The dynamics of one-sided incomplete information in motor disputes

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Abstract

Multi-period negotiation model is developed to investigate the optimal strategy of the incompletely informed defendant in the course of the negotiation process. We focus on the distribution function of settlements over time so as to test that; 1) the duration of the claim's settlement depends on the degree of litigants' informational asymmetry and, 2) those asymmetries in information have a dynamic pattern during the negotiation process. Competing risk models are applied to a Spanish motor insurance database. Both hypotheses are corroborated by empirical analysis. We show that some factors related to severity of injuries are negatively associated with the duration of the claim, suggesting that uncertainty on the magnitude of damages is reduced with these factors. Time-varying effects are observed for those explanatory factors related to the victim's age and the severity of injuries. The effect of these factors on the duration of the claim is attenuated over time, thereby supporting the assumption that the insurer's incomplete information is enriched during the course of negotiations.

Keywords

Litigation, dispute, cumulative incidence function, settlement delay, private information, mediation.

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1. Introduction

In Europe, motor insurance is compulsory for all drivers. Any person sustaining injuries as a consequence of a motor vehicle accident is entitled to a compensation for damages from the insurer of the at-fault party. Following an accident, a negotiation will usually be initiated between the victim and the insurer– or their respective lawyers – to determine the amount of damages to be paid out. Only when an agreement cannot be reached is the dispute resolved by judicial decision. In the case of motor bodily injuries, most claims are settled by negotiation, with fewer than 5% of cases in countries such as Spain, the UK or the US being taken to court (Ayuso and Santolino, 2012; Lewis, 2006; Derrig and Rempala, 2006).

The determinants of motor claim compensations and costs associated with alternative compensation systems have been extensively studied in the literature (Derrig and Weisberg, 2004; Ayuso et al., 2012; Ayuso and Santolino, 2012; Browne and Puelz, 1999; Bell, 2006). Alternative Dispute Resolution (ADR) mechanisms have gained popularity in recent years[2] to reach less costly motor claim settlements in terms of – private and social – costs and settlement duration (De Palo, 2013; Doornik, 2014). From these reports it is apparent that the settlement of motor vehicle injury disputes can be lengthy and that the legal process can be slow in many jurisdictions, with the trial date often being fixed several years after legal proceedings have been initiated. In an appreciable number of out-of-court settlements, agreement is not reached until the parties are actually on the courthouse steps (Londrigan, 1984; Deffains and Doriat, 1999). As a result motor vehicle claims may remain unsettled for several years regardless of the resolution mechanisms adopted.

Delay in litigation is generally costly (including the expense of hiring lawyers, paying court costs, making interest payments, etc.) and affects both parties to the litigation. From the insurers' point of view, delay extends uncertainty over long periods, making the computation of adequate provisions essential, while victims are left waiting to receive compensation for their injuries. Despite the obvious importance of this matter,

[2] European Mediation Directive 2008/52/EC, implemented in 2008, seeks to promote ADR mechanisms for the reaching of out-of-court agreements in civil disputes. In Spain, Law 5/2012 on Mediation in Civil and Commercial Disputes was introduced in 2012 to adapt national legislation to the European Directive.

the study of the causes of settlement delays has received only scant regard in the literature.

Multi-period bargaining models have been developed in the literature to explain why some cases are settled earlier than others (Spier, 1992; 2003; Fenn and Rickman, 1999). These bargaining models investigate the optimal strategy of litigants during the negotiation process. One-sided incomplete information is the theoretical foundation to their proposals, in which one of the parties has private knowledge regarding the magnitude of damages and negotiations are pursued by the other party in order to *uncover* this private information[3]. The negotiation is extended over several periods during which the incompletely informed litigant makes sequential offers to the informed litigant. Spier's multi-period model is a pioneering strategic bargaining model that addresses the time it takes to settle legal disputes (Spier, 1992). The author focuses on the US litigation system in which the parties have to bear their own legal costs. Fenn and Rickman (1999) adapt Spier's model to account for English cost allocation rules, where the losing litigant pays the legal costs of both parties.

Inspired on Spier's theoretical model (Spier, 1992), a multi-period bargaining model is developed to explain the time it takes the negotiation of the claim compensation. In our theoretical framework the degree of informational asymmetry is determined by the level of uncertainty that the defendant has regarding the magnitude of the compensation. The Perfect Bayesian Equilibrium (PBE) of the model provides an analytical solution when the uniform distribution is assumed on the range of feasible compensations[4]. This article investigates the effect of the claim severity on the compensation uncertainty and how that uncertainty affects the time the claim takes to settle. Dynamic nature of incomplete information during the negotiation process is examined. We explore the impact on the bargaining process when private information is actively disclosed over time as a result of the plaintiff's counter-demands.

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[3] Bargaining models dealing with two-sided incomplete information are found in the literature but are developed in a timeless framework (Daughety and Reinganum, 1994; Friedman and Wittman, 2007).

[4] The PBE concept is appropriate in situations of incomplete information (Spier, 1992). It requires litigants to behave rationally in each round of the negotiation given the insurer's beliefs that are generated by Bayes' rule.

This paper combines theory and data to test the key hypotheses that 1) claim duration is based on the level of compensation uncertainty, which is not always positively associated with claim severity, and 2) one-sided incomplete information has a dynamic pattern in the course of a negotiation. A motor insurance database is provided by a leading Spanish insurance company that reports out-of-court motor vehicle injury settlements. A survival analysis is carried out to determine which factors serve to delay motor claim settlements. Competing risk models are applied to estimate the distribution function of settlements over time. Specifically, the semi-parametric regression developed by Fine and Gray (1999), and generalized by Scheike and Zhang (2008), is used to model the distribution function of settlements. In a similar study, Fenn and Rickman (2013) provide an empirical analysis of factors leading the decision to drop or settle medical malpractice disputes over time by means of competing risk models. They investigate the relationship between time to resolution and the information about case strength, and found that cases involving little uncertainty, because they are either relatively weak or relatively strong, are resolved faster. Unlike this previous study, we allow in the regression analysis that explanatory factors have time-varying effects. Indeed, the hypothesis of dynamics in information asymmetries between the plaintiff and insurer is investigated by analysing the impact of explanatory factors over time. The time-varying effects of the explanatory factors are tested and specific time-functional forms for time-varying effects are studied. We examine whether the detection of time-varying effects provides any insights into time-negotiation patterns.

The rest of this paper is structured as follows. In the next section the theoretical bargaining model is examined when the dynamics of one-sided incomplete information are allowed. Survival models are described in section 3. Our data and empirical results are summarized in section 4. Section 5 concludes.

2. The theoretical bargaining model

A one-sided incomplete information bargaining model is developed based on Spier's model (Spier, 1992). Initial theoretical bargaining models were based on the divergence expectations theory (Shavell, 1982; Priest and Klein, 1984; Cooter and Rubinfeld, 1989). In these one-shot models, the surplus of out-of-court settlements is computed as the difference between the parties' subjective values of trial outcomes and the associated costs of both resolution procedures. Disputes are settled out-of-court when the surplus is positive; otherwise they are settled by judicial decision. In the previous one-off analysis, time does not play an explicit role.

Multi-period bargaining models have been developed to analyse those factors that influence settlement timing. Here we follow Spier's modelling approach (Spier, 1992) in assuming that the plaintiff has private information. Denoting the magnitude of damages by y, it is hypothesised that the court has the capacity to observe the actual damage sustained by the plaintiff and it awards the amount of restitution. The plaintiff is aware of the extent of the damage and, thus, the plaintiff has a better knowledge what the trial outcome will be should the claim be settled by judicial decision. Unlike the plaintiff, the defendant has incomplete information. For example, in the case of motor disputes, at early stages of the negotiation the defendant (the insurer) will have an evaluation of the victim's injury severity carried out by the medical staff of the insurance company. The plaintiff (victim) will have access to the insurer's medical examination, and likely his/her own partial medical examination. In addition to that medical evaluation, the victim is who knows the economic and non-economic damages sustained as a consequence of those injuries.

In this theoretical framework, we assume that the defendant does not know the magnitude of damages but knows at the initial stage of the negotiation that are drawn from a known distribution. We follow Spier's assumption that the defendant knows that damages y are drawn from a uniform distribution on $\left[\underline{y}, \overline{y}\right]$, where $\underline{y}$ is the minimum compensation the plaintiff would be awarded by the court and $\overline{y}$ the maximum compensation[5]. The only source of asymmetric information considered in the model is the magnitude of the damages. The degree of asymmetric information is determined by the level of uncertainty of the defendant regarding the compensation amount, where the

[5] The uniform distribution is a non-informative distribution, so it is assumed that defendant has not prior information related on how damages are distributed on the range $\left[\underline{y}, \overline{y}\right]$. The uniform distribution of damages has commonly been considered in multi-stage bargaining modeling approaches (Fenn and Rickman, 1999; Sobel and Takahashi, 1983; Cramton and Tracy, 1992).

range of the interval between the two bounds can be understood as a measure of that uncertainty. A higher degree of uncertainty is associated to the defendant as larger is the gap between the two compensation limits. This means that the other characteristics of the accident, including the level of liability, have no effect on the timing of the settlement as they are known to the litigants[6].

The trial date is exogenously fixed and known by litigants. Negotiation takes place over a known time span of T-1 periods. If an agreement is not reached, then the compensation is decided at trial in T. Let us consider that the defendant makes an offer to the plaintiff in each period of the negotiation. Each time a compensation offer is rejected by the plaintiff, the defendant uses this information to determine the lower bound of compensation in the next period. The offer made by the defendant during period t is denoted as S_t. In a multi-period model, the present value of future payments also has to be considered. The litigants discount the future at the same rate δ. Therefore, defendant knows that whether S_t is rejected, in period t+1 it must be fulfilled that the damages y are ranged on $\left[\underline{y}_{t+1}, \bar{y}\right]$, where $\underline{y}_{t+1} = \delta^{-T+t} S_t$.

As in Ayuso et al., (2012) defendant is assumed to be risk-neutral. The incompletely informed defendant computes a set of offers that partition the range of compensation payouts, where each offer is designed to minimize the expected payout given the remaining periods and the fact that plaintiff-types below the partition will have accepted earlier offers (Fenn and Rickman, 1999). Let $V_{(T-t, \underline{y}_t, \bar{y})}$ be the defendant's expected payoff at period t, where (T-t) are the number of remaining negotiation periods and $\underline{y}_t$ is the lower bound of compensation, for t=1,…,T. This optimisation problem needs to take into account the litigation costs, given that litigation is not free. We assume that losing litigant has to pay the costs incurred by both parties[7]. The total costs incurred by

[6] This simplifying assumption seems to be reasonable in the context of motor bodily injury claims as objective liability is applied in Spanish motor injury disputes. Fenn and Rickman (1999) analyse the effect of liability on the conditional probability of settlement, where the percentage of liability is known by litigants.

[7] Under Spanish rules the losing litigant has to pay the costs incurred by both parties (Ayuso and Santolino, 2012), but the model can be adapted when parties have to bear their own litigation costs.

the plaintiff and by the defendant at the beginning of each period of the negotiation are c. The litigants' trial costs are denoted by k.

First we analyse the model for a settlement time span of two periods (T=2). The defendant knows that damages y are in the range $\left[\underline{y}_1, \overline{y}\right]$. In the one-shot game the objective function to optimize is $V_{(1,\underline{y}_1,\overline{y})} = \Pr(S_1)\cdot S_1 + \Pr(\overline{S}_1)\delta\cdot\left(TC+k\right)+c$, where $\Pr(S_1)$ and $\Pr(\overline{S}_1)$ are the probabilities of the plaintiff accepting or rejecting S_1, respectively, and TC is the expected court awarded compensation. Note that damages are uniformly distributed in the range $(\overline{y}-\underline{y}_1)$, so $\Pr(S_1)=\left(\dfrac{\underline{y}_2-\underline{y}_1}{\overline{y}-\underline{y}_1}\right)$, $\Pr(\overline{S}_1)=1-\Pr(S_1)=\left(\dfrac{\overline{y}-\underline{y}_2}{\overline{y}-\underline{y}_1}\right)$ and $TC=\dfrac{\overline{y}+\underline{y}_2}{2}$. The objective function

$$
\begin{aligned}
V_{(1,\underline{y}_1,\overline{y})} &= \left(\frac{\underline{y}_2-\underline{y}_1}{\overline{y}-\underline{y}_1}\right)S_1 + \left(\frac{\overline{y}-\underline{y}_2}{\overline{y}-\underline{y}_1}\right)\delta\left(\frac{\overline{y}+\underline{y}_2}{2}+k\right)+c \\
&= \left(\frac{\delta^{-1}S_1-\underline{y}_1}{\overline{y}-\underline{y}_1}\right)S_1 + \left(\frac{\overline{y}-\delta^{-1}S_1}{\overline{y}-\underline{y}_1}\right)\delta\left(\frac{\overline{y}+\delta^{-1}S_1}{2}+k\right)+c
\end{aligned}
\qquad (1)
$$

is minimized by the offer $S_1^* = \delta(\underline{y}_1+k)$ and, then, $\underline{y}_2^* = \underline{y}_1 + k$.

We analyse now the model for a time span of three periods (T=3). Therefore, the defendant must offer a first amount S_1 and, if it is rejected by the victim, in the next negotiation period a second offer S_2. In this game, it must be fulfilled that $\delta^{-2}S_1 = \underline{y}_2$ and $\delta^{-1}S_2 = \underline{y}_3$, so plaintiffs with damages in the range $(\underline{y}_{t+1}-\underline{y}_t)$ will accept the compensation offer S_t, for t=1,2. In the first period the defendant's optimal first period offer S_1 must minimize the expected payoff $V_{(2,\underline{y}_1,\overline{y}_1)}$ which is given by,

$$V_{(2,\underline{y}_1,\overline{y})} = \Pr(S_1)\cdot S_1 + \Pr(\overline{S}_1)\delta\cdot V_{(1,\underline{y}_2,\overline{y})}+c \qquad (2)$$

where $V_{(1,\underline{y}_2,\overline{y})}$ is the expected payoff in the second period of negotiation (t=2) that is equal to,

$$V_{(1,\underline{y}_2,\bar{y})} = \Pr(S_2)\cdot S_2 + \Pr(\bar{S}_2)\delta\cdot\left(TC+k\right)+c$$
$$= \left(\frac{\underline{y}_3-\underline{y}_2}{\bar{y}-\underline{y}_2}\right)S_2 + \left(\frac{\bar{y}_2-\underline{y}_3}{\bar{y}-\underline{y}_2}\right)\left(\frac{\bar{y}+\underline{y}_3}{2}+k\right)+c.$$

The model is sequentially optimised. From the one-shot model, it is derived that the offer made by the defendant to the victim in the second period (*t*=2) is equal to the discounted sum of the lower bound and trial costs $S_2 = \delta(\underline{y}_2 + k)$. Then, expression (2) is optimised for the first period strategic offer $S_1^* = \delta^2(\underline{y}_1 + \delta^{-1}c + k)$ and optimal partitions are equal to $\underline{y}_2^* = \underline{y}_1 + \delta^{-1}c + k$ and $\underline{y}_3^* = \underline{y}_1 + \delta^{-1}c + 2k$. Let us now extend the negotiation to *T* periods. Optimal partitions when the model is generalized to *T* periods are as follows[8],

$$\begin{aligned} \underline{y}_t^* &= \underline{y}_{t-1} + \sum_{i=1}^{T-t}\delta^{-i}c + k = \underline{y}_1 + \sum_{j=1}^{t-1}\left(\sum_{i=1}^{T-(j+1)}\delta^{-i}c\right) + (t-1)k \qquad 1<t<T \\ y_T^* &= \underline{y}_{T-1} + k = \underline{y}_1 + \sum_{j=1}^{T-2}\left(\sum_{i=1}^{T-(j+1)}\delta^{-i}c\right) + (T-1)k \end{aligned} \tag{3}$$

The results can be explained as follows. In each period, the optimal offer for the defendant is the sum of the lower bound of feasible damages and the total future costs whether the dispute is resolved in trial. Therefore, gains from settlement in a period *t* are the future costs to be saved in next periods of the settlement process.

2.1 Theoretical predictions of the model

Our goal is to analyse how the duration of the settlement process is determined by the case severity and the degree of defendant's uncertainty regarding the magnitude of damages, and the dynamic nature of that uncertainty during the negotiation process. We focus on the distribution function of settlements over time. For the uniformly distributed random variable, the probability distribution function (pdf) is defined as follows,

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[8] Spier's modelling approach does not follow the assumption that $\delta^{T-t}S_t = \underline{y}_{t+1}$, however, offers are forced to be equivalent over time in financial terms $S_t = \delta S_{t+1}$. Under this framework, the model is optimised by $\underline{y}_t^* = \underline{y}_1 + \delta^{-T}\sum_{i=1}^{t-1}\delta^i c$ and $\underline{y}_T^* = \underline{y}_{T-1} + k$. See, for details, Spier (1992).

$$f(\underline{y}_1) = 0 \qquad t = 1$$

$$f(\underline{y}_t) = \frac{\underline{y}_t - \underline{y}_{t-1}}{\overline{y} - \underline{y}_1} = \frac{\sum_{i=1}^{T-t} \delta^{-i} c + k}{\overline{y} - \underline{y}_1} \qquad 1 < t < T \tag{4}$$

$$f(\underline{y}_T) = \frac{\underline{y}_T - \underline{y}_{T-1}}{\overline{y} - \underline{y}_1} = \frac{k}{\overline{y} - \underline{y}_1} \qquad t = T$$

and the cumulative distribution function (cdf) is equal to,

$$F(\underline{y}_1) = 0 \qquad t = 1$$

$$F(\underline{y}_t) = \frac{\underline{y}_t - \underline{y}_1}{\overline{y} - \underline{y}_1} = \frac{\sum_{j=1}^{t-1} \left(\sum_{i=1}^{T-(j+1)} \delta^{-i} c \right) + (t-1)k}{\overline{y} - \underline{y}_1} \qquad 1 < t < T \tag{5}$$

$$F(\underline{y}_T) = \frac{\underline{y}_T - \underline{y}_1}{\overline{y} - \underline{y}_1} = \frac{\sum_{j=1}^{T-2} \left(\sum_{i=1}^{T-(j+1)} \delta^{-i} c \right) + (T-1)k}{\overline{y} - \underline{y}_1} \qquad t = T$$

From expressions (4) and (5) a set of model predictions can be made. Hypotheses are formulated below.

H1. *Uncertainty over the magnitude of damages increases the time that cases will take to settle. More severe cases are positively associated with the settlement duration whether a higher level of uncertainty on the magnitude of compensation is involved.*

Previous studies showed that more severe cases take longer time to settle (Fenn and Rickman, 1999). We here postulate that this relationship does not hold in all the situations. We suggest that claim severity and duration are indirectly associated by means of compensation uncertainty. Indeed, we hypothesise that injury severity is positively associated with claim duration whether more severe cases involves a higher uncertainty on compensation amount. However, the duration of the negotiation is expected to be shorter whether the uncertainty on damages is reduced with claim severity. It can be shown as follows.

Let assume that the upper bound increases with the severity of damages and the lower bound has not variations. The maximum compensation amount associated to the more severe claim is $\overline{y}'$ such that $\overline{y}' > \overline{y}$ where $\overline{y}$ is the upper bound of the less severe case. So the interval of feasible compensations is ordered as $(\overline{y}' - \underline{y}_1) > (\overline{y} - \underline{y}_1)$. From expression (5) it is shown that $F'(\underline{y}_t) < F(\underline{y}_t)$ where $F'(\cdot)$ is the cdf of the uniformly distributed random variable in the range of damages $\left[\underline{y}_1, \overline{y}'\right]$. As a consequence, if $F'(\underline{y}_{t^*}) \geq F(\underline{y}_t)$ it must hold that $\underline{y}_{t^*} > \underline{y}_t$ or, equivalently, $t^* > t$.

However, the claim duration is expected to be shorter whether uncertainty over the amount of damages is negatively associated with injury severity. Let suppose that the maximum compensation amount increases with severity but uncertainty of damages is reduced. Limit bounds associated to the more severe case $\left[\underline{y}_1', \overline{y}'\right]$ are larger than those bounds associated to the less severe case, i.e. $\underline{y}_1' > \underline{y}_1$ and $\overline{y}' > \overline{y}$, but the range of the interval is lower $(\overline{y}' - \underline{y}_1') \leq (\overline{y} - \underline{y}_1)$. Note that it holds that $F''(\underline{y}_t) > F(\underline{y}_t)$ where $F''(\cdot)$ is the cdf of the uniformly distributed random variable in the range of damages $\left[\underline{y}_1', \overline{y}'\right]$. Consequently, $F''(\underline{y}_{t^*}) \leq F(\underline{y}_t)$ implies $\underline{y}_{t^*} < \underline{y}_t$ or, equivalently, $t^* < t$.

H2. *Uncertainty over the magnitude of damages fluctuates during the negotiation process. In the course of the negotiation incoming information is provided by the litigant with private information which affects the degree of uncertainty.*

We assume that the degree of uncertainty on the amount is dynamic over the course of the negotiation process where incoming information is provided by plaintiff's counter-demands. It is considered in the theoretical framework that each time a compensation offer is rejected by the plaintiff, the defendant uses this information to determine the lower bound of compensation in the next period. However, when the plaintiff makes a counter-demand and it too is rejected, the defendant would take advantage of this incoming information to compute the upper bound of compensation for the next period. That means, the upper bound of the compensation interval would depend on time, $\overline{y}_t$.

Note that the variation of the upper compensation bound over time is not restricted to a non-positive value. More often than not victims make a counter-demand that is lower than the previous one or they maintain the previous demand, $\overline{y}_t \geq \overline{y}_{t+1}$. However, the variation in the upper bound over time may be positive in some cases $\overline{y}_t < \overline{y}_{t+1}$. The reasons why the upper bound on compensation might be raised include, among others, the victim's suffering a relapse, unexpected additional expenses and more aggressive demands following the substitution of a lawyer. Consequently, the cdf may be negatively associated with time. We interpret this result to mean that the distribution function undergoes a readjustment when the upper bound on compensation changes.

3. Empirical analysis

3.1 Competing risk model

We seek to estimate the distribution function of the time it takes for claims disputes to be settled. The study of the duration of the claims settlement process can be undertaken by means of survival analysis. We are interested in analysing the effect of covariates on the duration of a claims settlement. The standard approach for exploring the relationship between the survival of a claim and a set of explanatory variables is to model the hazard function by means of the Cox regression model (Cox, 1972). In this study there is more than one possible event. Indeed, we distinguish between two different types of event: out-of-court settlements and court settlements. The occurrence of one event precludes the occurrence of the other. This constitutes the context of competing risks.

Let us define the out-of-court settlement as the 1st event and the court settlement as the 2nd event. One option when dealing with competing risks is to model the cause-specific hazards for the *k* event types, in our case two event types. This approach however entails certain drawbacks. When an event of interest is analysed, the cause-specific hazard Cox model considers competing risks of the event of interest as censored observations[9], and not as other possible events. Consequently, the cause-specific hazard function does not have a direct interpretation in terms of the cause-specific distribution function, because it depends on the cause-specific hazards for all the causes. The

[9] A censored observation is an observation that an event has not yet occurred at the time point of the study.

distribution function for the k-event $F_k(t,x)$, also called cumulative incidence function, is the probability of the occurrence of this event until time t conditional of a set of covariates x, in the presence of all possible events. As a result, the effect of covariates on survival probability cannot be readily summarized (Scheike and Zhang, 2008).

For competing risk data, Fine and Gray (1999) suggest a regression method such that the cumulative incidence function is directly modelled[10]. Let $\lambda_k(t,x)$ be the hazard related to the cumulative incidence function, as follows:

$$\begin{aligned}\lambda_k(t,x) &= \lim_{\Delta t\to 0}\frac{1}{\Delta t}\Pr\left\{t \le T \le t+\Delta t, \varepsilon = k \middle| T \ge t \cup (T \le t \cap \varepsilon \ne k), x\right\} \qquad k \in \{1,2\} \\ &= -\delta \log\{1-F_k(t,x)\}/\delta t\end{aligned}$$

Fine and Gray (1999) suggest a method for directly modelling the cumulative incidence function on the form,

$$F_k(t,x) = 1-\exp\{-\exp(\beta_k' x)\Lambda_k(t)\} \qquad k \in \{1,2\} \tag{6}$$

where β_k is a p-dimensional vector of parameters and x is the covariate vector. The function $\Lambda_k(t)$ has the form $\Lambda_k(t) = \int_0^t \lambda_{k0}(s)\delta s$, where $\lambda_{k0}(t)$ is the base line hazard for the k-th cause. We focus on modelling the cumulative incidence function of out-of-court settlements, k=1. Therefore, the k subscript is withdrawn to simplify notation, $F(t,x) = 1-\exp\{-\exp(\beta' x)u(t)\}$. This model corresponds to the complementary log-log transformation, $\text{cloglog}(1-F(t,x)) = u(t)+\beta' x.$ In this article we follow the generalization suggested by Sheike et al. (2008) in which a set of covariates is allowed to have time-varying effects,

$$\text{cloglog}(1-F(t,x)) = u'(t)z+\beta' x \tag{7}$$

[10] This flexible framework is adequate for dealing with data that consist of observations for which one of the k events occurred and of observations for which neither event has yet occurred (censored).

where z is a $(q+1)$ vector of covariates with time-varying effects $\{z=(1,z_1,...,z_j,...,z_q)'\}$. Note that the regression model (7) reduces to the Fine-Gray model when $z=1$. Estimators for $u(t)$ and β are iteratively obtained solving proper score equations and confidence bands are computed by means of resampling techniques (for details, see Scheike et al., 2008; Sheike and Zhang, 2008). The hypothesis of time-invariant effect may be tested by means of the Cramér-von Mises type test (see Martinussen and Sheike, 2006; Sheike and Zhang, 2011).

Specific time-functional forms are analysed for time-varying effects. In this article we consider the linear and quadratic parametric functions for those time-varying regressors, as follows:

$$\text{cloglog}(1-F\,(t,x))=u(t)+u_a'\times z+u_b'\times t\times z+u_c'\times t^2\times z+\beta' x \tag{8}$$

where u_a, u_b, u_c are the vector of parameters for the constant, linear and quadratic part of the time-varying effects. The parameters can now be easily interpreted. When a specific functional form is considered for the time-varying effects, the partial likelihood principle may be applied to obtain the parameter estimates (Gray, 1988; Fine and Gray, 1999).

3.2 Spanish motor disputes

We analyse third-party liability disputes between victims of motor vehicle accidents and the insurance company of the at-fault driver in Spain, where a legislative compensation system is in force to assess motor injury claims. The system seeks to reduce uncertainty over compensation payouts, primarily in disputes in which the main conflict concerns the amount of damages to be awarded[11]. The application of the compensation system is relatively straightforward involving the recognition of a basic payout to cover general damages depending on the severity of the victim's injuries. Correction factors are subsequently applied to adapt this general compensation to the particular circumstances/individual damages (Santolino, 2010; Santolino and Söderberg, 2012).

[11] Scheduled compensation systems exist in many European countries, including France, Belgium, Italy and Ireland (Rogers, 2001).

Following a traffic accident, the victim needs to bring charges against the at-fault driver to be entitled to compensation. Legal proceedings are then initiated. The first option available to the parties is to attempt to reach a friendly agreement regarding compensation for damages. During this negotiation a sequence of bid-demand rounds is played out. It is the insurer that will typically make the first offer of compensation based on the medical evaluation of the victim's injuries carried out by the medical staff of the insurance company. If this offer satisfies the victim's demands, then a settlement is reached and the negotiation proceedings come to an end. When the offer is rejected, the victim may present a counter-demand for compensation or break off negotiations and await the court hearing. If the victim makes a counter-demand, incoming information is revealed to the insurer regarding the magnitude of damages. Therefore, the insurer will take advantage of this information to readjust the level of uncertainty. When the victim makes a counter-demand, the onus shifts back to the insurer who has the option of accepting the counter-demand, rejecting it and presenting a fresh counter-offer, or awaiting the court hearing. These rounds of negotiation are repeated until a deal is reached, or the date for the court hearing arrives. In the latter case the action is resolved by judicial decision.

3.3 Data

Motor vehicle insurance data are provided by one of the leading motor car insurance companies operating in Spain. The dataset comprises a random sample of 5,000 victims that sustained injuries in traffic accidents in Spain, of which 4,781 claims were settled by negotiation between the insurer and the plaintiff and 219 were settled in court. All the victims in the sample received compensation in 2007. However, only 28 per cent of accidents occurred in 2007, with 57 per cent being recorded in 2006 and 15 per cent in 2005 or earlier. The victims had to be fully recovered or their injuries had to be stabilised before they could be compensated by the insurer. The time taken for the victim to recover was not included in the assessment of the duration of the settlement process. Thus, the duration was computed as the time between the date that the claim was settled and the date that the victim was deemed to be fully recovered from his or her temporary injuries, rather than the date on which the claim was made. In this way the potential endogeneity between the duration of the settlement process and the time taken by the victim to recover from his or her injuries is avoided.

The information regarding the claim (and included here in our dataset) was collected by the insurance company during the insurance claims process. The description of the variables and their associated descriptive statistics are shown in Table 1. The claims in the sample took an average of 224.35 days to be settled. However, major differences can be observed according to the settlement mechanism employed. The duration of claims settled by judicial decision was on average 649.61 days, with a standard deviation of 282.44 days. For out-of-court settlements the mean duration of the negotiation process was 204.86 days with a standard deviation of 179.58 days. The explanatory variables are classified as general factors, factors related to the region of the body where the injury was recorded and factors related to the severity of these injuries.

The general factors include the socio-demographic characteristics of the victim, such as age and gender, and victim type (i.e., role in accident). We hypothesize that the bargaining behaviour of the victims may be associated with their age and gender and, therefore, the length of the settlement procedure might, in part, be explained by these factors. The previous literature has reported the relationship between risk behaviour and the demographic features of agents (Ayuso et al., 2012; Doerpinghaus et al., 2008; Halek and Eisenhauer, 2001). Likewise, the victim's behaviour in the negotiation may also be conditioned by type. Note we classify victims according to the following types: driver, at-fault automobile passenger, no-fault automobile passenger and pedestrian or cyclist[12]. The victim's attitude can be expected to differ depending on whether they were a passenger in the at-fault automobile or otherwise. Indeed, Derrig and Weisberg (2004) claim that passengers of the at-fault automobile seek lower settlements because of a 'familiarity effect'. In the case of non-motorized road users, previous studies have shown that cyclists and pedestrians suffer more serious injuries than those suffered by car occupants, and so obtain higher compensation settlements (Pucher and Dijkstra, 2003; Ayuso et al., 2012). Here, we investigate whether longer claim durations are also expected to them.

[12] Motor insurance is third-party liability and, therefore, the at-fault driver is the only victim of a traffic accident not entitled to compensation for injuries sustained.

Table 1. Description of variables and statistics

Variable	Description	Mean	S.D.	Min.	Max.
Dependent variable					
Duration	Length of claim settlement (number of days of claim settlement)	224.346	206.397	0	2517
Procedure	1 if the compensation is agreed by negotiation; 2 if the compensation is awarded by judicial decision.	1.0438	0.205	1	2
Regressors					
General factors					
Victim's age	Age of the victim	37.778	16.659	2	98
Gender	1 if the injured victim is male; 0 otherwise.	0.455	0.498	0	1
Driver	1 if the injured victim was the driver; 0 otherwise.	0.496	0.487	0	1
At-fault Passenger	1 if the injured victim was the passenger in at-fault vehicle; 0 otherwise.	0.213	0.409	0	1
No-fault Passenger	1 if the injured victim was the passenger in no-fault vehicle; 0 otherwise.	0.166	0.372	0	1
Pedestrian/Cyclist	1 if the injured was a non-motorized road user; 0 otherwise.	0.125	0.330	0	1
Factors related to the injury body region					
Head	1 if injury located in head; 0 otherwise.	0.131	0.338	0	1
Neck	1 if injury located in neck; 0 otherwise.	0.681	0.466	0	1
Upper torso	1 if injury located in upper torso (thorax/dorsal); 0 otherwise.	0.242	0.428	0	1
Lower torso	1 if injury located in lower torso (abdomen/lumbar); 0 otherwise.	0.195	0.396	0	1
Upper extremities	1 if injury located in upper extremities; 0 otherwise.	0.265	0.441	0	1
Lower extremities	1 if injury located in lower extremities; 0 otherwise.	0.257	0.437	0	1
Factors related to the severity of injuries					
Score	Severity score of permanent injuries (divided by 100)	0.043	0.075	0	1
Hospital days	Number of recovery days in hospital (divided by 100)	0.019	0.111	0	4.51
Disable days	Number of out-patient recovery days with disability for working (divided by 100)	0.759	0.756	0	7.31
No-disable days	Number of out-patient recovery days without disability for working (divided by 100)	0.281	0.405	0	3.96

N=5,000.

Information regarding injuries is included in the remaining factors. This information is based on medical assessments carried out by the insurance company's own medical experts during the period of recovery. Injuries are grouped according to body region and their severity. In the case of body region, we analyse the influence on settlement duration of injuries to the head, neck, upper torso, lower torso, upper extremities and lower extremities. Some types of injury might be associated with greater uncertainty regarding compensation payouts (for instance, suspicion of fraud, unpredictable non-economic damages for pain and suffering, etc.).

The last four factors are concerned with the severity of the injury, in order to investigate the effect of case severity on the length of the settlement process. The score factor captures the degree of severity of permanent injuries and is stated in accordance with a legal medical scale. The aggregate score for injuries has an upper bound of 100 points, with a high score being indicative of a more serious permanent injury. Temporary disabilities are captured by three variables: time spent recovering in hospital; the out-of-hospital recovery period during which the victim is on sick leave; and, the recovery period during which the victim is able to work but is still receiving some form of out-patient therapy.

3.4 Results

The model regression (7), with a set of covariates with time-varying effects and another set with constant effects, is fitted to the data to estimate the cumulative incidence function. Hypothesis testing was carried out in order to select the non-parametric term of the regression model. We first applied a non-parametric model in which it is assumed that all variables have time-varying effects, $\text{cloglog}(1-F(t,x)) = u^{'}(t)z$. The significance of the non-parametric effects $u(t)$ was tested. We first tested whether an effect of a covariate is significantly different to zero $H_0 : u_j(t) = 0 \quad t \in [0,\tau]$, for j= 0,…q where τ is the point in time in which the study is conducted. Second, the Cramér-von Mises test was computed to analyse whether or not the effect varies with time, $H_0 : u_j(t) = u_j \quad t \in [0,\tau]$. Model estimates are shown in Table 2. Covariates with significant time-varying effects were selected to the non-parametric term (Table 2A). The rest of the covariates were included in the parametric term (Table 2B).

Let us first focus on the non-parametric effects. The covariate capturing the age of the victim shows a significant (p-value: 0.000) and varying effect with time (p-value: 0.000). This result suggests that the age of the victim is related to his/her bargaining behaviour thereby affecting the cumulative incidence function of the claims settlement. However, the effect of age is not constant on the cumulative incidence function. Similarly, we found that all four factors related to the severity of injuries are statistically significant and have strong time-varying effects. These results indicate that the severity score for permanent injuries and the length of time recovering from temporary injuries – days hospitalised, disability from work and out-of-hospital but able to work – do not have a constant effect on the estimated cumulative incidence function. The effect of these covariates on the cumulative incidence function depends on the point in the negotiation process that comes under consideration. Estimates of time-varying effects and the 95% confidence intervals of the covariates are plotted in the Appendix (Figure A.1).

Table 2. Cumulative incidence function of the duration of the settlement process

(A) Hypothesis testing of time-varying effects

Variable	*Label*	*Test*	*Statistic*	*p-value*
z_1	*Victim's age*	$H_0 : u_1(t) = 0$	66.100	0.000
		$H_0 : u_1(t) = u_1$	1.92×10^4	0.000
z_2	*Score*	$H_0 : u_2(t) = 0$	35.600	0.000
		$H_0 : u_2(t) = u_2$	1.80×10^3	0.000
z_3	*Hospital days*	$H_0 : u_3(t) = 0$	86.700	0.000
		$H_0 : u_3(t) = u_3$	1.05×10^2	0.000
z_4	*Disabled days*	$H_0 : u_4(t) = 0$	66.900	0.000
		$H_0 : u_4(t) = u_4$	6.21×10	0.000
z_5	*No-disabled days*	$H_0 : u_5(t) = 0$	40.700	0.000
		$H_0 : u_5(t) = u_5$	0.105	0.000

(B) Regression parameter estimates and p-values of constant-effect covariates

Variable	*Label*	*Coeff.*	*Estim.*	*p-value*
x_1	*Gender*	β_1	-0.012	0.725
x_2	*Passenger in no-fault vehicle*(*)	β_2	0.063	0.145
x_3	*Passenger in at-fault vehicle*(*)	β_3	0.302	0.000
x_4	*Pedestrian/Cyclist*(*)	β_4	0.101	0.094
x_5	*Head*	β_5	-0.109	0.024
x_6	*Neck*	β_6	0.102	0.038
x_7	*Upper torso*	β_7	0.169	0.000
x_8	*Lower torso*	β_8	0.083	0.054
x_9	*Upper extremities*	β_9	0.100	0.013
x_{10}	*Lower extremities*	β_{10}	0.065	0.142

N = 5,000.
(*) Base category is driver.

Specific time-parametric functional forms are investigated for those covariates with associated significant time-varying effects. The model regression (8) is fitted to the data, where quadratic time-functions were analysed for the time-varying effects. Significant coefficients of the covariates' interactions with the time functions are shown in Table 3. The recovery period spent in hospital is the only factor for which the coefficients of the quadratic time function are significant in explaining the cumulative incidence function. The remaining time-varying effects are adequately regressed by a linear time function.

Table 3. Cumulative incidence function of the settlement process duration

Variable	*Label*	*Coeff.*	*Estim.*	*p-value*
Time-varying effects				
z_1	*Victim's age*	u_1	0.006	0.000
$z_1 \times t$	*Victim's age by time*	$u_{1.1}$	-0.002×10^{-2}	0.003
z_2	*Score*	u_2	-4.320	0.000
$z_2 \times t$	*Score by time*	$u_{2.1}$	0.008	0.000
z_3	*Hospital days*	u_3	-1.300	0.005
$z_3 \times t$	*Hospital days by time*	$u_{3.1}$	0.006	0.013
$z_3 \times t^2$	*Hospital days by squared time*	$u_{3.2}$	-0.007×10^{-3}	0.034
z_4	*Disabled days*	u_4	0.200	0.000
$z_4 \times t$	*Disabled days by time*	$u_{4.1}$	-0.001	0.000
z_5	*No-disabled days*	u_5	0.338	0.000
$z_5 \times t$	*No-disabled days by time*	$u_{5.1}$	-0.001	0.002
Constant effects				
x_1	*Gender*	β_1	-0.008	0.790
x_2	*Passenger in no-fault vehicle*(*)	β_2	0.063	0.078
x_3	*Passenger in at-fault vehicle*(*)	β_3	0.271	0.000
x_4	*Pedestrian/Cyclist*(*)	β_4	0.076	0.140
x_5	*Head*	β_5	-0.074	0.098
x_6	*Neck*	β_6	0.125	0.000
x_7	*Upper torso*	β_7	0.194	0.000
x_8	*Lower torso*	β_8	0.103	0.009
x_9	*Upper extremities*	β_9	0.113	0.001
x_{10}	*Lower extremities*	β_{10}	0.082	0.030

N = 5,000. *Pseudo log-likelihood*: -36,447
(*) Base category is driver.

Time-varying effects

An interpretation of the results is provided below. Note that a positive coefficient indicates that if the variable takes a higher value, *ceteris paribus,* the probability of a settlement being reached increases and, therefore, we can expect a shorter settlement process. The opposite also holds. When the coefficient is negative, the settlement process is expected to be longer for higher values of the covariable. The positive coefficient of the victim's age factor indicates that the age of the victim is inversely related to the expected duration of the settlement process. A potential explanation is that the victims' tendency to display confrontational behaviour decreases with age (Doerpinghaus et al., 2008). However, the effect of the age factor on the cumulative incidence function is not independent of time. Indeed, the factor that captures the interaction of time with age presents a negative coefficient. Both coefficients of the factors associated with age should be interpreted jointly when the effect of the victim's age comes under analysis. The effect of age on the cumulative incidence function is positive – i.e., the settlement duration can be expected to be shorter – but decreases in tandem with the prolongation of the negotiation process.

This result supports the assumption that the bargaining process consists of rounds of offers and counter-demands. In the theoretical framework we assume that the insurer does not know the amount of compensation to be paid out to the victim, but that the insurer knows the upper and lower bounds of the payout. In subsequent rounds of the negotiation, new upper bounds are computed on the basis of the victim's new counter-demands. We interpret the time-varying age factors as being young victims that initially make high settlement claims and who also make proportionally greater reductions in their subsequent demands as these are rejected by the insurance company. A possible explanation would seem to be that young victims make more aggressive initial demands. However, they have to reduce their pretensions drastically as their demands are rejected by the insurer. This interpretation is consistent with the hypothesis that the insurer's incomplete information is enriched during negotiation (H2).

All four injury severity factors have time-varying effects, but the impact of these factors on the cumulative incidence function differs. Indeed, the factors can be grouped in two types according to this impact: on the one hand, we have the factor related to the severity score for permanent injuries and that associated with the length of time spent in hospital; on the other hand, we have the two factors capturing information related to the period spent by the victim recovering from his or her injuries out-of-hospital.

Note that the two factors associated with the permanent severity score and the period of hospitalisation present negative coefficients. As such, the length of the claim settlement is expected to be greater in the case of those victims that sustained the most severe permanent injuries and who spent longest periods in hospital. This result is in line with that the case complexity depends positively on the severity of the injury (Shavell, 2004; Santolino and Söderberg, 2012). This result suggests that compensation uncertainty increases with these two severity factors, widening the interval between the compensation limits. Consequently, a longer settlement process can be expected in cases involving claims for very severe injuries (Fenn and Rickman, 1999).

These injury severity factors have time-varying effects reflecting the dynamics in the asymmetric information. Linear and quadratic time interactions are estimated for the severity score and hospitalisation factors, respectively (Table 3). Both severity factors are similarly affected by time. The initial effect of these factors on the settlement process is attenuated with time. Higher values for these factors initially increase the expected duration of the settlement process. However, the effect of these factors on the cumulative incidence function is diluted as negotiations progress. This result is in line with the model's hypothesis (H2). This means that initially the severity of injuries is positively related with the survival distribution. However, this effect is gradually attenuated as incoming damages' information is provided by the victims to the insurers. The coefficient associated with the quadratic time interaction with the hospitalisation factor might indicate that the upper bound increases slightly over time for victims that were hospitalised after the accident and who had not reached a settlement after a long period – more than fifteen months. A possible interpretation is that this victim-type might suffer a relapse of their injuries that involve their having to incur unexpected additional expenses during the negotiation procedure. This would increase the upper compensation bound expected by the insurer.

The two factors capturing information related to the victims' out-of-hospital recovery period present positive coefficients. As such, shorter negotiations are initially expected for victims that spend longer periods recovering out-of-hospital. This result seems to support the hypothesis that the claim duration does not directly depends on the severity of the injury (H1). We interpret this result as indicating that compensation uncertainty does not increase with these two factors of severity. The cumulative incidence function of settlements depends on the interval between the compensation bounds, and the width of this range is determined by the insurer's uncertainty regarding compensation. Our results would seem to indicate that the width of the interval is reduced due to a lower degree of uncertainty regarding the amount of compensation. This can be explained by the fact that while the upper bound of damages increases with these two severity factors, the lower bound is also increased.

Under the Spanish system, victims are entitled to financial compensation for each day spent recovering from their injuries. The system stipulates a unitary compensation per day spent recovering when the victim is deemed disabled for work and a unitary compensation per day when fit to work. Victims are not required to prove they suffered damages in order to be entitled to basic compensation for the out-of-hospital recovery period. Victims are entitled to claim higher compensation for the period of disability than the legally stipulated amounts, but in this case they have to provide proof of the damages. This basic compensation for temporary disabilities caused by motor accidents is compatible with other forms of compensation, including remunerated sick leave paid by the social security, employer or both. Our results can be explained by the fact that basic compensation would, in general, be perceived by victims as being sufficient to cover the injuries sustained and, consequently, compensation uncertainty is not increased with these two factors[13].

However, the effect of these two factors is affected by the length of negotiation as displayed in Table 3. Indeed, these two factors show effects that vary linearly with time as indicated by the negative coefficients. This indicates that the effect of these factors on the cumulative incidence function is attenuated with time (H2). We hypothesize that victims that remain in the negotiation process after the initial rounds tend to be those for

[13] In 2013 the basic compensation paid per day spent recovering out-of-hospital when the victim is deemed disabled for work and fit for work are 58.24 Euros and 31.34 Euros, respectively. The equivalent rate for a hospitalised victim is also fixed (71.63 Euros in 2013). Following the same reasoning, this amount would not, on average, be sufficient to compensate the victim during hospitalization.

whom the basic legal compensation paid per day is insufficient to meet their actual damages and, so, the uncertainty regarding compensation is augmented.

Constant effects

Finally, we briefly discuss factors presenting constant estimated effects. We did not find significant differences in the expected duration of the settlement process in function of the gender of the victim (Table 3). No evidence of different negotiation behaviour by gender was found. As for victim-type, all the factors presented positive coefficients. In comparison with the driver the probability of settling the claim before a certain date increases if the victim is a passenger, cyclist or pedestrian. Therefore, longer negotiations are expected when the victim is the driver. However, it is shown in the literature that other types of victims involved in a motor accident suffer more serious injuries (Pucher and Dijkstra, 2003; Ayuso et al., 2012). A plausible reason is that drivers might be associated with a greater propensity for confrontation as a result of the driver having suffered greater non-economic damage (e.g., the victim required the vehicle involved in the accident for his daily life, for instance, doing the school run, going to work, etc.). As a result, more aggressive demands would be presented by drivers so a greater uncertainty over the magnitude of damages would be associated to them. This result would corroborate that less severe cases can take longer durations whether damages have a more uncertain magnitude (H1).

An interesting result is observed when a comparison between types of passengers is made. A greater reduction in the settlement survival function is observed when the victim is a passenger in the at-fault vehicle. This result would support the assumption that passengers in the at-fault automobile accept lower settlements due to the familiarity effect (Derrig and Weisberg, 2004). Note that passengers of the at-fault automobile have to bring a legal sue against the driver, who usually is a relative or friend, to be entitled to a compensation. As a result, a lesser propensity for confrontational behaviour in seeking shorter negotiations tends to be associated with passengers in the at-fault automobile. To conclude, factors related to the region of the body suffering injury present positive coefficients except the factor indicating that the injuries were to the head, where the coefficient is significant at the ten per cent level and negative.

Therefore, the probability of settling the claim before a certain time falls when the victim sustains injuries to the head. This region is particularly prone to serious injury. It would seem that this factor reflects injuries sustained to the head involve a greater uncertainty regarding damages.

4. Conclusions

In this article we develop a multi-period bargaining model that is inspired on the pioneer Spier's model (Spier, 1992). We hypothesised under this framework that the claim duration depends on the degree of one-sided informational asymmetry which fluctuates during the negotiation process. The initial dispute negotiation process can be interpreted as a sequence of rounds of offers and counter-demands. In each round the litigant with incomplete information (the insurer) makes a compensation offer and, if it is not accepted, the litigant with private information (the victim) makes a counter-demand. In this way, the extent of one-sided incomplete information is rapidly reduced thanks to the incoming information provided by the victim.

Competing risk models have been applied to a motor insurance database to estimate the distribution function of settlements over time showing that the models' hypotheses are extensively supported by results. Our empirical findings clearly indicate that the duration of the settlement process depends on the degree of uncertainty expressed by the insurer regarding the injuries actually sustained by the victim. In most cases, claims involving more severe injuries are characterised by longer settlement delays indicating greater uncertainty regarding compensation. One exception, however, is that of temporary out-of-hospital disabilities, since longer recovery periods do not increase the delay in the awarding of compensation. We attribute this to the fact that the compensation for temporary out-of-hospital disabilities is legally stipulated. In such instances, therefore, the Spanish legal system would fulfil the goal – which is explicitly mentioned in the preamble to the legislative act – of reducing uncertainty regarding compensation. Time-varying effects are observed for those explanatory factors related to the victim's age and the severity of his or her injuries. The effect of these factors on the survival function is diluted for longer negotiation processes suggesting that the degree of informational asymmetry presented by the insurer decreases during the negotiation.

Various policy implications can be derived directly form our findings. A directive has been implemented in Europe to promote the application of alternative dispute resolution (ADR) mechanisms so that out-of-court agreements can be reached in civil disputes. The theoretical multi-period bargaining model is based on the assumption that settlements can be reached just as fast as the informational asymmetries between the litigant parties are reduced. Our results indicate that there could be room for mediation/arbitration mechanisms to reduce delays in insurance settlements provided the impartial-party agents involved are able to attenuate informational asymmetries between litigants at a faster rate than is possible by direct negotiation.

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APPENDIX

Figure A.1. Estimates of time-varying effects (solid lines) with 95% confidence intervals (broken lines)

[INSERT FIGURES]

REFERENCES

Ayuso, M., L. Bermúdez, and M. Santolino, 2012. "Influence of the parties' behavioural features on motor compensation outcomes" *Journal of Risk Research*, 15 (6): 673-691.

Ayuso, M., and M. Santolino, 2012. "Forecasting the maximum compensation offer in the automobile BI claims negotiation process" *Group Decision and Negotiation*, 21 (5): 663-672.

Bell, P., 2006. "The Social Construction of Bodily Injury" *The Geneva Papers on Risk and Insurance - Issues and Practice,* 31: 340-356.

Browne, M.J., and R. Puelz, 1999. "The effect of legal rules on the value of economic and non-economic damages and the decision to file" *Journal of Risk and Uncertainty,* 18 (2): 189-213.

Cooter, R., and D. Rubinfeld, 1989. "Economic analysis of legal disputes and their resolution" *Journal of Economic Literature*, 27 (3): 1067-1097.

Cox, D., 1972. "Regression Models and Life Tables" Journal *of the Royal Statistical Society B*, 34: 187-220.

Cramton, P., and J. Tracy, 1992. "Strikes and Holdouts in wage bargaining: theory and data" *American Economic Review*, 82: 100-121.

Daughety, A., and J. Reinganum, 1994. "Settlement Negotiations with Two-sided Asymmetric Information: Model duality, Information distribution and Efficiency" *International Review of Law and Economics,* 14: 283-298.

Deffains, B., and M. Doriat, 1999. "The Dynamics of Pretrial Negotiation in France: Is there a Deadline Effect in the French legal System?" *International Review of Law and Economics,* 19: 447-470.

De Palo, G. 2013. "The Cost of Not-Using Mediation", *Mediation as an Alternative Dispute Resolution Method in Insurance Conflicts: New Scenarios under the Law 5/2012*, January 24, Barcelona, Spain.

Derrig, R.A., and G.A. Rempala, 2006. "A statistical analysis of the effect of anchoring in the negotiation process of automobile bodily injury liability insurance claims" *CAS Predictive Modelling Seminar*, October 4, Boston, MA.

Derrig, R., and Weisberg, 2004. "Determinants of total compensation for auto bodily injury liability under no-fault: investigation, negotiation and the suspicion of fraud" *Insurance and Risk Management*, 71 (4): 633-662.

Doerpinghaus, H., J. Schmit, and J. Yeh, 2008. "Age and gender effects on auto liability insurance payouts" *Journal of Risk and Insurance*, 75 (3): 527-550.

Doornik, K. 2014. "A rationale for mediation and its optimal use" *International Review of Law and Economics,* 38, 1-10.

Fenn, P., and N. Rickman, 1999. "Delay and Settlement in Litigation" *The Economic Journal*, 109: 476-491.

Fenn, P., and N. Rickman, 2013. "Information and the Disposition of Medical Malpractice Claims: A Competing Risks Analysis" *Journal of Law, Economics and Organization,* in press. doi: 10.1093/jleo/ewt002.

Fine, J., and R. Gray, 1999. "A Proportional Hazards Model for the Subdistribution of a Competing Risk" *Journal of the American Statistical Association*, 94 (446): 496-509.

Friedman, D, and Wittman, 2007. "Litigation with Symmetric Bargaining and Two-Sided Incomplete Information" *Journal of Law, Economics, and Organization*, 23: 98-126.

Gray, R., 1988. "A Class of K-Sample Tests for Comparing the Cumulative Incidence of a Competing Risk" *Annals of Statistics,* 16 (3): 1141-1154.

Jeong, J-H, and J. Fine, 2007. "Parametric regression on cumulative incidence function" *Biostatistics*, 8 (2): 184-196.

Lewis, R., 2006. "How important are insurers in compensating claims for personal injury in the UK?" *Geneva Papers on Risk and Insurance-Issues and Practice*, 31 (2): 323-339.

Londrigan, T., 1984. "Prejudgment Interest: Is There Profit in Court Delay – Plaintiff's Opinion" *The Judges' Journal,* 4: 12-49.

Martinussen, T., and T. Sheike, 2006. *Dynamic Regression Model for Survival Data*. New York: Springer.

Priest, G.L., and B. Klein, 1984. "The selection of disputes for litigation" *The Journal of Legal Studies*, 13 (1): 1-55.

Pucher, J., and L. Dijkstra, 2003. "Promoting safe walking and cycling to improve public health: lessons from The Netherlands and Germany" *American Journal of Public Health*, 93: 1509–1516.

Rogers, W.V.H. (ed.), 2001. *Damages for non-pecuniary loss in a comparative perspective*. New York: Springer.

Santolino, M. 2010. "Determinants of the decision to appeal against motor bodily injury judgements made by Spanish trial courts" *International Review of Law and Economics,* 30, 37-45.

Santolino, M., C. Bolance, and M. Alcañiz, 2012. "Factors affecting hospital admission and recovery stay duration of in-patient motor victims in Spain" *Accident Analysis and Prevention,* 49: 512-519.

Santolino, M., and M. Söderberg, 2012. “Modelling Appelate Courts’ responses in motor injury disputes” *European Journal of Law and Economics*, doi: 10.1007/s10657-012-9362-z.

Scheike, T., and M.-J. Zhang, 2008. “Flexible competing risk regression modeling and goodness-of-fit” *Lifetime Data Analysis*, 14 (4): 464-483.

Scheike, T., M.-J. Zhang, and T. Gerds, 2008. “Predicting cumulative incidence probability by direct binomial regression” *Biometrika*, 95 (1): 205-220.

Scheike, T., and M.-J. Zhang, 2011. “Analyzing Competing Risk Data Using the R timereg Package” *Journal of Statistical Software*, 38 (2): 1-15.

Shavell, S., 1982. “Suit, Settlement and Trial: A theoretical analysis under alternative methods for the allocation of legal disputes” *Journal of Legal Studies*, 11: 55-81.

Shavell, S., 2004. *Foundations of economic analysis of law*. Cambridge, MA: Harvard University Press.

Sobel, J., and I. Takahashi, 1983. “A multi-stage model of bargaining” *Review of Economic Studies*, 53 (2): 709-724.

Spier, K., 1992. “The Dynamics of Pretrial Negotiation” *Review of Economic Studies*, 59: 93-108.

Spier, K., 2003. “The use of ‘most-favored-nation’ clauses in settlement litigation” *RAND Journal of Economics*, 34 (1): 78-95.