# Trade with Asymmetric Information

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Events in financial markets before and during the crisis of late 2008 have stimulated renewed interest in modeling trade with asymmetric information. Robert Shimer's contribution to this volume joins the literature focusing on trade in securities that are claims on mortgages, where issuers of the securities had, in some important cases, superior information over investors about the probability distribution of payoffs from the mortgages.

The modern literature on trade with asymmetric information began with Akerlof (1970), a paper with 17,134 google scholar citations. The paper has been gaining citations recently at the astonishing rate of 161 per month. Consider the following setup that captures Akerlof's ideas: Two agents, one a buyer and the other a seller, are considering trading an object. The seller has private value S, a random variable unknown to the buyer. That buyer has a value $B = B(S) + \varepsilon$. The random variable $\varepsilon$ is known by the buyer and unknown by the seller. To the extent that $B(S)$ depends on $S$, the buyer's value is unknown to the buyer.

In a desirable trade, the buyer's realized value exceeds the seller's value ($B > S$), while in an undesirable trade, the reverse holds. A trading protocol is a set of rules governing the interaction of buyer and seller as they attempt to make a trade. A protocol can be like an auction where both sides submit bids, or can involve bargaining, where the parties make alternating offers until some stopping condition is satisfied. The central question in the literature is the

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efficiency of a protocol. A fully efficient protocol maximizes the gains to trade by generating every desirable trade and excluding every undesirable trade.

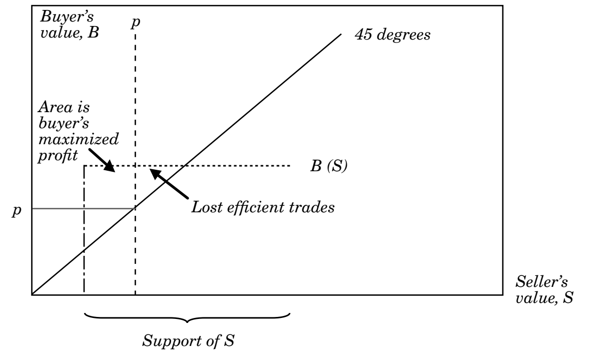
A threshold question in this literature is whether a third agent can hold an equity position in the trade. If so, a Vickrey protocol may deliver outstanding results. For example, in the case where B does not depend on S, that protocol would have both parties submit bids, with each party paying the amount the other bid, provided the buyer's bid exceeds the seller's. For all desirable trades, the third party would be making up the difference, paying the seller the difference between the two bids. The literature almost invariably excludes this possibility—protocols are limited to those where the seller receives what the buyer pays. The exclusion seems realistic, as it is hard to think of any practical examples of protocols with third parties who pay in.

Chatterjee & Samuelson (1983) was an early contribution in this framework, without the extra complication of the dependence of the buyer's value on the seller's value—the lemons problem. In their protocol, the buyer and the seller submit bids and the transaction occurs if the buyer submits a higher price than the seller. The buyer pays the seller a weighted average of the two bids, so the buyer always pays less than bid and the seller always receives a price higher than bid. Thus the protocol gains some of the efficiency of Vickrey while excluding any third-party pay in. The authors observed that the protocol supported many (but not all) desirable trades and excluded all undesirable ones. In the case of no correlation between the buyer's and seller's values, private information is not a big obstacle to trade. The desirable trades that the Chatterjee-Samuelson auction failed to consummate were those with lower joint value, so the failure is not too costly to the parties.

Myerson & Satterthwaite (1983) then proved a famous theorem showing the impossibility of achieving fully efficient trade with bilateral uncorrelated values ($B$ not a function of $S$) using any balanced-budget protocol.

Samuelson (1984) was an early discussion of the full Akerlof problem including the dependence of the buyer's realized value $B$ on the seller's value—the lemons problem. Akerlof demonstrated that trade could fail completely with a sufficiently strong dependence. Samuelson confirmed that the no-trade result is especially likely when the buyer's realized value moves one-for-one with the seller's value ($B'(S) = 1$). In this case, the buyer really cares about the

**Figure 1. Buyer Sets Price; Buyer's Value Constant**




Source: Authors' elaboration.

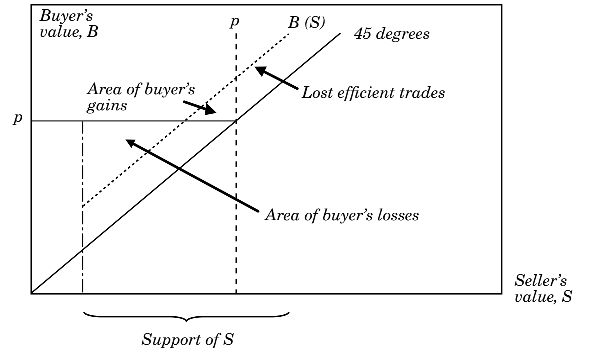
possibility that the seller has offered the object because it has a low value. Samuelson went on to show that a bargaining protocol where the buyer offers the seller a take-it-or-leave-it price is optimal for the buyer and maximizes the frequency of trading, though it leaves many efficient trades unexecuted. See also Kennan & Wilson (1993) and Chiu and Koeppl (2011) on this topic.

Figure 1 is the first of a sequence of graphs illustrating the basic issues. In all of the graphs, the horizontal axis is the seller's value and the vertical axis is the buyer's realized value. Points above the 45° line correspond to desirable trades. The buyer's take-it-or-leave-it price is the vertical line headed $p$ and the horizontal line also labeled $p$. In figure 1, there is no connection between the buyer's value and the seller's value—that is, no lemons problem. For simplicity, I omit the uncorrelated element called $\varepsilon$ above, so all trades take place along a line in the graphs.

In figure 1, there is a line of lost desirable trades where the buyer's value exceeds the price the buyer is offering. Trade occurs whenever the seller's value is below $p$, to the left of the vertical line. Because $p$ is less than $B$, the buyer gains from all trades. The area of the rectangle between $p$ and $B$ is the buyer's profit (integrated over that part of the distribution of $S$). The buyer picks the price $p$ to maximize that area.

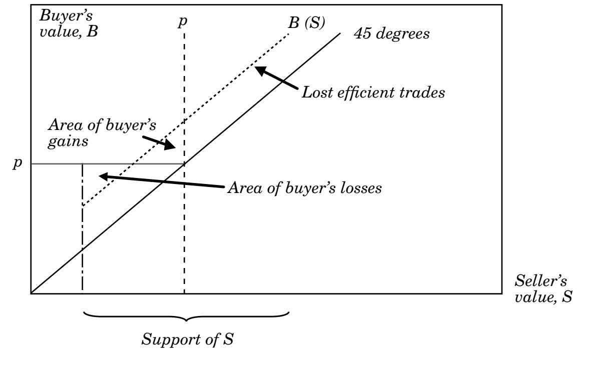
Figure 2 considers the case where the buyer's value *B(S)* rises point-for-point with $S$, so it is a parallel line above the 45° line. Trade

**Figure 2. Buyer Sets Price; Buyer's Value Rises with Seller's Value; High Price**




Source: Authors' elaboration.

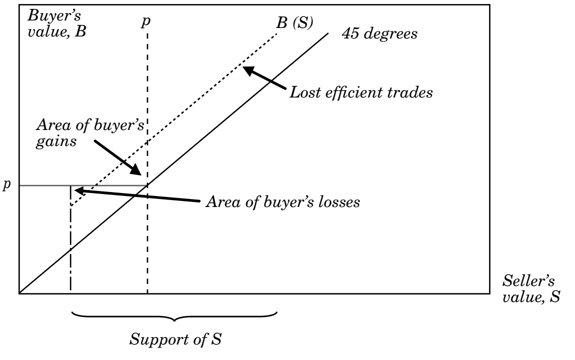
**Figure 3. Buyer Sets Price; Buyer's Value Rises with Seller's Value; Lower Price**




Source: Authors' elaboration.

is always desirable. In this figure, the buyer has chosen a high price, well up the support of $S$. The high price means that the line of non-trade is short. On the other hand, the line upon which trade occurs now extends deeply into the territory where the buyer incurs a loss from the transaction. Recall that this cannot occur in the uncorrelated

**Figure 4. Buyer Sets Price; Buyer's Value Rises with Seller's Value; Even Lower Price**




Source: Authors' elaboration.

case, but it is the big danger with positive correlation. The area of the triangle above the horizontal *p* line measures the gains when the buyer's value is above *p*, but that area may be more than offset by the area of the triangle where S is less than *p* and the buyer is incurring losses. Again, these areas are integrals over the distribution of *S*; they are literally areas only if the distribution of *S* is uniform.

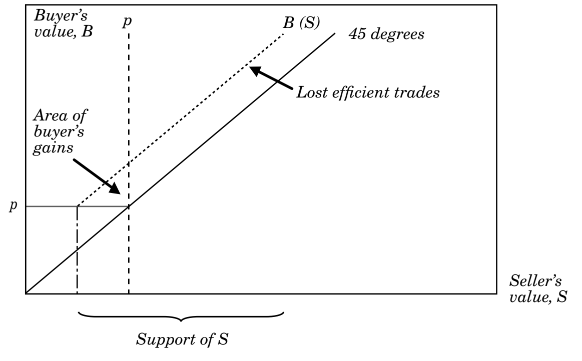
Figure 3 shows the potential benefit to the buyer of setting a lower price. That price lengthens the line of missed beneficial trades, but lowers the area of buyer's losses. Still, in the case of a uniform distribution of *S*, the net benefit to the buyer is zero.

Figure 4 shows the consequences of an even lower price. Even more beneficial high-seller-value trades are lost, but the area where the buyer trades, but at a loss, is much smaller.

Figure 5 shows the optimal price (in the case of a uniform distribution) where the buyer loses a large fraction of the potential benefit of higher-value trades but avoids all losing trades. This graph makes Akerlof's main point—the lemons problem may drive a market to the point of low volumes of trade even though the potential benefits of trade are high.

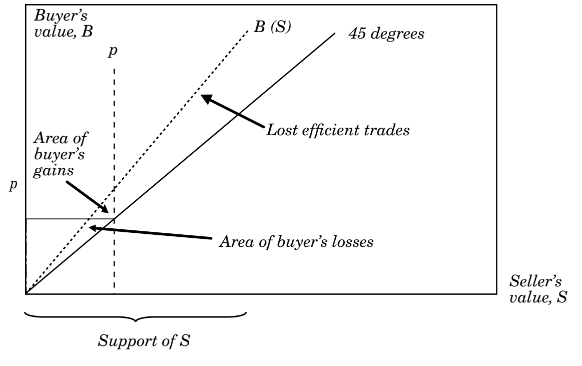
Finally, figure 6 shows what happens in the case where the buyer's value rises more than point-for-point with the seller's value. It is no longer the case that the buyer can pick a price that avoids any chance of trading at a loss while retaining a positive probability of

**Figure 5. Buyer Sets Price; Buyer's Value Rises with Seller's Value; Optimal Low Price**




Source: Authors' elaboration.

**Figure 6. Buyer Sets Prices; *B*'(*S*) > 1**




Source: Authors' elaboration.

trading at all. Akerlof's point that markets can collapse completely is particularly strong in this case. Models explaining the complete cessation of trading in many types of mortgage-related securities during and after the crisis rest on this analysis.

Recently, some literature has emerged considering the possibility of a second dimension of private information. With one dimension, as in Akerlof's original model, buyers make inferences about the quality of a car based on a single bit of information, the seller's decision to offer the car for sale. With a second dimension of private information—for example, urgency of the seller's desire to sell—buyers still have only that single bit of information, but interpret it in terms of both dimensions. To the extent that the population of sellers has a lot of urgent ones, the adverse selection problem is alleviated. In the real-estate market, it is common to see the claim of a "motivated seller." In general, sellers will try to offer some reason for selling other than a desire to dispose of a lemon.

There is an interesting interaction between the lemons theory and another line of research stimulated by the financial crisis, the theory of fire sales. That theory considers the decline in selling prices suffered when large numbers of holders of a type of security try to sell simultaneously. If the sales occur because of events exogenous to the sellers—as surely occurred during the crisis in many cases—the Akerlof adverse selection problem would be alleviated, because the fraction of sellers offering lemons falls in those cases.

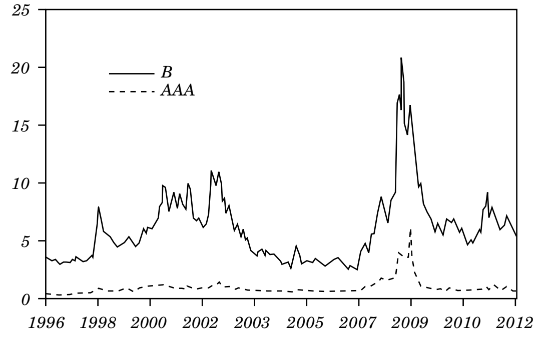
See Rochet and Choné (1998) to see how complex the theory becomes with more than one dimension of asymmetric information.

Where are adverse selection problems most severe in the real world? Definitely for goods and property—Akerlof chose the natural example of the used-car market. In securities markets, adverse selection has long been an explanation of the low volume of issuance of new equity by established companies. Bonds, especially mortgage-backed bonds with ample backing, such as overcollateralized senior tranches, traditionally traded as cash-like, with little concern about adverse selection. With large declines in the value of the collateral, the information-sensitivity of the bonds became much higher.

What aspects of asset-pricing events in the crisis do a model emphasizing adverse selection address? I would say meltdown in MBSs, for sure. But the apparent mispricing of government and corporate bonds requires other explanations, including fire sales. Figure 7 shows the wild movements of corporate bond spreads over Treasurys during the crisis. And even within Treasurys, the behavior of some spreads was remarkable and surely not the result of any information factors. Figure 8 shows the spread of inflation-protected Treasury bonds adjusted for the inflation protection by subtracting the expected rate of inflation from the inflation swap market.

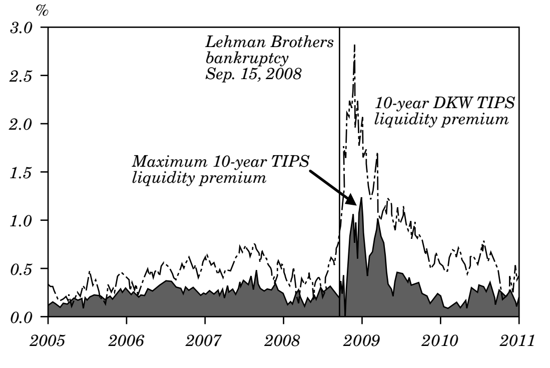
Because much of the attention currently being given to adverse selection in securities markets focuses on mortgage-backed bonds, it

**Figure 7. Corporate Bond Spreads over Comparable Treasurys**




Source: Board of Governors of the Federal Reserve System.

**Figure 8. TIPS Spread over Treasurys Less Inflation Swap Rate**




Source: Board of Governors of the Federal Reserve System.

is useful to note how these markets work. Generally, in normal times, the bonds are sold in a thick primary dealer market shortly before issuance to buy-and-hold investors. The secondary market is a thin dealer market where buyers and sellers dicker with dealers (who are mostly large banks). Search with recall seems the best description (see Zhu, 2012 and McAfee and McMillan, 1988).

The standard view of the freeze-up of MBS markets is the following: Before the crisis, overcollateralized claims on mortgage portfolios had zero perceived default probabilities and traded as safe bonds. Investors had essentially no concern about the compositions of the portfolios, so adverse selection was not a factor in transactions.

In the crisis, investors learned that overcollateralization was inadequate, given the magnitude of real-estate price declines, so they changed mode and adverse selection became a big issue. As all adverse-selection models predict, the result was a decline in transaction prices and in the likelihood that a seller could make a deal with a buyer. Fire sales occurred as financial institutions came under pressure from funding sources, so normally inactive secondary markets saw large volumes of selling interest.

The insights of Akerlof's 1970 paper continue to shape thinking about the performance of markets, especially securities markets since the financial crisis.

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