

Renegotiation-Blocking Through Financial Claims

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Abstract

Renegotiation of contractual agreements may lead to distortion of ex-ante incentives and inefficiencies. We examine the conditions under which this problem can be circumvented in a credible way by the use of financial claims. It is shown that if the contracting parties do not know exactly how many claims have been issued or who hold them then they are unwilling to participate in any renegotiation attempt and renegotiation blocking is successful. Moreover, this renegotiation blocking process does not generate additional inefficiencies. General bargaining mechanisms between claim holders and contracting parties and hidden renegotiation mechanisms are also examined.

Keywords: ex-ante welfare, financial claims, renegotiation, renegotiation-proof contracts

JEL Classification: D86, G19

1 Introduction

Renegotiation is an important constraint on the design of contracts. Some contracts, even though they may be ex-ante efficient, are not ex-post efficient and, therefore, they are renegotiated. As a result, a contract which is not renegotiation-proof is not credible, as it can not survive ex-post renegotiation. Thus, renegotiation-proofness is an additional constraint on contract/mechanism design. Moreover, the expectation of renegotiation may distort ex-ante incentives or tighten the incentive-compatibility constraints of some agents, which leads to inefficiencies.

Despite the presence of several papers that examine the conditions under which a contract or a mechanism is renegotiation-proof, (Dewatripont, 1988; Hart and Tirole, 1988; Beaudry and Poitevin, 1995; Maskin and Moore, 1999; Bester and Strausz, 2001), whether renegotiation can be credibly blocked, has received little attention in terms of formal models.

For example, Maskin and Moore (1999) propose third party payments and Maskin and Tirole (1999) propose lotteries as possible solutions to renegotiation but they do not formalize their arguments. Moreover it is not clear if these solutions work as they may be vulnerable to collusion with the third party or they may be circumvented through hidden side contracting (Hart and Moore, 1999).

The purpose of this paper is to provide a formal treatment of renegotiation blocking through the use of financial claims, which give the right to the bearer to ask compensation from the contracting parties if renegotiation occurs (payments to claim holders). Moreover, we show that whether renegotiation can be effectively blocked or not depends crucially on the information that the contracting parties have regarding the claims. If the parties know how many claims have been issued then claims cannot block renegotiation and the suggestion of Hart and Moore (1999) applies. However, if parties do not know how many claims have been issued and who holds them then renegotiation can be effectively blocked.

For the intuition behind this result, note that renegotiation can take place only if the financial claims linked to it are “nullified” by the contracting parties. Since the parties do not know who hold them, they can only make a public tender offer (i.e. publicly announce a price for each tendered claim). Once all claims are tendered, the contracting parties can tear them and go ahead with renegotiation. But since the contracting parties are never sure if all the claims have been tendered, they are sceptical about renegotiation and the process breaks down.

We show this result under two different assumption regarding the timing of events. In section 3.2 we examine the case where the contracting parties decide on renegotiation at the same time as the external claim holders decide whether to tender their claims or not. Since actions take place simultaneously, this case is modelled as a game of imperfect information. We show that “simple” financial claims, which give the right to the claim holder to demand a compensation at the event of renegotiation, are sufficient to block renegotiation. Indeed, we prove that the contracting parties’ expected payoff is maximized when they set the tender price equal to *zero*, which makes ex-post

renegotiation happen with *zero probability*.

In section 3.3 we examine the case where claim holders tender their claims before the contracting parties decide on renegotiation. In this case, the contracting parties condition their decision on the number of tendered claims. This situation is better described by a game of incomplete information where claim holders need to be provided with appropriate incentives in order to reveal their information (i.e. whether they hold a claim). Therefore, it is more appropriate to adopt a mechanism design approach and consider general “mechanisms” as a bargaining tool between the contracting parties and claim holders. Nonetheless, we show that the claims can be designed at the ex-ante stage to block any such mechanism. “Complex” claims, whose value depends not only on the renegotiation between the parties, but also on the participation decision of other claim holders in the mechanism can eliminate any incentive to participate in it along with the prospects of renegotiation.

Finally, section 4 formalizes the case where the contracting parties can engage in hidden renegotiation attempts which may involve side-contracts with multiple third parties. We show that as long as court hearings are open to the public, so that the claim holders can find out that there is a trial involving the contracting parties, then any hidden contract/mechanism can be rendered non-enforceable. This is because at least one party prefers to renege on her promise and to not fulfil the terms of the hidden contract, while her counter-parties do not take her to courts under the fear of the claims being exercised.

One may ask how is it possible that neither contracting party knows how many claims have been issued or who holds them. Several possible interpretations can be given. One possibility is to think that financial institutions offer this service to contracting parties for a fee: they issue a random number of claims and they distribute them through anonymous transactions in financial markets to claim holders. Moreover, the fear of losing their reputation prevents these institutions from revealing to their clients (the contracting parties) how many claims have been issued once the latter want to renegotiate. A simpler interpretation is to think that the contracting parties originally issue a large number of claims in physical form and then one of them grabs randomly some claims from the pile and destroys them (without counting). Then they distribute the remaining claims by handing them out to people in a marketplace.¹ In order to make the game description as simple as possible we adopt this interpretation.

Nonetheless, regardless of which interpretation is adopted, the main contribution of the paper is rather theoretical. If renegotiation generates substantial inefficiencies and renegotiation parties want to block it, then, in principle, they should be able to do so. Indeed, financial claims is a possible way they can achieve this.

Our paper is closely related to Evans (2012), who examines the issue of renegotiation in mechanism design when messages are costly. Evans (2012) shows that any Pareto-efficient social choice function can be implemented by a renegotiation-proof

¹Other interpretations may involve programming a software to print a random number claims or throwing them off a plane.

mechanism if message costs are strictly positive, even though possibly very small. We adopt a different approach. We allow for messages to be costless and we achieve renegotiation-proofness through the friction of endogenously generated asymmetric information. Moreover, we allow for quasi-concave payoff functions, while Evans (2012) restricts analysis to separable payoffs.

Watson (2007) shows that the set of implementable payoffs in mechanism design when renegotiation is possible depends on the technology of trade and the time that renegotiation takes place. When renegotiation takes place before sending messages to the designer, public action models and individual action models are equivalent. However, if renegotiation takes place after sending messages to the designer then individual action models can implement a wider set of payoffs than public action models.

Baliga and Sjöström (2009) show that contracting with third-parties can be used to implement first-best outcomes in hold-up and moral-hazard-in-teams problems despite the possibility of hidden side-contracting. Their results hold as long as side-contracting and the original agreement are modelled in a symmetric manner, in the sense that if the side-contracts specify secret messages and cash transfers, then the original agreement should be allowed to do so as well. On the other hand, we show how hidden side-contracting can be blocked if court hearings are public information (i.e. open to public).

The impact of renegotiation on contract design and efficiency has been examined in several fields: in the literature of short-term contracts (Dewatripont, 1989; Laffont and Tirole, 1990; Fudenberg, Holmstrom, and Milgrom, 1990; Rey and Salanié, 1996), in the literature of strategic delegation and third-party contracting (Katz, 1991; Bensaid and Gary-Bobo, 1993; Caillaud, Jullien, and Picard, 1995; Bester and Sakovics, 2001; Gerratana and Koçkesen, 2012b,a), in mechanism design (Rubinstein and Wolinsky, 1992; Maskin and Moore, 1999; Segal and Whinston, 2002; Maskin and Sjöström, 2002; Neeman and Pavlov, 2010; Brennan and Watson, 2013), in repeated games (Farrell and Maskin, 1989; Evans and Maskin, 1989; Bernheim and Ray, 1989; Asheim, 1991), in the hold-up literature (Aghion, Dewatripont, and Rey, 1994; Maskin and Tirole, 1999; Hart and Moore, 1999), in financial contracts (Snyder, 1996; Hart and Moore, 1998; Matthews, 2001). However, these papers do not examine if and how renegotiation can be blocked.

Nonetheless, previous papers have pointed-out that information asymmetries at the renegotiation stage may reduce the probability of renegotiation or block it completely. For example, Dewatripont (1988) and Dewatripont and Maskin (1990) show how parties may want to maintain information asymmetries in order to prevent future renegotiation even though information sharing may be costless. A similar argument is presented by Fudenberg and Tirole (1990). But the solutions of these papers are not general, as they take the information structure as given and, hence, they depend on the specifics of the economic problem at hand. Moreover, the introduction of information asymmetry in these models facilitates renegotiation-blocking, but it increases the inefficiency caused due to informational rents.

On the other hand this paper presents a simple and credible way to block renegotiation independently of the reason that contracting parties find ex-post renegotiation

beneficial. This is because it is based on asymmetric information only about the claims that block renegotiation themselves and not on the economic primitives. In other words, the source of renegotiation does not matter. Whether renegotiation is due to information revelation over time (Fudenberg and Tirole, 1990; Ma, 1991), irreversibilities (Dewatripont and Maskin, 1990), ex-post suboptimal punishments (Maskin and Tirole, 1999) or even time inconsistent preferences (something which is not usually assumed in contract theory) is irrelevant. For this reason issuing claims to block renegotiation does not interact with the other incentive compatibility constraints of the problem at hand, and so no additional inefficiency is caused by it. It only supports the credibility of the ex-ante optimal contracts.

In the following sections, we present these arguments in a formal manner. Section 2 presents the basic model and the main assumptions. Section 3.1 considers the case of complete information, when the contracting parties know the exact number of claim holders. Section 3.2 shows how financial claims can be used to block renegotiation in the case of imperfect information and 3.3 examines the case of incomplete information. Section 4 considers the case where hidden side-contracting is possible and section 5 discusses how the model can be modified to accommodate for other sources of renegotiation. Finally, section 6 provides a discussion on the assumptions of limited liability and issuance costs and concludes.

2 The Problem

In order to keep the analysis concrete, let us examine the case of two contracting parties who may want to renegotiate their original contract because of information revelation reasons (realization of an observable and verifiable state of the world). However, section 5 shows how the framework can be adopted to encompass other sources of renegotiation. Also the analysis can be extended to multiple contracting parties.

At $t = 0$ two contracting parties, i and j , agree on a contract κ^α , which defines a vector of verifiable actions $x(s) = (x_i(s), x_j(s))$ and the final allocation of a transferable resource $m(s) = (m_i(s), m_j(s))$ (“money”) as a function of a yet unrealized state of nature s and which are to take place at $t = 4$. Formally, $\kappa^\alpha = (x^\alpha(s), m^\alpha(s))$.

Given the contract, the two parties undertake some non-contractible (i.e. non-verifiable or unobservable) actions $y = (y_i, y_j)$ at time $t = 1$. At $t = 2$ the state s is revealed to the parties, who, in light of this new information, may want to renegotiate the original contract to κ^π at $t = 3$: $\kappa^\pi(s) = (x^\pi(s), m^\pi(s))$. Therefore, κ^π defines a new vector of verifiable actions and transfers to be executed given state s at $t = 4$ instead of the original contract κ^α . Finally, at $t = 4$, the contract is executed (κ^α if there is no renegotiation, κ^π if there is renegotiation) and payoffs are realized. Figure 1 below summarizes the timing of events.

For a contracting party p ($p \in \{i, j\}$) the payoff is a quasi-concave function of the vector of actions (x, y) , of its final allocation of “money” m_p and of the realized state s : $u_p(x, m_p, y; s)$. At $t = 4$, p ’s ex-post payoff, conditional on state s and the undertaken

3 A Simple Solution

3.1 Financial Claims to Block Renegotiation and the Case of Complete Information

The main result of the paper is that contract renegotiation can be blocked by issuing financial claims, which give the right to the bearer (the claim holder) to receive a compensation if renegotiation takes place. This result obtains as long as the total number of claims issued is unknown to the contracting parties. As a benchmark, and in order to show how asymmetric information is important for the result, we start from the case where the two parties know exactly how many claims have been issued.

More specifically, suppose that at t_{0-} , just before signing the contract κ^α , i and j try to block future renegotiation by issuing a number n of financial claims, which are redeemable in the event of renegotiation. This means that if i and j renegotiate the original contract κ^α , then the claim holders are entitled to a compensation C for each one of the claims they hold.

It is assumed that C is large enough so that at least one of the two parties prefers to execute the ex-ante optimal contract over renegotiation. This means that, given some exogenous weights β_i and β_j which are used to split the total payment that the parties make to the claim holders, C is large enough so that one of them would rather avoid renegotiation. Formally, let β_p be the share of the total payment to claim holders that party p pays ex-post and let $\beta_i + \beta_j = 1$.² Then we have the following assumption:

- **A.3:** There exists C large enough such that:

$$u_p(x^*(s), m_p^*(s)|y, s) > u_p(\bar{x}(s), \bar{m}_p(s) - \frac{1}{2}C|y, s) \text{ for all } p \in \{i, j\}$$

Under assumption **A.3**, if the compensation C is split evenly between i and j , then both of them prefer to execute the original contract than renegotiating and paying $C/2$. This assumption then implies that for any weights, β_i, β_j , of splitting C between the two parties at least one of the two parties does not want to renegotiate κ^* :

- Assumption **A.3** and the fact that $u_p(\cdot)$ is weakly increasing in its second argument imply that for all pairs $\{\beta_i, \beta_j\}$ such that $\beta_i + \beta_j = 1$:

$$u_p(x^*(s), m_p^*(s)|y, s) > u_p(\bar{x}(s), \bar{m}_p(s) - \beta_p C|y, s) \text{ for some } p \in \{i, j\}$$

However, the argument of Hart and Moore (1999) is that under complete information, i and j know that the total claims issued are n . If at $t = 2$, state s is revealed and both of them would like to renegotiate in this state, then at t_{2+} , just after the state is revealed, they can make a public tender offer to the claim holders, exchanging each tendered claim for a small price q .

²Thus, β_p reflects the ex-post bargaining power of party p . The higher β_p is, the higher share of any payment it agrees to pay and hence the lower its bargaining power.

Even though q may be close to zero, the best-response for each one of the claim holders is to tender her claims. This is because, even if a single claim is not tendered, renegotiation will not take place at $t = 3$ and the claims are valueless. Any proposed price $q > 0$ is worth more than each of the claims. This means that i and j can reap almost all of the benefit of renegotiation ex-post, which is, of course, anticipated at $t = 1$. This implies that ex-ante sub-optimal actions are undertaken and hence the failure of claims to block renegotiation.

3.2 Simple Claims and Imperfect Information

We now examine how the results change if neither i or j know exactly how many claims have been issued. In particular we show that if i and j make their decision to renegotiate at the *same time* as the claim holders make their decision to tender the claims, then the only possible equilibrium is for the two parties to not renegotiate the ex-ante contract, even though they have the option of a public tender offer.

In order to keep the description of the game as simple as possible, the following justification for the missing information is adopted: the contracting parties originally issue a large number of claims (N), then one of them grabs randomly some claims and destroys them and then they distribute the remaining ones to a large crowd. This avoids the strategic complications arising from assuming that they delegate these decisions to a financial firm. In any case, n , the total number of distributed claims, is now a random variable, which we assume to take values from \underline{n} to \bar{n} , with $\bar{n} \leq N$ and $\underline{n} \geq 0$. $f(n)$ is the probability that the number of distributed claims is equal to n .

In addition to **A.3**, we assume that one of the two contracting parties, say party i , finds renegotiation less beneficial than the other party whenever it believes that some claims are not tendered. Formally, if k is the total number of claims that the parties believe that are tendered, then we have the following assumption.

- **A.4:** For any value of q, k, n :

$$u_i(x^*(s), m_i^*(s) - \beta_i k q | y, s) - u_i(\bar{x}(s), \bar{m}_i(s) - \beta_i k q - \beta_i(n - k)C | y, s) > \\ u_j(x^*(s), m_j^*(s) - \beta_j k q | y, s) - u_j(\bar{x}(s), \bar{m}_j(s) - \beta_j k q - \beta_j(n - k)C | y, s)$$

In **A.4**, $m_i^*(s) - \beta_i k q$ is i 's final endowment in terms of money if there is no renegotiation and it makes a payment equal to $\beta_i k q$ to claim holders, while $\bar{m}_i(s) - \beta_i k q - \beta_i(n - k)C$ is its final endowment if renegotiate takes place, in which case i expects to pay $\beta_i k q$ in total for the tendered claims and $\beta_i(n - k)C$ in total for the non-tendered claims. The same interpretation applies to j . Thus **A.4** states that i benefits more from blocking renegotiation than j and hence i is less likely to renegotiate. This allows us to focus the analysis on i , since if i is willing to renegotiate then j is also willing to do so.

Note that **A.4** is without loss of generality. If we assume instead that both i and j are equally likely to block renegotiation (**A.4** holds with equality), then both of them receive the same expected gain from their decision to renegotiate and so analysing the

case of one of the two also gives us the analysis for the other. Finally, in order to simplify the notation in the analysis that follows, we suppress arguments y and s in u_p .

The timing of events is the same as in 3.1. That is, at t_{0-} , i and j issue and distribute n financial claims against renegotiation, with the realization of n being unknown to them or to the claim holders. The claims are given out for *free*. The claim holders are identical in terms of their characteristics and each one holds a single claim. At $t = 0$, i and j sign the contract κ^α , at $t = 1$ they undertake actions y_i, y_j and at $t = 2$ the state of nature is revealed. After this, at t_{2+} , the contracting parties, if they know that they are in a state that renegotiation is valuable, they make a public offer to claim holders to tender their claims in exchange for q units of “money” for each claim, where q is set by i (i.e. the party with the least willingness to renegotiate). At $t = 3$ the claim holders observe the tender offer and decide to tender their claims or not and i and j decide whether to renegotiate κ^α or not. Any non-tendered claim is exercised after this, at t_{3+} , and contracts are executed and final payoffs are realized at $t = 4$. This is also shown on the figure below.

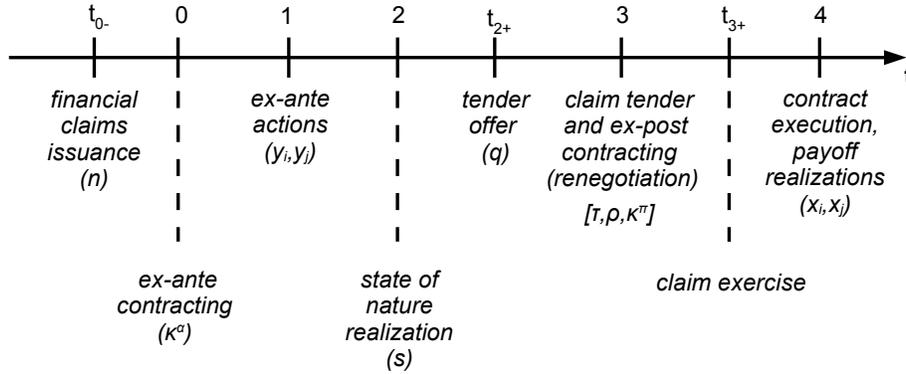


Figure 2: Timing of Events

Note that because the contracting parties decide on renegotiation at the same time as the claim holders decide whether to tender their claims, the game is one of imperfect information. Therefore we adopt Nash equilibrium as the solution concept for this subsection. We prove our claim by first examining the case where the two parties choose to set the price of a tendered claim equal to zero, which is effectively the case when no tender offer is made. Then we examine the case where the tender price is strictly positive and finally we show that setting the price equal to zero is optimal.

First, at t_{2+} the two parties would never set the tender price q at a level higher than or equal to C , since, by assumption **A.3**, they would rather set $q = 0$, renegotiate and pay C for each claim than gathering all claims for a price $q \geq C$ and then renegotiating. Therefore, we restrict the analysis to the case where $0 \leq q < C$.

At t_{3+} , if renegotiation does not take place, then the claims are valueless and whether they are exercised or not does not change payoffs. While if renegotiation takes place,

each claim is worth C and all non-tendered claims are exercised. Therefore, the interesting interactions happen at $t = 3$, when i , j and the claim holders decide their respective strategies.

Let ρ_i (ρ_j) be the probability with which i (j) agrees to renegotiate at $t = 3$. Since renegotiation is only possible when both parties agree on it, the probability of renegotiation is $\rho \equiv \rho_i \rho_j$. Also, let τ be the probability that a claim holder tenders her claim and let k be the total number of claims tendered. Since neither i or j or the claim holders know n , their strategies ρ_i , ρ_j and τ are independent of n and since actions are taken simultaneously ρ_i and ρ_j are independent of k . Also, each claim holder's payoff depends only on the total probability of renegotiation ρ , so her strategy τ is independent of the strategy of the other claim holders.

For a claim holder l , if she tenders her claim, she receives the price q and her utility is simply $u_l(m_l + q)$, where m_l is l 's endowment of "money". Note that claim holders receive no benefit or suffer no disutility from the contracts that i and j sign, so their payoff depends only on their final endowment of the transferable resource. If l does not tender, then with probability ρ there is renegotiation, in which case she exercises the claim and receives C , and with probability $1 - \rho$ there is no renegotiation and the claim is worthless, so her utility is $u_l(m_l)$. Therefore, her expected utility in this case is $U_l(\tau = 0) = \rho u_l(m_l + C) + (1 - \rho)u_l(m_l)$. So, l tenders only if $\rho \leq \frac{u_l(m_l + q) - u_l(m_l)}{u_l(m_l + C) - u_l(m_l)}$ and does not tender otherwise.

Similarly, we define the payoffs for i and j . For party i , if it decides not to renegotiate, then renegotiation is blocked and her payoff is given by the following expression, where we have suppressed arguments y and s in u_i to simplify the notation:

$$U_i(\rho_i = 0, \rho_j) = \sum_{k=0}^{\bar{n}} u_i(x^*, m_i^* - \beta_i k q) \mu(k, \tau) \quad (1)$$

$$\text{where } \mu(k, \tau) \equiv \sum_{n=\max\{k, \underline{n}\}}^{\bar{n}} \binom{n}{k} \tau^k (1 - \tau)^{n-k} f(n)$$

In (1), $u_i(x^*, m_i^* - \beta_i k q)$ is i 's utility when the original, ex-ante optimal contract $(x^*(s), m^*(s))$ is not renegotiated, k claims are tendered and i pays out fraction β_i of the total payment kq to claim holders. $\mu(k, \tau)$ is the probability that exactly k claims are tendered conditional on each claim holder tendering her claim with probability τ . On the other hand, if i chooses to renegotiate, her payoff also depends on the choice of j . j does not renegotiate with probability $1 - \rho_j$ and i 's payoff is as in (1), while j renegotiates with probability ρ_j and i 's payoff is then given by:

$$\sum_{k=\underline{n}}^{\bar{n}} u_i(\bar{x}, \bar{m}_i - \beta_i k q) \tau^k f(k)$$

$$+ \sum_{k=0}^{\bar{n}} \sum_{n=\max\{k+1, \underline{n}\}}^{\bar{n}} \lambda(k, n, \tau) u_i [\bar{x}, \bar{m}_i - \beta_i k q - \beta_i (n - k) C] \quad (2)$$

$$\text{where } \lambda(k, n, \tau) \equiv \binom{n}{k} \tau^k (1 - \tau)^{n-k} f(n)$$

In (2), $\tau^k f(k)$ is the probability that all claims are tendered, given the claim holders' strategy τ . In this case there are no outstanding claims after renegotiation, the renegotiated contract $(\bar{x}(s), \bar{m}(s))$ is executed, and i 's share of payment is $\beta_i k q$. On the other hand, with probability $\lambda(k, n, \tau)$ exactly k out of n claim holders tender their claims, with $k < n$, in which case $(\bar{x}(s), \bar{m}(s))$ is executed, and i pays out share β_i of the total payment $k q + (n - k) C$. Overall, i 's payoff of renegotiation when j renegotiates with probability ρ_j is equal to:

$$\begin{aligned} U_i(\rho_i = 1, \rho_j) &= (1 - \rho_j) \sum_{k=0}^{\bar{n}} u_i(x^*, m_i^* - \beta_i k q) \mu(k, \tau) + \rho_j \sum_{k=\underline{n}}^{\bar{n}} u_i(\bar{x}, \bar{m}_i - \beta_i k q) \tau^k f(k) \\ &+ \rho_j \sum_{k=0}^{\bar{n}} \sum_{n=\max\{k+1, \underline{n}\}}^{\bar{n}} \lambda(k, n, \tau) u_i [\bar{x}, \bar{m}_i - \beta_i k q - \beta_i (n - k) C] \end{aligned} \quad (3)$$

Therefore, i renegotiates with probability one only if (3) > (1). This means that i renegotiates only if $\rho_j A > 0$, where A is the expression given by equation (4) below.

$$\begin{aligned} A \equiv & \sum_{k=\underline{n}}^{\bar{n}} u_i(\bar{x}, \bar{m}_i - \beta_i k q) \tau^k f(k) + \sum_{k=0}^{\bar{n}} \sum_{n=\max\{k+1, \underline{n}\}}^{\bar{n}} \lambda(k, n, \tau) u_i [\bar{x}, \bar{m}_i - \beta_i k q - \beta_i (n - k) C] \\ & - \sum_{k=0}^{\bar{n}} u_i(x^*, m_i^* - \beta_i k q) \mu(k, \tau) > 0 \end{aligned} \quad (4)$$

So, if $\rho_j > 0$, then i renegotiates with probability one when $A > 0$. However, if $\rho_j = 0$, then i 's payoff is independent of its choice which implies that $\rho_i \in [0, 1]$. Similarly for j , if $\rho_i > 0$, j renegotiates with probability one if $B > 0$, where B is given by equation (5) below.

$$\begin{aligned} B \equiv & \sum_{k=\underline{n}}^{\bar{n}} u_j(\bar{x}, \bar{m}_j - \beta_j k q) \tau^k f(k) + \sum_{k=0}^{\bar{n}} \sum_{n=\max\{k+1, \underline{n}\}}^{\bar{n}} \lambda(k, n, \tau) u_j [\bar{x}, \bar{m}_j - \beta_j k q - \beta_j (n - k) C] \\ & - \sum_{k=0}^{\bar{n}} u_j(x^*, m_j^* - \beta_j k q) \mu(k, \tau) \end{aligned} \quad (5)$$

While if $\rho_i = 0$, then j 's payoff is independent of its strategy and $\rho_j \in [0, 1]$. The above analysis of the best-responses of the two parties indicates that it is possible to have an equilibrium where $\rho_i = \rho_j = 0$ due to coordination failure. This is because renegotiation requires coordination between the two parties, which generates complementarity in their choice, so that one examines the value of renegotiation only if it believes that the other will also do so.

Formally, suppose that $0 < q < C$ and consider the case where $\rho_i = \rho_j = 0$ and $\tau = 1$. This is an equilibrium of the subgame that starts at $t = 3$ even though all claim holders always tender their claims. This is because even if one party, say i , were to choose $\rho_i > 0$, the other one blocks renegotiation, so $\rho_i = 0$ remains a best-response. And because $\rho_i \rho_j = 0$ and $q > 0$, the claim holders' best-response is $\tau = 1$. On the other hand, $\rho_i = \rho_j = 0$ and $\tau < 1$ is not an equilibrium, because the claim holders' best response is to tender with probability one if $\rho = 0$. It is easy to check that the same argument holds when $q = 0$. The only difference is that claim holders are indifferent between tendering their claims or not when $q = 0$, and so $\tau \in [0, 1]$. We summarize this result in the following proposition.

Proposition 1 (*Coordination failure equilibrium*) *If condition **A.3** holds for both i and j then the subgame that starts at $t = 3$ has an equilibrium where $\rho_i = \rho_j = 0$, $\tau = 1$, if $q > 0$, and $\rho_i = \rho_j = 0$, $\tau \in [0, 1]$, if $q = 0$.*

The above equilibrium is not very interesting for the purposes of this paper because renegotiation is merely blocked by the inability of the contracting parties to coordinate their actions. It is also unstable in the sense that it does not survive the refinement of trembling hand equilibrium. Therefore, we ignore it for the remainder of the analysis.

Having analysed the best-response functions of the parties and the claim holders and the possibility of coordination failure, we return to the analysis of other equilibria under the case of $q = 0$. In this case, because $\rho u_l(m_l + C) + (1 - \rho)u_l(m_l) \geq u_l(m_l)$ for any $\rho \in [0, 1]$, the claim holders always prefer to not tender their claims, apart from the case where $\rho = 0$, in which case they are indifferent and $\tau \in [0, 1]$. Therefore, for any $\rho > 0$, the best-response for l is to set $\tau = 0$. However, if $\tau = 0$ then $k = 0$ and then, due to **A.3**, either $A < 0$ or $B < 0$, so at least one of the two parties' best-response is to block renegotiation by setting $\rho_p = 0$. In other words, if $q = 0$ then there cannot exist an equilibrium of the subgame with $\rho > 0$.

If $\rho = 0$ then l is indifferent between her actions and so $\tau \in [0, 1]$. However, for this to be an equilibrium it must also be the case that it is a best-response for i or j to set $\rho_i = 0$ or $\rho_j = 0$. This requires that either $A \leq 0$ or $B \leq 0$. To find the values of τ consistent with this requirement, let us first define the values of τ such that i is indifferent between renegotiating or not by defining the following set: $\bar{T}_{i0} = \{\tau | A = 0, q = 0\}$. \bar{T}_{i0} is non-empty. To see this, note that:

$$\lim_{\tau \rightarrow 0} A = \sum_{n=\underline{n}}^{\bar{n}} u_i(\bar{x}, \bar{m}_i - \beta_i n C) f(n) - u_i(x^*, m_i^*) < 0$$

The above expression is negative when $\tau \rightarrow 0$, because, by **A.4**, $A < B$ and, by **A.3**, at least one of the expressions A and B is negative. On the other hand:

$$\lim_{\tau \rightarrow 1} A = u_i(\bar{x}, \bar{m}_i) - u_i(x^*, m_i^*) > 0$$

The above expression is positive when $\tau \rightarrow 1$ due to **A.1**. Since A is a continuous function of τ , there must exist $\bar{\tau}_{i0} \in (0, 1)$ such that $A = 0$, so \bar{T}_{i0} is non-empty. Moreover, when $q = 0$, A is strictly increasing in τ so the cut-off value $\bar{\tau}_{i0}$ is unique. This implies that for any $\tau \in [0, \bar{\tau}_{i0}]$, $A \leq 0$, $\rho = 0$ and the requirement for equilibrium is satisfied. Additionally, since $\rho_i = 0$, j 's payoff is independent of its decision ρ_j , so $\rho_j \in [0, 1]$. We summarize this result in the following proposition.

Proposition 2 *If $q = 0$ the only possible equilibria of the subgame that starts at $t = 3$ is the ones where $\rho_i = 0$ (no renegotiation), $\rho_j \in [0, 1]$ and $\tau \in [0, \bar{\tau}_{i0}]$. i 's equilibrium payoff is $u_i(x^*, m_i^*)$.*

Note that equilibria with $\rho_j = 0$ and $\rho_i > 0$ are not possible due to **A.4**, which implies that, if $\bar{\tau}_{j0}$ exists, then $\bar{\tau}_{j0} < \bar{\tau}_{i0}$, so if $\rho_j = 0$ then $\rho_i = 0$ as well.

Next, we let $q > 0$ and we examine the equilibria of the subgame that starts at $t = 3$. The first result is that the subgame has no equilibrium in pure strategies. To see this suppose that claim holders tender with probability one. Then $\tau = 1$, $\mu(k, \tau = 1) = f(k)$ and $\lambda(k, n, \tau = 1) = 0$. This implies that i 's and j 's expected payments are independent of their decision to renegotiate, and because, by definition, (\bar{x}, \bar{m}) provides higher utility to both than (x^*, m^*) , we have that $A > 0$ and $B > 0$. Therefore, if $\tau = 1$ then $\rho_i = 1$ and $\rho_j = 1$. However, if $\rho = 1$ then l 's best-response is to not tender, since $u_l(m_l + C) > u_l(m_l + q)$.

Similarly, if the claim holders never tender ($\tau = 0$), then $k = 0$ and both $A < 0$ and $B < 0$. Therefore, i and j prefer to block renegotiation: $\rho = 0$. However, if $\rho = 0$ then $u_l(m_l + q) > u_l(m_l)$, so l prefers to tender: $\tau = 1$. We present this result in the following proposition.

Proposition 3 *If $q > 0$, there is no equilibrium with $\tau = 0$ or $\tau = 1$ in the subgame that starts at $t = 3$.*

Therefore, if $q > 0$ the only possible equilibria of the game are mixed strategy, where $\tau \in (0, 1)$, which implies that i is indifferent between renegotiating or not and claim holders are indifferent between tendering their claims or not. For l to be indifferent between tendering the claim or not it must be that $u_l(m_l + q) = \rho u_l(m_l + C) + (1 - \rho)u_l(m_l)$ and so we have the following critical value for ρ :

$$\bar{\rho} \equiv \frac{u_l(m_l + q) - u_l(m_l)}{\rho u_l(m_l + C) - u_l(m_l)} \quad (6)$$

Similarly, for i to be indifferent between renegotiating or not τ must be such that $A = 0$. Similarly to the case where $q = 0$, let $\bar{T}_i = \{\tau | A = 0, q > 0\}$. \bar{T}_i is non-empty. To see this, note that:

$$\lim_{\tau \rightarrow 0} A = \sum_{n=\underline{n}}^{\bar{n}} u_i(\bar{x}, \bar{m}_i - \beta_i n C) f(n) - u_i(x^*, m_i^*) < 0$$

On the other hand:

$$\lim_{\tau \rightarrow 1} A = \sum_{n=\underline{n}}^{\bar{n}} [u_i(\bar{x}, \bar{m}_i - \beta_i n q) - u_i(x^*, m_i^* - \beta_i n q)] f(n) > 0$$

Since A is a continuous function of τ , there exists $\bar{\tau}_i \in (0, 1)$ such that $A = 0$. Moreover, by assumption **A.4**, if $A = 0$ then $B > 0$ and j 's best response is $\rho_j = 1$. Therefore, any $\tau \in \bar{T}_i$, $\rho_i = \bar{\rho}$, $\rho_j = 1$ is a mixed strategy equilibrium of the subgame. Moreover, it is impossible to have a mixed strategy equilibrium with $\rho_j < 1$ and $\rho_i > \bar{\rho}$, because this would require $A = B = 0$, which is incompatible with **A.4**. We summarize this result in the following proposition.

Proposition 4 *If $q > 0$, the subgame that starts at $t = 3$ has only mixed strategy equilibria, with equilibrium strategies $(\rho_i = \bar{\rho}, \rho_j = 1, \bar{\tau}_i)$, with $\bar{\rho}$ given by (6) and $\bar{\tau}_i \in \bar{T}_i$.*

In proposition 4 the overall probability of renegotiation ρ is equal to $\bar{\rho}$. And because i is indifferent between renegotiating or not, its equilibrium payoff is given by either (1) or (3). Hence, we have the following corollary.

Corollary 1 *If $q > 0$ then at $t = 3$ i 's subgame equilibrium payoff is given by:*

$$U_i^* = \sum_{k=0}^{\bar{n}} u_i(x^*, m_i^* - \beta_i k q) \mu(k, \bar{\tau}) \quad (7)$$

As the proposition 2 verifies, corollary 1 also applies to the limit case where $q = 0$.

The next step is to examine the optimal price of the tender offer at t_{2+} . At this point i chooses q to maximize its utility. And irrespectively of the value of β_i , (7) is maximized for $q = 0$.³ Since the optimal price at t_{2+} is zero, then proposition 2 applies and we have the following result.

³Note that, even though $\bar{\tau}$ implicitly depends on q , the maximum value of (7) is $u_i(x^*, m_i^*)$, irrespectively of the effect of q on $\bar{\tau}$.

Proposition 5 *At t_{2+} i sets $q = 0$. The equilibrium probability of renegotiation is $\bar{\rho} = 0$ and the probability of a claim holder tendering is $\tau \in [0, \bar{\tau}_{i0}]$, with $0 < \bar{\tau}_{i0} < 1$.*

Since contracting parties anticipate the equilibrium of the subgame at t_{2+} , they take the optimal actions y^* at $t = 1$, sign the optimal contract κ^* at $t = 0$ and they choose to issue the claims at t_{0-} .

Overall, the result changes dramatically between the case of section 3.1 and the game of this section. In the former case renegotiation always takes place while in the latter case it never takes place. i strictly prefer to set $q = 0$ (effectively, not to make a tender offer) and stick with the original contract than to set $q > 0$. This is because claim holders do not always tender their claims if $q > 0$ and so the benefits of renegotiation do not exceed the cost of the tender offer. Of course, the result depends on the fact that the actions of contracting parties and the claim holders are taken simultaneously and that i determines q . In the next section we show how complex claims can be used to block any renegotiation attempt when these assumptions are relaxed.

3.3 Complex Claims and Incomplete Information

We now examine the case where the claim holders are allowed to move before the contracting parties make their final decision on renegotiation. In fact, we allow for a more general bargaining game (a “mechanism”) between the contracting parties and the claim holders after the state of the world is revealed. We also allow the mechanism to renegotiate the terms of the claims themselves. Moreover, assumption **A.4** is not required for the purposes of this section, so we keep only assumptions **A.1**, **A.2** and **A.3**.

Generally, the contracting parties could commit (through a public announcement) to a price (or transfer) “rule” $q(k)$ and a renegotiation probability “rule” $\rho(k)$ as a function of the number of claim holders k who choose to participate in this renegotiation process. Let $M[q(k), \rho(k)]$ be mechanism which allows the parties to commit to $q(k)$ and $\rho(k)$ at $t = 2_+$. Participating in this mechanism is an effective way for a claim holder to tender her claim, since she gives up the rights conferred by it. Therefore, one can think of $q(k)$ as the aggregate transfer that a claim holder receives from participating in the mechanism plus the value of the renegotiated claim. Such a mechanism needs to be incentive compatible and individual rational.

Incentive compatibility means that the claim holders prefer to participate:

$$\sum_{k=0}^{\bar{n}-1} u_l[m_l + q(k+1)]f(k) \geq \sum_{k=0}^{\bar{n}-1} [\rho(k)u_l(m_l + C) + [1 - \rho(k)]u_l(m_l)]f(k) \quad (8)$$

The left hand side of (8) is the expected payoff of participating conditional on the other claim holders participating with probability $\tau = 1$, which implies that $k = n$

with probability $f(k) = f(n)$, while the right hand side of (8) is the expected payoff of not participating conditional the other claim holders participating. The individual rationality conditions for the claim holders and for the contracting parties, conditional on $\tau = 1$, are respectively:

$$\sum_{k=0}^{\bar{n}-1} u_l[m_l + q(k+1)]f(k) \geq u_l(m_l) \quad (9)$$

$$\sum_{k=\underline{n}}^{\bar{n}} [\rho(k)u_p[\bar{x}, \bar{m}_p - \beta_p k q(k)] + [1 - \rho(k)]u_p[x^*, m_p^* - \beta_p k q(k)]] f(k) \geq u_p(x^*, m_p^*) \quad (10)$$

The above conditions apply to the case of “simple” claims of section 3.2, where a claim holder receives a fixed payment C only on the event of renegotiation. Therefore, the optimal mechanism M^* is the one that maximizes the utility of both contracting parties conditional on satisfying the above conditions. Under this more general approach on the bargaining between the parties and claim holders, simple claims may not lead to a zero probability of renegotiation as they did in the previous section.

However, more complex claims, where the value of the exercised claim depends on the potential participation of other claim holders in $M[q(k), \rho(k)]$, can circumvent this concern. Specifically, consider the following “complex” claims, which contain two clauses. (1) “*No renegotiation*” clause: if i and j renegotiate the original contract κ^* then the claim holder receives the right to demand compensation C from them. This is the same as the clause of the simple claims of section 3.2. (2) “*No participation*” clause: for any public mechanism $M[q(k), \rho(k)]$ that i and j propose, if a claim holder chooses *not to participate* in it, then she receives the right to demand compensation C from each of the claim holders who decide to *participate* in $M[q(k), \rho(k)]$. In other words, if a claim holder l decides to *participate* in the renegotiation mechanism $M[q(k), \rho(k)]$ (effectively tendering her claim) and receives payment $q(k)$, then a claim holder d who decides *not to participate* in $M[q(k), \rho(k)]$ (not tender) can demand a payment C from l at $t = 4$.

Here, we are assuming that the mechanism itself and the participants are verifiable in courts, which is the case, since $M[q(k), \rho(k)]$ generates an enforceable agreement. Moreover, because at $t = 2$ the contracting parties do not know who holds the claims, they can only contact the claim holders through a public announcement and therefore the mechanism $M[q(k), \rho(k)]$ cannot be secret.

We now show that the “complex” claims change the incentives of claim holders entirely. In fact, no claim holder would find it profitable to participate. To see this, suppose that a claim holder l believes that there are n claim holders in total and out of them k other claim holders choose to participate and d choose not to, with $k+d = n-1$. Then, if l does not participate she receives payoff:

$$u_l(\tau = 0) = \rho(k)u_l[m_l + C + kC] + [1 - \rho(k)]u_l[m_l + kC] \quad (11)$$

While, if l participates she receives payoff:

$$u_l(\tau = 1) = u_l[m_l + q(k + 1) - dC] \quad (12)$$

The first expression above comes from the fact that, if l does not participate, she receives the right to ask for the payment C from each of the k claim holders that participated, while the second expression comes from the fact that, if l participates, she needs to pay C to each of the d claim holders who did not participate. Note that, as we also showed in section 3.2, $q(k) < C$ for any value of k , otherwise at least one of the contracting parties' individual rationality constraint is violated due to **A.3**.

Incentive compatibility for l requires that (11) \geq (12). But if $k + d = n - 1 \geq 1$, this is impossible. If $k = 0$ and $d = n - 1$, then $u_l[m_l] > u_l[m_l + q(k + 1) - (n - 1)C]$ so (11) $<$ (12) for any value of $\rho(k)$. If $k = n - 1$ and $d = 0$, then $u_l[m_l + (n - 1)C] > u_l[m_l + q(k + 1)]$ and (11) $<$ (12) for any value of $\rho(k)$ again. Generally, if $k + d \geq 1$, then $u_l[m_l + kC] > u_l[m_l + q(k + 1) - dC]$ and l 's incentive compatibility is impossible to hold. In other words, as long as l knows that there exists at least one more claim holder apart from her ($\underline{n} > 1$), it is a *strictly dominant strategy* for l not to participate in $M[q(k), \rho(k)]$. This result requires the weak assumption that the minimum number of distributed claims is greater than one, which is consistent with the previous section. Thus, we have the following result.

Theorem 1 *If the “complex” claims with the “no renegotiation” and the “no participation” clauses are used, then (a) any mechanism $M[q(k), \rho(k)]$ is not incentive compatible and (b) both the original contract between the contracting parties and the financial claims on it are renegotiated with probability zero.*

Part (a) of the theorem follows from the analysis above. For part (b), since no claim holders participate in $M[q(k), \rho(k)]$, then all the external claims remain outstanding and therefore the contracting parties choose to not renegotiate. This means that the results of the previous section go through even if the mechanism design approach is adopted.

Note that, as mentioned above, the intention of the contracting parties to renegotiate the claims needs to be made publicly known, because they do not know who the claim holders are. This avoids the possibility of secret mechanisms. And because renegotiating the claims generates an enforceable agreement, those who decided not to participate can verify who participated (signed the new agreement). Therefore, the claim holders who decide to participate in such a mechanism cannot avoid the payment demanded by those who did not participate. This renders the claims themselves renegotiation-proof and blocks at the same time the possibility of renegotiation by the contracting parties.

4 Hidden Renegotiation and Side Contracting

Another possibility for the contracting parties to avoid paying the claim holders and to renegotiate the original contract is by conducting hidden renegotiations between them-

selves, possibly with the involvement of third parties other than the claim holders, as Hart and Moore (1999) suggest. These side-contracts may either replace the original contract entirely or they may describe a set of actions and transfers such that in combination with κ^* they imply that contract $\bar{\kappa}$ is implemented. And it is reasonable to assume that the claim holders cannot observe the hidden renegotiation process or, even if they could, they cannot prove in courts that it concerns the contract κ^* because of the involvement of other parties.

In this section we examine the above arguments formally and we claim that as long as court hearings are open to public, then hidden renegotiation can be prevented from taking place. The main reasoning is that hidden side-contracting produces a new contractual agreement among i , j and possibly some third parties. Each party complies with it, only because of the fear that the other parties will take it to courts if it reneges on its promises. But since the contracting party can prove in courts that the combination of the hidden contract with κ^* violates its original desire at $t = 0$ not to renegotiate κ^* , then this is enough to trigger the claims. And as long as the claims include a clause which rewards the party who reneged on the hidden contracts and punishes those who took it to the courts, then the hidden contracts become non-enforceable and any hidden renegotiation attempt fails to take place. We formalize this reasoning below.

As in previous sections, κ^* denotes the ex-ante optimal contract and $\bar{\kappa}$ the ex-post optimal contract chosen by i and j . We continue to use the term “contracting party/-ies” to refer to i and j and the term “claim holders” to refer to the bearers of the claims issued by i and j . In addition, i and j may sign a hidden side-contract with the possible involvement of “third-parties”, which we assume to be different intermediaries from the claim holders. Let P^h be the set of all possible third parties that engage with i and j in hidden renegotiations and let K^h be the set of all possible hidden contracts that they may sign. $\hat{\kappa}$ denotes a contract in K^h and h denotes a contracting third party in P^h .

For i and j , we assume that the side contracts are designed so that if they are executed along with κ^* then they generate the same final outcome as $\bar{\kappa}$.⁴ Formally:

$$u_p(x^*(s), \hat{x}(s), m_p^*(s), \hat{m}_p(s)|y, s) \equiv u_p(\bar{x}(s), \bar{m}_p(s)|y, s) \quad \forall \hat{\kappa} \in K^h, p \in \{i, j\}$$

Moreover, since $\hat{\kappa}$ implies a vector $(\hat{x}(s), \hat{m}(s))$ of verifiable actions and final endowments (after transfers are made) for all parties involved in the hidden renegotiations, then $u_h(\hat{x}(s), \hat{m}_h(s)|y, s)$ denotes the ex-post payoff for the third party h if $\hat{\kappa}$ is executed. At this point it is also useful to define the parties’ payoffs when one of them reneges on its promises in $\hat{\kappa}$ while contract κ^* is executed as originally planned. Let $\{x^*(s), \hat{x}^{-p}(s), m^*(s), \hat{m}^{-p}(s)\}$ denote the final outcome when contract κ^* is executed by both parties, but party p reneges on its promises in contract $\hat{\kappa}$. Then for party p the final payoff is $u_p(x^*(s), \hat{x}^{-p}(s), m_p^*(s), \hat{m}_p^{-p}(s)|y, s)$ while for the other party, party p' ,

⁴The arguments of this section also apply to the case where the side-contract contract replaces the initial contract κ^* entirely.

the payoff is $u_{p'}(x^*(s), \hat{x}^{-p}(s), m_p^*(s), \hat{m}_p^{-p}(s)|y, s)$, and for the third party h the payoff is $u_h(\hat{x}^{-p}(s), \hat{m}_h^{-p}(s)|y, s)$, since h does not participate in κ^* . Note that because we examine transaction problems in which external enforcement is necessary for the compliance of the parties with the terms of the agreement (i.e. explicit contracting as opposed to self-enforcing agreements), the following inequalities are implied by the above:

$$u_p(x^*(s), \hat{x}^{-p}(s), m_p^*(s), \hat{m}_p^{-p}(s)|y, s) > u_p(\bar{x}(s), \bar{m}_p(s)|y, s) \quad \forall \hat{\kappa} \in K^h, p \in \{i, j\} \quad (13)$$

$$u_{p'}(\bar{x}(s), \bar{m}_{p'}(s)|y, s) > u_{p'}(x^*(s), \hat{x}^{-p}(s), m_p^*(s), \hat{m}_p^{-p}(s)|y, s) \quad \forall \hat{\kappa} \in K^h, \\ p, p' \in \{i, j\}, p \neq p' \quad (14)$$

Inequality (13) states that any party p benefits by reneging on the contractual terms of $\hat{\kappa}$, while (14) states that if p reneges on its contractual terms, then the other party's payoff is reduced. In sum, (13) and (14) capture the prisoner's dilemma nature of contractual agreements.⁵ It is the threat of enforcement through courts that makes $\hat{\kappa}$ credible. Finally, let \hat{C} be a net transfer such that for any $\hat{\kappa}(s) = \{\hat{x}(s), \hat{m}(s)\}$ in K^h the following conditions are satisfied:

$$u_{p'}(x^*(s), \hat{x}^{-p}(s), m_p^*(s), \hat{m}_p^{-p}(s)|y, s) > u_{p'}(\bar{x}(s), \bar{m}_{p'}(s) - \hat{C}|y, s) \quad \forall y \in Y, s \in S, \hat{\kappa} \in K^h \\ \text{and } p, p' \in \{i, j\}, p \neq p' \quad (15)$$

$$u_h(\hat{x}^{-p}(s), \hat{m}_h^{-p}(s)|y, s) > u_h(\hat{x}(s), \hat{m}_h(s) - \hat{C}|y, s) \quad \forall y \in Y, s \in S, \hat{\kappa} \in K^h \text{ and } h \in P^h \quad (16)$$

In words, \hat{C} is designed so that, regardless of which hidden contract is executed, if party p reneges on its promises in $\hat{\kappa}$, then the other party (p') prefers outcome $\{x^*(s), \hat{x}^{-p}(s), m_p^*(s), \hat{m}_p^{-p}(s)\}$ over enforcing $\hat{\kappa}$ (and therefore $\bar{\kappa}$) and paying out \hat{C} . Similarly, any third party h prefers the final outcome $\{x^*(s), \hat{x}^{-p}(s), m_p^*(s), \hat{m}_p^{-p}(s)\}$ over paying \hat{C} and having $\hat{\kappa}$ enforced. Therefore, the possibility of paying out \hat{C} prevents the parties in $\hat{\kappa}$ from going to courts if someone reneges on its promises.

The timing of events is as follows. As in the previous sections, the parties issue the claims at t_{0-} . We assume that the claims are “complex” (i.e. they incorporate the two clauses of subsection 3.3) and on top of that they include an additional “*no side-contracting*” clause, which states the following: If (a) any of the contracting parties, i or j , is taken to court because it reneged on the terms of some contract $\hat{\kappa}$, and (b)

⁵The typical example is the buyer-seller agreements, in which the seller has an incentive to avoid delivering the order to the buyer and the buyer has an incentive to avoid making the payment to the seller. See for example Segal (1999).

the party proves to the court that it reneged on its obligations because complying with them would imply a different set of outcomes for it than the ones described by κ^* , then any claim holder reserves the right to demand compensation \hat{C} for her and an additional compensation \hat{C} for the party taken to the court from each of the plaintiffs. Finally, the claim holder has the right to demand these compensations as many times as needed, as long as conditions (a) and (b) above apply.

The timing of events between $t = 0$ and $t = 3$ are the same as in figure 2. In addition, at $t = 3.1$ i and j decide whether to sign a hidden side contract $\hat{\kappa}$ with a set of third parties P^h . We assume that i and j retain a hard copy of this contract.⁶ At $t = 3.2$, i , j and the parties in P^h decide to execute the contractual terms of the hidden contract or not and at $t = 3.3$ any of the contracting members may take the others to court to demand that the contract is enforced. $t = 3.4$ is the court stage, where the defendant provides its evidence and the court decides whether the side contract should be executed or not. We assume that the court hearings are open to the public. At $t = 3.5$ the claim holders observe whether the “no side-contracting” clause applies and the court’s decision and decide whether to exercise their claims. Finally, at $t = 4$ the final set of outcomes and payoffs are realized for all players. The overall time-line is represented in figure 3.

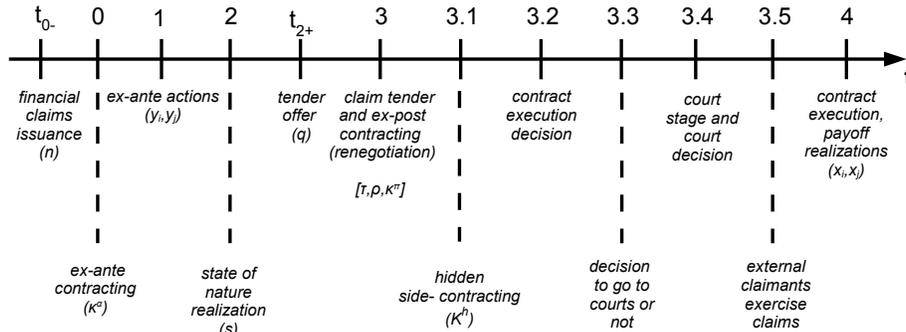


Figure 3: Timing of Events

Since stages 3.3 to 3.5 are relevant only if a contracting party reneges on $\hat{\kappa}$, we first analyse these stages when party d (the “defendant” in the court) does not fulfil its contractual terms at $t = 3.2$. In this case, at $t = 3.5$, the claim holders decide whether to exercise their claims or not. Regardless of the courts final decision at $t = 3.4$, the claim holders always prefer to exercise their right and receive \hat{C} , since conditions (14) and (15) imply that $\hat{C} > 0$. Therefore, whether claim holders receive \hat{C} or not depends on whether the defendant proves that complying with the hidden contracts violates κ^* or not.

⁶Any rational individual would demand that she holds a copy of the contracts that she has signed, otherwise she cannot prove her claims to a court and her rights would become non-enforceable.

At the court stage ($t = 3.4$), the court decides whether to enforce $\hat{\kappa}$ or not, while the defendant presents its evidence. If d provides the hard evidence and shows that $\hat{\kappa}$ violates its initial willingness not to renegotiate κ^* and if the court, based on this evidence, decides not to enforce $\hat{\kappa}$ then d 's payoff is equal to $u_d(x^*(s), \hat{x}^{-d}(s), m_d^*(s), \hat{m}_d^{-d}(s) + \hat{C}|y, s)$, since d is still eligible to receive \hat{C} . And by (13) and the fact that $\hat{C} > 0$, it is a best-response for d to provide the evidence to the court than to have $\hat{\kappa}$ enforced. If, on the other hand, the court decides to enforce $\hat{\kappa}$, despite d 's evidence, then, d 's payoff is $u_d(\bar{x}(s), \bar{m}_d(s) + \hat{C}|y, s)$ which is still greater than $u_d(\bar{x}(s), \bar{m}_d(s)|y, s)$ which it would receive if it did not provide the evidence. Therefore, regardless of the court's final decision it is a dominant strategy for d to provide the evidence at the court stage.

As a result, because of condition (15), the other contracting party does not have the incentive to take d to the courts and enforce $\hat{\kappa}$ at $t = 3.3$. Similarly, because of condition (16), any third party h prefers not to enforce $\hat{\kappa}$ than to take d to the courts. Hence, any contract $\hat{\kappa}$ becomes effectively non-enforceable. Due to this and inequality (13), i 's and j 's best response at $t = 3.2$ is not to execute the contractual terms of $\hat{\kappa}$, since they will not be taken to the courts if they renege on the contractual terms. And at $t = 3.1$ the contracting parties do not initiate the hidden side-contracting process, since they anticipate that it will not be enforced anyway. Overall, we have the following theorem.

Theorem 2 *If the claims issued at t_{0-} include the “no renegotiation” and “no participation” clauses of section 3.3 and the “no side-contracting” clause of this section, then the set of hidden side-contracts K^h becomes non-enforceable and the contracting parties do not take part in any hidden side-contracting at $t = 3.1$.*

A few notes are required at this point. (a) Because the claims are conditional on the courts *final decision*, the payment \hat{C} is made *after* the courts decision is implemented. This means that the claim holders and the defendants have the final say in terms of net transfers. Therefore, if the hidden renegotiations include a clause that d should pay for \hat{C} , then the exercise of the claims results in d recovering any payment it made *back* from the recipients and in receiving \hat{C} in addition.

(b) Because the clause allows claim holders to use the claims as many times as d is taken to courts, any hidden contracting after $t = 4$ leads to the same result as above.

(c) At the court stage the defendant needs only to prove that complying with both κ^* and $\hat{\kappa}$ implies a different set of final outcomes for it than κ^* to trigger the clause on the claims. It does not need to prove that hidden side-contracting took place. While this makes little difference if there exists only a single side-contract, as is the case of the above analysis, it is important for the case where i and j sign several side-contracts with third parties. In the latter case, the defendant may be unable to prove that side-contracting took place since it may have signed contracts only with the third parties, who act as intermediaries between it and the other contracting party. But it is still

in position to prove that the combinations of contracts it has signed violate its initial desire to implement $\{x^*(s), m_d^*(s)\}$. This is an effective way to prove that, as far as it is concerned, renegotiation has taken place.

5 Other Sources of Renegotiation

The analysis of the previous sections was focused only on the case of renegotiation due to information revelation and irreversibility. The information revelation happens at $t = 2$, when the state of the world becomes public knowledge, but at this point of time the contracting parties have already make their decisions regarding the actions $y = \{y_i, y_j\}$. Because these actions are irreversible, the new information regarding the state may mean that the original contract κ^* is not optimal any more and so renegotiation becomes an issue.

We focused on this case because it is one of the most commonly encountered in contract theory literature. Examples of models that fit this description are Ma (1991), Fudenberg and Tirole (1990) and Dewatripont and Maskin (1990). Also the literature on soft-budget constraints can be included in this category, like the papers by Dewatripont and Maskin (1995), Dewatripont and Roland (2000) and Kornai, Maskin, and Roland (2003). However, our framework can be easily modified to analyze other sources of renegotiation while retaining the main result. We examine some important alternative sources of renegotiation below.

5.1 Suboptimal Punishments

In many mechanism design problems it is possible to construct efficient mechanisms which implement general classes of social choice functions, but the mechanisms may involve punishments to all the participants, something that is suboptimal and should be expected to be renegotiated. Because renegotiation undermines the credibility of the mechanism, some social functions become non-implementable. Examples of this case include Maskin and Tirole (1999), Maskin and Moore (1999), Segal (1999), Che and Hausch (1999), Segal and Whinston (2002) and the implementation problem considered in Evans (2012).

Our proposed solution can be used in these models too. To see this, consider a general mechanism design environment in which each agent i possesses some private information v_i (or simple v if all agents possess the same information hidden from the mechanism designer as in the papers above) and agents receive allocations m and undertake enforceable actions x as a function of their *verifiable* reports y on their private information and some public information set s . Formally, $\kappa(y, s) = \{x(y, s), m(y, s)\}$. Now, suppose that there exists an optimal mechanism κ^* , which induces agents to report truthfully their private information and which implements efficient outcomes (on the equilibrium path), so that $y^*(\kappa^*) = v_i$ and κ^* is ex-ante Pareto optimal. This is equivalent to assumption **A.1**. Next, suppose that κ^* is not renegotiation-proof, which means

that there is a public information set s and some reports/actions y by the agents (off equilibrium path), which induce a suboptimal allocation (punishment) by the mechanism. So there exists some other allocation $\{\bar{x}(y, s), \bar{m}(y, s)\}$ which is Pareto superior to $\{x^*(y, s), m^*(y, s)\}$. This is equivalent to assumption **A.2**.

Nonetheless, as long as there exists at least one player who prefers the outcome $\{x^*(y, s), m^*(y, s)\}$ over the outcome $\{\bar{x}(y, s), \bar{m}(y, s) - \beta_p C\}$ (assumption **A.3**), then our result applies. Simply let agents issue complex claims, like the ones in section 4, which give claim holders the right to demand compensation C if $\kappa^*(y, s)$ is renegotiated, i.e. whenever the outcome $\{\bar{x}(y, s), \bar{m}(y, s)\}$ is implemented instead of outcome $\{x^*(y, s), m^*(y, s)\}$.

Note that the state of the world may be unobservable (s is empty) or only partially observable in this case, as for example in the case of the hold-up literature (Maskin and Tirole, 1999; Segal, 1999), in which case the implemented outcomes (x, m) may depend only on the message/action vector y . But as long as agents' reports and the implemented outcomes are verifiable, the unobservability (or non-verifiability) of the state of the world does not alter the analysis.

5.2 Time Inconsistent Preferences and Other Commitment Problems

Even though this case is not usually considered in the contract theory literature, some papers have considered the implications of time inconsistent preferences on contract design. Examples include O'Donoghue and Rabin (1999) and DellaVigna and Malmendier (2004). In principle, one could use our model in order to generate a commitment device for agents who suffer from time-inconsistency problems.

The set-up is actually simpler in this case. Consider a single agent p , who finds optimal a set of verifiable actions y^* at $t = 0$ but due to a preference change at $t = 1$ she prefers some other set of actions \bar{y} . If p would like to commit her future self to action set y^* then she could achieve this by issuing claims that pay out compensation C to any claim holder if she undertakes any action other than y^* . The necessary condition in this case is that at $t = 1$ p prefers y^* to \bar{y} and paying out C , which is the adaptation of condition **A.3** to this case.

Finally, note that similar arguments can be made for other commitment problems, like the ones that appear in papers regarding the time-inconsistency of policy makers (Kydland and Prescott, 1977; Barro and Gordon, 1983; Netzer and Scheuer, 2010) or in the literature on optimal deadlines, which are usually ex-ante optimal commitments but ex-post suboptimal (Toxvaerd, 2006; Mason and Valimaki, 2008; Bonatti and Horner, 2011).

6 Discussion and Conclusion

6.1 Limited Liability and Renegotiation

The analysis in the previous sections was done under the assumption of unlimited liability. This means that both the contracting parties and the claim holders have sufficient wealth to cover the value of the claim C . This may not be the case in all applications of interest. However, as long as civil law allows for other types of punishment (e.g. prison) for persons who are unable to pay out all their debts, the necessary condition for the credibility of the solution can be relaxed.

Specifically, let $\tilde{x}(s)$ denote the set of verifiable actions that are undertaken at $t = 4$ when contract $\bar{\kappa} = \{\bar{x}, \bar{m}\}$ is executed and the contracting parties are punished because they do not have sufficient wealth to cover the claim value. Then condition **A.3** can be modified to:

- **A.5:** There exists $\tilde{x}(s)$ such that, for any $\{\beta_i, \beta_j | \beta_i + \beta_j = 1\}$
 $u_p(x^*(s), m_p^*(s) | y, s) > u_p(\tilde{x}(s), 0 | y, s)$ for some $p \in \{i, j\}$

A.5 is weaker than **A.3** and, as discussed above, it should be expected to hold whenever the legal system allows one to be imprisoned for not been able to repay her debts.

According to section 3.3, claim holders may also be liable for paying out C , if they have participated in the renegotiation process. However, in these cases limited liability is not an issue because claim holders do not benefit from the renegotiation directly. Therefore, their total pledgeable wealth is equal to $m_l + q(k)$ (if k of them participate). Even if $m_l + q(k) < C$ and even if renegotiation does not take place, those who did not participate find it optimal to seize the total wealth of those who did. This makes participation in a mechanism suboptimal and, therefore, the limited liability constraint does not impact the results.

6.2 Positive Issuance Costs

Another implicit assumption of the above analysis is that the cost of issuance of claims is zero. Clearly this is not the case. Even if the contracting parties issue these claims in the simplest possible way (they do not use financial markets but issue the claims themselves), some lawyer fees are probably involved.

Since these costs take place at the ex-ante stage (before the contracting members sign any contract), the analysis does not become more involved. As long as the ex-ante benefit of blocking renegotiation exceeds the cost of issuing the claims, the value of renegotiation blocking is positive and the above analysis remains valid. Otherwise, renegotiation cannot be blocked by financial claims.

However, we should reasonably expect that issuance costs are relatively small in most cases of interest for two reasons. First, since the contracting parties intend to sign

a contract anyway, they can minimize the issuance costs by exploiting the synergies of doing the claim issuance and signing the contract κ^α at the same time (e.g. minimizing lawyer fees). Second, because in most economic transactions where contracts are actually used the potential benefits of contracting are substantial enough to justify the additional costs. For example, see Gagnepain, Ivaldi, and Martimort (2013) for a recent empirical study on the costs of renegotiation (i.e. potential benefits of renegotiation blocking).

6.3 Conclusion

In this paper we examine the conditions under which financial claims can be used in an effective way to block the renegotiation of contractual agreements. The results highlight the importance of information regarding the number and identity of claim holders. We show that if the contracting parties know exactly how many claims have been issued, then financial claims cannot block renegotiation. But if the contracting parties do not know exactly how many claims have been issued, then renegotiation blocking is possible. This may require “complex” claims, with special clauses, like the “no participation” clause of section 3.3 in order to block general bargaining games between the claim holders and the contracting parties, or like the “no side-contracting” clause of section 4 in order to block any hidden side-contracts. Nonetheless, if the prospect of renegotiation is costly for the contracting parties from an ex-ante point view, then they should be willing to adopt any credible commitment to block it. In this paper we show that financial claims can in theory fulfil this role.

References

- AGHION, P., M. DEWATRIPONT, AND P. REY (1994): “Renegotiation Design with Unverifiable Information,” *Econometrica*, 62(2), 257–282.
- ASHEIM, G. (1991): “Extending Renegotiation-Proofness to Infinite Horizon Games,” *Games and Economic Behavior*, 3(3), 278–294.
- BALIGA, S., AND T. SJÖSTRÖM (2009): “Contracting with Third Parties,” *American Economic Journal: Microeconomics*, 1(1), 75–100.
- BARRO, R., AND D. GORDON (1983): “Rules, Discretion and Reputation in a Model of Monetary Policy,” *Journal of Monetary Economics*, 12(1), 101–121.
- BEAUDRY, P., AND M. POITEVIN (1995): “Contract Renegotiation: A Simple Framework and Implications for Organization Theory,” *Canadian Journal of Economics*, 28(2), 302–335.
- BENSAID, B., AND R. GARY-BOBO (1993): “Commitment Value of Contracts under Renegotiation Constraints,” *Econometrica*, 61(6), 1423–1429.
- BERNHEIM, D., AND D. RAY (1989): “Collective Dynamic Consistency in Repeated Games,” *Games and Economic Behavior*, 1(4), 295–326.
- BESTER, H., AND J. SAKOVICS (2001): “Delegated Bargaining and Renegotiation,” *Journal of Economic Behavior and Organization*, 45(4), 459–473.
- BESTER, H., AND R. STRAUZ (2001): “Contracting with imperfect commitment and the revelation principle: the single agent case,” *Econometrica*, 69(4), 1077–1098.
- BONATTI, A., AND J. HORNER (2011): “Collaborating,” *The American Economic Review*, 101(2), 632–663.
- BRENNAN, J., AND J. WATSON (2013): “The Renegotiation-Proofness Principle and Costly Renegotiation,” *Games*, 4, 347–366.
- CAILLAUD, B., B. JULLIEN, AND P. PICARD (1995): “Competing Vertical Structures: Precommitment and Renegotiation,” *Econometrica*, 63(3), pp. 621–646.
- CHE, Y.-K., AND D. B. HAUSCH (1999): “Cooperative Investments and the Value of Contracting,” *American Economic Review*, 89, 125–147.
- DELLAVIGNA, S., AND U. MALMENDIER (2004): “Contract Design and Self-Control: Theory and Evidence,” *The Quarterly Journal of Economics*, 119(2), 353–402.
- DEWATRIPONT, M. (1988): “Commitment through renegotiation-proof contracts with third parties,” *The Review of Economic Studies*, 55(3), 377–390.

- (1989): “Renegotiation and Information Revelation Over Time: The Case of Optimal Labor Contracts,” *The Quarterly Journal of Economics*, 104(3), 589–619.
- DEWATRIPONT, M., AND E. MASKIN (1990): “Contract Renegotiation in Models of Asymmetric Information,” *European Economic Review*, 34(2-3), 311–321.
- (1995): “Credit and Efficiency in Centralized and Decentralized Economies,” *The Review of Economic Studies*, 62(4), 541.
- DEWATRIPONT, M., AND G. ROLAND (2000): “Soft Budget Constraints, Transition, and Financial Systems,” *Journal of Institutional and Theoretical Economics*, 156(1), 245–60.
- EVANS, R. (2012): “Mechanism Design with Renegotiation and Costly Messages,” *Econometrica*, 80(5), 2089–2104.
- EVANS, R., AND E. MASKIN (1989): “Efficient renegotiationproof equilibria in repeated games,” *Games and Economic Behavior*, 1(4), 361–369.
- FARRELL, J., AND E. MASKIN (1989): “Renegotiation in repeated games,” *Games and economic behavior*, 1(4), 327–360.
- FUDENBERG, D., B. HOLMSTROM, AND P. MILGROM (1990): “Short-Term Contracts and Long-Term Agency Relationships,” *Journal of Economic Theory*, 51(1), 1–31.
- FUDENBERG, D., AND J. TIROLE (1990): “Moral Hazard and Renegotiation in Agency Contracts,” *Econometrica: Journal of the Econometric Society*, 58, 1279–1319.
- GAGNEPAIN, P., M. IVALDI, AND D. MARTIMORT (2013): “The Cost of Contract Renegotiation: Evidence from the Local Public Sector,” *American Economic Review*, 103(6), 2352–83.
- GERRATANA, E., AND L. KOÇKESEN (2012a): “Renegotiation-Proof Third-Party Contracts under Assymmetric Information,” Working Paper.
- (2012b): “Strategic Effects of Renegotiation-Proof Contracts,” *The BE Journal of Theoretical Economics*, 12(1).
- HART, O., AND J. MOORE (1998): “Default and Renegotiation: A Dynamic Model of Debt,” *The Quarterly Journal of Economics*, 113(1), 1–41.
- (1999): “Foundations of Incomplete Contracts,” *Review of Economic Studies*, 66(1), 115–138.
- HART, O. D., AND J. TIROLE (1988): “Contract Renegotiation and Coasian Dynamics,” *The Review of Economic Studies*, 55(4), pp. 509–540.

- KATZ, M. L. (1991): “Game-Playing Agents: Unobservable Contracts as Precommitments,” *The RAND Journal of Economics*, 22(3), pp. 307–328.
- KORNAI, J., E. MASKIN, AND G. ROLAND (2003): “Understanding the Soft Budget Constraint,” *Journal of Economic Literature*, 41(4), 1095–1136.
- KYDLAND, F., AND E. PRESCOTT (1977): “Rules Rather than Discretion: The Inconsistency of Optimal Plans,” *The Journal of Political Economy*, 85, 473–491.
- LAFFONT, J., AND J. TIROLE (1990): “Adverse Selection and Renegotiation in Procurement,” *The Review of Economic Studies*, 57(4), 597–625.
- MA, C. A. (1991): “Adverse Selection in Dynamic Moral Hazard,” *The Quarterly Journal of Economics*, 106(1), 255–275.
- MASKIN, E., AND J. MOORE (1999): “Implementation and Renegotiation,” *Review of Economic Studies*, 66(1), 39–56.
- MASKIN, E., AND T. SJÖSTRÖM (2002): “Implementation Theory,” *Handbook of Social Choice and Welfare*, 1, 237–288.
- MASKIN, E., AND J. TIROLE (1999): “Unforeseen Contingencies and Incomplete Contracts,” *Review of Economic Studies*, 66(1), 83–114.
- MASON, R., AND J. VALIMAKI (2008): *Dynamic Moral Hazard and Project Completion*. Citeseer.
- MATTHEWS, S. (2001): “Renegotiating Moral Hazard Contracts under Limited Liability and Monotonicity,” *Journal of Economic Theory*, 97(1), 1–29.
- NEEMAN, Z., AND G. PAVLOV (2010): “Renegotiation-Proof Mechanism Design,” Discussion paper, Unpublished Manuscript.
- NETZER, N., AND F. SCHEUER (2010): “Competitive Markets without Commitment,” *Journal of Political Economy*, 118(6), pp. 1079–1109.
- O’DONOGHUE, T., AND M. RABIN (1999): “Incentives for Procrastinators,” *The Quarterly Journal of Economics*, 114(3), 769–816.
- REY, P., AND B. SALANIÉ (1996): “On the Value of Commitment with Asymmetric Information,” *Econometrica*, 64(6), pp. 1395–1414.
- RUBINSTEIN, A., AND A. WOLINSKY (1992): “Renegotiation-Proof Implementation and Time Preferences,” *The American Economic Review*, 82(3), pp. 600–614.
- SEGAL, I. (1999): “Complexity and Renegotiation: A foundation for Incomplete Contracts,” *The Review of Economic Studies*, 66(1), 57–82.

- SEGAL, I., AND M. D. WHINSTON (2002): “The Mirrlees Approach to Mechanism Design with Renegotiation (with Applications to Hold-up and Risk Sharing),” *Econometrica*, 70(1), 1–45.
- SNYDER, C. M. (1996): “Negotiation and Renegotiation of Optimal Financial Contracts Under the Threat of Predation,” *The Journal of Industrial Economics*, 44(3), pp. 325–343.
- TOXVAERD, F. (2006): “Time of the Essence,” *Journal of Economic Theory*, 129(1), 252–272.
- WATSON, J. (2007): “Contract, Mechanism Design, and Technological Detail,” *Econometrica*, 75(1), 55–81.