is costly and claims are cut off) becomes:

$$C(q) + \int_{q^\sigma}^{q_l^r \sigma} RG(q_l^r \sigma - \theta)h(\theta)d\theta + \int_{q_l^r \sigma}^{\infty} \tau_s G(q_l^r \sigma - \theta)h(\theta)d\theta$$

On the other hand, when delivering q_l^r , the total cost to the seller becomes $C(q_l^r) + \int_{q_l^r \sigma}^{\infty} \tau_s G(q_l^r \sigma - \theta)h(\theta)d\theta$

Thus, the seller will deliver optimal quality when

$$(A_l) : C(q) + \int_{q^\sigma}^{q_l^r \sigma} RG(q_l^r \sigma - \theta)h(\theta)d\theta > C(q_l^r)$$

for all $q < q_l^r$. Denote the set of q_l^r that fulfill (A_l) by Φ_l .

The problem for the court is then to:

$$\text{Minimize w.r.t. } q_l^r : C(q_l^r) + \int_{q_l^r \sigma}^{\infty} (\tau_s + \tau_b)G(q_l^r \sigma - \theta)h(\theta)d\theta$$

$$+ \int_{q_l^r \sigma}^{\infty} Rh(\theta)d\theta + \int_{q_l^r \rho}^{\infty} Rh(\theta)d\theta$$

s.t. $q_l^r \in \Phi_l$

Given the court's choice, an equilibrium that implements this level of quality will arise in the game between the seller and the buyer.

It will now be shown that as wear and tear sets in, i.e. as ρ becomes small (such that the good should be expected to break down in most, but not all states of nature), it will be advantageous to cut off claims in the second period. Thus, in the limit, as ρ converges to zero, the incentive effect of allowing claims will be dominated by the administrative cost. Naturally, if ρ were zero, this would clearly be the case, but the point is to show that when there are potentially valid claims (but only a few), the administrative cost will outweigh the incentive effect.

¹⁸The buyer strategy in equilibrium will be to accept when the price is no higher than that level which make the buyer break even, given $q^* = q_c^r$.

Proposition 2

When state verification is costly, then as ρ converges to zero, cutting off claims after the first period lowers social cost

The proof is in Appendix B.

The proof presents the trade-off in an intuitive way. The number of states in which dysfunctions are defects tends to decrease over time, while the number of states in which dysfunctions are the natural consequence of wear and tear increases. Even if only a small fraction of the increasing number of naturally occurring dysfunctions are viewed by buyers as defects and lead to claims, the costs of unwarranted claims will at one point exceed the positive incentive effect of allowing claims. Naturally, buyers will realize that the probability of prevailing will decrease over time, but as long as some buyers will attempt to raise a claim even though uncertain about the merit, or as long as some are sufficiently convinced about the validity of their claim for it to be worthwhile for them to raise a claim, it will be optimal to cut off claims at some point in time.

Attention now turns to the empirical evidence. The question to be addressed is whether the effects in the model can be found in the data.

4. Empirical Evidence

As mentioned in the Introduction, both the default and the mandatory (minimum) limitation period was lengthened in Denmark in (the beginning of) 2002. In 2003, as the effect of the new law began to show in its second year, Professor Møgelvang-Hansen and I conducted a survey ([10]) involving retailers of durable goods. Of 1,300 questionnaires sent out, about 300 responded, and of these, 291 responses were useful. The sectors were: used cars, new cars, computers and standard software, women's and men's clothing, electric home appliances, furniture, radio and television, shoes, and telecommunication products. Also, statistics were obtained from the Organization of Wholesale Distributors of Consumer Electronics in Denmark (BFE), which showed the increase in the number of repairs and replacements within this sector as a consequence of the legal changes introduced in 2002.

For the purposes of the present article, the data concerning the effect on retailers' quality selection of goods and the effect on the number of claims and overall administrative costs are of particular significance.

4.1. Empirical Findings Concerning the Impact on Quality

Table 1 below reveals that the extension of the limitation period seems to have affected retailers' quality selection of goods. The survey question was:

Have you, on the background of an increase in the number of complaints, discontinued the sale of any goods which were resulting in too many complaints?

Table 1

Sectors	I	F	No	Do not know	answers
All sectors	14.2%	29.1%	53.8%	2.9%	275
Used cars	22.7%	36.4%	31.8%	9.1%	22
Cars	11.5%	19.2%	69.2%	.0%	26
Computers and software	18.8%	39.1%	39.1%	3.1%	64
Household appliances	18.2%	18.2%	59.1%	4.5%	22
Furniture	16.1%	19.4%	64.5%	.0%	31
Radio and television	12.5%	28.1%	59.3%	3.1%	32
Clothing	6.3%	28.1%	72.7%	6.3%	32
Shoes	10.0%	30.0%	60.0%	.0%	30
Telecommunication	6.3%	31.3%	62.5%	.0%	16

I: Yes, it has indeed affected our range of products

F: Yes, but only in very few cases

Thus, in the aggregate, *14% of the respondents answered that it had in fact influenced their selection while 29% had made changes but only in a few cases. The remaining 54% of the sellers had made no changes.* This indicates that although many are unaffected, seller behavior has been affected in the direction one would expect, and to a non-negligible extent. One caveat should, however, be mentioned: Although the question explicitly refers to the effect of the increase in claims, there is a possibility that the respondents fail to distinguish this from the effect of the presumption rule. At the same time, the presumption shifted in favor of the buyer for the first six month after purchase (i.e. the burden of proof shifted to the seller). Note for example that selection has been more heavily affected for used cars than for new cars which might well have to do with the presumption rule. However, it is hard to imagine the presumption rule to play a significant role for televisions or radios, where a dysfunction shortly after purchase indicates an original defect (unless the item has been dropped in which case there will often be damage to suggest this). Yet, selection has been significantly affected also for television and radios, suggesting that the extended limitation period has played a role.

4.2. Empirical Findings Concerning Administrative Costs

The survey question was: Do your customers make more claims now than before the change of law? The possible answers were: a) Much more frequently, b) A little more frequently, c) No change, d) Do not know.

The answers are shown in Table 2:

Table 2

Sectors	M.m.f	L.m.f	No change	Do not know	answers
All sectors	6.2%	23.4%	67.0%	3.4%	291
Used cars	9.1%	31.8%	50.0%	9.1%	22
Cars	.0%	37.9%	62.1%	.0%	29
Computers and software	3.1%	16.9%	76.9%	3.1%	65
Household appliances	4.3%	17.4%	78.3%	.0%	23
Furniture	12.5%	28.1%	53.1%	6.3%	32
Radio and television	5.3%	15.8%	71.1%	7.9%	38
Clothing	.0%	24.2%	72.7%	3.0%	33
Shoes	9.4%	25.0%	65.6%	.0%	32
Telecommunication	23.5%	23.5%	52.9%	.0%	17

M.m.f: Much more frequently

L.m.f: A little more frequently

Note that the presumption rule may again have caused the increase in claims; however, data for Consumer Electronics presented below indicate that the extension of the limitation did cause a substantial increase in claims in this sector, which indicates that the increase shown in Table 2 was in large part due to the new limitation period.

The Organization of Wholesale Distributors of Consumer Electronics in Denmark (BFE) provided data showing the increase in the number of repairs and replacements as a consequence of the new limitation period. The data covered audio-visual products such as DVD's, videos, disc-men, video-cameras, and radio and television, and is graphically depicted in Møgelvang-Hansen and Lando [10]. For present purposes, the overall conclusion is that

¹⁹It should be added that some retailers may also be affected by consumers' increased right to demand a replacement. Survey responses revealed that there was a marked increase in the number of replacements, although many retailers simply disregarded the law in this regard (see Møgelvang-Hansen and Lando [10]).

for this industry, the extension of the limitation period resulted in a 20% to 30% increase in the number of warranted claims for repair and replacement. As the radio and television sector was about average in Table 2 above, this suggests that the average increase in the sectors under investigation was in the neighborhood of 20%.

The survey also contained the following question:

Question: Has the number of unwarranted claims increased after the change of law²⁰?

	L. Inc.	S. inc.	No change	Fall	Do not know	answers
All sectors	7.7%	28.6%	56.8%	.0%	7.0%	287
Used Cars	19.0%	38.1%	33.3%	.0%	9.5%	21
Cars	.0%	46.4%	50.0%	.0%	3.6%	28
Computers/software	4.6%	20.0%	67.7%	.0%	7.7%	65
Household appliances	4.3%	17.4%	73.9%	.0%	4.3%	23
Furniture	9.4%	25.0%	50.0%	.0%	15.6%	32
Radio and TV	5.3%	23.7%	60.5%	.0%	10.5%	38
Clothing	.0%	25.0%	68.8%	.0%	6.3%	32
Shoes	16.1%	38.7%	45.2%	.0%	.0%	31
Telecommunication	23.5%	41.2%	35.3%	.0%	.0%	17

L. Inc: Large increase

S.inc: Small increase

Again, there are significant differences between the different industries, reflecting nearly the same pattern as for the increase in claims. Overall, it appears that the increase in the number of unwarranted claims was somewhat larger than the increase in claims: On average, 29.6% respond that there has been either a large or a small increase in the number of claims while more than 36% respond that there has been either a large or small increase in the number of unwarranted claims. This is at least indicative of a significant increase in unwarranted claims, at least as perceived by retailers, consistent with the model.

Again, however, part of the effect may be due to the change of presumption during the first six months after purchase. While claims raised under

²⁰ Again, it should be noted that the law has shifted the burden of proof for the first six months which may perhaps affect the results.

the presumption rule may have been legally warranted, it is conceivable that retailers may have considered them unwarranted.

Still, the evidence is consistent with a significant increase in the number of unwarranted claims due to the extension of the limitation period.

5. Application to the market for used goods

6. Discussion

This section discusses aspects of the model and of the suggested rationale.

First, in the equilibrium of the model and in obvious contrast with reality, there were no valid claims in equilibrium, since sellers rationally chose to adhere to the required quality standard. This is a common shortcoming of abstract models of tort and contract law that analyze settings of negligence. However, the reasons why valid claims arise in reality do not put into question the rationale suggested. Thus, one reason for the existence of valid claims is that it may not be worthwhile for sellers to produce the required level of quality, since buyers may not find it worthwhile to raise valid claims - either because the cost of doing so is high or because it can be difficult for them to prove the cause of the dysfunction. In this case, the limitation period may be argued to detract from an already insufficient incentive for the seller to deliver quality. However, the model does capture the possibility that too few claims are raised, as the G -function expresses that buyer's may not only overestimate but also underestimate their right to a remedy. And Proposition 2 holds even when many buyers do not raise valid claims (outside equilibrium). Indeed, the rationale may be strengthened in this case, as can be illustrated in the case where quality is either 0 or 1, and where too few claims are raised for it to be worthwhile for the producer to produce quality 1. Cutting off claims will then save administrative costs of both valid and invalid claims without affecting quality. Another reason for the existence of valid claims in reality is that quality is the result of a random production process that can result in faulty products. This could be incorporated into the model without affecting the result that the incentive effects will at one point become dominated by the administrative cost of allowing claims, as long as even a very small fraction of the increasing number of dysfunctions leads to invalid claims. The same applies to a third reason why valid claims arise in equilibrium, namely that producers or sellers make mistakes in their production decisions. Thus, the suggested rationale does not hinge on the model assumptions that exclude valid claims from occurring

in the equilibrium of the model.

Second, the reasons for the parties to incur administrative costs in the model may be questioned. Indeed, when no valid claims arise in equilibrium, it may be asked why buyers do not learn that sellers deliver adequate quality. However, even within the assumptions of the model (where as just discussed valid claims do not arise in equilibrium), there may be reason to expect buyers to raise claims, at least stochastically, for if buyers did not raise claims, sellers would no longer produce adequate quality. Thus, it is hard to escape the conclusion that claims must be raised, at least occasionally, or at least when quality appears to be very low. A model could have been constructed in which buyer raise claims as part of a mixed strategy, or in which valid claims do arise in equilibrium for one of the reasons just given, and where buyers would hence have an incentive to raise claims. However, while such a model would be more complex, the rationale of the limitation period that would emerge from such a model would be unaffected.

Third, it should be noted that the model is not inconsistent with the idea that limitation periods lower the problem of buyer moral hazard. Although buyers do bear the burden of proof (after the first six months), it is evident that buyers are sometimes granted a remedy despite their own negligent use, due to the difficulty of ascertaining the cause of a dysfunction. To the extent that this occurs, cutting off claims lowers the problem of buyer moral hazard. This rationale for the limitation period should hence be considered as complementary to that of this article which stresses administrative costs and investigation costs.

Fourth, as mentioned, cutting off claims is not the only way to lower the number of claims raised. One might instead require a higher standard of proof as time passes, or give a right to remedies only when the good is very significantly below adequate quality. Within the logic of the model, the buyer would then be discouraged from bringing a claim, unless it has clear merit. Indeed, nothing in the model provides reason to believe that an all-or-nothing solution is preferable to a more graduated approach whereby the buyer's rights diminish over time. However, communicating to retailers or to consumers time-varying standards of proof or time-varying required levels of quality would be difficult, and there would be uncertainty about when a dysfunction is clearly a defect²¹. Due to such uncertainty, there would still be

²¹Time varying fees for bringing claims also seems a remote possibility in practice for similar reasons.

disagreement about when a dysfunction is a defect and so investigation costs would still be incurred that with the passage of time would be increasingly hard to justify with reference to seller incentives.

Finally, how the legal regulation interacts with market forces such as warranties has not been touched upon in this article. Naturally, to the extent that goods that are supposed to last for many years are covered by warranties of longer duration (although, as noted by Emons [5], the duration of warranties tends to be shorter than the life-time of the product), the optimal default rule, which then regulate goods of shorter expected lifetimes, will as mentioned also be shorter. More interestingly, one may wonder how the legally stipulated limitation periods, mainly the minimum period which applies to consumer sales, interacts with the signaling role²² of warranties²³. This is left for future research.

7. Conclusion

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Appendix A.

Proof of Proposition 1.

Let $E(R) = \int_{q^{opt}\sigma}^{\infty} Rh(\theta)d\theta + \int_{q^{opt}\rho}^{\infty} Rh(\theta)d\theta$. It will be shown that *the equilibrium strategy for the seller is:*

$$(q^*, p^*) = (q^{opt}, 2(\alpha + q^{opt}) - E(R))$$

when the court requires $q^r = q^{opt}$. The cost for the seller of delivering q^{opt} when it is the required standard becomes simply $C(q^{opt})$ as no claims will be valid, and hence no claims will be raised under full information. Adhering to the required standard is hence optimal for the seller if

$C(q^{opt}) < C(q) + \int_{q\sigma}^{q^{opt}\sigma} Rh(\theta)d\theta + \int_{q\rho}^{q^{opt}\rho} Rh(\theta)d\theta$ for all $q < q^{opt}$. This will be fulfilled, since when $q^{opt} = Arg \min C(q) + \int_{q\sigma}^{\infty} Rh(\theta)d\theta + \int_{q\rho}^{\infty} Rh(\theta)d\theta$, then $C(q) +$

²²First analyzed by Spence [15] and Grossman [7].

²³In the Danish context, warranties are restricted by a regulation by the Consumer 'Ombudsmand', who has barred warranties of shorter duration than the mandatory limitation period. Thereby, the extension of the limitation period led to a decrease in the number of warranties. However, insurance policies similar to warranties have in some branches substituted for warranties.

$\int_{q\sigma}^{\infty} Rh(\theta)d\theta + \int_{q\rho}^{\infty} Rh(\theta)d\theta > C(q^{opt}) + \int_{q^{opt}\sigma}^{\infty} Rh(\theta)d\theta + \int_{q^{opt}\rho}^{\infty} Rh(\theta)d\theta$, which implies that $C(q) + \int_{q\sigma}^{q^{opt}\sigma} Rh(\theta)d\theta + \int_{q\rho}^{q^{opt}\rho} Rh(\theta)d\theta > C(q^{opt})$, since $\int_{q\sigma}^{\infty} Rh(\theta)d\theta - \int_{q^{opt}\sigma}^{\infty} Rh(\theta)d\theta = \int_{q\sigma}^{q^{opt}\sigma} Rh(\theta)d\theta$ and $\int_{q\rho}^{\infty} Rh(\theta)d\theta - \int_{q^{opt}\rho}^{\infty} Rh(\theta)d\theta = \int_{q\rho}^{q^{opt}\rho} Rh(\theta)d\theta$.

The buyer will anticipate the level of quality q^{opt} and will accept when the price is less than or equal to $2(\alpha + q^{opt}) - (\int_{q^{opt}\sigma}^{\infty} Rh(\theta)d\theta + \int_{q^{opt}\rho}^{\infty} Rh(\theta)d\theta)$.

If the price is higher, the buyer will reject the offer. Given this strategy, the seller will make the suggested offer $(q^*, p^*) = (q^{opt}, 2(\alpha + q^{opt}) - E(R))$. QED

Appendix B.

Proof of Proposition 2:

Denote the solution to $Min(B)$ subject to (A) , i.e. the solution to the minimization problem without a limitation period by q^* . Note that $C(q_i^*) < Min_q(C(q) + \int_{q\sigma}^{q_i^*\sigma} RG(q_i^*\sigma - \theta)h(\theta)d\theta)$ and denote $Min_q(C(q) + \int_{q\sigma}^{q_i^*\sigma} RG(q_i^*\sigma - \theta)h(\theta)d\theta) - C(q_i^*)$ by $\kappa > 0$. It follows that q_i^* is also a solution to (A) when

ρ is sufficiently small, for then the last expression $\int_{q\rho}^{q^r\rho} RG(q^r\sigma - \theta)h(\theta)d\theta$ of

the left-hand side of (A) can be made to be arbitrarily close to zero by the assumption that h is bounded above. Thus, when $C(q_i^*) < Min_q(C(q) + \int_{q\sigma}^{q_i^*\sigma} RG(q_i^*\sigma - \theta)h(\theta)d\theta)$, then $C(q_i^*) < Min_q(C(q) + \int_{q\sigma}^{q_i^*\sigma} RG(q_i^*\sigma - \theta)h(\theta)d\theta) + \int_{q\rho}^{q_i^*\rho} RG(q_i^*\sigma - \theta)h(\theta)d\theta$ when ρ is so small that $\int_{q\rho}^{q_i^*\rho} RG(q_i^*\sigma - \theta)h(\theta)d\theta < \kappa$.

$C(q_i^*) < Min_q(C(q) + \int_{q\sigma}^{q_i^*\sigma} RG(q_i^*\sigma - \theta)h(\theta)d\theta)$ the latter expression set of q^r that solve (A) and the set of q_i^r that solve (A_l) . These sets are non-empty as $q = 0$ is an element in both.

When ρ converges to zero, these two constraints converge. Thus, when ρ is sufficiently small, there will exist a solution to (A_l) , \tilde{q}_i^r , that is very close to the solution q^* , which is a solution to (A) . This can be shown by contradiction. Assume that as ρ converges to zero, any solution to (A_l) is no closer to q^* than the constant ν . Thus, for any ∂ , $\|\tilde{q}_i^r - q^*\| > \nu$ although

$\|\rho - 0\| < \partial$.

This means that for q' between \tilde{q}_i^r and q^* , there exists a q'' such that

$$(A_l) : C(q'') + \int_{q''\sigma}^{q'\sigma} RG(q'\sigma - \theta)h(\theta)d\theta < C(q')$$

$$\text{while } C(q'') + \int_{q''\sigma}^{q^*\sigma} RG(q^*\sigma - \theta)h(\theta)d\theta + \int_{q''\rho}^{q^*\rho} RG(q^*\sigma - \theta)h(\theta)d\theta \geq C(q^*)$$

This follows simply from the fact that $\int_{q\rho}^{q^r\rho} RG(q^r\sigma - \theta)h(\theta)d\theta$ converges to zero when ρ converges to zero, given that $h(\theta)$ is bounded above. Thus, for any ε , it is possible to find a ∂ , such that $\|\tilde{q}_i^r - q^*\| < \varepsilon$ when $\|\rho - 0\| < \partial$. Hence, if the court chooses \tilde{q}_i^r , total social cost becomes $C(\tilde{q}_i^r) + \int_{\sigma\tilde{q}_i^r}^{\infty} (\tau_s +$

$$\tau_b)G(\tilde{q}_i^r\sigma - \theta)h(\theta)d\theta + \int_{\tilde{q}_i^r\sigma}^{\infty} Rh(\theta)d\theta + \int_{\tilde{q}_i^r\rho}^{\infty} Rh(\theta)d\theta$$

$$\text{Compare with (B) : } C(q^*) + \int_{q^*\sigma}^{\infty} (\tau_s + \tau_b)G(q^*\sigma - \theta)h(\theta)d\theta + \int_{q^*\rho}^{\infty} (\tau_s + \tau_b)G(q^*\rho - \theta)h(\theta)d\theta + \int_{q^*\sigma}^{\infty} Rh(\theta)d\theta + \int_{q^*\rho}^{\infty} Rh(\theta)d\theta$$

and note that the difference between the two expressions converges to $\int_{q^*\rho}^{\infty} (\tau_s + \tau_b)G(q^*\rho - \theta)h(\theta)d\theta$ as ε diminishes, given the continuity of all functions involved. However, this expression does not converge towards zero, it expresses the cost of handling all the claims where the buyer perceives the good to be defective in the second period although they are not. As long as such mistakes occur, there will be a benefit to cutting off claims, since the incentive effect of allowing claims becomes increasingly small as ρ diminishes. *QED*.

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