A Rationale for the Limitation Period in Sales Law*

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Abstract

The duration of a buyer's claim for remedies is a frequent source of negotiations in private contracts, and is a contested contract law issue. Disagreement concerns even the basic issue as to whether a rationale exists at all for cutting off the buyer's claim some time after purchase. The present article argues that a rationale can be given for cutting of the buyer's claim, and sets forth the factors determining the optimal duration of the buyer's claim (the optimal limitation period). The basic trade-off is based on two factors: the physical deterioration of (physical) goods and the cost of investigating the nature of a dysfunction. Physical deterioration means that the number of dysfunctions that are due to defects falls from some point in time onwards. This implies that the effect of allowing claims on the seller's incentive to deliver high quality goods declines over time, while the cost of investigations (and other costs of claims) will not fall to the same degree. This trade-off is argued to be the essential one for physical goods, rather than the trade-offs often argued to be decisive, such as those involving deteriorating evidence, risk considerations or the desirability of allowing sellers to 'close their books´.

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1. Introduction

In most countries, sales law limits the time period during which the buyer can claim a remedy in case of a defective good. After the expiration of the limitation (or prescription) period, the buyer cannot raise a claim against the seller, unless the seller has offered a warranty of longer duration.[1] The statute of limitation in sales law is the subject of longstanding political controversy; opponents argue that cutting off claims is unfair to the buyer and lowers the seller's incentives to deliver non-defective goods. Moreover, they emphasize that there is no compelling rationale for cutting off claims due to the mere passage of time, leading to their conclusion that 'abolishing or at least extending the default) limitation period is long overdue'.[2]

The aim of the present paper is to argue that there exists an economic efficiency rationale for the limitation period in sales law, and to establish the main factors that, according to this rationale, determine the optimal length of the period. Moreover, the paper will address the policy issue[3] whether a shorter limitation period should apply to the sale of used goods than to the sale of newly produced goods.

As indicated, the basic question can be phrased in terms of why the mere passage of time (after delivery of the good to the buyer) should be relevant for the enforceability (validity) of the buyer's claim. Two main answers have been provided in the law and economics literature, neither of which, however, applies with full force in the context of sales law. One answer holds that evidence and memory deteriorate over time, causing higher administrative cost and more errors in settlement or adjudication as time passes.[4]Consequently, allowing claims may not be worthwhile from some point in time onwards.

[1]The law generally specifies both a default period and a mandatory, minimum period. The former applies to both interfirm and consumer sales. The latter generally applies to consumer sales only, and ensures that the consumer has a minimum period during which she can make a claim. There is also a distinction between the socalled relative and absolute limitation period where the relative refers to the time allowed for the buyer to make a claim after discovering a defect. This paper concerns only the absolute limitation period.

[2]Commitee report 1403/2001 (Betænkning 1403/2001), p. 146. For a similar view, see the Norwegian committe report NOU 1993:27, the Danish reports 1133/1988 (on services) and the Swedish report SOU 1995:11. The latter advocated a default period of five years.

[3]In the European setting, the EU directive 99/1944 allows for a shorter period than two years for used goods, but some countries (including that of the present author) have controversially chosen not to do so.

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

However, in sales law, the relevant evidence predominantly concerns the state of the good at the time of the dysfunction.[5]The other answer to the fundamental question of why the age of the claim should be relevant[6] holds that cutting off claims serves to provide buyers with an incentive to use goods carefully. However, sales law requires the buyer to prove that the good was defective at the time of purchase,[7] in contrast to what is typically the case for warranties[8]. Hence, if a dysfunction arises due to carelessness on the part of the buyer, the burden of proof already cuts off the claim.[9] Therefore, buyer moral hazard also does not provide a compelling rationale for the limitation period.[10]

The rationale suggested in this paper is based on the notion that the trade-off between the incentive effect and the administrative cost of allowing claims changes over time due to wear and tear. Declining durability over time due to wear and tear implies that the incentive effect of allowing claims is likely to decline from some point in time onwards. For it is less imminent to prevent a dysfunction that occurs two, three or four years after delivery than one that occurs shortly after. Put differently, a good that dysfunctions shortly after purchase is defective by a wide margin, while a good that breaks down several years after purchase is more nearly of adequate durability, and it is hence relatively more important to prevent the former (early) breakdown than the latter. By contrast, the costs for the parties (and for the legal system) of handling claims may remain significant over time. These costs are mainly that for the buyer of raising a claim, the cost for the seller

[5]Note, however, that a good is defined as 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. Moreover, there can of course be information concerning the state of the good at the time of purchase that vanishes over time. The claim is that this is not sufficiently typical to provide a convincing rationale for the limitation period.

[6]This theory is reviewed below.

[7]Although for the first six month, the burden of proof is on the seller (according to the rule in several European countries).

[8]See e.g. Cooper and John [3], Dybvig and Lutz [4], reviewed below.

[9]Naturally, mistakes in settlement and adjudication do occur, which leaves room for buyer moral hazard, but it is not clear that mistakes are so common as to induce significant moral hazard on the part of buyers.

[10]Also, the idea that the limitation period economizes on the need for the seller to keep records does not appear essential, as records concerning the purchase are typically not of paramount importance in disputes over defective goods (and it is the buyer who must keep the proof of purchase).

of responding to it, the potential cost for both of them of arguing over the claim, and in some cases the cost of investigating the validity of the claim, either through physical inspection of the good and/or through third party adjudication. These costs are incurred in part due to asymmetric information and in part due to conflicting beliefs about when a dysfunction can be considered a defect (such conflicting beliefs can to some extent be explained by asymmetric information but biased perception can also play a role). It will be argued that the costs of conflict resolution are likely to remain significant over time. For example, when buyers sometimes make mistakes in assessing the cause of a dysfunction, or (importantly) in assessing what legally counts as a defect, and the number of dysfunctions increases over time due to wear and tear (and wrong usage), there is likely to be a non-negligible cost of handling invalid claims as time passes. Hence, even if only a small fraction of dysfunctions leads to claims, the cost is likely to be significant due to the increasing number of dysfunctions.

The case of asymmetric information will be analyzed first, and the model will then be extended to include unwarranted claims.

The remainder of the article is organized as follows. Section 2 reviews the literature on limitation periods. Section 3 presents the model and its extension, while Section 4 discusses whether the rationale suggests a shorter limitation period for used (than for newly produced) goods; the EU-directive (99/44/EF) allows the period to be no shorter than one year. Section 5 presents empirical data bearing on the suggested rationale, while Section 6 discusses critical assumptions of the analysis. Section 7 concludes.

2. The Literature

Statutes of limitations have received scant attention in the law and economics literature. In the context of sales, the focus has been on the rationale of the limited duration of *warranties* (e.g. Dybvig and Lutz [4], Cooper and Ross [3], and Emons [6]). Dybvig and Lutz as well as Cooper and Ross argue that as time passes, dysfunctions become more likely to be caused by wrong usage, and less likely to be caused by errors of production. Cutting off claims at some point then provides the best achievable (second-best) combination of buyer and seller incentives. Emons [6] explains the limited duration of warranties in terms of the producer's attempt to screen low-intensity users from high-intensity users.

Neither of these theories, however, applies directly to the case of sales law,

where the buyer bears the burden of proof of negligence (and of causation),[11] and where wrong usage by the buyer, therefore, tends to cut off the buyer's claim. Still, since the burden of proof is a matter of degree, and cannot be administered without error, buyer moral hazard may well be part of the rationale for the limitation period, as will be discussed below.

In the only existing formalized analysis of limitation periods, Miceli [14] derives optimal statutes of limitations and statutes of repose[12]in the area of product liability,[13] based on a trade-off between incentives and administrative costs. Longer duration increases the seller's incentive to exercise care, but also increases the number of claims and hence the administrative costs incurred. On the critical question as to why the age of the claim is relevant to the trade-off between incentives and administrative costs, 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 on 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.[14] However, discounting future litigation costs is a more salient issue in product liability (than in sales law), since in the case of product liability 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 the use of a harmful drug), wheras in sales law limitation periods tend to be one, two or three years. Intuitively, the effect of discounting on future litigation costs therefore does not seem to provide a rationale for the limitation period in sales law.

Landes and Posner [10] 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 fresher and more evidence is available. When error is more likely, litigation costs are harder to justify by their effect on deterrence. This explanation may account for the ubiquitousness of limitation periods in law (since many kinds

[11] with the exception, in some jurisdictions, of an initial period after purchase.

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

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

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

of evidence deteriorate over time), but suffers from two drawbacks in the context of sales law. First, an alternative is to raise the standard of proof for old claims; this might cut off dubious claims while allowing claims that clearly are valid. However, as discussed below, this may not be a realistic alternative. Second, as already mentioned, 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 th buyer's reasonable expectations, a question that can often be answered through investigation of the good's current state. Naturally, the probability that one will attach to the possibility that the good was defective at the time of purchase is likely in many instances to decrease with the time during which the good has not suffered a dysfunction, but this is not an instance of deteriorating evidence but of updating of beliefs.

Palfrey and Romer [**?**] analyze the effect of alternative dispute resolution mechanisms in the context of sales law. They assume that both buyers and sellers may make mistakes concerning the durability of the good, calling for dispute resolution. Relevant to the current context, they show that a costless, precise and unbiased dispute resolution mechanism may lower efficiency compared to a costly and imprecise mechanism, since the buyer may be more likely to raise claims in the first place when a costless and precise dispute resolution mechanism is available to handle the buyer's appeal against the seller's possible rejection of the claim. When the buyer raises claims, she confers a cost also on the seller, who must inspect the good (which the seller does, by assumption, whenever there is disagreement). This externality is at the root of their main result which can be stated in the present context to be that when the parties may make errors in judging the validity of a claim, and claims are costly to handle, it may be better to cut off claims entirely[15]. This result is well established in the theory of litigation (see e.g. Shavell [16]), but does not provide an answer to the fundamental question of the present paper as to why time passed since purchase should be a criterion for cutting off claims.

Finally, various other rationales have been offered in the legal literature. For example, it has been suggested by Martin [13], that cutting off claims allows businesses (and consumers) to 'close their books', i.e. to dispose of

[15]Their result that cutting off claims (the absence of a dispute resolution mechanism and a no warranty equilibrium) may be preferable to a situation where claims are raised hinges on their assumption that quality of the good is exogenous and on their assumption that claims are welfare-enhancing to the extent that claims allow two rather than one person to inspect the quality of the good.

old files. Again, however, this concern does not seem salient in the area of sales contracts, where specific details about the product typically are not needed to assess a dysfunction, and the buyer must keep proof of purchase. Moreover, it has 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 a lower cost. The seller may be a large firm while the buyer may be a consumer or a small firm averse to risk. Thus, á priori it seems difficult to account for limitation periods on the basis of a concern for the allocation of risk.

3. Two models of a changing trade-off between incentives and administrative costs

3.1. A model of asymmetric information

In short overview, the model is the following. After exercising either high or low effort in securing the durability of the good, the seller sets a price of the good. The buyer can neither observe the seller's effort nor the durability (quality) of the good, but takes into account the existence of a remedy in one or both periods, as well as the seller's incentive to exercise effort, when accepting or rejecting the offer. If the buyer accepts the offer, she uses the goods for two periods. If the good turns out to be dysfunctional in one of the two periods, the buyer observes the state of nature in which it breaks down and can infer whether the good was defective (too frail). The seller, on the other hand, cannot observe the state, and may not trust the buyer. If the seller inspects the good, he can become informed about the durability (frailty) of the good, but only after incurring an inspection cost (which is paid by the party who turns out to be wrong). The parties may attempt to avoid this cost by agreeing to a sharing of the repair cost. However, since they are asymmetrically informed, they may not end up in agreement, but may choose to incur the cost of inspection. The two periods differ in terms of the states in which the good becomes dysfunctional. Thus, due to wear and tear, the good becomes dysfunctional in more states in period two than in period one. In this setting, it can be shown that the cost of inspection will at one point outweigh the incentive effect of allowing claims such that it will at one point be socially optimal to cut off claims.

The model can be described in more detail as follows. The seller's production process is stochastic, i.e. not entirely controllable. He may exercise either low ($e = 0$) or high effort ($e = 1$) in securing the durability of the good, and if effort is high, the probability that the good will be of low durability

(a 'lemon', L rather than a high durability good, H) is ϕ, while if effort is low, the probability is assumed to equal one. The cost to the seller of exercising effort is C.For simplicity, a lemon yields the same utility in use as a non-lemon (when it is not dysfunctional), namely u per period.

After exercising either high or low effort, the seller sets a price p. The buyer can neither observe e, nor the level of durability, and so must accept or reject the offer, as a function of p only. This response function $f(p)$ takes the values of 0 (reject) or 1 (accept). The cost of production is not incurred when the buyer rejects the offer.[16]If a good breaks down, the buyer will observe the state of nature, θ, while the seller will not. The buyer then presents the good to the seller to have the good repaired. The seller does not know the state of nature but can observe the durability of the good (or equivalently, the state of nature) at a cost of inspection I. To introduce the possibility of Coasian bargaining (that may avoid the cost of inspection), the seller can make an offer to pay the share υ of the repair cost, $0 \leq \nu(e,p,t) \leq 1$, $t = 1, 2$. For short, denote the function $\nu(e,t)$.[17] If the buyer accepts, there will be no inspection (the parties will share the repair cost as suggested by the seller), while if the buyer declines, the seller will offer a contract to the buyer according to which the seller inspects the good, and the buyer pays for the inspection (and the repair) if the good turns out not to have been defective (while if the inspection shows that the good was defective, the seller pays for these expenses).[18]

The buyer then either accepts or rejects the seller's sharing proposal. This decision is termed $\lambda_t(p, \nu(t), \theta)$, abbreviated $\lambda_t(\nu(t), \theta)$ where $\lambda_t(\nu(t), \theta)$ is either 1 (acceptance) or 0 (rejection). For simplicity, when the good has been repaired in the first period, it will not become defective in the first period again, and as far as durability in the second period is concerned, after repair the good is a lemon with probability ϕ, as it would be if the seller had chosen $e = 1$.[19]

To formulate the idea that a good may be subject to more or less strain,

[16]This is an assumption also made by Dybvig and Lutz [**?**].

[17]As a formality, this is the strategy also when $f = 0$ (the same applies to the other strategies that are chosen after the buyer's acceptance or rejection of the price).

[18]How the system works in practice differs (in Denmark). For example, some sellers pay for the investigation regardless of the result, for reasons discussed below.

[19]This means that incentives to repair well are not studied here. It is assumed, of course, that it is not part of the optimal outcome for the seller to produce low quality and then repair.

states of nature will be indexed by the strain they impose on the product; a higher state signifies greater strain. Thus, the state space is the interval $\Theta = \left[\underline{\theta}, \overline{\theta}\right]$ in both periods, and the durability or endurance of the good is indexed by the critical state it can withstand; if the state (the strain) is higher than the critical state (strain), the good will dysfunction. When the level of durability is high (H), the good will be functional in the interval $[\underline{\theta}, \sigma_H]$ in period 1,where $\sigma_H \leq \overline{\theta}$. On the other hand, the good will need repair in the interval $\left[\sigma_H, \overline{\theta}\right]$ in period 1. Wear and tear (decay) can then be introduced by assuming that the good will be functional in the interval $[\underline{\theta}, \rho_H]$ in period 2, and dysfunctional in the interval $\left[\rho_H, \overline{\theta}\right]$, where $\rho_H < \sigma_H$. The states can be thought of as either acts of nature or as different intensities of use (or abuse), but the buyer's incentive will be de-emphasised in the model in order to keep the model tractable. The role of buyer moral hazard will be taken up in the general discussion at the end.

When the good is of low durability (L), the corresponding variables are σ_L and ρ_L, where $\sigma_L < \sigma_H$ and $\rho_L < \rho_H$.For simplicity, the density function of states (strains) in both periods will be $h(\theta)$. To exclude uninteresting complications, h is assumed to be upper bounded.

Thus, when durability is H, the probability of dysfunction will be $\int_{\sigma_H}^{\overline{\theta}} h(\theta)d\theta$ in the first period, and $\int_{\rho_H}^{\overline{\theta}} h(\theta)d\theta$ in the second period, since dysfunction will occur in states higher than σ_H in the first period and in states higher than ρ_H in the second period.

It will be assumed to be efficient that the seller exercises high effort[20], and the judge will hence find the good defective if the good is found to be of type L rather than of type H.[21]

Repair rather than replacement (or reduction in price or cancellation of the purchase) will furthermore be assumed to be optimal when a good fails.[22] Thus, if the product becomes dysfunctional in a state $\theta_1 < \sigma_H$ in the first period, the product is defective (for it should only become dysfunctional in higher states where the strain is greater), and the buyer can then require

[20] The expression for when this is the case is omitted since it plays no role in the following.

[21] The assumption is that the judge cannot observe effort but only quality and that the rule is strict liability for defective goods.

[22] This assumption might of course be unrealistic, especially near the end of the life time of the product. However, the cost of investigation might be incurred regardless of the remedy, and for this reason whether one or the other remedy will be effectual will not affect the substance of the analysis, which lies in the trade-off between investigation costs and incentives for producing quality.

that the seller pays for the repair. On the other hand, if the good becomes dysfunctional in a state $\theta_1 > \sigma_H$, the buyer does not have a legal claim on the seller, but must pay for the repair herself, at a cost of R.[23]

3.1.1 Characterizing the equilibrium

Denote by $\Theta^t_{breakdown}(e)$ the states of nature in which the good breaks down in period $t = 1, 2$ and by $E^t_s(e)$ and $E^t_b(e)$ the expected cost of repair and inspection to the seller and the buyer, respectively, conditional on inspection being undertaken in period $t = 1, 2$. The seller's pay-off can then be expressed as:

$$\begin{aligned} EU_s &= f(p)(eC + \sum_{t=1}^{t=2} \int_{\Theta^t_{breakdown}(e)} \lambda(\nu(t), \theta)((1 - \nu(t))R + \\ &\quad (1 - \lambda(\nu(t), \theta))E^t_s(e)h(\theta)d\theta \end{aligned}$$

while the buyer's expected pay-off is:

$$\begin{aligned} EU_b &= f(p)(2u - p - \sum_{t=1}^{t=2} \int_{\Theta^t_{breakdown}(e)} \lambda_t(\nu(t), \theta)\nu R + \\ &\quad (1 - \lambda_t(\nu(t), \theta))E^t_b(e)h(\theta)d\theta \end{aligned}$$

An equilibrium is a strategy by the seller: $(e^*, p^*, \nu^*(e^*, t))$ and a strategy by the buyer $(f^*(p), \lambda^*_t(\nu(t), \theta))$, where neither can increase their expected utility by deviating from these strategies. When observing (or not observing) a dysfunction or breakdown, both update the probability that the good is a lemon using Bayesian updating. Note that the seller's type is known to the buyer, so it is a game of complete information.

To solve the game, it is useful to start from the end-nodes of the game. Thus, the equilibrium response function $\lambda^*_t(\nu(t), \theta)$ maximizes the buyer's expected utility given the state θ,the probability which the buyer attaches to

[23]Note 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 that cannot be distinguished from a defect. However, the suggested rationale would only be strengthened by this extension.

the durability being L or H, and $v^*(t).\nu^*(t)$ maximizes the seller's expected utility given the equilibrium response function $\lambda_t^*(\nu(t),\theta)$, as in a Stackelberg equilibrium. Finally, the equilibrium response function $f^*(p)$ maximizes EU_b given the response functions $\nu^*(t)$ and $\lambda_t^*(\nu(t),\theta)$.

The derivation of $\lambda_t^*(\nu(t),\theta)$ is much simplified by the following consideration. Consider the first period and assume that the good has turned dysfucntional. If the state $\theta \in [\sigma_L;\sigma_H]$, the buyer will not accept any share of the cost of repair, since the good must have been of low durability. On the other hand, if $\theta \in \left[\sigma_H;\overline{\theta}\right]$, the good might or might not be of high durability, but regardless of its durability, when the state is revealed, it will become clear that the legal requirement of causality is not fulfilled: the good would have broken down regardless of its durability in which case the costs of repair and inspection must be born by the buyer. So, either any share will be rejected or any share will be accepted by the buyer. The choice for the seller is therefore to either offer to pay for the repair:$v = 0$ or to offer nothing, $v = 1$. The seller's strategy depends on whether $e = 0$ or $e = 1$.If $e = 1$,the seller must calculate the probability that the good is of low durability, given that it breaks down in period 1. Thus, denote the event that the good is a lemon by L and the event that $\theta \in [\sigma_L;\sigma_H]$ by D. Denote by A the event that the seller is liable for repair and inspection, i.e. $L' \cap D$.Then the probability of seller liability in period 1 is $p_1(A) = \phi \int_{\sigma_L}^{\sigma_H} h(\theta)d\theta$, since the two events are independent. By the formula for Bayesian updating,

$$p_1(A \mid breakdown) = \frac{p_1(breakdown \mid A)p_1(A)}{p_1(breakdown)}$$

So, $p_1(A \mid breakdown) = \frac{\phi \int_{\sigma_L}^{\sigma_H} h(\theta)d\theta}{\phi \int_{\sigma_L}^{\overline{\theta}} h(\theta)d\theta + (1-\phi)\int_{\sigma_H}^{\overline{\theta}} h(\theta)d\theta}$With this notation, the seller will choose $v = 1$ if

$$p_1(A \mid breakdown)(I + R) < (1 - p_1(A \mid breakdown))R$$

If the seller has chosen $e = 0$, he knows the good to be of low durability. The probability that he will be liable if the good breaks down and the cause is inspected, is then (setting $\phi = 1$):

$$\frac{\int_{\sigma_L}^{\sigma_H} h(\theta)d\theta}{\int_{\sigma_L}^{\overline{\theta}} h(\theta)d\theta}$$

He will then offer to pay for the repair if

$$\frac{\int_{\sigma_L}^{\sigma_H} h(\theta)d\theta}{\int_{\sigma_L}^{\overline{\theta}} h(\theta)d\theta}(I+R) > (1-\frac{\int_{\sigma_L}^{\sigma_H} h(\theta)d\theta}{\int_{\sigma_L}^{\overline{\theta}} h(\theta)d\theta})R$$

In the second period, probabilities must be conditioned on the occurrence (or non-occurrence) of a breakdown in period 1. If the good did break down in period 1, it will have been repaired, and by assumption the probability of it being a lemon is then ϕ, as in the first period. If the good did not break down in period 1, the conditional probability that the good is a lemon is no longer ϕ but lower than ϕ. It is calculated in Appendix A. Denote it by $\phi^{'}$.The formula above for when the seller will offer to pay for the repair in period 1 then carries over to period 2, with $\phi^{'}$ substituting for ϕ when the good did not break down (and of course ρ substituting for σ).Thus, if B is the joint event that $\theta \in [\rho_L; \rho_H]$ and L (the good is a lemon), the probability that the buyer has a valid claim when the good breaks down in period 2 (but did not break down in period 1) can be written:

$$p_2(B \mid \text{ breakdown}) = \frac{\phi^{'} \int_{\rho_L}^{\rho_H} h(\theta)d\theta}{\phi^{'} \int_{\rho_L}^{\overline{\theta}} h(\theta)d\theta + (1-\phi^{'}) \int_{\rho_H}^{\overline{\theta}} h(\theta)d\theta}$$

and the seller will offer to pay for repair when $p_2(B \mid breakdown)(I+R) > (1-p_2(B \mid breakdown))R$

To analyse whether claims should be cut off at some point, the passage of time can be captured by the size of ρ_H (and ρ_L), in the sense that when the first period is thought of as of long duration, the states in which the good will function in the second period will be few, meaning that ρ_H (and ρ_L) will be low.

The main proposition can now be stated.

Proposition:
When ρ_H is sufficiently small, it minimizes total costs to cut off claims in the second period.

Proof: See Appendix B.

The intuition is that allowing claims will at some point in time no longer affect the seller's incentive constraint, since even if the seller produces low

durability, *causality* can rarely be proven in the second period[24] when dysfunctionality will occur in many states regardless of durability. On the other hand, given that production errors occur even when the seller exercises high effort, the buyer will continue to raise valid claims, and these will lead to inspection costs as the seller will not offer to pay for repair of the many dysfunctional goods, most of which are not defective.

Note that when total cost is minimized, it is advantageous to both parties from an ex-ante perspective to cut off claims, as follows from Coasean logic and as shown in a different, but closely related context by Eide [5].

3.2. An extension of the model including unwarranted claims

In the model above, inspection costs were incurred only for warranted claims. However, buyers do of course sometimes raise unwarranted claims that may have to be incurred. The determination of what constitutes a non-performing good often involves difficult assessments both concerning what caused the dysfunction and concerning what legally counts as a defective product. Concerning the cause, factors unknown to the buyer can sometimes affect the functionality of a good. This is apparent e.g. in case of electronic products such as a computers, where electric currents (e.g. from lightning but also from other electronic equipment or gadgets) can interfere with the functionality of the good without the buying being aware of it. Or downloads from unsafe sources may affect functionality, without the buyer noticing. Concerning what is legally a defective good, the assessment is often uncertain, as stressed by Palfrey and Romer [**?**] (p. 99). Most buyers will e.g. be unaware of the legal practice of the dispute resolution board to which the case may ultimately or penultimately be appealed, and may perhaps also be biased in their view of what should ´fairly´ be viewed as a defect.

To put these possibilities of error in terms of the model, the buyer may err concerning the state of nature, θ, and/or concerning the strain which the good should be able to withstand. For simplicity, it can be assumed that the buyer only errs concerning the state of nature. If the buyer estimates the state of nature to be $\widetilde{\theta}$ and the required durability in the second period to be ρ_H, and if it is assumed, for simplicity, that the buyer's errors are of the self-serving kind, the total error can be expressed in terms of how much $\widetilde{\theta}$ differs from θ. Denote this total error by x and assume that its density function is $g(x)$ on some interval $(0, \zeta)$, where it is understood that ζ is not

[24] I.e.it cannot be proven that what caused the dysfunction was the defect, since the dysfunction would have occurred even without the defect.

so high as to make the error incompatible with the size of the interval $(\underline{\theta},\overline{\theta})$. Let $G(x)$ denote the corresponding distribution function. Assume, as Palfrey and Romer implicitly do in their paper reviewed above [**?**], that the buyer holds an incorrect belief with subjective certainty, i.e. the buyer does not consider how likely it is that she is mistaken. If the buyer is aware of the fact that she may be wrong, as seems likely to be the case, she will naturally raise fewer unwarranted claims. This will complicate the analysis but will not add much as long as the buyer will raise claims when the evidence is sufficient for her to believe that the good must be defective. Then, assuming the same set-up as in the model above, the buyer will, if the seller does not offer to pay for repair, insist on an inspection not only when the good is a lemon but also when it is of high durability but the buyer is convinced that it cannot have been. When the good is of high durability, H, an unwarranted claim arises in the second period in a state $\theta > \rho_H$, when the error is greater than $\theta - \rho_H$. This occurs with probability $1 - G(\theta - \rho_H)$.The probability of an unwarranted inspection then becomes:

$$(1-\phi)\int_{\rho_H}^{\overline{\theta}}(1-G(\theta-\rho_H))h(\theta)d\theta$$

The incentive for the seller to offer to pay for the repair is the same as in the model above, since what determines this probability is the likelihood that the good is defective, not whether the buyer will demand an inspection of a good that is not defective (as by assumption, the buyer will pay for such inspections). Thus, the difference as compared with the model above is that the transaction costs saved by cutting off claims in the second period will be not only $\phi I\int_{\rho_L}^{\rho_H}h(\theta)d\theta$ but also $(1-\phi)I\int_{\rho_H}^{\overline{\theta}}(1-G(\theta-\rho_H))h(\theta)d\theta$. The important point is that while $\phi I\int_{\rho_L}^{\rho_H}h(\theta)d\theta$ converges to zero as ρ_H goes toward zero, this is not the case for $(1-\phi)I\int_{\rho_H}^{\overline{\theta}}(1-G(\theta-\rho_H))h(\theta)d\theta$. When a good breaks down in a state θ above ρ_H, the probability that the buyer considers the

good to be defective will be $(1 - G(\theta - \rho_H))$ which might be significant and which will not converge to zero. Hence, the rationale for cutting off claims is considerably strengthened by buyer misperception and the existence of unwarranted claims.

buyer mistakes.

4. Application to markets for used goods

As mentioned, the model throws light on the advisability of differentiating between new and used goods, something which the EU-directive 99/44/EF allows member states to do. However, in the Danish context, the commission of experts that advised the Parliament on the implementation of the EU-directive was opposed to differentiation,[25] arguing that a buyer of a used good does not have a claim in the first place, unless the dysfunction is one that could not reasonably have been expected. This requirement will negate most claims, the commission argued, and for this reason it expected the market for used goods also to function efficiently without differentiation.

However, the present models casts the issue in a different light. To apply the models to the market for used goods, the incentive effect of allowing claims must be reformulated as the effect on truthful disclosure on the part of the seller of the durability of the good. The model then points to the following consideration. For used goods it will often be the case that ρ_H is low; the good will naturally break down even if not a lemon. According to Proposition 1, this implies that the seller is unlikely to offer to repair at own expense, and that a deadweight inspection cost will be incurred. Moreover, there might well be dysfunctions that the seller has not detected but which nevertheless will be considered a defect. Thus, in the political hearings preceding the implementation of the directive, the Danish Automobile Association expressed the difficulty for sellers of *predicting dysfunctions* (Moegelvang and Lando, [12], p. 16). This translates into a high ϕ of the model, which implies a high deadweight cost $\phi I \int_{\rho_L}^{\rho_H} h(\theta)d\theta$.Indeed, if most of the dysfunctions that the seller might predict will materialize within a relatively short period after sale, the present analysis suggests the optimality of a short limitation period for used cars. Moreover, when uncertainty is pervasive concerning what

[25]In its report (betænkning) 1403/2001, p. 149, the commision stated that: ´the existing definition of what constitutes a defective good is sufficiently flexible to be able to accommodate the specific circumstances of such sales´.

constitutes non-performance, the cost of wrongful inspections (and of negotiations) is likely to be high, pointing towards a shorter limitation period for used goods.

The argument just made in favor of differentiating for used goods naturally generalizes to goods of shorter durability. However, the distinction between used and new goods may be easier to administer, although it is worth noting the Norwegian rule that sets the general limitation period at two years but which also stipulates that if the good should, by normal use, last longer, the period is extended to five years (Commision report (Betænkning) 1403/2001, p. 143)[**?**].

5. Empirical evidence

The implementation in Denmark of the EU Directive 1999/44/EC, which took effect at the beginning of 2002, extended the two limitation periods, both the default period and the minimum limitation period for consumer sales, from one to two years. This provided an opportunity to measure the importance of the minimum limitation period.

In 2003, as the effect of the new law began to show in its second year, a survey was conducted (see [12]) 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, we obtained statistics 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 extension of the limitation period.

The data concern the effect on retailers' quality selection of goods and the effect on the number of claims and overall administrative costs.

5.1. Evidence Concerning the Impact on Incentives

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

Have you, on the basis of the parameter in question 5a or 5b, 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

Question 5a referred to in the question concerned whether customers bring claims more frequently than before whereas question 5b concerned the extension of the limitation period.

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 other caveat should 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. 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 plays a very 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 indeed played an important role[26].

5.2. Empirical Findings Concerning Administrative Costs

[26]It should be added that some retailers may also been 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 (2006)).

The survey question asked 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.

Apart from the survey data, 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 deadline. The data covered audio-visual products such as DVD's, videos, disc-men, videocameras, and radio and television. , and is graphically depicted in Møgelvang-Hansen and Lando (2006). For present purposes, the overall conclusion is that 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 law[27]?

	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% responded 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 suggested rationale.

One caveat, however, must be mentioned. Part of the increase in the number of unwarranted claims as perceived by retailers[28] may have been due to the presumption rule, which for the first six months puts the burden of proof on the seller. While claims raised under the presumption rule may have been legally warranted, retailers may have considered them unwarranted.

[27] 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.

[28] Our impression was that the retailers were generally trustworthy in their answers to our survey questions. For example, many reported that the new law had not affected their costs. But of course their answers are subjective.

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

6. Discussion

This section discusses some of the assumptions of the model and some aspects of reality that the model does not cover.

First, buyer moral hazard has been downplayed in the model, not because it is not important but for analytical tractability. However, it should be stressed, along the lines of the warranty literature reviewed above, 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. In conclusion, buyer moral hazard may constitute a further rationale for statutes of limitation in sales which complements the rationale based on conflict resolution costs (or administrative costs/transaction costs).

Second, 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 durability. However, this would not only be difficult to implement in practice, it would also not help within the first model, as only warranted claims are raised (assuming that strict liability for a defective good is not replaced by the negligence rule, which would be informationally difficult).

Third, how the legal regulation interacts with market forces such as warranties has not been touched upon in this article. To the extent that those goods that are supposed to last for many years are covered by warranties of longer duration (although, as noted by Emons [6], 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 also be shorter.

Fourth, the model does not capture well the difficulties that arise, when the remedies of consumer sales law, namely repair and replacement (i.e. specific performance) are given effect over a longer span of time. For example, when repair is very costly, as tends to be the case for certain complex or highly technological products, replacement becomes the only remedy. However, replacement is a costly remedy to the seller when long time has passed since purchase. For example, for some products, the life-cycle is short, due to

technological progress, and it can be costly for the seller to maintain a stock of technologically outdated products (and the seller is not always authorized to replace the old model with a new). When the seller cannot replace the old good, the buyer may void the sale and obtain a refund of the price; when the price of the product falls over time due to technological advances, this can enrich the buyer, which may not be part of an optimal scheme. Such complications speak in favor of a shorter limitation period, especially for certain categories of goods for which innovation occurs frequently. More generally, the extension of the buyer's claim cannot be seen in isolation from the whole set of remedies, and a trade-off may exist between giving the buyer strong protection and extending the buyer's remedies for a long time.

Fifth, the effort of the seller could have been modeled as a continouos variable, in which case the inspection and repair cost in the second period would continue to affect the seller's effort. Note, however, that in such a formulation, the seller's effort would be excessive in equilibrium, since it would pay for him to lower the probability of a dysfunction below the socially optimal level, in order to save on inspection costs. So while even for small ρ_H the effort would continue to be affected by the raising of claims, the effect would not be welfare enhancing. In earlier versions of the present paper (Lando [11]), the seller's choice was continuous, and similar results were obtained as in the present paper.

7. Conclusion

The present article has argued that allowing buyers to raise claims for remedies is likely to remain costly over time in terms of conflict resolution costs, while the negative effect on the seller's incentive to deliver durable goods is likely to decline in importance relative to the conflict resolution costs. And that it hence becomes optimal to cut off the buyer's claim at some point in time. Conflict resolution costs are incurred both because the buyer and the seller may be asymmetrically informed about what has caused a dysfunction, and because they may both make mistakes in their assessment of when a good is defective.

The empirical evidence indicated that an extension of the limitation period in Denmark (taking effect in 2002) from one to two years significantly increased the number of claims (though to a varying extent, depending on the category of goods), and also strenghened the incentive for the seller not to sell goods that are likely to lead to claims (in the second year). While the

evidence does not allow us to draw a conclusion as to the relative effect of these effects, the evidence appears consistent with the proposed rationale.

Appendix A

The conditional probability that the good is a lemon when there was no breakdown in the first period can be calculated by the formula for Bayesian updating:

$$prob(L \mid \text{no breakdown}) = \frac{prob(\text{no breakdown} \mid L) * prob(L)}{prob(\text{no breakdown})}$$

which implies that

$$prob(L \mid \text{no breakdown}) = \frac{\phi \int_{\underline{\theta}}^{\sigma_L} h(\theta)d\theta}{\phi \int_{\underline{\theta}}^{\sigma_L} h(\theta)d\theta + (1-\phi) \int_{\underline{\theta}}^{\sigma_H} h(\theta)d\theta}$$

Appendix B.

Consider an equilibrium in which the seller exercises high effort $e^* = 1$. (If the equilibrium is one of low effort, when claims are allowed in both periods, nothing is lost in terms of economic efficiency by cutting off claims in the second period). When ρ_H is sufficiently low, the equilibrium strategy cannot be for the seller to offer to repair at own cost, since $\phi' \int_{\rho_L}^{\rho_H} h(\theta)d\theta$ or $\phi \int_{\rho_L}^{\rho_H} h(\theta)d\theta$ can be made arbitrarily small by making ρ_H sufficiently low when $h(\theta)$ is bounded above. The latter assertion can be derived from the observation that when $h(\theta) < K$, where K is some constant, $\int_{\rho_L}^{\rho_H} h(\theta)d\theta < \int_{\underline{\theta}}^{\rho_H} Kd\theta = K(\rho_H - \underline{\theta})$ which converges to zero when ρ_H converges to $\underline{\theta}$.When the seller does not offer to repair at own cost in the second period, the buyer will not require an inspection when the good is not defective, but will require an inspection when the good is defective. Moreover, assume that in the first period, the seller does offer to pay for repair (this assumption is without loss

of generality; the result holds also if this is not optimal for the seller). These equilibrium strategies can be put in more formal terms: Thus, when ρ_H is sufficiently low, the equilibrium has $(e^* = 1, \nu^*(e^* = 1, t = 2) = 0, \nu^*(e^* = 1, t = 1) = 1)$, while p^* is set at a level to make the buyer indifferent between accepting and rejecting; $f^*(p) = 1$ and $\lambda_1^*(\nu(1), \theta) = 1$ and $\lambda_2^*(\nu(2), \theta) = 0$ when $\theta < \rho_H$, otherwise $\lambda_2^*(\nu(2), \theta) = 1)$. Thus, in the second period, the inspection cost, which constitute a deadweight loss, will amount to:

$$\phi \int_{\rho_L}^{\rho_H} Ih(\theta)d\theta$$

In this equilibrium, the seller's IC-constraint can be derived from the expected cost of exercising high or low care. If the seller exercises high effort, the expected cost is $C + (1-\phi)R\int_{\sigma_H}^{\overline{\theta}} h(\theta)d\theta + \phi R\int_{\sigma_L}^{\overline{\theta}} h(\theta)d\theta + \phi(R+I)\int_{\rho_L}^{\rho_H} h(\theta)d\theta$

while the expected cost of exercising low effort is:

$R\int_{\sigma_L}^{\overline{\theta}} h(\theta)d\theta + R\int_{\rho_L}^{\overline{\theta}} h(\theta)d\theta$ since investigation will not be undertaken when the seller knows that the good is a lemon. Thus, the IC constraint becomes:

$$C + (1-\phi)R\int_{\sigma_H}^{\overline{\theta}} h(\theta)d\theta + \phi R\int_{\sigma_L}^{\overline{\theta}} h(\theta)d\theta + \phi(R+I)\int_{\rho_L}^{\rho_H} h(\theta)d\theta < R\int_{\sigma_L}^{\overline{\theta}} h(\theta)d\theta + R\int_{\rho_L}^{\overline{\theta}} h(\theta)d\theta$$

The question is how strategies will change when claims are cut off after the first period. Naturally the strategies for the second period are simplified in that defects are simply repaired at the buyer's expense. When claims are cut off after the first period, the costs to the seller when exercising high effort are:

$$C + (1-\phi)R\int_{\sigma_H}^{\overline{\theta}} h(\theta)d\theta + \phi R\int_{\sigma_L}^{\overline{\theta}} h(\theta)d\theta$$

The costs to the seller when exercising low effort, in which case the good

will be a lemon with certainty, is $R\int_{\sigma_L}^{\overline{\theta}} h(\theta)d\theta$, since the seller will repair all goods that break down. The incentive constraint hence becomes: $C + (1 - \phi)R\int_{\sigma_H}^{\overline{\theta}} h(\theta)d\theta + \phi R\int_{\sigma_L}^{\overline{\theta}} h(\theta)d\theta < R\int_{\sigma_L}^{\overline{\theta}} h(\theta)d\theta$.

Now, the point is that when ρ_H is sufficiently small (and $h(\theta)$ is bounded above), the latter IC-condition will be fulfilled when the former is. Thus, note that the terms referring to the first period are the same in the two IC-conditions. The terms referring to the second period are $\phi(R+I)\int_{\rho_L}^{\rho_H} h(\theta)d\theta$ on the left hand side and $R\int_{\rho_L}^{\overline{\theta}} h(\theta)d\theta$ on the right hand side in the former IC constraint while there are no terms in the second IC constraint. When ρ_H is low, both of these terms are small, and both can be made arbitrarily small by letting ρ_H be sufficiently small. Hence, their difference can also be made arbitrarily small which means that when the former IC-condition is fulfilled (with strict inequality) for a sufficiently small ρ_H, so is the latter. When the incentive for the seller to exercise high effort is the same (whether or not claims are cut off in the second period), the remaining strategies will also be the same for both the buyer and the seller in the first period (while strategies simplify in the second period when the buyer has no claim for a remedy). This means that when ρ_H becomes this small, the only difference between the two equilibria is the deadweight loss of $\phi\int_{\rho_L}^{\rho_H} I * h(\theta)d\theta$, incurred in the second period.

QED.

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