

Eckardt, Martina

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Working Paper No. 23

The Evolution of the German Tort Law in the 19th Century
– An Economoc Analysis of the Evolution of Law

by

Martina Eckardt

Universität Rostock

Wirtschafts- und Sozialwissenschaftliche Fakultät

Institut für Volkswirtschaftslehre

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The Evolution of the German Tort Law in the 19th Century – An Economic Analysis of the Evolution of Law

Martina Eckardt*

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Abstract

Despite the advances in New Institutional Economics about the economic consequences of institutions and legal rules, up to now we have only limited knowledge about the mechanisms of the evolution of law. By combining the main ideas of Evolutionary Economics and New Institutional Economics this paper tries to contribute to our understanding of the process of institutional innovations. It is shown that the decisive factors that explain legal change are (1) the cognitive creativity of the actors and (2) wealth effects caused by negative technological externalities, which result from the use of new technologies. The main focus is on the evolution of the German tort law in the 19th century beginning with the introduction of the strict liability rule for railway accidents by the Prussian Railway Law in 1838. This was a complete break with the whole German tradition of tort law which was firmly based for centuries on the negligence rule. This case study shows how the co-evolution of technical and legal changes triggered off a trial-and-error-process of legal innovations and imitations that resulted in the present-day broad diffusion of the liability rule in the German tort law.

Keywords: Evolutionary Economics, New Institutional Economics, Economic Analysis of Law

JEL-classification: D72, K13, N43, O31

* Lehrstuhl für Volkswirtschaftslehre – Geld und Kredit, Universität Rostock, Parkstraße 6, D-18057 Rostock.

1. Introduction

The introduction of railways in the 19th century not only had a serious impact on the industrialization and on the evolution of the modern corporation but also on property rights' structures, at least in Germany. Eight days after the first Prussian railway line was opened in 1838 the *Preußisches Eisenbahngesetz* (Prussian Railway Law) was enacted. Among other things, it prescribed that railway accidents had to be treated by the courts according to the strict liability rule. This was a complete break with the whole German tradition of tort law which for centuries was firmly based on the negligence rule. From then to the present day the application of the strict liability rule has been extended to more and more fields by legal and court decisions. Besides the Prussian Railway Law, a decisive step in the evolution of the modern German liability law was the *Allgemeines Deutsches Handelsgesetzbuch* (General German Code of Commercial Law) in 1861. As it prohibited the exclusion of liability by contract it contained a serious restriction of the freedom of contract. These are the first of a series of further legal acts in the evolution of the modern German tort law which have led from the hitherto ubiquitous predominance of the negligence rule to a widespread use of the strict liability rule today.

In contrast to our sound knowledge about the economic consequences of single legal rules which we owe to the *Economic Analysis of Law* and the *New Institutional Economics*, up to now we know relatively little about the mechanisms of the legal changes.¹ No elaborated economic theory of the evolution of law yet exists, which one could apply to analyze the complex trial-and-error-process of legal innovations and imitations, despite important efforts in this area of research.² *New Institutional Economics* primarily considers the effects which institutions exert on the incentive structure of economic agents, with enormous success in the explanation of the role of institutions for economic outcomes (Eggertsson 1990). However, as it is based on the neoclassical paradigm, it is mainly concerned with the analysis and comparison of equilibrium states, and not with processes of innovation that always entail some novelty, thus making the concept of a given set of alternatives, from which the best one is chosen according to some objective function, improper.³ *Public Choice Theory* which analyzes the properties of different political structures and rules also has enormously contributed to our understanding of the incentives of political systems and thus on the outcomes of political processes (Mueller 1989; 1997). But it also remains within the neoclassical framework by assuming a given set of political alternatives from which the actors chose the best one according to their particular objective functions. It does not deal with the generation of novel, i.e.

¹ As the subject of the following is on the process of legal innovations and imitations we are not concerned with the economic incentives set by given legal rules. With regard to the efficiency aspects and distributional consequences of the negligence rule compared to the strict liability rule, see for example Cooter/Ulen (1995), Landes/Posner (1987), Posner (1992, 163ff.), Schäfer/Ott (1995, 127ff.).

² See for example De Alessi/Staaf (1991), Aranson (1992), Barzel (1989), Buchanan/Tollison/Tullock (1980), Coase (1960), Cooter/Ulen (1995), Demsetz (1967), Eggertsson (1990), Hayek (1973, 1976, 1979), Knight (1992), Libecap (1989), Mueller (1989), North (1981, 1990), Okruch (1999), Posner (1992), Richter/Furubotn (1996), Wangenheim (1996), Williamson (1985). For a comprehensive discussion of these different approaches see Eckardt (1998).

³ The neoclassical maximization rule, according to which the spending for new information or for innovatory activities are optimal if the marginal return equals the marginal costs, can only be applied under the assumption of a given and closed set of alternatives from which the best one can be chosen. If one integrates novelty, the maximization method can no longer be applied because we do not have a closed action space anymore (Hesse 1997, Witt 1993a).

hitherto unknown legal innovations. Finally, North/Thomas (1973) and North (1981; 1990) have made important contributions to an economic theory of institutional change by developing further the various approaches. However, also this conceptual framework cannot be used for the explanation of legal change caused by technological innovations, because it does not deal with such innovatory processes in detail, and because it does not contain a coherent evolutionary theory of institutional change. Therefore, the central approaches of the *New Institutional Economics* cannot be used where the generation of new institutions is explicitly considered. But they have given us important insights into the incentives that are exerted by different political, bureaucratic and organizational restrictions which will be used in the following.

This paper is intended to contribute to our understanding of the very complex mechanisms of legal evolution by combining the main ideas of *Evolutionary Economics* and *New Institutional Economics*. Although the focus will be on the coevolution of technical and legal changes, to simplify our analysis we examine only one direction of this interrelation. While we take technological changes as exogenous, we analyze the resulting incentives on changing the law. The starting point of our analysis is that the introduction of technical innovations always also causes new negative technological externalities⁴ which produce wealth reductions for some actors. As legal rules always refer only to already known problems and damage, the emergence of new negative externalities requires an innovative process of adapting the law so that the novel damaging activities are prohibited or compensations are paid for them.⁵ Obviously, as any political activity to change the law causes costs, a collective action of the negatively affected persons will only take place if the volume of wealth reduction is sufficiently high, relative to the costs of political action. In the following, we assume that the decisive factor that determines the opportunity costs of political activities is the rate of adoption of the new technology. As this changes over time, it also induces a change in the volume of negative externalities. Therefore, the opportunity costs of political action alter within the lifecycle of a technology. Thus, a trial-and-error process of legal innovations and imitations is triggered off in which wealth effects and cognitive aspects are the decisive factors.

To model this experimental process of legal change, we refer to some of the core ideas of *Evolutionary Economics*. Although up to now no theory comparable to the neoclassical paradigm exists, *Evolutionary Economics* offers some promising building blocks for our problem as it is concerned with processes of economic change, in which the generation and diffusion of innovations are treated, at least partially, as endogenous, and are not assumed to be completely exogenous (Nelson 1995). *Evolutionary Economics* was developed mainly with regard to the study of technical evolution and its impact on economic change.⁶ One important step to study the impact of technical innovations on the economy was the development of the life cycle theory. Based on Schumpeter's ideas (Schumpeter 1928, 1939) Heuss (1965) has presented a comprehensive theory of the market cycle, which tries to integrate both processes of technical as well as economic change. Berg (1995) has further extended this concept to comprehend rent-seeking activities in dependence on the stage of the market cycle. But whereas

⁴ In the following, we always refer to negative technological externalities if it is not stated otherwise.

⁵ As we are concerned only with processes of statutory innovations in this paper, we do not consider legal innovations by court decisions. But of course, a comprehensive economic theory of the evolution of law has to contain this mechanism for the generation of legal innovations as well. See De Alessi/Staaf (1991), Aranson (1992), Cooter/Ulen (1995), Hayek (1973), Okruch (1999), Posner (1992), Wangenheim (1996).

⁶ See for example Andersen (1994), Coombs/Saviotti/Walsh (1987), Dosi et.al. (1988), Freeman (1974), Magnusson (1994), Metcalfe/Saviotti (1991), Mokyr (1990), Nelson/Winter (1982), Rosenberg (1976, 1982, 1994), Saviotti (1996), Silverberg/Dosi/Orsenigo (1988), Witt (1993b).

he treats only technical changes in an evolutionary way, we try to apply this line of reasoning also to statutory innovations by modeling their emergence as a trial-and-error-process. Reacting to new problems, which result from the use of new technologies, the different actors (the government, political parties, interest groups and individuals) start to experiment with new legal rules. If these are judged as useful devices they are positively selected; otherwise, modifications are carried out to eliminate their shortcomings, thus creating path-dependencies.

In Section 2 the main elements of such an economic theory of legal evolution are introduced. The usefulness of such an approach will then be illustrated in Section 3 by its application to the above mentioned innovations of the German liability law in the 19th century.

2. The Basic Elements of an Economic Theory of Legal Evolution

In recent years, *Evolutionary Economics* has made a lot of efforts to deal with innovations without assuming them as exogenously given (Hodgson 1993; Nelson 1995; Witt 1992). One promising way seems to follow the analogy drawn from evolutionary biology by using a variation-selection-approach (Nelson 1995, 54ff.), but without overstressing it, as we are dealing with human beings as the central actors. Social, not biological factors are therefore decisive for our reasoning. By describing the variation mechanisms we can study how new economic products, technical devices or institutions like legal rules are generated, while by specifying the relevant selection environment and its mechanisms we can derive hypotheses about what kind of innovations won't be viable and could therefore be excluded.

With respect to the evolution of legal rules we therefore have to specify who are the actors and how they generate new legal rules, what is the relevant selection environment, that is what restrictions determine the viable innovations, and through what mechanisms does the selection process work.

2.1 Variation Mechanism: A Cognitive-Creative Model of Action

As our approach is based on methodological individualism, individuals are seen as the central actors. They are the agents who generate innovations, both technical as well as institutional. When we look at legal innovations generated by the legislation, we find the ruler or government on the supply side and on the demand side the political parties and the affected individuals and interest groups.

In the second stage, we have to lay out the assumptions about the cognitive capabilities of the actors who create legal innovations. Firstly and most importantly, we assume that people's cognitive capability is characterized by creativity (Boulding 1956; Lachmann 1943; Shackle 1958; 1979). As cognitive science tells us, the human brain seems to spontaneously recombine sensual perceptions, thus offering us continuously new interpretations and new ideas about the outside world (Hesse 1990; Pöppel 1985). It is, therefore, the ultimate source of novelty, from which all realized innovations stem from. As we are unable to predict in advance either the content of our next thought or after what time (of thinking about it) a particular idea will occur the whole notion of the neoclassical theory of information economics makes no sense with regard to the emergence of novel ideas (Witt 1993a). Because of this creativity we do not know what our next idea will be and therefore we do not know of what alternatives our action space consists. Therefore, we cannot use an algorithm to derive the optimal alternative.

Secondly, we assume that people only have subjective perceptions and interpretations of the outside world. They therefore have to use theories to interpret the relationships between the cognitively perceived impressions. These theories in turn cannot be checked in an objective

way for their substance as every such proof is itself again based on subjective interpretations of the objective world, as the theory of knowledge shows us (Hayek 1952; Popper 1987). The same idea lies behind the "mental models" used by Denzau/North (1994, 4) as the "internal representations that individual cognitive systems create to interpret the environment."

Third, we assume that the actors rationally choose from their thus created action space. But because of the above assumptions, their actions will always only turn out the way they ought to by chance or in well-structured and stable environments. Unexpected side-effects will occur, because of one's subjective theories about the underlying situation, the possibility of creative responses of other actors, whose action space will be affected, and the limited cognitive capacities in processing available informations. Through feedback-effects from the external environment and through communication the actors can try to improve their subjective mental models (Denzau/North 1994, 16ff.),⁷ but – to stress the point again – there is no way to know how close one's mental model is to reality (i.e. whether one has the *true* model of reality or not).

What are the consequences of these assumptions for the generation of legal innovations? Firstly, as all actors are thought of as creative, the generation of novelty is ubiquitous. Each perception of a situation and each resulting action contains some novelty, as no two persons are the same and therefore have their own subjective interpretations. So we have a source which generates new ideas endogenously, the basis of the innovations which may result. Secondly, even if one actor simply tries to imitate the action of another actor by using the same devices or adopting the same strategies, this will also always be a creative act which again entails some sort of novelty, as the literature on the diffusion of technical innovations has shown (Dosi 1988; Silverberg/Dosi/Orsenigo 1988).

Basing our argument on these realistic assumptions about human action, therefore, heterogeneity should be superfluous. Yet in reality, the world is a lot more structured than our premises may lead us to assume. To explain why, despite the stated tendency of a continual generation of new ideas, we perceive a much more homogenous world we have to turn to the selection mechanisms which determine which new ideas will be successful.

2.2. Selection Environment and Mechanisms

Starting from Schumpeter (1942) and Downs (1957) who modeled political phenomena in an analogy to the market as competitive processes, *Public Choice Theory* and *New Institutional Economics* also took up this line of research. We can distinguish between the supply and the demand side of legal innovations. The ruler, the government or the ruling parties are the actors on the supply side. On the demand side, on the one hand, the relevant actors are the companies using the new technology and thus producing negative externalities, and the people affected by these as they are suffering from wealth reductions, on the other hand.⁸ The latter comprise customers and employees of the companies⁹ as well as actors without any contractual relationship to them.

Combining the above introduced cognitive-creative model of action with the well-elaborated

⁷ Learning processes play an important role in this respect.

⁸ To complete the picture, the companies and employees of stagnating markets which suffer from competition by the new technology are also important actors which demand regulations in the political process to secure their market position.

⁹ Negative externalities may also exist when there is a contractual relationship, if the externalities are not part of the contractual arrangement.

models of *Public Choice Theory* enables us – at least partially – to overcome the static nature of traditional *Public Choice Theory* (Meier/Haury 1990; Meier/Slembeck 1994). As statutory innovations always entail some sort of collective action, the actors on the supply and demand side have to create a common collective understanding of the relevant problem. To be more precise, the generation of some kind of a shared mental model, at least among the relevant political actors, is a necessary condition so that they can push through their interests in form of a legal innovation. The formation of politically effective interest groups therefore, first requires political entrepreneurs who manage to create a common cognitive framework among the potential members of an interest group about the problem on hand and the possible legal solutions to it. Within the restrictions set by the constitution the laid down selection mechanisms (access to the legislation, voting rules etc.) then determine which of the proposed legal innovations will be successful within this internal selection process. The legal ruling is then subject to a further external selection process which decides whether it is an adequate problem-solving measure or not. If not, there may be new efforts to modify it via another legislative procedure.

The formation of interest groups requires not only some shared mental models, but also enough people who are willing to spend the necessary organizational costs (Olson 1965; 1982). This depends on their opportunity costs which are influenced by the relevant political and economic selection environment. On the one hand, the constitution of a polity determines the access of different groups of the population to the legislation, thus imposing different costs on different groups of actors for political activities. On the other hand, the opportunity costs of the interest group formation are influenced by the extent to which the individuals are affected by the negative externalities generated by the new technology. In the following section, therefore, we will first analyze the costs of political activity imposed by the constitution and its selection mechanisms. Then we take a look at the change in the opportunity costs generated by the new technology during its life cycle, which results in a change of the incentive structures of different interest groups, who compete for political influence to form the law according to their respective interests. Finally, we look briefly at the supply side of new legal rules.

2.2.1 The Political Environment – Constitutional Restrictions and the Formation of Interest Groups

The constitution, which we take as exogenous, determines the access to the process of legal innovation by statutory law-making.¹⁰ It stipulates who is allowed to vote and who to be elected, as well as defining the central tasks and powers of the government. It also outlines the essential selection mechanisms of the legislative law-making (especially the voting rules). These constitutional rules determine the basic costs of political activity for the supply and demand side of legal innovations. As they give different access to the political process for the various groups of the population, the respective costs of political activity differ, too. Roughly speaking, the more formal the constitutional rights given to a part of the population to participate in the legislation are, the lower will be the costs of political activities for these actors. Therefore, the constitution represents the fundamental selection environment that limits the range of the interest groups, which are successful in creating new legal rules. By identifying these restrictions, we can thus derive first tentative hypotheses of those interests which will be articulated more easily than others in the political process and which therefore have a better

¹⁰Constitutions are part of the formal political rules of a society. They "broadly define the hierarchical structure of the polity, its basic decision structure, and the explicit characteristics of agenda control" (North 1990a, 47).

chance of being realized.

Following North (1990a, 48ff.), we distinguish between different political systems according to the form and range of participation in the legislation, which different parts of the population are entitled to. Thus, in a very abstract way we can capture the main features of the political systems in Germany in the 19th century. The first model, which also characterizes the Prussian monarchy at the beginning of the 19th century, is an autocratic polity with a ruler on the one hand and a constituency without universal suffrage on the other hand. Obviously, the costs of influencing the process of law-making are virtually prohibitive for most people in such a political environment. In accordance with North (1990a, 48f.) we assume that, nevertheless, the sovereign has to act "like a discriminating monopolist, offering to different groups of constituents protection and justice or at least the reduction of internal disorder and the protection of property rights in return for tax revenue." As the ruler's main objective is to maximize his power, he will enact regulations both to promote economic growth and to reduce political unrest of influential interest groups.

In a second model, North assumes that besides the sovereign a "representative body reflecting the interests of constituent groups and their role in bargaining with the ruler" (North 1990a, 49) exists. For the actors represented by this body, the costs of political influence are much lower now than for those without any formal rights to participate in the legislation. Such a body, the *Herrenhaus*, which represented members of the nobility appointed for life by the Prussian king, was part of the Prussian Constitution of 1850 which also included an elected parliament, the *Abgeordnetenhaus*. Its members were elected according to the three-class electoral system, thus giving more political weight to the wealthier classes of the population. Prussia was thus a constitutional monarchy, which contained both democratic and feudal elements. The political power was divided between the ruler, a representative body and a parliament, although supremacy resided with the monarch and the wealthier parts of the electorate. But with the introduction of an elected parliament, the costs of political activities for broader parts of the population were reduced and the emergence of multiple interest groups was facilitated.¹¹

Each type of constitution imposes different costs for political activities on the political actors. The transition from an autocratic constitution to a constitutional monarchy, which at least in part let larger shares of the population take part in the legislation, results in a shift of the costs of expressing one's interests. Thus, the costs of achieving their objectives increased for the groups hitherto privileged with a more exclusive access to the legislation, whereas for the thus far disadvantaged actors the costs of political activities decreased. It is therefore to be expected that in a representative monarchy more interest groups will be directly competing for political influence than in an autocratic regime. Under a stable economic environment the transition to a broader participation of the population in the legislation will lead to a more fierce competition among a growing number of newly formed interest groups for carrying through their interests in the form of legal rules. Besides, also the government can no longer afford to ignore the interests of the now more influential parts of the population if it wants to remain in power. Therefore, changes are to be expected in favor of these groups also from the supply side of legal innovations.

Over and above this outline of the costs imposed by different constitutions on the formation of interest groups we can also formulate more precise hypotheses by looking at the opportu-

¹¹See North (1990a, 49f.) for the resulting changes the existence of multiple interest groups brings about in representative democracies.

nity costs generated over the life cycle of a new technology.

2.2.2 The Economic Environment – Technological Life Cycles and the Demand for Legal Innovations

Let us for the moment assume that the constitution is not subject to any alterations,¹² so that we can look in more detail to the effects exerted by the changes in the life cycle of a new technology on the costs of political activities. This will be done first with regard to the actors that are negatively affected by the new technology and then with regard to those that generate the negative externalities as a by-product of their economic activities.

To model the change in the economic environment with its effects on the demand for legal innovations of the negatively affected actors, we use the life cycle theory as an heuristic device. According to this, industries show some uniform patterns with respect to the rate of market entries and exits, output growth, changes in prices and so on (Audretsch 1987; Audretsch/Feldman 1996; Heuss 1965). Several different phases in the evolution of a market can be distinguished, each with its own characteristic constraints, behavioral incentives, and outcomes (see *Diagram 1*). Over these different market stages, the pressure to solve the accompanying problems varies, thus setting incentives to change the law.

In the introduction stage of a market an innovating entrepreneur with little risk aversion introduces a new technology.¹³ If it turns out to be a success he or she will earn innovational profits from his or her leading position, thus unintentionally attracting other entrepreneurs to enter the market and to imitate the successful technical innovation in order to get some of the possible gains themselves (growth phase). With the growing use of the new technology and the consequently increasing competition, the profits start melting away. Thus one can observe the transition from a monopoly to increasing competition as a typical market structure, which finally leads to a concentration process resulting in an oligopolistic or again monopolistic market structure as demand is saturated (mature phase). Linked to each stage of this cycle is a change in the main strategic action parameters the firms use and thus in the relevant selection mechanisms (price competition, product differentiation, advertising and so on).¹⁴

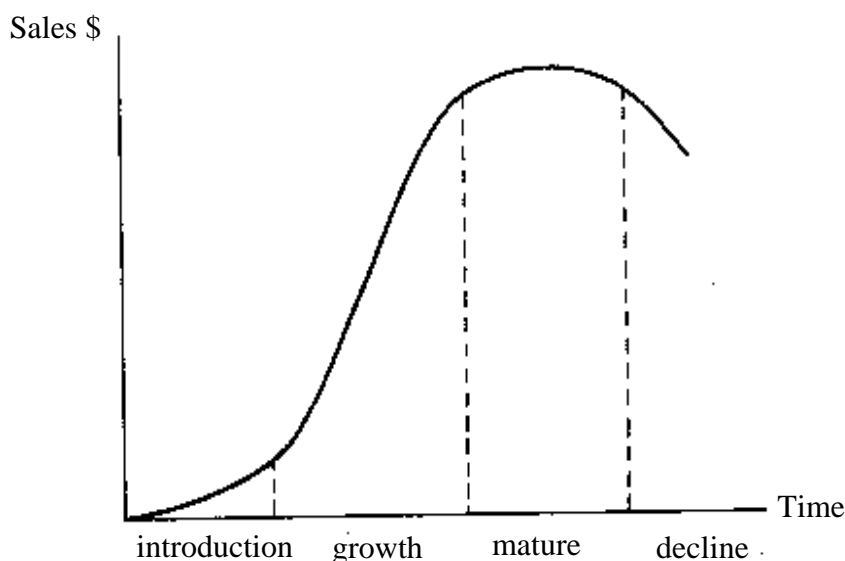
Over the life cycle of the new technology, the volume of negative externalities also varies (Eckardt 1998, 143ff.). As the overall volume of externalities increases with the growing use of the new technology, a scale effect exists. Thus, either more people will be affected by the resulting negative wealth effects or the same people will be affected more. A third possibility is that both effects will take place simultaneously, depending on the respective technology and the spatial dissemination of its externalities. With the increasing externalities and the resulting individual wealth reductions, the opportunity costs of political activities decrease to change the law to get some form of compensation. Because of this decline in the opportunity costs of political action for the negatively affected actors, we can expect that interest groups which try to reduce or to prevent such wealth reductions will emerge during the later stages of the life cycle. Thus, *ceteris paribus*, the demand for legal innovations which offer compensation for the wealth reductions or which prohibit the further production of these negative externalities, will be highest in the stages of mature or stagnating industries (Eckardt 1998, 215ff.).

¹²This is true for the United States or the United Kingdom for example, but unfortunately, this did not hold for the German case neither in the last century, nor in this. Therefore, we have to abolish this assumption later.

¹³For the following, see Heuss (1965).

¹⁴The selection mechanisms of the economic environment play only a secondary role because in this paper, we are interested in legal innovations as a result of the political process.

Diagram 1: The Technological Life Cycle



Source: Audretsch (1987, 299)

This thesis has to be modified if we assume that some kind of organization already exists at the beginning of the market cycle which can be used by the negatively affected actors to promote their interests. Every formation of a new interest group requires high initial set-up costs. A political entrepreneur has to convince others of his or her point of view, he or she has to create some kind of shared mental model among the potential members of the respective organization regarding the problems to be addressed and what would be the appropriate problem-solving measures to be taken (Meier/Slembeck 1994, 21ff.). The high degree of uncertainty involved, the necessity to build up a formal organization that manages to overcome the free-rider behavior of potential members, and economies of scale with respect to the resources necessary to become well-known are the main reasons for the high initial set-up costs in forming an interest group (Olson 1965, 1982). As these are sunk costs they will no longer be taken into account once they have been spent. Thereafter, the costs to its members in expressing their interests in the political process are lower.¹⁵ Despite a relatively low volume of wealth reductions in the early market phases, we may then see some demand for legal innovations to reduce or prevent the further production of negative externalities as by-products of the new technology.

To complete the picture, let us turn to the producers of the negative externalities, which are generated as a by-product of the new technology. Do we have to expect any demand for legal innovations from their part, too? The answer would be yes. To see why, let us first consider under what circumstances the formation of interest groups on the part of the producers is likely. In this respect the changing selection environment over the life cycle of the new technology also plays an important part (Berg 1995, 153ff.). In the introduction and growth stage of the life cycle high profits are to be made due to early market entries and the resulting monopolistic market structure and to the high rates of productivity growth that are associated

¹⁵Important examples are trade unions, chambers of commerce, trade associations and so on. Their formation may take a lot of time and require a lot of efforts and resources to get them into being, but once they exist the costs of using them for expressing demand in the political area are much lower.

with the steep learning curve of the initially immature technology. In contrast to this, the mature and decline stages are characterized by lower rates of productivity growth, a largely exhausted technological paradigm, and low profits because of the fierce competition. Thus, the opportunity costs of political activities of the companies also vary over the life cycle. Whereas the gains from investment in the further technical and economic development of the new technology are high relative to the possible gains from political activities in the early market phases, this alters with the exhaustion of the technological paradigm and the change in the economic selection environment in the later phases. Therefore, it is to be expected that the remaining companies try to secure their market position through some rent-seeking activities in the political process. Moreover, with declining productivity rates and stronger competition in the stagnation phase they must reduce production costs. Thus, they have incentives to externalize as many costs as possible or to prevent other interest groups from achieving an internalization of these externalities through the legislation. In the later stages of the life cycle one can assume strong competition for political influence among interest groups with opposing objectives.

Referring to Olson (1965, 1982), one can try to derive further statements about the relative strength of the conflicting interest groups in the legislation. Whereas the producers of the negative externalities are a rather small group with homogeneous objectives, the actors negatively affected by these externalities may consist of a large group of quite dispersed people with heterogeneous goals. Thus, the producers of the externalities may exert more influence in the polity and may be able to prevent legal innovations which would internalize the wealth reductions to their disadvantage.¹⁶ A different picture evolves if the damaged actors themselves are also a small group with homogeneous interests, e.g. if the companies producing intermediate products and their buyers operate in an oligopolistic market structure. In this case, the outcome of the political competition for influence in the legislation cannot be predicted without further knowledge of the relative bargaining-power of the parties involved in the political process.

Let us summarize the results of the influence of the economic selection environment on the demand for legal innovations. The formation of interest groups is modeled as a function of the market cycle that is characterized by changing opportunity costs for political activities. It has been shown that the demand of the negatively affected actors should be higher in the later market stages. If an organization already exists which can be used to represent the new interests generated by the new technology also in the early market stages demand for statutory innovations can be expected. The demand of the producers of the negative externalities will also be higher in the later market stages because the possible gains from political investments are higher than in the early stages where gains from investment in R&D etc. exceed the rather uncertain political investments.

If we combine these findings with the previous statements about the influence of the constitution in force, we can derive further hypotheses according to the additional costs imposed on different groups of actors by the constitutional restrictions.

2.2.3 The Supply of Legal Innovations by the Ruler or the Government

In accordance with North (1990a, 48), we have assumed that the main objective for the ruler

¹⁶Prominent examples are the efforts of the various environmental and consumer protection movements over the last decades that were not able to carry through their interests against the strong political influence of the producers of negative externalities.

or the government is to remain in power. Because of the assumption of an endogenously changing environment and of the cognitive-creative model of action described above, the means available to the ruler or the government to achieve this end are not clear at all. Therefore, he or she will experiment with all kinds of regulations. That is, in our approach, the ruler or the government do not only react to the demand expressed by different interest groups, but they are political entrepreneurs who offer legal innovations to gain or to keep the support of the population. Thus, we have an *autonomous supply* of legal innovations by the ruler or the government, independent of any expressed demand (Eckardt 1998, 228f.). However, usually we are not able to decide whether the enactment of a statute is the consequence of such an autonomous supply or of the demand from some interest group, as generally simultaneously both interest groups demand some kind of legal innovation and the ruler or the government offer some. Therefore, in the following, we only talk about an *autonomous* supply of legal innovations from the government if we cannot discover any well-defined interest group demand. Referring to our above made statements about the demand for legal innovations expressed by interest groups, it is to be expected that only in the early market stages an obviously autonomous supply will emerge.

Several reasons for such an autonomous supply can be distinguished (Eckardt 1998, 230ff.). First, there may be some diffuse demand in the population, e.g. some fear about the possible consequences of the use of a new technology etc., that calls for action but has not yet led to the formation of an politically effective interest group. In this case, we can expect the government to act by passing a legal rule to lessen the public apprehension. Further, there may be some demand from the lower branches of the public administration which are directly confronted with the negative impacts of a new technology and call for more precise instructions. Finally, the economic policy model of the ruler or the government, which guides their political perceptions and resulting activities, might structure their mental models in such a way that they think some collective legal rule necessary. Even if we assume that the ruler or the government pursue only their own interests, their actions are based on cognitive perceptions about public responsibilities, the underlying problems and the available means to solve them.¹⁷ Based on these perceptions they may consider it necessary to supply legal innovations to cope with new problems, which arise as by-products of technical innovations.

2.3 Summary - Main Hypotheses

By using a variation-selection approach, we modeled the evolution of the law as a trial-and-error process. Because of new problems, which emerge as side-effects of technical innovations, an experimental process is triggered off in which legal innovations are generated and modified if they do not turn out to be appropriate for the underlying problems. We have tried to show that both cognitive creativity and wealth effects are the decisive factors in this process of legal evolution. Whereas the cognitive creativity of the actors leads to the endogenous generation of novel legal innovations, statements about the viable legal solutions can be derived by specifying the political and economic selection environment.

¹⁷See for example North (1981, 45ff., 1990b), Meier/Slembeck (1994, 53ff.).

Thus, our hypotheses can be summarized as follows:

- Over its life cycle, a rising volume of negative technological externalities emerges as a by-product of the use of the new technology.
- The wealth reductions caused by these negative externalities also vary over the life cycle, altering the opportunity costs for the formation of interest groups, and thus, the incentive structure for political activities.
- As the opportunity costs of the damaged actors become lower in the later stages of the market cycle, they will express demand for legal innovations that are favorable to them. The same holds for the producers of the negative externalities.
- In the early market stages an explicit demand for legal innovations is to be expected only if a suitable organization already exists, so that the high initial set-up costs for the formation of an interest group not have to be spent.
- It is also in these early stages that an autonomous supply of legal innovations by the ruler or the government may occur.

The appropriateness of this approach to the legal evolution will be shown by its application to the evolution of the German tort law in the 19th century.

3. Empirical Analysis of the Evolution of the German Tort Law in the 19th Century

The emphasis of the following is on the introduction of the strict liability rule under the *Prussian Railway Law* in 1838 and on the prohibition of the contractual exclusion of liability under the *General German Code of Commerce* in 1861. After a short description of the content of each legal innovation, we will analyze the changes in the economic and political selection environment, in particular with respect to the relevant actors and interest groups, before we briefly discuss the different proposed legal variants of the respective innovation processes. A short look at the impacts of the legal innovation finally enacted may indicate the reasons for further legal innovation processes.

3.1 The Introduction of the Strict Liability Rule with the Prussian Railway Law in 1838

With the introduction of railways in the various German states and the successive development of the industrial sector based on fossil fuels and modern technology like steam engines, the problem of negative technological externalities like industrial injuries and environmental pollution was put on the agenda. The evolution of the modern German tort law started with the passing of the *Prussian Railway Law* (PRL) in 1838. This was the first of a number of legal innovations which tried to cope with the resulting problems of the industrialization process.

3.1.1 The Previous Tort Law and the Content of § 25 PRL

Traditionally, German law was based on the so-called *Gemeinen Recht* (German Common Law), which was derived from the ancient Roman law and the medieval law (Schlosser 1993). In Prussia a modified codification of this law had been in force since 1794, the *Allgemeines Landrecht für die Preußischen Staaten* (ALR). In both cases the tort law was based on the negligence rule (Coing 1989; 512ff., Ogorek 1975). According to this rule, the victim of an accident was only compensated by the party that caused the harm if this party had acted will-

fully or negligently, in particularly if it had violated some legal duties. The burden of proof rested on the victim, who had to offer one hundred percent evidence that the defendant had really caused the damage. If the victim could not prove this she or he did not get any compensation. The negligence rule was also applied to occupational accidents. An injured worker thus had to sue the person who had caused the accident, i.e. normally a colleague. If he could prove that the defendant had caused the accident, he would in principle be entitled to some compensation. But as workers did not have any savings in those times, they normally could not pay for the damages, so the victim would not receive any compensation at all. The employer was only liable for occupational injuries if he himself had caused them willfully or negligently or if he had violated some special legal duties, for example if he had chosen obviously unsuitable employees or if he had neglected the legal responsibility to supervise the employees who had caused the damage (*custodia in eligiendo vel negligiendo*) (Coing 1989; 521f.; Ogorek 1975, 68ff.). Under the *ALR* the strict liability rule came into force only in some special cases. Carriers like landlords, carters, and bargees were subject to this more severe rule (*receptum*) (Ogorek 1975, 81ff.). They were liable for every damage that was suffered by their activities regardless of fault. Furthermore, they were also liable for any damage which was caused by their employees. Only if the damage was caused by the plaintiff or resulted from acts of God were they not liable.

With the *Prussian Railway Law* (PRL) this strict liability rule was extended to damage that was caused in transit by rail (Eger 1896, 213ff.). Under § 25 of this law, each railway company was liable for all damage incurred by rail on persons and goods during the journey, with the exception of such damage which was caused by the harmed person or which happened by unavoidable chance. But the dangerous nature of railways did not fall in this latter class. § 25 PRL was not part of the obligatory law; it could be altered or excluded by contract at any time.

On first sight, this extension of the strict liability rule to railways seems a quite straightforward application of the carrier liability of the *ALR* to this new means of transport. But a closer examination of the innovation process reveals that this was by no means a matter of course for the political actors that participated in the legislative process. Firstly, we analyze the economic and political selection environments which set the outer bounds for the actors who had a chance to express their interests in the legislation process. Then we look at the various legal variants that were proposed and at last, we examine the effectiveness of the finally enacted legal innovation.

3.1.2 The Economic Selection Environment

The *PRL* was enacted on the 3rd November in 1838, with the first Prussian railway line having opened only four days earlier on the 30st October (Klee 1982). Its length was 34 km, with the whole German railway network amounting to 141 km (Fremdling 1975, 48, *Table 1*). Railways were a complete new transportation technology both in Germany and in Prussia.¹⁸ If one thus takes the length of the railway network as an indicator for the market phase, railways clearly were in the introduction stage of their life cycle. Because of the low rate of use, the volume of negative technological externalities was also very small. Unfortunately, we do not have any figures about these, but as the introduction of railways caused a lot of public

¹⁸The first German railway line was opened in 1835 with a distance of 6 km between the two Bavarian cities Nürnberg and Fürth. The steam locomotive together with the engineer were imported from the United Kingdom, where the first railway line, which was operated with steam engines, was put into service in 1825 (Jackman 1966).

excitement had the figures been high, it would have become public knowledge (Then 1997, 73ff.). Therefore, we should not expect that any demand existed for a more strict liability rule than the negligence rule of the *ALR*.

Why then was a special railway law passed in Prussia during the introduction phase of the railway technology? It was mainly concerned with questions of the compulsory purchase of property, compensations for the land-owners along new projected lines, and with the regulation of the operation and the tariffs of private railway companies as the Prussian monarch had decided against a state-owned railway system.¹⁹ As since 1833 more and more entrepreneurs had been demanding concessions for railway lines from the Prussian administration, the Prussian monarch instructed his executives to draw up a statute in 1835; the outcome was the enactment of the *PRL* in 1838 (Stumpf 1938, 16ff.). To gain insight in the innovation process that led to the introduction of the strict liability rule under § 25 of this law, we have to examine more closely the political selection environment and the actors involved.

3.1.3 The Political Selection Environment

Following North (1990a, 48), Prussia was an autocratic regime where the monarch and its executives held the legislative authority. The sovereign was not subject formally to any control by the population (Boldt 1987, 91ff.). The classes had to be summoned only for granting new loans, but they had no right to participate in the legislation. Besides the monarch and his ministers, a legislative commission which was part of the Ministry of the Interior (*Gesetzeskommission*), and the council of state (*Staatsrat*), an advisory board, took part in the legislative process. The members of these groups were either members by birth, like the princes who made up part of the council of state, or had been appointed by the monarch himself, for example the ministers and the public servants.

The legislative process proceeded as follows: after the monarch had ordered the ministers to draft a bill, the legislative commission made a first proposal that was discussed among the ministers in charge. The resulting bill was forwarded to the monarch who for his part obtained advice from the council of state. He could then either agree on the bill and sign it or recommit it to the ministers and the legislative commission, who then had to work out a new version which was again forwarded to the monarch, and so on. Both among the ministers, the legislative commission and the council of state, the majority rule was in force, but the ultimate decision-making powers rested with the monarch who was free to disregard all previous decisions of his executives.

Thus, on the one hand, the power of the monarch was formally nearly absolute, as he had the ultimate decision-making powers over passed statutes. Moreover, formally, he alone decided about what kind of problems the ministers and public servants were to deal with. As he was not subject to an election and formally did not have to ask any other part of the population for consent, he had a lot of scope to pursue his own interests. Correspondingly, that meant nearly prohibitive high costs of political activity for the other actors who had no formal rights to participate in the legislative process. Neither organized political parties nor interest groups in the modern sense existed. Only through informal relations to the monarch or his executives was it possible to put forward one's special interests. As Prussia was a feudal society in these days, it seems appropriate to assume that only the nobility and the wealthier part of the population

¹⁹According to the Prussian constitution the monarch would have had to summon the classes to get their approval for the necessary additional borrowing for a state-owned railway system. But as this would have had strengthened their political influence, at first, he had preferred the extension of the railway network by private companies (Mester 1985a, 201f.).

could exercise influence on the legislation by such informal contacts.

However, because of the more complex social and economic problems, a legislative structure had been adopted to incorporate more knowledge in the law-making process and to reconcile the various and sometimes conflicting needs and interests of the society, even under an autocratic regime such as the Prussian one. Through the diverse bodies and actors that were involved in the law-making process, a broad range of other views and interests could affect the legislation. In particular, it was the explicitly stated task of the council of state to assess the possible consequences of a proposed bill and to make suggestions for its improvement.

In summary, one can say that the higher classes and the wealthier part of the population had the opportunity to influence the legislation whereas the opportunity costs of the lower classes had been prohibitively high. In fact, as far as we know, there was no interest group which explicitly expressed a demand for particular legal protection with respect to railway accidents and related externalities around the passing of the *Prussian Railway Law*. Therefore, it has to be assumed that this legal innovation was an autonomous supply based on the cognitive conceptions of economic policy by the ruler and his administration. In contrast to that, rent seeking interests did not play an important role, if any at all. To see whether this hypothesis, which corresponds to the theoretically derived thesis about the supply and demand structure for legal innovations over the life cycle of a new technology described above, is correct, we have to take a closer look at the generation of the new legal rule itself.

3.1.4 The Legal Innovation Process

As already mentioned, the Prussian king had ordered his ministers to submit a railway bill in 1835, but the tightening of the liability law for railways was not put on the agenda until in 1837. In the following period, five different variants of legal tort rules were presented in the various bodies which were involved in the law-making.

At first the minister of justice suggested a strict liability rule for all damages that were caused directly or indirectly by the operation of railways (Stumpf 1938, 38ff.). He justified this with the claim that such a rule would result in a higher standard of care by the responsible railway companies. The minister of police, who was responsible for public safety and trade inspection, took a different view. According to him the existing negligence rule under the *PRL* was sufficient. In his view, there was no need for a tightening because of the low numbers of railway accidents that occurred in other countries and because of the self-interest of the railway companies to avoid accidents. Moreover, the application of the strict liability rule was seen as a break with the whole former tradition of the German tort law. Finally, the first draft of the *PRL* proposed a third variant. The railway companies should be liable for all damages that were caused by their employees during the transport if the victim him/herself could not successfully sue. In its assessment the state council was in favor of the first variant, i.e. the strict liability rule proposed by the minister of justice. They recommended that alternatively the victim should be entitled to subsidiary damages against the railway companies if they could not gain any compensation from the responsible party. The railway companies, in turn, should be entitled to recourse to the responsible party. This recommendation of the council of state was justified by the asymmetric information and the resulting impossibility for a victim to prove unambiguously who had caused an accident or another negative externality. Furthermore, they specified the particular obligation of the state to care for its inhabitants as a reason for a more severe liability rule. In this hearing it was the first time that the strict liability for carriers under the *ALR* with respect to damages caused by railway accidents was referred to. The rule finally passed under § 25 *PRL* was a modification of the first proposal made by the minister of justice. The strict liability rule was not applied to all damages that resulted from the running of railways, but only to those that occurred during the transport.

The legal innovation process had been a multi-layered process in which different views and perceptions about the problem in hand were expressed. Over a period of nearly two years diverse liability rules were discussed. For the actors involved it was by no means obvious from the beginning that an imitation of the strict liability rule for carriers to damages caused by railways would be adequate or even necessary at all. We did not find any indications for rent seeking interests from organized interest groups that tried to influence the law-making in this respect. In contrast to this, cognitive processes rather prevailed. Because of the novelty of the railway technology and the resulting possible negative externalities the perceptions of the actors about the problem in hand and the possible solutions to it played a central role. In the course of the continuous discussions and modifications of the proposed liability rules a shared mental model about the riskiness of railways was formed among the involved actors.

Looking at the generation of § 25 PRL one can thus summarize that for the actors involved the liability of railway companies really was a novel problem. No obvious connection to the long established strict liability rule for carriers existed for them. Despite the relatively few actors involved in the law-making process a broad range of heterogeneous legal variants for the problem in hand was suggested. As we do not know the details of the decision-making process we cannot make any statements as to whether the resulting liability rule was based on a broad cognitive agreement among the actors, or whether it was the outcome of the majority ruling, nor whether it was based on power or just on chance. But – what should have become clear by the broad description of this legal innovation process: the outcome could have been quite different. No functional relationship between transportation – by whatever means – and the strict liability rule, independent from the perceptions of the actors, can be established, even if it seems quite clear from our point of view that the well-established strict liability rule of the *ALR* was copied.

3.1.5 The External Selection of the Strict Liability Rule for Railways

The next question to be posed is whether the dominating perception that the strict liability rule was adequate for railway accidents proved to be accurate. To assess this, we are first going to look at the future volume of negative externalities caused by railways to see whether they really turned out to be a dangerous operation. As we have shown above, the total volume of damage is determined by technical and economic change. According to our argument, it will increase disproportionately in the growth and mature stages of the life cycle of the new technology. That is, the growth in knowledge which would enable a reduction of the negative externalities must be smaller than the scale effect which leads to an increase because of the higher use of the new technology. In the following section, we first analyze the further technological and economic developments and their impacts on the volume of negative externalities caused by railways, then we look at the effectiveness of § 25 PRL.

Technical Improvements

Over the decades which followed the introduction of the railways, a large number of important technical innovations were made which improved the security of the railway transport, thus reducing both the injuries incurred by the passengers and damages to the carried goods (Röll 1893, 530ff., 544ff., 3292ff.; Reichsverkehrsministerium 1938, 79ff.). Most important for the prevention of railway accidents proved to be innovations with respect to the embankment and the materials used, the construction of the wheels, axles and steam engines, and the introduction of continuous brakes for the whole train in contrast to brakes for each single freight car (Hertwig 1935; Mahr 1935; Metzelin 1935). Furthermore, innovations which helped to improve the coordination of the growing volume of traffic contributed to the security of the railway transport. In particular the introduction of telegraphs and changes in the signaling turned out to be very important innovations (Born 1935; Matschoß 1935; Mester

1985b). Whereas telegraphs were already diffused around the mid-1840s and installed next to the railroad tracks, the introduction of improved signaling and the continuous brakes did not take place until the mid-1870s.

Of further importance was the foundation of the *Verband der Deutschen Eisenbahnverwaltungen* (German Railway Association) in 1847, which originated from the *Verband der Preussischen Eisenbahnen* (Prussian Railway Association) which was founded in 1846 ("Festschrift ..." 1896). Members had been both private and public railway lines, and besides companies from the different German states foreign railways like the Hungarian, Austrian and Belgian ones. On first sight, the formation of this interest group seems to contradict our thesis above that in the introduction and growth stages of a new technology no such organizational activities take place. But the main reason for this early interest group formation was based on technical necessities rather than on rent seeking interests. With the growth of the railway network and the resulting traffic expansion, more coordination was necessary. Up to the foundation of the *Deutsches Reich* (German Reich) in 1871, Germany was an alliance which consisted of thirty-nine sovereign states of quite different sizes, constitutions, statutes, currencies and units of measurement and weights. Therefore, the expansion of the railways also meant an increase in international traffic among these sovereign states, which obviously required special coordination (Mester 1985a; Völkel 1985). But the German Railway Association also dealt with security aspects. In 1850, the first meeting of railway technicians took place and discussed norms and standards that were to be gradually applied by the members ("Festschrift ..." 1896, 43ff., Reichsverkehrsministerium 1938, 535). In 1851, the German Railway Statistics were introduced, where *inter alia* the causes for railway accidents were listed, especially fractures of axles, wheels and switches. Thus, it seems quite plausible to assume that the underlying reasons of the foundation of the German Railway Association were the particular needs of the railway technology rather than rent seeking interests.

One would anticipate that this multitude of technical improvements would bring an improvement in the security of the railways and thus a reduction in the number of accidents and the volume of damages caused by the railway transport. That is, the growing technical knowledge should have led to decreasing negative externalities over the market cycle. However, before we can accurately assess this, we have to take a look at the scale effect, too.

Economic Changes

From 1840 to 1850 the single-track railway network increased from 185 km to nearly 3000 km, i.e. by about sixteen fold in Prussia, and from 462 km to 5875 km, about twelve fold in Germany as a whole (*Table 1*). In the following decades the growth rates of the single-track lines remained fairly constant (about 85% on average per decade until 1880), while the railway companies promoted the extension of the double-tracked main lines and the construction of branch lines (Fremdling 1975, 48). The increase in railway companies employees paralleled this development (*ibid.*, 24f.). With the growing railway network, both passenger services and freight traffic increased too (*ibid.*; *Table 2*). The same held for income, expenditure and earnings on capital (*ibid.*; *Table 3*). Parallel to this, the transport charge per kilometer fell (*ibid.*, 55ff.). The development in Prussia was similar to that of the other German states. From the end of the 1850s, a growing concentration of railway companies took place. On the one hand, there were mergers of small companies, while on the other hand, the Prussian state engaged more in the railway business. It either conducted small local lines that were not profitable for private companies, or held shares and lent capital at reduced costs for the construction of new lines (Breitfeld 1985, 186; Röhl 1893, 2696ff.; Ziegler 1996, 46ff.).

If we consider the various input and output indicators we recognize a disproportional growth per year until around 1870, albeit with decreasing annual growth rates. In the following dec-

ades, the railway sector was characterized by nearly steady growth, until in the 1930s the competition from mass automobilization led to a relative decline in the volume of rail traffic (Hamm 1984). Thus, the railways were in the growth stage of their life cycle from around 1840 to 1870, then they moved into the mature stage which lasted until the 1930s. Because of the high profits in the early years, a lot of market entries took place following the lead entrepreneurs. In the 1860s, the first wave of concentration took place, with growing efforts of the state to nationalize the profitable private railway lines in the following years (Ziegler 1996).

Volume of Wealth Reductions

In section 2 we argued that in the growth stage of a new technology the scale effect will outweigh the knowledge effect, thus causing a growing volume of negative technological externalities. We have no detailed figures about this volume with regard to the use of railways, but from the 1840s on, statistics about railway accidents in Prussia exist. These data can be used as an indicator for our thesis.

The number of all people injured or killed by railway accidents rose from 52 in 1851 to 1403 in 1879 (*Table 4*). Over the years the number of people injured or killed increased, but the numbers stabilized by around 1870. The group most affected were railway employees. From 1851 to 1870, on average three quarters of all people killed or injured were railway employees, 6% were passengers and 13% were people who had no contractual relationship with the railway companies. The high proportion of affected employees can be put down to the fact that they not only suffered injuries by accidents during passenger services but also during freight traffic, and that most accidents happened not while a train was in motion but during loading and unloading and during the switching of the trains and wagons at the stations.

However, the number of accidents went up not only in absolute, but also in relative terms. Since the 1860s the number of persons affected by a railway accident in relation to all passengers had been increasing. While in 1860, on average one person per 100,000 passengers was injured or killed by a railway accident, by 1870 this relation fell to one person per 60,000 passengers (Statist. Nachrichten). The same holds true if one relates the number of people affected by accidents to kilometers covered. Thus, with the growing importance of the railway traffic the number of people negatively affected increased disproportionately. That seems to validate our thesis according to which a growing volume of externalities exists in the growth stage of the railway technology, a growth which is not halted by the increased knowledge about the reasons for and measures required to reduce these effects. In other words, despite the technical improvements with regard to the security of the railway transport the rapid growth of the volume of traffic had a contradictory impact on the volume of negative externalities, as measured by the number of people killed or injured in railway accidents.

To assess whether despite the absolute and relative increase in people harmed by railway accidents § 25 PRL might nevertheless have given incentives to reduce the volume of negative externalities, we finally have to analyze the effectiveness of this legal innovation.

Effectiveness of § 25 Prussian Railway Law

During the drafting and hearings of § 25 PRL the critics of the traditional negligence rule expressed the opinion that this rule would not be effective because of the asymmetric information and market power of the parties involved. That this view was quite correct also became obvious with regard to the strict liability rule which was finally adopted. § 25 PRL was not part of the compulsory law, i.e. this rule could be abandoned at any time in favor of other rules the parties had agreed upon by contract. In particular, they could also agree that they would use the traditional negligence rule of the *ALR* instead of the stricter risk liability rule. This possibility was indeed widely used by the railway companies. Due to their strong market

power, they weakened the liability rule in their business terms, either by completely abandoning them or by reducing the damages paid (Eger 1896, 486ff., 513ff., 554ff.; "Festschrift ..." 1896, 192ff., 259f., 271f.).

Lawsuits under the traditional negligence rule normally were decided in favor of the railway companies. Generally, the damaged party was not able to prove that the railway company itself had caused the accident and the resulting damage. Normally, the defendant was an employee against whom it had to be proved that he had willfully or negligently caused a steam engine explosion or a derailment, for example. If the reason for the accident was a purely technical one, for example due to defects in the material, no defendant at all was at hand. Because of asymmetric information, as a rule it was impossible for the plaintiff to prove unambiguously the causes of an accident. Therefore, he had nearly no way to win any damages. If someone nevertheless succeeded in proving this, the convicted party normally had no savings to pay the damages (Lehmann 1864; 1865; 1869; Ogorek 1975). Moreover, there was broad scope for the interpretation of § 25 PRL. Particularly controversial was what kind of damages the terms *acts of God* and *chance* included, what kind of accidents were part of accidents that happened during the *transport* by the railway, and whether this paragraph should be applied only to steam engine railways or also to railways drawn by horses or to streetcars (ibid.).

If we take a look at the statistics we can see that 52% of the passengers who had suffered an accident on the railway were counted as being injured with no fault of their own. One can therefore assume that a little more than half of the affected passengers received some kind of damages. The other half either was shown to have been partially to blame for the accident, so that they were not entitled to any damages, or the defendant could prove that the accident happened by chance. In contrast to this, only 12% of all railway employees that suffered injury or loss from a railway accident were granted some damages. As most victims were part of this group, only a very small proportion was compensated for the injury incurred. With respect to the objective of § 25 PRL – to give incentives to enhance the security of the railway transport and to compensate the victims of railway accidents – it can therefore be stated that this objective was not reached. A reduction in the number of accidents was not achieved nor were the people negatively affected compensated. Thus, this first legal innovation which tried to cope with the new negative externalities of the railway technology turned out not to be an adequate response to the perceived problem. With the absolute and relative increase of railway accidents and people involved the initial judgement by parts of the Prussian administration that the railway technology was 'harmful' proved to be accurate. Nevertheless, the strict liability rule under § 25 PRL did not turn out to be either an adequate or a successful legal solution by the tort law to this problem, esp. with regard to occupational accidents of the railways employees. In so far, renewed legislative innovation processes should be expected – and in fact, they did indeed take place. But it was not the occupational accidents which were the object of new legal efforts in the first place. Instead, the well-organized merchants managed to push through a statute that served their interests.

3.2 Renewed Legislative Efforts: The General German Code of Commerce in 1861

With the enactment of the *Allgemeines Deutsches Handelsgesetzbuch* (*General German Code of Commerce*) in 1861 under art.423, a prohibition of the contractual exclusion of liability with respect to damages incurred on goods during the transport by railways was introduced. Only damage which was caused by the peculiarities of the transported goods themselves did not fall under this rule. Thus the property rights structure changed in favor of the merchants and to the disadvantage of the railway companies. On first sight, this contradicts our thesis that in the growth stage of a new technology no organized interest groups and no legal changes that are results of distributional demands should be expected. But a closer look at the

particular circumstances reveals that the selection environment contributed to low costs for political activities of the merchants.

3.2.1 Selection Environment

During industrialization, the political and economic integration among the German states increased (Treue 1994). In 1848 the National Assembly of the Paulskirche in Frankfurt passed a resolution for a unified code of commercial law for all German states (Schlosser 1993, 144ff.). However, it was not until 1857 that a committee was set up for the drafting of such a statute and this was finally enacted in 1861. The *General German Code of Commerce* (GGCC) was based on the French *Code de Commerce*, which was passed in 1807, and on a Prussian and an Austrian draft bill. It should be stressed that again the legal regulation of railway accidents was not the original reason for the legislative process. One can only wonder whether the pressure exerted by the damage caused by railways would have been sufficiently high to trigger off such a process. Probably this would not have been the case, so that there would have been no tightening of the liability law.

The formal constitutional frame within which the GGCC was generated was the *Deutscher Bund* (German League), a confederation of the sovereign German states that existed from 1815 to 1866 (Boldt 1987; 1993). As it had no own legislative power the bills agreed upon had to be ratified by its member states. Thus, this was a multi-layered legislative process. Within the German League, a committee was set up in which the single member states were represented according to their population size. Three readings took place, with the finally successful bill being passed under the majority rule. This bill was then laid before the assembly of the league (*Bundesversammlung*), in which the member states were also represented according to their size. After the bill was agreed upon by the assembly it still had to be ratified by the governments of the members according to their respective constitutions. Prussia for example, which played an important part in this law-making, had adopted a new constitution in 1850 which contained some democratic elements. According to this the legislative power was divided between the monarch, the *Herrenhaus*, that is the upper house consisting of members of the nobility appointed for life by the monarch, and the *Abgeordnetenhaus*, the parliament which was elected according to the three-class electoral system under which the wealthier parts of the electorate had more seats and thus more influence. In contrast to the former Prussian constitution, now more actors had formal rights to participate in the legislation with resulting lower costs of political activities.

3.2.2 Competing Interest Groups: The German Railway Association and the Chambers of Commerce

Because of the multitude of actors involved, a multitude of perceptions, interests and proposed problem solutions also entered the legislation. Besides the committee set up by the German League, the administrations of the various member states, especially the Prussian and Austrian one, played an important role in the generation of the different variants both of the whole GGCC as well as with respect to the provision for damages caused by railway accidents. The competition for influence among the opposing interest groups took place against this constitutional background. On the one side, the merchants were interested in improvements of the terms of transportation as freight transports by rail played an increasingly important role the more the railway network grew and tariffs fell. But the railway companies in Prussia had enough market power to abolish the strict liability rule of § 25 PRL in their business terms. Thus, the merchants had to rely on the negligence rule of the ALR, which in practice meant that they had to bear the costs of the damages themselves. The same held true for most of the other German states, where damages caused by railway accidents were decided

according to the *German Common Law* and thus also according to the negligence rule. Moreover, the monarchs of the different states presumably had an interest in low food prices and thus in low costs of transportation because of the high growth rate of the population. Therefore, it can be assumed that they would have supported an improvement in the liability law for freight. On the other side, the railway companies, who had joined in the German Railway Association, had no interest in weakening their own legal position. As we have already pointed out, the foundation of this association in 1847 was first and foremost a result of the particular requirements of the railway technology, especially with respect to the necessary co-ordination and standardization of the growing international volume of traffic. Nevertheless, once the initial set-up costs had been spent this organization could also be used for other purposes than to pursue the original productivity-enhancing objectives. And indeed, the German Railway Association soon proved to be an influential interest group, able to push through the interests of its members within the political process ("Festschrift ..." 1896).

In contrast to the relative small number of railway companies (both state-owned and private enterprises), the number of merchants was high with accordingly high costs of forming an effective interest group. But the merchants, too, had quite delimited interests (improvements of the liability for freight) and they already had a well-established organization, too. From 1815 on, chambers of commerce arose in Prussia with the support by the state (Fischer 1964, Ullman 1988, 22ff.). They were modeled according to the French example. In 1848, a statute on chambers of commerce was passed, the *Handelskammergesetz*, which combined elements of the traditional guilds and the new chambers of commerce. Of utmost importance was the introduction of compulsory membership in the chambers of commerce for the merchants by this law. Between 1850 and 1870 a lot of new chambers of commerce were founded in Prussia, which led to the setting up of the *Prussian Handelstag* in 1860 and to the *German Handelstag* in 1861 as umbrella organizations. In addition, single chambers of commerce, such as the Cologne branch, had a lot of political influence. On the one hand, these associations had to carry out government tasks, while on the other hand, they represented the special interests of their members. With the 1848 statute both the set-up costs for a well-organized interest group were lowered enormously and the free-rider problem was solved by the introduction of the compulsory membership. With these organizations the merchants now had institutionalized access to the public administration and to the government, which also reduced for them the costs of expressing political demands.

Nevertheless, it seems that, despite these advantages, the single chambers of commerce did not manage to push through their interests directly against the railway companies and the German Railway Association. In particular, they could not prevent the German Railway Association from laying down in their conditions for freight transport, passed in 1850, that the strict liability rule under § 25 PRL should not be applied. So they seized the opportunity to pursue their interests with the help of the political process and used the passing of the *GGCC* to achieve a tightening of the liability for freight by statute rather than by direct contractual arrangements.

3.2.3 The Legal Innovation Process: Discussed Variants and Final Outcome

The legislative process itself was characterized by a multitude of petitions by these interest groups during the hearings and readings of the *GGCC* bill (Eger 1895, 25ff.). They were made both to the committee that had the task to draft the bill and to the governments of the sovereign member states of the German League. This found partial expression in the discussed variants for a statutory provision of the liability on freight that were proposed during the drafting of the *GGCC*.

The early Prussian bill for a single German Code of Commerce – dating from 1850 – did not

provide for any change of the traditional liability for carriers (Eger 1895, 27ff.). But the first reading of the *GGCC* contained a second variant according to which it was prohibited for all carriers to exclude liability by contract. This provision would have meant a tightening of the liability rule not only for railways but also for carriers and bargees, for example. But in the second reading of the *GGCC* a third variant was proposed which stipulated that the exclusion of liability should be banned only for railway companies but not for other carriers or the postal services. This variant led to widespread activities of the German Railway Association, which tried to influence the governments of the member states of the German League to prevent such a rule from being enacted. As a counter-reaction to these activities, the merchants wrote petitions and memorandums. The result was a form of a compromise in the third reading of the bill. According to this, the exclusion of liability could be banned if it was in the interest of free trade and traffic, or if it contributed to the balance of power among the contracting parties. But also this fourth variant led to rent seeking-activities. Both the private Prussian railway companies and the powerful Chamber of Commerce of Cologne submitted petitions to the Prussian *Herrenhaus*. In the end, neither group managed to push through its interests. The *GGCC*, finally passed in 1861, contained a fifth variant under art.423 which, on the one hand, provided for a tightening of the liability law for railway companies as it prohibited the exclusion of liability by contract, and on the other hand, provided for exceptions to this rule if the merchants themselves had demanded cheaper conditions for the transport, or if the freight itself was particularly susceptible to damages. But only in these cases was the strict liability rule not applied.

Art.423 *GGCC* thus contained a clear improvement of the legal position of the merchants and a weakening of the property rights of the railway companies. However, from the material available it cannot be decided whether the merchants had been more successful in winning influential member states to support their objectives in the legislation or whether this question was primarily part of the broader bargaining process and therefore used instrumentally by the involved governments.

Despite the fairly efficient provision which tried to allocate the risk for damages according to the informational asymmetries among the parties, once again a deterministic or functional mechanism cannot be detected which led to the final legal innovation under art.423. Unfortunately, we do not know the details about the discussions among the multitude of actors involved in the law-making of the single readings. But it can be assumed that, similarly to the innovation process from which § 25 PRL emerged, a lot of diverse proposals must have been discussed because of the multitude of creative actors involved, with their different interests and their different cognitive background. With regard to the cognitive frameworks it can be stated that, in contrast to the generation of § 25 PRL, a shared mental model seems to have existed. The problem in hand was merely a distributional one, not a cognitive one. Thus, the various variants were all within the scope of the strict liability rule of the traditional carrier liability and the § 25 PRL. And whereas nearly two decades earlier fierce discussions took place as to whether the imitation of the strict liability rule for railways would not be a break with the whole tradition of the German tort law, now a relatively strict restriction of the freedom of contract between merchants and railway companies was agreed upon which contradicted notably the *laissez-faire* attitude of the civil law prevailing in these days, and yet didn't provoke much unrest.

Because of the underlying shared perceptions of the actors about the problem in hand and adequate solutions to it, distributional aspects dominated the debate. But because of the multitude of creative actors involved and the power relations among them the legal rule finally adopted can not be seen as the only viable one, as we do not know the role that historical contingencies played.

3.3 The External Selection Process: Outlook on Further Modifications and Legal Innovations

With the introduction of art.423 GGCC, the tort law for the transport of goods by the railways was only slightly modified within the scope of the strict liability for carriers and § 25 PRL. But the enactment of a statute shows only that its various legal provisions have successfully passed the internal selection mechanism of the political law-making process. To assess a particular legal rule – like the strict liability rule for railway accidents – one has to take a look at the external selection, too.²⁰

The strict liability rule for freight by railways according to art.423 GGCC was in force from the enactment of the GGCC in 1861 until its replacement by the *Handelsgesetzbuch* (German Commercial Code) which was passed in 1897 and which is still in force today. The strict liability for railways can now be found under art.454 with slight modifications of the terminology used, but with the same content. In this respect, therefore, the innovation of art.423 GGCC was positively selected, in existence now for nearly one and a half centuries. Furthermore, to assess whether this rule was not only in force, but also positively selected by the courts, that is, by the judges, one has to examine court decisions, a task that cannot be fulfilled in this paper. Because of the scope for interpretation that the application of each statutory provision always implies, special juridical qualifications would be necessary, too, in order to assess whether the rule on hand was applied according to the interests of the political actors who had supported its enactment.

However, the rule would have been effective if it had created incentives for the actors to reduce the volume of negative technological externalities or to pay damages for the ones still occurring. Unfortunately, we have no figures about the damage in freight transport caused by railways. But in 1869 the prohibition of the contractual exclusion of strict liability was imitated for the passengers services in Prussia by the Prussian *Zusatzgesetz*, via an additional statute to the PRL (Eger 1895, 32; Ogorek 1975, 63). It thus improved the legal position of the potential victims of accidents related to rail transport, as the Prussian railway companies in general had excluded the strict liability rule under § 25 PRL by contract for their employees and customers. For the railway employees, however, this was still just a marginal improvement of their property rights. Instead of the contractual exclusion of the strict liability the railway companies now started to raise the duties of care for their employees in such a way that nearly each occupational accident could be traced back to the breach of such a duty by the employee. Because of this contributory negligence the employee then lost any claims for damages. Moreover, as most occupational accidents happened not during transport by rail but during other activities related to its operation, the main reason for occupational accidents was still excluded. Therefore, the actual situation for the most affected group by railway accidents did not improve much, despite the tightening of their property rights (*ibid.*).

Finally in 1871 with the passing of the *Reichshaftpflichtgesetz* (RHG) (Liability Law of the German Reich) an extension of § 25 PRL was set in force. The personal and objective scope of the strict liability of railway accidents was raised with § 1 RHG. First, § 1 RHG was extended to all damages caused by the operation of railways. This imitation of § 25 PRL was a real improvement to the legal position of the railway employees. Thus, § 25 PRL turned out to be only partially successful with respect to passenger services, as § 1 RHG was a modified version of § 25 PRL. Secondly, in contrast to the PRL, the RHG was in force throughout the whole German Reich, whereas the PRL only covered Prussia. § 2 RHG contained a legal in-

²⁰For more details see Eckardt (1998, 327ff.).

novation for the tightening of the liability without fault for the employer. Under this rule, he was liable not only for his own negligence but also for negligence of his senior employees. But this rule was only applied to mining, quarrying and factories. It was the first step towards coping with the increasing number of industrial injuries. After a short time, it was superseded by the Unfallversicherungsgesetz (Accident Insurance Law) which was passed in 1884 (Wickenhagen 1980). With the enactment of this statute the traditional legal path of coping with occupational accidents was abandoned. Instead of damages paid according to the civil tort law, a compulsory insurance for all employees was introduced which provided for the subsistence of injured workers and their relatives. With this innovation, a new paradigm for the legal treatment of industrial accidents was introduced which is still in force today.

But the strict liability rule which was first introduced in § 25 PRL in 1838 and then imitated in § 1 RHG was also widely adopted. It was successively imitated to cope with new technologies that were judged to be risky. Thus, the strict liability rule was imitated for statutory provisions on accidents by motor vehicles in 1908, by air transport in 1922, by the mains in 1943, to damages of the water balance in 1957, to the use of nuclear power in 1959, to drugs in 1972, to product liability in 1989, to genetic engineering in 1990 and to negative technological externalities caused by plants in 1990. And although the negligence rule remained the central liability rule of the German tort law, the judges have raised the standards for the duty of care of the producer or user of new technologies to such an extent that this traditional liability rule increasingly creates incentives similar to the strict liability rule.

4. Conclusions

The objective of this paper was to contribute to our understanding of the co-evolution of technical and legal change. Because of the complexity of this subject we have confined our study to the exploration of the process of legal innovations by legislation. Thus, we assumed technical innovations as exogenous and analyzed the incentives that were exerted by them on the process of legal change. That is, we did not take into account the feedback-effects which resulted from changes in the legal environment for the innovative activities of companies. Furthermore, we looked only at the process of statutory innovations, and did not take the subject of judicial innovations into consideration. Consequently, we were not able to consider the interdependencies of the process of statutory and judicial legal changes. Nevertheless, we hope that we have shown both theoretically and empirically that one can gain more insights in this very important field of research by combining some of the main ideas of *New Institutional Economics* and of *Evolutionary Economics*.

Legal changes are seen as the results of cumulative variation-selection-processes. The cognitive creativity of the actors involved provides for the generation of legal (as well as technical) innovations. But the potential multitude of heterogeneous outcomes is limited by the political and economic selection environment that determines the opportunity costs of collective political activities which are a necessary precondition for statutory innovations. A decisive factor in this respect are the wealth reductions caused by the negative technological externalities, which are by-products of the use of technical innovations. As they vary over the lifecycle of a technology, the opportunity costs of political activities and thus the incentives for statutory changes vary, too. In addition, legal innovations are influenced by the hitherto applied legal rules which structure to some extent the cognitive frameworks of the involved actors and thus shape the path of legal change.

We have tried to show the fruitfulness of this approach by its application to the evolution of the German tort law in the 19th century. Because of the importance of path-dependencies we referred to two statutory innovations that stem from the introduction and growth stage of the

lifecycle of the railway technology. With respect to the introduction of the strict liability rule for railway accidents under § 25 PRL in 1838, we concentrated on the variation process. It could be shown that according to our theoretically derived hypotheses, cognitive aspects were most important with regard to legal innovations in the early market stages. Moreover, even in this apparently clear case, a multitude of diverse opinions about both the underlying problem and the adequate solutions to it were discussed. That is, the introduction of § 25 PRL has to be seen, at least in part, as random or based on historical contingencies. No mechanism could be detected that provided for the adoption of an *efficient* legal rule, nor did rent seeking-interests play any role. In the second case study – the prohibition of the contractual exclusion of liability for damages on goods transported by the railways under art.423 GGCC – we emphasized the influence of the political and economic selection environment on the formation of interest groups. Because of earlier developments exogenous to the process of statutory law-making, the set-up costs for the formation of interest groups both for the railway companies and the merchants were enormously lowered. Therefore, they had well-functioning organizations at their disposal already in the early market stages, which they could use for political activities. However, these legal innovations proved to be only of limited usefulness because of the limited knowledge the actors involved had about the underlying problem and future developments. Nonetheless, they formed the basic starting point for future innovations and modifications of the German tort law whenever fundamentally novel technological paradigms emerged. Empirically, our approach should further be applied to other legal innovations that were enacted over the lifecycle of the railway technology to test whether our hypotheses are valid. In particular, some econometric studies should be undertaken. Additionally, it would be desirable to use this approach to analyze legal innovations that are a result of the emergence of other technical innovations. Besides, while this approach was developed with reference to the German law, comparative studies would be desirable to see whether it is also an accurate model for other legal systems.

It seems that there is still a long way to go until a coherent economic theory of the evolution of the law is formulated. Even with respect to the problem treated in this paper – legal innovations caused by technical change – a number of unresolved questions have to be answered. Theoretically, a more formal specification of the variation and selection mechanisms seems to be adequate. Moreover, with respect to the retention mechanisms we only dealt with path-dependencies resulting from the cognitive frameworks and shared mental models of the actors. But there are other aspects to be integrated like network externalities, scale and learning effects. Furthermore, as already mentioned, the interdependencies of statutory and judicial legal innovations have to be studied in more detail, because only taken together do they make for a theory of legal change. But all in all, this combination of evolutionary and neo-institutional theorizing seems a promising way to reach a coherent theory of the co-evolution of technical and legal change.

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Appendix

Table 1: The railway network of Prussian and German railways, 1835-1879 (in kilometers)

Year	Germany single- track	double-track	Prussia single- track	double-track
1835	6			
1836	6			
1837	20			
1838	141		34	
1839	242		69	
1840	462	117	185	
1841	677	135	395	18
1842	922	248	588	113
1843	1310	264	815	136
1844	1758	264	924	136
1845	2151	286	1106	158
1846	3291	426	1972	188
1847	4317	650	2424	320
1848	5002	1139	2718	567
1849	5458	1229	2880	632
1850	5875	1248	2967	365
1851	6162	1334	3153	731
1852	6649	1394	3487	735
1853	7177	1557	3697	803
1854	7608	1808	3697	992
1855	7862		3822	1040
1856	8672		4373	1184
1857	9055		4652	1426
1858	9721	2873	4901	1550
1859	10648		5452	1600
1860	11157		5762	1742
1861	11567		5951	1800
1862	12150		6113	1821
1863	12773	3710	6416	1960
1864	13240	4048	6560	2110
1865	14034	4400	6895	2265
1866	14941	4618	7133	2418
1867	15793	4929	7425	2640
1868	16442	5275	10125	3645
1869	17322	5673	10457	3796
1870	18810	5959	11460	4067
1871	20405	6337	12474	4377
1872	22522	7454	13632	4971
1873	23853	8061	14461	5398
1874	25495	8290	15493	5575
1875	27931	9152	16940	6358
1876	29088	9186	17556	6391
1877	30288	9476	18346	6514
1878	31337	9601	18974	6634
1879	33094	9782	20134	6795

Source: Fremdling (1975, 48).

Table 2: Passenger services and freight traffic on German and Prussian railways, 1840-1879
(mio. Personenkm bzw. Tonnenkilometer)

Year	Personenkilometer (Mio.)		Tonnenkilometer (Mio.) (inkl. livestock transport)	
	Germany	Prussia	Germany	Prussia
1840	62,3	20,1	3,2	0,5
1841	97,2	42,5	8,1	3,9
1842	145,3	84,9	14,5	8,6
1843	185,0	113,0	25,6	18,3
1844	255,7	153,0	33,2	23,0
1845	308,5	161,7	50,8	28,4
1846	427,8	224,5	81,9	46,6
1847	546,7	318,8	159,7	105,2
1848	614,9	346,4	168,4	112,2
1849	664,3	359,4	233,8	149,5
1850	782,7	421,7	302,7	194,2
1851	865,3	440,5	393,8	239,0
1852	914,2	450,2	527,4	330,7
1853	935,1	477,8	620,8	412,5
1854	1040,8	505,2	897,7	551,5
1855	1090,4	531,9	1094,9	663,0
1856	1263,0	627,4	1241,8	752,5
1857	1457,1	740,5	1531,2	907,8
1858	1490,6	760,6	1505,0	876,6
1859	1637,2	810,1	1475,2	816,9
1860	1732,9	874,6	1675,2	963,7
1861	1900,9	958,6	1997,6	1157,8
1862	2063,7	1042,4	2431,4	1452,4
1863	2359,8	1201,8	2776,8	1637,5
1864	2571,2	1384,0	3219,8	1934,9
1865	2676,0	1385,9	3671,8	2244,0
1866	3131,8	1772,7	3777,0	2291,1
1867	2977,9	1518,9	4527,1	2707,6
1868	3236,1	2073,1	5184,0	3590,4
1869	3533,8	2271,7	5520,4	3848,1
1870	4446,8	3029,5	5875,9	4176,6
1871	5031,3	3374,3	7072,0	4918,4
1872	5019,9	3157,9	8361,3	5724,6
1873	5692,7	3553,8	10060,0	7016,8
1874	5843,7	3651,6	10295,6	7193,5
1875	5994,3	3784,1	10624,6	7443,6
1876	6109,4	3826,0	10978,7	7737,3
1877	6111,9	3750,3	11224,7	7953,9
1878	6151,2	3777,6	11497,1	8035,4
1879	6147,5	3825,3	12244,3	8644,6

Source: Fremdling (1975, 17).

Table 3: Employees, income, expenditure and capital earnings of German and Prussian railways, 1840-1879 (mio. mark)

year	Germany				Prussia			
	employee	income	expen- diture	capital earnings	employ- ees	income	expen- diture	capital earnings
1840	1648	3,6	2,0	1,539	648	1,1	0,8	0,314
1841	2776	5,8	3,4	2,420		2,6	1,7	0,972
1842	4114	9,1	5,1	4,022	2335	5,3	3,0	2,304
1843	5719	13,0	6,5	6,456	3299	8,3	3,9	4,353
1844	8475	17,4	9,3	8,018	4884	10,7	5,6	5,094
1845	9541	20,6	11,2	9,462	4976	11,5	6,1	5,348
1846	12505	30,0	16,3	13,675	7065	17,4	9,6	7,776
1847	17059	42,4	23,3	19,027	9674	26,2	13,7	12,441
1848	20910	46,0	27,7	18,336	11449	27,5	15,8	11,739
1849	23345	55,9	29,8	26,168	12534	32,6	16,6	16,014
1850	26084	67,5	34,6	32,916	13706	39,3	18,8	20,478
1851	32487	77,7	37,8	39,984	17163	43,8	20,6	23,162
1852	38625	92,0	44,6	47,509	20633	51,5	24,6	26,924
1853	44287	105,9	53,6	52,318	23687	59,6	30,1	29,451
1854	47734	125,1	62,3	60,708	26326	70,3	36,5	33,799
1855	51480	145,9	74,7	69,047	27380	81,0	43,0	37,997
1856	55427	164,1	82,7	79,262	30276	92,1	49,5	42,517
1857	64975	191,8	90,3	96,913	34357	106,9	53,8	53,193
1858	70145	191,0	94,4	93,474	36181	105,7	53,6	52,083
1859	80102	196,1	95,6	99,127	41467	103,2	50,1	53,119
1860	85608	218,2	100,2	117,607	44852	117,4	52,1	65,35
1861	90159	243,6	110,0	133,608	48420	132,3	58,5	73,774
1862	93782	275,8	122,3	153,494	51502	151,5	66,0	85,493
1863	101859	292,5	135,2	157,284	56462	160,6	72,6	88,022
1864	105740	322,2	145,7	176,510	58005	180,0	77,9	102,067
1865	113570	353,6	160,2	193,355	62294	196,5	85,5	110,973
1866	121630	374,5	182,9	191,613	64859	208,9	98,1	110,767
1867	131867	414,7	205,5	209,154	73190	222,3	109,7	112,658
1868	143562	450,5	222,2	228,348	96987	290,8	140,9	149,869
1869	153778	472,2	231,4	240,868	101388	310,3	146,9	163,393
1870	161014	510,7	253,3	257,429	106542	314,8	161,2	180,595
1871	178461	608,0	305,0	302,985	122506	397,8	193,0	204,816
1872	193506	670,7	381,7	288,958	135875	434,5	238,8	195,678
1873	234114	750,7	464,0	286,693	162114	490,5	297,4	193,155
1874	263554	788,9	503,6	285,266	178350	516,1	326,6	189,485
1875	274018	836,9	492,4	344,580	182476	552,1	313,5	238,648
1876	278107	843,5	484,7	358,776	182724	553,8	303,6	250,182
1877	262490	839,3	476,1	363,188	179091	551,3	310,1	241,167
1878	269185	800,3	441,6	358,669	179203	550,9	277,2	273,671
1879	272831	814,8	436,3	378,527	182143	565,9	276,8	289,133

Source: Fremdling (1975, 24f., 141, 143)

Table 4: People injured or killed on Prussian railways, 1851-1879

Year	Passengers			Railway employees			Others (with suicide)			Suicide			Total		
	K	I	A	K	I	A	K	I	A	K	I	A	K	I	A
1851	1	4	5	20	20	40	4	3	7	1	1	2	25	27	52
1852	2	0	2	31	47	78	9	7	16	6	2	8	42	54	96
1853	2	2	4	58	52	110	20	6	26	8	1	9	80	59	139
1856	3	1	4	63	84	147	24	9	33	8	3	11	90	94	184
1858	0	0	0	64	112	176	27	8	35	13	0	13	91	120	211
1860	0	5	5	51	111	162	39	5	44	16	0	16	90	121	211
1862	1	3	4	72	96	168	52	25	77	22	3	25	125	124	249
1864	1	15	16	102	196	298	63	18	81	27	2	29	166	229	395
1866	21	44	65	135	204	339	95	29	124	39	3	42	251	277	528
1868	4	17	21	183	320	503	127	30	157	40	3	43	314	367	681
1870	41	184	225	179	526	707	96	64	160	20	5	25	316	774	1090
1871	40	126	166	240	638	878	122	81	203	38	5	43	402	845	1247
1873	11	127	138	314	988	1302	176	81	257	57	2	59	501	1196	1697
1875	13	41	54	269	1107	1376	180	74	254	79	6	85	462	1222	1684
1877	14	62	76	186	1026	1212	163	67	230	66	13	79	363	1155	1518
1878	12	46	58	173	1030	1203	190	86	276	86	7	93	375	1162	1537
1879	8	45	53	197	893	1104	175	71	246	68	9	77	380	1023	1403

K = Killed

I = Injured

A = All

Source: Statistische Nachrichten von den Preußischen Eisenbahnen, (diff. vols.), Berlin.

Table 5: Passengers and Railway Employees, killed or injured by railway accidents, Prussia 1854-1870

Passengers

	1			2			Total			1/all
	killed	injured	all	killed	injured	all	killed	injured	all	
1854	0	6	6	0	0	0	0	6	6	1
1855	0	1	1	0	2	2	0	3	3	0,33
1856	0	1	1	3	0	3	3	1	4	0,25
1857	0	0	0	1	1	2	1	1	2	...
1858	0	0	0	0	0	0	0	0	0	...
1859	0	0	0	0	2	2	0	2	2	...
1860	0	3	3	0	2	2	0	5	5	0,60
1861	3	8	11	0	4	4	3	12	15	0,73
1862	0	2	2	1	1	2	1	3	4	0,50
1863	1	2	3	3	2	5	4	4	8	0,38
1864	0	8	8	1	7	8	1	15	16	0,50
1865	5	32	37	2	3	5	7	35	42	0,88
1866	1	18	19	20	26	46	21	44	65	0,29
1867	0	5	5	2	4	6	2	9	11	0,45
1868	1	8	9	3	9	12	4	17	21	0,43
1869	0	7	7	4	10	14	4	17	21	0,33
1870	16	121	137	25	63	88	41	184	225	0,61

Average 0,52

1 = victim without own fault

2 = victim because of own carelessness

Railway Employees

	3			4			Total			3/all
	killed	injured	all	killed	injured	all	killed	injured	all	
1854	1	18	19	58	55	113	59	73	132	0,14
1855	4	9	13	67	38	105	71	47	118	0,11
1856	6	24	30	57	60	117	63	84	147	0,20
1857	4	19	23	50	142	192	54	161	215	0,11
1858	4	20	24	60	92	152	64	112	176	0,14
1859	5	4	9	63	96	159	68	100	168	0,05
1860	3	15	18	48	96	144	51	111	162	0,11
1861	1	21	22	73	80	153	74	101	175	0,13
1862	4	11	15	68	85	153	72	96	168	0,09
1863	3	30	33	77	114	191	80	144	224	0,15
1864	7	45	52	95	151	246	102	196	298	0,17
1865	4	17	21	134	210	344	138	227	365	0,06
1866	10	35	45	125	169	294	135	204	339	0,13
1867	15	50	65	149	213	362	164	263	427	0,15
1868	6	33	39	177	287	464	183	320	503	0,08
1869	13	76	89	201	522	723	214	598	812	0,11
1870	7	97	104	172	429	601	179	526	705	0,15

Average 0,12

3 = victim without own fault

4 = victim because of own carelessness

Source: Statistische Nachrichten von den Preußischen Eisenbahnen, diff. vols., Berlin