Negotiating cultures in corporate procurement[☆]

(This version: June 12, 2015)

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Abstract

In a repeated procurement problem, the incumbent can undertake a relationship-specific investment that generates opportunity costs of switching for the buyer. We investigate the impact of the negotiating culture on investment incentives, favoritism in the procurement contract allocation, and buyer profit. We compare a stylized competitive negotiating culture with a stylized protective culture. The cultures differ in the way the buyer uses the entrance threat to exert pressure on the incumbent. Our main result is that the relative performance of the cultures depends non-monotonically on the expensiveness of the investment.

Keywords: repeated procurement, mechanism design, optimal auction, limited commitment, hold-up, asymmetric information

JEL classification: C73, D44, D82, L62

[☆]Previous versions of this article circulated under the name "Asymmetric procurement systems." We would like to thank Deniz Dizdar, Hans-Peter Grüner, Johannes Koenen, David Martimort, Benny Moldovanu, Tymofiy Mylovanov, Elisabeth Schulte, Giancarlo Spagnolo, Konrad Stahl, Nora Szech, various participants of seminars where this research was presented, the Co-Editor Thomas Gresik, an anonymous Associate Editor and three anonymous referees for their helpful comments. The first author gratefully acknowledges financial support from the Deutsche Forschungsgemeinschaft through the Center of Doctoral Studies in Economics at the University of Mannheim and through SFB/TR 15.

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1. Introduction

In many corporate procurement processes all over the world, buyers face similar challenges. Procurement is typically repeated; switching from an incumbent to an entrant causes opportunity costs; the size of these costs can be affected by non-contractible relationship-specific investments; and there is little long-term commitment power. Despite these similarities, negotiating cultures differ strongly across the world. In some regions exerting competitive pressure seems to be the overriding objective. In other regions the buyer seems to protect the incumbent from direct competitive pressure. In order to gain a better understanding of the role of the negotiating culture in procurement processes, we compare a stylized competitive culture with a stylized protective culture. In particular, we investigate how the negotiating culture affects investment incentives, favoritism in the allocation of procurement contracts, and buyer profit.

A prominent example is the automotive industry.[1] The U.S. car industry differs substantially from the Japanese car industry in the way competitive pressure is exerted on incumbents. According to McMillan (1990), "United States industry [...] has traditionally been less willing than Japanese industry to forego the benefits of bidding competition. [...] Incumbents and outside bidders were treated equally [...]. Lowering the price was the overriding objective." He argues further, "[In Japanese procurement] there is considerable stability in the contractor/supplier relationship, implying that new contracts are not simply awarded to the lowest bidder, but that incumbents receive some sort of special treatment."

With respect to the implied effects, the stylized facts suggest that in the U.S. car industry incentives to make relationship-specific investments are low and the identity of the incumbent changes frequently over time. By contrast, in the Japanese car industry incumbents are willing to make significant relationship-specific investments and relationships tend to be long term. Although the differences may largely be rooted in the industry histories and business cultures, both procurement systems can by now be seen as complex systems of incentives to which firms respond rationally.[2] The recurring historic attempts of Western car producers to imitate their Japanese counterparts indicate that they view the Japanese system as being superior.[3]

We interpret a negotiating culture as a precommitment to a certain way of allocating procurement contracts. For a given negotiating culture, we analyze the infinite repetition of a procurement cycle consisting of a production phase followed by a contract renewal phase. During each production phase, the current incumbent supplier can undertake measures that generate relationship-specific benefits but are not contractible ex ante; for instance, this might be improvements in just-in-time production. Such measures often have three distinct features: they can only be undertaken within an enduring relationship, they can be undertaken at different degrees, and a substantial part of the implied benefits is backloaded and is realized only when

[1] See Hahn et al. (1986), McMillan (1990), Dyer and Ouchi (1993), Dyer (1996a), and Liker and Choi (2004) for stylized facts and empirical evidence.

[2] For the United States, such an interpretation is evident. McMillan (1990) also interprets Japanese procurement in this way: "There need be nothing mysterious about how Japanese business practices work, nor need the success of the Japanese system be explained by reference to things uniquely Japanese like the Shinto–Confucian ethic or Japan's consensus culture. [...] Rather, Japanese industry can be understood as having attained, as the end-point of an evolutionary process, a complex system of incentives to which firms respond rationally."

[3] See Liker and Choi (2004) for an overview. See Hahn et al. (1986) and McMillan (1990) in particular for the attempts of U.S. manufacturers to implement just-in-time production at the beginning of the 1980s and Dyer (1996b) for Chrysler's attempt in the first half of the 1990s. See also Helper and Sako (1995).

the relationship is continued. Thus, we model investment as a continuous decision by the incumbent that generates additional benefits for the buyer if the buyer continues her relationship with the incumbent.[4] In each contract renewal phase, the buyer knows the extent to which the continuation of the relationship generates additional benefits and designs a procurement mechanism that governs her decision to continue the relationship or to switch to the entrant. Each supplier privately learns his cost of producing in the next production phase, the selected mechanism is played, and the procurement cycle starts anew.

Our interpretation of the negotiating cultures is as follows. In the competitive culture, the buyer faces no restrictions in her procurement mechanism choice. She can use the entrant at will to exert competitive pressure on the incumbent. In the protective culture, the incumbent is protected from direct competition with the entrant. The buyer negotiates first bilaterally with the incumbent and approaches the entrant only when the negotiations with the incumbent break down. Roughly speaking, the competitive culture relies on simultaneous negotiations whereas the protective culture relies on sequential negotiations.

The buyer's expected profit in each procurement cycle is affected through two channels: profits from investment and contract allocation, which can be attributed to the current cycle, and rents from future cycles, which can be extracted in the current cycle. As the buyer is limited in the protective culture in how she can use the entrance threat to exert pressure on the incumbent, the contract allocation is generally better for her in the competitive culture, but investment incentives and future rent extraction might be better in the protective culture.

As we are interested in procurement problems in which each player behaves opportunistically at any point in time, we study Markov perfect equilibria. Our main result shows that the optimal negotiating culture depends non-monotonically on the expensiveness of the investment. At the extremes, that is, where the investment is very cheap or expensive, the competitive culture performs best. If investment is expensive, competitive pressure is directly beneficial, whereas if investment is cheap, competitive pressure encourages investment. By contrast, if the investment is intermediately expensive, the protective culture is superior. Significant investments require the security that comes with protection. The repetition of the procurement problem adds non-trivial effects through future rent extraction, but we find that the non-monotonicity result holds for any importance of the future as measured by the discount factor.

2. Literature

Our article is related to the literature on investment incentives in procurement problems in which a single supplier can make a cost-reducing investment.[5] In Laffont and Tirole (1988) the buyer designs the procurement mechanism before an incumbent supplier makes an investment decision. By contrast, we study a problem in which an observable investment is made before the procurement mechanism is designed. In the cited article the buyer uses the mechanism design to affect the investment decision whereas the incumbent uses the investment to affect the mechanism design in ours. Arozamena and Cantillon (2004) analyze procurement through a first-price auction when a single supplier can make an observable investment prior

[4] This is in line with McMillan (1990), who emphasizes that "there are actions an incumbent can undertake during the course of the initial contract that improve productivity or quality."

[5] See Dasgupta (1990), Tan (1992), Piccione and Tan (1996), and Bag (1997) for procurement problems in which ex ante symmetric suppliers can all make unobservable investments.

to the auction. Cisternas and Figueroa (2014) investigate a two-period procurement problem in which the first-period winner can make an observable investment and the buyer cannot commit to the second-period mechanism prior to the investment. The considered model is related to our model of the competitive culture, but the analyzed questions are not of direct interest for our comparison of different negotiating cultures.

Lewis and Yildirim (2002, 2005) investigate different infinitely repeated procurement problems with asymmetries evolving over time. They employ commitment assumptions that are similar to ours. The resulting mechanism design problems are related to the design problem that we obtain for the competitive culture. Lewis and Yildirim (2002) consider asymmetries arising through learning-by-doing. They study the effect of experience on favoritism and the evolution of learning. Lewis and Yildirim (2005) consider asymmetries through switching costs. They study the comparative statics with respect to the switching technology and the buyer's preferences with regard to switching costs. By contrast, we consider asymmetries arising through an investment decision by the incumbent and are interested in assessing precommitments to different subsets of mechanisms from the buyer's perspective.

Calzolari and Spagnolo (2009) and Board (2011) analyze how incentives for observable but non-contractible behavior can be set through relational contracts. The incentives rely on the threat of exclusion from future interaction, which we assume in our base model to be not credible. Both articles find that the principal might interact only with a limited number of agents under the optimal relational contract. In common with this literature, in our study the principal might benefit from restrictions on her freedom of action.[6]

Our article is also related to the literature that employs an exit/voice approach to explain differences in, and the evolution of, buyer-supplier relationships in the automotive industry (e.g., Helper (1990, 1991), Helper and Levine (1992), and Helper and Sako (1995)). Depending on how problems are resolved, supplier relations are classified into exit-based relations, which rely on much competitive pressure, and voice-based relations, which rely on little competitive pressure in combination with cooperation. Although this literature acknowledges that history and cultural predispositions are both important factors for the performance of purchasing strategies, it focuses on the role of history and economic factors (e.g., the structure of the final product market or the access to capital). We investigate instead the role of cultural predispositions.

Finally, our article is related to the literature comparing procurement systems. This literature differs with respect to the considered procurement problem and the interpretation of the systems. Relationship-specific investments play an important role in most parts of this literature.[7] McLaren (1999) and Spencer and Qiu (2001) consider problems in which the effect of investment on bargaining positions plays a crucial role, whereas we are interested in a problem in which the entire bargaining power lies in the hands of the buyer. Li (2013) considers a problem in which the entire bargaining power at a final renegotiation stage also lies in the hands of the buyer. Yet it is the buyer who can strategically affect the final mechanism design problem. Taylor and Wiggins (1997) consider a repeated procurement problem in which the nature of the investment and the buyer's instruments differ. Their problem lies in the inducement of an unobservable quality investment and the difference between the systems lies in the employed punishment mechanisms.

[6] See also Bernheim and Whinston (1998) for the general observation that if some variable is non-contractible, further restrictions on the set of feasible contracts can improve welfare.

[7] An exception is Cabral and Greenstein (1990). They consider a procurement problem in which a price-taking buyer is subject to exogenously given switching costs but in which there is no endogenous investment. A precommitment to ignore the switching costs can be beneficial for the buyer because it induces more competitive pricing.

In the American system, shipments are inspected on delivery and payment is withheld when the quality is insufficient. In the Japanese system, the buyer accepts and pays for any shipment but cuts off the supplier from future business when the quality turns out to be inadequate.

3. A reduced procurement problem

We present our procurement problem in two steps. In this section, we analyze a reduced procurement problem that consists of a single procurement cycle. Future play is only reflected through exogenously given continuation values. Then, in the next section, we introduce the repeated procurement problem and argue that it reduces to the problem that we study in this section. As we will by then have already understood the investment incentives and the procurement mechanism design, we will be able to focus on the effect of repetition.

3.1. The reduced game

There is a buyer B, an incumbent supplier I, and an entrant supplier E. The buyer resides either in the competitive negotiating culture C or the protective negotiating culture P. We denote a generic supplier by k and a generic culture by S. For a given culture S, the timing is as follows:

1. *Investment.* The incumbent chooses an observable investment $y \in [0, \infty)$ at constant marginal cost $\gamma \in (0, 1)$. The buyer's procurement benefit is $R+y$ if she continues her relationship with the incumbent and R if she switches to the entrant.[8] We are interested in the case in which R is large enough that the buyer always wants to procure the product.[9] The parameter $\gamma \in (0, 1)$ measures the expensiveness of the relationship-specific investment relative to its benefits.[10]
2. *Private information.* Each supplier privately learns his cost of producing in the next production phase.[11] Supplier k's production cost $x_k \in [0, 1]$ is the realization of a random variable X_k. X_I and X_E are independently drawn from the same distribution function $F(x_k) = x_k^{1/\alpha}$ with $\alpha > 0$. Let $f = F'$, $x = (x_I, x_E)$ and $X = (X_I, X_E)$.
3. *Procurement mechanism.* The buyer chooses a procurement mechanism $M \in \mathcal{M}^S$ that governs the probability that the next procurement contract is awarded to supplier k, q_k, and the monetary transfer that the buyer makes to supplier k, t_k. The set $\mathcal{M}^S$ contains all the mechanisms that are consistent with the negotiating culture S. We will define $\mathcal{M}^C$ and $\mathcal{M}^P$ below.
4. *Profits in the current procurement cycle.* The procurement mechanism is played. This determines q_I, q_E, t_I, and t_E. The realized profit is $-\gamma y + t_I - q_I x_I$ for the incumbent, $t_E - q_E x_E$ for the entrant, and $(q_I + q_E)R + q_I y - t_I - t_E$ for the buyer.

[8]It is only important for our results that the investment is observable to the buyer. Moreover, as long as the buyer has all the bargaining power, it is not important for our results whether the benefits accrue to the buyer or to the incumbent.

[9]Think of a situation in which the buyer produces a complex product and the part in question is crucial for production. It can then be prohibitively costly for her not to procure the part.

[10]A low (high) γ can alternatively be interpreted as an important (unimportant) investment. This interpretation follows from substituting $y = 1/\gamma \cdot z$ and considering z as the incumbent's investment decision. The investment z then generates the same cost for any γ, but γ scales the benefits generated by the investment.

[11]In the automotive industry, production phases are long (up to seven years) and new contracts are typically for modified versions of the original part. The exact specifications of the modifications are subject to imperfect information until the next contract renewal phase. To rule out issues of learning and signaling, we employ the polar assumption that the incumbent has no superior information at the time he makes his investment decision.

5. *Profits from future procurement cycles.* We pursue a reduced-form modeling approach in which future play is not modeled explicitly. We assume that the present value of supplier k's future rents depends on the negotiating culture and on his role in the next procurement cycle. He realizes a continuation value of V_I^S (V_E^S) if he is the next incumbent (entrant). The buyer realizes a continuation value of V_B^S. Let $V^S := (V_I^S, V_E^S, V_B^S)$.[12]

Procurement mechanisms. A procurement mechanism $(\mathcal{B}_I, \mathcal{B}_E, q, t)$ is comprised of four components: a message set $\mathcal{B}_k$ for each supplier k; an allocation rule $q : \mathcal{B}_I \times \mathcal{B}_E \to \{(q_I, q_E) \in [0,1]^2 | q_I + q_E \leq 1\}$; and a transfer rule $t : \mathcal{B}_I \times \mathcal{B}_E \to \{(t_I, t_E) \in \mathbb{R}^2\}$. The suppliers' participation in the procurement mechanism is voluntary. We model this by assuming that each message space must contain a "non-participation message" $\emptyset$. For any message of the other supplier, the message $\emptyset$ ensures supplier k a zero probability of obtaining the procurement contract $q_k = 0$ and a zero transfer payment $t_k = 0$.[13] A direct procurement mechanism (q, t) is any procurement mechanism with $\mathcal{B}_I = \mathcal{B}_E = [0,1] \cup \{\emptyset\}$. That is, each supplier is asked to make a cost announcement. We denote the set of all direct mechanisms by $\mathcal{M}$.

Revelation principle. As the revelation principle will apply to our setting we can restrict, without loss of generality, attention to direct mechanisms $M = (q,t) \in \mathcal{M}^{\star, V^S} := \{M \in \mathcal{M} | \forall k$: when the vector of continuation values is V^S and the other supplier $-k$ participates and reports truthfully, participation in mechanism M and truthful reporting is optimal for supplier $k\}$.[14] As we can restrict attention to such mechanisms, what the mechanism prescribes for the case in which one supplier does not participate does not feed back on incentives. More precisely, when M' and M'' are two direct mechanisms that differ for each supplier k only in what the mechanism prescribes for the case in which the other supplier does not participate, then either both mechanisms belong to $\mathcal{M}^{\star, V^S}$ or none does. Moreover, when both of them belong to $\mathcal{M}^{\star, V^S}$, they imply the same expected equilibrium payoffs for all players. In the remainder of this article, this allows us to ignore what the considered mechanisms prescribe for the case in which one supplier does not participate. That is, we need only to describe how the mechanisms map cost announcements $x \in [0,1]^2$ into procurement contract allocations $q(x) = (q_I(x), q_E(x))$ and transfer payments $t(x) = (t_I(x), t_E(x))$.

Negotiating cultures. In the competitive culture $S = C$, the buyer faces no restrictions in her procurement mechanism choice: $\mathcal{M}^C = \mathcal{M}$. In the protective culture $S = P$, the buyer decides on the continuation of her relationship with the incumbent before negotiating with the entrant. In terms of direct mechanisms, this corresponds to $\mathcal{M}^P = \{(q,t) \in \mathcal{M} | \forall x'_E, x''_E \in [0,1] \cup \{\emptyset\} : q_I(x_I, x'_E) = q_I(x_I, x''_E)\}$.[15]

[12] Because of our assumption that the buyer always wants to procure, only the continuation values arising when the procurement contract is awarded to one of the suppliers will be important for our analysis.

[13] This way of modeling non-participation has the advantage that we do not need to specify separate mechanisms that are relevant when only one supplier participates.

[14] $\mathcal{M}^{\star, V^S}$ does not depend on y and it depends on S only through V^S. S affects the feasibility of mechanisms but not the suppliers' incentives for given continuation values. y affects the buyer's preferences over mechanisms but not the suppliers' reporting incentives.

[15] The definition of $\mathcal{M}^P$ includes the implicit assumption that the buyer can commit to how she will negotiate with the entrant in case the negotiations with the incumbent break down. Such an assumption is not necessary. It follows as a corollary from our results in the main text that we could alternatively assume the following: The buyer designs at first a mechanism that governs only her relationship with the incumbent. Only if it turns out that the relationship with the incumbent has broken down, she designs a mechanism that governs her relationship with the entrant. Because of the commitment problem that this implies, the buyer's design problem is subject to an additional constraint. In the main text, we study the relaxed problem in which this additional constraint is ignored. Since it will follow from our indirect implementation of the optimal procurement mechanism that the additional constraint is not binding (see Remark 1 below), the solution to the relaxed problem also solves the problem with the additional constraint.

Equilibrium notion. For a given vector of continuation values V^S, each player's expected payoff is completely specified by the incumbent's investment decision $y \in [0, \infty)$ and the buyer's mechanism choice $M \in \mathcal{M}^{\star, V^S}$:

$$\begin{aligned} \Pi_I(y, M; V^S) &= \mathbf{E}_X[-\gamma y + t_I(X) - q_I(X)X_I + q_I(X)(V_I^S - V_E^S) + V_E^S] && (1) \\ \Pi_E(M; V^S) &= \mathbf{E}_X[t_E(X) - q_E(X)X_E + q_E(X)(V_I^S - V_E^S) + V_E^S] && (2) \\ \Pi_B(y, M; V^S) &= \mathbf{E}_X[(q_I(X) + q_E(X))R + q_I(X)y - t_I(X) - t_E(X) + V_B^S] && (3) \end{aligned}$$

For each negotiating culture S and each vector of continuation values V^S, we are interested in an investment decision $y^{S,V^S} \in [0, \infty)$ and a mechanism choice for each possible investment $M^{S,V^S} : [0, \infty) \to \mathcal{M}^S \cap \mathcal{M}^{\star, V^S}$ such that

$$\begin{aligned} &\text{(EQ1)} \quad \forall y \in [0, \infty) : M^{S,V^S}(y) \in \arg \max_{M \in \mathcal{M}^S \cap \mathcal{M}^{\star, V^S}} \Pi_B(y, M; V^S) \\ &\text{(EQ2)} \quad y^{S,V^S} \in \arg \max_{y \in [0, \infty)} \Pi_I(y, M^{S,V^S}(y); V^S). \end{aligned}$$

Each combination of y^{S,V^S} and $M^{S,V^S}(y)$ that satisfies (EQ1) and (EQ2) corresponds to a perfect Bayesian equilibrium of the game implied by the negotiating culture S and the vector of continuation values V^S.

3.2. The optimal procurement mechanism design

We are interested in how the buyer designs the procurement mechanism for a given negotiating culture S, a given vector of continuation values V^S, and a given investment decision y. By (EQ1) the buyer chooses a mechanism $M = (q, t) \in \mathcal{M}^S \cap \mathcal{M}^{\star, V^S}$ to maximize $\Pi_B(y, M; V^S)$.

The implications of incentive compatibility and individual rationality are standard (see, e.g., Baron and Myerson (1982)). For an allocation rule $q(x)$ there exists a transfer rule $t(x)$ such that $(q, t) \in \mathcal{M}^{\star, V^S}$ if, and only if, each supplier k's interim expected winning probability $\mathbf{E}_X[q_k(X)|X_k = x_k]$ is weakly decreasing in x_k. Moreover, the expected transfers are for any mechanism $(q, t) \in \mathcal{M}^{\star, V^S}$, for which individual rationality constraints are binding for suppliers with the worst possible cost realizations, completely determined by the allocation rule:

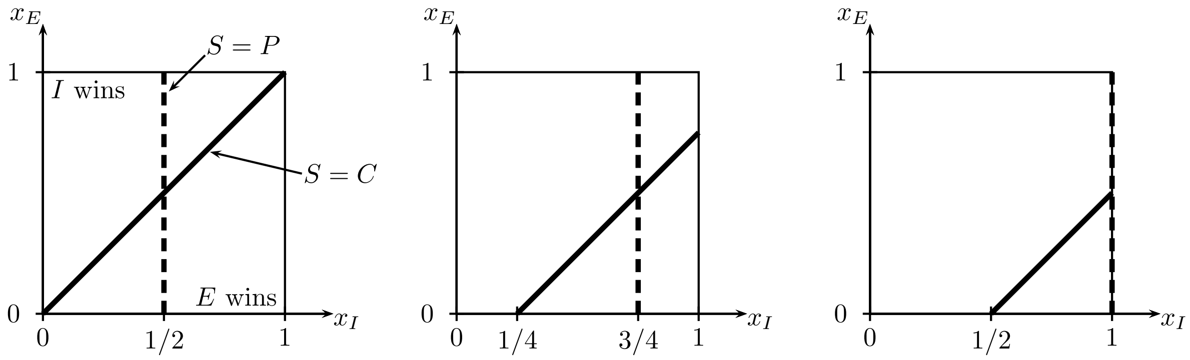
$$\mathbf{E}_X[t_k(X)] = \mathbf{E}_X[q_k(X)(J(X_k) - (V_I^S - V_E^S))] \tag{4}$$

with $J(x_k) := x_k + F(x_k)/f(x_k) = (1 + \alpha)x_k$. When the buyer procures from supplier k, she has to bear the virtual cost $J(x_k)$, which is important in many procurement auction problems. This can be interpreted as supplier k's actual cost plus the effect that procuring from supplier k at cost x_k has on this supplier's expected information rent. On the other hand, the buyer is able to extract some future rents today. As each supplier can ensure he receives a payoff of V_E^S by not participating in the procurement mechanism, the buyer can extract only the winning supplier's advantage of becoming the next incumbent, $V_I^S - V_E^S$.[16]

(4) allows us to write the buyer's expected profit (3) as

$$\Pi_B(y, M; V^S) = \mathbf{E}_X[q_I(X)(R + y - J(X_I) + V_I^S - V_E^S) + q_E(X)(R - J(X_E) + V_I^S - V_E^S)] + V_B^S. \tag{5}$$

[16] The effect that future rent extraction relies on expected asymmetries in the future arises also in Lewis and Yildirim (2005) in the context of switching costs. Large switching costs, like a large incumbency advantage, impose a high indirect pressure and allows for the extraction of significant future rents. See also Lewis and Yildirim (2002) and Cisternas and Figueroa (2014).



(a) $y = 0$ (b) $y = 1/2$ (c) $y = 1$

Figure 1: Optimal allocation for different investments [$\alpha = 1$]

It depends only through the allocation rule $q(x)$ on the mechanism choice. Thus, the buyer's procurement mechanism design problem corresponds to the problem of designing an allocation rule. The derivation of the optimal allocation rule is standard for the competitive culture (see Myerson (1981)) and it follows from a simple adaptation of the standard procedure in the protective culture. We obtain the following result:[17]

Proposition 1 (Optimal allocation rule) *(a) If $S = C$, the allocation rule $(q_I^{C,y}, q_E^{C,y})$ with $q_I^{C,y}(x) = 1$ if $y \geq J(x_I) - J(x_E)$, $q_I^{C,y}(x) = 0$ if $y < J(x_I) - J(x_E)$ and $q_E^{C,y}(x) = 1 - q_I^{C,y}(x)$ is optimal. (b) If $S = P$, the allocation rule $(q_I^{P,y}, q_E^{P,y})$ with $q_I^{P,y}(x) = 1$ if $y \geq J(x_I) - 1$, $q_I^{P,y}(x) = 0$ if $y < J(x_I) - 1$ and $q_E^{P,y}(x) = 1 - q_I^{P,y}(x)$ is optimal.*

As we assume that R is "large", the buyer only decides between continuing her relationship with the incumbent and switching to the entrant. In the competitive culture, the incumbent competes directly with the entrant. It is optimal for the buyer to continue the relationship when her virtual profit from this, $R+y-J(x_I)+V_I^C-V_E^C$, exceeds her virtual profit from switching, $R-J(x_E)+V_I^C-V_E^C$. By contrast, in the protective culture, the incumbent competes only with the buyer's expectation of the entrant. The optimal allocation follows from comparing the virtual profit from continuing the relationship, $R+y-J(x_I)+V_I^P-V_E^P$, with the expected virtual profit from switching, $\mathbf{E}_X[R - J(X_E) + V_I^P - V_E^P] = R - 1 + V_I^P - V_E^P$. These comparisons imply the allocation rules in the proposition. As the buyer can extract the same future rent regardless of which supplier wins, future play does not matter for the optimal allocation.

Figure 1(a) illustrates the structural difference between the optimal allocations in the two negotiating cultures when there is no investment. The solid (dashed) curves describe the optimal allocation in the competitive culture (protective culture). The incumbent wins in the northwest of these curves and the entrant wins in the southeast. When the investment increases, the incumbent wins in both negotiating cultures more often.[18] The curves that describe the optimal allocation move to the southeast (compare

[17]To simplify the presentation of our results, we assume that the buyer procures from the incumbent in the case where she is indifferent.

[18]This corresponds to a favoring relative to lower investments. Favoritism can also be interpreted in absolute terms. Efficiency requires that the incumbent wins if $y \geq x_I - x_E$. However, in the competitive culture, he wins only if $y \geq (1+\alpha) \cdot (x_I - x_E)$. This implies that he wins for any investment that does not imply winning with certainty too rarely and is thus "disfavored." This kind of "disfavoring" arises also in Cisternas and Figueroa (2014) and Lewis and Yildirim (2002) for other investment technologies. In the protective culture, for any investment that does not imply winning with certainty, the incumbent is neither clearly favored nor clearly disfavored. He wins too often when x_E is low but too seldom when x_E is high.

Figures 1(a), 1(b) and 1(c)). When the investment is high enough the incumbent wins with certainty. The investments for which this is the case differ for the two negotiating cultures. In the competitive culture, the investment must make the incumbent better (in terms of the buyer's virtual profit) than the best possible entrant. In the protective culture, it is sufficient to be better than the expected entrant. Thus, in the protective culture, the incumbent wins with certainty already for smaller investments.

Corollary 1 (Investment necessary to win for sure) *(a) $q_I^{C,y}(x) = 1$ for all x if and only if $y \geq \overline{y}^C := J(1) = 1 + \alpha$. (b) $q_I^{P,y}(x) = 1$ for all x if and only if $y \geq \overline{y}^P := J(1) - 1 = \alpha$.*

The revenue equivalence theorem specifies that any mechanism that implements the optimal allocation and for which individual rationality constraints are binding for the suppliers with the worst possible cost realizations is optimal. The following corollary describes an optimal indirect mechanism for each of the two negotiating cultures.

Remark 1 (Optimal procurement mechanism) *In the competitive culture, a reverse second-price auction with a highest admissible bid of $1 - y/(1+\alpha) - (V_I^C - V_E^C)$ and a constant bonus of $y/(1+\alpha)$ for the incumbent is optimal. That is, the incumbent obtains $y/(1+\alpha)$ more than the minimum of the entrant's bid and the highest admissible bid when he wins. In the protective culture, a sequence of two take-it-or-leave-it offers is optimal. The buyer offers the procurement contract first to the incumbent at $\min\{(1+y)/(1+\alpha), 1\} - (V_I^P - V_E^P)$. If the incumbent declines, she offers it to the entrant at $1 - (V_I^P - V_E^P)$. The buyer makes the same offers irrespective of whether she can commit to her offer to the entrant at the time she makes her offer to the incumbent or not. The mechanism without commitment corresponds to optimal sequential negotiations. Thus, the comparison between the two negotiating cultures can also be interpreted as a comparison between simultaneous and sequential negotiations.*

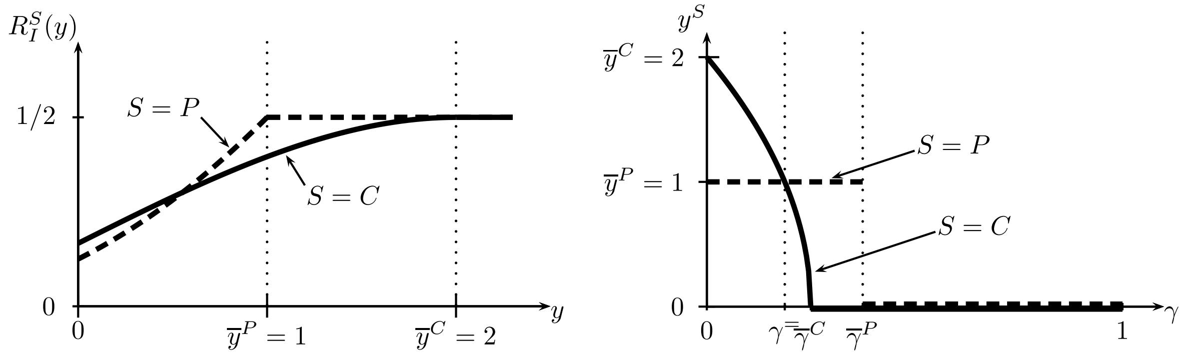
3.3. Investment incentives

Next we can approach the question of how the incumbent invests for a given negotiating culture S and a given vector of continuation values V^S. By (EQ2), he chooses an investment $y \in [0, \infty)$ to maximize $\Pi_I(y, M^{S,V^S}(y); V^S)$. The allocation rule of the mechanism $M^{S,V^S}(y)$ is given by $(q_I^{S,y}, q_E^{S,y})$ as described in Proposition 1. By using (4) in (1), we obtain that the incumbent's expected payoff depends only through this allocation rule on the procurement mechanism: $\Pi_I(y, M^{S,V^S}(y); V^S) = -\gamma y + R_I^S(y) + V_E^S$ with

$$R_I^S(y) := \mathbf{E}_X[q_I^{S,y}(X) \cdot F(X_I)/f(X_I)]. \tag{6}$$

The incumbent has to bear the cost of his investment, γy, but the investment is only indirectly rewarded through its effect on his expected information rent from the procurement mechanism in the current procurement cycle, $R_I^S(y)$. Since the future advantage of becoming the next incumbent is extracted from the winning supplier, the incumbent's investment decision has no effect on which rents he earns in the future. Thus, the continuation values do not affect the investment incentives. This allows us to write $y^{S,V^S} = y^S$.

Consider first uniformly distributed cost ($\alpha = 1$). The optimal procurement contract allocation is then as illustrated in Figure 1 and areas in the (x_I, x_E)–space correspond to probabilities. This allows us to provide graphical intuitions for the properties of the optimal investment. We will proceed in three steps: a statement of the properties of the incumbent's revenue from investment $R_I^S(y)$; an explanation of how these properties translate into investment incentives; and the motivation of the properties of $R_I^S(y)$ that are crucial for the differences in the investment incentives.



(a) Revenue from investment

(b) Optimal investment

Figure 2: Investment incentives [$\alpha = 1$]

Properties of the incumbent's revenue from investment. Figure 2(a) depicts $R_I^S(y)$ for the competitive culture (solid curve) and the protective culture (dashed curve). $R_I^S(y)$ is strictly increasing until an investment is reached for which the incumbent wins with certainty; afterwards it is constant. The incumbent then realizes in both cultures the information rent that is associated with winning with certainty, $\mathbf{E}_X[F(X_I)/f(X_I)] = 1/2$. There are three important differences between $R_I^C(y)$ and $R_I^P(y)$:

(REV1) The highest possible revenue is already reached for smaller investments in the protective culture.

(REV2) Before the revenue becomes constant, the marginal revenue is decreasing in the competitive culture but increasing in the protective culture. That is, revenue is concave in the competitive culture but convex in the protective culture.

(REV3) The highest possible revenue increase from investment, $R_I^S(\overline{y}^S) - R_I^S(0)$, is higher in the protective culture.

Investment incentives. Figure 2(b) illustrates how the optimal investment y^S depends on the parameter γ that measures the expensiveness of the investment. The optimal investment is higher in the competitive culture when investment is cheap, it is higher in the protective culture when investment is intermediately expensive, and there is no investment in both cultures when investment is expensive.

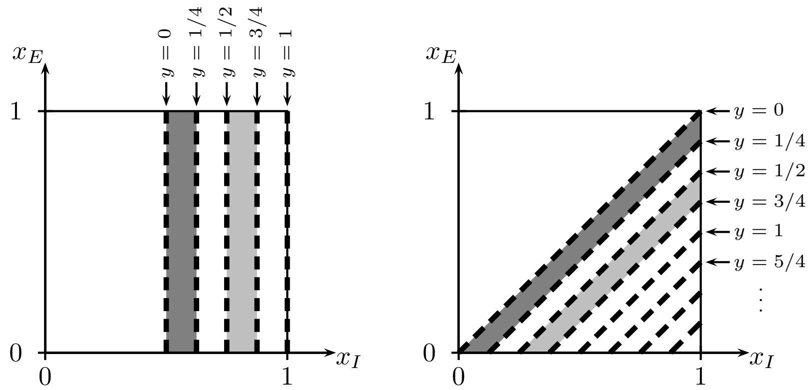
The intuition is as follows. Since revenue in culture S is constant for any $y \geq \overline{y}^S$, $\overline{y}^S$ constitutes the highest investment that might be induced in this culture. If the investment is sufficiently cheap (consider $\gamma \to 0$), the incumbent strives to get the highest possible revenue; that is, $y^S \to \overline{y}^S$. Since the investment needed to get the highest possible revenue is, from property (REV1), higher in the competitive culture, the investment incentives are better there. On the other hand, if investment is sufficiently expensive, the optimal investment must eventually go to zero in either culture. There remains a need to explain why investment incentives are better in the protective culture when investment is intermediately expensive. By virtue of property (REV2), revenue is convex in the protective culture. Thus, the optimal investment problem has a corner solution. The incumbent invests either $y = \overline{y}^P$ or $y = 0$. This has the consequence that the highest possible investment $y = \overline{y}^P$ is still induced when investment is relatively expensive and this occurs as long as the highest possible revenue increase from the investment exceeds its cost: $R_I^P(\overline{y}^P) - R_I^P(0) \geq \gamma\overline{y}^P$. When γ is so large that $R_I^P(\overline{y}^P) - R_I^P(0) = \gamma\overline{y}^P$, it follows from property (REV3) that, in the competitive culture, the incumbent strictly prefers to make no investment rather than any investment $y \geq \overline{y}^P$. Hence, the investment incentives are better in the protective culture. It turns out that even a stronger property holds. The investment incentives are so much better in the protective culture that this culture still induces the highest possible investment when the competitive culture induces no investment at all.

Motivation of the crucial properties of $R_I^S(y)$. Property (REV1) follows directly from Corollary 1. The other two properties deserve explanation. We investigate first the intuition behind property (REV2). (REV2) basically states that the revenue change from an increase in the investment by Δ, $R_I^S(y+\Delta)-R_I^S(y)$, is decreasing in y in the competitive culture but increasing in y in the protective culture. We can decompose this revenue change as follows:

$$\begin{aligned} R_I^S(y+\Delta) - R_I^S(y) \quad = \quad & \underbrace{\mathrm{Prob}_X[I \text{ wins for } y+\Delta \text{ but not for } y]}_{\text{increase in the incumbent's winning probability}} \\ & \times \underbrace{\mathbf{E}_X[F(X_I)/f(X_I)|I \text{ wins for } y+\Delta \text{ but not for } y]}_{\substack{\text{marginal effect of the additional winning} \\ \text{on the incumbent's expected information rent}}}. \end{aligned}$$

As $F(x_I)/f(x_I) = \alpha x_I$ is increasing in x_I and as an increase in y implies that the incumbent wins in both cultures in additional cases where his costs are higher, the marginal effect on the expected information rent increases in both cultures in y. How y affects the increase in the winning probability is illustrated in Figure 3. The dashed lines describe how the allocation changes when the investment increases stepwise by $\Delta = 1/4$. The area between two adjacent lines corresponds to the increase in the winning probability. For example, the dark grey areas (light grey areas) illustrate the probability increase when the investment increases from 0 to $0 + \Delta$ (from 1/2 to $1/2 + \Delta$). In the competitive culture, each step implies a lower and lower increase in the winning probability. Intuitively, an increase in the investment leads only to an additional favoring of the incumbent when x_E turns out to be low. When x_E is high, the incumbent wins anyway. The set of values of x_E for which the investment has an effect becomes smaller as y increases and vanishes as $y \to \overline{y}^C$. As the marginal effect on the expected information rent is bounded, it follows that also the revenue change must vanish eventually. That is, $R_I^C(y+\Delta) - R_I^C(y)$ must eventually decrease in y. The major difference in the protective culture is that x_E has no effect on the allocation. Each step implies the same increase in the winning probability but as the marginal effect on the expected information rent becomes larger, the revenue change $R_I^P(y+\Delta) - R_I^P(y)$ is increasing y.

Finally, let us explain the intuition for property (REV3). Since the maximum possible revenue from investment coincides in the two cultures, the property is equivalent to $R_I^C(0) > R_I^P(0)$. That is, we need to determine in which culture the incumbent is better off when he does not invest. When there is no investment, the incumbent wins in both cultures with a probability of 1/2 (see Figure 1(a) again). However, in the competitive culture, he wins compared to the protective culture in more cases in which his costs are high but in less cases in which his costs are low. As the effect of winning on the expected information rent is larger for higher cost realizations, it follows that $R_I^C(0) > R_I^P(0)$. Intuitively, the buyer screens the incumbent better when she concentrates on him than when she deals simultaneously with him and the entrant.



(a) $S = P$ (b) $S = C$

Figure 3: Changes in the allocation for investment increments Δ [$\alpha = 1$, $\Delta = 1/4$]

For any $\alpha \neq 1$, the properties of $R_I^S(y)$ are very similar to those for $\alpha = 1$.[19]. The only difference is that the revenue is in the competitive culture for $\alpha > 1$ only "eventually concave" instead of concave. Since this is inconsequential for the properties of optimal investment in which we are interested, these properties extend to the case with $\alpha \neq 1$:[20]

Proposition 2 (Optimal investment) *Define*

$$\overline{\gamma}^P := \frac{1}{1+\alpha} - \left(\frac{1}{1+\alpha}\right)^{2+1/\alpha} \text{ and } \overline{\gamma}^C := \begin{cases} \frac{1}{2}\frac{1}{1+\alpha} & \text{if } \alpha \leq 1 \\ \frac{1}{1+\alpha}\left(\frac{1+\alpha}{4\alpha}\right)^{1/\alpha} & \text{if } \alpha > 1 \end{cases} .$$

(a) $y^P = \overline{y}^P$ if $\gamma \leq \overline{\gamma}^P$, and $y^P = 0$ if $\gamma > \overline{\gamma}^P$. (b) y^C is decreasing in γ with $\lim_{\gamma\to 0} y^C = \overline{y}^C$, $y^C < \overline{y}^C$ if $\gamma \in (0,1)$, and $y^C = 0$ if $\gamma \geq \overline{\gamma}^C$. (c) $\overline{\gamma}^C < \overline{\gamma}^P$.

Two implications of Proposition 2 are important. First, the three investment cost regions illustrated by the dotted lines in Figure 2(b) exist for any α:

Corollary 2 (Investment regions) *There exists $\gamma^= \in (0, \overline{\gamma}^P)$ such that $y^C \geq y^P$ if $\gamma \in (0, \gamma^=]$, $y^P > y^C$ if $\gamma \in (\gamma^=, \overline{\gamma}^P]$ and $y^P = y^C = 0$ if $\gamma \in (\overline{\gamma}^P, 1)$.*

Second, whenever the protective culture induces an investment, this culture is indeed more protective in terms of the probability with which the relationship is continued.

Corollary 3 (Continuation probability) *If $\gamma \in (0, \overline{\gamma}^P]$, the continuation probability is one in the protective culture but strictly smaller than one in the competitive culture.*

Corollaries 2 and 3 allow for the conclusion that even though protection has for any $\gamma \in (0, \overline{\gamma}^P]$ a clearly positive effect on the continuation probability, protection can cause investment incentives to deteriorate as well as enhance them.

[19] See Lemma A2 in the Proof of Proposition 2.
[20] To simplify the presentation of our results, we assume that the incumbent chooses the largest optimal investment.

	$\gamma \in (0, \gamma^{=}]$	$\gamma \in (\gamma^{=}, \overline{\gamma}^{P}]$	$\gamma \in (\overline{\gamma}^{P}, 1)$
procurement mechanism design for given y: $\Pi_B(y, M^{S,\mathbf{0}}(y); \mathbf{0})$	$S = C$ better		
investment incentives: y^S	$S = C$ better	$S = P$ better	equally bad
total effect: $\widehat{\Pi}^{\mathbf{0}}_B(S)$	$S = C$ better	?	$S = C$ better

Table 1: Comparison of the negotiating cultures from the buyer's perspective when $V^C = V^P = \mathbf{0}$

3.4. The optimal negotiating culture when profits from future cycles are of minor importance

Our main interest lies in how the two negotiating cultures compare from the buyer's perspective. The repetition of the procurement problem is likely to affect the two negotiating cultures differently. This requires us to model the repetition of the procurement problem explicitly and to derive how the continuation values differ in the two cultures. What we can do by now is explain how the two cultures compare when future procurement cycles are of minor importance; that is, when continuation values are close to zero. In the next section we explain why the result that we obtain here extends to the case in which future cycles matter.

Define $\widehat{\Pi}^{\mathbf{0}}_B(S) := \Pi_B(y^S, M^{S,\mathbf{0}}(y^S); \mathbf{0})$ with $\mathbf{0} := (0, 0, 0)$. Two implications of our analysis in Subsection 3.2 are important. First, for any given investment $y \in [0, \overline{y}^C)$, the buyer in the protective culture is constrained in her procurement mechanism choice, whereas she is not constrained in the competitive culture. Thus, the procurement mechanism design is better in the competitive culture: $\Pi_B(y, M^{C,\mathbf{0}}(y); \mathbf{0}) > \Pi_B(y, M^{P,\mathbf{0}}(y); \mathbf{0})$. Second, investment is unambiguously good for the buyer. That is, $\Pi_B(y, M^{S,\mathbf{0}}(y); \mathbf{0})$ is strictly increasing in y. In Subsection 3.3, we have analyzed which culture is better in inducing investment incentives. Table 1 summarizes the relevant effects.

If investment is either sufficiently cheap or sufficiently expensive, the competitive culture is clearly superior: if $\gamma \leq \gamma^{=}$, the investment incentives and the procurement mechanism design are both better in the competitive culture; if $\gamma \in (\overline{\gamma}^{P}, 1)$, neither culture induces an investment but the competitive culture is still better in the procurement mechanism design. For all other investment cost parameters γ, the buyer faces a trade-off between a better procurement mechanism design (competitive culture) and better investment incentives (protective culture). If $\gamma \in [\overline{\gamma}^{C}, \overline{\gamma}^{P}]$, the difference in investment incentives is extreme: protection of the incumbent improves his investment incentives so much that the highest possible investment is induced in the protective culture, whereas no investment is induced in the competitive culture (see Proposition 2). It turns out that this renders the protective culture superior.

Proposition 3 (Optimal negotiating culture, $\boldsymbol{V^S = 0}$) *Let $\gamma^{=}$ be defined as in Corollary 2. There exists $\overline{\gamma}^{\mathbf{0}} \in (\gamma^{=}, \overline{\gamma}^{C})$ such that the following is true: $\widehat{\Pi}^{\mathbf{0}}_B(C) > \widehat{\Pi}^{\mathbf{0}}_B(P)$ for any $\gamma \in (0, \overline{\gamma}^{\mathbf{0}})$. $\widehat{\Pi}^{\mathbf{0}}_B(P) > \widehat{\Pi}^{\mathbf{0}}_B(C)$ for any $\gamma \in (\overline{\gamma}^{\mathbf{0}}, \overline{\gamma}^{P}]$. $\widehat{\Pi}^{\mathbf{0}}_B(C) > \widehat{\Pi}^{\mathbf{0}}_B(P)$ for any $\gamma \in (\overline{\gamma}^{P}, 1)$.*

4. The repeated procurement problem

4.1. The repeated game

There is a buyer and two suppliers, supplier 1 and supplier 2. For a given negotiating culture $S \in \{C, P\}$, these players interact in an infinite sequence of procurement cycles. The relationship between them at the beginning of a procurement cycle is described by a state variable $(\omega_1, \omega_2) \in \{(I, E), (E, I)\}$. ω_1 (ω_2) describes the role of supplier 1 (supplier 2). In each of the two states, the game described by 1–4 in Subsection 3.1 is played. In particular, this means that R is still large enough for the buyer to always want to procure. At the end of each procurement cycle, the roles of the suppliers are updated: if a supplier wins the procurement contract, he becomes the next incumbent; otherwise, he starts into the next procurement cycle as an entrant. Production costs are serially independent.[21] Future payoffs are discounted by the factor $\delta \in (0, 1)$.

As equilibrium concept for the game implied by a negotiating culture, we adopt the notion of Markov perfect equilibrium with anonymous procurement mechanisms and supplier-symmetric strategies.[22] Serial independence of production costs implies that all payoff-relevant information at the beginning of a procurement cycle is summarized by our state variable (ω_1, ω_2). Our interest in Markov perfect equilibrium allows us to restrict attention to strategies that depend only on payoff-relevant information. Thus, each player's behavior in any procurement cycle depends on behavior in previous procurement cycles only through the current state ((E, I) or (I, E)). Moreover, behavior in future procurement cycles affects a player only through continuation values that depend on his identity (B, 1 or 2) and the subsequent state ((E, I) or (I, E)). This allows us to apply the revelation principle separately to the procurement mechanism design problem in each procurement cycle. Anonymity and supplier-symmetric strategies imply that each player's behavior in a procurement cycle depends only on his current role (B, I or E) and that his continuation value depends only on his role in the next procurement cycle (B, I or E). Hence, equilibrium behavior can be computed by considering the reduced procurement problem described by 1–5 in Subsection 3.1. Any combination of y^{S,V^S}, $M^{S,V^S}(y)$ and V^S that satisfies (EQ1), (EQ2) and

$$\text{(EQ3)} \quad V^S = V(y^{S,V^S}, M^{S,V^S}(y^{S,V^S}), V^S)$$
$$\text{with } V(y, M, V) := (\delta\Pi_I(y, M; V), \delta\Pi_E(y, M; V), \delta\Pi_B(y, M; V))$$

constitutes a Markov perfect equilibrium. The only difference to the problem analyzed in Section 3 is that continuation values now derive endogenously through condition (EQ3). This means that the investment is y^S and that the allocation rule is $(q_I^{S,y^S}, q_E^{S,y^S})$.

4.2. Extractability of future rents

We can now proceed to find out which negotiating culture allows the buyer to extract more future rents. By the analysis in Subsection 3.2, she can extract in each negotiating culture S the advantage of becoming

[21] Serial independence rules out issues of strategic learning and signaling. It allows us to focus on the role of investment incentives and of rent extraction through asymmetries in future competition. See Laffont and Tirole (1993) for strategic learning in dynamic regulation. See also Footnote 11.

[22] See Maskin and Tirole (2001) or Section 13.2.1 in Fudenberg and Tirole (1991) for a definition of Markov perfection. Anonymity implies that procurement mechanisms only differentiate between the suppliers based on their roles, but not on their identities. Supplier symmetry implies that a supplier's behavior depends on his role, but not on his identity.

	$\gamma \to 0$	$\gamma \in (0, \overline{\gamma}^C)$	$\gamma \in [\overline{\gamma}^C, \overline{\gamma}^P]$	$\gamma \in (\overline{\gamma}^P, 1)$
profit attributable to current cycle: $\widehat{\Pi}_B^{\mathbf{0}}(S)$	$S = C$ better	?	$S = P$ better	$S = C$ better
extraction of rents from future cycles: $V_I^S - V_E^S$	equally good in the limit	$S = P$ better	$S = P$ better	$S = C$ better
total effect: $\widehat{\Pi}_B^{\delta}(S)$	$S = C$ better	?	$S = P$ better	$S = C$ better

Table 2: Comparison of the negotiating cultures from the buyer's perspective for general δ

the next incumbent, $V_I^S - V_E^S$, from the winning supplier. By (EQ3),

$$V_I^S - V_E^S = \delta(-\gamma y^S + R_I^S(y^S) - R_E^S(y^S)) \tag{7}$$

with $R_E^S(y) := \mathbf{E}_X[q_E^{S,y}(X) \cdot F(X_E)/f(X_E)]$. Although becoming the next incumbent may have persistent effects, the incumbency advantage is only affected by the investment cost and the difference between the incumbent's and the entrant's expected information rent in the subsequent procurement cycle. This is because each supplier anticipates that the advantages that lie further into the future will be extracted through the procurement mechanism in the procurement cycle that precedes it.

The discount factor δ affects $V_I^S - V_E^S$ only through a multiplicative factor that does not depend on the negotiating culture. Thus, it determines the importance of future rent extraction but does not affect in which negotiating culture the incumbency advantage is larger:

Proposition 4 (Incumbency advantage) *(a)* $\lim_{\gamma\to 0}(V_I^C - V_E^C) = \lim_{\gamma \to 0}(V_I^P - V_E^P)$*. (b) If* $\gamma \in (0, \overline{\gamma}^P]$*, then* $V_I^P - V_E^P > V_I^C - V_E^C \geq 0$*. (c) If* $\gamma \in (\overline{\gamma}^P, 1)$*, then* $V_I^C - V_E^C = 0 > V_I^P - V_E^P$*.*

It is not very surprising that the incumbency advantage is higher in the protective culture for $\gamma \leq \overline{\gamma}^P$. In this culture, the incumbent is strongly favored whereas the entrant receives no rent at all. It is more surprising why the incumbency advantage is higher in the competitive culture for $\gamma > \overline{\gamma}^P$. Since in this case neither culture induces an investment, asymmetries between the incumbent and the entrant can arise only through asymmetries in the negotiation protocol. The incumbent and the entrant are treated symmetrically in the competitive culture such that $V_I^C - V_E^C = 0$. By contrast, the buyer treats the suppliers asymmetrically by negotiating sequentially with them in the protective culture. Since the buyer becomes less aggressive as his options fade away, it is an advantage to negotiate second. Hence, $V_I^P - V_E^P < 0$.

4.3. Optimal negotiating culture

Finally, we can determine which negotiating culture is better from the buyer's perspective when the repetition of the procurement problem matters. That is, we are interested in $\widehat{\Pi}_B^{\delta}(S) := \Pi_B(y^S, M^{S,V^S}(y^S); V^S)$ with $V_I^S - V_E^S$ as derived in Subsection 4.2 and $V_B^S = \delta \widehat{\Pi}_B^{\delta}(S)$. As neither the investment incentives nor the allocation of the next procurement contract is affected by the repetition of the procurement problem (see Subsections 3.2 and 3.3), we obtain from (5) that $\widehat{\Pi}_B^{\delta}(S) = (\widehat{\Pi}_B^{\mathbf{0}}(S) + V_I^S - V_E^S)/(1-\delta)$. That is, the buyer's expected profit in each procurement cycle is comprised of two parts: a profit $\widehat{\Pi}^{\mathbf{0}}_B(S)$, which would arise also without repetition (see Subsection 3.4), and an additional profit $V^S_I - V^S_E$, which arises only because of the repetition (see Subsection 4.2). Table 2 summarizes the relevant effects from Proposition 3 and Proposition 4.

For $\delta \to 0$ we obtain $\widehat{\Pi}^{\delta}_B(S) \to \widehat{\Pi}^{\mathbf{0}}_B(S)$ such that Proposition 3 applies. For any $\delta > 0$ an additional profit arises from the repetition. Despite this additional, non-trivial effect, the non-monotonicity result from Proposition 3 extends:[23]

Proposition 5 (Optimal negotiating culture) *There exists $\gamma' \in (0, \overline{\gamma}^C)$ such that $\widehat{\Pi}^{\delta}_B(C) > \widehat{\Pi}^{\delta}_B(P)$ for any $\gamma \in (0, \gamma')$. $\widehat{\Pi}^{\delta}_B(P) > \widehat{\Pi}^{\delta}_B(C)$ for any $\gamma \in [\overline{\gamma}^C, \overline{\gamma}^P]$. $\widehat{\Pi}^{\delta}_B(C) > \widehat{\Pi}^{\delta}_B(P)$ for any $\gamma \in (\overline{\gamma}^P, 1)$.*

The intuition is as follows. Consider first $\gamma \leq \overline{\gamma}^P$. Whenever $\widehat{\Pi}^{\mathbf{0}}_B(P) > \widehat{\Pi}^{\mathbf{0}}_B(C)$, this is due to the fact that investment incentives are much better in the protective culture. Since this implies also that $V^P_I - V^P_E > V^C_I - V^C_E$ (see Proposition 4 (b)), repetition enlarges the set of investment cost parameters for which the protective culture is superior. Moreover, it enlarges it more the more important repetition is for the buyer. However, when investment is sufficiently cheap, the difference between the incumbency advantage in the two negotiating cultures is negligible for any discount factor (see Proposition 4 (a)). The competitive culture is then still superior because it induces better investment incentives. Consider now $\gamma > \overline{\gamma}^P$. In this case, neither culture induces an investment. Since without investment the incumbent has a disadvantage when he gets protected (see Proposition 4 (c)), the additional effect strengthens the superiority of the competitive culture.

4.4. Discussion of the equilibrium concept

Our interest in Markov strategies is motivated by our interest in industries in which all players behave opportunistically at any point in time. At the same time, we assumed that the buyer is committed to a negotiating culture. We discuss in this subsection why a commitment to a negotiating culture is not essential for our results and what happens when we drop the Markov assumption.

Endogenous culture choice. In practice, a change in the negotiating culture seems to be possible but very expensive (see Dyer (1996b)). We consider now an extension of our theoretical model in which this possibility is included. The state variable describes the prevailing negotiating culture apart from the roles of the suppliers. Each procurement cycle starts with an additional stage:

0. *Negotiating culture choice.* The buyer decides between staying in the prevailing negotiating culture S and switching to the other culture, say $-S$, at a transition cost $c_{-S} \geq 0$.

A Markov perfect equilibrium is described by any combination of y^{S,V^S}, $M^{S,V^S}(y)$, V^S and S such that (EQ1), (EQ2), (EQ3) and

$$\text{(EQ4)} \quad \widehat{\Pi}^{\delta}_B(S) \geq \widehat{\Pi}^{\delta}_B(-S) - c_{-S}$$

[23] We establish the non-monotonicity result by identifying three regions: a region of low and of high investment cost parameters in which the competitive culture is superior and a region of intermediate investment cost parameters in which the protective culture is superior. The three regions are constructed such that the non-monotonicity result can be proven in the simplest way. We refrain from investigating whether exactly three regions exist as this is much more involved and not necessary for establishing our main result.

hold. It follows directly from our analysis so far that a buyer who starts in the culture that is better for her according to Proposition 5 never switches. A buyer who starts in the culture that is worse switches only if switching is relatively cheap. If, for instance, the protective culture is optimal and $c_P > \widehat{\Pi}^{\delta}_B(P) - \widehat{\Pi}^{\delta}_B(C)$, then it is consistent with our model that both negotiating cultures coexist.[24]

Markov perfect equilibrium (MPE) and perfect public equilibrium (PPE). In a PPE, strategies condition on history only through publicly available information. Our MPE is a specific PPE in which any public information that is not payoff-relevant is ignored. By conditioning the current behavior on past behavior that is not payoff-relevant, under certain conditions it becomes possible to support higher equilibrium investments through threats. This can most easily be demonstrated for $\gamma \in (0, \overline{\gamma}^P]$ and $S = P$. The MPE is then given by $y^{P,V^P} = \overline{y}^P$, $M^{P,V^P}(y)$ as specified in Subsection 3.2, and $(V_I^P, V_E^P, V_B^P) = (\delta(-\gamma\overline{y}^P + R_I^P(\overline{y}^P)), 0, \delta/(1-\delta)\cdot(R + \overline{y}^P - \mathbf{E}_X[X_I]) - \delta(-\gamma\overline{y}^P + R_I^P(\overline{y}^P)))$. For the considered parameter values, the MPE has the feature that the relationship with the incumbent is continued with certainty in each contract renewal phase. We now construct a PPE with the desired properties by modifying this MPE. The idea is as follows: the incumbent invests $y^\star > \overline{y}^P$ in the expectation that the buyer will continue the relationship and that she will cover the additional investment cost, $\gamma(y^\star - \overline{y}^P)$, ex post. If the buyer does this, the incumbent will invest again $y^\star$ in the next procurement cycle; otherwise, he will punish the buyer by choosing only the MPE investment $\overline{y}^P$. It turns out that this behavior constitutes a PPE if the buyer is sufficiently patient ($\delta \geq \gamma$) but not if she is eager to behave opportunistically ($\delta < \gamma$).[25] A similar reasoning applies also for $S = C$ and for other values of γ but it is more involved.[26]

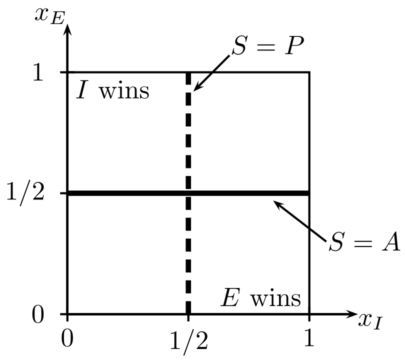
MPE has the nice feature of being essentially unique. It is the appropriate solution concept for situations in which δ is relatively low; that is, in situations in which the players are eager to behave very opportunistically. Thus, our analysis is particularly relevant for industries in which procurement cycles are long (i.e., where the contract renewal phase recurs only every couple of years). For instance, this is the case for many important parts in the automotive industry.

In industries in which the players are sufficiently patient, the MPE coexists with many different PPE. We have described one class of PPE above, but there are many degrees of freedom to construct other classes. Thus, one needs to argue carefully what could be the best prediction for equilibrium play. Yet, even in situations in which the MPE seems not to be the best prediction, there might be a role for our analysis of the MPE. First, better investment incentives in the MPE make it in a reasonable class of PPE cheaper to

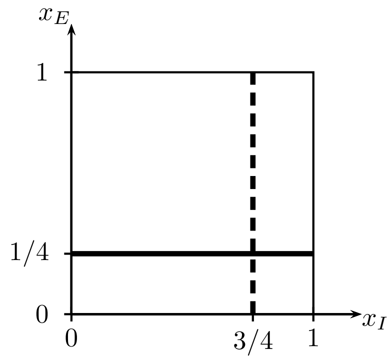
[24]Such a reasoning might explain why the attempts of car producers to change the negotiating culture occurred mainly after technological changes caused changes in the belief about the profitability of a culture change.

[25]Let $M^\star(y)$ be the mechanism that differs from $M^{P,V^P}(y)$ only by an additional lump-sum transfer of $\gamma(y - \overline{y}^P)$ to the incumbent. Consider the following modification of the MPE strategies in which current behavior conditions on the mechanism in the preceding cycle, say M': the incumbent invests $y = y^\star$ if $M' = M^\star(y^\star)$ and $y = \overline{y}^P$ otherwise; the buyer chooses the mechanism $M^\star(y^\star)$ if $y = y^\star$ and $M^{P,V^P}(y)$ otherwise. Continuation values are given by $(V_I^P, V_E^P, V_B^P + \delta/(1-\delta)\cdot(1-\gamma)(y^\star - \overline{y}^P))$. Under which conditions do the modified strategies constitute a PPE? If $M' = M^\star(y^\star)$, the incumbent is by construction indifferent between the investment $y = y^\star$ and the best other investment $y = \overline{y}^P$. Thus, only the buyer might have an incentive to deviate. If $y = y^\star$, the optimal deviation from the mechanism $M^\star(y^\star)$ is the mechanism $M^{P,V^P}(y^\star)$. By deviating, the buyer saves the lump-sum transfer $\gamma(y^\star - \overline{y}^P)$, but her profit in each future procurement cycle reduces by $(1-\gamma)(y^\star - \overline{y}^P)$. It follows from this that a deviation is profitable (unprofitable) if $\delta < \gamma$ ($\delta > \gamma$).

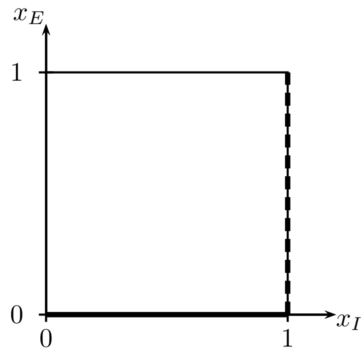
[26]If the relationship with the incumbent is not continued with certainty in the MPE, it is a priori unclear whether an increase in the investment is beneficial for the buyer under the supposition that she has to cover the additional investment cost. On the other hand, the additional investment costs are then partially covered by an increase in the incumbent's information rent. This makes it more complicated to derive explicit conditions under which a PPE exists that supports a higher investment.



(a) $y = 0$



(b) $y = 1/2$



(c) $y = 1$

Figure 4: Optimal allocation for $S = P$ and $S = A$ [$\alpha = 1$]

support higher investments. Thus, our analysis of investment incentives in Subsection 3.3 remains relevant for the assessment of different negotiating cultures. Second, understanding the MPE is important because it constitutes a reasonable threat point in PPE.

5. Extensions

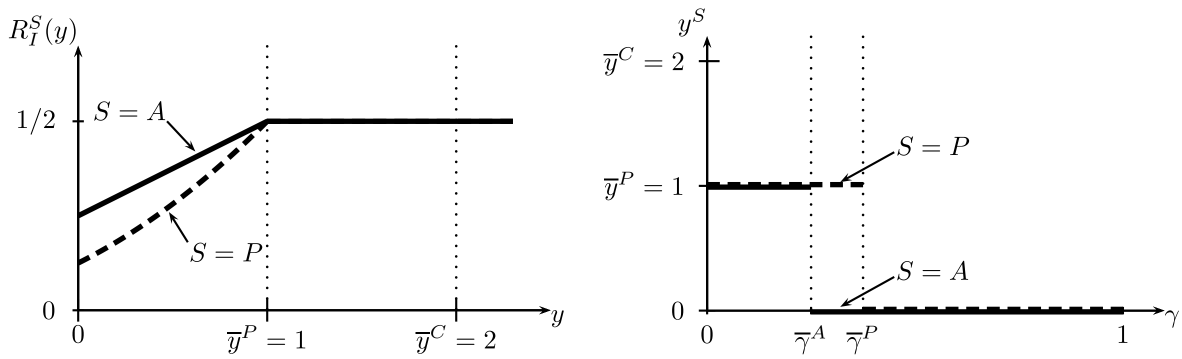
The main force behind our non-monotonicity result (Propositions 3 and 5) is the structural difference in the marginal revenue from investment that is implied by the two negotiating cultures. This difference relies mainly on the fact that the incumbent competes against the best entrant in the competitive culture whereas he competes only against the buyer's expectation thereof in the protective culture. Considering a single entrant and our specific class of investment cost functions improves the tractability of the problem and it allows us to derive the non-monotonicity result theoretically.[27] Moreover, our modeling assumptions endow us with a tractable framework that can be used to study different extensions.

5.1. The anti-protective negotiating culture

In our model future rent extraction works better when the advantage of being the next incumbent is higher. In Subsection 4.2 we found that in the protective culture it might be a disadvantage to start the next procurement cycle as the incumbent. This gives rise to the question as to whether there is a role for a culture in which the sequence of negotiations is reversed. Thus, consider the anti-protective negotiating culture $S = A$ in which the buyer negotiates first bilaterally with the entrant and approaches the incumbent only when the negotiations with the entrant break down. We consider uniformly distributed costs ($\alpha = 1$) again. This allows us to use a graphical reasoning process to explain the effects.

Proposition 6 (Anti-protective culture) *Let $\alpha = 1$. If $\gamma > \overline{\gamma}^P$ and δ is sufficiently large, the anti-protective culture is strictly optimal for the buyer. In all other cases the competitive culture or the protective culture is optimal.*

[27] In an earlier working paper version of this article, we numerically obtain similar results for more than two entrants, linear or quadratic cost functions, and other distributional assumptions.



(a) Revenue from investment

(b) Optimal investment

Figure 5: Investment incentives for $S = P$ and $S = A$ $[\alpha = 1]$

For a given investment y, the optimal procurement contract allocation in the anti-protective culture follows from comparing the virtual profit from switching to the entrant, $R - J(x_E) + V_I^A - V_E^A$, with the expected virtual profit from continuing the relationship with the incumbent, $\mathbf{E}_X[R + y - J(x_I) + V_I^A - V_E^A] = R + y - 1 + V_I^A - V_E^A$. It follows that $q_I^{A,y}(x) = 1$ if $x_E \geq (1-y)/2$ and $q_I^{A,y}(x) = 0$ if $x_E < (1-y)/2$. Figure 4 illustrates the procurement contract allocation in the protective and in the anti-protective culture for different investment levels. Given any investment, the incumbent wins in both cultures with the same probability but the cultures differ in his expected information rent conditional on winning. In the protective culture, this rent increases in the investment since a higher investment leads to additional winning in cases where the incumbent's cost are higher. By contrast, in the anti-protective culture, this rent is constant since the incumbent's cost has no effect on the allocation. As a consequence, the marginal revenue from the investment and the highest possible revenue gain from the investment are both higher in the protective culture (see Figure 5(a)). Thus, investment incentives are better in the protective culture (see Figure 5(b)). The proposition shows that whenever the protective culture induces investment ($\gamma \leq \overline{\gamma}^P$), the protective culture is at least weakly better for the buyer than the anti-protective culture. It follows from our analysis in the preceding sections that the competitive culture is optimal if investment is cheap and that the protective culture is optimal if investment is intermediately expensive.

The question remains as to whether there is a role for the anti-protective culture when neither culture induces an investment ($\gamma > \overline{\gamma}^P$). The anti-protective culture allows in this case the extraction of positive future rents whereas the other two cultures do not. Thus, the buyer faces a trade-off between better current rent extraction (competitive culture) and better future rent extraction (anti-protective culture). It turns out that when the players are sufficiently eager to behave opportunistically (low δ), the competitive culture is superior. Yet, when they are sufficiently patient (high δ), there is a role for the anti-protective culture.

5.2. Switching costs

Our framework can also be used to study the performance of the competitive and the protective culture when there are exogenously given switching costs instead of an endogenous relationship-specific investment. Suppose the buyer realizes a value of R_{sc} from procuring, but in both cultures switching to the entrant causes her to incur an exogenously given fixed cost of $y_{sc} \in [0, \overline{y}^C)$. Her procurement benefit is then R_{sc} if she continues her relationship with the incumbent and $R_{sc} - y_{sc}$ if she switches to the entrant. When we define $R_{sc} := R + y_{sc}$, we obtain that the buyer's benefit is $R + y_{sc}$ from continuing the relationship and R from switching. Thus, technically, the switching costs problem corresponds to our original problem with an exogenously given investment $y^S = y_{sc}$ and $\gamma = 0$.[28]

Any combination of $M^{S,V^S}(y_{sc}) \in \mathcal{M}^S \cup \mathcal{M}^{\star,V^S}$ and $V^S \in \mathbb{R}^3$ that satisfies (EQ1) and (EQ3) with $y^S = y_{sc}$ constitutes a Markov perfect equilibrium of the game implied by the negotiating culture S. Thus, the optimal procurement contract allocation is as derived in Subsection 3.2; the incumbency advantage is as described in (7) with $\gamma = 0$; and the buyer's continuation value is $V_B = \delta\Pi(y_{sc}, M^{S,V^S}(y_{sc}); V^S)$. This completely determines the buyer's expected profit in culture S, $\widehat{\Pi}_B^{sc}(S) := \Pi(y_{sc}, M^{S,V^S}(y_{sc}); V^S)$. We have

$$\widehat{\Pi}_B^{sc}(S) = (\mathbf{E}_X[q_I^{S,y_{sc}}(X)(R + y_{sc} - J(X_I)) + q_E^{S,y_{sc}}(X)(R - J(X_E))] + V_I^S - V_E^S)/(1 - \delta).$$

As the "investment" y_{sc} is the same in both cultures and as competitive pressure is, by construction, higher in the competitive culture, the part of the buyer's profit that can be attributed to the current cycle is clearly higher in the competitive culture. The protective culture can only be superior if it is better at extracting future rents and the discount factor is sufficiently high. For the case in which the future is sufficiently important, we ascertain that there is a role for both negotiating cultures:

Proposition 7 (Switching costs) *(a) Let $\delta = 0$. Then, $\widehat{\Pi}_B^{sc}(C) > \widehat{\Pi}_B^{sc}(P)$. (b) There exists $\delta' \in (0, 1)$ such that for any $\delta \in (\delta', 1)$, $\widehat{\Pi}_B^{sc}(C) > \widehat{\Pi}_B^{sc}(P)$ if y_{sc} is close to zero and $\widehat{\Pi}_B^{sc}(P) > \widehat{\Pi}_B^{sc}(C)$ if $y_{sc} \in [\max\{\overline{y}^P, 1\}, \overline{y}^C)$.*

The intuition for (b) is as follows. Consider $\delta \to 1$. In each procurement cycle the buyer then obtains

$$\mathbf{E}_X[q_I^{S,y_{sc}}(X)(R + y_{sc} - X_I) + q_E^{S,y_{sc}}(X)(R - X_E)] - 2R_E^S(y_{sc}).$$

This corresponds to expected social welfare net of twice the expected information rent of the entrant (which is what the buyer has to leave to each supplier in order to ensure participation). If y_{sc} is close to zero, the competitive culture allocates almost efficiently and it implies a lower information rent for the entrant than it would be in the protective culture (recall that negotiating second is an advantage when the investment is sufficiently small). This makes the competitive culture clearly superior. By contrast, if y_{sc} is high, the stronger favoring of the incumbent in the protective culture implies that the entrant's expected information rent is lower in the protective culture. Since it is also efficient for high y_{sc} that the incumbent is strongly favored, the protective culture is superior.[29]

5.3. Suppliers can be excluded from the procurement process in the future

We assumed that the buyer has no long-term commitment power within a negotiating culture. In particular, she could not commit to exclude a supplier from the procurement process in the future. In any

[28] With switching costs instead of an investment, our model of the competitive culture is like the special case of the model in Lewis and Yildirim (2005) in which the learning and forgetting of skills occurs with certainty after a switch of suppliers. The analysis in this subsection transfers our research question of comparing different negotiating cultures into their framework. See Farrell and Klemperer (2007) for a survey of the classical switching costs literature.

[29] Cabral and Greenstein (1990) argue that committing to ignore switching costs can be beneficial in a model in which prices are set by the suppliers. We find here that a commitment to a negotiating culture that implies higher switching costs can be beneficial in a model in which the procurement mechanism is designed by the buyer. This is in line with the comparative statics analysis in Lewis and Yildirim (2005), who find that measures that increase switching costs can be beneficial for the buyer.

culture S, this had the consequence that the buyer had to leave a rent of V_E^S to each supplier in order to induce participation. We now consider what happens when the buyer can commit to exclude a supplier from the procurement process in the future.

The change in the assumption does not affect investment incentives or the allocation rule of the optimal mechanism; it affects only which future rents can be extracted. The buyer can additionally extract V_E^S from each supplier. Her expected profit corresponds to $\widehat{\Pi}_B^{ex}(S) = (\widehat{\Pi}_B^{\mathbf{0}}(S) + (V_I^S - V_E^S) + 2V_E^S)/(1-\delta)$. The incumbency advantage is as in the original model (see (7)) but the continuation value of the entrant differs. As rents of the entrant that lie further into the future will be extracted through the procurement mechanism of the future cycle that precedes it, the entrant's continuation value becomes her discounted information rent in the next cycle, $\delta R_E^S(y^S)$. Thus, we have $\widehat{\Pi}_B^{ex}(S) = (\widehat{\Pi}_B^{\mathbf{0}}(S) + \delta(-\gamma y^S + R_I^S(y^S) + R_E^S(y^S)))/(1-\delta)$. We obtain the following result:

Proposition 8 (Exclusion possible) *If either $\delta = 0$ or δ is close to 1 and $\alpha \geq 1$, Proposition 5 extends to the case in which V_E^S is also extractable by the buyer.*

If $\delta = 0$, the buyer cannot extract future rents anyway. All results extend. The case in which δ is close to 1 is more interesting. The buyer then basically maximizes social welfare. If γ is close to zero, the allocation coincides (almost) in the two cultures, but the investment is more efficient in the competitive culture.[30] This renders the competitive culture superior. If $\gamma > \overline{\gamma}^P$, there is no investment in both cultures. Only the efficiency of the allocation matters. As the competitive culture allocates efficiently when there is no investment, it is again superior. The case in which $\gamma \in [\overline{\gamma}^C, \overline{\gamma}^P]$ is more involved. As the entrant earns no rent in the protective culture, but he does so in the competitive culture, the competitive culture becomes relatively better. Nevertheless, we find that the protective culture is, at least for sufficiently high α, still superior.

6. Conclusions

For a procurement problem featuring three economic problems—hold-up, asymmetric information, and repetition—we compare a competitive with a protective negotiating culture. Our main result establishes that the relative performance of the two cultures from the buyer's perspective depends non-monotonically on the expensiveness of the relationship-specific investment relative to the potential benefits from competitive bidding. The competitive culture is superior when the investment is either cheap or expensive, whereas the protective culture is superior when the investment is intermediately expensive.

For the most important parts that are needed in the automotive industry, investment is associated with significant potential benefits but the costs are significant too. In terms of our model, such situations are probably best described by intermediate investment cost parameters.[31] When we identify the protective culture with Japanese-style procurement and the competitive culture with U.S.-style procurement, our model predictions are consistent with the stylized facts from the automotive industry as discussed in the introduction. Investment incentives are low in the competitive culture (no investment is induced), whereas

[30] Since $\gamma < 1$ and since the benefits are realized (almost) with certainty in both cultures, more efficient here means higher.
[31] We can also interpret such situations as situations with intermediately important investment. See Footnote 10.

significant relationship-specific investments are induced in the protective culture (the highest inducible investment $\overline{y}^P$ is induced). In the competitive culture, the optimal procurement mechanism treats the incumbent and the entrant equally and the identity of the incumbent changes frequently over time, whereas the buyer-supplier relationship is very long term in the protective culture. Putting all the effects together, the protective culture turns out to be superior from the buyer's perspective.[32] On the other hand, our model gives rise to the conclusion that procuring every part in the same way is suboptimal. This is in line with what Hahn et al. (1986) argue: "[...] the use of a competitive or a cooperative approach in dealing with suppliers is not always a clear-cut choice. A sound purchasing management strategy generally requires a good mix of both approaches for an optimal result."

Although our base model is set up so that it fits best the procurement problem in the automotive industry, it also introduces a tractable framework for studying negotiating cultures in corporate procurement from a more general perspective. We demonstrate three directions in which our model can be modified to better fit the procurement problem in other industries: an alternative negotiating culture, switching costs instead of a relationship-specific investment, and stronger commitment power on the buyer's side. As for the original model, we obtain for each modification that there is a role for the competitive and for the protective negotiating culture.

[32] Our model predictions are also in line with what changed after Chrysler created an American keiretsu at the beginning of the 1990s. According to Dyer (1996b), "Minimal supplier investments in coordination mechanisms and dedicated assets" changed into "Substantial investment," and "No guarantee of business relationship beyond the contract" changed into "Expectation of business relationship beyond the contract."

Appendix A. Proofs

Proof of Proposition 1.

We prove first an auxiliary result that allows us to reformulate the buyer's mechanism design problem.

Lemma A1 *Let $V^S \in \mathbb{R}^3$. Define $\overline{q}_k(x_k) := \mathbf{E}_X[q_k(X)|X_k = x_k]$ and $\overline{t}_k(x_k) := \mathbf{E}_X[t_k(X)|X_k = x_k]$. $(q,k) \in \mathcal{M}^{\star,V^S}$ if and only if*

$$\overline{q}_k(x_k) \text{ is non-increasing for any } k, \tag{A.1}$$

$$\overline{t}_k(x_k) = \overline{q}_k(x_k)(x_k - (V_I^S - V_E^S)) + \int_{x_k}^1 \overline{q}_k(x'_k)dx'_k + \kappa_k \text{ for any } k, \text{ and} \tag{A.2}$$

$$\kappa_k \geq 0 \text{ for any } k. \tag{A.3}$$

Proof. Consider how a supplier k plays a mechanism $M = (q,t)$. A potential investment by him is then already sunk and is not relevant to his behavior in a given mechanism. When supplier k's private information is x_k and he believes that the other supplier will announce his information truthfully, he chooses his announcement $\widehat{x}_k$ to maximize $U_k(x_k, \widehat{x}_k) := \overline{t}_k(\widehat{x}_k) - \overline{q}_k(\widehat{x}_k)(x_k - (V_I^S - V_E^S)) + V_E^S$. M is incentive compatible if, and only if, $x_k \in \arg\max_{\widehat{x}_k \in [0,1]} U_k(x_k, \widehat{x}_k)$ for any x_k and any k. M is individual rational if, and only if, $U_k(x_k, x_k) \geq V_E^S$ for any x_k and any k. By standard reasoning, incentive compatibility is equivalent to (A.1) and $U_k(1,1) - U_k(x_k, x_k) = -\int_{x_k}^1 \overline{q}_k(x'_k)\mathrm{d}x'_k$ for any k. By using the definition of $U_k(\cdot,\cdot)$ and the notation $\kappa_k := \overline{t}_k(1) - \overline{q}_k(1)(1 - (V_I^S - V_E^S))$ to rewrite the second condition, we obtain (A.2). For incentive compatible mechanisms, individual rationality is equivalent to $U_k(1,1) \geq V_E^S$ for any k. By using the definition of $U_k(\cdot,\cdot)$ and (A.2), this can be rewritten as (A.3). q.e.d.

The buyer's problem is to choose a mechanism $M = (q,t) \in \mathcal{M}^S$ that satisfies (A.1), (A.2) and (A.3) to maximize $\Pi_B(y, M; V^S)$. By using (A.2) and integration by parts, we obtain

$$\begin{aligned}\Pi_B(y, M; V^S) \quad &= \quad \mathbf{E}_X[q_I(X)(R + y - J(X_I) + V_I^S - V_E^S) + q_E(X)(R - J(X_E) + V_I^S - V_E^S)] \\ &\quad -\kappa_I - \kappa_E + V_B^S.\end{aligned}$$

It is clearly optimal to set $\kappa_I = \kappa_E = 0$. Thus, the buyer's problem is to choose an allocation rule that is consistent with the negotiating culture S and satisfies the monotonicity constraint (A.1) to maximize (5). Because of the assumption that R is "large", an allocation rule with $q_E(x) = 1 - q_I(x)$ is optimal.

(a) Consider $S = C$. Then, any function $q_I(\cdot)$ is feasible. When we consider the relaxed problem in which the monotonicity constraint is ignored, the maximization of (5) corresponds to the pointwise maximization of $q_I(x)(R+y-J(x_I)) + (1-q_I(x))(R-J(x_E))$. The buyer compares E's virtual cost $J(x_E)$ with I's virtual cost corrected by the benefits of the relationship-specific investment $J(x_I) - y$. Since $J(\cdot)$ is increasing for the considered distributions, the ignored monotonicity constraint is satisfied for the function $q_I(\cdot)$ that solves the relaxed problem. Thus, the solution to the relaxed problem is also the solution to the original problem. This implies (a).

(b) Consider $S = P$. Only functions $q_I(\cdot)$, which depend only through x_I on x, are consistent with this negotiating culture. This allows us to rewrite (5) as

$$\begin{aligned}\Pi_B(y, M; V^P) \quad &= \quad \mathbf{E}_X[\mathbf{E}_X[q_I(X)(R + y - J(X_I)) + (1 - q_I(X))(R - J(X_E))|X_I]] \\ &\quad +V_I^P - V_E^P + V_B^P \\ &= \quad \mathbf{E}_X[q_I(X)(R + y - J(X_I)) + (1 - q_I(X))(R - 1)] + V_I^P - V_E^P + V_B^P. \end{aligned} \tag{A.4}$$

The transformations arise as follows: The first equality follows from the law of iterated expectations. The second equality follows since $\mathbf{E}_X[q_I(X)|X_I] = q_I(X)$ for any mechanism that is consistent with the negotiating culture and since $\mathbf{E}_X[J(X_E)|X_I] = \mathbf{E}_X[J(X_E)] = 1$.

When we consider the relaxed problem in which the monotonicity constraint and the consistency constraint is ignored, the maximization of (A.4) corresponds to the pointwise maximization of $q_I(x)(R + y -$

$J(x_I)) + (1 - q_I(x))(R - 1)$. The buyer compares I's actual virtual cost corrected by the benefits of the investment $J(x_I) - y$ with E's expected virtual cost 1. The ignored monotonicity constraint is again satisfied since $J(\cdot)$ is increasing. Moreover, the ignored consistency constraint is satisfied since the buyer's preferred allocation does not depend on x_E. Thus, the solution to the relaxed problem also solves the original problem. This implies (b). q.e.d.

Proof of Corollary 1.
The corollary follows directly from Proposition 1 and $J(0) = 0$. q.e.d.

Proof of Proposition 2.
We derive first some important properties of $R_I^S(y)$.

Lemma A2 *(a) For any S, $R_I^S(y)$ is continuous, strictly increasing on $[0, \overline{y}^S]$ and constant on $[\overline{y}^S, \infty)$. (b) Let $S = P$. Marginal revenue is then strictly increasing on $[0, \overline{y}^P]$. (c) Let $S = C$. Marginal revenue is then continuous on $[0, \overline{y}^C]$. It is strictly positive for $y \in [0, \overline{y}^C)$ and it converges to zero as $y \to \overline{y}^C$. If $\alpha \leq 1$, marginal revenue is strictly decreasing on $[0, \overline{y}^C]$. (d) $R_I^C(\overline{y}^C) - R_I^C(0) < R_I^P(\overline{y}^P) - R_I^P(0)$.*

Proof. (a) By using the structure imposed by Proposition 1 in (6), by writing the expected value as an integral, and by using $J(x_k) = (1 + \alpha)x_k$, we obtain

$$R_I^S(y) = \begin{cases} \int_0^{(y+1)/(1+\alpha)} F(x_I)\mathrm{d}x_I & \text{if } S = P \\ \int_0^{y/(1+\alpha)} F(x_I)\mathrm{d}x_I + \int_{y/(1+\alpha)}^1 (1 - F(x_I - y/(1+\alpha)))F(x_I)\mathrm{d}x_I & \text{if } S = C \end{cases} \tag{A.5}$$

for $y \leq \overline{y}^S$ and $R_I^S(y) = \int_0^1 F(x_I)\mathrm{d}x_I$ for $y \geq \overline{y}^S$. The claimed continuity and monotonicity properties follow straightforwardly.

(b) Consider $S = P$. For $y \in [0, \overline{y}^P]$, it follows from (A.5) that marginal revenue is given by $1/(1 + \alpha) \cdot F((y + 1)/(1 + \alpha))$. Since this expression is strictly increasing in y, marginal revenue is strictly increasing on $[0, \overline{y}^P] = [0, \alpha]$.

(c) Consider $S = C$. For $y \in [0, \overline{y}^C]$, it follows from (A.5) that marginal revenue is given by

$$\frac{1}{1+\alpha}\int_{y/(1+\alpha)}^1 f(x_I - y/(1+\alpha))F(x_I)\mathrm{d}x_I \tag{A.6}$$

$$= \frac{1}{1+\alpha}\int_0^{1-y/(1+\alpha)} F(x_I + y/(1+\alpha))f(x_I)\mathrm{d}x_I$$

$$= \frac{1}{1+\alpha}\mathrm{Prob}_X(X_I \leq 1 - y/(1+\alpha)) \times \mathbf{E}_X[F(X_I + y/(1+\alpha))|X_I \leq 1 - y/(1+\alpha)]. \tag{A.7}$$

The transformations arise as follows: The first equality follows from an index transformation. The second equality follows from rewriting the integral as a conditional expectation.

The probability term and the conditional expectation term are both bounded on $[0, \overline{y}^C]$. Moreover, both terms are continuous by continuity of the distribution function. This implies that the marginal revenue is bounded. Since the probability term and the conditional expectation term are both strictly positive on $[0, \overline{y}^C)$, the marginal revenue is strictly positive on $[0, \overline{y}^C)$. Since the probability term goes to zero as $y \to \overline{y}^C$ and since the conditional expectation term is bounded, the marginal revenue goes to zero as $y \to \overline{y}^C$.

Consider now $\alpha \leq 1$. $f(\cdot)$ is then continuously differentiable. This allows us to compute the curvature of the revenue by differentiating (A.6):

$$\frac{1}{(1+\alpha)^2}\left(-f(0)F(y/(1+\alpha)) - \int_{y/(1+\alpha)}^1 f'(x_I - y/(1+\alpha))F(x_I)\mathrm{d}x_I\right)$$

If $\alpha = 1$, the revenue is concave because $f(0) = 1$ and $f'(\cdot) = 0$. If $\alpha < 1$, the revenue is concave because $f(0) = 0$ and $f'(\cdot) > 0$.

(d) Since $R_I^S(\overline{y}^S)$ does not depend on S, we need to show that $R_I^C(0) > R_I^P(0)$. By (A.5) with $y = 0$ and by using that $F(x_I) = x_I^{1/\alpha}$ to compute the integrals, we get

$$R_I^C(0) = \int_0^1 (1 - F(x_I))F(x_I)\mathrm{d}x_I = \frac{\alpha}{1+\alpha}\frac{1}{2+\alpha} \tag{A.8}$$

and

$$R_I^P(0) = \int_0^{1/(1+\alpha)} F(x_I)\mathrm{d}x_I = \frac{\alpha}{1+\alpha}\left(\frac{1}{1+\alpha}\right)^{(1+\alpha)/\alpha}. \tag{A.9}$$

By simplifying, we obtain that $R_I^C(0) > R_I^P(0)$ is equivalent to $(1+\alpha)\ln(1+\alpha) > \alpha\ln(2+\alpha)$. Using that concavity of $\ln(\cdot)$ implies $\ln(2+\alpha) < \ln(1+\alpha) + (\ln(1+\alpha))' \cdot 1$, we get that $(1+\alpha)\ln(1+\alpha) > \alpha(\ln(1+\alpha) + 1/(1+\alpha))$ is a sufficient condition for what we have to show. This inequality can in turn be written as $\xi(\alpha) := (1+\alpha)\ln(1+\alpha) - \alpha > 0$. As $\lim_{\alpha\to 0}\xi(\alpha) = 0$ and as $\xi'(\alpha) = \ln(1+\alpha) > 0$ for any $\alpha > 0$, we are done. q.e.d.

(a) Consider $S = P$. Since marginal revenue by Lemma A2 (a) is zero for $y \geq \overline{y}^P$, $y^P \leq \overline{y}^P$. Since marginal revenue by Lemma A2 (b) is convex for $y \leq \overline{y}^P$, and since marginal costs are constant, the optimal investment problem has a corner solution. We obtain that $y^P = \overline{y}^P$ if $-\gamma\overline{y}^P + R_I^P(\overline{y}^P) \geq R_I^P(0)$ and $y^P = 0$ otherwise. Finally, note that (A.5) implies that $R_I^P(\overline{y}^P) - R_I^P(0) = \int_{1/(1+\alpha)}^1 x_I^{1/\alpha}\mathrm{d}x_I$. By computing the integral, we get $R_I^P(\overline{y}^P) - R_I^P(0) = \overline{\gamma}^P\overline{y}^P$. This implies the result.

(b) Consider $S = C$.

(b.i) Suppose that monotonicity is violated. That is, suppose that there exist γ_1 and γ_2 with $\gamma_1 < \gamma_2$ such that $y_1^C > y_2^C$. Optimality requires $-\gamma_1 y_1^C + R_I^C(y_1^C) + V_E^C \geq -\gamma_1 y_2^C + R_I^C(y_2^C) + V_E^C$ and $-\gamma_2 y_2^C + R_I^C(y_2^C) + V_E^C \geq -\gamma_2 y_1^C + R_I^C(y_1^C) + V_E^C$. By adding the left-hand sides and the right-hand sides up, and by simplifying, we obtain that $-(\gamma_2 - \gamma_1)(y_1^C - y_2^C) \geq 0$ is necessary for the two inequalities to hold. Since this contradicts our supposition, we can conclude that y^C must be decreasing in γ.

(b.ii) Since marginal revenue is by Lemma A2 (a) zero for $y \geq \overline{y}^C$, $y^C \leq \overline{y}^C$. Suppose there exists $\gamma \in (0,1)$ such that $y^C = \overline{y}^C$. Optimality requires $-\gamma\overline{y}^C + R_I^C(\overline{y}^C) + V_E^C \geq -\gamma y + R_I^C(y) + V_E^C$ for any $y \in [0, \overline{y}^C]$. However, since Lemma A2 (c) implies that there exists $y' \in [0, \overline{y}^C)$ such that the marginal revenue is below the marginal costs on $[y', \overline{y}^C]$, $y^C = \overline{y}^C$ cannot be optimal. Hence, $y^C < \overline{y}^C$ for any $\gamma \in (0,1)$.

(b.iii) Let any sequence $(\gamma_n)_{n=1}^\infty$ with $\lim_{n\to\infty}\gamma_n = 0$ be given. Let $(y_n^C)_{n=1}^\infty$ be any sequence where y_n^C is an optimal investment for marginal cost γ_n. We need to show that $\lim_{n\to\infty} y_n^C = \overline{y}^C$. Since $(y_n^C)_{n=1}^\infty$ is bounded by the first argument in (b.ii), it suffices to show that any convergent subsequence of $(y_n^C)_{n=1}^\infty$ converges to $\overline{y}^C$. Let any convergent subsequence of $(y_n^C)_{n=1}^\infty$ be given by $(y_{\tau(n)}^C)_{n=1}^\infty$ where $\tau : \mathbb{N} \to \mathbb{N}$ is an increasing function. Optimality requires that $-\gamma_{\tau(n)}y_{\tau(n)}^C + R_I^C(y_{\tau(n)}^C) + V_E^C \geq -\gamma_{\tau(n)}\overline{y}^C + R_I^C(\overline{y}^C) + V_E^C$ for any n. Since $\lim_{n\to\infty}\gamma_{\tau(n)} = 0$ by our supposition, necessary for this is $\lim_{n\to\infty} R_I^C(y_{\tau(n)}^C) \geq R_I^C(\overline{y}^C)$. Since $R_I^C(\cdot)$ is by Lemma A2 (a) strictly increasing on $[0, \overline{y}^C]$, this requires $\lim_{n\to\infty} y_{\tau(n)}^C = \overline{y}^C$. Hence, $\lim_{n\to\infty} y^C = \overline{y}^C$.

(b.iv) Consider first $\alpha \leq 1$. By Lemma A2 (c), the marginal revenue is strictly decreasing. It follows from (A.6) with $y = 0$ that an upper bound on the marginal revenue is given by $1/(1+\alpha) \cdot \int_0^1 f(x_I)F(x_I)\mathrm{d}x_I = 1/(1+\alpha) \cdot 1/2 = \overline{\gamma}^C$. If $\gamma \geq \overline{\gamma}^C$, investment $y = 0$ is optimal. Consider now $\alpha > 1$. $F(\cdot)$ is then concave and we obtain from (A.7) an upper bound on the marginal revenue as follows:

$$\begin{aligned}
& \frac{1}{1+\alpha}F(1 - \frac{y}{1+\alpha})\mathbf{E}_X[F(X_I + \frac{y}{1+\alpha})|X_I \leq 1 - \frac{y}{1+\alpha}] \\
\leq \; & \frac{1}{1+\alpha}F(1 - \frac{y}{1+\alpha})F(\mathbf{E}_X[X_I|X_I \leq 1 - \frac{y}{1+\alpha}] + \frac{y}{1+\alpha}) \\
= \; & \frac{1}{1+\alpha}F(1 - \frac{y}{1+\alpha})F((1 - \frac{y}{1+\alpha})^{1+1/\alpha}\frac{1}{1+\alpha} + \frac{y}{1+\alpha})
\end{aligned}$$

$$\leq \frac{1}{1+\alpha}F(1-\frac{y}{1+\alpha})F((1-\frac{y}{1+\alpha})\frac{1}{1+\alpha}+\frac{y}{1+\alpha})$$
$$= \frac{1}{1+\alpha}F(\frac{1}{1+\alpha}(1-\frac{1}{1+\alpha}y)(1+\frac{\alpha}{1+\alpha}y)) \quad \text{(A.10)}$$

The transformations arise as follows. The first inequality follows from applying Jensen's inequality to (A.7). The first equality follows from using that $\mathbf{E}_X[X_I|X_I \leq 1-y/(1+\alpha)] = (1-y/(1+\alpha))^{1+1/\alpha}/(1+\alpha)$. The second inequality follows from using that $F(\cdot)^{1+1/\alpha} \leq F(\cdot)$ for any $\alpha > 0$. The second equality follows from using that $F(z_1)F(z_2) = F(z_1 z_2)$ for the considered distributions and from simplifying. We then obtain an upper bound on (A.10) by maximizing over y. Since $F(\cdot)$ is strictly increasing, the maximum of (A.10) is assumed by the value of y that maximizes $(1-y/(1+\alpha))(1+\alpha y/(1+\alpha))$. This is $y = (\alpha-1)(1+\alpha)/(2\alpha)$. By plugging this into (A.10) and by simplifying, we obtain the following upper bound on marginal revenue:

$$1/(1+\alpha)\cdot F((1+\alpha)/(4\alpha)) = \overline{\gamma}^C.$$

Hence, if $\gamma \geq \overline{\gamma}^C$, investment $y = 0$ is optimal.

(c) Consider first $\alpha \leq 1$. By rearranging and simplifying, we obtain that $\overline{\gamma}^P > \overline{\gamma}^C$ is equivalent to $(1+\alpha)^{1+\alpha} > 2^\alpha$. This is in turn equivalent to $\xi_1(\alpha) := (1+\alpha)\ln(1+\alpha) - \alpha\ln(2) > 0$. Since $\xi_1(0) = 0$, a sufficient condition for $\overline{\gamma}^P > \overline{\gamma}^C$ is $\xi_1'(\alpha) > 0$ for all $\alpha \in (0,1]$. Since we have $\xi_1'(\alpha) = \ln(1+\alpha) + 1 - \ln(2)$, $\ln(1+\alpha) > 0$ for all $\alpha \in (0,1]$, and $1 > \ln(2)$, we obtain the result.

Consider now $\alpha > 1$. Define $\mathcal{F} : \mathbb{R}_+ \to \mathbb{R}_+$ by $\mathcal{F}(z) := z^{1/\alpha}$. We can use this to rewrite $\overline{\gamma}^P > \overline{\gamma}^C$ as $1/(1+\alpha) - \mathcal{F}(1/(1+\alpha))/(1+\alpha)^2 > \mathcal{F}((1+\alpha)/(4\alpha))/(1+\alpha)$. By multiplying both sides of the inequality with $(1+\alpha)$ and by rearranging, we obtain that $\xi_2(\alpha) := 1/(1+\alpha)\cdot\mathcal{F}(1/(1+\alpha)) + \mathcal{F}((1+\alpha)/(4\alpha)) < 1$. We can then write

$$\begin{aligned}
\xi_2(\alpha) &= \frac{1}{1+\alpha}\cdot\mathcal{F}(1/(1+\alpha)) + \frac{\alpha}{1+\alpha}\cdot\mathcal{F}(1/4\cdot(1+\alpha)^{\alpha+1}/\alpha^{\alpha+1}) \\
&\leq \mathcal{F}(\frac{1}{1+\alpha}\cdot 1/(1+\alpha) + \frac{\alpha}{1+\alpha}\cdot 1/4\cdot(1+\alpha)^{\alpha+1}/\alpha^{\alpha+1}) \\
&= \mathcal{F}(1/(1+\alpha)^2 + (1+1/\alpha)^\alpha\cdot 1/4) \\
&\leq \mathcal{F}(1/4 + (1+1/\alpha)^\alpha\cdot 1/4) =: \xi_3(\alpha).
\end{aligned}$$

The transformations arise as follows: The first equality uses that $\mathcal{F}(z_1) = z_2\mathcal{F}(z_1/z_2^\alpha)$ for any $z_2 > 0$. The inequality follows from the concavity of $\mathcal{F}(\cdot)$ for $\alpha > 1$ and Jensen's inequality. The second equality follows from simplifying. The second inequality follows from the monotonicity of $\mathcal{F}(\cdot)$ and $1/(1+\alpha)^2 < 1/4$ for $\alpha > 1$. It follows that $\xi_3(\alpha) < 1$ is a sufficient condition for $\xi_2(\alpha) < 1$. Using that $\mathcal{F}(\cdot)$ is invertible with $\mathcal{F}^{-1}(1) = 1$, we get that $\xi_3(\alpha) < 1$ is equivalent to $(1+1/\alpha)^\alpha < 3$. Since the left-hand side of this inequality is increasing with limit $\exp(1) < 3$, we obtain the result. q.e.d.

Proof of Corollary 2.

The corollary is a direct consequence of Proposition 2. q.e.d.

Proof to Corollary 3.

The corollary is a direct consequence of Propositions 1 and 2. q.e.d.

Proof of Proposition 3.

Let $\gamma^=$ be defined as in Corollary 2. We distinguish between four cases.

Case 1: $\gamma \in (\overline{\gamma}^P, 1)$. By Proposition 2, $y^C = y^P = 0$. By (5), $\widehat{\Pi}_B^{\mathbf{0}}(S) = \mathbf{E}_X[q_I^{S,0}(X)(R - J(X_I)) + q_E^{S,0}(X)(R - J(X_E))]$. Since this expression is by Proposition 1 maximized by $S = C$ but not by $S = P$, $\widehat{\Pi}_B^{\mathbf{0}}(C) > \widehat{\Pi}_B^{\mathbf{0}}(P)$.

Case 2: $\gamma \in (0, \gamma^=]$. By (5), $\widehat{\Pi}^{\mathbf{0}}_B(S) = \mathbf{E}_X[q_I^{S,y^S}(X)(R + y^S - J(X_I)) + q_E^{S,y^S}(X)(R - J(X_E))]$. By a revealed preferences argument, $\widehat{\Pi}^{\mathbf{0}}_B(C) \geq \mathbf{E}_X[q_I^{C,y^P}(X)(R + y^C - J(X_I)) + q_E^{C,y^P}(X)(R - J(X_E))]$. Since $y^C \geq y^P$ by Corollary 2, $\mathbf{E}_X[q_I^{C,y^P}(X)(R+y^C - J(X_I)) + q_E^{C,y^P}(X)(R - J(X_E))] \geq \mathbf{E}_X[q_I^{C,y^P}(X)(R + y^P - J(X_I)) + q_E^{C,y^P}(X)(R - J(X_E))]$. By a reasoning like that in Case 1, Proposition 1 implies $\mathbf{E}_X[q_I^{C,y^P}(X)(R + y^P - J(X_I)) + q_E^{C,y^P}(X)(R - J(X_E))] \geq \widehat{\Pi}^{\mathbf{0}}_B(P)$. Hence, $\widehat{\Pi}^{\mathbf{0}}_B(C) > \widehat{\Pi}^{\mathbf{0}}_B(P)$.

Case 3: $\gamma \in [\overline{\gamma}^C, \overline{\gamma}^P]$. Since $y^P = \overline{y}^P$ by Proposition 2 (a) and $q_I^{P,y^P}(x) = 1$ by Proposition 1 (b), we obtain by (5)

$$\widehat{\Pi}^{\mathbf{0}}_B(P) = R + \overline{y}^P - \mathbf{E}_X[J(X_I)] = R + \alpha - \int_0^1 (1+\alpha)x_I \cdot \frac{1}{\alpha} x_I^{1/\alpha - 1} \mathrm{d}x_I = R + \alpha - 1.$$

Since $y^C = 0$ by Proposition 2 (b) and since the allocation rule is symmetric by Proposition 1 (a), we obtain by (5)

$$\widehat{\Pi}^{\mathbf{0}}_B(C) = R - 2\mathbf{E}_X[(1 - F(X_I))J(X_I)] = R - 2\int_0^1 (1 - x_I^{1/\alpha}) \frac{1+\alpha}{\alpha} x_I^{1/\alpha} \mathrm{d}x_I = R - \frac{2}{2+\alpha}.$$

It follows that $\widehat{\Pi}^{\mathbf{0}}_B(P) > \widehat{\Pi}^{\mathbf{0}}_B(C)$ is equivalent to $\alpha - 1 > -2/(2+\alpha)$. Since this inequality becomes $\alpha^2 + \alpha > 0$ after rearranging, it is satisfied for any $\alpha > 0$.

Case 4: $\gamma \in [\gamma^=, \overline{\gamma}^C]$. It remains to establish that there exists $\overline{\gamma}^{\mathbf{0}} \in [\gamma^=, \overline{\gamma}^C]$ such that $\widehat{\Pi}^{\mathbf{0}}_B(C) > \widehat{\Pi}^{\mathbf{0}}_B(P)$ if $\gamma \in [\gamma^=, \overline{\gamma}^{\mathbf{0}})$ and $\widehat{\Pi}^{\mathbf{0}}_B(P) > \widehat{\Pi}^{\mathbf{0}}_B(C)$ if $\gamma \in (\overline{\gamma}^{\mathbf{0}}, \overline{\gamma}^C]$. We know from Case 2 and Case 3 that the inequalities are true for the boundaries of the interval. Thus, to prove the result, it suffices to show that (i) $\widehat{\Pi}^{\mathbf{0}}_B(P)$ is constant in γ and that (ii) $\widehat{\Pi}^{\mathbf{0}}_B(C)$ is decreasing in γ.

Note that γ affects $\widehat{\Pi}^{\mathbf{0}}_B(S)$ only through its effect on y^S. By Proposition 2 (a), $y^P = \overline{y}^P$ for any γ in the considered interval. This implies (i). By Proposition 2 (b), y^C is decreasing in γ on the considered interval. By (5), we have for any $y' > y''$ that $\Pi_B(y', M, \mathbf{0}) - \Pi_B(y'', M, \mathbf{0}) = (y' - y'')\mathbf{E}[q_I(x)] \geq 0$. The inequality is strict when the relationship with the incumbent is continued with a positive probability in mechanism M. Since it is always optimal for the buyer to continue her relationship with the incumbent with a probability that is bounded away from zero, these properties imply that $\max_{M \in \mathcal{M}^C} \Pi_B(y, M, \mathbf{0})$ must be increasing in y. From this we obtain (ii). q.e.d.

Proof of Proposition 4.
(c) Consider first $\gamma \in (\overline{\gamma}^P, 1)$. By Proposition 2, $y^P = 0$ and $y^C = 0$. By Proposition 1 (a), the allocation in culture $S = C$ is symmetric for this investment. Hence, $V_I^C - V_E^C = 0$. It remains to show $V_I^P - V_E^P < 0$. By (7), this is equivalent to $R_I^P(0) < R_E^P(0)$. By Proposition 1 (b), I wins with investment $y = 0$ in culture $S = P$ if $x_I \leq 1/(1+\alpha)$ and he loses otherwise. By using this in (6), we obtain

$$R_I^P(0) = \int_0^{1/(1+\alpha)} x_I^{1/\alpha} \mathrm{d}x_I = \frac{\alpha}{1+\alpha} \left(\frac{1}{1+\alpha} \right)^{1/\alpha + 1}. \tag{A.11}$$

Moreover, for $S = P$, we obtain

$$\begin{aligned} R_E^P(0) &= \mathrm{Prob}_X[X_I > 1/(1+\alpha)]\mathbf{E}_X[F(X_E)/f(X_E) | X_I > 1/(1+\alpha)] \\ &= (1 - F(1/(1+\alpha))) \int_0^1 F(x_E) \mathrm{d}x_E = \left(1 - \left(\frac{1}{1+\alpha} \right)^{1/\alpha} \right) \frac{\alpha}{1+\alpha}. \end{aligned} \tag{A.12}$$

The transformations arise as follows: The first equality uses that by Proposition 1 (b) with $y = 0$, $q_E^{P,0}(x) = 1$ if $x_I > 1/(1+\alpha)$ and $q_E^{P,0}(x) = 0$ if $x_I \leq 1/(1+\alpha)$. The second equality uses that by independence of X_I and X_E, $\mathbf{E}_X[F(X_E)/f(X_E) | X_I \geq 1/(1+\alpha)] = \mathbf{E}_X[F(X_E)/f(X_E)]$. The third equality follows from computing the integral.

It remains to show that (A.12) exceeds (A.11). By rearranging, we obtain that this is equivalent to $(1+\alpha)^{1+\alpha} > (2+\alpha)^{\alpha}$, which in turn can be rewritten as $\xi_4(\alpha) := (1+\alpha)\ln(1+\alpha) - \alpha\ln(2+\alpha) > 0$. Since $\xi_4(0) = 0$, $\xi_4'(\alpha) > 0$ for all $\alpha > 0$ is sufficient for the result. We have $\xi_4'(\alpha) = \ln(1+\alpha) + 1 - \ln(2+\alpha) - \alpha/(2+\alpha)$. As the concavity of $\ln(\cdot)$ implies $\ln(2+\alpha) < \ln(1+\alpha) + (\ln(1+\alpha))' \cdot 1$, sufficient for $\xi_4'(\alpha) > 0$ is $\ln(1+\alpha)+1-(\ln(1+\alpha)+1/(1+\alpha))-\alpha/(2+\alpha) > 0$. The left-hand side corresponds to $\alpha/(1+\alpha)-\alpha/(2+\alpha)$. Since this is strictly positive, we are done.

(a) and (b) Consider now $\gamma \in (0, \overline{\gamma}^P]$. If I does not invest in culture $S = C$, he is treated like an entrant. If he decides to invest, he must be better off. Hence, by a revealed preferences argument, $V_I^C - V_E^C \geq 0$. It remains to show that $V_I^P - V_E^P > V_I^C - V_E^C$. By Proposition 2 (a), $y^P = \overline{y}^P$. By Proposition 1 (b), I wins for this investment in culture $S = P$ for sure. It follows from this

$$R_I^P(\overline{y}^P) - R_E^P(\overline{y}^P) = \int_0^1 F(x_I)\mathrm{d}x_I. \tag{A.13}$$

By Proposition 1 (a), in culture $S = C$, I wins if $x_E \geq x_I - y/(1+\alpha)$ and he loses otherwise. For any $y \leq \overline{y}^C$, we obtain

$$\begin{aligned} R_I^C(y) - R_E^C(y) &= \left(\int_0^1 F(x_I)\mathrm{d}x_I - \int_{y/(1+\alpha)}^1 F(x_I - y/(1+\alpha))F(x_I)\mathrm{d}x_I\right) \\ &\quad - \int_0^{1-y/(1+\alpha)} (1 - F(x_E + y/(1+\alpha)))F(x_E)\mathrm{d}x_E \\ &= \int_0^1 F(x_I)\mathrm{d}x_I - \int_0^{1-y/(1+\alpha)} F(x_I)\mathrm{d}x_I. \end{aligned} \tag{A.14}$$

The second equality follows from using that the second integral becomes $\int_0^{1-y/(1+\alpha)} F(x_I)F(x_I + y/(1+\alpha))\mathrm{d}x_I$ after an index transformation and by then consolidating the last two integrals.

By using (A.13), (A.14) and (7), we obtain that $V_I^P - V_E^P > V_I^C - V_E^C$ is equivalent to

$$-\gamma(\overline{y}^P - y) + \int_0^{1-y/(1+\alpha)} F(x_I)\mathrm{d}x_I > 0 \tag{A.15}$$

for $y = y^C$. $y = y^C$ does not necessarily minimize the left-hand side of (A.15). We show that the inequality holds even for the value of y from $[0, 1+\alpha]$ that minimizes the left-hand side of (A.15). First, note that if the left-hand side is strictly positive for some $\gamma \in (0, \overline{\gamma}^P]$ and for any $y \in [0, 1+\alpha]$, then it is also strictly positive for any smaller γ and any $y \in [0, 1+\alpha]$. Thus, we need only to show that the left-hand side of (A.15) with $\gamma = \overline{\gamma}^P$ (that is, $\varphi(y) := -\overline{\gamma}^P(\alpha - y) + \int_0^{1-y/(1+\alpha)} F(x_I)\mathrm{d}x_I$) is strictly positive for any $y \in [0, 1+\alpha]$. We have $\varphi'(y) = \overline{\gamma}^P - 1/(1+\alpha)F(1 - y/(1+\alpha))$. It can be easily verified that $\varphi(y)$ is strictly convex, $\varphi'(0) = \overline{\gamma}^P - 1/(1+\alpha) < 0$, and $\varphi'(1+\alpha) = \overline{\gamma}^P > 0$. Thus, $\varphi(y)$ possesses an interior global minimum that is characterized by $\varphi'(y) = 0$. The minimizer is given by $y^* = (1+\alpha)(1 - ((1+\alpha)\overline{\gamma}^P)^\alpha)$. We obtain

$$\begin{aligned} \varphi(y^*) &= -\overline{\gamma}^P\left(\alpha - (1+\alpha)(1 - ((1+\alpha)\overline{\gamma}^P)^\alpha)\right) + \int_0^{((1+\alpha)\overline{\gamma}^P)^\alpha} F(x_I)\mathrm{d}x_I \\ &= -\overline{\gamma}^P\left((1+\alpha)((1+\alpha)\overline{\gamma}^P)^\alpha - 1\right) + \alpha\overline{\gamma}^P((1+\alpha)\overline{\gamma}^P)^\alpha \\ &= \overline{\gamma}^P\left(1 - ((1+\alpha)\overline{\gamma}^P)^\alpha\right). \end{aligned}$$

The second equality follows from computing the integral and the third equality follows from simplifying. It follows immediately that $\varphi(y^*) > 0$ is equivalent to $\overline{\gamma}^P < 1/(1+\alpha)$. Since this holds by the definition of $\overline{\gamma}^P$ in Proposition 2, we are done. q.e.d.

Proof to Proposition 5.

All three parts of the proposition follow directly from $\widehat{\Pi}_B^\delta(S) = (\widehat{\Pi}_B^{\mathbf{0}}(S) + V_I^S - V_E^S)/(1-\delta)$, Proposition 3 and Proposition 4. q.e.d.

Proof to Proposition 6.

The derivation of the optimal procurement contract allocation for a given investment is analogous to the derivations in Subsection 3.2. The comparison described in the text (in the paragraph after the proposition) implies that $q_I^{A,y}(x) = 1$ if $x_E \geq (1-y)/2$ and $q_I^{A,y}(x) = 0$ if $x_E < (1-y)/2$. Moreover, as is the case for the other two cultures, the incumbent has to bear the entire cost of his investment, but a higher investment is only rewarded indirectly through an increase in the information rent from the procurement in the current procurement cycle. Thus, he chooses an investment to maximize $-\gamma y + R_I^A(y)$ with $R_I^A(y) = \text{Prob}_X[x_E \geq (1-y)/2]\mathbf{E}_X[F(X_I)/f(X_I)] = (1+y)/4$. It follows that the optimal investment is given by $y^A = 1$ if $\gamma \leq \overline{\gamma}^A := 1/4$ and $y^A = 0$ if $\gamma > \overline{\gamma}^A$. We distinguish three cases.

Case 1: $\gamma \leq \overline{\gamma}^A$. Since $\overline{\gamma}^A < \overline{\gamma}^P = 3/8$, we obtain that investment, procurement contract allocation, and future rent extraction coincide in the protective and the anti-protective culture. This implies $\widehat{\Pi}_B^\delta(P) = \widehat{\Pi}_B^\delta(A)$. Since $\widehat{\Pi}_B^\delta(C) > \widehat{\Pi}_B^\delta(P)$ for sufficiently small γ, we also obtain that $\widehat{\Pi}_B^\delta(C) > \widehat{\Pi}_B^\delta(A)$ for sufficiently small γ.

Case 2: $\gamma > \overline{\gamma}^P$. Since $\widehat{\Pi}_B^\delta(C) > \widehat{\Pi}_B^\delta(P)$ by Proposition 5, only $S = C$ or $S = A$ can be optimal. Since $\overline{\gamma}^A = \overline{\gamma}^C = 1/4 < \overline{\gamma}^P$, $y^A = y^C = 0$. For $S \in \{A, C\}$, it follows from Subsections 4.2 and 4.3 that

$$\widehat{\Pi}_B^\delta(S) \quad = \quad \Big(\mathbf{E}_X[q_I^{S,0}(X)(R - J(X_I)) + q_E^{S,0}(X)(R - J(X_E))] + \delta(R_I^S(0) - R_E^S(0))\Big)\frac{1}{1-\delta}.$$

Since $(1-\delta)\widehat{\Pi}_B^\delta(S)$ is linear in δ, it suffices to consider $(1-\delta)\widehat{\Pi}_B^\delta(S)$ for $\delta = 0$ and $\delta = 1$. Since future rent extraction does not matter for $\delta = 0$, it follows from Proposition 3 that $\widehat{\Pi}_B^\delta(C) > \widehat{\Pi}_B^\delta(A)$. Thus, consider that $\delta = 1$. We then have for $\alpha = 1$

$$\begin{aligned}
(1-\delta)\widehat{\Pi}_B^\delta(S) &= R - \mathbf{E}_X[q_I^{S,0}(X)X_I + q_E^{S,0}(X)3X_E)] \\
&= \begin{cases} R - 4\int_0^1\int_{x_I}^1 x_I \mathrm{d}x_E \mathrm{d}x_I & \text{if } S = C \\ R - 3\int_0^{1/2} x_E \mathrm{d}x_E - \int_{1/2}^1\int_0^1 x_I \mathrm{d}x_I \mathrm{d}x_E & \text{if } S = A \end{cases} \\
&= \begin{cases} R - 16/24 & \text{if } S = C \\ R - 15/24 & \text{if } S = A \end{cases}
\end{aligned}$$

Hence, $\widehat{\Pi}_B^\delta(C) < \widehat{\Pi}_B^\delta(A)$. It follows that there exists a threshold $\delta' \in (0,1)$ such that $S = C$ is optimal if $\delta < \delta'$ and $S = A$ is optimal if $\delta > \delta'$.

Case 3: $\gamma \in (\overline{\gamma}^A, \overline{\gamma}^P]$. Since $\widehat{\Pi}_B^\delta(P) > \widehat{\Pi}_B^\delta(C)$ by Proposition 5, only $S = P$ or $S = A$ can be optimal. The supposition implies $y^P = 1$ and $y^A = 0$. As in the previous case, we need only to consider $(1-\delta)\widehat{\Pi}_B^\delta(S)$ for $\delta = 0$ and $\delta = 1$. For $\delta = 0$, we know from the previous case that $S = C$ outperforms $S = A$. Hence, $\widehat{\Pi}_B^\delta(P) > \widehat{\Pi}_B^\delta(A)$ for $\delta = 0$. Thus, consider that $\delta = 1$. As shown in the previous case, $(1-\delta)\widehat{\Pi}_B^\delta(A) = R - 15/24$. Since $(1-\delta)\widehat{\Pi}_B^\delta(P) = R + 1$, we also obtain that $\widehat{\Pi}_B^\delta(P) > \widehat{\Pi}_B^\delta(A)$ for $\delta = 1$. It follows that $\widehat{\Pi}_B^\delta(P) > \widehat{\Pi}_B^\delta(A)$ for any $\delta \in (0,1)$. q.e.d.

Proof to Proposition 7.

(a) Let $\delta = 0$. By (7), $V_I^S - V_E^S = 0$. We get

$$\widehat{\Pi}_B^{sc}(S) = \mathbf{E}_X[q_I^{S,y_{sc}}(X)(R + y_{sc} - J(X_I)) + q_E^{S,y_{sc}}(X)(R - J(X_E))].$$

Since this expression is by Proposition 1 maximized by $S = C$ but not by $S = P$, $\widehat{\Pi}_B^{sc}(C) > \widehat{\Pi}_B^{sc}(P)$.

(b) Since $\widehat{\Pi}_B^{sc}(S)$ is continuous in δ, it suffices to prove the inequalities for $\delta \to 1$. The expected profit that the buyer obtains in each procurement cycle converges then to

$$\mathbf{E}_X[q_I^{S,y_{sc}}(X)(R + y_{sc} - X_I) + q_E^{S,y_{sc}}(X)(R - X_E)] - 2R_E^S(y_{sc}). \tag{A.16}$$

Consider first the case in which y_{sc} is close to zero. The expected value term is then, by the construction of the cultures and by $y_{sc} < \overline{y}^C$, strictly higher in culture $S = C$. By the continuity of $R_E^S(y_{sc})$, it suffices to show that $R_E^P(0) > R_E^C(0)$. Since the incumbent and the entrant are symmetric in culture $S = C$ when there is no investment, $R_I^C(0) = R_E^C(0)$. Thus, it follows from (A.8) that $R_E^C(0) = 1/(2+\alpha) \cdot \alpha/(1+\alpha)$. By (A.12), $R_E^P(0) = (1 - (1/(1+\alpha))^{1/\alpha}) \cdot \alpha/(1+\alpha)$. By rearranging, we obtain that $R_E^P(0) > R_E^C(0)$ is equivalent to $(1+\alpha)^{1+\alpha} > (2+\alpha)^\alpha$. Since this is what we have already shown in Proposition 4 (c), we can conclude that the competitive culture is superior.

Consider now $y_{sc} \in [\max\{\overline{y}^P, 1\}, \overline{y}^C)$. Since $1+\alpha > \max\{\alpha, 1\}$, the set $[\max\{\overline{y}^P, 1\}, \overline{y}^C)$ is non-empty. By Proposition 1 (b), $q_I^{P,y_{sc}}(x) = 1$ for all x. This implies $R_E^P(y_{sc}) = 0$. Thus, (A.16) becomes for $S = P$

$$R + y_{sc} - \mathbf{E}_X[X_I]. \tag{A.17}$$

On the other hand, (A.16) is for $S = C$

$$\begin{aligned} & \mathbf{E}_X[q_I^{C,y_{sc}}(X)(R + y_{sc} - X_I) + q_E^{C,y_{sc}}(X)(R - X_E)] - 2R_E^C(y_{sc}) \\ = \;& R + y_{sc} - \mathbf{E}_X[X_I] + \mathbf{E}_X[q_E^{C,y_{sc}}(X)(-y_{sc} + X_I - (1+2\alpha)X_E)]. \end{aligned} \tag{A.18}$$

Since $y_{sc} \geq 1$ and $y_{sc} < \overline{y}^C$ by our supposition, the second expected value expression is strictly negative. This implies that (A.17) exceeds (A.18). That is, the protective culture is superior. q.e.d.

Proof to Proposition 8.
If $\delta = 0$, $\widehat{\Pi}_B^{ex}(S) = \widehat{\Pi}_B^{\mathbf{0}}(S)$. The result follows directly from Proposition 3.

Thus, consider $\delta \to 1$. The reasoning in the text shows that the expected profit that the buyer obtains in each procurement cycle is $\widehat{\Pi}_B^{\mathbf{0}}(S) + \delta(-\gamma y^S + R_I^S(y^S) + R_E^S(y^S))$ and that it converges to

$$-\gamma y^S + \mathbf{E}_X[q_I^{S,y^S}(X)(R + y^S - X_I)) + q_E^{S,y^S}(X)(R - X_E)] \tag{A.19}$$

as $\delta \to 1$.

By Proposition 2, $\lim_{\gamma\to 0} y^C = \overline{y}^C$ and $\lim_{\gamma \to 0} y^P = \overline{y}^P$. By Proposition 1, $\lim_{\gamma\to 0} q_I^{S,y^S}(x) = 1$ for all x and for both cultures. Thus, (A.19) is larger for $S = C$ than for $S = P$ when γ is sufficiently close to zero. That is, the competitive culture is superior.

Consider now $\gamma > \overline{\gamma}^P$. By Proposition 2, $y^C = y^P = 0$. (A.19) becomes $\mathbf{E}_X[q_I^{S,y^S}(X)(R - X_I) + q_E^{S,y^S}(X)(R - X_E)]$. By Proposition 1, the allocation in culture $S = C$ minimizes just this expression whereas the allocation in culture $S = P$ does not. The competitive culture is again superior.

Finally, consider $\gamma \in [\overline{\gamma}^C, \overline{\gamma}^P]$. By Proposition 2, $y^P = \alpha$ and $y^C = 0$. Since there is no investment in culture $S = C$, (A.19) is strictly smaller than R in this culture. It suffices to show that (A.19) exceeds R for $S = P$. Since $\lim_{\gamma\to 0} q_I^{P,y^P}(x) = 1$ for all x by Proposition 1 (b), (A.19) becomes $R + (1-\gamma)\alpha - \mathbf{E}_X[X_I]$. Moreover, we have

$$R + (1-\gamma)\alpha + \mathbf{E}_X[X_I] \geq R + (1 - \overline{\gamma}^P)\alpha - \frac{1}{1+\alpha} = R + (\alpha - 1) + \left(\frac{1}{1+\alpha}\right)^{2+1/\alpha} \alpha. \tag{A.20}$$

The inequality follows from $\gamma \leq \overline{\gamma}^P$ and from computing the expected value. The equality follows from using the definition of $\overline{\gamma}^P$ and from simplifying. As the expression on the right-hand side of (A.20) exceeds R for any $\alpha \geq 1$, the protective culture is superior. q.e.d.

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