

# Strategic Mis-Selling and Pre-Contractual Cognition\*

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## Abstract

This paper examines the asymmetric awareness between a seller and a buyer, where the latter can invest cognitive resources before contracting. In the one-shot interaction, it is impossible for the seller to always tell the truth. If the extent of mis-selling is low, the seller always announces that nothing of the product will go wrong. Otherwise, the seller randomizes between truth-telling and mis-selling if something of the product is wrong. The transaction cost of pre-contractual cognition increases with the extent of mis-selling as the extent of mis-selling is small and decreases thereafter. Finally, reputation with a “tip” mechanism or competition between sellers may yield a separating equilibrium where the transaction cost vanishes.

*Keywords:* Mis-selling, cognition, unforeseen contingencies, asymmetric information

*JEL Classification:* D82, D83, D86, L14, L15

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# 1 Introduction

Selling inappropriate products (goods or services) which do not deliver the proper utility levels for consumers - in other words, mis-selling products - is of practical importance in many industries. The problem is especially serious in modern-day industries where consumers are unaware and therefore do not perceive all the payoff-relevant features of the products, unless they incur sufficient cognitive costs before the purchasing decision.

As a result of information disadvantages, consumers may be unaware of some low-quality aspects of products, say, harmful radiation from computer monitors or cell-phones, added chemicals in foods, and side effects of medicines. Consumers may also be adversely surprised by the add-on costs of cartridges after buying a printer, or of using the telephone in a hotel. Moreover, the contractual implications of some services are extremely complex. The Office of Communications in the United Kingdom found mis-selling in telecom services to be a growing problem.<sup>1</sup> Similarly, consumers in financial services are increasingly exposed to the mis-selling of complex financial products, such as endowment mortgages, private pensions, investment funds and insurance products. The Financial Services Authority noted as early as 2000 that one in eight consumers in the United Kingdom who had bought a financial product in the past five years later regretted her choice.<sup>2</sup> More recently, thousands of people in Hong Kong, Singapore and Taiwan took to the streets to protest and demand a refund of the money they lost from the financial products backed by failed Lehman Brothers in the financial crisis.<sup>3</sup>

Economists have noted the importance of the mis-selling problem, but typically emphasize only one particular downside of mis-selling, namely that the consumers are hurt at the post-contractual stage.<sup>4</sup> However, the overall significance of the mis-selling problem is largely underestimated when one only looks at consumer complaints, these being just the “tip of the iceberg”.

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<sup>1</sup>See *Protecting citizen-consumers from mis-selling of fixed-line telecoms services*, Office of Communications, UK, 22 November 2004.

<sup>2</sup>See *Informed decisions? How consumers use Key Features: a synthesis of research on the use of product information at the point of sale*, Financial Services Authority, November 2000.

<sup>3</sup>See the article “Troubled Securities in Asia” in *The Economist*, November 20th 2008.

<sup>4</sup>For example, Inderst and Ottaviani (2008) study the mis-selling problem in the principal-agent framework. Furthermore, their paper focuses on the intra-organizational incentives for an employee not to mis-sell, while our paper sheds light on the direct interaction between a buyer and a seller in the market.

In fact, sometimes mis-selling per se does not reduce social surplus. It hurts the consumer, yet benefits the seller. In these cases, mis-selling is purely a problem of redistribution. In this paper, we shed light on a different and probably more important problem of mis-selling: the transaction cost of pre-contractual cognition by consumers, which is the “submerged part of the iceberg”.

Hayek (1945) argues that not only does the price mechanism help to utilize knowledge dispersed among individuals, but it also promotes the efficient division of knowledge. When consumers have unforeseen contingencies, however, the price mechanism may fail. If the regulator also lacks the corresponding knowledge and therefore cannot promote the awareness of consumers, mis-selling prevents the division and sharing of knowledge among individuals. Although consumers may be unaware, they are aware that they may be unaware of something. The possibility of mis-selling induces too much cognitive resources being spent on pre-contractual thinking by the consumers in order to avoid their being potentially hurt. To return to the examples mentioned above, in order to avoid being exploited, consumers have to read many books, surf the Internet, or discuss with people specialized in computer technology, food safety, telecommunications, or finance, which results in socially wasteful duplication of cognitive efforts.

In this paper, we address this issue through a model along the lines of Tirole (2009). We study the interaction between a seller (he) and a buyer (she) who is aware of the possibility that the status quo product may not be appropriate, meaning that at the post-contractual stage she may not be satisfied with it. However, the buyer can think about the appropriateness of the product before contracting.

We deviate from Tirole (2009) in two main aspects.<sup>5</sup>

First, we assume that the seller knows whether the status quo product is appropriate for the buyer or some novel product, which is unforeseen by the buyer, is appropriate, whereas in Tirole’s model both parties are uninformed *ex ante*. The assumption that the seller is better informed is natural in the

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<sup>5</sup>Besides these two differences, we assume that the buyer has the full bargaining power for analytic simplicity. Moreover, we abstract away from the adjustment cost in Tirole’s model of renegotiation by assuming that mis-selling does not directly reduce social surplus. The role of a positive adjustment cost in his model is to produce the interesting result of the buyer’s insufficient cognition as a free riding problem. However, since the seller is informed about the product-appropriateness in our mis-selling problems, the pre-contractual cognition of the buyer is purely rent-seeking and therefore wasteful.

mis-selling context because of the seller's specialization in the industry. Given his knowledge, the seller can strategically announce the appropriateness of the product to the buyer. If the status quo product is not appropriate, the seller either mis-sells it or offers an alternative (novel) product that opens the buyer's eyes. After introducing asymmetric awareness between the seller and the buyer, in this paper, we focus on the problem of strategic mis-selling.

Second, in Tirole's model, the seller is uninformed *ex ante*, so selling inappropriate products is not the seller's deliberate action, and there is no need to examine instruments that deter him from doing so. In contrast, in our model, we allow a transfer of money from the seller to the buyer in the case of mis-selling. This can be the result of a litigation process. Since it is commonly known that the seller knows the product-appropriateness, the transfer is to deter the seller's intent of mis-selling.

In our model, three key parameters determine the equilibrium. The first parameter is the *a priori* probability that the status quo product is not appropriate, which may lead to mis-selling. We call this the *extent* of the mis-selling problem. The second parameter is the loss of the buyer when the seller successfully mis-sells. We call this the *effect* of the mis-selling problem. The last parameter is the transfer of money from the seller whose mis-selling behavior is found out by the buyer.

We show that there is no *separating* equilibrium in which the seller always truthfully reports the appropriate product. In the case where the status quo product is inappropriate, if the seller does not mis-sell, that is, the seller reveals the novel product, the buyer has no incentive to question the purchasing decision. However, it jeopardizes the seller's incentive to report truthfully, as mis-selling can never be found out before contracting.

When the extent of mis-selling is low in the economy as in many developed countries, there is a *pooling* equilibrium where the seller always announces that the status quo product is appropriate, even though it may not be appropriate. The buyer has a low incentive to question the purchasing decision, thus the seller prefers to mis-sell as the probability of being punished without getting any rent is low. Therefore, developed countries produce "simple men".

When the extent of mis-selling is high as in some less-developed countries, we have no pure-strategy equilibrium. If the seller mis-sells with certainty whenever it is possible, the buyer has to stay on her toes so as to avoid the mis-selling. The seller then has no incentive to mis-sell, since the probability of being caught is high. Conversely, the argument for no separating equilib-

rium applies. Thus, given that the status quo product is inappropriate, only when the seller randomizes between truth-telling and mis-selling appropriately, can the buyer choose a corresponding cognition level such that seller is indeed indifferent between truth-telling and mis-selling, which generates a *semi-separating* equilibrium. This is in contrast to Tirole (2009) where the seller would strictly prefer to mis-sell. Further, it is worth noting that, in these countries, as the equilibrium cognition level is high, consumers are relatively know-it-all.

We define the transaction cost as the expected cognition cost of the buyer. We show that in the pooling equilibrium, the transaction cost is increasing in the extent of the mis-selling problem. In a semi-separating equilibrium, however, we have the *opposite* result: the greater the extent of the mis-selling, the smaller the transaction cost, because a greater extent of mis-selling induces a much higher probability of awareness-inducing information disclosure by the seller. Hence, the transaction cost is increasing in the extent of the mis-selling problem as long as the extent of the mis-selling is small as in many developed countries, and is decreasing thereafter, as in some less-developed countries.

Note that only in a separating equilibrium does the transaction cost vanish, because, in this case, there is no mis-selling and the buyer therefore does not think. However, the separating equilibrium does not exist. Thus, our ideal society where worthy trust is everywhere and there is no wasteful cognition is an impossible world in the one-shot interaction setting. As “the economic institutions of capitalism have the main purpose and effect of economizing on transaction costs”, (Williamson, 1985, p. 17) we then study whether the particular transaction cost of pre-contractual cognition can be saved by some properly designed market institutions.

First, we show that reputation may induce a separating equilibrium in each period, which shatters the mis-selling behavior of the seller, if both buyer and seller are sufficiently patient and the probability of detecting past cheating behavior is sufficiently high. In the separating equilibrium, the buyer rewards the seller’s truthful report of the novel product by paying a higher price, or a “tip”. However, whenever mis-selling occurs in some period in the separating equilibrium, the economy cannot go back to the outcome where no pre-contractual cognition of the buyer is exerted no matter how long the policy of anti-mis-selling campaigns has been exercised. But the out-of-equilibrium amnesty, which destroys the evidence of this mis-selling spot, can let the economy return immediately to the outcome where the

transaction cost vanishes. Thus, the “big-bang” approach of reform is more effective than the gradualist strategy in the context of mis-selling problems. Lastly, if it is impossible for the seller to know the product-appropriateness in some period, we cannot save the pre-contractual cognition completely. Nonetheless, a smaller probability of unawareness of the seller reduces the transaction cost, which reflects the value of the seller’s specialization.

Second, in the one-shot interaction setting, if two sellers compete for the buyer simultaneously, there is always a pure-strategy equilibrium where both sellers truthfully report the appropriate product. In contrast to Tirole (2009), in the context of asymmetric information, competition between sellers plays a role of reducing transaction costs, as two sellers may simultaneously reveal the novel product to the buyer. Hence, reputation or competition may induce a separating equilibrium and minimize the transaction cost.

The remainder of the paper is organized as follows: Section 2 reviews the related literature. Section 3 presents the basic model. Sections 4 and 5 discuss the role of reputation and competition, respectively. We conclude in section 6.

## 2 Related literature

### 2.1 Economics of Information

This paper considers a novel contracting problem with asymmetric information.<sup>6</sup> First, at the contracting stage, the uninformed party, namely the buyer, proposes the price (in each bargaining period, and uses delay as a screening device as in Appendix A.2). This problem belongs to the standard screening problem, which was first formally developed by Mirrlees (1971). Second, our model is close to the price-quality-signaling literature especially by Bester and Ritzberger (2001), which endogenizes the buyer’s information on the product quality by the information acquisition approach introduced by Hirshleifer (1971), and Crémer, Khalil and Rochet (1998a, b). The pre-contractual cognition in our model is a special kind of information acquisition in the unawareness context. However, the buyer has the full bargaining power in our model. Thus, we abstract from the signaling problem, yet focus on the cognition-saving mechanisms. Furthermore, in our model, the seller

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<sup>6</sup>Cf. Bolton and Dewatripont (2005) and Laffont and Martimort (2002) for a detailed account of this extensive literature on economics of asymmetric information.

*may* be able to announce some awareness-inducing information that opens the buyer's eyes, which is absent in the standard literature of asymmetric information.

## 2.2 Incomplete Contracts

We have several rationales for incomplete contracts so far: non-verifiability (Williamson (1985), Grossman and Hart (1986), Hart and Moore (1990), Aghion and Tirole (1997), Maskin and Tirole (1999)), signaling (Aghion and Bolton (1987), Spier (1992), Hermalin and Katz (1993)), explicit writing costs (Dye (1985), Anderlini and Felli (1999), Battigalli and Maggi (2002)), reading costs (Rasmusen (2001)), and second-best incentives: e.g., effort substitution in multi-task environments (Holmström and Milgrom (1991)) and strategic ambiguity (Bernheim and Whinston (1998)).

Recent approaches endogenize incompleteness of contracts from bounded rationality introduced by Simon (1957). Bolton and Faure-Grimaud (2009) and Tirole (2009) endogenize incomplete contracts from the parties' insufficient cognition. In contrast, when one party is fully rational and the other party is boundedly rational, contractual incompleteness can be the result of strategic shrouding by the rational party. (Filiz-Ozbay (2007), Gabaix and Laibson (2006), von Thadden and Zhao (2009)) In our paper, the incomplete contract, which leads to mis-selling, stems from both the buyer's inadequate cognition and the seller's strategic shrouding.

## 2.3 Unawareness and Contract Design

In cognitive psychology, Kahneman and Tversky (1973, 1974) argue that people use an availability heuristic to judge probabilities. In economics, the corresponding notion is unawareness.

Fagin and Halpern (1988) and Modica and Rustichini (1994) first discuss unawareness formally. Later, Heifetz, Meier and Schipper (2006), Li (2009), and Galanis (2007) model unawareness, which circumvents the impossibility result of non-trivial unawareness by Dekel, Lipman and Rustichini (1998). From then on, unawareness is possible to express. Its economic implications in contracting problems are discussed in the following papers. Gabaix and Laibson (2006) model consumers' unawareness of some add-ons (actions of one's opponents). Eliaz and Spiegler (2006) study screening consumers' awareness of future changing tastes (preferences). von Thadden and Zhao

(2009) design the incentives for agents who are possibly unaware of their own choice possibilities (one’s own actions). Filiz-Ozbay (2007) examines an insuree’s unawareness of future contingencies of calamities (actions of nature).

Considerable progress in modeling unawareness has been made by Board and Chung (2006), which makes awareness of unawareness possible of expression.<sup>7</sup> Awareness of unawareness plays an important role particularly in contracting problems. Although contracting parties are unaware, they are aware that they might be unaware of something. For example, Chung and Fortnow (2008) model the interaction between a contract writer and an interpreter. In equilibrium, the writer who is aware that she is unaware of something writes a simple contract to signal her low awareness. In addition, awareness of unawareness also plays an important role in Tirole (2009) and the present paper. A contracting party exerts cognitive efforts before contracting only if he is aware of his potential unawareness.

## 3 The Basic Model

### 3.1 The Setup

There are two risk-neutral contracting parties: a buyer ( $B$ , she) and a seller ( $S$ , he). The buyer wants to buy one unit indivisible product (good or service) from the seller. There is a *status quo* product  $A$  available from the seller.  $A$  can be interpreted as a displayed good on sale or a standard form contract for a service. If  $A$  is appropriate,  $A$  delivers utility  $v > 0$  to the buyer. If  $A$  is not appropriate, however, the buyer’s utility from  $A$  reduces to  $v - h$  with  $h > 0$ . In the latter case, we assume that there always exists a *novel* product  $A'$ , which is appropriate, (meaning it delivers utility  $v$  to the buyer,) but is unforeseen by the buyer.

If  $A$  is not appropriate, mis-selling may come in many guises. First, in a *low-cost-low-quality* interpretation, the buyer may be unaware of some utility-relevant features of the status quo product before contracting. For example, after using a computer monitor with a severe radiation problem ( $A$ ), the buyer is hurt by  $h$ , but this monitor is  $h$ -cheaper to produce than a

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<sup>7</sup>In dynamic games, Halpern and Rego (2006) and Heifetz, Meier and Schipper (2009) also discuss awareness of unawareness. Further, Chen and Zhao (2009) synthesize the existing solution concepts of contracting models with awareness of unawareness in a principal-agent framework.

LCD monitor ( $A'$ ). Second, in an *add-ons* interpretation, as in the example in Gabaix and Laibson (2006), the buyer may be unaware of the future cost of cartridge when buying a printer. If the seller sells a status quo printer with high future cartridge costs, and shrouds the attribute of cartridge to the buyer, the seller saves a cost  $h$  for the ink-saving technique. But the buyer has to pay  $h$  for the cartridge in the future. By these two interpretations, we normalize only the cost of producing the appropriate product to zero, whereas the seller's cost of producing  $A$  is  $-h$  if  $A$  is not appropriate. Finally, in a *hold-up* interpretation in the style of Tirole (2009), the unforeseen features of the product, say a design, are not costly for the seller to adjust *ex post*. That is, if  $A'$  is appropriate, the seller could convert  $A$  into  $A'$  at zero cost. At the post-contractual stage, however, the buyer is locked in, so the seller can hold her up by asking for more payment  $h$ . In other words, the seller blackmails the unaware buyer *ex post*. By this interpretation, the seller's cost of producing any product is normalized to zero.

Hence, the *effect* of the mis-selling problem is modeled by a constant  $h$ . If  $A$  is not appropriate, and the buyer consumes  $A$ , the magnitude  $h$  is not only the buyer's loss from mis-selling but also the rent for the seller who mis-sells. By mis-selling, there is a redistribution of payoff from the buyer to the seller.<sup>8</sup>

Figure 1 shows the time line, while Appendix A.1 presents the detailed game structure.

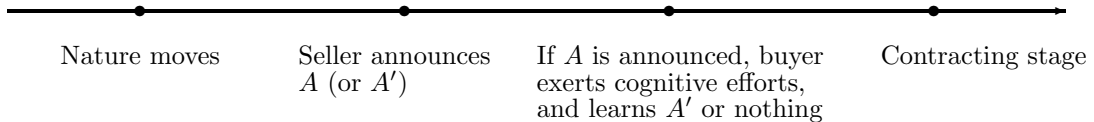


Figure 1: Timeline

The more detailed timing is as follows:

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<sup>8</sup>In general, the gain of the seller in the case of mis-selling  $h'$  may be different from the loss of the buyer  $h$ . Particularly, it is quite plausible to assume a deadweight loss of mis-selling ( $h' < h$ ). This extension is straightforward without changing the qualitative results. Our motivation of this simplification compared with Tirole (2009) is that since the seller has been already informed about the product-appropriateness, the buyer's pre-contractual cognition is purely rent-seeking. Therefore we focus only on this more important transaction cost in the mis-selling context, and rule out the possibility of insufficient cognition of the buyer as a free riding problem in Tirole (2009) which needs the assumption of a deadweight loss of hold-up.

- Stage 1: Nature moves.

Nature  $N$  chooses  $A$  to be *not* appropriate with probability  $\rho$ . In other words, with probability  $\rho$ , something of the status quo product hurts the buyer. We call  $\rho$  the *extent* of the mis-selling problem, since, with probability  $\rho$ , the status quo product is inappropriate, which leads to the potential mis-selling problem.

In contrast to Tirole (2009), we assume that the seller knows nature's move, while the buyer does not.<sup>9</sup> Facing the known product  $A$ , the buyer is aware that  $A$  might be not appropriate for her. In other words, the buyer is aware that something may go wrong with  $A$ . Here, we assume common knowledge of the game and rationality. Since the two parties have a common prior  $\rho$ , the problem is a classical one of asymmetric information between the buyer and the seller. If  $A$  is appropriate, we call the seller type- $A$ ; otherwise, we call him type- $A'$ .

- Stage 2: Seller's announcing stage.

At this stage, the seller can say something to the buyer. He may announce that the status quo product  $A$  is appropriate, or point out that  $A$  does not deliver  $v$  to the buyer and shows a novel product  $A'$ , which is appropriate.

If the seller is type- $A$ , then he can only announce that  $A$  is appropriate, since  $A$  is indeed appropriate, and the buyer cannot be harmfully surprised *ex post*. However, type- $A'$  seller contemplates two options: falsely saying that the status quo product  $A$  is appropriate (mis-selling) on the one hand and unveiling  $A'$  (truth-telling) on the other hand.

Note that we have an asymmetry of information transmission in two states of nature ( $A$  and  $A'$ ). Here, announcing  $A$  provides only *soft* information. The buyer remains uncertain of the appropriateness of  $A$  (if the seller may mis-sell in equilibrium). However, announcing  $A'$  immediately reveals the *hard* evidence that  $A$  is not appropriate, and is therefore an eye-opener for the buyer, because the seller can report  $A'$  to the buyer only if  $A$  is de facto not appropriate. Intuitively, the seller can announce something surprising only if the buyer is indeed unaware of something. For example, if the buyer is unaware of the future cartridge when buying a printer, the seller may hide

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<sup>9</sup>The seller's information advantage is common in situations where the seller is a specialized firm that has the capacity to design the product and thus gains detailed knowledge of the product-appropriateness, whereas the buyer who demands something and has no ability to produce it is therefore relatively unfamiliar with product. Nevertheless, we get back to the case where the seller may be uninformed as well in section 4.3.

the cost of cartridge or mention it to the buyer. In other words, if nothing of the status quo product goes wrong, the seller cannot prove it just by words (which are cheap). However, if something of the status quo product is really wrong, the seller can provide the awareness-inducing information to the buyer.<sup>10</sup>

Let  $q$  be the probability that type- $A'$  seller mis-sells, which is endogenous.

- Stage 3: Buyer's cognition stage.

If  $q > 0$  and the seller says  $A$  is appropriate, the buyer still does not know whether or not  $A$  is appropriate. However, the buyer can think, that is, make an effort to contemplate the situation in this case. For example, an investor can read a book of finance for “dummies”, surf the Internet to search for the relevant financial information, or discuss with friends who are familiar with finance.

Formally, the buyer chooses her *cognition* level  $b$ , which maps bijectively to the probability that the buyer learns that  $A'$  is appropriate given that  $A'$  is in fact the appropriate product. In other words, if something of the status quo product goes wrong, the buyer can find it out with probability  $b$ . However, if nothing goes wrong ( $A$  is appropriate) the buyer finds nothing after pre-contractual cognition.

The buyer bears a cognition cost, or thinking cost,  $C(b)$  that is a smooth, strictly increasing and strictly convex function with the properties  $C(0) = C'(0) = 0$  and  $C(1) = \infty$ .

- Stage 4: Contracting stage.

We assume for simplicity that the buyer has full bargaining power at the contracting stage and thus makes a take-it-or-leave-it offer to the seller. Nevertheless, Appendix A.2 shows that the pricing result is robust to a more general bargaining protocol where the buyer makes all the offers in an infinite-horizon setting. We also assume the outside options of both parties yield zero payoffs.

If the seller reveals  $A'$  to the buyer, the buyer is suddenly aware of  $A'$  and proposes a contract that consists of a price  $p$  and a full specification of the

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<sup>10</sup>The feature of asymmetry of information transmission in two states ( $A$  and  $A'$ ) here is thus different from cheap-talk games (See, e.g., Crawford and Sobel, 1982) where information is always soft and persuasion games (See, e.g., Milgrom (1981) and Milgrom and Roberts (1986)) where information is always hard.

product  $A'$ .<sup>11</sup> Facing the contract, the seller decides whether to accept it.

If the buyer is told that  $A$  is appropriate, and after the buyer has thought about it at stage 3, there are two possibilities.

(1) The buyer learns that  $A$  is not appropriate by pre-contractual cognition, thus she knows the seller has cheated her. The buyer then demands  $A'$  and proposes a price  $p$  subject to the seller's participation.<sup>12</sup> We assume that whenever the buyer knows that the seller mis-reports the product, the buyer can sue the seller for a monetary transfer  $t \in (0, h)$ .

To shed light on the mere transaction cost of pre-contractual cognition, we assume that the buyer receives the transfer even without consuming the product. In fact, what is crucial in the model is punishing the cheating type- $A'$  seller so as to deter mis-selling even if the buyer has not consumed the product yet. To avoid the welfare loss from punishing the seller, the monetary punishment should be returned to society, namely, the buyer, as she is the only remaining player in the game. We consider the case of multiple buyers in Appendix A.3 where an individual buyer's cognition may be reduced as a free-riding result.

Since we have assumed that there is common knowledge that the seller knows the product-appropriateness, the buyer knows that mis-selling happens not by chance but occurs only if the seller has an intent of doing it. Hence, the buyer will sue the seller for willful mis-selling. Even if it is possible that the seller does not know the product-appropriateness, due to the seller's specialization in the industry, we assume that the seller can acquire the information with zero cost. Hence, liability of the seller requires the seller to take appropriate care to report the product.<sup>13</sup> As Milgrom (2008) argues

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<sup>11</sup>Of course, after the seller reveals  $A'$ , the cost of understanding  $A'$  for the buyer is not zero in reality. However, it should be much lower than the cost of learning  $A'$  by the buyer alone. Thus, without loss of generality, we normalize the cost of understanding  $A'$  to zero. Further, the seller may manipulate the understanding cost for the buyer, say, by disclosing the awareness-inducing information only in the fine print. In this case, we would rather interpret the seller's behavior as strategic mis-selling (announcing  $A$ ).

<sup>12</sup>Introducing the possibility that the buyer may demand  $A$  does not change our results. In equilibrium, the buyer will gain the same share of the surplus in trading both  $A'$  and  $A$ , but the equilibrium price  $p$  is lower in the latter case.

<sup>13</sup>A similar discussion is in the accident (tort) law literature. Here the buyer is a victim, and the seller is an injurer. Assume that the mis-selling accident is unilateral, namely only the seller's care affects the mis-selling risk. We impose the rule of strict liability, meaning the seller has the liability to pay all the loss for the buyer within the seller's asset requirement. Note that the negligence rule, which says that the seller pays for the

“... what is needed ... is to hold the seller liable for failures to reveal promptly not only the verifiable information that the seller knew, but also the information that it *should have known* under the circumstances.”

Now one might consider increasing the transfer  $t$  arbitrarily in the constitution so as to deter mis-selling. In reality, however, the judicial system is imperfect. When the seller mis-sells, the court will judge it correctly with probability  $z$ . Because of the seller’s limited liability  $W$ , it is very likely that the *expected* transfer  $t$  is less than  $zW$ .<sup>14</sup>

It is worth noting that a deterministic transfer  $t$  in the case of mis-selling can be implemented via a litigation mechanism as shown in Appendix A.4 when only type- $A'$  seller can provide hard evidence of mis-selling to the court of law. When there is symmetric information of mis-selling between the buyer and the seller *ex post*, the transfer can be realized based on the *spirit* but not the *letter* of their contract, although product-appropriateness is not verifiable by the court of law. We also show in Appendix A.4 that even in this case  $t$  cannot be arbitrarily high. Here we content ourselves with a simple analysis in which the transfer is modeled by an exogenous constant  $t$  smaller than  $h$  whenever the buyer knows the seller’s false report.

(2) The second possibility is that the buyer remains uncertain of whether  $A$  is appropriate. Then the buyer proposes a contract, including a price  $p$  and the specification of  $A$ , under uncertainty.

Suppose  $A'$  is appropriate. The buyer can only demand  $A$ , although it is not appropriate. The imperfect description in the contract reflects a misleading contract. If the seller accepts the contract, then, at the post-

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buyer’s loss only if the seller’s care is less than the level the court specifies (due care), is not feasible when the court cannot detect the seller’s efforts of care. (See, e.g., Shavell, 2004)

<sup>14</sup>One may wonder whether we can solve the problem by the standard Nash implementation approach by Maskin (1999) or subgame perfect implementation approach by Moore and Repullo (1988) and Maskin and Tirole (1999). However, both approaches cannot provide unique equilibrium, as the preferences of both parties over the transfer decision are state-independent, namely, the buyer always prefers a transfer, and the seller always prefers no transfer.

One may also wonder whether we can solve the problem by these approaches before the buyer’s uncertainty is resolved. However, standard approaches are not robust to the asymmetric information context as we assume here. See, e.g., Aghion, Fudenberg and Holden (2009) and Kunimoto (2008).

contractual stage, the buyer receives payoff

$$v - p - h + t - C(b),$$

and the seller receives

$$p + h - t.$$

*Ex post*, the buyer will find out that  $A$  is actually not appropriate, because she is hurt by  $h$ . The buyer then sues the seller for a transfer  $t$ .

Suppose  $A$  is appropriate. Since there is no mis-selling problem, if the seller accepts the contract, then, at the post-contractual stage, the buyer receives  $v - p - C(b)$ , and the seller receives  $p$ .

## 3.2 Equilibrium

We solve the game backwards by using the solution concept of perfect Bayesian equilibrium.<sup>15</sup>

### 3.2.1 Pricing

At stage 4, when type- $A'$  seller tells the buyer  $A'$  or the buyer finds that  $A'$  is appropriate by cognition, the buyer optimally demands  $A'$ . Sequential rationality implies that the seller accepts the contract if and only if  $p \geq 0$  and the optimal price proposed by the buyer is  $p = 0$ .

An interesting finding is that when the seller says  $A$  is appropriate and the buyer finds nothing after cognition the optimal price remains  $p = 0$ . To show this point, let

$$\hat{\rho} \equiv \frac{\rho q(1-b)}{1-\rho+\rho q(1-b)}$$

be the posterior probability of mis-selling from the buyer's view given that the buyer finds nothing after cognition and the buyer believes that type- $A'$  seller's probability of mis-selling is  $q$ .<sup>16</sup> Here the buyer's belief is updated according to Bayesian rule.

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<sup>15</sup>The problem is modeled as a standard extensive form game. The connection to games with unawareness is discussed in Appendix A.5. In general, games with unawareness can be mapped to games with incomplete information, and the extended solution concepts of the former coincide with the corresponding standard solution concepts of the latter. See, e.g., Feinberg (2009).

<sup>16</sup>In equilibrium, the buyer has a correct belief of  $q$ .

Suppose the buyer proposes some price  $p \geq 0$ . Then both types of sellers accept it. The buyer therefore receives her expected payoff

$$U_1 \equiv (1 - \hat{\rho})(v - p) + \hat{\rho}(v - h + t - p) - C(b).$$

The buyer's best proposal is  $p = 0$  given that  $p \geq 0$ .

Suppose the buyer proposes price  $p \in [t - h, 0)$ . Then type- $A$  seller will reject it. The buyer receives her expected payoff

$$U_2 \equiv \hat{\rho}(v - h + t - p) - C(b).$$

The buyer's best proposal is  $p = t - h$  given that  $p \geq t - h$ .

If  $p < t - h$ , both types of sellers reject it. Thus, the buyer receives payoff  $-C(b)$ .

To focus on the welfare loss of pre-contractual cognition, we abstract from the inefficient contracting result where a mutually beneficial trade may break down. Now we make the following assumption:

**Assumption 1**  $v - \rho(h - t) > \rho v$ .

The interpretation of Assumption 1 is, given that there is no cognition and type- $A'$  seller mis-sells with certainty, the buyer always prefers  $p = 0$  and contracting with both types of sellers (where the buyer gets  $v - \rho(h - t)$ ) to  $p = t - h$  and contracting with only type- $A'$  seller (where the buyer gets  $\rho v$ ). Hence, we rule out the case in which there are only "lemons" in the market, and mutually beneficial trades break down for type- $A$  seller. (Akerlof, 1970) This assumption holds when the extent and the effect of mis-selling are not too high, namely  $\rho$  and  $h$  and are sufficiently small, and the gain from trade  $v$  is large enough.

Assumption 1 implies

$$(1 - \rho)v - \rho(h - t) > 0$$

that also implies

$$(1 - \hat{\rho})v - \hat{\rho}(h - t) > 0, \tag{1}$$

since  $\hat{\rho} < \rho$  holds for all  $b > 0$  and  $q$ .

Inequation (1) is equivalent to  $U_1 > U_2$ . Hence,  $p = 0$  is better than  $p = t - h$  for the buyer. Intuitively, after the buyer exerts cognitive efforts and finds nothing, and type- $A'$  seller *may* not mis-sell with probability one,

the buyer believes that mis-selling is less likely to occur, and is more willing to contract with both types of sellers.

Moreover, Assumption 1 also implies that the price  $p < t - h$  is never optimal, as  $v > 0$ . For the buyer, contracting with both types of sellers is also better than her outside option, since there is a positive gain from trade.

Furthermore, Appendix A.2 shows that if Assumption 1 holds,  $p = 0$  without delay is also the equilibrium outcome in a general bargaining game where the buyer makes all the offers in an infinite-horizon setting in which delay can work as a screening device for the buyer.<sup>17</sup>

We now continue to solve the game backwards.

### 3.2.2 No Separating Equilibrium

Suppose, at stage 2,  $q = 0$ , i.e., type- $A'$  seller tells the buyer  $A'$  with certainty. Then at stage 3, the buyer's optimal cognition is  $b = 0$ . Since there is no mis-selling problem anymore, it is not worthwhile for the buyer to spend any resource on thinking. However, if  $b = 0$ , it turns out that type- $A'$  seller optimally pretends to be type- $A$ , since type- $A'$  seller will get the rent from mis-selling with certainty (and  $h - t > 0$ ). Thus, it is impossible to have a *separating equilibrium* in which the buyer can tell type- $A$  seller and type- $A'$  seller apart for sure without cognition.<sup>18</sup>

### 3.2.3 Pooling Equilibrium

Alternatively, suppose  $q = 1$  at stage 2, i.e., type- $A'$  seller mis-sells with certainty. Then at stage 3, given that  $p = 0$ , the buyer maximizes her payoff in expectation

$$\max_b (1 - \rho)v + \rho b(v + t) + \rho(1 - b)(v - h + t) - C(b)$$

where  $1 - \rho$  is the probability that  $A$  is appropriate,  $\rho b$  is the probability that  $A$  is not appropriate and the buyer knows it by pre-contractual cognition, and  $\rho(1 - b)$  is the probability of mis-selling.

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<sup>17</sup>In Appendix A.6, we show that if this assumption fails, there is even no equilibrium in which the buyer strictly prefers to contracting with only type- $A'$  seller or proposing nothing.

<sup>18</sup>The negative result is akin to the Grossman-Stiglitz paradox, which says that there is no pure-strategy equilibrium of pricing when acquiring quality-information is costly for consumers in the market. (See Grossmann and Stiglitz, 1980)

The assumptions on  $C(\cdot)$  imply that the optimal cognition is  $b^*$  such that

$$C'(b^*) = \rho h. \quad (2)$$

The marginal cost of cognition equals the marginal benefit from avoiding mis-selling. Equation (2) reflects that the equilibrium cognition is increasing in  $\rho h$ , namely, the product of the extent and the effect of the mis-selling problem.

When  $\rho$  is small, we have that  $b^*$  is small. Thus, if  $t$  is also not too large, we have that

$$(1 - b^*)(h - t) + b^*(-t) \geq 0, \quad (3)$$

which means that  $q = 1$  is indeed optimal for type- $A'$  seller. Therefore, when  $\rho$  and  $t$  are small, there is a *pooling equilibrium* in the sense that both type- $A$  and type- $A'$  sellers announce that  $A$  is appropriate. Intuitively, if the extent and the transfer from type- $A'$  seller are low, the buyer therefore does not exert too much cognition, then type- $A'$  seller has an opportunity to mis-sell.

Formally, if  $\rho h \leq C'(1 - \frac{t}{h})$  holds, we have such pooling equilibrium.<sup>19</sup> It is straightforward to see that pooling is more likely to occur for smaller  $\rho$  and  $t$ , yet the role of  $h$  is indeterminate. It is so because increasing  $h$  raises the benefit of mis-selling for the seller, which enhances the seller's incentive to mis-sell, yet also raises the buyer's cognition level, which reduces the seller's incentive to mis-sell. Hence, we cannot judge its impact on the validity of condition (3).

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<sup>19</sup>Pooling equilibrium occurs if and only if

$$(1 - b^*)(h - t) + b^*(-t) \geq 0$$

where  $b^*$  is characterized by equation (2), which is equivalent to

$$b^* \leq 1 - \frac{t}{h}.$$

By strict convexity of  $C(\cdot)$ , it is also equivalent to

$$C'(b^*) \leq C'(1 - \frac{t}{h}),$$

which is nothing but

$$\rho h \leq C'(1 - \frac{t}{h}).$$

### 3.2.4 Semi-Separating Equilibrium

However, when  $\rho h > C'(1 - \frac{t}{h})$ , there is no pure-strategy equilibrium, since in this case we have

$$(1 - b^*)(h - t) + b^*(-t) < 0, \quad (4)$$

i.e., a high level of cognition by the buyer in the pooling equilibrium deters type- $A'$  seller from mis-selling.

For large  $\rho$  and  $t$ , let us therefore investigate the mixed-strategy equilibrium. We assume all parties have perfect recall, so the concept of behavioral strategies is tantamount to that of mixed strategies. Suppose type- $A'$  seller chooses a behavioral strategy  $q \in (0, 1)$  at stage 2. Then at stage 3, the buyer solves the following problem upon observing  $A$ :

$$\max_b \frac{(1 - \rho)v + \rho qb(v + t) + \rho q(1 - b)(v - h + t)}{1 - \rho + \rho q} - C(b)$$

where the posterior probability that  $A$  is appropriate is  $\frac{1 - \rho}{1 - \rho + \rho q}$ , the posterior probability that  $A'$  is appropriate and the buyer knows it by cognition is  $\frac{\rho qb}{1 - \rho + \rho q}$ , and the posterior probability of mis-selling is  $\frac{\rho q(1 - b)}{1 - \rho + \rho q}$ .

Similarly, our assumptions on  $C(\cdot)$  guarantee that the optimal cognition is  $b^*$  such that

$$C'(b^*) = \frac{\rho q h}{1 - \rho + \rho q}. \quad (5)$$

Since type- $A'$  seller plays a non-degenerate behavioral strategy, at stage 2, he is indifferent between announcing  $A$  and  $A'$ , i.e., the following equation is satisfied.

$$(1 - b^*)(h - t) + b^*(-t) = 0.$$

Therefore, the equilibrium cognition is

$$b^* = 1 - \frac{t}{h}, \quad (6)$$

so the equilibrium cognition level is determined by  $h$  and  $t$  and independent of  $\rho$ . In particular,  $b^*$  is increasing in  $h$  and decreasing in  $t$ . If  $h$  is higher, type- $A'$  seller has a higher incentive to mis-sell. To keep the seller still indifferent between announcing  $A$  and  $A'$ , the buyer has to think more carefully to

reduce type- $A'$  seller's incentive to mis-sell. We have the opposite and yet analogous intuition for a higher  $t$ .

Plugging  $b^*$  in (6) into equation (5), we have

$$q^* = \frac{(1 - \rho)C'(1 - \frac{t}{h})}{\rho(h - C'(1 - \frac{t}{h}))}. \quad (7)$$

In equilibrium, an appropriate  $q^*$  induces the buyer to choose the optimal cognition such that type- $A'$  seller is indeed indifferent between mis-selling and truth-telling, which we dub *semi-separating equilibrium*.<sup>20</sup> This result is in contrast to Tirole (2009). Although the seller has no bargaining power, in the presence of the transfer  $t$ , type- $A'$  seller here has no strict incentive to shroud  $A'$ . Disclosure of  $A'$  by the seller is possible, though not necessary, in equilibrium.

We summarize the results we have so far in the following proposition.

**Proposition 1** *Under Assumption 1, the equilibrium price is  $p = 0$  that is accepted by the seller.*

*There is no separating equilibrium where two types of sellers are distinguished by the buyer with certainty.*

*If  $\rho h \leq C'(1 - \frac{t}{h})$ , there is a pooling equilibrium where both types of sellers announce that  $A$  is appropriate, and the buyer's cognition  $b^*$  is characterized by equation (2).*

*Otherwise, there is a semi-separating equilibrium where type- $A'$  seller randomizes between mis-selling and truth-telling with type- $A'$  seller's probability of mis-selling  $q^*$  given by equation (7), and the buyer's cognition level  $b^*$  is given by equation (6).*

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<sup>20</sup>The feature of semi-separating equilibrium smacks of an inspection game. The buyer is the counterpart of an inspector, and the seller is the counterpart of an inspectee. (See, e.g., Avenhaus, von Stengel and Zamir, 2002) Nevertheless, there are some substantial differences. First, in our model, there are heterogeneous sellers, and it is impossible for type- $A$  seller to mis-sell. Hence, when the fraction of type- $A$  seller, namely  $\rho$ , is high, there exists a pure-strategy equilibrium that is a pooling one. Second, in most inspection games, the inspector has a binary choice: alarm or not alarm. But our buyer here chooses a continuous cognition level  $b$  to update her belief. Thus, the buyer chooses an appropriate  $b$ , which is a pure strategy, in equilibrium. Third, in inspection games, players move simultaneously, yet in our model, the seller moves first. If the seller reveals  $A'$ , the buyer therefore needs not to think. Fourth, there are two types of errors for the inspector in the statistical parlance. However, our model excludes the buyer's type I error, since describing  $A'$  implies that  $A'$  is indeed appropriate.

### 3.3 Graphical Interpretation

Figures 2 and 3 illustrate the buyer's best response function  $b(q)$  and type- $A'$  seller's best response correspondence  $q(b)$  in semi-separating equilibrium and pooling equilibrium, repetitively. Here  $b(q)$  is strictly increasing in  $q$ ,<sup>21</sup>  $b(0) = 0$ , and  $b(1) < 1$  by equation (5). Inequalities (3) and (4) imply  $q(b) = \{1\}$  for small  $b$ ,  $q(b) = \{0\}$  for large  $b$ , and  $q(b) = [0, 1]$  for some  $b$  in-between.

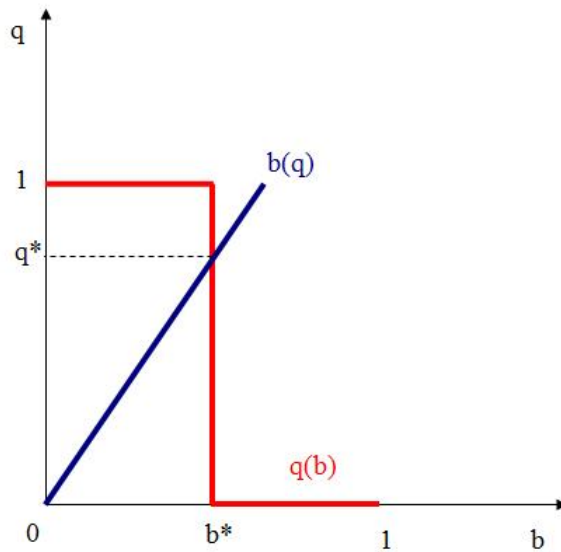


Figure 2: Semi-Separating Equilibrium

Figure 2 shows that if  $q$  is too large, the buyer chooses a large  $b(q)$  to avoid being mis-sold to. But a large  $b$  implies that  $q(b)$  is zero, i.e., the seller dare not to mis-sell. Conversely, if  $q$  is too small, the buyer has no incentive to think and thus chooses a small  $b$ . A small  $b$  implies  $q(b)$  is one, i.e., the seller has incentive to mis-sell. Thus, the equilibrium  $q^*$  has to be not too

<sup>21</sup>By equation (5), we infer that

$$\frac{dC'(b^*)}{dq} = \frac{d\left(\frac{\rho q h}{1-\rho+\rho q}\right)}{dq} = \frac{\rho(1-\rho)h}{(1-\rho+\rho q)^2} > 0.$$

large and not too small. In the figure, the intersection of  $b(q)$  and  $q(b)$  is the unique candidate for equilibrium  $b^*$  and  $q^*$ .

Thus, when  $\rho$  and  $t$  are large, there is a semi-separating equilibrium in the sense that type- $A'$  seller randomizes between mis-selling and truth-telling. In contrast, when  $\rho$  and  $t$  are small, the pooling equilibrium is depicted in Figure 3. In this case,  $b(q)$  and  $q(b)$  intersect at  $q = 1$ , which implies a pure-strategy equilibrium.

However, since  $b(q)$  is strictly increasing in  $q$  and  $b$  is positive in any equilibrium,  $b(q)$  and  $q(b)$  can never intersect at  $q = 0$ . Thus, separating equilibrium does not exist, as the figures show.

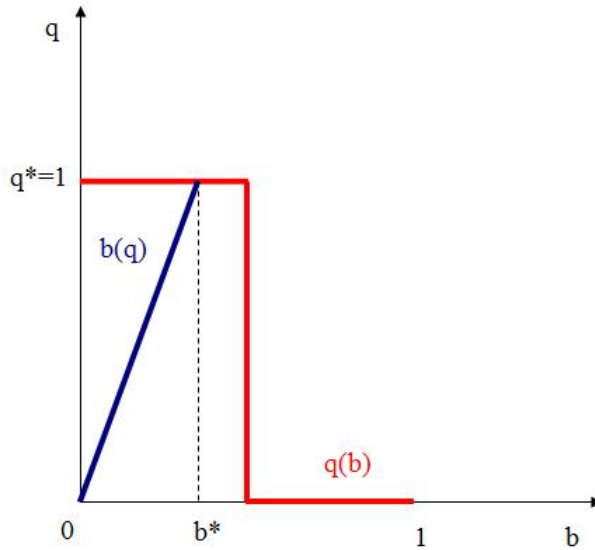


Figure 3: Pooling Equilibrium

In summary, Figure 4 illustrates the results in Proposition 1.

### 3.4 Economic Implications

Pooling equilibrium happens in many developed countries where unforeseen contingencies are not so likely to occur. In these countries, the consumers are “simple” men in the sense that they do not acquire much information on the product-appropriateness. Although the seller mis-sells with certainty

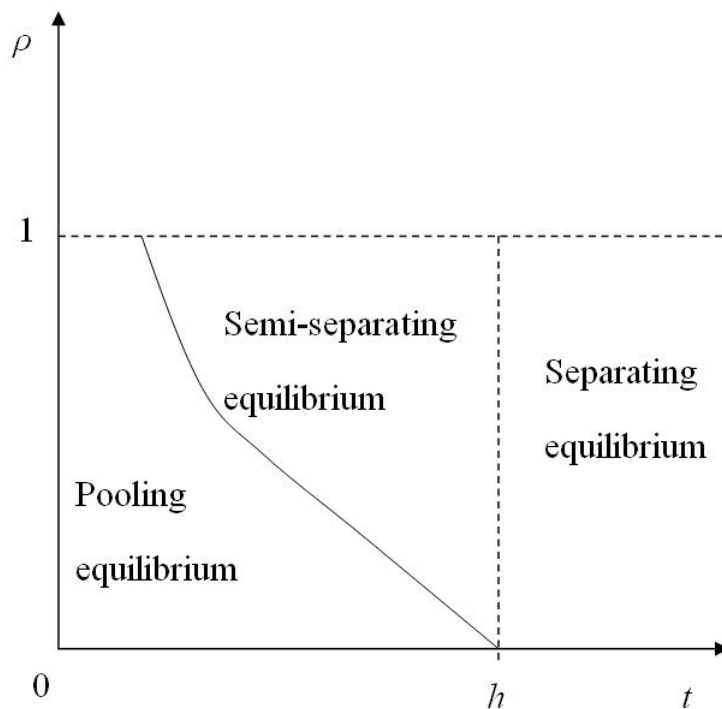


Figure 4: Graphical Illustration of Proposition 1

whenever he has an opportunity, the consumers are not afraid of it, because it is a small-probability event.

However, semi-separating equilibrium happens in less-developed countries. As the extent of mis-selling is high, the consumers have to be alert. Thus, the consumers in less-developed countries are relatively less simple. Nevertheless, in semi-separating equilibrium, the seller may open the consumers' eyes. The consumers therefore need not acquire too much information like a "know-it-all".

### 3.5 Robustness

The results so far are robust to a number of extensions.

*Heterogeneous Buyers:* We assume only partially unaware buyers, meaning the buyers are aware of their potential unawareness. In reality, a number

of buyers are completely unaware, i.e., they are naive in the sense that they always believe what the seller says, and do not exert any cognition. If we allow diversely unaware buyers, the results are qualitatively similar. The main change is that the pooling equilibrium is more likely to occur, because type- $A'$  seller has a higher incentive to mis-sell due to the opportunity to exploit more completely unaware buyers in the population.<sup>22</sup>

Furthermore, if we allow that a fraction of buyers have the same information as the seller has, that is, some buyers know  $A'$  without the need of costly cognition when  $A$  is not appropriate, the qualitative results remain as well, except that the pooling equilibrium is less likely to occur. More informed buyers in the population increase the probability of type- $A'$  seller being punished when he mis-sells.

Note that the buyer has full bargaining power in our model. This softens the problem of externality of the existence of a different type of buyers on the buyers we have in the model.

*Heterogeneous Sellers:* The model assumes that all sellers are immoral in the sense that they mis-sell whenever it is worthwhile for them. Suppose a fraction of sellers are honest, that is, they always truthfully report the appropriate product. It only reduces the buyer's incentive to think, which makes the pooling equilibrium more likely to occur.

In addition, we discuss the case where the seller may not be informed in section 4.3.

*More than Two States of Nature:* Suppose there are not only the appropriate and non-appropriate products, but an order of appropriate products. Simplifying a bit, we have three states of nature:  $A$ ,  $A'$  and  $A''$ . After  $A'$  is revealed, the buyer may think further to look for the more appropriate  $A''$ .

If the seller only knows  $A'$ , then our analysis is not modified before the buyer's cognition for  $A''$ , because there is asymmetric information only on  $A'$  between them. After  $A'$  is revealed, we are back to the model by Tirole (2009), since both parties are uninformed about  $A''$ . However, if the seller is

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<sup>22</sup>Alternatively, we can reinterpret it as heterogeneous cognitive cost functions. One is  $C_1$  as assumed before. The other is  $C_2$  such that  $C_2(0) = 0$  and  $C_2(b) = \bar{C}$  for  $b > 0$  where  $\bar{C}$  is a sufficiently large constant. The buyer with the later function will never think and always contracts with the seller as long as Assumption 1 is satisfied. Hence, there is no behavioral difference between these two interpretations, although the beliefs of the buyers in two interpretations are different. Thus, we can model completely unaware buyers "as-if" their cognition costs are significantly high. (See, e.g., Friedman (1953) for the "as-if" justification.)

fully informed, type- $A''$  seller can pretend to be  $A$  or  $A'$ . Nevertheless, our qualitative results still hold. That is, when  $t$  is small, we still have a pooling equilibrium. Conversely, we have a semi-separating equilibrium where type- $A'$  seller or type- $A''$  seller (or both) randomizes his choices.

### 3.6 Welfare Comparatives

We view social surplus of the buyer and the seller as our welfare criterion. In any outcome of the game, we have only one source for a welfare loss: the cognition cost  $C(b)$  for the buyer. Thus, we define the *transaction cost* as the expected cognition cost

$$L \equiv (1 - \rho(1 - q))C(b)$$

where  $\rho(1 - q)$  is the probability that type- $A'$  seller opens the buyer's eyes, which is the mere situation in which no cognition efforts of the buyer is involved. Otherwise, the buyer has to bear the cognition cost  $C(b)$ . In the model, we have three free parameters:  $\rho$ ,  $h$  and  $t$ . The comparative statics of the transaction cost with respect to these parameters are in the following proposition.

**Proposition 2** *If  $\rho h \leq C'(1 - \frac{t}{h})$ , we have  $\frac{dL}{d\rho} > 0$ ,  $\frac{dL}{dh} > 0$  and  $\frac{dL}{dt} = 0$ . Otherwise, we have that  $\frac{dL}{d\rho} < 0$ , the sign of  $\frac{dL}{dh}$  is ambiguous, and  $\frac{dL}{dt} < 0$ .*

**Proof.** See Appendix A.7. ■

When  $\rho h \leq C'(1 - \frac{t}{h})$ , there is a pooling equilibrium where type- $A'$  seller mis-sells with certainty. Thus, the buyer exerts her cognition efforts with certainty. The transaction cost therefore is  $L = C(b)$ . The higher  $\rho$ , the higher the cognition level  $b$  the buyer exerts in order to avoid being mis-sold to, and thus the higher  $L$ . By the same token,  $L$  is increasing in  $h$ . In the pooling equilibrium, however, the buyer's cognition level  $b$  is independent of the transfer  $t$ , because changing  $t$  does not influence the buyer's marginal payoff of cognition, although the buyer prefers a higher  $t$ .

When  $\rho h > C'(1 - \frac{t}{h})$ , there is a semi-separating equilibrium. Since  $q$  is endogenous, the welfare comparative statics are not so straightforward as above.

Particularly striking is that we have the opposite result that  $L$  is *decreasing* in  $\rho$  here. Since, in the semi-separating equilibrium, what determines the

cognition of the buyer is only type- $A'$  seller's indifference condition, which is equation (6), having more type- $A'$  sellers in the population does not alter the buyer's cognition level. However, when  $\rho$  is large, to keep the buyer employing the same cognition level as before, type- $A'$  seller has to reduce  $q$ . Equation (7) implies  $q$  decreases at a higher rate than  $\rho$ . Thus, the overall probability that the buyer exerts cognition is lower. Although  $\rho$  is higher, there is much higher probability of information disclosure. Hence,  $L$  is reduced for a higher  $\rho$ .

In a nutshell, *there is a cutoff value  $\bar{\rho}$  such that  $L$  is increasing in  $\rho$  as long as  $\rho < \bar{\rho}$  (as in many developed countries) and is decreasing thereafter (as in some less-developed countries).*

In the semi-separating equilibrium, however, whether or not  $L$  increases as  $h$  increases is ambiguous. Since raising  $h$  has an ambiguous impact on equilibrium  $q$ , we cannot judge the welfare consequence of it.

Lastly, a higher  $t$  reduces  $L$  in the semi-separating equilibrium. For a higher  $t$ , to guarantee type- $A'$  seller's indifference condition, the buyer's cognition level  $b$  is lower. The only way to maintain the buyer's low cognition level is to reduce type- $A'$  seller's probability of mis-selling  $q$ . Since both  $b$  and  $q$  are reduced,  $L$  is reduced.

The welfare comparatives suggests that a benevolent court of law should increase  $t$  to the largest extent.<sup>23</sup> However,  $t$  is bound above by the limited liabilities of the parties (as shown in Appendix A.4). Therefore,  $t$  can be interpreted as the highest possible transfer, depending on the wealth of the parties in the litigation process.

It is worth mentioning that the results in Proposition 2 are robust to the more general case with a direct deadweight loss of mis-selling  $\Delta$ . To see it, let the transaction cost be  $L = (1 - \rho(1 - q))C(b) + \rho q \Delta$  where  $\rho q \Delta$  is the expected welfare loss from mis-selling. It is straightforward to see that  $\frac{dL}{d\rho} > 0$ ,  $\frac{dL}{dh} > 0$  and  $\frac{dL}{dt} = 0$  in the pooling equilibrium. In the semi-separating equilibrium, since  $\rho q$  is lower for a higher  $\rho$  as shown in Appendix A.7, we still have that  $\frac{dL}{d\rho} < 0$ . Further, the sign of  $\frac{dL}{dh}$  is ambiguous as well. Lastly,  $q$  is decreasing in  $t$ , so  $\frac{dL}{dt} < 0$  remains.

Suppose there were a separating equilibrium in which  $q = 0$ . Then  $b = 0$ , since it is not worthwhile for the buyer to think any more. Thus  $L = 0$ , that

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<sup>23</sup>Although, in the pooling equilibrium,  $t$  plays no role in the transaction cost, the court of law may choose the highest  $t$  in order to enhance the buyer's welfare as a tie-breaking rule.

is, the transaction cost vanishes. However, the separating equilibrium does not exist as shown in Proposition 1. Roughly speaking, our ideal society where we have trust everywhere and no wasteful cognition is spent is an impossible world. Nevertheless, we can improve our world by some market institutions as shown in the following sections.

## 4 Reputation

In section 3, we have the negative result of no separating equilibrium, which would be the ideal outcome. However, our discussion so far has focused only on one-shot interaction. We now consider a large economy with a continuum of buyers and sellers in repeated relationships.

Assume that time is discrete and infinite. Buyers and sellers are matched randomly in each period. Assume that the state of nature ( $A$  is appropriate or not) is drawn randomly in each period, and *independently* across periods. In different periods, different products are traded. Both buyers and sellers are uncertain about the state of nature in the future periods. The buyer does not know the appropriateness of the future product, and the seller does not know which product the buyer will need in the future periods. For example, a buyer who bought a laptop yesterday may buy a mouse ( $A$ ) today or a status quo printer with high add-on costs of inks ( $A'$ ) tomorrow.

We assume the Poisson death process, i.e., the parties alive at a period remain in the economy in the next period with probability  $\lambda \in (0, 1)$ . Each party who quits at a period is offset by a new party in the period. Let  $\delta_0$  be the parties' discount factor. Thus, two parties share the same *relevant* discount factor  $\delta \equiv \delta_0 \lambda$ . To simplify the exposition, we assume in this section that the transfer is  $t = 0$ . Ignoring the positive transfer only simplifies the presentation. Thus, the unique equilibrium in the stage game is the pooling one. Since there is no punishment cost for type- $A'$  seller, he mis-sells with certainty in equilibrium in the stage game.

### 4.1 Existence of Separating Equilibrium

We now check if a separating equilibrium in each period is possible in equilibrium dynamics.

Consider the following trigger strategies of the parties. Type- $A'$  seller always unveils  $A'$ , but the buyer pays some price  $\tilde{p} > 0$  *only* after the novel

$A'$  is reported, and the buyer does not think at all ( $b = 0$ ). The high price  $\tilde{p}$  can be interpreted as a tip for the seller for bringing the payoff-relevant unforeseen message to the buyer.<sup>24</sup> The actions in the other nodes in the stage game are the same as in Proposition 1. However, if some party deviates from it, the new partner can detect this cheating behavior with probability  $x$  in each future period. A high  $x$  represents a transparent society in which, say, the media can broadly transmit the complaints from some parties, although the contents of those complaints are not verifiable. Detection leads to the outcome that two parties play the pooling equilibrium in this period.<sup>25</sup> The buyer does not pay the tip any more, and type- $A'$  seller does not reveal  $A'$ . It is clear that if they play the reciprocal action profile in each period described as above, the transaction cost reduces to  $L = 0$ .

Now we assess the condition under which the trigger strategy profile is sustainable.

First, we check type- $A'$  seller's incentive for a deviation. If he deviates from revealing  $A'$ , his *net* gain in the current period is  $h - \tilde{p}$ . Since the buyer has no pre-contractual cognition, he can successfully mis-sell, but he loses the tip  $\tilde{p}$ .

However, the seller has the risk of losing his individual reputation later. The net loss in the future is

$$\frac{\delta\rho}{1-\delta} (\tilde{p} - (1-x)h - x(1-b^*)h)$$

where  $b^*$  is the equilibrium cognition level given by equation (2). In each future period, if  $A$  is appropriate, which happens with probability  $1 - \rho$ , the seller gains zero payoff, irrespective of whether or not he is detected. If  $A$  is not appropriate, which happens with probability  $\rho$ , the seller loses the tip  $\tilde{p}$  and yet gains the expected rent  $(1-x)h + x(1-b^*)h$  from mis-selling. Here, the seller mis-sells with certainty in each future period by virtue of the stationarity of the game.

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<sup>24</sup>One may consider the possibility of rewarding the seller in the case where  $A$  is indeed appropriate at the post-contractual stage. But, as shown in Appendix A.8, the strategy with zero-rewarding when  $A$  is appropriate creates the highest possibility for the existence of separating equilibrium in each period.

<sup>25</sup>One may wonder about the possibility of using no trade as the harshest punishment to enhance cooperation between the buyer and the seller in the spirit of Abreu (1986). However, the optimality is not robust to the case with a small probability that the seller is uninformed as well, as we will see in section 4.3.

Hence, type- $A'$  seller has no incentive to mis-sell if

$$h - \tilde{p} \leq \frac{\delta\rho}{1-\delta} (\tilde{p} - (1-x)h - x(1-b^*)h),$$

which can be written as,

$$\tilde{p} \geq \frac{1-\delta+\delta\rho(1-xb^*)}{1-\delta+\delta\rho}h,$$

which reflects a minimal level of the tip. Thus, the buyer has to commit to remunerate at least  $\tilde{p}^* = \frac{1-\delta+\delta\rho(1-xb^*)}{1-\delta+\delta\rho}h$  to type- $A'$  seller in order to enhance his truthful report. Note that  $\tilde{p}^* < h$ , that is, the minimal tip is smaller than the effect of mis-selling. Thus, it may be worthwhile for the buyer to pay the tip.

Second, we check the buyer's incentive for a deviation. If she deviates from paying  $\tilde{p}^*$  for type- $A'$  seller with a truthful report, her net gain in the current period is  $\tilde{p}^*$ , where the buyer only pays price zero so as to guarantee the seller's acceptance of the contract in this period.

However, the buyer loses her reputation in expectation, and the net loss in the future is

$$\frac{\delta}{1-\delta} (xC(b^*) + \rho x(1-b^*)h - \rho\tilde{p}^*).$$

In each future period, if the buyer's misbehavior is detected, which occurs with probability  $x$ , the two parties play the strategies of the pooling equilibrium in the stage game. The buyer therefore has to bear the cognition cost  $C(b^*)$ . With probability  $\rho x(1-b^*)$ , she is mis-sold to. But she does not have to pay  $\tilde{p}^*$  in the future anyway due to the stationarity of the game.

Hence, the buyer has no incentive to misbehave if

$$\tilde{p}^* \leq \frac{\delta}{1-\delta} (xC(b^*) + \rho x(1-b^*)h - \rho\tilde{p}^*). \quad (8)$$

Substituting for  $\tilde{p}^*$ , we conclude that the buyer has no incentive to misbehave if

$$C(b^*) \geq \frac{1-\delta(1-\rho(1-x))}{\delta x}h. \quad (9)$$

**Proposition 3** *If the cognition level  $C(b^*)$  in the pooling equilibrium in the stage game is high, both parties are patient ( $\delta$  is high), the detection probability  $x$  is high, and the extent  $\rho$  and the effect  $h$  of the mis-selling problem are low, then separating equilibrium in each period is likely to exist.*

Since the right hand side of inequation (9) is strictly decreasing in  $\delta$  and  $x$ , and converges to zero when  $\delta$  and  $x$  converge to 1, the analysis yields:

**Proposition 4** *There exist some cutoff values  $\bar{\delta}$  and  $\bar{x} < 1$  such that for all  $\delta \geq \bar{\delta}$  and  $x \geq \bar{x}$  separating equilibrium in each period exists.*

In words, if both buyer and seller are sufficiently patient and the probability of detection is sufficiently high, there exists an equilibrium where the mis-selling problem vanishes. In this case, since no cognition is involved, reputation minimizes the transaction cost.<sup>26</sup>

In the equilibrium dynamics, the buyer commits to give the seller a “tip” if and only if the seller brings the surprising news to her before contracting. The tip promotes the seller’s incentive to reveal the novel product to the buyer. Since “surprise” is not contractible, however, this tip-institution does not work in the one-shot interaction due to sequential rationality in the stage game. Hence, the convention of tips in a dynamic economy is an instrument of reducing the mis-selling behaviors and pre-contractual cognition.

## 4.2 Persistence of Pre-Contractual Cognition

We now use the history-dependence approach initiated by Tirole (1996) to investigate the effect of a one-time shock of mis-selling on the separating equilibrium.

Suppose, at period 0,  $A$  is not appropriate and the economy has a shock such that the seller mis-sells. The thought experiment is as follows. Suppose all sellers truthfully report the appropriate product from period 1 to  $T$  ( $> 0$ ) in order to gain the buyer’s trust at period  $T$ ; and all sellers born at and before period 0 are locked into mis-selling. At period  $T$ , if the seller says  $A$  is appropriate, the probability that  $A$  is indeed appropriate before the buyer’s

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<sup>26</sup>The alternative way of modeling reputation is assuming finite time horizon and yet two types of sellers: an opportunistic one as we assume throughout the paper and a honest one who always reports the appropriate product. (See, e.g., Kreps et al., 1982) In the sequential equilibrium, the opportunistic seller may still truthfully report the product in the beginning periods in order to gain the buyer’s trust in the later periods. However, the opportunistic seller must mis-sell at least in the last period. Therefore the buyer has to exert cognitive efforts in the last period. Thus, the assumption of infinite time horizon is crucial for shattering the transaction cost of pre-contractual cognition. But introducing two types of sellers does not alter our results qualitatively.

cognition is

$$\begin{aligned} & \frac{1 - \rho}{1 - \rho + \rho(1 - x)(1 - \lambda)(\lambda^T + \lambda^{T+1} + \lambda^{T+2} + \dots)} \\ &= \frac{1 - \rho}{1 - \rho + \rho(1 - x)\lambda^T} \end{aligned}$$

which is strictly less than one for all  $T < +\infty$ . Thus, after period 0, the probability of mis-selling given that  $A$  is announced to be appropriate is always positive, no matter how long the sellers truthfully report the appropriate product. Since the buyer's cognition cost function  $C$  is continuous, the pre-contractual cognition cannot be completely saved. Whenever mis-selling occurs in some period, for any finite periods of *anti-mis-selling campaigns*, the economy cannot go back to the equilibrium outcome where no pre-contractual cognition of the buyer is exerted. As in Tirole (1996), however, the out-of-equilibrium *amnesty*, which destroys the evidence of this mis-selling spot, can let the economy return immediately to the separating equilibrium outcome where the transaction cost vanishes. In other words, the “big-bang” approach is more effective than the gradualist strategy in the context of mis-selling problems. We summarize the results in the following proposition:

**Proposition 5** *The policy of anti-mis-selling campaigns cannot shatter pre-contractual cognition, but amnesty saves the pre-contractual cognition completely.*

### 4.3 Secret Awareness of the Seller

The analysis in the last subsection focuses on the effect of a one-time *generation-specific* shock of mis-selling. Here we consider the possibility that mis-selling may come from an infinite cost of acquiring the product-appropriateness information for some seller in some period (whereas we assumed that the seller is always informed about the product appropriateness, or equivalently the cost of acquiring the information is zero in the baseline model.)

Based on Green and Porter (1984), we assume that when  $A$  is not appropriate, in each period, the seller is as unaware as the buyer with probability  $\alpha$ . The buyer cannot observe whether or not the seller is aware. Now it is not optimal for the buyer to punish the seller forever in the case of mis-selling, because mis-selling may be unavoidable in some situations, and is therefore

not the seller's liability. Suppose that the seller who sells an inappropriate product in period 0 is punished from period 1 to  $T$  whenever the seller is detected in these periods.

Let  $V^+$  (respectively,  $V^-$ ) denote the present discounted value of the seller's payoff beginning from a cooperative phase (respectively, non-cooperative phase). Formally, we define them recursively:

$$V^+ = (1 - \alpha) (\rho \tilde{p} + \delta V^+) + \alpha (\rho h + \delta V^-)$$

and

$$V^- = \frac{1 - \delta^T}{1 - \delta} \rho \theta h + \delta^T V^+$$

where  $\theta \equiv (1 - x) + x(1 - b^*) \in (0, 1)$  is probability of successful mis-selling given that  $A$  is not appropriate in a period from period 1 to  $T$ . Starting from the cooperative phase, with probability  $1 - \alpha$ , the seller receives the expected tip  $\rho \tilde{p}$ , and the two parties continue to cooperate in the next period. With probability  $\alpha$ , the seller is uninformed, and therefore gains the expected rent  $\rho h$  by chance. Then they switch to the non-cooperative phase. In the beginning  $T$  periods of the non-cooperative phase, they play the pooling equilibrium in the stage game where the seller receives the expected rent  $\rho \theta h$ . Thus, the inefficient cognition occurs in these  $T$  periods. After these  $T$  periods, they switch to the cooperative phase.

On the seller's side, we have to consider the incentive constraint of the informed type- $A'$  seller. The aware seller will not pretend to be unaware:

$$\tilde{p} + \delta V^+ \geq h + \delta V^-$$

which can be written as,

$$\tilde{p} \geq \tilde{p}^*(T) \equiv \frac{1 - \delta + \delta(1 - \delta^T)((\theta - \alpha)\rho + \alpha)}{1 - \delta + \delta(1 - \delta^T)((1 - \alpha)\rho + \alpha)} h, \quad (10)$$

which implies that

$$\frac{d\tilde{p}^*(T)}{dT} = \frac{\rho \delta^{T+1} (1 - \theta) (1 - \delta) \ln \delta}{(1 - \delta + \delta(1 - \delta^T)((1 - \alpha)\rho + \alpha))^2} h < 0.$$

**Proposition 6** *The minimal tip  $\tilde{p}^*(T)$  that the buyer has to reward the seller for not deviating is decreasing in the length of punishing the seller  $T$ .*

Intuitively, the tip  $\tilde{p}$  as a carrot and punishment length  $T$  as a stick are substitutes for the buyer to incentivize the seller's cooperative behavior.

Since mis-selling may occur by chance, our social goal is to minimize the punishment periods  $T$  in which the cognition costs of the buyer are involved. However, reducing  $T$  raises  $\tilde{p}^*(T)$ . On the buyer's side, the buyer's incentive constraint for not deviating is the same as before. Thus,  $\tilde{p}^*(T)$  is bound above by the buyer's incentive constraint (8). Inequation (8) implies  $\tilde{p}$  cannot exceed

$$\frac{\delta x (\rho h (1 - b^*) + C (b^*))}{1 - \delta + \rho \delta}.$$

Plugging it into equation (10), we have that in the equilibrium dynamics, the smallest punishment periods  $T^*$  has the property that  $\frac{dT^*}{d\alpha} > 0$ . Therefore, we obtain the following proposition:

**Proposition 7** *In the equilibrium dynamics, the pre-contractual cognition is strictly increasing in  $\alpha$  which is the probability that type- $A'$  seller is unaware of  $A'$ .*

Hence, the lack of knowledge of the seller that is unavoidable raises the transaction cost. In other words, specialization of the seller reduces the transaction cost.

## 5 Competition

In this section, we extend the model in section 3 to a setting with two sellers ( $S_1$  and  $S_2$ ) who simultaneously report the product in stage 2. The two sellers here are in the same industry. Thus, the product-appropriateness is industry-specific. The two sellers belong to the same type. If  $A$  is appropriate, they can only report  $A$ , but if  $A'$  is appropriate, the payoff matrix of their interaction situation is described in Table 1.

$S_1, S_2$	$A$	$A'$
$A$	$(1 - b^*)(\frac{h}{2} - t) + b^*(-t), (1 - b^*)(\frac{h}{2} - t) + b^*(-t)$	$-t, 0$
$A'$	$0, -t$	$0, 0$

Table 1: Payoff Matrix of Competition for two type- $A'$  Sellers

In the payoff matrix,  $b^*$  is the buyer's equilibrium cognition level in this competition context. If both sellers choose  $A'$ , they obtain payoff zero, no

matter whose product is chosen by the buyer in the end, which is due to the buyer's full bargaining power. If, say,  $S_1$  chooses  $A$  and  $S_2$  chooses  $A'$ , the buyer is immediately aware of  $A'$ . Then the buyer sues  $S_1$  for a transfer  $t$ . But  $S_2$  gets zero payoff. If they both choose  $A$ , they obtain their expected payoff. We assume that the two sellers have equal probability of being chosen. The gain of mis-selling is therefore  $\frac{h}{2} - t$ , since only one of their products can be chosen by the buyer, and the buyer can sue both sellers at the post-contractual stage.

In the case of competition, we have the following proposition.

**Proposition 8** *Suppose  $A$  is not appropriate. If  $\frac{h}{2} - t < 0$  or  $\rho h > C'(1 - \frac{2t}{h})$ , truth-telling by two sellers ( $A', A'$ ) is the unique equilibrium. Otherwise, we have multiple equilibria: truth-telling ( $A', A'$ ), mis-selling ( $A, A$ ) and the totally-mixed-strategy one. In the latter case, the disclosure decisions of  $A'$  are strategically complementary for the two sellers.*

**Proof.** See Appendix A.9. ■

As one would expect, truth-telling as an action profile ( $A', A'$ ) by two type- $A'$  sellers is an equilibrium in the Nash implementation fashion (Maskin, 1999). Given that one seller unveils  $A'$ , the other seller has no incentive to mis-sell due to the punishment  $t$  for mis-selling. Furthermore, if  $\frac{h}{2} - t < 0$ , announcing  $A'$  is also a strictly dominant strategy. In this case, the equilibrium ( $A', A'$ ) is therefore unique. Competition reduces the rent of mis-selling for the seller, and yet does not alter his cost of the transfer. Thus, no seller has an incentive to mis-sell.<sup>27</sup> Therefore, when competition is present, there exists separating equilibrium in the sense that both types of sellers truthfully report the appropriate product, which reduces the transaction cost to zero.

Nevertheless, competition is by no means a panacea. When  $\frac{h}{2} - t \geq 0$  and  $\rho h \leq C'(1 - \frac{2t}{h})$ , there are multiple equilibria. In essence, two type- $A'$  sellers' disclosure decisions of  $A'$  are strategically complementary. That is, they reveal their private information hand in hand here.<sup>28</sup>

<sup>27</sup>It implies here that the number of sellers and the transfer  $t$  are substitutes. Hence, introducing a sufficient number of sellers can always achieve the unique equilibrium ( $A', A'$ ) even though  $t$  is bounded above. In reality, however, only a limited number of sellers enter the market due to some entry barrier. Thus, without loss of generality, we assume there are only two such sellers.

<sup>28</sup>Notice that we can design the competition mechanism differently to let equilibrium

To sum up, competition *may* induce separating equilibrium, which minimizes the transaction cost. This result is in contrast to Tirole (2009). In the context of asymmetric information and the legal punishment for the seller who mis-sells, competition between sellers plays a role of reducing the transaction cost.

## 6 Concluding Remarks

### 6.1 Policy Recommendations

Atkinson et al. (2000) suggest *ex ante* solutions to the mis-selling problem mainly via promoting public awareness, say providing independent advice to consumers, and educating consumers through mass media, schools and so on. Korobkin (2003) also recommends *ex ante* intervention by legislatures, say mandatory information disclosure rule. However, the *ex ante* mechanism is valid only if the regulator knows the product-appropriateness in each industry, which is not plausible.

One may consider the possibility of using catch-all clauses in the law. For example, the legislator can require the seller to disclose all the add-ons without the need of describing the particular names of the add-ons. However, catch-all clauses are always vague. For instance, besides the cost of inks, consumers also need printing paper, a computer, and even electricity for using a printer. It is not reasonable, however, to define these additional costs as add-ons. Moreover, how the seller discloses the eye-opening information is relevant. If the seller puts the information only in fine print, it is nothing but mis-selling in our model. The cognition cost of the buyer turns to be the cost of reading the fine print. Further, fine print also weakens the instrument of warranties to solve the mis-selling problem, because the fine print per se involves a new problem of the buyer's limited cognition and the seller's "misrepresentation".

Some scholars suggest the *ex post* judicial mechanism, say by using the Unconscionability doctrine to interpret contracts, which refuses to enforce those contracts with unconscionable terms.<sup>29</sup> However, this doctrine as ap-

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( $A'$ ,  $A'$ ) more likely to be unique. If, say,  $S_1$  announces  $A$  and  $S_2$  announces  $A'$ ; we transfer the punishment  $t$  for  $S_1$  to  $S_2$ , then a weaker condition  $\frac{b}{4} - t < 0$  guarantees the equilibrium uniqueness.

<sup>29</sup>See Korobkin (2003) and Becher (2008).

plied by common law courts is not defined by status, and thus is too vague. By contrast, we suggest a mechanism in Appendix A.4 that may reduce the transaction cost. However, this judicial mechanism is still imperfect.

Nonetheless, our analysis shows that, without an omniscient legislator and a perfect judicial system, we can still achieve the ideal separating equilibrium in which the transaction cost vanishes via the market institution, namely reputation or competition.

First, to ensure the separating equilibrium by the reputation mechanism, we advocate “tips” in the economy, which require that both buyer and seller are sufficiently patient and the probability of detecting the past cheating behavior is sufficiently high, that is,  $x$  and  $\delta$  are high enough. A high  $\delta$  can be realized through some effort to reduce the mortality rate  $1 - \lambda$ . A high  $x$  can be achieved through freedom of the press, which means journalists have the opportunity to move without friction and to report scandals without any interference. In the case where it is commonly known that the seller is well-informed about the product-appropriateness, if the out-of-equilibrium shock of mis-selling occurs, amnesty can let the economy go back to the outcome where the pre-contractual cognition is completely saved. Thus, a firm with a mis-selling spot in the past should change its brand. Lastly, if the seller may be unaware as well, we should promote the specialization of the sellers in any industry to increase the probability of the seller’s awareness  $\alpha$  in order to reduce the transaction cost.

Second, to promote voluntarily information disclosure by the seller of buyer-unforeseen features of the product, we should reduce the entry barrier in the industry so as to induce competition among sellers.

It is worth noting that in the separating equilibrium neither mis-selling nor litigation occurs. Thus, even in a world where the transaction cost from direct mis-selling and litigation are non-negligible, these two market institutions still achieve the first best outcome.

## 6.2 Applications

The analytic framework of the seller’s strategic mis-selling against the buyer’s pre-contractual cognition in the case of asymmetric awareness can be applied to numerous problems.

In financial markets, investors may be uncertain as to whether or not the firm has false statements, but they can employ some accountant to audit the firm. Audit here can be interpreted as cognition. In contrast to the

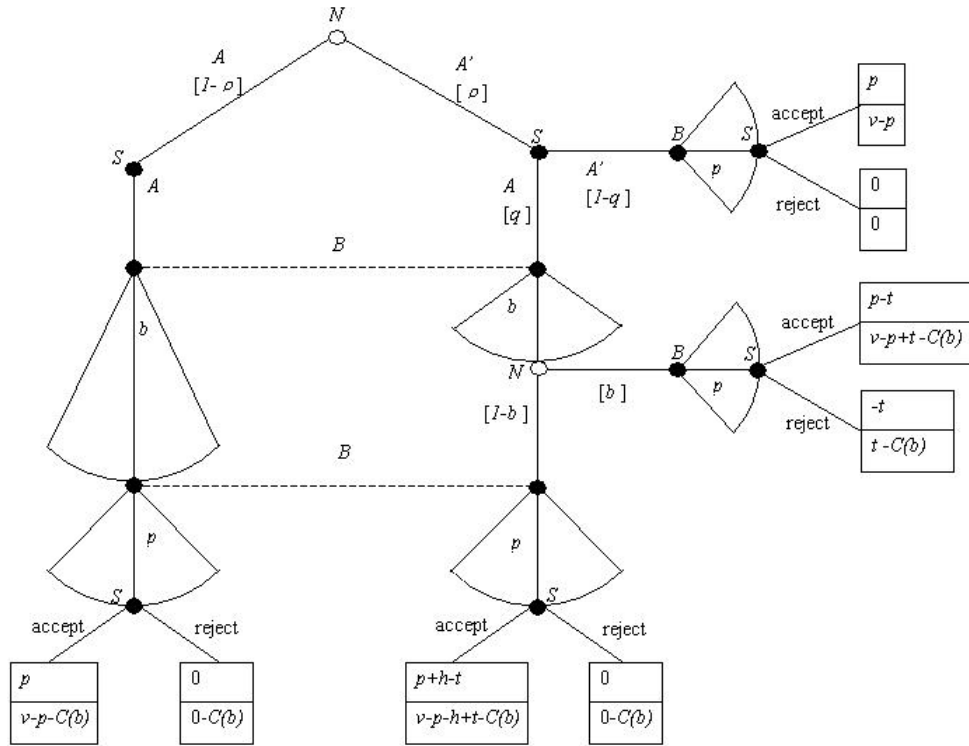
conventional audit literature, if the accountant finds that the firm is cheating, it must provide hard evidence. Otherwise, the investors remain uncertain, since finding nothing provides only soft information. In addition, the firm can also provide hard evidence of its own flaw. It would be interesting to study the strategic statements of the firm in the accounting problems.

In politics, there is also asymmetric information on the appropriateness of platforms between the politicians and voters. It would be also interesting to study strategic disclosure of flaws in competitors' platforms in political competition, given that the voters can make efforts to contemplate on the platforms.

Hence, our model is merely a starting point. These further issues give us a rich outline for the future research in asymmetric awareness and pre-contractual cognition in broader social problems.

# A Appendix

## A.1 Game Tree



## A.2 An Infinite-Horizon Bargaining Game where the Buyer makes All the Offers

Instead of assuming a take-it-or-leave-it offer of the buyer in the contracting stage, we consider here a general bargaining protocol where the buyer makes all the offers in an infinite-horizon bargaining game, which is based on Deneckere and Liang (2006). The buyer here can use delay as a screening device to separate the sellers' types.

The buyer's final equilibrium offer must be  $p_0 = 0$  where the subscript 0 denotes the last period. It is because any lower offer would not be accepted by type- $A$  seller, whereas any higher offer would be accepted, and therefore

dominated. We suppose now there are  $n(\geq 0)$  periods that remain before the last period with  $p_0 = 0$  in equilibrium. In order to minimize information rent for type- $A'$  seller, type- $A'$  seller should be indifferent between accepting the current offer  $p_n$  and waiting  $n$  more periods to receive  $p_0$ , i.e.,

$$h - t + p_n = \delta^n (h - t + p_0)$$

where  $\delta$  is the discount factor. Hence, the buyer optimally chooses  $p_n = (\delta^n - 1)(h - t)$  in the current period. The buyer's expected payoff is therefore

$$\begin{aligned} & (1 - \hat{\rho})\delta^n (v - p_0) + \hat{\rho}(v - h + t - p_n) - C(b) \\ & = (1 - \hat{\rho})\delta^n v + \hat{\rho}[v - \delta^n (h - t)] - C(b). \end{aligned}$$

It is left to determine the optimal periods of delay  $n$ . Assumption 1 implies

$$(1 - \rho)v > \rho(h - t)$$

that also implies

$$(1 - \hat{\rho})v > \hat{\rho}(h - t),$$

or equivalently

$$(1 - \delta^n)(1 - \hat{\rho})v > (1 - \delta^n)\hat{\rho}(h - t) \text{ for all } n > 0,$$

or, after some manipulations,

$$(1 - \hat{\rho})v + \hat{\rho}(v - (h - t)) - C(b) > (1 - \hat{\rho})\delta^n v + \hat{\rho}[v - \delta^n (h - t)] - C(b) \text{ for all } n > 0.$$

Hence  $n = 0$  is optimal for the buyer. That is, the buyer optimally chooses  $p_0 = 0$  in the first period, which leads to pooling equilibrium.

Note that since we have implicitly assumed perfect commitment of strategies *ex ante*, we have ignored the renegotiation problem after the buyer observes one period of delay. Nevertheless, the pooling equilibrium is per se renegotiation-proof. Hence, the result  $p_0 = 0$  in the first period is also robust to the possibility of renegotiation.

### A.3 Multiple Buyers in the Pooling Equilibrium

We assume that the economy has two buyers ( $B_1$  and  $B_2$ ). For the exposition of the idea of the results after introducing multiple buyers, we focus only the pooling equilibrium.

Given buyer 2's cognition level  $b_2$ , buyer 1 chooses  $b_1$  to maximize

$$(1 - \rho)v + \rho(b_1 b_2 + b_1(1 - b_2) + (1 - b_1)b_2) \left( v + \frac{t}{2} \right) + \rho(1 - b_1)(1 - b_2) \left( v - h + \frac{t}{2} \right) - C(b_1).$$

Here  $t$  is maximal transfer from the seller. When mis-selling is detected, the monetary punishment for the seller is returned to the society. Thus, each buyer shares half of the transfer.

Since the problem is symmetric for buyer 2, the equilibrium cognition levels of two buyers are  $b_1 = b_2 = b^*$  such that

$$(1 - b^*)\rho h = C'(b^*).$$

Thus, the equilibrium cognition level in the pooling equilibrium is lower compared to the single-buyer case, as each buyer can free ride the other buyer's cognition. However, because there are two buyers here, it is still ambiguous whether the total transaction cost is lower or not.

Note that the analysis above assumes away the possibility of collusion between one buyer and the seller. (Tirole, 1986) When one buyer finds mis-selling and the other does not, the informed buyer can be silent on the information of the mis-selling and ask the seller for a secrete transfer up to  $t$ . Thus, the unique informed buyer has to be rewarded by the total transfer in a collusion-proof equilibrium.

Therefore buyer 1 chooses  $b_1$  to maximize

$$(1 - \rho)v + \rho b_1 b_2 \left( v + \frac{t}{2} \right) + \rho b_1(1 - b_2)(v + t) + \rho(1 - b_1)b_2 v + \rho(1 - b_1)(1 - b_2) \left( v - h + \frac{t}{2} \right) - C(b_1).$$

The equilibrium cognition levels of two buyers are  $b_1 = b_2 = b^{**}$  such that

$$(1 - b^{**})\rho h + \frac{\rho t}{2} = C'(b^{**}).$$

Each buyer is therefore incentivized to choose a higher cognition level  $b^{**}$  compared to the equilibrium cognition level in the collusion-free case.

Note that it is ambiguous whether each buyer's cognition in the collusion-proof equilibrium is higher or lower than that in the pooling equilibrium in the single-buyer case. The buyer is more likely to choose a higher cognition level in the two-buyer case if the problem of collusion dominates the free riding problem, i.e.,  $t$  is relatively high.<sup>30</sup>

#### A.4 A Litigation Process to Punish type- $A'$ seller and Reward the Buyer

In this section, we show that the transfer  $t$  from the seller to the buyer in the case of mis-selling is bounded above by mechanism design approach.

Assume the goal of the benevolent court of law is to transfer  $t$  units of money from the seller to the buyer if and only if  $A'$  is appropriate and the seller mis-sells. Note that both parties' preferences over the transfer decision are state-independent, i.e., the seller always prefers no transfer, and the buyer always prefers a transfer. Hence, the standard implementation approach cannot provide unique equilibrium that implements the court's goal. However, in contrast to the standard implementation problem, we assume here that type- $A'$  seller can provide hard evidences of the mis-selling behavior, where as type- $A$  seller and the buyer can only make the cheap talk. The litigation process is based on a mechanism by Ben-Porath and Lipman (2008).

The mechanism is as follows. The seller chooses between providing (the evidence of his type)  $A'$  or nothing. If  $A'$  is provided, the game ends, and the transfer is realized. If nothing is provided, which is interpreted as the seller's claim of his type  $A$ , the buyer then chooses between saying  $A$  is appropriate and not. The former is interpreted as the buyer's agreement with the seller, whereas the later is interpreted as her challenge to him. If the buyer says  $A$  is not appropriate, the game ends, and the transfer is realized. But the buyer is punished by  $f_1(> t)$ , and the seller is punished by  $\varepsilon(> 0)$ . If the buyer says  $A$  is appropriate, then the seller has another chance to provide the evidence. If the evidence  $A'$  is provided, the transfer is realized. Now the buyer is punished by  $f_2(> f_1)$ , and the seller is rewarded by  $r_2(> t)$ . If nothing is provided again, the game ends without any transfer of money.

We now prove that this mechanism implements the court's goal.

Suppose  $A$  is appropriate. The seller can provide nothing in each stage.

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<sup>30</sup>A similar discussion on the free riding and collusion problems in the context of patent challenges with multiple buyers is in Chiou (2007).

If the buyer says  $A$  is appropriate, she receives zero. If not, the buyer receives  $t - f_1$ . Thus, the buyer will not challenge, and the transfer is not made.

Suppose  $A$  is not appropriate. In the last stage, the seller receives  $r_2 - t$  for providing the evidence and zero otherwise. Thus, the seller will provide the evidence. Taking it into account, the buyer knows that she receives  $t - f_2$  for saying that  $A$  is appropriate and  $t - f_1$  otherwise. Thus, the buyer will challenge the seller's mis-report. Lastly, in the first stage, the seller will provide the evidence  $A'$ , since  $\varepsilon > 0$ .

Hence, no matter  $A$  is appropriate or not, there is a *unique* subgame perfect equilibrium where the court's goal is implemented.

It is worth mentioning that most buyers cannot be punished arbitrarily off the equilibrium path, due to limited liabilities of the parties. Since the mechanism requires that  $f_2 > f_1 > t$ , the court cannot raise  $t$  arbitrarily to deter the mis-selling here.

Although the mechanism is only one possible litigation process, along the lines of Ben-Porath and Lipman (2008), we can further show that there is no perfect information mechanism<sup>31</sup> with punishment bounded below  $\frac{t}{2}$  that implements the court's goal. Suppose by contradiction there is one. Suppose  $A$  is appropriate. Let  $(\sigma_B^*, \sigma_S^*)$  be a subgame perfect equilibrium. Then, for all  $\sigma_B$ , when  $(\sigma_B, \sigma_S^*)$  is played, the probability that the transfer is realized is strictly less than  $1/2$ . To see it, suppose not. For some  $\sigma_B'$ , when  $(\sigma_B', \sigma_S^*)$  is played, the probability that the transfer is realized is greater or equal than  $1/2$ . The buyer then has an incentive to deviate to  $\sigma_B'$ , because her expected payoff is strictly positive, since the punishment is strictly less than  $\frac{t}{2}$ . So  $(\sigma_B^*, \sigma_S^*)$  is not an equilibrium, a contradiction. Thus, by playing  $\sigma_S^*$ , the seller receives an expected payoff strictly greater than  $-t$ , since the probability of being punished is less than  $1/2$ , and the punishment is strictly less than  $\frac{t}{2}$ . Now suppose  $A$  is not appropriate. The strategy sets of the buyer and the seller are the same as before. Then the seller can choose  $\sigma_S^*$  to guarantee an expected payoff strictly greater than  $-t$ . Hence, the transfer cannot be realized when  $A$  is not appropriate, a contradiction.

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<sup>31</sup>A perfect information mechanism is a sequential-move game where the past actions are perfectly observed. Here the actions are providing hard evidences or cheap talks.

## A.5 Connection to Games with Unawareness

Suppose that the seller knows the true game as shown in Appendix A.1. However, after the seller says that  $A$  is appropriate, at either node in the buyer’s non-singleton information set, the game tree from the buyer’s view is described in Figure 5, which is almost the same as the true game, except the prior probability  $\rho$  and the name of  $A'$ . The buyer still does not know whether something will go wrong for  $A$ , and believes that, with probability  $\phi$ ,  $A$  is not appropriate and some novel product  $X$ , which she is unaware of, delivers utility  $v$  to her. Here  $X$  is a “virtual move” by nature in the buyer’s subjective game in terms of Halpern and Rego (2006).

The extended solution of the games with unawareness is the same as the corresponding solution in our original game, except that the objective extent of the mis-selling  $\rho$  is replaced by the buyer’s subjective one  $\phi$ . Thus, from the behavioral point of view, there is no qualitative difference between these two models whenever  $\phi > 0$ . As the buyer is aware that something may go wrong for  $A$ , she believes that  $\phi > 0$ . Further, the buyer may have sufficient experience of purchasing products. Thus, it is also plausible that the buyer knows the correct prior  $\rho$ . However, the problem is that Bayesian approach in our original model lacks the epistemic foundation of unawareness.

## A.6 The Case where Assumption 1 fails

When Assumption 1 fails, the buyer contemplates three alternatives.

First, the buyer exerts  $b^*$ , and contracts with both types of sellers. The result is described in Proposition 1.

Second, the buyer exerts  $b'$ , and contracts with only type- $A'$  seller. Under this plan, the buyer proposes  $p = h - t$ , and therefore solves the following problem upon observing  $A$ :

$$\max_b \frac{(1 - \rho)0 + \rho qb(v + t) + \rho q(1 - b)v}{1 - \rho + \rho q} - C(b).$$

Compared to the first plan, the buyer loses utility  $v$  from contracting with type- $A$  seller, but gains additional utility  $h - t$  from type- $A'$  seller in the case where mis-selling is not detected. Since the price  $h - t$  is so low that it is common knowledge that the trade occurs only if  $A$  is not appropriate, there is no transfer *ex post* in this case.

The optimal cognition level is  $b'$  is characterized by

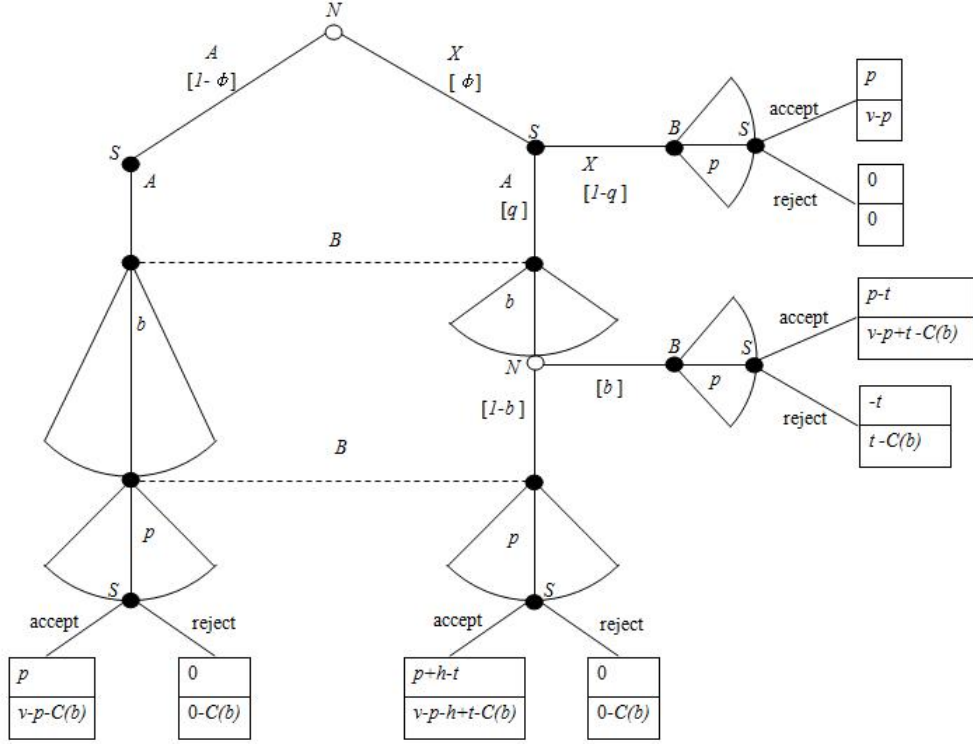


Figure 5: Game tree from the buyer's view upon observing  $A$

$$C'(b') = \frac{\rho qt}{1 - \rho + \rho q}. \quad (11)$$

Suppose the second plan is strictly better than the first one for the buyer, which is possible only for a positive  $q$ . Equation (11) implies  $b'$  is also positive. However, because type- $A'$  seller's expected net payoff from mis-selling is

$$(1 - b')0 + b'(-t) < 0$$

for any  $b' > 0$ , type- $A'$  seller's optimal  $q$  is zero, a contradiction.

Hence, there is no equilibrium in which the buyer strictly prefers the second plan.

Third, the buyer may exert some cognition effort, and contracts with no sellers. Under this plan, the buyer proposes any price  $p > h - t$ , and therefore

solves the following problem upon observing  $A$ :

$$\max_b \frac{(1-\rho)0 + \rho qb(v+t) + \rho q(1-b)0}{1-\rho + \rho q} - C(b).$$

Along similar lines of the arguments in the second plan, there is no equilibrium in which the buyer strictly prefers the third plan.

## A.7 Proof of Proposition 2

When  $\rho h \leq C'(1 - \frac{t}{h})$ , there is a pooling equilibrium, so  $q = 1$ . The transaction cost is therefore  $L = C(b)$ . By (2), we have that

$$\frac{dL}{d\rho} > 0, \quad \frac{dL}{dh} > 0, \quad \text{and} \quad \frac{dL}{dt} = 0.$$

When  $\rho h > C'(1 - \frac{t}{h})$ , there is a semi-separating equilibrium.

First, we show  $\frac{dL}{d\rho} < 0$ .

To see this, by equation (6), we have  $\frac{dC(b)}{d\rho} = 0$ . Thus

$$\frac{dL}{d\rho} = C(b) \frac{d(1 - \rho(1 - q))}{d\rho}.$$

Equation (7) implies

$$\frac{d\rho q}{d\rho} = \frac{d\left(\frac{(1-\rho)C'(1-\frac{t}{h})}{h-C'(1-\frac{t}{h})}\right)}{d\rho} = -\frac{C'(1-\frac{t}{h})}{h-C'(1-\frac{t}{h})}.$$

Since  $h - C'(1 - \frac{t}{h}) > 0$  (otherwise,  $q < 0$  by equation (7)), we have  $\frac{d\rho q}{d\rho} < 0$ . Furthermore, we have

$$\frac{d(1 - \rho(1 - q))}{d\rho} = -1 + \frac{d\rho q}{d\rho} < 0.$$

We therefore obtain  $\frac{dL}{d\rho} < 0$ .

Second, we judge the sign of  $\frac{dL}{dh}$ .

By definition,

$$\frac{dL}{dh} = (1 - \rho(1 - q))C'(b) \frac{db}{dh} + C(b) \frac{d(1 - \rho(1 - q))}{dh}.$$

Equation (6) and (7) imply

$$\begin{aligned}\frac{dL}{dh} &= (1 - \rho(1 - q^*)) C'(b^*) \frac{t}{h^2} + C(b^*)(1 - \rho) \frac{tC''(b^*) - hC'(b^*)}{h(h - C'(b^*))^2} \\ &= \frac{1 - \rho}{h(C'(b^*) - h)^2} [tC'(b^*)(h - C'(b^*)) + C(b^*)(tC''(b^*) - hC'(b^*))]\end{aligned}$$

of which the sign is ambiguous. If  $tC''(b^*)$  is sufficiently low compared to  $hC'(b^*)$ , we have  $\frac{dL}{dh} < 0$ , although we have  $h - C'(b^*) > 0$  here. Otherwise, we have  $\frac{dL}{dh} > 0$ .

Lastly, we show  $\frac{dL}{dt} < 0$ .

To show this, we first have

$$\frac{dL}{dt} = (1 - \rho(1 - q))C'(b) \frac{db}{dt} + C(b) \frac{d(1 - \rho(1 - q))}{dt}.$$

By equation (6) and (7), we have

$$\frac{dL}{dt} = -\frac{(1 - \rho(1 - q^*))C'(b^*)}{h} - \frac{C(b^*)(1 - \rho)C''(b^*)}{h(h - C'(b^*))^2} < 0.$$

## A.8 Proof of zero-rewarding when $A$ is appropriate at the post-contractual stage in Section 4

We now consider the possibility that a tip is also given to type- $A$  seller.

Consider the following strategy profile in the stage game.

Type- $A'$  seller always unveils  $A'$ , but the buyer pays some price  $\tilde{p}' > 0$  for  $A'$  after  $A'$  is reported and pays some price  $\tilde{p} > 0$  for  $A$  if  $A$  is de facto appropriate at the post contractual stage, and the buyer does not think at all ( $b = 0$ ). The actions in the other nodes in the stage game are the same as in Proposition 1.

Detection of deviation in the past leads to the outcome that two parties play the pooling equilibrium in this period.

First, we check type- $A'$  seller's incentive for a deviation. If he deviates from revealing  $A'$ , his *net* gain in the current period is  $h - \tilde{p}'$ .

However, the seller's loss in the future is

$$\frac{\delta}{1 - \delta} ((1 - \rho)x\tilde{p} + \rho(\tilde{p}' - (1 - x)h - x(1 - b^*)h)).$$

where  $b^*$  is given by equation (2). In each period, if  $A$  is appropriate, which happens with probability  $1 - \rho$ , the seller loses utility  $\tilde{p}$  given that he is detected. If  $A$  is not appropriate, which happens with probability  $\rho$ , the seller loses the tip  $\tilde{p}'$  and yet gains the expected rent  $(1 - x)h + x(1 - b^*)h$  from mis-selling.

Hence, type- $A'$  seller has no incentive to mis-sell if

$$\tilde{p}' \geq \frac{(1 - \delta + \delta\rho(1 - xb^*))h - \tilde{p}x\delta(1 - \rho)}{1 - \delta + \rho\delta}.$$

Thus, the buyer has to commit to remunerate at least

$$\tilde{p}'(\tilde{p}) \equiv \frac{(1 - \delta + \delta\rho(1 - xb^*))h - \tilde{p}x\delta(1 - \rho)}{1 - \delta + \rho\delta}$$

to type- $A'$  seller in order to enhance his truthful report. Note that  $\tilde{p}'$  and  $\tilde{p}$  are *substitutes* for the seller's truthful report.

Second, we check the buyer's incentive for a deviation.

Suppose  $A$  is not appropriate. If she deviates from paying  $\tilde{p}'(\tilde{p})$  for type- $A'$  seller with a truthful report, her net gain in the current period is  $\tilde{p}'(\tilde{p})$ , where the buyer only pays price zero so as to guarantee the seller's acceptance of the contract.

However, the buyer loses her reputation in expectation and the loss in the future is

$$\frac{\delta}{1 - \delta} (xC(b^*) + \rho x(1 - b^*)h - \rho\tilde{p}'(\tilde{p}) - (1 - \rho)\tilde{p}).$$

In each future period, if the buyer's misbehavior is detected, which occurs with probability  $x$ , the buyer has to bear the cognition cost  $C(b^*)$ . With probability  $\rho x(1 - b^*)$ , she is mis-sold to. But she has not to pay  $\tilde{p}'(\tilde{p})$  with probability  $\rho$  and  $\tilde{p}$  with probability  $1 - \rho$ .

Hence, substituting for  $\tilde{p}'(\tilde{p})$  and after some manipulation, the buyer has no incentive to misbehave if

$$\tilde{p} \leq \frac{\delta x C(b^*) - (1 - \delta(1 - \rho(1 - x)))h}{\delta(1 - x)(1 - \rho)} \quad (12)$$

Thus, a smaller  $\tilde{p}$  enhances the buyer's incentive for giving a tip to the seller for his truthful report when  $A$  is not appropriate.

Suppose  $A$  is appropriate. If she deviates from paying  $\tilde{p}$  for type- $A$  seller at the post-contractual stage, her net gain in the current period is  $\tilde{p}$ .

The buyer's loss in the future is also

$$\frac{\delta}{1-\delta} (xC(b^*) + \rho x(1-b^*)h - \rho\tilde{p}(\tilde{p}) - (1-\rho)\tilde{p}).$$

Similarly, the buyer has no incentive to misbehave if

$$\tilde{p} \leq \frac{\delta((1-\delta+\rho\delta)xC(b^*) + \rho h(x+\delta-bx-x\delta-\rho\delta+bx\delta+x\rho\delta-1))}{1-\delta+\delta^2\rho(1-x)(1-\rho)} \quad (13)$$

Hence, by inequation (12) and (13), we find that  $\tilde{p} = 0$  makes separating equilibrium in each period most likely to occur.

Furthermore, when  $\tilde{p} = 0$ , condition (12), which turns to be equivalent to condition (9), implies condition (13).

To show it, condition (13) is equivalent to

$$(1-\delta+\rho\delta)xC(b^*) + \rho h(x+\delta-bx-x\delta-\rho\delta+bx\delta+x\rho\delta-1) > 0,$$

that is,

$$C(b^*) > \frac{\rho h(bx-\delta-x+x\delta+\rho\delta-bx\delta-x\rho\delta+1)}{(1-\delta+\rho\delta)x}.$$

Therefore, by condition (9), it is equivalent to show

$$D \equiv \frac{(1-\delta(1-\rho(1-x)))h}{\delta x} - \frac{\rho h(bx-\delta-x+x\delta+\rho\delta-bx\delta-x\rho\delta+1)}{(1-\delta+\rho\delta)x} > 0,$$

which always holds, since

$$D = \frac{(1-\delta)(1-\delta+\rho\delta(1-bx))h}{\delta x(1-\delta+\rho\delta)} > 0.$$

## A.9 Proof of Proposition 8

Obviously,  $(A', A')$  is an equilibrium, since  $t > 0$ .

If  $\frac{h}{2} - t < 0$ , announcing  $A'$  is also a strictly dominant strategy. Thus,  $(A', A')$  is the unique equilibrium.

If  $\frac{h}{2} - t \geq 0$ , by a similar reasoning in section 3, there are two cases.

The first case is  $\rho h \leq C'(1 - \frac{2t}{h})$ .

In this case,  $(A, A)$  is also an equilibrium, because we now have

$$(1 - b^*)\left(\frac{h}{2} - t\right) + b^*(-t) \geq 0. \quad (14)$$

where  $b^*$  is given by equation (2). For the buyer, after she chooses one of the sellers while facing  $(A, A)$ , the game is the same as that in section 3, except that  $t$  in the buyer's payoff is doubled, because she may *ex post* sue both type- $A'$  sellers. However, this does not change the equilibrium cognition level  $b^*$ , as  $b^*$  is independent of  $t$ .

We now look for a mixed-strategy equilibrium. Let  $q_i$  be the probability that seller  $S_i$  chooses  $A$  for  $i = 1, 2$ . Since  $b$  is determined by  $q_1$  and  $q_2$ , in any equilibrium, we have

$$C'(b) = \frac{\rho q_1 q_2 h}{1 - \rho + \rho q_1 q_2}. \quad (15)$$

Note that if  $q_1 = 0$ , then  $S_2$  chooses  $A'$  with certainty since  $t > 0$ , which leads to equilibrium  $(A', A')$ . If  $q_1 = 1$ , then  $S_2$  chooses  $A$  with certainty by inequation (14), which leads to equilibrium  $(A, A)$ . Thus, we look for the totally-mixed-strategy equilibrium. Hence, two sellers must be both indifferent between  $A$  and  $A'$ . The following two conditions therefore hold.

$$q_1 \left[ (1 - b)\left(\frac{h}{2} - t\right) + b(-t) \right] - (1 - q_1)t = 0. \quad (16)$$

$$q_2 \left[ (1 - b)\left(\frac{h}{2} - t\right) + b(-t) \right] - (1 - q_2)t = 0. \quad (17)$$

So the mixed-strategy equilibrium is characterized by equation (15)-(17).

Obviously, in equilibrium, we have  $q_1 = q_2$ . Otherwise, equation (16)-(17) cannot hold. Hence, the disclosure decisions of  $A'$  are strategically complementary for two type- $A'$  sellers in this case.

Furthermore, the totally-mixed-strategy equilibrium exists, because of inequation (14) and  $t > 0$ .

The second case to consider is  $\rho h > C'(1 - \frac{2t}{h})$ .

Then  $(A, A)$  is not an equilibrium because in this case we have

$$(1 - b^*)\left(\frac{h}{2} - t\right) + b^*(-t) < 0.$$

Furthermore, the totally-mixed-strategy equilibrium does not exist as well, since inequation (14) fails and yet  $t > 0$ .

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