Risky Business:
The Clearance and Settlement of Financial Transactions

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ABSTRACT

The process of clearing and settling trades involves risks to both investors and the brokerage firms that represent them. Because of this, the International Organization of Securities Commissions (IOSCO) has appointed a technical committee to explore the problems of clearing and settlement in a global market. We argue for minimizing the length of the settlement cycle. This is a consideration that IOSCO should address.

In this paper we explore the nature of these risks, how they can be reduced; and we develop a way to estimate the size of these risks and their impact on transaction costs. We demonstrate that the risk brokerage firms face increases as the length of the settlement cycle increases. We provide a method to quantify some of the effects on transaction costs of changes in the settlement period. We discuss some strategies that brokerage firms may take to minimize the risk associated with clearance and settlement. And, as noted, we argue for minimizing the length of the settlement cycle.

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1. Introduction

Everybody should be aware that trading in securities markets usually involves some degree of risk. It is not as well recognized that the process of clearing and settling trades also involves risks. There are risks to both investors and the brokerage[1] firms that represent them. What are these risks? How can they be reduced? Can we develop an insight into the size of these risks and their impact on transaction costs? This paper attempts to answer these questions. This paper also argues that since the participants in each national financial market are interdependent and the financial markets of the world are interdependent, it is imperative that the International Organization of Securities Commissions (IOSCO) consider ways of reducing those risks, especially the possibility of reducing and harmonizing the length of the settlement cycle.

Risk is a very complex phenomenon. A position with only highly risky components may, nevertheless, be relatively riskless. At most we can only highlight some of the major sources of risk to market participants, i.e., both investors and brokers. Below we analyze the major factors that increase settlement risk and demonstrate that the risk brokerage firms face increases as the length of the settlement cycle increases. This implies that the longer the settlement cycle, the greater the transaction costs of trading. These factors argue for minimizing the length of the settlement cycle within the limits imposed by communications, reporting requirements, settlement procedures and so on. Settlement risk is also shown to increase with the price and volatility of the securities involved, and the average size of transactions. These risks are acute in periods of market turmoil, such as October 19, 1987, and may actually aggravate the situation by generating market uncertainty.

Finally, we develop a simplified model for the assessment of the risk associated with settlement and clearance. The appendix to the paper shows how one may quantify the effects of

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[1]Throughout the text we use the terms broker and brokerage firm in the generic sense. It is to be interpreted as including all types of financial services firms that engage in brokerage activity in the financial instruments markets.

a reduction in the settlement period on transaction costs. We do not attempt to provide empirical estimates here.

2. The Sources and Nature of Settlement Risk

Settlement and clearance involves risk to both investors and their brokers. In this section, we identify the major sources of this risk. We argue that most of these risks increase with the length of the settlement cycle.

A. Error Risk

Unless it is made within a fully-automated trading system, every time a trade is made there exists the risk that the two parties to the transactions have not actually agreed on its terms.[2] There are numerous kinds of errors that may be made, but the following are among the major sources of error:

- Incorrect identification of side, buy vs. sell;
- Incorrect identification of the counterparty;
- Incorrect identification of the instrument traded;
- Discrepancies in reported price;
- Discrepancies in reported quantity or amount, and
- Discrepancies in settlement terms or location.

The longer a trade containing an error remains uncorrected, the greater the risk to the firms involved in the trade. These risks are high during periods of market turmoil or unexpectedly high volume.

B. Market Risk

Until a trade is finally settled, the trade incorporates the risk that it may have to be remade at a later time by which time the market price may have changed. The greater the length of time until settlement, the greater the price change may be, and the greater the probability of a price

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[2]To be sure one of the brokers can make an incorrect trade in a fully-automated trading system. That becomes a problem between the brokerage firm and its customer. The brokerage firm cannot disclaim the details of the order or trade it entered into the computer.

change. This problem is compounded when the unsettled trade involves cross-border trading, because there is also a foreign exchange risk (*FX*), which also increases over time. With market risk, one broker will benefit at the expense of another if the trade must be remade. When placing the trade, however, a brokerage firm does not know whether it will win or lose. Those with risk aversion view this uncertainty as a (implicit) transaction cost.

C. Counterparty Risk

All trades involve counterparty risk, whether the counterparty is a dealer, broker, bank, or clearing house. The inability of the counterparty to complete its part of the contract will require, at the least, that the trade be remade. In the worst case, the counterparty fails before the final consummation of the transaction, but after the other party has delivered the securities or monies involved. Such counterparty failures can cost not only the difference in the asset's price, but the entire cost of the original transaction's value and the cost of executing the trade again. An important aspect of counterparty risk is payment and delivery risk. A bank, acting as agent for the buyer or seller may fail even though the counterparty itself did not fail. However, since there is often a close financial relationship between the two, the failure of an agent can precipitate the failure of the counterparty for which it acts.

D. Financial Crisis Risk

When one of the counterparties to a trade suffers financial failure, its unsettled trades have to be unwound. Every brokerage firm acting as a counterparty during the settlement cycle will find that those trades cannot be completed. It will be necessary for those firms to redo the failed trades. This will be costly for several reasons. The clerical expense of unravelling will be costly.[3] For those trades for which the counterparties to the failed firm represented buyers, funds

[3]It should be noted that clerical costs increase more than proportionately to the number of errors that have to be corrected. As the number increases, a larger percentage of the time of the processing staff must be devoted to those corrections. That leaves fewer resources to do the regular processing and that can easily lead to a greater frequency of errors.

that were expected will have to be replaced. For those trades for which the counterparties represented sellers, the interest consequence will be much less.[4]

In either case, the capital of the firms will be somewhat impaired. In either case, it will be necessary to repair the customers' failed trades. Again in those cases in which the firms represented buyers, the firms will have to repurchase the securities. When prices fall, they profit. When prices rise, they incur losses. Similarly, on those trades in which they represented sellers, the firms will make or lose money, depending upon how the market had moved.

In other words, the firms are exposed to a market risk. As a consequence, there is a non-zero probability that one or more firms will fail. In turn, that increases the probability that some of the remaining firms which were healthy enough to survive the bankruptcy of the first brokerage firm will not survive the consequent failure of others.

While the customers of the firms whose counterparty fails are protected by those firms, the customers of the failed broker are exposed to market risk.[5] From the point of view of customers who have engaged in transactions that were not completed, remedial measures will have to be taken. The price of the security may have moved against the customer, providing smaller proceeds to a seller or increasing the cost to a buyer. The customer may have experienced only an opportunity loss if it decides against proceeding with the planned trade. Worse still, the customer may simply not have access to its securities. Of course, prices may just as easily move in the customer's favor. Because of this uncertainty, the customer is clearly at risk. Furthermore, the customer is at greater risk per unit of currency involved than the actual counterparties to the failed firm. A single customer is unlikely to have many trades in a single day. The

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[4]We distinguish between the financial failure of a firm and the failure to settle a particular trade on time, conventionally called a fail.

[5]In some countries, e.g., the U.S., customers have some protection because their securities held by brokerage firms must be segregated. Unfortunately, the same is not true of the failed firm's selling investors' cash. To be sure, customer accounts are protected to some extent by the insurance provided by the Securities Investor Protection Corporation (SIPC). It should be noted that even when the securities are segregated, the market risk of the investor is significant since there may be long delays before the investor has access to those securities for sale or delivery. This may be particularly costly if the investor has only partially completed developing or unwinding a strategy involving more than one transaction.

customer is then exposed not only to market risk, but to what would ordinarily be the diversifiable[6] risk of the asset involved. The counterparties, having typically engaged in trades in a significant number of securities, have, in effect, a diversified portfolio and are therefore subject largely to market risk. The risk is largely, rather than solely, market risk because the "portfolio" of incompleted trades was not chosen by the brokers in question and hence may not be efficient in the sense of having diversified away all non-market risk.

Now, if the settlement cycle is, say, two days instead of one, and results in the failures of the same firms that failed in the one day cycle, the number of trades that will have to be unwound would be, roughly, double. Because the exposure of each firm with a two day settlement cycle is double the exposure with a one day cycle, more firms are likely to fail. That increases the number of trades that will have to be remade and hence increases the risk exposure of the firms involved by more than a factor of two.

Indeed, as the length of the settlement cycle increases to τ days, the exposure grows faster and faster because each additional failure increases the probability of still more failures. In other words, had the settlement cycle in the U.S. been ten business days instead of five last October, the very high risk of financial collapse that actually existed would have been increased very substantially. This component of risk is compounded by the growth in market risk.

Not only is there 2τ days of trading subjected to market risk instead of τ days when the settlement cycle is doubled from τ to 2τ days, the variance of market prices increases. The 2τ day variance of prices is twice as great as the τ day variance of prices. Thus with a two day cycle

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[6]As was noted above, a position may consist solely of very risky assets, but the position as a whole may nevertheless be relatively riskless. This is because, with a diversified portfolio, adverse developments with respect to one asset may be offset by favorable developments with respect to another. The limitation to reducing risk by diversification results from the tendency of the fortune of some assets to be affected by the same factors so that those assets are, to some extent, favorably or unfavorably affected at the same time. The risk that can be eliminated by diversification is known as diversifiable risk.

A properly managed portfolio has an organic risk and trading in the components takes place with the view to the effect of that trading on that organic risk. To the extent that this is so, our remarks on risk must be viewed as a simplification. Unfortunately, to the extent that there is a clearing and settlement failure, the risk return objective of the trade may not be realized.

the market risk associated with the trades engaged in on the first day of the cycle is greater than the market risk associated with the trades engaged in on the second day of the cycle.

Similarly with a settlement cycle of 2τ days, the variance associated with the trades of the first day are 2τ times the variance associated with the trades of the last day, and the variance associated with the trades of the second day are $2\tau - 1$ times the variance associated with the trades of the last day. If variance was invariant with respect to the length of the settlement cycle, the market risk with a 2τ day cycle would still be twice the market risk with a τ day cycle because there is twice the investment involved. However, since variance is not invariant with respect to the length of the settlement cycle but increases with the length, the risk grows faster than the length of the cycle.

The growth in risk is further compounded when the trade involves more than one currency. In such cases there is a foreign exchange risk, and there too the variance is proportional to the length of the settlement cycle. Here again a doubling of the length of the settlement cycle not only subjects twice as many trades to a foreign exchange risk, but also compounds the risk due to the growth of the variance with the settlement cycle.[7]

Under these circumstances, should there be a financial crisis, the market impact under a scenario in which 2τ days' unsettled trades must be unwound will be far worse than one in which only τ days' unsettled trades must be unwound and incomparably worse than one in which only one day's unsettled trade has to be resolved.

Even with a one day settlement cycle, the collapse of a single major player in the international markets would be significant. With a long settlement cycle, the repercussions of the failure of even a single player could be fatal. The odds are very high that the number of other

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[7]Since a corresponding *FX* forward trade may have been made at the time of the original trade, the necessity of redoing the financial instruments trade will not only create the need for a new *FX* trade with a new value date, it unhedges the original *FX* trade.

It should be noted, however, that the risk associated with mixed currency portfolios can be a very complicated phenomenon. Part of this complication results from the fact that many currencies tend to move together and the yield on an asset in terms of the currency in which it is denominated may be affected by changes in the value of that currency and the trading that takes place in that portfolio is generally undertaken with the effect on the riskiness of the portfolio as a whole.

players having outstanding transactions with the failed firm would be large. As each firm moved to protect itself by whatever means were available, the "daisy-chain" reaction produced can topple other firms, including themselves. The result would be a Pyrrhic victory.

3. The Settlement Period and Transaction Costs

Lengthening the settlement cycle not only increases the counterparty risk of every brokerage firm, it also increases the risks to those firms of customers defaulting.

To see the interrelationship between the broker's risk and the length of the settlement cycle, consider the cash flows corresponding to a trade. When an investor, *B*, buys securities through a broker, *b*, that broker in turns commits itself to accepting the shares from the broker, *s*, which represents the selling investor, *S*, and to paying the agreed upon value of the transaction. If *B* and *S* live up to their commitments, *b* and *s* act solely as conduits for the cash and securities. Under normal circumstances, investors almost always honor their trades. The costs of reneging, which may include the opportunity cost of being closed out of the market, explicit penalties, the cost of litigation and so on, are simply too high. Under severe financial constraints, however, the probability of default becomes significant.

Unfortunately defaults by their customers do not relieve their brokers of the responsibility of completing the trades with their counterparties. It is because of this possibility of default under conditions of stress that the length of the settlement cycle affects the cost of intermediation.

The brokerage firm *b* can expect *B* to accept the financial responsibilities for his or her trades when the market has risen during the settlement cycle. *B* will clearly benefit from doing so. He or she will be better off by the product of the number of shares purchased times the increase in price since the purchase.

If, however, the price of the security purchased falls during that period and *B* is under severe financial strain, especially in periods of severe market stress, *B* may not be able to get the funds needed to meet its obligations and will default. *B* is therefore in a position to earn the profit identified in the above paragraph if the market rises and to gain or lose nothing if market

stress forces a default. That is precisely the type of cash flow associated with a European[8] call option issued by *b* with an exercise price equal to the trade price and a maturity equal to the length of the settlement cycle. Thus with default as a possibility, *b*'s net position is not quite that of a pure conduit. The value of that option must be considered a component of *b*'s cost.

The value of the call that *b* thus provides *B* can be estimated by the application of the Black-Scholes (1973) formula.[9] According to that formula the value of the call option at the time of the trade depends on the trade price (which is simultaneously the market and exercise price), the length of the settlement cycle (the time to maturity), the interest rate, and the volatility of the security purchased.

With that formula it can be shown that the longer the cycle, the greater the value of the option. Furthermore, it can be shown that the responsiveness of the option value to the length of the cycle varies directly with the market price of the underlying security.

Thus, lengthening the settlement cycle reduces brokers' expected profit. The impact is greatest when the probability of default is high, i.e., during periods when investors face severe financial constraints.[10] It also follows that the impact is greatest for high priced securities and volatile securities, and that total losses are higher the greater the average size of the trade.

If the cost of capital (including equity) is included in the transaction fee, and the brokerage industry is competitive, brokers' expected profits (over and above the cost of capital) will be zero. Since increasing the settlement cycle increases the value of the option, transaction fees will have to rise if the cost of capital is to be earned.

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[8]A European call can only be exercised on its expiration date.

[9]F. Black and M. Scholes, 1973, "The Pricing of Options and Corporate Liabilities," Journal of Political Economy, May-June, 637-59. While that formula is quite complex, that need not concern us directly.

[10]During periods of market stress, such as that which occurred in October, 1987, dealers quoted significantly wider spreads for many financial instruments thereby increasing transaction costs.

4. What Role for IOSCO?

It is not clear how much the world's regulatory authorities can do to prevent another October 19, 1987. They can, however, take steps to eliminate the structural shortcomings of the markets that exacerbated the consequences of the recognition that the market was overpriced and that overpricing could not be sustained. Since the probability of brokerage bankruptcy increases with the length of the settlement cycle, the risk of financial collapse emanating from settlement failures is also an increasing function of the length of the settlement cycle. It follows that the cycle should therefore be shortened as much as possible. This would not only decrease the risk of failure, it would increase the liquidity of markets by reducing transaction costs. Ideally the regulatory authorities would work for the adoption of fully automated and integrated trading and clearing systems that would reduce the trading and clearing cycle to zero. If transactions could be settled the moment they were executed, there would be no settlement risk.

Unfortunately, since the achievement of this Nirvana seems remote, the regulators might direct their efforts at least to minimize and harmonize the settlement cycle by reducing it to one day.[11] First, IOSCO could attempt to obtain a statement of this objective from their membership. Agreement among the securities regulators of the major financial markets on the benefits of such one day settlement harmonization could have a significant psychological impact on market participants. Certainly the market operators of the world should be encouraged to examine their trading systems to determine the changes that would be required to achieve next day settlement.

The technical committee, established at the 1987 Rio de Janeiro meetings, could report, hopefully at the 1989 IOSCO meeting, on the changes that would be required in both trading and settlement systems for each country which had agreed to a next day settlement goal. Once that

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[11]This would also have the virtue of harmonizing the securities and futures payment periods. During the market break the securities firms that had sold on the cash market and bought on the futures market were not able to use the proceeds from the cash market to provide the margin for their purchases of futures since the funds were not forthcoming in time. As a consequence, a number of firms encountered significant problems. While even a one day settlement on the cash market would not have provided the firm with the cash to fund the margins for the futures contract, it would have made it significantly easier for the firms to borrow the money.

was done, a timetable for implementation of the harmonization of a one day settlement cycle could be adopted. Among the preconditions for achieving this goal are:

1. The dematerialization or immobilization through interconnected depositories of the financial instruments subject to that cycle.
2. The modification of trading systems so that there is a "locked-in" agreement on all terms between the two parties at the moment of trading. This will enable the settlement cycle to begin as soon as the trade is completed, and would permit the development of true real time risk measurement and management systems.
3. The improvement of international *FX* systems to enable currency exchanges to be effected immediately, rather than with the traditional minimum two day cycle of the spot market.
4. The upgrading of both national and international custody systems for financial instruments held for investors to permit immediate cross-border telecommunications of all the essential trade details and authorizations to receive and deliver the financial instruments against payment in whatever currency is required.

There is systemwide interdependence among brokers, since they trade with each other; the failure of any one entity can have impact on others. Thus, the globalization of markets is reinforcing the interdependence of the financial systems of the different countries. It is, therefore, imperative that the members of IOSCO work together to achieve common clearance and settlement standards. Should they fail to do so, any country may discover that interdependence in a most unpleasant way. We cannot be sure that there will be the luxury of an extended period of time to cure these significant market structural defects.

APPENDIX

A Model of Changes in the Settlement Period

The impact of a change in the settlement period for stocks on the position of brokers and investors is a topic that has received little attention in the academic literature. Here, we develop a model of brokerage that can be used to analyze the effect of a change in the settlement period on the financial position of brokers. The model can be used to show how policy changes could be made to strengthen the financial position of brokerage firms so that they are better able to withstand periods of financial turmoil such as October 19, 1987.

We show that extending the settlement period increases the risk faced by brokerage firms, particularly during periods of market stress. The model can be used to develop quantitative estimates of the impact of a change in the settlement period. We prove that the impact of reducing the settlement period is greatest for risky and higher priced securities, and leads to a decrease in transaction costs, and hence, in a competitive market, to a decrease in brokerage fees.

As we argued in the paper, the settlement period affects the financial position of brokers through a variety of sources. The major source of risk to brokers comes from default by the counterparty, and embodies market risk and financial crisis risk. Our focus on brokers stems from policy considerations. In our opinion, brokers bear a large part of settlement risk and this is reflected in their fees. Policy reforms aimed at reducing the settlement risks faced by brokers are likely to be the most effective method of strengthening the marketplace. We will ignore the risks borne by investors and others from errors in recording transactions and so on. However, it should be recognized that whenever a firm fails, the protection of the customers' assets through segregation does not protect the customers from market risk since there will frequently be delays before those assets can be traded, and cash is not segregated.[12]

We begin by analyzing the cash flows corresponding to a trade. For concreteness, suppose on day 0 investor B buys n shares of stock from investor S, the seller, at a price of S_0 dollars per share. Investor B is represented by a broker, labeled b, who promises to accept the

[12]Except for futures transactions in certain countries such as in the U.S.

shares from investor S's broker, labeled s, and pay nS_0 dollars to s. If the settlement period is τ days, broker b, representing the buyer, accepts n shares on day τ from s and pays s nS_0 dollars. If investor B pays the broker nS_0 dollars for the n shares, broker b's net financial position is unaffected by the transaction; b merely acts as a conduit for cash and securities. The pattern of transactions is shown below.

The Pattern of Cash and Stock Transactions

$$B \leftarrow n \text{ shares} \leftarrow b \leftarrow n \text{ shares} \leftarrow s \leftarrow n \text{ shares} \leftarrow S$$

$$B \rightarrow nS_0 \rightarrow b \rightarrow nS_0 \rightarrow s \rightarrow nS_0 \rightarrow S$$

As we see, if investor B honors the trade, the cash flows for his broker, b, at time τ exactly offset each other. As we have noted, normally investors consider excessive the costs of failing to honor a previous transaction. However, when investors are under severe financial constraints, e.g., during a market break, the probability of a default is non-zero.[13] Even if B defaults, the broker b must still honor his side of the transactions with s. The possibility of default under conditions of market stress is where the settlement period affects the position of the broker.

Let ρ be the probability that investor t may be unable or unwilling to meet his obligations. Here, ρ is a number between zero and one. For purposes of illustration, we shall assume ρ is a constant. In a more formal model, we would allow ρ to depend upon trade size, the stock price and the penalty costs of defaulting. The higher the implicit and explicit costs of defaulting, the smaller is ρ. Our assumption that ρ is a constant does not alter the qualitative nature of our results. If the market has risen since the trade, investor B clearly benefits from accepting financial responsibility for the trade. Let S_τ be the stock price on day τ. If S_τ is greater than S_0,

[13]The need for turning on the credit faucet by the Federal Reserve System on October 20 is clear evidence that normal funding sources of brokers believed that the default risk had increased significantly.

investor B's profit is $n(S_\tau - S_0) > 0$ and investor B will honor the trade since it improves his financial position.

However, if the market has gone down between day 0 and day τ, investor B has suffered a loss, and if he is under severe financial constraints, B may be unable to raise nS_0 dollars and will default. Consequently, if investor B is under severe financial constraints, his profits at time τ are described by $\text{Max}[n(S_\tau - S_0), 0]$. This condition is easily interpreted. If the stock price has risen over the settlement period, B will honor the trade because it is profitable to do so; if the stock price has fallen, B must default when he cannot accept a loss because of the severe cash constraints he faces. Inspecting B's cash flows, we see that they are equivalent to holding n European call options issued by broker b, each with an exercise price of S_0 and a maturity of τ days.

If default is a possibility, the broker's net position is non-zero. Since b's cash flows are exactly the opposite of B's flows, we can assess the position of the broker if we know the price of a call option. Black and Scholes (1973) provide a formula to value European call options. Black and Scholes prove that the value of a call option at time t depends only upon five factors:

- the current stock price, S_t,
- the exercise price, K,
- the time to maturity, T,
- the interest rate, r, and
- the volatility of the stock, σ.

The Black-Scholes formula is based on a number of simplifying assumptions. The formula is quite complex, and does not concern us directly. For further details, see, e.g., Cox and Rubinstein, Option Markets, Prentice-Hall, 1985. Instead, denote the price of such a call option using the Black-Scholes formula as:

$$C_t = C(S_t, K, T, r, \sigma) \ . \tag{1}$$

To complete the model, we assume that b charges a brokerage fee of β and that the transaction costs per share (i.e., clerical costs, settlement costs, etc.) incurred by the broker is $\psi(n)$. The

transaction costs per share may or may not depend on trade size. Then, b's expected profit per share, denoted π, is given by:

$$\pi = \beta - \psi(n) - \rho C(S_0, S_0, \tau, r, \sigma) \tag{2}$$

where we have substituted S_0 for S_t, S_0 for K, and τ for T in equation (1). We see that when investor B defaults, the settlement period affects the broker's position indirectly through the pattern of cash flows.

To analyze the effect of a change in the settlement period on the broker's financial position we can assess the effect of increasing the maturity date of a call option. In the Black-Scholes model, it is easy to show that increasing the maturity date increases the value of the call, although at a decreasing rate. This is true for all option pricing models including the binomial model. Formally, we see that:

$$\frac{\partial \pi}{\partial \tau} = -\frac{\rho \partial C(S_0, S_0, \tau, r, \sigma)}{\partial \tau} < 0 . \tag{3}$$

Thus decreasing the settlement period increases brokers' expected profits. Increasing the settlement period has the opposite effect. From equation (3) it follows that the impact is greatest when ρ is high, i.e., in periods in which investors face severe financial constraints. Now, it can be shown that:

$$\frac{\partial C}{\partial \tau} = \frac{S_0 \sigma}{2\sqrt{\tau}} N'(h) + S_0 e^{-r\tau} \, rN\left(h - \sigma\sqrt{\tau}\right) \tag{4}$$

where N(·) is the cumulative normal distribution and $h = \frac{r\sqrt{\tau}}{\sigma} + \frac{1}{2}\sigma\sqrt{\tau}$. From (4), $\frac{\partial C(S_0, S_0, \tau, r, \sigma)}{\partial \tau}$ increases with S_0, the negative impact of extending the settlement period is greatest for high priced stocks and for volatile stocks, exactly what our intuition would suggest. The argument when B sells stock is symmetric, and we do not develop the details here.

Finally, consider the impact of extending the settlement period on eventual brokerage fees. If the brokerage industry is competitive, brokers earn zero expected profits on their transactions, so that from equation (2) we see that the per share brokerage fee is:

$$\beta(n) = \psi(n) + \rho C(S_0, S_0, \tau, r, \sigma) \ . \tag{5}$$

Increasing τ increases $C(S_0, S_0, \tau, r, \sigma)$ and raises competitive brokerage fees as will an increase in ρ.

To sum up, we have developed a model of brokerage where the broker acts as a conduit between two investors, guaranteeing the transaction. If default is impossible, the broker's net position is a wash. With default a possibility, this is not so. Default occurs when investors suffer large losses on previous trades and cannot meet their obligations as they normally do. We analyzed the pattern of their cash flows, which are equivalent to call options. This gives us a way to value the impact of a change in the settlement period on the position of a broker. Given estimates of ρ, we can use the Black-Scholes formula to quantify the effects of changing the settlement period. The adverse effect of extending the settlement period is particularly acute for high priced stocks that are highly volatile.