Endogenous Enforceability of Private Agreements and the Role of Institutional Agents*

Aristotelis Boukouras†

Work In Progress: 21 May 2009

Abstract

The purpose of this paper is to show that the determination of what is enforceable in a given society and what is not matters for social welfare. In order to achieve this, we present an economy with multiple groups of agents, each one of which faces a hold-up problem. The hold-up would stop to exist if agents could commit not to renegotiate their original agreement, but any private contract with such a clause is not renegotiation-proof. We show that the solution to this problem requires a broader contract between the agents and the enforcement authority, which we call the social contract. We also show that the social contract is renegotiation-proof if it specifies two conditions: i) an economy-wide delegate responsible for the enforcement of the social contract and ii) a set of non-enforceable private contracts.

Keywords: institutional agent, hold-up, social contract, time inconsistency
JEL Classification: D02, D82, D86

*I would like to thank Asako Ohinata, Kostas Koufopoulos, Herakles Polemarchakis and Claudio Mezzetti, for their very useful comments and remarks, for which I feel grateful.

†University of Warwick, Department of Economics, a.boukouras@warwick.ac.uk

1 Introduction

The main body of the economic literature on contract theory assumes that private agreements are enforceable by an external authority so that private contracts are binding for the contracting members. Because the role of enforcement institutions is obvious in this context, the related papers do not attempt to explicitly model the enforcement authority and how it achieves its goals.

The purpose of this paper is to show that the explicit modeling of the enforcement authority affects the set of implementable outcomes in a given economy, when compared to a model which takes enforcement as exogenous. Moreover, we show that our approach can rationalize two stylized facts of enforcement institutions: i) the existence of institutional agents (such as judges or bureaucrats) who act on behalf of these institutions and derive rewards from their function, and ii) the fact that not all types of private agreements are permitted in a society.

In order to make these points, we present a simple economy which consists of multiple pairs of agents. Each pair is comprised by a producer and a consumer of a specialized good and they face a hold-up problem. The hold-up problem could be solved by a mechanism of transfers contingent on trade, if agents could commit not to make any private agreement for transfers of resources ex-post. However, this solution is not time-consistent and, as a result, mechanisms with exogenous enforcement can not implement the first-best outcome.

In the first part of the paper we show that the hold-up problem can be solved by the introduction of a social contract between an institutional player, who has the enforcement power in the economy, and the rest of the agents. The social contract specifies what types of private agreements are enforceable or not at each point in time and the rewards and punishments for the institutional player, if he acts according with its clauses or not. An appropriately designed social contract can make the commitment to no-private contracting time consistent by rendering any such agreement non-enforceable. Furthermore, we show that such a social contract is renegotiation-proof ex-post.

In the second part we provide game theoretic foundations of the origins of social contracts and institutional agents through a broader three-stage game. In the first stage agents propose social contracts, which determine the enforcement institutions, and vote for one of them. Given a selected social contract, in the second stage, agents exert effort and the state of nature is determined and, in the third stage, the institutional agent enforces agreements and production and consumption takes place. We show that the features of the social contract of the previous part arise endogenously in equilibrium and that the sub-game perfect Nash equilibria of the game implement the first-best effort levels for all but one of the pairs in the economy.

We believe that these results are interesting because: i) We explicitly model an aspect of contract theory, which has been neglected in the literature so far, and we show that this can affect the set of implementable outcomes. ii) We show that the existence of economy-wide delegates, who enforce institutional constraints, is a necessary requirement for the renegotiation-proofness of institutions and hence we provide a rationale for the role of bureaucrats. iii) The set of enforceable agreements is endogenously incomplete i.e. not all agreements are enforceable.

The issue of imperfect enforcement has been examined in other papers as well. Telser (1980) is one of the first papers to model self-enforcing agreements, while Bull (1987) examines self-enforcing agreements in the context of the US labor market and Ray (2002) examines their time-structure. However, these papers are concerned with cases where contract enforcement is impossible and this is an economic restriction which agents can not overcome. Other papers, like Cooley, Marimon and Quadrini (2004) and Ellingsen and Kristiansen (2008), are concerned with the impact of limited enforceability on financial contracting. Krasa and Villamil (2000) consider the case where enforcement of the contractual agreement is a choice variable of the contracting members but it is costly and show that the costly state verification model can be seen as a reduced form of their enforcement problem. None of the above papers, however, examines the issue of enforceability from the aspect of the enforcement authority creation and function in the economy.

On the other hand, there is an extensive literature that is concerned with the issues of institutional authority. Aghion and Tirole (1997), Aghion, Alesina and Trebbi (2004), Greif and Laitin (2004), Greif et al (2008), Laffont and Martimort (1998), Sanchez and Straub (2006) are some of the papers concerned with the issues of authority in organizations or the endogenous formation of institutions. Our main difference is that we focus on enforcement institutions and we combine in our analysis both the questions of how these institutions emerge and how authority is determined.

Another type of literature that is related to our paper is the literature concerned with the issues of delegation. These papers examine the ability of an uninformed principal to extract information from an informed agent, who is asked to perform a task. Some examples are the papers by Holmstrom (1982), Fershtman, Judd and Kalai (1991), Faure-Grimaud, Laffont and Martimort (2003), Szalay (2005) and Alonso and Matouschek (2008). While in these papers delegates act on behalf of a principal, in our model institutional agents are economy-wide delegates who act on behalf of the society. We also eschew away from issues of information extraction as we assume that the actions of institutional agents are fully observable by the rest of the agents.

A final category of papers, closely related to ours, are the papers regarding the hold-up

problem. Since the seminal contributions by Grossman and Hart (1986) and Hart and Moore (1990), a long list of papers has been devoted on presenting the inefficiencies generated by this problem or on solving it [1]. We do not attempt to solve the most general hold-up problem in this paper. We use a simple example of hold-up, which can not be solved by any mechanism presented in the literature so far, in order to show the importance of enforcement institutions in solving time-inconsistency problems. However, we intend to generalize our solution in future work.

For the rest of the paper, we proceed as follows. Section 2 presents a simple model with only two agents who face a hold-up problem. We exogenously impose the social contract and the institutional agent in order to show how the mechanism works. In section 3 we present a more general model, with multiple pairs of agents facing the hold-up problem and we allow agents to choose a social contract and the set of institutional agents. We derive the main results of the paper and we discuss the intuition of the results, the justification of our assumptions and alternative specifications of the model. Section 4 concludes.

2 A simple model with two agents

A producer (p) and a consumer (c) face a simple hold-up problem with bilateral externalities. The producer has the ability to produce one unit of good g which is custom-made to satisfy the preferences of the consumer. This good has valuation equal to v for the consumer in terms of some numeraire commodity.

However, the cost of the good, which is again reflected in terms of the numeraire commodity, is uncertain and depends on the state of nature. There are two states of nature, one with a high cost ($\theta_1 : c_1 = c_H$) and one with a low cost ($\theta_2 : c_2 = c_L$). The probability of the low-cost state depends on the effort level of both the producer and the consumer of the good. If e_p and e_c are the effort levels exerted by them, then $f(e_p, e_c)$ is the joint probability function of the low cost state arising. Assume that $f(e_p, e_c)$ is a concave function. Effort is costly and is reflected by the strictly convex functions $c_c(e_c)$ and $c_p(e_p)$ for the consumer and the producer respectively, with $c_c(0) = c_p(0) = 0$. Let $0 < c_L < v < c_H$ and $v - c_L > c_H - v$.

The agents are endowed with a sufficiently large amount of the numeraire commodity w (for the purposes of this paper it is sufficient that $w > v - c_L$). Moreover, agents are risk neutral. The utility of the producer depends only on the amount of the numeraire commodity that he consumes, but the utility of consumer also depends on good g. In terms of notation, $u_p = c_p^n$

[1] see for example Aghion, Dewatripont and Rey (1994), Che and Hausch (1999), Hart and Moore (1999), Maskin and Moore (1999), Maskin and Tirole (1999a), Maskin and Tirole (1999b), Guriev and Kvassov (2005) and Evans (2008)

and $u_c = c_c^n + \delta v$, where c_p^n and c_c^n are the consumption levels of the numeraire commodity by the producer and the consumer respectively and δ is an indicator function that takes the value one if the consumer consumes good g and zero otherwise. If agents decide to trade after the state of nature is realized, they divide the surplus according some exogenous bargaining power. Let β_c be the proportion of the economic surplus that the consumer receives according to his bargaining power, with $0 < \beta_c < 1$ and $\beta_c + \beta_p = 1$.

We also assume that the effort levels and effort costs, the state of nature and the level of utility of each agent are observable but non-verifiable. The above assumptions constitute a special case of the standard hold-up problem. In addition, assume that the effort levels of the agents are non-transferable, so that property rights can not solve the problem. This is a plausible additional assumption since in many cases of economic interest the economic surplus may depend on the actions of some individuals which can not be easily replicated by others. In our example, the producer may have a specific set of skills which are needed for the production of the good, which the consumer does not have. The effort level he initially exerts may be interpreted as the exercise of these skills in order to be more productive in the required task. On the other hand, the effort level of the consumer may reflect the exercise of skills which are needed for the proper use of the good (e.g. driving skills or learning how to use a computer). In return, the more skilled is the consumer in the use of the good, the easier it is for the producer to comply with the needs of the consumer and the higher are the chances that the required cost of production is low [2].

Characterizing the first-best and second-best outcomes for this problem is straightforward. Conditional on the fact that trade is beneficial only if the low-cost state arises, the optimal effort levels are given as a solution to the following set of equations:

$$\frac{\partial f(e_p, e_c)}{\partial e_c}(v - c_L) = \frac{\partial c_c(e_c)}{\partial e_c} \tag{1}$$

$$\frac{\partial f(e_p, e_c)}{\partial e_p}(v - c_L) = \frac{\partial c_p(e_p)}{\partial e_p} \tag{2}$$

[2] Alternatively, the model can be formulated so that uncertainty is added on the consumption side of the economy. For instance, the valuation for the good could be high or low and its probability can depend on the effort level of the consumer. In this case, there would be four states of nature, but the main results of the paper would be the same if the trade generates social surplus in only one of the four states. The economic interpretation would be similar as well, especially if we think of goods which require some effort from the consumers' part in order to learn how to use them efficiently.

Let e_c^* and e_p^* be the optimal effort levels associated with the above system of equations. Therefore, the vector $e^* = (e_c^*, e_p^*)$ is the best possible outcome, that would arise if agents could endogenize the externalities generated by their efforts. However, because agents receive only part of the benefit generated by their efforts, without any mechanism to correct their incentives, the exerted effort levels are given by the equations:

$$\beta_c \frac{\partial f(e_p, e_c)}{\partial e_c}(v - c_L) = \frac{\partial c_c(e_c)}{\partial e_c} \tag{3}$$

$$(1 - \beta_c)\frac{\partial f(e_p, e_c)}{\partial e_p}(v - c_L) = \frac{\partial c_p(e_p)}{\partial e_p} \tag{4}$$

Let $\widehat{e} = (\widehat{e_c}, \widehat{e_p})$ be the vector of efforts that solve the above equations. Then, it is easy to check that $\widehat{e_c} < e_c^*$ and $\widehat{e_p} < e_p^*$, which means that the chosen effort levels are sub-optimal. This is essentially the effect of the hold-up problem.

If effort choices were transferable, an easy solution to this problem would be the allocation and trade of property rights on the effort decisions. Also, if either of the variables, that are non-verifiable, could be verified, even at some cost, then the agents could design mechanisms of subsidy provision or punishments in order to make the first-best effort levels committing. For example, if the state of nature were costlessly verifiable, then the following mechanism would implement the first-best effort levels: the consumer and the producer give out $t_c = f(e_c^*, e_p^*)(1-\beta_c)(v-c_L)$ and $t_p = f(e_c^*, e_p^*)\beta_c(v-c_L)$ units of the numeraire commodity to a risk-neutral agent, who has the obligation to return to them $s_c = (1 - \beta_c)(v - c_L)$ and $s_p = \beta_c(v - c_L)$ units respectively, if the low-cost state arises. In such a case, agents receive a subsidy in the low-cost case which aligns the marginal costs and benefits of effort exertion to the social costs and benefits and therefore achieves first-best outcomes.

Of course, as the relevant literature points out (see for example Hart and Moore (1990) or Maskin and Tirole (1999a)), the problem with such a mechanism is that truth-telling about the state of nature is not incentive compatible when the states of nature are non-verifiable. If the high-cost state arises, agents have incentive to lie in order to receive and redistribute the subsidies between them. Such redistributions require binding agreements on net transfers of resources. Ex-ante, agents prefer to ban such transfers, so that the mechanism satisfies incentive compatibility and generates optimal incentives for effort provision, but ex-post agents prefer to renegotiate the mechanism and allow for binding agreements. Therefore, the mechanism fails to provide efficient effort exertion.

This section of the paper shows how this problem can be circumvented by the introduction of an **institutional player**, a type of delegate, who enforces the mechanism and whose final payoff depends on the outcome of the mechanism. In this case, we show that endogenous commitment not-to-renegotiate the mechanism ex-post arises because the institutional player has an incentive to block any renegotiation that reduces his expected payoff. Furthermore, the enforceability of ex-post transfers and the incentives of the institutional player arise endogenously, through the ex-ante **social contract** between the agents and their delegate.

For the rest of this section we assume the timing of events as represented by Figure 1, which is similar to the one adopted by Watson (2007).

Figure 1: Timing of Events

In Propositions 1 and 2 we establish the main results of this section. Proposition 1 provides a social contract that implements the first-best effort levels in the economy described above, while Proposition 2 shows that the participation of the institutional player and the endogenous enforceability of ex-post transfers are necessary conditions for the implementation of the first-best effort levels. But first some useful definitions.

Definition 1: An **institutional player** ($\Sigma = 1$) is a player whose actions and rewards are

determined by the agents through a social contract. The action set of the institutional player is the payment of subsidies to the agents and the enforcement of the exchange of goods conditional on the messages about the state of nature and the enforcement or not of private contracts.

Definition 2: A **social contract** $S(\mathbf{m}, \mathbf{t}, \mathbf{s}, \tau(g), \Sigma, \Phi(Q), \mathbf{r})$ is a contract between the consumer, the producer and potentially an institutional player, which defines the ex-ante payments of the agents, the ex-post message space, the subsidies paid to the agents conditional on messages, the exchange of goods conditional on messages, the inclusion of the institutional player or not and the enforceability of the private contracts. If the institutional player is included in the social contract, then the ex-ante payments are paid to him, the ex-post subsidies are paid by him conditional on the messages of the agents, and the social contract also defines the reward of the institutional player conditional on messages.

We assume that even if an institutional agent is not included in the social contract, the consumer and the producer can still utilize the enforcement authority of the economy, which we treat as an automaton or a machine in that case. We do this so that we can contrast our results with the existing literature, which assumes that enforcement authorities exist but they are not explicitly modeled. The cases of exogenous enforcement with complete or incomplete set of enforceable agreements are special cases of social contracts in our framework. In section 3, we make the more realistic assumption that the economy starts of from a point of no institutions and we derive their existence and structure endogenously.

Definition 3: A **private contract** $q(\mathbf{m}, \rho, g)$ or $q(\rho, g)$ is any agreement between the consumer and the producer for a net transfer of resources. This includes agreements for transfer of resources conditional on each agent sending a specific message to the institutional player. Q is the set of all possible contracts. The enforcement of private contracts depends on the social contract.

For the purposes of the following two propositions, assume that the institutional player is an (exogenous) agent with no other economic interaction with the consumer or the producer, who is risk-neutral and has an outside option of zero (the opportunity cost from not participating in the social contract). He also possesses an initial endowment of w.In section 3 we provide a more reasonable explanation for the origins of institutional players and the related outside options.

Proposition 1: There exists a social contract $S(\mathbf{m}, \mathbf{t}, \mathbf{s}, \tau(g), \Sigma, \Phi(Q), \mathbf{r})$ which implements the first-best effort levels for the hold-up problem presented above. Furthermore, such a social contract is renegotiation-proof.

Proof: The proof proceeds by construction. Below, we present a social contract S and we show that it implements the first-best effort levels and that it is renegotiation-proof. Consider the social contract, signed by the consumer the producer and the institutional player, and which determines:
i) In period 0, the consumer and the producer make the ex-ante payments $t_c = f(e_c^*, e_p^*)(1 - \beta_c)(v - c_L)$ and $t_p = f(e_c^*, e_p^*)\beta_c(v - c_L)$ respectively to the institutional player.
ii) In period 7, the institutional player enforces the trade $\tau(g) = (1 - \beta_c)v - \beta_c c_L$ if both agents send the message that the cost is low ($m_c = m_p = c_L$). He also pays subsidies $s_c = (1 - \beta_c)(v - c_L)$ and $s_p = \beta_c(v - c_L)$ to the consumer and the producer respectively. For all the other combinations of messages, he does not enforce the trade and does not pay any subsidies.
iii) The institutional player does not enforce any private contract.
iv) The institutional player receives the reward $r = 0$ for acting according to the social contract, but receives the punishment (net transfer split between the two other agents) $r = -w$ for not complying with it.

First, notice that the enforcement of a private contract is a necessary condition for making the transfers of resources time-consistent and hence for its execution. Suppose that the consumer and the producer try to circumvent the mechanism and sign a private contract in period 5, after they have observed the state of nature, for trading the good g at a price $\tau(g)$. Then if the institutional player acts according to the social contract and does not enforce this private contract, the best-response for the consumer is not to make the payment to the producer and the best-response of the producer is not to produce the good. Therefore, any transfer of resources outside the mechanism requires the participation of the institutional player. But if the institutional player enforces a private contract, then he violates the initial social contract and suffers a disutility of $-w$, which is not a best-response from his part. Therefore, without renegotiation of the social contract at period 4, no private agreement is executed in period 7 and the two agents are compelled to do the trading of the good through the mechanism.

Suppose that the low-cost state arises in period 3. Then, the most preferred message for the consumer and the producer is $m_c = m_p = c_L$. If they both send the same message, then they the good and they also receive the subsidies. The overall utility for the consumer is $u_c = v - \tau(g) + s_c = v - c_L$ and for the producer is $u_p = \tau(g) - c_L + s_p = v - c_L$. Otherwise, they lose both the surplus from trade and the subsidies, which is clearly a dominated outcome for

either of them.

Suppose that the high-cost state arises in period 3. Without renegotiation of the social contract and without any private contract between the two, the consumer prefers the trade through the mechanism than no-trade but the producer does not. If both agents send the message $m_c = m_p = c_L$ then $u_c = v - c_L > 0$, but $u_p = \tau(g) - c_H + s_p = v - c_H < 0$. Therefore, the best-response of the consumer is to send the message c_L if the producer does so as well (and he is indifferent between messages otherwise), but the producer strictly prefers to send the message c_H and avoid any trading. The result is that no trade takes place in the high-cost state of nature.

If private contracts were enforceable, then the consumer would persuade the producer to send the message c_L by promising the conditional transfer $q(m_p = c_L) = c_H - v$. This transfer would be credible because $v - c_L > c_H - v$. Since private contracts are not enforceable, though, such a promise is not time-consistent and this relaxes the incentive compatibility constraint of the producer. Given the best-response messages of the the agents in the two states of the world, the optimal effort levels are determined by the following equations:

$$\max_{e_c}\{E(u_c) = f(e_1, e_2)(v - c_L) - c_c(e_c)\} \tag{5}$$

$$\max_{e_p}\{E(u_p) = f(e_1, e_2)(v - c_L) - c_p(e_p)\} \tag{6}$$

The first-order conditions of (5) and (6) are given by equations (1) and (2), and therefore the proposed mechanism gives the incentives to the agents to achieve the first-best investment levels.

We turn now to the issue of renegotiation-proofness. Consider first the ex-post renegotiation. If the low-cost state arises then the consumer and the producer can enforce the trade and receive the subsidies by sending messages to the institutional player, which provides them the maximum ex-post payoff. Therefore, any renegotiation of the social contract can not increase their payoffs and agents have no incentive to renegotiate the social contract. If, the high-cost state arises, then the two agents can increase their pay-offs if they modify the social contract so that private contracts are enforceable ($\Phi(Q) = Q$). In such a case, net transfers of resources between the two agents are allowed and they can extract the subsidies by lying about the state of nature. However, the institutional player anticipates the renegotiation of the social contract in the bad state. Furthermore, any credible reward the agents are willing

to provide to him in order to agree to renegotiate does not cover for the losses by paying out the subsidies ($v - c_L > 2v - c_L - c_H$). Therefore, the institutional player does not agree to renegotiate the social contract in period 4.

A similar type of argument shows that the institutional player does not agree to renegotiate the social contract in the interim stage. ■

The social contract presented above is not the only one that can implement the first best effort levels. As long as the set of contracts of type $q(\mathbf{m}, \rho, g)$ are not enforceable in period 5, the consumer and the producer have no credible way of extracting the subsidies and redistributing them among them. Therefore, the optimal action for the producer is to not allow the trade to take place. This means that partial incompleteness of the set of enforceable contracts is enough to guarantee the result. Proposition 2 below presents shows the necessary conditions for the implementation of first-best effort levels.

Proposition 2: The existence of the institutional player and the non-enforcement of private contracts contingent on messages are necessary conditions for the implementation of first-best effort levels.

Proof: First, we prove that any renegotiation-proof mechanism S that does not include an institutional player ($\Sigma = \emptyset$) can not implement the first-best effort levels. Consider any mechanism $S(\,.\,, \Sigma = \emptyset)$ and assume that the mechanism infers that the cost is low if the agents send the messages $\widehat{\mathbf{m}}$. Implementation of the first-best effort levels requires that trade takes place and appropriate subsidies are provided only in the low-cost state. Therefore, in terms of ex-post utility, the combination of incentive compatibility and efficiency requires:

$$u_c(\widehat{m}_c, \widehat{m}_p|c_L) = v - c_L \geqslant u_c(m'_c, \widehat{m}_p|c_L), \forall m'_c \tag{7}$$

$$u_p(\widehat{m}_p, \widehat{m}_c|c_L) = v - c_L \geqslant u_p(m'_p, \widehat{m}_c|c_L), \forall m'_p \tag{8}$$

$$u_i(\widetilde{m}_i, \widehat{m}_j|c_H) = 0 \geqslant u_i(\widehat{m}_i, \widehat{m}_j|c_H), \ for\ some\ \widetilde{m}_i \neq \widehat{m}_i\ and\ for\ some\ i \in \{c, p\} \tag{9}$$

$$u_j(m_j, \widetilde{m}_i|c_H) = 0\ , \forall m_j\ and\ j \neq i \tag{10}$$

Equations (7) and (8) imply that the aggregate subsidy given in the low-cost state is equal to the surplus: $\sum s_i = v - c_L$. Equation (9) requires that at least one of the agents has the incentive not to trade if the high-cost state arises.

If the mechanism $S(\,.\,, \Sigma = \emptyset)$ allows for private contracts, contingent on messages, equation (9) can not be satisfied. This is because $\sum s_i = v - c_L > c_H - v$ and therefore

there is always a private contract $q(\widehat{m}_i, \pi, \emptyset)$ such that $u_i(\widehat{m}_i, \widehat{m}_j|c_H) + \pi > 0$. Without loss of generality, assume that $S(\,.\,, \Sigma = \emptyset)$ specifies the price τ, if g is traded, and subsidies $\{s_c, s_p\}$. Then $u_c(\widehat{m}_c, \widehat{m}_p|c_H) = v - \tau + s_c$, $u_p(\widehat{m}_p, \widehat{m}_c|c_L) = \tau - c_H + s_p$ and $u_c(\widehat{m}_c, \widehat{m}_p|c_H) + u_p(\widehat{m}_p, \widehat{m}_c|c_L) = \tau - c_H + s_p = (v - c_L) - (c_H - v) > 0$. Therefore, there exists a net-transfer π and a private contract $q(\widehat{m}_i, \pi, \emptyset)$ such that $u_c(\widehat{m}_c, \widehat{m}_p|c_H) + \pi > 0$ and $u_p(\widehat{m}_p, \widehat{m}_c|c_L) - \pi > 0$, which violates the incentive compatibility-cum-efficiency condition.

If, on the other-hand, $S(\,.\,, \Sigma = \emptyset)$ does not allow for the enforcement of private contracts, then there are two possibilities. Either equation (9) can not be satisfied, in which case the result of the proposition holds, or equation (9) is satisfied. In this case, however, M is not ex-post renegotiation proof, because there exists another mechanism $S'(\,.\,, \Sigma = \emptyset)$, which allows for private contract enforcement and makes both agents better off, as shown above. This completes the first part of the proposition, namely that the existence of the institutional player is a necessary condition for the implementation of the first-best effort levels.

The necessity of the non-enforcement of the private contracts follows from the first part of the proof. Even if the mechanism specifies an institutional player, equations (7)-(10) must still be satisfied, and with enforceable agreements of the form $q(\mathbf{m}, \pi, \emptyset)$, we already showed how equation (9) is violated. ■

Propositions 1 and 2 show that the modeling of the enforcement institutions and the agents, who work on their behalf, changes the set of implementable outcomes for this type of problems. This implies that certain types of societal constraints, which are necessary for increasing social surplus, can not be endogenously supported without a stakeholder on their enforcement. However, in the analysis so far we have omitted to deal with the question of where social contracts and institutional agents come from. In the next section we try to answer these questions. Moreover, we provide a rudimentary theory for the centralization of the enforcement authority and the importance of bureaucracy.

3 Choosing Social Contracts

This section builds on the model and the results of the previous section. Consider an economy that lasts for one period and consists of 2n agents. Agents are categorized in two mutually exclusive sets, the set C of consumers and the set P of producers, each of one of which contains n agents. For each consumer c_i in C, there exists one producer p_j in P who has the know-how to produce a specialized good g_{ij} for the consumer and the consumer values the

specialized good of only that particular producer [3]. In addition, each agent has access to an autarchic technology, which he can use to produce a non-specialized good.

As before, assume that all agents are risk-neutral and they are all initially endowed with y_0 units of the generic good. The technology of production of the specialized good remains the same as in the previous section and it is represented by the same set of variables and relations as in section 2 $(v, c_L, c_H, e_c, e_p, f(e_c, e_p), c_c(e_c), c_p(e_p), \beta_c, \beta_p)$. The only difference is that there are multiple pairs of producers and consumers. Therefore, we need to make the additional assumption that the probability of the low-cost state arising for one of the specialized goods does not depend on the effort levels of other agents, apart from the consumer that values the good and the producer who has the know-how for producing it. In other words, the probabilities of cost function for specialized goods are independently distributed and there is aggregate uncertainty in the economy.

The technology of the non-specialized good is represented by the production function:

$$y(e) = 0, \ if \ e < \underline{e}$$

$$y(e) = \underline{y}, \ if \ e \geqslant \underline{e}$$

Let $\underline{y} - c(\underline{e}) > 0$, so that agents prefer to exert effort in the production of the non-specialized good than doing nothing. Therefore, exerting effort has two potential values for an agent, depending on what type of productive activity the agent pursues. Let e_i^u and e_i^g denote the effort level exerted for the production of the non-specialized good or for increasing the probability of the low-cost state for the specialized good respectively. We assume perfect substitutability between the two types of effort and hence the total cost of effort is: $c_i(e) = c_i(e_i^u + e_i^g)$.

For a pair of consumer and producer $\{c, p\}$, let $\mathbf{e}^*(e_c^u, e_p^u) = (e_c^*(e_c^u, e_p^u), e_p^*(e_c^u, e_p^u))$ be the optimal effort levels for the production of the specialized good if the agents exert effort levels e_c^u and e_p^u respectively in the autarchic production. Let $\widehat{\mathbf{e}}(e_c^u, e_p^u) = (\widehat{e_c}(e_c^u, e_p^u), \widehat{e_p}(e_c^u, e_p^u))$ be the second best effort levels, given e_c^u and e_p^u. Then we assume that the following relations hold:

i) $\min \{ f\left(e_c^*(0,0), e_p^*(0,0)\right)\beta_c(v - c_L) - c_c\left(e_c^*(0,0)\right) \ , \ f\left(e_c^*(0,0), e_p^*(0,0)\right)(1 - \beta_c)(v - c_L) - c_p\left(e_p^*(0,0)\right) \} \geqslant \underline{y} - c_i(\underline{e}), \quad for \ i \in \{c, p\}:$ specialization of production is socially optimal if agents can commit on the efficient levels of effort.

[3]The model can be easily extended to include less extreme assumptions and maintain the same qualitative results. For instance, the model can be extended to allow for partial substitutability between the specialized goods of different producers. Or it can incorporate heterogeneity of productive capabilities and endogenous matching between consumers and producers.

ii) $\min \{ f\left(\widehat{e}_c(0,0),\widehat{e}_p(0,0)\right)\beta_c(v-c_L) - c_c\left(\widehat{e}_c(0,0)\right) \ , \ f\left(\widehat{e}_c(0,0),\widehat{e}_p(0,0)\right)(1-\beta_c)(v-c_L) - c_p\left(\widehat{e}_p(0,0)\right) \} < \underline{y} - c_i(\underline{e}), \quad for\ i \in \{c,p\}:$ specialization of production is not optimal if agents exert the second-best effort levels.

iii) $\min \{ f\left(e_c^*(0,0),e_p^*(0,0)\right)\beta_c(v-c_L) - c_c\left(e_c^*(0,0)\right) \ , \ f\left(e_c^*(0,0),e_p^*(0,0)\right)(1-\beta_c)(v-c_L) - c_p\left(e_p^*(0,0)\right) \} \geqslant \max \{ f\left(e_c^*(\underline{e},\underline{e}),e_p^*(\underline{e},\underline{e})\right)\beta_c(v-c_L) - c_c\left(e_c^*(\underline{e},\underline{e}) + \underline{e}\right) \ , \ f\left(e_c^*(\underline{e},\underline{e}),e_p^*(\underline{e},\underline{e})\right)(1-\beta_c)(v-c_L) - c_p\left(e_p^*(\underline{e},\underline{e})\underline{e}\right) \}, \quad for\ i \in \{c,p\}:$ Agents prefer exerting effort only for the specialized good than exerting effort for both.

Effectively, agents in this economy face the dual problem of how to best incentivize effort for the specialized goods and how to allocate effort to the autarchic production, if at all. The previous assumptions simplify this problem greatly [4]. In light of the previous section, we allow agents to write social contracts and elect institutional players in order to credibly commit to efficient effort provision. This means that institutional agents are occupied with an additional activity, namely contract enforcement, and this requires an additional technological assumption on how many activities can be done at the same time.

For the rest of this section, we assume that contract enforcement activities and directly productive activities (effort exertion) are mutually exclusive. That is the institutional players do no exert effort for enforcing agreements and they are able to enforce multiple agreements at the same time, but they can not be occupied in any other economic activity at the same time. Again, this assumption is done to simplify the analysis and it can be generalized to include a cost of effort for each enforcement activity. In this case, our model, the model where enforcement authority and economic activity are not mutually exclusive and the model where an agent conducts a limited extent of enforcement, arise as special cases of this approach, but the main intuition of result remains.

We model the overall problem of the creation of institutions of enforcement and effort exertion as a three stage-game, each stage of which may potentially have multiple sub-stages.

In stage one, agents decide on the social contract. First, each agent is allowed to propose a social contract $S(\mathbf{m}, \mathbf{t}, \mathbf{s}, \tau(g), \Sigma, \Phi(Q), \mathbf{r})$ and then agents vote for one of the proposals. For any proposal to become a valid social contract for the economy, all agents must vote for it (unanimity requirement), even if there is only one proposal made [5]. If no proposal achieves the unanimity requirement, then there are no enforcement institutions in the economy, and agents can utilize only the autarchic production technology. In this case, the game ends

[4] We are currently working on relaxing them

[5] This means that agents have the option of not voting at all.

with effort exertion, production and consumption under autarchy (the state of nature is inconsequential for autarchic production and therefore it is omitted from the analysis of this sub-game).

The social contract specifies the set Σ of institutional players, which can potentially be more than one, the enforcement power for each one of them, $\Phi_\sigma(Q)$, the ex-ante payments $\mathbf{t}$, the message space $\mathbf{m}$, the ex-post subsidies $\mathbf{s}$ and trade $\tau(g)$ conditional on messages and the rewards or punishments $\mathbf{r}$ for each institutional player for complying or deviating from the social contract.

Σ is a subset of the agents in the economy. The enforcement power $\Phi_\sigma(Q)$ determines whether the institutional player σ has the authority to enforce private contracts or not, with $\Phi_\sigma(Q) = Q$ meaning that σ is obliged to enforce any private contract q and $\Phi_\sigma(Q) = \emptyset$ meaning that σ is obliged not to enforce any private contract. For any other set $\widehat{Q} \subset Q$, $\Phi_\sigma(Q) = \widehat{Q}$ means that σ is obliged to enforce any private contract $q \in \widehat{Q}$, but he is obliged not to enforce the rest of private contracts in Q.

The vector $\mathbf{t}$ consists of the ex-ante transfers $t_{i,j}$ that from agent i to agent j. j maybe an institutional player or not. If he is an institutional player, then the transfer is part of the mechanism for the implementation of optimal effort levels. If he is not an institutional player, then it is just a redistributive transfer. Therefore, $\mathbf{t}$ is an $2n \times 2n$ vector.

For simplicity, the message space $\mathbf{m}$, the prices of specialized goods $\tau(\mathbf{g})$ and the vector of subsidies for each agent $\mathbf{s}$ are the same for all institutional players [6]. The vector $\mathbf{r}$ represents the rewards r_σ^+ and punishments r_σ^- for each institutional player σ for enforcing or not the social contract. The net rewards for enforcing the social contract are generated by the difference between the ex-ante transfers to institutional players and the expected ex-post subsidies.

In the second stage, agents decide how much effort to exert on autarchic and specialized production, and the state of nature is determined. After the determination of the state, agents can renegotiate the social contract and sign private contracts.

In the third stage, agents send messages about the cost of production to the institutional players, who enforce production and trading or not accordingly. Institutional players also enforce (or not) private contracts if asked. Finally, consumption takes place.

Figure 2 presents the stages of the game and the timing of events.

Notice that the unanimity requirement for the selection of the social contract acts as a participation constraint. If the enforcement of a proposed social contract gives lower utility to an agent than the utility of autarchy, then the agent can block the social contract by not

[6] We can relax this assumption without affecting the results of the analysis. In this case, social contracts can include multiple sub-mechanisms, one for each proposed institutional player.

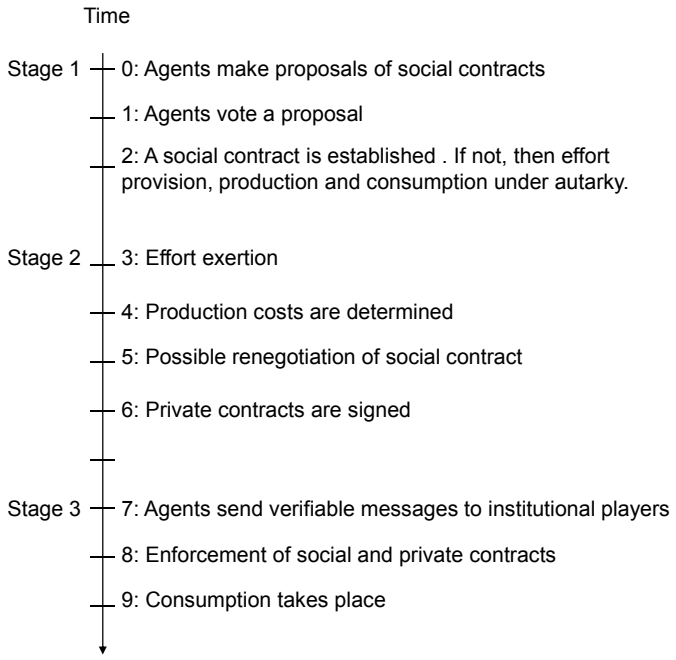

Figure 2: Timing of Events

voting for it. Therefore, there can be no equilibrium of the game where the final expected utility for a subset of agents is below their autarchic utility levels. For the rest of the section, when we refer to participation constraints, we imply the autarchic utility level for each agent.

On the other hand, any proposal that generates a Pareto undominated allocation and satisfies the participation constraints of all agents can be an equilibrium of the game. This is again a result of the unanimity requirement, because it gives veto power to each player. We will comment on the importance of this point in the discussion that follows Proposition 3.

If a certain social contract is selected in stage one, the selected institutional players do not exert effort in stage two. The rest of the agents decide on how much effort to exert in producing the generic good or investing effort for the specialized good and what messages to send. Let $T_i(\mathbf{m}|S, c_K)$ denote the utility of an agent i as a function of the messages, if trade takes place in state c_K and under the social contract S. Then the pair $\{c, p\}$ solves the following system of equations in stage two:

$$\max_{e_c^u, e_c^g, m_i} f(e_c^g, e_p^g) T_c(\mathbf{m}|S, c_L) + \left(1 - f(e_c^g, e_p^g)\right) T_c(\mathbf{m}|S, c_H) + I_u \underline{y} - c_c(e_c^u + e_c^g) \tag{11}$$

$$\max_{e_p^u, e_p^g, m_i} f(e_c^g, e_p^g) T_p(\mathbf{m}|S, c_L) + \left(1 - f(e_c^g, e_p^g)\right) T_p(\mathbf{m}|S, c_H) + I_u \underline{y} - c_p(e_p^u + e_p^g) \tag{12}$$

I_u is an indicator function that takes the value 1 if $y = \underline{y}$ and the value 0 otherwise. Of course, there are only two values of e_i^u that are useful for the analysis 0 and $\underline{e}_i^u$, because for any other value of the variable the agent does not increase his benefit but increases his cost.

For the social contract of the previous section $T_c(\mathbf{m}|S, c_L) = T_p(\mathbf{m}|S, c_L) = v - c_L$ and $T_c(\mathbf{m}|S, c_H) = T_p(\mathbf{m}|S, c_H) = 0$. Notice that $T_i(\mathbf{m}|S, c_k)$ does not depend on the effort level. The effort level only increases or decreases the probability of trade and subsidies in each state. But, due to the externalities, the maximum values of (11) and (12) also depend on the effort choice of the other agent involved in the trade of the specialized good.

Because of the assumption that we made above, if the social contract of the previous section is adopted (or an equivalent), agents will exert effort only for the production of the specialized good. Their expected utility in stage two is $f\left(e_c^*(0,0), e_p^*(0,0)\right)(v - c_L) - c_c\left(e_c^*(0,0)\right)$, $f\left(e_c^*(0,0), e_p^*(0,0)\right)(v - c_L) - c_p\left(e_p^*(0,0)\right)$, depending on the cost function of effort.

The ex-ante utilities of the agents depend also on the transfers they are asked to make. For an institutional player, the expected utility is the difference between the ex-ante transfers and the expected subsidies, plus the reward (minus the punishment) of enforcing the social contract:

$$E(u_\sigma) = \sum_{i \in C} t_{i,\sigma} + \sum_{j \in P} t_{j,\sigma} - f\left(e_i^*(0,0), e_j^*(0,0)\right)\left(\sum_{i \in C} s_{i,\sigma} + \sum_{j \in P} s_{j,\sigma}\right) + r_\sigma \tag{13}$$

For a non-institutional player ($i \in (C \cup P) - \Sigma$) the ex-ante utility is provided by:

$$E(u_i) = -\sum_{\sigma} t_{i,\sigma} + f\left(e_i^*(0,0), e_j^*(0,0)\right)(v - c_L) - c_i\left(e_i^*(0,0)\right) \tag{14}$$

Because of the unanimity condition, a necessary condition for the selection of a social contract is that the extra surplus generated by its implementation is enough to cover for the

opportunity cost of institutional players, which is the loss of the autarchic production. This is represented by equation (16):

$$\sum_{l\in(C\cup P)-\Sigma}\left[f\left(e_l^*(0,0),e_m^*(0,0)\right)(v-c_L)-c_l\left(e_l^*(0,0)\right)\right]-\sum_{l\in(C\cup P)}\left(\underline{y}-c_l(\underline{e})\right) \tag{15}$$

If (16) does not hold, then the aggregate surplus is not enough to provide all agents with the autarchic utility level and at least one of them will not vote for it.

Given the previous analysis, we show that the social contract, specified in section 2, arises endogenously. More interestingly, there exists only one institutional player in equilibrium and, therefore, we show that centralization of authority arises endogenously. The centralization of authority improves agents welfare and fosters specialization. Proposition 3 summarizes these results.

Proposition 3: If equation (16) is satisfied for $\Sigma > \kappa$ and $\kappa \in N$, all social contracts, which are enforced in the sub-game perfect equilibria of the game, contain only one institutional player and at least one of them is voted by all agents. Furthermore, $2(n-1)$ agents exert the first-best effort level for the production of the specialized good. If equation (16) is violated for all κ, then no social contract is selected and the economy remains in the state of autarchy.

Proof: For the first part of the proposition, suppose that (16) holds for $\Sigma > \kappa$ and $\kappa > 1$. Then we show that any proposal of a social contract S that specifies a number λ of institutional players, with $1 < \lambda \leqslant \kappa$, can not be selected in equilibrium.

Consider any such proposal $S(\mathbf{m},\mathbf{t},\mathbf{s},\tau(g),\Phi(Q),\mathbf{r},\Sigma(\lambda))$. Without loss of generality, let σ_λ be the last of the proposed institutional players and $T(\sigma_\lambda)$ the aggregate proposed transfers made to him. Consider now an alternative social contract $S'(\mathbf{m},\mathbf{t}',\mathbf{s},\tau(g),\Phi(Q),\mathbf{r},\Sigma(\lambda-1))$, which is exactly the same as S, but for two differences. First, σ_λ is not an institutional player in S', and second the transfer of every other player to σ_λ is equal to $t'_{i,\sigma_\lambda} = t_{i,\sigma_\lambda} - \epsilon$, $\forall l \in C\cup P$ and $\epsilon < \frac{\underline{y}-c_{\sigma_\lambda}(\underline{e})}{\#(C\cup P)}$. Clearly, the proposed contract S' makes everyone better off. This is because all other agents make a lower transfer to σ_λ (or even receive a small transfer from him), and hence they are better off. But also σ_λ is better off, because, under S', he is not an institutional player and he gains the opportunity cost of autarchic production. Hence, his additional payoff under the alternative proposal is $\underline{y} - c_{\sigma_\lambda}(\underline{e}) - \#(C\cup P)\epsilon$, which is strictly positive. Since S'

makes everyone better off, all agents will vote for it and hence S can not be an equilibrium social contract.

The rest of the Proposition follows from the analysis of section 2 and 3. Specifically, $2(n-1)$ will exert optimal effort level because there exists at least one mechanism, the one analyzed in section 2, which satisfies incentive compatibility and gives first-best incentives to agents. For the rest two agents, one of them is the institutional player (a necessary requirement for the support of first-best effort levels) and, as a result, one of the pairs of the specialized production loses the opportunity of trade. Therefore, the other agent utilizes the autarchic technology.

If equation (16) does not hold for $\kappa = 1$, then the additional aggregate surplus generated by enforcement institutions is not enough to cover for the cost of autarchic production by one agent and therefore, institutions are inefficient. No social contract can make all agents agree and hence the economy remains in the state of autarchy. ■

Notice that Proposition 3 does not impose any restriction on the utility levels attained in equilibrium other than the participation constraints. Define the **Restricted Pareto Frontier** as the part of the Pareto Frontier such that all agents receive at least their reservation utilities. Then the following statement is a direct implication of Proposition 3.

Corollary 2: The sub-game perfect Nash equilibria of the game in section 3 implement the Restricted Pareto Frontier of the economy.

The main result of Proposition 3 is the centralization of enforcement authority. Despite the fact that we allow for multiple institutional agents, in equilibrium only one will be proposed and selected. This is due to the opportunity cost of foregone production by institutional agents. Of course, the mutual exclusivity between production and enforcement activities is a strong assumption, but it can be relaxed [7]. The important point is that institutions in this model are not simple constraints on the actions of individuals agreed on some earlier stage. The enforcement authority works efficiently only if there is an agent who represents its interests. In that respect, the institutional agent can be interpreted as a economy-wide delegate, a bureaucrat or a judge, whose presence makes certain threats or actions credible.

Also, the first stage of the game in section 3 and the unanimity condition on the selection rule are ad hoc. But these assumptions can be easily relaxed or replaced by other assumptions without affecting our main results. For instance, one could adopt a sequential bargaining

[7] We are currently working on this direction

approach or a citizen candidate type of model, where the winner candidate chooses his most preferred social contract. The important thing is that, even under those specifications, the existence of institutional agents and incomplete enforceability are necessary conditions for reaching the Pareto frontier of the economy.

Furthermore, our formulation of the first stage is consistent with the criterion of Jackson and Barbera (2004) for self-stable constitutions. In their paper, they show that constitutions which require unanimity in order to be modified and simple majority for on any other political decision are stable, in the sense that if this selection rule is applied to the constitution itself it will not be modified. In our case, the social contract is the equivalent of the constitution and, since it requires unanimity in order to be selected, the equivalent condition to the criterion of Jackson and Barbera is renegotiation-proofness. In section 2, we showed that this condition holds.

4 Conclusion

The main purpose of the paper is to show how the modeling of enforcement institutions matters for an economy and make a first step in answering the question of how they arise. Section 2 focused on showing the first part of the argument. We presented a simple hold-up problem and argued that the only types of mechanism that solve it require the existence of institutional agents and imperfect enforceability of private agreements.

Section 3 presented a three stage game. In all equilibria of the game, the social contracts, which satisfy the necessary conditions of section 2, arise endogenously. Therefore, this section provides game theoretic foundations for the endogenous emergence of enforcement and bureaucracy. In addition, if one is ready to accept the assumption of mutual exclusivity between production and enforcement activities, the section shows that in equilibrium enforcement authority is centralized: only one institutional agent is selected.

We are currently working on a number of directions to extend these results. First, we allow for a more general autarchic technology function and relax the assumption of mutual exclusiveness of activities. Second, we generalize the hold-up problem of section 2 and, third, we allow for more complicated contractual environments, where agents face other types of contractual issues apart from the hold-up problem. We hope that these extensions will give a richer set of predictions for the optimal enforcement authority and the social contract.

References

Aghion Philippe, Mathias Dewatripont and Patrick Rey, 1994,"Renegotiation Design with Unverifiable Information", Econometrica, Vol. 62, No. 2 (Mar., 1994), pp. 257-282

Aghion, Philippe and Jean Tirole, 1997, "Formal and Real Authority in Organizations", The Journal of Political Economy, vol. 105, no. 1, pp. 1-29

Aghion, Philippe, Alberto Alesina and Fransesco Trebbi, 2004,"Endogenous Political Institutions", The Quarterly Journal of Economics, Vol. 119, No. 2, pp. 565-611

Alonso, Ricardo and Niko Matouschek, 2008, "Optimal Delegation", Review of Economic Studies, Vol. 75, No. 1, pp. 259 - 293

Barbera Salvador and Matthew Jackson, 2004, "Choosing How to Choose: Self-Stable Majority Rules and Constitutions", Vol. 119, No. 3, pp. 1011-1048

Bull, Clive, 1987, "The Existence of Self-Enforcing Implicit Contracts", The Quarterly Journal of Economics, Vol. 102, No. 1, pp. 147-159

Che Yeon-Koo and Donald B. Hausch, 1999, "Cooperative Investments and the Value of Contracting", The American Economic Review, Vol. 89, No. 1, pp. 125-147

Cooley, Thomas, Ramon Marimon and Vincenzo Quadrini, 2004, "Aggregate Consequences of Limited Contract Enforceability", The Journal of Political Economy, vol. 112, no. 4, pp. 817-847

Ellingsen, Tore and Eirik G. Kristiansen, 2008, "Financial Contracting under Imperfect Enforcement", working paper

Evans, Robert, 2008, "Simple Efficient Contracts in Complex Environments", Econometrica, Vol. 76, No. 3, pp. 459491

Faure-Grimaud Antoine, Jean-Jacques Laffont and David Martimort, 2003, "Collusion, Delegation and Supervision with Soft Information", The Review of Economic Studies, Vol. 70, No. 2, pp. 253-279

Fershtman Chaim, Kenneth L. Judd and Ehud Kalai, 1991, "Observable Contracts: Strategic Delegation and Cooperation", International Economic Review, Vol. 32, No. 3, pp. 551-559

Greif, Avner and David D. Laitin, 2004, “A Theory of Endogenous Institutional Change”,The American Political Science Review, Vol. 98, No. 4, pp. 633-652

Greif, Avner, Yadira G. De Lara and Saumitra Jha, 2008,“The Administrative Foundations of Self-Enforcing Constitutions”, American Economic Review: Papers and Proceedings, Vol. 98, No. 2, pp. 105109

Grossman, Sanford and Oliver D. Hart, 1986, “The Costs and Benefits of Ownership: A Theory of Vertical and Lateral Integration”, The Journal of Political Economy, Vol. 94, No. 4, pp. 691-719

Guriev Sergei and Dmitriy Kvassov, 2005, “Contracting on Time”, The American Economic Review, Vol. 95, No. 5, pp. 1369-1385

Hart Oliver and John Moore, 1990, “Property Rights and the Nature of the Firm”, The Journal of Political Economy, vol. 98, no. 6, pp. 1119-1158

Hart Oliver and John Moore, 1999, “Foundations of Incomplete Contracts”, Review of Economic Studies, Vol. 66, pp. 115138

Holmstrom, Bengt, 1982, “On the Theory of Delegation”

Krasa, Stefan and Anne P. Villamil, 2000, “Optimal Contracts When Enforcement is a Decision Variable”, Econometrica, Vol. 68, No. 1, pp. 119-134

Laffont, Jean-Jacques and David Martimort, 1998, “Transaction costs, institutional design and the separation of powers”, European Economic Review, Vol. 42, pp. 673-684

Maskin Eric and John Moore, 1999, “Implementation and Renegotiation”, Review of Economic Studies, Vol. 66, pp. 39-56

Maskin Eric and Jean Tirole, 1999a, “Unforeseen Contingencies and Incomplete Contracts”, Review of Economic Studies, Vol. 66, pp. 83-114

Maskin Eric and Jean Tirole, 1999b, “Two Remarks on the Property-Rights Literature”, Review of Economic Studies, Vol. 66, pp. 139-149

Ray, Debraj, 2002, “The Time Structure of Self-Enforcing Agreements”, Econometrica, Vol. 70, No. 2, pp. 547-582

Sanchez-Pages Santiago and Stephane Straub, 2006, “The Emergence of Institutions”, working paper

Szalay, Dezsoe, 2005, “The Economics of Extreme Options and Clear Advice”, Review of Economic Studies, 2005, Vol 72, pp. 1173-1198

Telser, L. G., 1980, “A Theory of Self-Enforcing Agreements”, The Journal of Business, Vol. 53, No. 1, pp. 27-44

Watson, Joel, 2007, “Contract, Mechanism Design and Technological Detail”, Econometrica, Vol. 75, No. 1, pp. 5581

Rewrite when production takes place and when ex-ante transfers are paid.
Implications of eq 16 for assumptions on surplus generated by first and second best.