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Abstract

A buyer wants to purchase an innovative good from a seller. Both parties are risk-neutral, and payments from the buyer to the seller must be non-negative. After the contract is signed, the seller privately observes a signal, which may be informative about the seller's costs. We compare two contracting regimes. In the case of specific performance, the courts enforce the trade level specified in the contract. In the case of at-will contracting, the seller is free to walk away from the contract after the signal has been realized. While the buyer prefers specific performance and the seller prefers at-will contracting, the optimal regime from an economic efficiency point-of-view depends on the informativeness of the signal.

Keywords: Contract theory; specific performance; at-will contracts; asymmetric information; ex-post inefficiencies

JEL Classification: D86; H57; K12; D82; D23; L14

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1 Introduction

Consider a buyer who wants to procure an innovative good or service from a seller. At the time the contract is written, due to the innovative nature of the good, the seller's costs of providing the good are still uncertain. After the contract has been signed, the seller privately observes a signal that might reveal the costs to the seller, but there is also a positive probability that the seller does not gain an informational advantage over the buyer. In this simple buyer-seller scenario, we compare two different contracting regimes. In the case of "specific performance," the courts will enforce the trade level that the parties have contractually specified. In the case of "at-will contracting," the seller is free to walk away from the contract after the seller has observed the cost signal. Hence, in the first case the delivery will be mandated, while in the second case the seller holds the right not to deliver.[1] Which of the two contracting regimes is to be preferred from an economic efficiency point-of-view?

For example, suppose the government wants to purchase novel military hardware. At the time the contract is written, it is still unknown how profitable it will be for the contractor to produce a new weapon system with specific capabilities required by the government. After the contract has been signed, the contractor may have to make some relationship-specific investments to develop the new weapon system. Suppose that any such investments are contractible, so the investment costs can be reimbursed by the government.[2] Yet, while developing the

[1] Our usage of the terms "specific performance contracts" (where courts can enforce contractually specified levels of trade) and "at-will contracts" (where trade must be ex-post voluntary) follows Aghion et al. (1994, p. 258). See Bolton and Dewatripont (2005, chapter 12) for a review of the literature on these two contracting regimes in symmetric-information setups.

[2] In its "Guidance on Using Incentive and Other Contract Types" issued in March 2016, the U.S. Department of Defense points out that in the context of major system developments characterized by low initial production rates and the necessity of R&D activities, cost-reimbursement contracts may be used, allowing contractors to receive payments for their investments even when the final product will not be delivered. In contrast, such contracts are prohibited by the

new system, the contractor may gain an informational advantage over the government. For instance, the contractor may learn that there will be positive spillovers to other business activities that will not show up in the contractor's accounting system, even though they will in effect reduce the contractor's costs. Similarly, the contractor might learn that the production process will be unusually demanding, so that more time and personal effort of the managerial staff will be required, which makes the project less profitable for the contractor due to the associated opportunity costs.

Clearly, the seller would prefer to have the right to pull out of the contract at-will when she learns that it is not as profitable as she hoped, while the buyer would prefer a specific-performance contract that guarantees delivery of the required good or service. However, the interesting question that we want to address in this paper is whether the expected gains from trade are larger in the case of specific performance or in the case of at-will contracting.

The two contracting regimes that we study play an important role in the literature on incomplete contracts and the hold-up problem. In particular, the seminal work of Hart and Moore (1988) has shown that parties may have insufficient incentives to make noncontractible relationship-specific investments when only at-will contracts can be written. In contrast, Chung (1991), Aghion et al. (1994), Nöldeke and Schmidt (1995), and subsequent papers have shown that the underinvestment problem may be solved when specific performance contracts are enforceable. Therefore, in these settings specific performance is usually the superior regime.[3]

In the literature on incomplete contracts and the hold-up problem it is usually

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Department of Defense for the acquisition of standard commercial items.

[3]See Fares (2006) for a literature survey on the hold-up problem in specific-performance and at-will contracting regimes. For example, Bös and Lülfesmann (1996), Smirnov and Wait (2004), and Herbst and Walz (2017) assume that only at-will contracting is possible, while Edlin and Reichelstein (1996), De Fraja (1999), and Chemla et al. (2007) allow for specific performance contracts. Note that in Bös and Lülfesmann (1996), where one of the parties is a welfare-maximizer, and in Lülfesmann (2001), where the parties have several trading opportunities, the hold-up problem may be solved even with at-will contracts.

assumed that the parties are symmetrically informed, so in accordance with the Coase Theorem ex-post efficiency is always achieved. The present paper is complementary to this literature. Instead of studying incentives to make noncontractible investments, we focus on ex-post frictions due to asymmetric information. Indeed, Moore (2016, p. 12) has recently argued that "Hold-up is important, but looking around the world, it seems that ex-post inefficiencies are even more important".[4] It turns out that the focus on ex-post inefficiencies can lead to markedly different conclusions. Specifically, in contrast to the usual finding of the literature on incomplete contracts, we find that the expected total surplus can be strictly larger under the at-will contracting regime.

In our setup the buyer and the seller are risk-neutral and there are no informational asymmetries at the contracting stage. Thus, if unlimited transfer payments were feasible, the buyer could always implement the first-best solution and extract the expected total surplus by making the seller a residual claimant.[5] However, in line with recent papers on procurement problems such as Martimort and Straub (2016), we impose a limited liability constraint, so payments from the buyer to the seller must be non-negative. While starting with Innes (1990) many contributions to the contract-theoretic literature have studied models with limited liability, these papers usually explore how to induce an agent to exert unobservable effort.[6] The present contribution is different from this literature,

[4]Similarly, Hart and Moore (2008, p. 2) have pointed out that in the literature on incomplete contracts "the emphasis on noncontractible ex-ante investments seems overplayed". The importance of ex-post inefficiencies has also been emphasized by Williamson (2000).

[5]This is a standard result is contract theory, see e.g. Laffont and Martimort (2002) and Bolton and Dewatripont (2005).

[6]For early papers in this literature, see also Baliga and Sjöström (1998) and Pitchford (1998). More recent contributions include e.g. Ohlendorf and Schmitz (2012), Chen and Chiu (2013), Hoppe and Schmitz (2013b, 2021), Schmitz (2013), Kragl and Schöttner (2014), Tamada and Tsai (2014), Axelson and Bond (2015), Kräkel and Schöttner (2016), Cato and Ishihara (2017), At et al. (2019), Kräkel (2021), and Müller and Schmitz (2021). This literature is focused on motivating agents to exert high effort, which is not an issue in the present paper.

because in our setup there are no hidden action problems. Instead, our results are driven by the fact that after the contract has been signed, the seller may gain an informational advantage over the buyer with regard to her costs.[7]

Specifically, suppose that it is ex-post efficient to trade when the seller learns that the costs are low, while it would be ex-post inefficient to trade when the seller learns that the costs are high. Yet, we also allow for the possibility that the seller learns nothing. Indeed, following Lewis and Sappington (1993) a branch of the contract-theoretic literature has studied asymmetric information problems in which a production decision must be taken when the agent may be ignorant about the costs.[8] To consider the most interesting case, suppose that it is ex-post efficient to trade when the seller remains uninformed.

It turns out that when the seller will gain an informational advantage over the buyer with a relatively small probability only, then at-will contracting can yield a larger expected total surplus than specific performance. Intuitively, the reason is as follows. In the case of at-will contracting, trade must be voluntary ex post. When it is quite likely that the seller will remain uninformed, the buyer does not want to forgo the opportunity to trade with an uninformed seller. Hence, the price must be so large that an informed low-cost seller would enjoy a rent. The buyer cannot extract the seller's rent, because payments must not be negative and the seller cannot be contractually forced to deliver a good when ex post the seller prefers not to do so. In contrast, in the case of specific performance the buyer can extract the seller's rent by specifying an ex-post inefficient trade level for an

[7]In practice, it has often been emphasized that cost uncertainties and informational advantages of contractors are important problems in procurement. For instance, with regard to defense procurement, see Rogerson (1995), Sadeh et al. (2000), Coughlan and Gates (2009), and Markowski et al. (2009).

[8]Lewis and Sappington (1993) emphasize that "private research or on-the-job experience can sometimes provide privileged information for the agent, but will fail to do so at other times". See e.g. Crémer et al. (1998), Kessler (1998), Iossa and Stroffolini (2005), Khalil et al. (2006), Hoppe and Schmitz (2013a), Iossa and Martimort (2015), Su (2017a),Ye and Li (2018), and Downs (2021) for related contributions in which the agent may remain uninformed.

informed high-cost seller. In contrast to negative payments, trading the good when the costs are high is an ex-post inefficient way to transfer utility from the seller to the buyer. Hence, from an economic efficiency perspective at-will contracting can be the superior regime, as it avoids this kind of ex-post inefficiency.[9]

Note that our result may help to explain why in some cases the legal framework is such that indeed only at-will contracts are enforceable. For instance, in the United States the courts will often not enforce specific performance in the context of personal service contracts.[10] The aforementioned literature on incomplete contracts could not explain the prevailing legal situation, because in this literature an at-will contracting regime could not yield a strictly larger expected total surplus than a specific performance regime.

However, when the seller will gain an informational advantage over the buyer with a relatively large probability, then also in our setting specific performance can yield a larger expected total surplus than at-will contracting. The reason is that in the case of at-will contracting, the buyer offers a contract that inefficiently excludes an uninformed seller from trading. When it is rather unlikely that the seller remains uninformed, it is more profitable for the buyer to forgo the opportunity to trade with an uninformed seller and to extract the rent from an informed low-cost seller instead. In contrast, in the case of specific performance the buyer can

[9]The inefficiency in the case of specific performance is a novel feature of our setup. While the case of at-will contracting is a straightforward application of Sappington (1983) and Lewis and Sappington (1993) to our simple procurement problem, to my knowledge the case of specific performance with limited liability and a potentially ignorant agent has not been studied in the literature so far.

[10]See e.g. Nosal (2001). Even though the present model is not specifically tailored to labour contracts, note that in employment relationships it is quite plausible that workers are not perfectly informed about their opportunity costs. In particular, Bar-Isaac and Leaver (2021) have recently pointed out that when an employer wants to retain a worker, then the employer might not reveal information about the worker to the labour market, so it is likely that both the employer and the worker remain uninformed about whether other potential employers would be willing to pay a higher wage to the worker.

offer a contract according to which only an informed low-cost seller would like to deliver the good ex post, but delivery will also be enforced when the seller remains uninformed.

Taken together, our analysis demonstrates that a welfare comparison between specific performance and at-will contracting may be less straightforward than has been suggested by the previous contract-theoretic literature. Depending on the circumstances, each of the two contracting regimes can turn out to be optimal when one takes the possibility of ex-post frictions due to asymmetric information into account.

Organization of the paper. The remainder of the paper is organized as follows. In Section 2, we introduce our model, which is the most simple procurement problem in which the trade-off between the two contracting regimes occurs. In Section 3, we analyze the case of at-will contracting, where the seller is free to walk away from the contract. In Section 4, the case of specific performance is analyzed, where contractually specified trade levels will be enforced by the courts. We compare the two contracting regimes in Section 5. Concluding remarks follow in Section 6. Throughout the paper, we focus on simple posted-price contracts. In the Appendix we show that this approach is without loss of generality, as the results do not change when we allow for general revelation mechanisms.

2 The model

Consider two risk-neutral parties, a buyer (he) and a seller (she). At some initial date 1, the buyer offers a contract to the seller about the delivery of a good or service at date 2. The reservation utilities of the parties are zero, and payments from the buyer to the seller must be non-negative.[11] Let $x \in [0, 1]$ denote the

[11] The limited liability assumption is often made in the related literature, see e.g. the recent work on public procurement by Martimort and Straub (2016), Buso and Greco (2021), and Pi (2021). Martimort and Straub (2016) point out that the limited liability assumption can alternatively be motivated by viewing the contractor as being infinitely risk-averse below zero

trade level, i.e. the quantity of the good that the seller provides to the buyer. The buyer's gross benefit from obtaining the quantity x of the good is given by bx, while the seller's cost is ψx.[12] The cost level ψ will be either ψ_L or ψ_H, where $0 \leq \psi_L < b < \psi_H$. At date 1, both parties know that the costs will be low with probability $\pi \in (0,1)$, so the expected cost level is $E[\psi] = \pi\psi_L + (1-\pi)\psi_H$.

After the contract has been signed, but before the good has to be delivered, the seller privately observes a signal $\sigma \in \{\psi_L, \psi_H, \emptyset\}$ about her costs.[13] Specifically, with probability $\lambda \in (0,1)$ the buyer learns whether the costs are low ($\sigma = \psi_L$) or high ($\sigma = \psi_H$), while otherwise the seller remains uninformed ($\sigma = \emptyset$). All elements of the model except for the realization of the signal σ are common knowledge.

The first-best benchmark solution. The ex-post efficient trade level at date 2 is

$$x^{FB}(\sigma) = \begin{cases} 1 & \text{if } \sigma = \psi_L, \text{ or if } \sigma = \emptyset \text{ and } E[\psi] \leq b, \\ 0 & \text{otherwise.} \end{cases}$$

Thus, trade should take place if the seller learns that the costs are low, while

wealth. The implications of bounded payments have also been studied in contexts different from procurement, e.g. in the field of environmental economics. In particular, see Goldlücke and Schmitz (2018) who study pollution claim settlements, though without allowing for ignorance in the sense of Lewis and Sappington (1993).

[12] Following the canonical trade models in the incomplete contracting literature (Hart and Moore, 1988) as well as in the literature on ex-post frictions due to asymmetric information (Myerson and Satterthwaite, 1983), we consider a simple linear setup. At the cost of a more involved exposition, our model could be generalized to strictly concave benefit functions and strictly convex cost functions, where the Spence-Mirrlees property holds (cf. Laffont and Martimort, 2002).

[13] Note that after the contract has been signed, the seller might have to make relationship-specific investments and Williamson's (1985) "fundamental transformation" takes place; i.e., the parties are locked in. As has been emphasized by Hart and Moore (2008), investments are not necessary for the fundamental transformation. In analogy to Hart and Moore (2008, p. 5), at the cost of additional notation it "would be easy to fit relationship-specific investments explicitly into the analysis, but we would then suppose that these investments were contractible", so the investment costs could simply be reimbursed by the buyer.

trade should not take place if the seller learns that the costs are high. If the signal observed by the seller does not contain any valuable information, then trade should take place whenever the expected costs $E[\psi]$ are smaller than the benefit b. Therefore, the expected total surplus at date 1 in the first-best benchmark solution reads

$$S^{FB} = \begin{cases} \lambda\pi(b - \psi_L) + (1-\lambda)(b - E[\psi]) & \text{if } E[\psi] \leq b, \\ \lambda\pi(b - \psi_L) & \text{otherwise.} \end{cases}$$

3 At-will contracting

Suppose first that the contracting regime is "at-will"; i.e., the seller cannot be forced to provide the good at date 2. Hence, the seller always has the option not to deliver the good, in which case she will get no payment. The best that the buyer can do at date 1 is to offer paying the price $p^{AW} = \psi_L$ or the price $p^{AW} = E[\psi]$ for delivery of the quantity $x = 1$ of the good. In the first case, the seller will provide the good if and only if $\sigma = \psi_L$. In the latter case, the seller will provide the good if and only if $\sigma \in \{\psi_L, \emptyset\}$. The buyer prefers to offer $p^{AW} = E[\psi]$ whenever

$$(1 - \lambda + \lambda\pi)(b - E[\psi]) \geq \lambda\pi(b - \psi_L) \tag{1}$$

holds. Observe that condition (1) cannot be satisfied when the benefit b is smaller than the expected costs $E[\psi]$. Yet, if $E[\psi] < b$ holds, then condition (1) is satisfied whenever the probability λ that the seller is informed is sufficiently small.

We show in the Appendix with the help of the revelation principle (cf. Myerson, 1982) that also when we allow for more general mechanisms, the buyer cannot make a larger expected profit than with the simple fixed-price contracts just described. Thus, we can state our first result.

Proposition 1 *In the case of at-will contracting, the trade level at date 2 is given by*

$$x^{AW}(\sigma) = \begin{cases} 1 & \textit{if } \sigma = \psi_L, \textit{ or if } \sigma = \emptyset \textit{ and condition (1) holds,} \\ 0 & \textit{otherwise.} \end{cases}$$

Note that after every signal the trade level is weakly lower than the first-best level; i.e., $x^{AW}(\sigma) \leq x^{FB}(\sigma)$ for all σ. In particular, consider the case $E[\psi] < b$, where in the first-best solution trade should take place when the seller remains uninformed. If the seller learns the cost realization with a sufficiently large probability λ, then condition (1) is not satisfied, so there is a downward distortion of the trade level, $x^{AW}(\emptyset) = 0 < x^{FB}(\emptyset) = 1$. Intuitively, the reason for this ex-post inefficiency is as follows. While the offer $p^{AW} = E[\psi]$ would be accepted by an uninformed seller, it would leave the information rent $E[\psi] - \psi_L$ to an informed low-cost seller. When the buyer knows that the seller will be informed about her costs with a large probability, then the buyer prefers to offer $p^{AW} = \psi_L$ only. In this way the buyer does not leave a rent to the seller, but he forgoes the opportunity to trade with an uninformed seller. The buyer is willing to do so provided that it is rather unlikely that the seller will be uninformed.

As a consequence, at date 1 the buyer's expected payoff is

$$u_B^{AW} = \begin{cases} (1 - \lambda + \lambda\pi)(b - E[\psi]) & \text{if condition (1) holds,} \\ \lambda\pi(b - \psi_L) & \text{otherwise,} \end{cases}$$

and the seller's expected payoff is

$$u_S^{AW} = \begin{cases} \lambda\pi(E[\psi] - \psi_L) & \text{if condition (1) holds,} \\ 0 & \text{otherwise.} \end{cases}$$

Note that the seller enjoys an expected information rent whenever condition (1) holds. We can conclude our analysis of at-will contracting with the following result.

Proposition 2 *In the case of at-will contracting, the expected total surplus at date 1 reads*

$$S^{AW} = \begin{cases} \lambda\pi(b - \psi_L) + (1 - \lambda)(b - E[\psi]) & \textit{if condition (1) holds,} \\ \lambda\pi(b - \psi_L) & \textit{otherwise.} \end{cases}$$

4 Specific performance

Now let us consider the case of specific performance; i.e., suppose a contractually agreed-upon trade level will be enforced by the court. Recall that in the case of at-will contracting, the seller never got a rent if trade occurred only when $\sigma = \psi_L$, while an informed low-cost seller enjoyed a rent if trade occurred whenever $\sigma \in \{\psi_L, \emptyset\}$. In the case of specific performance, the buyer cannot be worse off, because he could simply offer the same contract as in the case of at-will contracting. Yet, under some circumstances the buyer can now make a strictly larger profit. Specifically, if trade takes place when $\sigma \in \{\psi_L, \emptyset\}$, the buyer can extract the seller's rent (in an ex-post inefficient way) by also requiring a positive trade level when $\sigma = \psi_H$.

To see this, suppose that at date 1 the buyer offers an option contract $[(p_I, x_I), (p_{II}, x_{II})]$. At date 2, after having observed the realization of the signal σ, the seller can decide whether she choose the price-quantity pair (p_I, x_I) or (p_{II}, x_{II}).

Contract C1. One possibility for the buyer is to offer $[(p_I = \psi_L, x_I = 1), (p_{II} = 0, x_{II} = 0)]$, which simply replicates the offer that was optimal for the buyer under at-will contracting if condition (1) does not hold. In this case, the seller chooses alternative I if and only if she learns that her costs are low $(\sigma = \psi_L)$. The buyer's expected payoff given contract *C1* is thus given by $\lambda\pi(b - \psi_L)$.

Contract C2. Another possibility for the buyer is to offer $[(p_I, x_I = 1), (p_{II} = 0, x_{II})]$, where the price p_I and the quantity x_{II} are set such that the seller will choose alternative I if she learns $\sigma \in \{\psi_L, \emptyset\}$, and alternative II if she learns $\sigma = \psi_H$. Note that given specific performance, the price p_I may now be strictly smaller than $E[\psi]$ and the quantity x_{II} may now be strictly larger than zero. When the parties have agreed on such a contract at date 1, it will be enforced by the court at date 2, even though at date 2 an uninformed seller or an informed high-cost seller would prefer to walk away from the contract. At date 1 the seller is willing to accept the offer if the participation constraint

$$\lambda\pi(p_I - \psi_L) - \lambda(1 - \pi)x_{II}\psi_H + (1 - \lambda)(p_I - E[\psi]) \geq 0$$

holds. Moreover, an uninformed seller has an incentive to choose alternative I if the constraint

$$p_I - E[\psi] \geq -x_{II} E[\psi]$$

is satisfied. The buyer will optimize by setting the quantity x_{II} and the price p_I so that both constraints are binding; i.e., she sets $x_{II} = \hat{x}$, where

$$\hat{x} := \frac{\lambda\pi\left(E[\psi] - \psi_L\right)}{\left(1 - \lambda + \lambda\pi\right)E[\psi] + \lambda\left(1 - \pi\right)\psi_H},$$

and $p_I = (1 - \hat{x})E[\psi]$. Note that the trade level $\hat{x}$ is larger than zero, smaller than one, and increasing in the probability λ that the seller learns the realization of the costs. Given this contract, it is straightforward to check that the seller will also choose alternative I if $\sigma = \psi_L$, and she will choose alternative II if $\sigma = \psi_H$. Moreover, the seller does not get a rent and thus the buyer's expected payoff given contract *C2* can be written as

$$\lambda\pi(b - \psi_L) + (1 - \lambda)(b - E[\psi]) + \lambda(1 - \pi)(b - \psi_H)\hat{x}.$$

The buyer's expected payoff under contract *C2* is larger than his expected payoff under contract *C1* whenever the condition

$$(1 - \lambda)(b - E[\psi]) \geq \lambda(1 - \pi)(\psi_H - b)\hat{x} \tag{2}$$

holds. Observe that condition (2) cannot be satisfied when the benefit b is smaller than the expected costs $E[\psi]$. Yet, if $E[\psi] < b$ holds, then condition (2) is satisfied whenever the probability λ that the seller is informed is sufficiently small.

In the Appendix, by invoking the revelation principle we show that also when we allow for more general mechanisms, the buyer cannot do better than with the simple contracts just described. We can now state the following result.

Proposition 3 *In the case of specific performance, the trade level at date 2 is given by*

$$x^{SP}(\sigma) = \begin{cases} 1 & \text{if } \sigma = \psi_L, \text{ or if } \sigma = \emptyset \text{ and condition (2) holds,} \\ \hat{x} & \text{if } \sigma = \psi_H \text{ and condition (2) holds,} \\ 0 & \text{otherwise.} \end{cases}$$

Note that if condition (2) is satisfied, then $x^{SP}(\psi_H) > x^{FB}(\psi_H) = 0$ holds; i.e., there is an upward distortion of the trade level. Intuitively, when the probability λ that the seller will be informed is relatively small, then the buyer does not want to forgo the opportunity to trade with an uninformed seller, which means that ex post an informed low-cost seller will enjoy a rent. Since payments from the buyer to the seller must not be negative, the buyer cannot extract the seller's expected information rent with a suitable up-front payment, so he instead extracts the expected rent by insisting on an ex-post inefficient trade level in case that the seller's costs are high. If condition (2) does not hold and $E[\psi] < b$, then there again is a downward distortion of the trade level when the seller is uninformed, $x^{SP}(\emptyset) = 0 < x^{FB}(\emptyset) = 1$. Intuitively, when the probability λ that the seller will be informed is relatively large, the buyer prefers to pay ψ_L only, such that an uninformed seller will be excluded from trade.[14]

Observe that in the case of specific performance, the buyer always offers a contract such that the seller's participation constraint is binding; i.e., at date 1 the seller's expected payoff is $u_S^{SP} = 0$. Thus, compared to at-will contracting, the seller is (weakly) worse off in the case of specific performance. The buyer's expected payoff equals the expected total surplus, $u_B^{SP} = S^{SP}$, which is characterized in the following result.

Proposition 4 *In the case of specific performance, the expected total surplus at date 1 reads*

$$S^{SP} = \begin{cases} \lambda\pi(b - \psi_L) + (1-\lambda)(b - E[\psi]) - \lambda(1-\pi)(\psi_H - b)\hat{x} & \textit{if condition (2) holds,} \\ \lambda\pi(b - \psi_L) & \textit{otherwise.} \end{cases}$$

[14]Notice that the first-best solution is always attained when λ goes to one, in which case there would be only the informed low-cost type and the informed high-cost type. As a consequence, in the case of specific performance there can be ex-post inefficiencies only when there are more than two states of the world, which in our setting follows from imperfect post-contractual learning. It should be noted that Rotemberg and Saloner (1994) have also argued that economic circumstances which create a third state of the world can make it harder to provide incentives, albeit in a different setting focused on noncontractible effort.

5 Specific performance vs. at-will contracting

We can now compare the expected total surplus levels that are attained in the two different contracting regimes. First, note that there is no difference between the regimes when the probability π of low costs is so small that $E[\psi] > b$ holds. In this case, it is ex-post efficient when only an informed low-cost seller provides the good, which is what happens in both regimes, because neither condition (1) nor condition (2) can be satisfied. In the remainder of this section, let us consider the more interesting case in which the probability π of low costs is sufficiently large, so $E[\psi] < b$ holds, i.e., it is also efficient to trade when the seller is uninformed.

When the seller will gain an informational advantage with a sufficiently small probability λ only, then both conditions (1) and (2) are satisfied, so a comparison of Propositions 2 and 4 immediately shows that the expected total surplus is larger in the case of at-will contracting. Intuitively, the reason for this novel result is as follows. In the case of at-will contracting, trade always takes place except when the seller learns that the costs are high. Thus, the first-best solution will be achieved and the seller enjoys an information rent when her costs are low. The buyer cannot extract the expected rent, since payments must not be negative and trade must always be ex-post voluntary. In contrast, specific performance allows the buyer to extract the seller's expected information rent, albeit in an inefficient way. In the case of specific performance, the trade level will be positive even when the seller learns that the costs are high. This ex-post inefficiency is the reason why the expected total surplus is smaller in the case of specific performance.

Yet, there are intermediate values of λ such that condition (2) holds, while condition (1) does not hold.[15] For these values of λ, the expected total surplus is larger in the case of specific performance. The reason is as follows. Since condition

[15] To prove this formally, let $\hat{\lambda}$ denote the level of λ such that condition (1) holds with equality. It is straightforward to verify that at $\lambda = \hat{\lambda}$ the left-hand side of condition (2) is strictly larger than the right-hand side. Therefore, by continuity there must exist probabilities $\lambda > \hat{\lambda}$ such that condition (1) is violated, but condition (2) is still satisfied.

(1) is violated, in the case of at-will contracting trade takes place only if the seller learns that she has low costs, while the first-best solution would require trade also when the seller remains uninformed. In contrast, since condition (2) is satisfied, in the case of specific performance trade takes place when the seller is uninformed. Yet, the trade level is also positive when the seller learns that the costs are high. Therefore, there is an ex-post inefficiency in both regimes. In order to compare the two regimes, recall that under specific performance the expected total surplus equals the buyer's expected payoff, and when condition (2) holds the buyer prefers contract *C2* to contract *C1*. But the buyer's expected payoff given contract *C1* under specific performance equals the expected total surplus in the case of at-will contracting when condition (1) is violated. Therefore, the expected total surplus must be larger in the case of specific performance.

Finally, when the seller will be informed with a sufficiently large probability λ, then neither condition (1) nor condition (2) can hold. In this case, there is no difference between at-will contracting and specific performance. In both regimes, trade takes place only if the seller learns that the costs are low, while there is no trade when the seller is uninformed, which is ex-post inefficient.

The following proposition summarizes our main findings. Part (i) of the Proposition is illustrated in Figure 1.[16]

Proposition 5 *(i) Suppose that it is ex-post efficient to trade when the seller learns that the costs are low or when the seller remains uninformed (i.e., $b > E[\psi]$ holds). If the seller becomes informed with a sufficiently small probability λ, then at-will contracting yields a larger expected total surplus than specific performance ($S^{SP} < S^{AW} = S^{FB}$). There exist intermediate values of λ, such that specific performance yields a larger expected total surplus than at-will contracting ($S^{AW} < S^{SP} < S^{FB}$). For sufficiently large levels of λ, there is no difference between at-will contracting and specific performance ($S^{AW} = S^{SP} < S^{FB}$).*

[16] In the figure, $\psi_L = 0.1$, $\psi_H = 0.9$, $\pi = 0.6$, and $b = 0.6$. In this example, condition (1) holds if λ is smaller than 0.48, while condition (2) holds if λ is smaller than 0.84.

(ii) Suppose that it is ex-post efficient to trade only when the seller learns that the costs are low (i.e., $b < E[\psi]$ holds). In this case, there is no difference between at-will contracting and specific performance ($S^{AW} = S^{SP} = S^{FB}$).

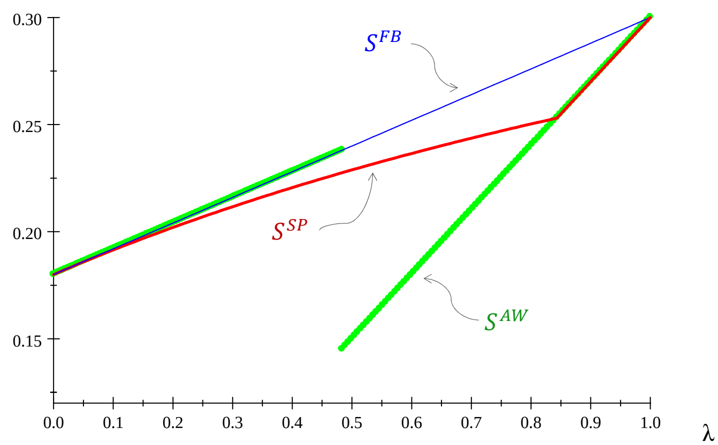

Figure 1. The expected total surplus levels in the case of at-will contracting (S^{AW}) and in the case of specific performance (S^{SP}), compared to the first-best benchmark (S^{FB}), as functions of the probability λ with which the seller will be informed.

Before we conclude, let us make a final observation with regard to the timing. Consider a situation where condition (1) is violated, but condition (2) holds, so specific performance yields a larger expected total surplus than at-will contracting. So far, we have assumed that the buyer offers the contract before the signal is realized, and the buyer can commit not to renege on the contract. Suppose now that the buyer cannot rule out making a new offer after the seller has learned the realization of σ. Would the seller still sign the contract at date 1, or would she prefer to wait until the signal has realized? Note that once the signal is realized, the buyer's optimal offer corresponds to the optimal at-will contract. Yet, when condition (1) is violated, then the seller would not get a rent under at-will contracting ($u_S^{AW} = 0$). Hence, the seller would be willing to sign the specific performance contract at date 1 already. A sophisticated buyer thus offers a contract early on, i.e. before the signal is realized.

As an illustration, in August 2020 the European Commission (the executive branch of the European Union) and AstraZeneca wrote a contract about the delivery of a large number of vaccine doses against the novel coronavirus that originated in Wuhan, China, in 2019. In January 2021, the European Commission basically argued that the parties agreed on a specific performance contract, so they expected AstraZeneca to deliver a concrete number of doses as specified in the contract. In contrast, AstraZeneca argued that the contract was rather of an at-will nature; i.e., AstraZeneca said they tried to do their best but they were not obliged by the contract to deliver a specific number of doses at a specific point in time.[17] It may well be the case that a specific performance contract would have been desirable from an efficiency point-of-view. Yet, even when it is legally possible, designing a watertight specific performance contract is not a trivial task, so a lack of competence on the side of the European Commission might be a natural explanation for why other countries such as the United States, the United Kingdom, and Israel were much more successful in purchasing vaccines than the European Union.[18]

[17]Peel and Mancini (2021) have reported in the *Financial Times* that the EU's health commissioner said that the European bloc remained "united and firm" in its belief that AstraZeneca's "contractual obligations must be met". Note that in the U.K., Prime Minister Boris Johnson's administration signed a contract with AstraZeneca in May 2020 already. As pointed out by Norman et al. (2021) in the *Wall Street Journal*, AstraZeneca has argued that its "contract with the EU only requires the company to make its best effort to supply doses", since in August 2020 AstraZeneca said that "we cannot commit contractually because we are three months behind the U.K." Hence, according to AstraZeneca the contract with the EU is at-will only, while they could have agreed on a specific performance contract if the EU had acted as swiftly as the U.K. did.

[18]See e.g. Rachman (2021), who has argued in the *Financial Times* that the European Commission "lacked the in-house expertise to meet the challenge of vaccine procurement", and that the "result has been an unseemly row with AstraZeneca over a contract that the commission insists is watertight, but that many lawyers regard as full of holes". Similarly, Pancevski and

6 Concluding remarks

In the literature on incomplete contracts and the hold-up problem, several authors such as Hart and Moore (1988) and Aghion et al. (1994) have emphasized the markedly different implications of specific performance and at-will contracting regimes. According to these symmetric-information models, the hold-up problem can often be solved in the case of specific performance, while usually there are insufficient incentives to make noncontractible relationship-specific investments when only at-will contracting is feasible.

However, in practice both contracting regimes are observed. For instance, Ulen (1984, p. 375) has pointed out that "in the civil law countries specific performance is the routine contract remedy", while Epstein (1984) emphasizes the prominent place that common law has given to the contract at will.[19] In the context of defense procurement, Bös (1996, p. 280) has argued that "the assumption of at-will contracting seems quite adequate", pointing to examples in which sellers cancelled delivery without being sued for breach of contract. Against this backdrop, it seems to be desirable to go beyond the existing incomplete contracts literature in order to study frameworks in which at-will contracting may be more efficient than specific performance.

In our simple procurement setting, when the seller can gain an informational

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Norman (2021) have emphasized in the *Wall Street Journal* that "negotiating vaccine purchases wasn't something the commission had done previously". In contrast, in the U.S., President Donald Trump's successful "Operation Warp Speed" was "led by a four-star general and a pharmaceutical executive". Like the U.K., also the U.S. managed to sign vaccine purchasing contracts three months earlier than the EU. As we have seen in the analysis of our model, a sophisticated buyer offers a contract early on. Remarkably, the President of the European Commission von der Leyen had already been criticized for her inapt handling of defense procurement when she was the German Minister of Defense, see e.g. Reuters Staff (2017).

[19] See also Shavell (2006, p. 855), who particularly emphasizes the role of specific performance in situations where the seller is judgment-proof, i.e. where negative payments are not enforceable. Yet, Shavell (2006, p. 858) also points out that contracts to perform personal services generally cannot be specifically enforced.

advantage over the buyer with a relatively small probability only, then at-will contracting may indeed be better than specific performance from an efficiency point-of-view. However, in line with the standard finding of the literature, also in our setup there are parameter constellations such that the expected total surplus can be larger when specific performance contracts are enforceable. In particular, this may be the case if the seller can gain an informational advantage over the buyer with a relatively large probability. Note that in practice the probability with which the seller can gain an informational advantage may depend on various characteristics of the procurement problem (such as the expertise of the buyer, the novelty of the good, the quality of monitoring technologies, and the reliability of the accounting system).[20]

Finally, even though authors such as Hart and Moore (2008) and Moore (2016) have argued that the emphasis on noncontractible investments might have been overplayed in the literature on incomplete contracts, investment incentives still are an important issue. The present paper has ignored incentives to invest in order to focus on ex-post inefficiencies, so it is complementary to the incomplete contracting literature that has ignored ex-post inefficiencies in order to focus on investment incentives. While adding contractible investments to the present model would be straightforward, in future research it might be worthwhile to also introduce noncontractible investments into our framework in order to study the implications of specific performance and at-will contracting in hold-up problems with asymmetric information.[21]

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[20] For instance, when the buyer is an expert and has access to an effective monitoring technology, then it might be less likely that the seller will be able to gain an informational advantage over the buyer.

[21] So far, there are only a few papers that have studied investment incentives in incomplete contracting models with asymmetric information, cf. Schmitz (2006, 2008, 2017, 2021), Goltsman (2011), Lau (2011), Goldlücke and Schmitz (2014), Vasconcelos (2014), Su (2017b), and Choi and Triantis (2021). These papers have not addressed the choice between specific performance and at-will contracting regimes.

Appendix

In the Appendix, we allow for general trading mechanisms. Invoking the revelation principle (cf. Myerson, 1982), we show that the buyer cannot attain a higher expected payoff than with the simple contracts that were discussed in the main part of the paper.[22]

A.1 At-will contracting

Suppose that at date 1 the buyer offers a direct revelation mechanism (t_L,x_L; t_H,x_H; $t_\emptyset$,$x_\emptyset$), where t_i denotes a transfer payment from the buyer to the seller and $x_i \in [0,1]$ denotes the trade level, conditional on the seller announcing $i \in \{L, H, \emptyset\}$ at date 2. The mechanism must be constructed such that it will be in the seller's self-interest to announce $i = L$ if $\sigma = \psi_L$, $i = H$ if $\sigma = \psi_H$, and $i = \emptyset$ if $\sigma = \emptyset$. Hence, the buyer's problem is to maximize his expected payoff

$$\lambda\pi(x_L b - t_L) + \lambda(1-\pi)(x_H b - t_H) + (1-\lambda)(x_\emptyset b - t_\emptyset) \tag{3}$$

subject to the relevant constraints. In particular, to ensure truthful self-selection at date 2, we have to impose the incentive compatibility constraints

$$\begin{aligned}
t_L - x_L\psi_L &\geq t_H - x_H\psi_L, && (\mathrm{IC}_{LH})\\
t_L - x_L\psi_L &\geq t_\emptyset - x_\emptyset\psi_L, && (\mathrm{IC}_{L\emptyset})\\
t_H - x_H\psi_H &\geq t_L - x_L\psi_H, && (\mathrm{IC}_{HL})\\
t_H - x_H\psi_H &\geq t_\emptyset - x_\emptyset\psi_H, && (\mathrm{IC}_{H\emptyset})\\
t_\emptyset - x_\emptyset E[\psi] &\geq t_L - x_L E[\psi], && (\mathrm{IC}_{\emptyset L})\\
t_\emptyset - x_\emptyset E[\psi] &\geq t_H - x_H E[\psi]. && (\mathrm{IC}_{\emptyset H})
\end{aligned}$$

For example, the constraint (IC_{LH}) ensures that a seller who has observed the signal $\sigma = \psi_L$ does not claim to have observed the signal $\sigma = \psi_H$. The other incentive compatibility constraints have analogous interpretations. Moreover, at

[22] We thus follow the Bayesian mechanism design approach; see Fudenberg and Tirole (1991, chapter 7), Laffont and Martimort (2002), and Bolton and Dewatripont (2005) for textbook expositions.

date 1 the seller is willing to agree to the buyer's offer whenever the participation constraint

$$\lambda\pi(t_L - x_L\psi_L) + \lambda(1-\pi)(t_H - x_H\psi_H) + (1-\lambda)(t_\emptyset - x_\emptyset E[\psi]) \geq 0 \qquad \text{(PC)}$$

is satisfied. Furthermore, the limited liability constraints $t_L \geq 0$, $t_H \geq 0$, $t_\emptyset \geq 0$ must be satisfied. Finally, in the case of at-will contracting trade at date 2 must be voluntary. Therefore, the constraints

$$\begin{aligned} t_L - x_L\psi_L &\geq 0, && (\text{AW}_L) \\ t_H - x_H\psi_H &\geq 0, && (\text{AW}_H) \\ t_\emptyset - x_\emptyset E[\psi] &\geq 0 && (\text{AW}_\emptyset) \end{aligned}$$

must be satisfied in order to ensure that for each possible realization of the signal σ the seller will prefer fulfilling the contract to walking away from the contract.

Note that (PC) and the limited liability constraints are redundant, because they are implied by (AW_L), (AW_H), and ($\text{AW}_\emptyset$). Moreover, (AW_L) is redundant, because it is implied by (IC_{LH}), $\psi_L < \psi_H$, and (AW_H). Similarly, ($\text{AW}_\emptyset$) is redundant due to ($\text{IC}_{\emptyset H}$), $E[\psi] < \psi_H$, and (AW_H).[23]

We now consider the relaxed problem of maximizing (3) subject to ($\text{IC}_{L\emptyset}$), ($\text{IC}_{\emptyset H}$), and (AW_H). It will be easy to check that the solution to this relaxed problem satisfies the omitted incentive compatibility constraints, so it is also the solution to the original problem. Note that ($\text{IC}_{L\emptyset}$) must be binding in the solution to the relaxed problem, because otherwise one could increase (3) by reducing t_L without violating any of the remaining constraints. Similarly, ($\text{IC}_{\emptyset H}$) must be binding, because otherwise $t_\emptyset$ could be reduced, and (AW_H) must be binding, because otherwise t_H could be reduced. As a consequence, $t_H = x_H\psi_H$, $t_\emptyset = x_H\psi_H + (x_\emptyset - x_H)E[\psi]$, and $t_L = x_H\psi_H + (x_\emptyset - x_H)E[\psi] + (x_L - x_\emptyset)\psi_L$ must hold. Plugging the transfer payments into (3) shows that the relaxed problem

[23] Observe also that the incentive compatibility constraints imply that the monotonicity constraint $x_H \leq x_\emptyset \leq x_L$ must hold.

boils down to maximizing

$$\lambda\pi\left(b-\psi_{L}\right)x_{L}+\left(\lambda\left(1-\pi\right)\left(b-\psi_{H}\right)+\left(1-\lambda+\pi\lambda\right)\left(E[\psi]-\psi_{H}\right)\right)x_{H}$$
$$+\left((1-\lambda+\lambda\pi)(b-E[\psi])-\lambda\pi(b-\psi_{L})\right)x_{\emptyset}.$$

The coefficient of x_L is always positive, so it is optimal to set $x_L = 1$. The coefficient of x_H is always negative, so it is optimal to set $x_H = 0$.[24] Moreover, the coefficient of $x_\emptyset$ is positive whenever condition (1) holds, so the optimal trade level is given by $x^{AW}(\sigma)$ for each σ. Note that the solution satisfies the omitted constraints. Thus, the optimal direct revelation mechanism yields the outcome characterized in Section 3. According to the revelation principle, it is therefore impossible for the buyer to do better with more complicated mechanisms.

A.2 Specific performance

Suppose again that at date 1 the buyer offers a direct revelation mechanism (t_L,x_L; t_H,x_H; $t_\emptyset$,$x_\emptyset$) in order to maximize his expected payoff (3). Since now it is possible to enforce contractually specified trade levels at date 2, we no longer impose the constraints (AW_L), (AW_H), and ($\mathrm{AW}_\emptyset$). However, the incentive compatibility constraints, the participation constraint, and the limited liability constraints still have to be satisfied.

First observe that (PC) must now be binding. In order to see this, consider a contract (t_L,x_L; t_H,x_H; $t_\emptyset$,$x_\emptyset$) that solves the buyer's optimization problem. If for this contract the constraint (PC) were not binding, then there would exist a sufficiently small $\varepsilon > 0$ such that the modified contract ($\hat{t}_L$,$\hat{x}_L$; $\hat{t}_H$,$\hat{x}_H$; $\hat{t}_\emptyset$,$\hat{x}_\emptyset$) with $\hat{x}_i = (1-\varepsilon)x_i + \varepsilon$ and $\hat{t}_i = (1-\varepsilon)t_i$ for $i \in \{L, H, \emptyset\}$ also satisfies (PC). The modified contract would also satisfy all incentive compatibility and limited liability

[24] As a consequence, the solution of the maximization problem always satisfies the monotonicity constraint $x_H \leq x_\emptyset \leq x_L$. It should be noted that if the model were adapted to strictly concave benefit functions, then we could make suitable hazard rate assumptions in order to ensure that the monotonicity constraint is not binding (cf. Laffont and Martimort, 2002, chapter 3.1). While the analysis becomes somewhat more tedious, the main economic insights of the paper carry over to this case.

constraints, and it would yield a larger expected payoff for the buyer. Hence, the participation constraint must be binding, so the buyer's expected payoff equals the expected total surplus

$$\lambda\pi(b-\psi_L)x_L+\lambda(1-\pi)(b-\psi_H)x_H+(1-\lambda)(b-E[\psi])x_\emptyset. \tag{4}$$

We now consider a relaxed problem, where we omit some of the constraints. It will be straightforward to check that the solution to this relaxed problem satisfies the omitted constraints, so it is also the solution to the original problem. The relaxed problem is to maximize the buyer's expected payoff subject to the binding participation constraint, ($\text{IC}_{L\emptyset}$), ($\text{IC}_{\emptyset H}$), and $t_H \geq 0$. The binding participation constraint can be written as

$$t_H = x_H\psi_H - \frac{\lambda\pi}{\lambda(1-\pi)}\left(t_L - x_L\psi_L\right) - \frac{1-\lambda}{\lambda(1-\pi)}\left(t_\emptyset - x_\emptyset E[\psi]\right).$$

Note that if ($\text{IC}_{L\emptyset}$) or ($\text{IC}_{\emptyset H}$) were not binding, we could relax the remaining constraints by decreasing t_L or $t_\emptyset$. Thus, $t_\emptyset = t_H + (x_\emptyset - x_H)E[\psi]$ and $t_L = t_H + (x_\emptyset - x_H)E[\psi] + (x_L - x_\emptyset)\psi_L$. Straightforward calculations show that then the constraint $t_H \geq 0$ can be rewritten as

$$\left(\lambda(1-\pi)\psi_H + (1-\lambda+\pi\lambda)E[\psi]\right)x_H - \lambda\pi\left(E[\psi]-\psi_L\right)x_\emptyset \geq 0.$$

Therefore, if $E[\psi] > b$, such that $x^{FB}(\emptyset) = 0$, then the buyer implements the first-best solution by setting $x_H = x_\emptyset = 0$, $x_L = 1$, $t_H = t_\emptyset = 0$, $t_L = \psi_L$. If $E[\psi] < b$, then the first-best solution (which requires $x^{FB}(\emptyset) = 1$ and $x^{FB}(\psi_H) = 0$) will not be attained, because $-\lambda\pi\left(E[\psi]-\psi_L\right) < 0$. The binding constraint $t_H = 0$ then implies[25]

$$x_H = \frac{\lambda\pi\left(E[\psi]-\psi_L\right)}{(1-\lambda+\lambda\pi)E[\psi]+\lambda(1-\pi)\psi_H}x_\emptyset = \hat{x}x_\emptyset.$$

Plugging this expression into (4) shows that the buyer's expected payoff can be written as

$$\lambda\pi(b-\psi_L)x_L + \left[(1-\lambda)(b-E[\psi]) - \lambda(1-\pi)(\psi_H-b)\hat{x}\right]x_\emptyset.$$

[25] Observe that $\hat{x} \in (0,1)$, so this constraint ensures that $x_H \leq x_\emptyset$ holds and thus the solution will satisfy the monotonicity constraint.

As a consequence, in the case $E[\psi] < b$ the solution to the buyer's problem is $x_H = \hat{x}$, $x_L = x_\emptyset = 1$, $t_H = 0$, $t_L = t_\emptyset = (1-\hat{x})E[\psi]$ if condition (2) holds, and it is $x_H = x_\emptyset = 0$, $x_L = 1$, $t_H = t_\emptyset = 0$, $t_L = \psi_L$ otherwise. Observe that the solution satisfies the omitted constraints. Hence, the optimal direct revelation mechanism yields the outcome characterized in Section 4. By the revelation principle, it is thus impossible for the buyer to do better with more complicated mechanisms.

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