

# Essays on Adverse Selection

by

Rajneesh Sharma

A dissertation submitted to the Graduate Faculty in Business in partial fulfillment of the requirements for the degree of Doctor of Philosophy, The City University of New York

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This manuscript has been read and accepted for the Graduate Faculty in Business in satisfaction of the dissertation requirement for the degree of Doctor of Philosophy.

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## **Abstract**

### **Essays on Adverse Selection**

by

**Rajneesh Sharma**

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This is the executive summary of essays on adverse selection that comprise the dissertation. The essays analyze adverse selection, in particular Information Asymmetry under different settings. The first essay “Study of the Introduction of Stock Index Futures Contracts on Underlying Stocks: Evidence from Toronto Markets” with examines the effect of introduction of futures contract on information asymmetry in the stock market around introduction of two stock index futures contracts (the Toronto Equity Futures Contract and the Toronto Stock Exchange 300 Composite Index Contract). There is evidence of increase in proportion of informed trading after the introduction of the futures contract for non-index stocks. Also there is a decrease in the costs of supplying liquidity in individual stocks and an increase in the asymmetric information component of the spread.

The second essay “Financing Acquisitions with Contingent Value Rights (CVR’s) and Put Options” builds a game theoretic and studies the efficacy of use of put options/ CVR’s as a partial payment method in Mergers. This paper considers two-sided information asymmetry between the target and the acquirer, and investigates how such a problem may be mitigated by the choice of means of payment. This study models the use of equity coupled with either put options or contingent value rights as a means of payment in acquisitions. The model predicts

that the use of CVR's and Put options is better for the acquirer if the information asymmetry relating to its value is high. The model is further extended assuming imperfect resolution of the acquirer's type at expiry.

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Study of the Introduction of Stock Index Futures  
Contracts on Underlying Stocks: Evidence from Toronto  
Markets

*Abstract*

Stock index based futures contracts have a direct relationship with underlying stocks. In this paper, we examine the effect of introduction of a futures contract on microstructure variables of underlying stocks. This study examines changes in trade size, share volume, number of transactions per day, volatility, overall bid-ask spread, and components of bid-ask spread of individual stocks around introduction of a stock index futures contract. We study the introduction of two stock index futures contracts (the Toronto Equity Futures Contract and the Toronto Stock Exchange 300 Composite Index Contract) on the stocks. We find evidence of increase in proportion of informed trading after the introduction of the futures contract for non-index stocks. The volatility of, and the spreads for, the non-index stocks decrease after the first futures contract is introduced. We also find evidence of a decrease in the costs of supplying liquidity in individual stocks and an increase in the asymmetric information component of the spread.

A stock index futures contract is a futures contract based on a stock index. Since stock indices are derived from individual stock prices, there is a direct relation between stock index futures contracts and underlying individual stock markets. Due to intra-day trading in both futures and underlying stock markets, there is reason to suspect that stock index futures should also affect market microstructure variables in individual stock trading. The study of the possible influence of stock index futures contracts on underlying stocks is of interest to regulators, practitioners and academicians alike. We study the introduction of two stock index futures contracts (the Toronto Equity Futures Contract and the Toronto Stock Exchange 300 Composite Index Contract) on the stocks. In particular, we are interested in changes in volatility, in overall spreads and in components of spreads of individual stocks upon the introduction of the stock index futures contract.

Our study measures the impact of the introduction of two different futures contracts. In 1982 the Toronto Stock Exchange started trading a futures contract based on an index of ten stocks. In 1984 this contract was rescinded and a new contract based on an index of three hundred stocks was introduced. The three hundred stocks included the ten stocks which formed the index of the original futures contract. Since there were no other futures contracts based on an index with a composition of the same underlying stocks, our study can isolate the impact of the introduction of an index futures contract. We also have intra-day data available to us.

Choi and Subrahmanyam (1994) mention that some of the variables studied have an intra-day flavor, thus necessitating the need for an intra-day study. Another factor of concern is program trading. The simultaneous existence of program trading can make it difficult to isolate the impact of the introduction of a futures contract. A change in spreads may occur, due to increased program trading related to the new futures contract. Program trading on the Toronto Stock Exchange and the Toronto Futures Exchange was non-existent during the time period of our study.

On January 27, 1983 the Toronto Stock Exchange started trading an equity futures contract. The contract was designed for Canadian markets and was termed the Toronto Equity Futures Contract (henceforth “TEF Contract”). The contract required delivery of 100 shares of 10 underlying firms. The contract traded for a year before it was replaced by a futures contract on the Toronto Stock Exchange 300 composite Index (henceforth “TSE300 contract”). In January of 1984 the Toronto Stock Exchange opened a separate exchange for futures trading. The new exchange, called the “Toronto Futures Exchange”, was designed to support trading of futures contracts, which at the time were being traded on the Toronto Stock Exchange. Simultaneously, the Toronto Equity Futures Contract was replaced with a futures contract on the TSE 300 composite index. This index consisted of 300 companies. The new contract was cash settled. The ten stocks from the TEF contract were a part of the TSE 300 composite, hence a part of new contract. Thus there is an opportunity to study the behavior of individual stocks around the initiation of a futures contract. There is also unique opportunity around the changes in the contract specifications. The stocks that

were in the TEF contract were also in the TSE 300 contract. Thus not only can we study the index stocks and non-index stocks around the introduction of the two contracts, but we can also study the effect on stocks that formed the first contract around the introduction of the second contract. We thus are able to isolate the effects of the first futures contract introduction and the incremental effects of the introduction of the revised index.

Lack of available data has restricted the study of the full impact of the introduction of stock index futures contracts on underlying stock markets. Jegadeesh and Subrahmanyam (1993) studied the impact of the introduction of S&P 500 futures contracts on underlying stocks using end-of-month closing bid-ask quotes to conduct their analysis. Choi and Subrahmanyam (1994) studied the effect of the introduction of MMI index futures contracts. They use intra-day quotes to conduct their analysis. However, stocks present in the MMI index were already part of the S&P 500 index. When the MMI index futures contract was initiated there was an existing futures contract on the S&P 500 index. Therefore, the effects measured in the study would be the marginal effects of the introduction of a second index contract. There was also extensive program trading in existence when the MMI index futures contract was introduced. Some of the effects observed may not be due to the futures contract directly but rather due to program trading associated with the futures contract.

A futures contract can be used by market makers to hedge their inventory risk. This may cause a reduction in the cost of supplying liquidity, thereby causing a

reduction in bid-ask spreads. On the other hand, uninformed traders may migrate from individual stocks to the index futures contract, due to the benefits of a reduction of trading costs and diversification. This can cause the proportion of informed traders to increase in individual stocks, thereby increasing the asymmetric information component of the spread in individual stocks. We find evidence of decrease in spreads after the introduction of futures contract for the non-index stocks. Moreover, we find support for a decrease in the cost of supplying liquidity. The effect was more pronounced on non-index stocks at the time of the first futures contract (TEF contract). We also find that the asymmetric information component of the spread increases after the futures' contracts are introduced. The increase in the asymmetric information component of the spread is more pronounced with the introduction of TEF contract than with the TSE contract.

The remainder of this paper is organized into 5 sections. Section 2 reviews the literature and develops the hypotheses. Section 3 describes the data and methodology. Section 4 provides empirical results. Section 5 concludes.

## **Section 2: Hypothesis Development**

### *Bid-Ask Spread*

Bid-ask spread consists of three components: fixed costs, inventory maintenance costs and asymmetric information costs. All three of these components may be affected by a futures contract.

Asymmetric information component compensates the market maker for losses

from trades of informed traders (Copeland and Galai (1983) and Glosten and Milgrom (1985)). Index futures are instruments for low cost diversification. Informational asymmetries due to firm-specific private information are considerably less severe in futures markets than they are in individual stock markets. Therefore, a futures contract will draw away uninformed traders from individual stocks. The proportion of informed traders in the stock market will increase, thereby increasing the spread. Furthermore, with the increase in spread, uninformed traders will have an even greater incentive to move to futures markets (Gammill and Perold (1989)). Gorton and Pennacchi (1993) present a model in which liquidity traders are able to improve their welfare by trading in a composite security or a bundled asset. Subrahmanyam (1990) developed a model where liquidity traders are better off trading in diversified “baskets” of securities as compared to individual securities in the presence of informed traders. Costs to liquidity traders are lower when they trade in the basket in the presence of traders with security-specific information. With the introduction of futures contracts, liquidity traders can thus reduce their costs by trading on the entire index. Liquidity traders could have held index stocks, non-index stocks or both prior to switching to the futures contract. Therefore, introduction of a stock index futures contract should affect non-index stocks as well. Jegadeesh and Subrahmanyam (1993) argue that since well-diversified portfolios are good substitutes for each other, with the introduction of an index futures contract, there will be a migration of liquidity traders from both index and non-index stocks. Thus an increase in spreads may be exhibited in both index and non-index stocks. The

increase in spreads should exhibit itself in the adverse selection component of the spread.

**H.1:** *The adverse selection component of the spread will increase after the introduction of the futures contract.*

Conversely, Index futures can provide low-cost opportunities for market makers to hedge their inventory risk. This may reduce market makers' inventory holding costs, thus causing a decrease in the inventory component of the spread, thereby reducing the overall spreads.

**H.2:** *The inventory maintenance component of the spread will decrease after the introduction of the futures contract.*

One advantage that this event has is the non-existence of program trading during the period of our study. In the presence of program trading there can be changes in spreads related to program trading itself. Stock index futures may increase informed trading based on market-wide factors, which trickle down to individual stocks via program trading. This will increase bid-ask spread. Program trading based on the TSE index became popular much later than the time period for our study. Thus we are able to isolate the effect of the introduction of index futures with the confounding effect of program trading.

### ***Volume, Number of Transactions and Trade Size***

Gammill and Perold (1989) and Subrahmanyam (1990) have argued that the introduction of a stock index would cause a migration of traders from stocks to futures contracts. This would reduce the volume and number of transactions in

individual stock markets. In contrast, trading volume and number of transactions could increase due to arbitrage related activities<sup>1</sup>. The overall effect is ambiguous for index stocks. For the non-index stocks there should be a reduction in the volume and number of transactions as uninformed traders move from stocks to futures contract. Assuming that informed traders trade in bigger lots, the trade size for the non-index stocks should increase.

**H.3:** *Trading activity (Volume and Number of Transactions) of non-index stocks should decrease after the introduction of a futures contract.*

**H.4:** *Trade Size for the non-index stocks should increase after the introduction of a futures contract.*

#### *Volatility*

Practitioners and regulators have always considered a significant linkage between volatility and futures trading. Choi and Subrahmanyam (1994) test for changes in volatility after the introduction of the MMI index futures contract. They find no significant changes in the volatility of MMI stocks. However, stocks in the MMI index were also in the S&P index. The S&P 500 index futures contract were already trading at the time when the MMI index contract was introduced. Therefore the effects observed may be subdued. Also there was significant program trading, which may in itself affect volatility. Since there were no preexisting contract based stocks on the Toronto Stock Exchange, this study can test for the effects on volatility

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<sup>1</sup> Even without program trading, it is possible to have a manual arbitrage trading. The costs involved would be lower for the first futures contract as it is based on only ten stocks.

without any confounding effects. Choi and Subrahmanyam (1994) present following hypotheses relating to the impact of a futures contract on underlying stock's volatility: Stock index futures increase arbitrage-related activities via program trading. This increases short-term price swings, thereby increasing volatility. On the other hand, index futures increase market-wide informed trading. This causes information to be impounded in the prices quickly, which reduces volatility. Due to absence of program trading this study can check the effect of index futures on volatility without the concerns raised from program trading.

**H.5:** *The volatility of individual stocks will decrease after the introduction of a futures contract.*

### **Section 3: Data and Methodology**

Data is obtained from equity history files obtained from the Toronto Stock Exchange. These files contain all trades and quotes. The data also contains volume and other trade identification variables.

Trading of the first equity futures contract on the Toronto Stock Exchange started on January 27, 1983. The Toronto Equity Futures (TEF) contract was based on an index comprising ten stocks only. Later, on January 16, 1984, this contract was revised to include 300 stocks. The new contract is based on the TSE 300 Composite Index. The total sample is divided into four time periods. The first and second time periods are related to the TEF contract and the third and fourth time periods are related to the TSE 300 contract. The first time period is from Dec 13, 1982 to Jan 26, 1983 and is termed as "Pre-TEF". The Pre-TEF period contains observations from 30

trading days prior to the introduction of the TEF contract. The second time period is from Jan 27, 1983 to Mar 9, 1983 and is termed “Post-TEF”. The Post-TEF period contains observations from 30 trading days after the introduction of TEF contract. The third time period is from Dec 1, 1983 to Jan 13, 1984 and is termed the “Pre-TSE” period. The Pre-TSE period contains observations from 29 trading days prior to the introduction of TSE contract. The fourth time period is from Jan 16, 1984 to Feb 24, 1984 and is termed “Post-TSE”. The Post-TSE period contains observations from 30 trading days after the introduction of the TSE contract.

However, not all stocks traded during both the pre and post time periods. We have included only stocks that traded on at least one day in both the pre and the post periods. In case of multiple listings we use the class of common stock that is most actively traded. We also exclude any firm’s stocks if there was a stock split during the time period examined. During our period of analysis, the Toronto Stock Exchange had a differential tick system. Minimum tick for any stock with a price below \$.50 was \$.005 (half a cent). For stocks trading between \$.50 and \$3.00 the minimum tick was \$.01 (one cent). For stocks with price between \$3.00 and \$5.00 the minimum tick was \$.05 or (five cents). And for any stock trading above \$5.00, the minimum tick was \$.125 (1/8 of a Dollar). Some of the microstructure variables can be impacted by the differential tick sizes. For example, Ronen and Weaver (2001) find that volatility is directly related to tick size. Thus, to reduce the confounding effects of tick size, we limit our analysis to those stocks which always traded above \$5.00 during the time period analyzed. We further restrict our sample to those stocks

with an average frequency of trades greater than or equal to 4 trades per day.

Choi and Subramanyam (1994) show that index trading affects non-index stocks also. This study analyses the impact of the introduction of futures trading on the stocks which make up the index and also on the stocks which do not make up the index. We divide the stocks into various categories. Table 1 contains the number of stocks used for analysis in each category. For analysis around the first futures contract (TEF contract) we divide all stocks into three categories, namely TEF-10, Non-TEF and Match-TEF. Category TEF-10 contains ten stocks that form the index for the TEF contract. Category Non-TEF contains all stocks aside from the ten stocks from the TEF-10 category. There are 179 stocks in the Non-TEF category. We further match ten stocks with stocks in the TEF contract on the basis of market capitalization. We categorize these stocks as matched stocks (Match-TEF).

For analysis at the introduction of the TSE300 contract, we use five different categories of stocks. The TEF-10 category is the same as before, containing the same 10 stocks. Category TSE-300 contains stocks which were in the TSE 300 index as of January of 1984. This category contains 173 stocks. The remainder 127 stocks are excluded from analysis due to the reasons detailed above. Category TSE-290 contains all the stocks that form the TSE 300 index except the ten stocks from TEF-10 category. The TSE-290 category contains 163 stocks. The next category is Non-TSE, which contains stocks that are listed but were not in the TSE 300 Composite Index. We have 49 stocks in this category. Since we only have 49 stocks in the non-index category, we cannot match all the stocks in the Index with a non-index stock.

Therefore we do not have a Match-TSE category.

With the introduction of the futures contract on the TSE 300 Composite in January 1983 we have a unique opportunity to study the impact of the introduction of a basket security on underlying securities. We are able to study stocks that are not part of the TSE 300 Index (category TSE290). We also study stocks that are part of the index but are not in the TEF. The most unique study would be of the ten stocks, which are part of the TSE 300 composite and which underlie the TEF. With the introduction of a contract on the TSE 300, the old contract is scrapped. These stocks are now part of the new contract. Their weights in the index underlying the futures contract are therefore reduced.

The data has some “Error Quotes”. In some quotes, bid or ask or both bid and ask would differ drastically with previous and subsequent quotes. Often the decrease would be by a multitude of ten. For example a quote would jump from \$5.50-\$5.75 to \$55.00 -\$57.50. Then it would come back down again in the next few quotes. We try to identify such quotes, and only in very apparent cases, do we delete those observations. Out of a total of 286,076 quotes, only 20 quotes are deleted.

## **Section 4: Empirical Results**

### ***4.1 Volume, Number of Transactions and Trade Size***

Futures contracts provide another instrument for traders. Gammill and Perold (1989) and Subrahmanyam (1990) predict that with the introduction of futures contract there will be a migration of traders from stocks to futures. This should reduce the volume and number of transactions in individual stocks. However, futures trading

also provides increased opportunities for arbitrage. Arbitrage related trading would increase trading in stocks that form the Index. This increase should not affect non-index stocks. We hypothesize that the volume and number of transactions for non-index stocks will decrease upon introduction of a futures contract. Also the trade size for the non-index stocks should increase as uninformed traders who trade in smaller trade size migrate to futures trading. However, the hypothesized impact is ambiguous for index stocks.

The results for changes in volume for the TEF contract are reported in table 2 and for those for the TSE300 contract in table 3. We find that at the introduction of the TEF contract, the volume decreases for TEF and Match-TEF stocks. Average daily volume decreases from 67,804 to 66,302 shares for TEF stocks. Average daily volume for Non-TEF stocks increases from 15,445 to 15,994. At the introduction of the TSE-300 futures contract there is an increase in volume for all categories. However all these changes are statistically insignificant. Our hypothesis related to the number of transactions is same as that for volume. We expect for non-index stocks the number of transactions would decrease. The results for changes in the number of transactions for the TEF contract and the TSE300 contract are presented in tables 4 and 5, respectively. We find that at the introduction of the TEF contract, the number of transactions for TEF-10 stocks increased from 120.6 to 141.8 and the increase is significant at the 5% level. For Non-TEF stocks and matched stocks there is an insignificant decrease in the number of transactions. For the TSE-300 contract, the number of transactions for TEF-10 stocks increases from 103.0 to 120.8. The increase

is significant at the 10% level. The number of transactions for TSE-290 stocks increased, from 18.7 to 19.9, an increase significant at 5% level. Changes in volume and number of transactions provide weak evidence for an increased activity in the index stocks.

We expect the trade size for the non-index stocks to increase. The results for the changes in the trade size for the TEF contract are reported in table 6 and for the TSE 300 contract in table 7. For the TEF contract trade size for the TEF stocks decreases significantly from 553.0 to 500.6 and for increases for the Non-TEF stocks. There is also a decrease in trade size for matched stocks. For the TSE contract there is an insignificant increase in trade size for all categories of stocks. If the uninformed traders trade in a smaller trade size, the increased trade size for the non-index stocks for both contracts indicates a decrease of uninformed trading in the non-index stocks.

#### **4.2 Volatility**

Index Futures trading can cause an increase in arbitrage related activity, thereby increasing short-term price swings and volatility. On the other hand, futures invite more informed trading; thus new information is impounded in the price more quickly, thereby reducing volatility. Choi and Subrahmanyam (1994) find no significant changes in volatility. However, there was program trading during the time period of their study. Program trading by itself also affects volatility. During the time period of our study there was no significant program trading on the Toronto Stock Exchange. Thus we can isolate the effect of futures contracts on the volatility of underlying stocks. We expect the volatility to decrease after the introduction of

futures contracts.

### *Unconditional Volatility*

The results for unconditional volatility are presented in table 8 for the TEF contract and in table 9 for the TSE300 contract. We find that unconditional volatility for both TEF-10 and Non-TEF stocks decreases after the introduction of the TEF contract. Volatility for the TEF-10 decreased by .0029, which is insignificant. Volatility for Non-TEF stocks decreased by 0.0349 and is significant at the 1% level. Volatility for the matched sample decreased by 0.0054 and this decrease is significant at the 10% level. Upon the introduction of futures contracts on the TSE 300, we find that volatility showed an insignificant increase for all categories of stocks. The decrease in the volatility in the non-index stocks may be caused by migration of uninformed traders away from the individual stocks.

### *Control Regressions for Volatility*

The results thus far may be due to factors other than futures contracts. To control for confounding factors we perform regression analysis, which incorporates known relationships for the variables we examine. For example, Jones, Kaul and Lipson (1994) document a relationship between the number of transactions and volatility. They find that trade size yields no additional information beyond that of frequency of transactions. Therefore, we model volatility as a function of the number of transactions and the change from the introduction of contracts. Specifically, we employ the following model for analysis around introduction of the TEF contract:

$$VAR_{ij} = \alpha_0 + \alpha_1 * NUM_{ij} + \alpha_2 * DUM_{TEF} + \varepsilon_i \quad (1)$$

where  $VAR_{ij}$  is volatility for firm  $i$  on day  $j$ ,  $NUM_{ij}$  is the number of transactions for firm  $i$  on day  $j$  and  $DUM_{TEF}$  is a dichotomous variable which is equal to 0 for the period before the introduction of the TEF futures contract (Pre-TEF period) and to 1 in the period after the introduction of the TEF futures contract (Post-TEF period). Based on the documented direct relationship between trading activity and volatility we expect  $\alpha_1$  to be positive. However the variable of interest is  $\alpha_2$ . If  $\alpha_2$  is negative it would imply that volatility has decreased. A positive  $\alpha_2$  would imply an increase in volatility. The results for equation 1 (the TEF contract) are provided in Table 12. For the TEF contract we find a decrease in volatility for all categories of stocks. The decrease is significant at the 1% level for Non-TEF stocks, at the 10% level for matched stocks and insignificant for TEF-10 stocks.

We employ a similar model for analysis around the introduction of the TSE 300 composite futures contract:

$$VAR_{ij} = \beta_0 + \beta_1 * NUM_{ij} + \beta_2 * DUM_{TSE} + \varepsilon_i \quad (2)$$

where  $DUM_{TSE}$  is 0 or 1 for the pre- and post-TSE periods.. The results for equation 2 (TSE300 contract) are presented in the Table 15. At the introduction of the TSE 300 composite futures contract, we find an insignificant increase in volatility for all categories of stocks. These results are very similar to unconditional results. The changes in volatility are most significant for non-index stocks for the first contract.

#### *Pooled sample regression analysis for Volatility*

We also conduct pooled sample regression similar to the specification used by

Choi and Subrahmanayam (1994). Since we are combining all the categories of stocks in one regression, the results of this specification should be more robust. Specifically, we employ the following model for analysis around introduction of the TEF contract:

$$\begin{aligned}
 VAR_{ij} = & \gamma_0 + \gamma_1 * NUM_{ij} + \gamma_2 * TEF10_i + \gamma_3 * TEF10_i * NUM_{ij} \\
 & + \gamma_4 * MATCH_i + \gamma_5 * MATCH_i * NUM_{ij} \\
 & + \gamma_6 * DUM_{TEF} + \gamma_7 * DUM_{TEF} * NUM_{ij} \\
 & + \gamma_8 * DUM_{TEF} * TEF10_i + \gamma_9 * DUM_{TEF} * TEF10_i * NUM_{ij} \\
 & + \gamma_{10} * DUM_{TEF} * MATCH_i + \gamma_{11} * DUM_{TEF} * MATCH_i * NUM_{ij} \\
 & + \gamma_{12} TREND_j
 \end{aligned} \tag{3}$$

where  $VAR_{ij}$  is volatility for firm  $i$  on day  $j$ ,  $NUM_{ij}$  is the number of transactions for firm  $i$  on day  $j$  and  $TEF10_i$  is a dichotomous variable which is equal to 0 if firm  $i$  is not in the TEF index and 1 if it is one of the ten stocks which make up the TEF index. Similarly  $MATCH_i$  is equal to 0 if the firm is not in the control sample and 1 if the firm is in control sample.  $DUM_{TEF}$  is 0 in the pre-TEF futures period and 1 in the post-TEF futures period.  $TREND_j$  is a trend variable, which is equal to day  $j$ . The variables of primary interest are  $\gamma_6$ ,  $\gamma_6 + \gamma_8$ ,  $\gamma_6 + \gamma_{10}$ . The three variables are the differences in volatility between pre- and post-TEF futures period for non-TEF stocks, TEF stocks and control sample stocks respectively. Table 13 contains the results of estimation of equation 3. Table 14 contains the results of the test of joint significance. The coefficient for  $\gamma_6$  is negative and significant, supporting our results from previous analysis, indicating a decrease in volatility for non-TEF stocks.

Similarly the differences in volatility of TEF and Matched stocks ( $\gamma_6 + \gamma_8, \gamma_6 + \gamma_{10}$ ) are insignificant. We find a significant decrease in volatility after the introduction of the first contract (TEF contract) for non-index stocks. The coefficient for the trend variable  $\gamma_{12}$  is positive and significant. The increasing trend in volatility would likely have subdued the results for unconditional and control regression results. Also of interest is the variable  $\gamma_7$ .  $\gamma_7$  is the change in the impact of the number of transactions on the volatility for Non-TEF stocks. The coefficient for  $\gamma_7$  is significant and positive. The impact on volatility of the number of transactions has increased after the introduction of the futures contract. This is additional evidence supporting the assertion that the proportion of informed trading increases after the introduction of the futures contract for the Non-TEF stocks. However,  $\gamma_7 + \gamma_9$  and  $\gamma_7 + \gamma_{11}$  the parameters of the change in impact on volatility of the number of transactions for TEF and matched stocks, are insignificant. One possible explanation is that the migration of uninformed traders is more from the small stocks than from large stocks.

We employ a similar model for analysis around the introduction of the TSE 300 composite futures contract. Specifically

$$\begin{aligned}
VAR_{ij} = & \delta_0 + \delta_1 * NUM_{ij} + \delta_2 * TSE290_i + \delta_3 * TSE290_i * NUM_{ij} \\
& + \delta_4 * TEF10_i + \delta_5 * TEF10_i * NUM_{ij} + \delta_6 * DUM_{TSE} \\
& + \delta_7 * DUM_{TSE} * NUM_{ij} + \delta_8 * DUM_{TSE} * TSE290_i \\
& + \delta_9 * DUM_{TSE} * TSE290_i * NUM_{ij} + \delta_{10} * DUM_{TSE} * TEF10_i \\
& + \delta_{11} * DUM_{TSE} * TEF10_i * NUM_{ij} + \delta_{12} TREND_j
\end{aligned} \tag{4}$$

where  $TSE290_i$  is a dichotomous variable which is equal to 0 if firm  $i$  is not in the

TSE290 category and 1 if it is in the TSE 290 category. Similarly  $TEF10_i$  is equal to 0 if the firm is not in the TEF10 category and 1 if the firm is in TEF10 category.  $DUM_{TSE}$  is 0 in the pre TSE 300 composite futures period and 1 in the post TSE 300 composite futures period. Again the variables of primary interest are  $\delta_6$ ,  $\delta_6 + \delta_8$  and  $\delta_6 + \delta_{10}$  which are the differences in variance between pre- and post-TSE 300 composite futures period for NON-TSE stocks, TSE290 stocks and TEF 10 stock categories, respectively. Table 16 contains the results of the estimation of equation 4. The results are similar to control regression specification. We find an insignificant increase after the introduction of TSE300 contract. Table 17 contains the results of the test of joint significance. All the relevant coefficients are insignificant.

The results indicate significant change in volatility only for the first contract. As with the unconditional results and control regression results at the introduction TSE 300 contract there is no significant change in volatility.

#### *Unconditional Changes in Quoted Percentage Bid-Ask Spreads*

Spreads may decrease as the cost of supplying liquidity decreases due to better hedging opportunities available to market makers. On the other hand spreads can also increase due to increased proportions of informed traders. The results for unconditional spreads are presented in table 10 for the TEF contract and in table 11 for the TSE300 contract. We find that average time weighted percentage spreads for both TEF-10 and Non-TEF stocks decrease after introduction of TEF contract. Percentage spreads for TEF-10 stocks decreased by 0.0004 and is significant at the 5% level. Percentage spreads for Non-TEF stocks decreased by 0.0018 and the

decrease is significant at the 1% level. The decrease in spreads of stocks that are not in the index is consistent with the findings of Choi and Subrahmanyam (1994). Upon the introduction of the TSE300 contract, spreads of TEF-10 stocks increased and that of TSE290 and those of Non-TSE stocks decreased. However none of the resulting changes are significant.

*Regression analysis on spreads*

Similar to volatility, there may be confounding factors blurring the true impact of the futures contract on quoted spreads. To test this, we model percentage spreads as a function of volatility, volume, price and contract dummy. The specification used is similar to Jegadeesh and Subramanyam (1993) and Stoll (1978).

$$SPD_{ij} = \eta_0 + \eta_1 * VAR_{ij} + \eta_2 * PRC_{ij} + \eta_3 * VOL_{ij} + \eta_4 * DUM_{TEF} + \varepsilon_{ij} \quad (5)$$

where SPD, VAR, PRC, VOL are spread, volatility, price, and volume for firm  $i$  on day  $j$  and  $DUM_{TEF}$  is a dichotomous variable which is equal to 0 if day  $j$  is in the Pre-TEF period and 1 if day  $j$  is in the Post-TEF period. The variable of interest is  $\eta_4$ , which indicates how the spreads have changed after the introduction of the TEF futures contract.

Larger variance increases the inventory carrying risk for a market maker. It also amplifies trading by informed traders and increases adverse selection risk for a market maker. Among others, Stoll (1978) and Coller and Yohn (1997) have found a positive relation between return variance and spreads. The volatility of returns also

denotes information asymmetry and we expect its coefficient to be positively related to spreads. Therefore, we expect  $\eta_1$  to be positive. For an equal number of shares traded, fixed costs are spread over a higher dollar volume for high priced stocks. This yields a lower fixed cost component and hence lowers spreads. Prior research such as that of Demsetz (1968) and more recently Coller and Yohn (1997) have found a positive relation between prices and spreads, therefore we expect  $\eta_2$  to be positive. A higher trading volume provides greater opportunities for a market maker to offset any inventory imbalance, thereby reducing inventory risk for the market maker. Prior research has also identified a negative relation between spreads and trading volume (Demsetz (1968) and Coller and Yohn (1997)). We expect  $\eta_3$  to be negative.

Table 18 contains the results of estimation of equation 5.  $\eta_4$  is negative for all categories of stocks. The reduction in spreads is insignificant for TEF stocks, significant at the 1% level for Non-TEF stocks and significant at the 5% level for matched stocks.

We employ a similar model for analysis around the introduction of TSE 300 contract:

$$SPD_{ij} = \kappa_0 + \kappa_1 * VAR_{ij} + \kappa_2 * PRC_{ij} + \kappa_3 * VOL_{ij} + \kappa_4 * DUM_{TSE} + \varepsilon_{ij} \quad (6)$$

Where  $DUM_{TSE}$  is a dichotomous variable, which is equal to 0 if day j is in the TSE period and 1 if day j is in the post-TSE period. Table 21 contains the results from estimation of equation 6 (TSE contract). Again we find a decrease in spreads after the

introduction of the futures contract. The variable of interest  $\kappa_4$  is negative and significant for TSE 290 stocks and Non-TSE stocks. It is negative and insignificant for the TEF-10 category.

*Pooled sample regression analysis of spreads*

Similar to volatility we also estimate pooled sample regression on spreads. The specification used is similar to Choi and Sunrahmanayam (1994); for TEF contract the specification is

$$\begin{aligned}
SPD_{ij} = & \lambda_0 + \lambda_1 * VAR_{ij} + \lambda_2 * PRC_{ij} + \lambda_3 * VOL_{ij} + \lambda_4 * TEF10_i \\
& + \lambda_5 * TEF10_i * VAR_{ij} + \lambda_6 * TEF10_i * PRC_{ij} + \lambda_7 * TEF10_i * VOL_{ij} \\
& + \lambda_8 * MATCH_i + \lambda_9 * MATCH_i * VAR_{ij} + \lambda_{10} * MATCH_i * PRC_{ij} \\
& + \lambda_{11} * MATCH_i * VOL_{ij} + \lambda_{12} * DUM_{TEF} + \lambda_{13} * DUM_{TEF} * VAR_{ij} \\
& + \lambda_{14} * DUM_{TEF} * PRC_{ij} + \lambda_{15} * DUM_{TEF} * VOL_{ij} + \lambda_{16} * DUM_{TEF} * TEF10_i \\
& + \lambda_{17} * DUM_{TEF} * TEF10_i * VAR_{ij} + \lambda_{18} * DUM_{TEF} * TEF10_i * PRC_{ij} \\
& + \lambda_{19} * DUM_{TEF} * TEF10_i * VOL_{ij} + \lambda_{20} * DUM_{TEF} * MATCH_i \\
& + \lambda_{21} * DUM_{TEF} * MATCH_i * VAR_{ij} + \lambda_{22} * DUM_{TEF} * MATCH_i * PRC_{ij} \\
& + \lambda_{23} * DUM_{TEF} * MATCH_i * VOL_{ij} + \lambda_{24} * TREND_j
\end{aligned}
\tag{7}$$

where  $SPD_{ij}$ ,  $VAR_{ij}$ ,  $PRC_{ij}$ ,  $VOL_{ij}$  are spread, volatility price, and volume for firm  $i$  on day  $j$ .  $TEF_i$ ,  $MATCH_i$ ,  $DUM_{TEF}$  and  $TREND_j$  are as defined in the regression for volatility. The variables of primary interest are  $\lambda_{12}$ ,  $\lambda_{12} + \lambda_{16}$ , and  $\lambda_{12} + \lambda_{20}$ . These three variables represent the differences in spreads between pre- and post-TEF futures periods for Non-TEF stocks, TEF stocks and control sample stocks, respectively. The results from estimation of equation 7 (TEF contract) are in Table 19 and tests for joint

significance are in Table 20. The trend variable  $\beta_{24}$  is negative and significant. Thus, the results obtained in the unconditional and control regression analysis may be suspect. If there is an overall decreasing trend in the time period analyzed, the unconditional and control regression analysis would show a decrease in spreads after the introduction of the TEF contract, even if the futures contract had no effect on the spreads. The coefficient for  $\lambda_{12}$  is negative and significant, however  $\lambda_{12} + \lambda_{16}$  and  $\lambda_{12} + \lambda_{20}$  are insignificant. The spreads for the Non-TEF stocks decreased but there was no change for the TEF or Matched stocks. We further examine any change sensitivity of the spreads to volatility, price and volume. The variables  $\lambda_{13}$ ,  $\lambda_{13} + \lambda_{17}$ ,  $\lambda_{13} + \lambda_{21}$  represent any additional change in the relationship between volatility and spreads after the introduction of TEF contract for Non-TEF, TEF 10 and Match stocks.  $\lambda_{13}$  is positive and significant, while  $\lambda_{13} + \lambda_{17}$  and  $\lambda_{13} + \lambda_{21}$  are insignificant. After the introduction of the contract for Non-TEF stocks the impact of volatility on spreads increased. This is further evidence of a possible increased proportion of informed trading in the Non-TEF stocks.  $\lambda_{14}$ ,  $\lambda_{14} + \lambda_{18}$ , and  $\lambda_{14} + \lambda_{22}$  represent any additional change in price and spreads. We find the coefficient for  $\lambda_{14}$  to be positive and significant and while the other two to be insignificant. The impact of price on stocks increased for the Non-TEF stocks. Similarly, the impact of volume also increased for the Non-TEF stocks while changing insignificantly for the TEF and Matched stocks. The effect of the introduction of the futures contract is more on the non-index.

Similarly for analysis around the introduction of the TSE 300 futures contract we employ the following specification:

$$\begin{aligned}
SPD_{ij} = & \mu_0 + \mu_1 * VAR_{ij} + \mu_2 * PRC_{ij} + \mu_3 * VOL_{ij} + \mu_4 * TSE290_i \\
& + \mu_5 * TSE290_i * VAR_{ij} + \mu_6 * TSE290_i * PRC_{ij} + \mu_7 * TSE290_i * VOL_{ij} \\
& + \mu_8 * TEF10_i + \mu_9 * TEF10_i * VAR_{ij} + \mu_{10} * TEF10_i * PRC_{ij} \\
& + \mu_{11} * TEF10_i * VOL_{ij} + \mu_{12} * DUM_{TEF} + \mu_{13} * DUM_{TEF} * VAR_{ij} \\
& + \mu_{14} * DUM_{TEF} * PRC_{ij} + \mu_{15} * DUM_{TEF} * VOL_{ij} + \mu_{16} * DUM_{TEF} * TSE290_i \\
& + \mu_{17} * DUM_{TEF} * TSE290_i * VAR_{ij} + \mu_{18} * DUM_{TEF} * TSE290_i * PRC_{ij} \\
& + \mu_{19} * DUM_{TEF} * TSE290_i * VOL_{ij} + \mu_{20} * DUM_{TEF} * TEF10_i \\
& + \mu_{21} * DUM_{TEF} * TEF10_i * VAR_{ij} + \mu_{22} * DUM_{TEF} * TEF10_i * PRC_{ij} \\
& + \mu_{23} * DUM_{TEF} * TEF10_i * VOL_{ij} + \mu_{24} * TREND_j
\end{aligned} \tag{8}$$

The variables are as defined above. The variables of interest are  $\mu_{12}$ ,  $\mu_{12} + \mu_{16}$ , and  $\mu_{12} + \mu_{20}$ . The three variables are the differences in spreads between pre- and post-TEF futures periods for NON-TSE stocks, TSE290 stocks and TEF10 stocks, respectively. The results of the estimation of equation 8 are in Table 22 and the results of the test of joint significance are in Table 23. There is a significant upward overall trend during the time period analyzed as evidenced from the coefficient of  $\mu_{24}$ . The coefficients of  $\mu_{12}$  and  $\mu_{12} + \mu_{16}$  are significant and negative and for  $\mu_{12} + \mu_{20}$  is the coefficient insignificant. The results show a significant decrease in spreads for the Non-TSE and TSE 290 categories and no significant change for the TEF10 category. The results also indicate a decrease in the impact of volatility and an increase in the impact of volume on spreads for the Non-TSE stocks. The results for the second contract are mixed, compared to the results of the first contract.

#### *Asymmetric Information Component Analysis*

In order to further understand changes in spreads due to the introduction of futures contracts, we determine changes in the components of spreads. We

decompose spreads in liquidity and in the asymmetric information component and examine the changes in each component due to futures contracts. We use Madhavan, Richardson, and Roomans (1997) model to estimate the components of spread. We also assume that order flow is uncorrelated. Specifically we use:

$$P_t - P_{t-1} = \phi(x_t - x_{t-1}) + \Delta\phi DUM_{TEF}(x_t - x_{t-1}) + \theta(x_t) + \Delta\theta DUM_{TEF}(x_t) \quad (9)$$

where  $P$  is the trade price of a security at time  $t$  or  $t-1$ . Time  $t-1$  denotes time at the last trade.  $x$  is the sign indicator of the trade. To determine the sign indicator we first determine the mid-point of the spread by taking the average of bid and ask prevalent at the time of the trade. We further classify a trade to be a buy if the trade price is above the mid-point of the spread; otherwise it is classified as a sell. ‘ $x$ ’, the sign indicator of the trade, is  $+1$  for a buy and  $-1$  for a sell.  $\phi$  is the cost of supplying liquidity.  $\theta$  is the asymmetric information parameter. We are interested in the changes in  $\phi$  and  $\theta$  after the introduction of the contract.  $DUM_{TEF}$  is a dichotomous variable, which is equal to 0 in the Pre-TEF period and is equal to 1 in the Post-TEF period.  $\Delta$  indicates a change in either liquidity or asymmetric parameters in the post period. The estimates are obtained for each unique stock symbol and then averaged. We are interested in the coefficient for the changes in liquidity costs and the asymmetric information parameter. We expect the costs of supplying liquidity to decrease and of asymmetric information costs to increase.

Table 24 provides results from the estimation of Equation 9. For TEF and Non-TEF stocks the cost of providing liquidity decreases as expected. The decrease is insignificant for TEF stocks, and is significant at the 1% level for the Non-TEF

stocks. Matched stocks show an insignificant increase in the cost of providing liquidity. For all three categories, the information asymmetry costs increased as expected. The increase is insignificant for TEF and matched stocks and significant at the 1% level for Non-TEF stocks. The results provide support for hypotheses 1 and 2. For TEF 10 and Non-TEF stocks the decrease in the liquidity component of the spread is more than the increase in the information asymmetry component thereby causing overall reduction in spreads.

We use a similar set up for the TSE300 contract. Specifically we use

$$P_t - P_{t-1} = \phi(x_t - x_{t-1}) + \Delta\phi DUM_{TSE}(x_t - x_{t-1}) + \theta(x_t) + \Delta\theta DUM_{TSE}(x_t) \quad (10)$$

Table 25 provides results from the estimation of Equation 10. For all categories of stocks the cost of supplying liquidity decreases; however, the change is only significant for TSE 290 stocks at the 10% level. Though the information asymmetry component of the spread increases after the introduction of the TSE 300 contract for all categories of stocks, the increase is only significant for Non-TSE stocks at the 10% level. The results also show the combined effect to be a decrease in spreads for the index stocks (TEF10, TSE 290) and an increase in spreads for the non-index stocks (Non-TSE). Overall, we find weak evidence for our hypothesis that the liquidity component of the spreads decreases and that the information asymmetry component of the spreads increases. One reason for less significant results may be the existence of the TEF 10 contract. Because of a pre-existing contract the effects of the introduction of the new contract are marginal in nature.

## **Section 5: Conclusion**

An index futures contract provides traders an instrument to enable them to trade a basket of stocks at a lower cost. If a futures contract is not available, then for traders to diversify, they have to buy individual stocks at significant trading costs. Upon availability of an index futures contract, uninformed traders looking to diversify will migrate from individual stocks to the futures contract in order to reduce their trading costs. This in turn will increase the proportion of informed traders trading in individual stocks. This will cause the asymmetric information component of the spread for individual stocks to increase. On the other hand, with futures contracts, market makers have a better opportunity to hedge their inventory risks. This should reduce the inventory carrying costs for market makers, thereby reducing the inventory costs component of the spread. We examine these issues around introduction of the Toronto Equity Futures Contract and the Toronto Stock Exchange 300 composite Index futures contract.

This study examines the changes in spreads and its components of individual stocks around the introduction of two futures contracts. The Toronto Equity Futures Contract was based on a basket of 10 stocks and was introduced in January of 1983. Subsequently, in January 1984, it was modified to include all 300 stocks in the Toronto 300 composite Index. We examine the stocks which form the Toronto Equity Futures Contract, stocks that are part of the TSE 300 Index but are not in the TEF contract, and stocks which are not part of TSE 300 composite Index.

We find no significant change in volume from to after the introduction of both

contracts. There is however, a significant increase in the number of transactions for index stocks upon the introduction of both the TEF contract and the TSE300 contract. Also, the trade size increases for non-index stocks for both futures contracts, indicating an increased proportion of informed traders. There is also a significant decrease in the volatility of non-index stocks upon the introduction of the TEF contract; supporting the hypothesis that introduction of a futures contract has a significant effect on non-index stocks.

We find that spreads decrease for non-index stocks for both contracts. After the introduction of the first contract the spreads for the non-index stocks become more sensitive to volatility, price and volume. We further study the impact of futures contracts at different components of bid-ask spread. For both contracts we find a reduction in the cost of supplying liquidity. One reason for this could be that the market makers have better hedging opportunities due to the presence of a futures contract. We also find an increase in the asymmetric information component of the spread after the introduction of both contracts. This increase provides support for the hypothesis that uninformed traders migrate from individual stocks to futures contracts.

Futures provide an additional instrument for traders to trade. It is a low-cost alternative to buying individual stocks. Uninformed traders are able to obtain the benefit of low cost trading and diversification with futures contracts. Thus at the introduction of the futures contract there should some migration of uninformed traders to futures markets from the individual stock's market. This would increase the

proportion of informed traders trading in individual stocks. Also since market makers are able to hedge using a futures contract, the cost of supplying liquidity should decrease. This study does find an increase in asymmetric information costs and a decrease in the cost of supplying liquidity.

## References

- Choi, H., and A. Subrahmanyam, 1994, "Using Intraday Data to Test for Effects of Index Futures on the Underlying Stock Markets," *Journal of Futures Markets*, 14, 292-322
- Coller, M., and T.L Yohn, 1997, "Management Forecasts and Information Asymmetry: An Examination of Bid-Ask Spreads," *Journal of Accounting Research*, 35, 181-191
- Copeland, T., and D. Galai, 1983, "Information Effects on the Bid-Ask Spread," *Journal of Finance*, 38, 1457-1469
- Demsetz, H., 1968, "The Costs of Transacting," *Quarterly Journal of Economics*, 82, 33-53
- Gammill, J.F., and A.F. Perold, 1989, "The Changing Character of Stock Market Liquidity," *Journal of Portfolio Management*, 15 (Spring), 13-18
- Glosten, L., and P. Milgrom, 1985, "Bid, Ask and Transaction Prices in a Specialist Market with Heterogeneously Informed Traders," *Journal of Financial Economics*, 14, 71-100
- Gorton, G.B., and G.G. Pennacchi, 1990, "Financial Intermediaries and Liquidity Creation," *Journal of Finance*, 45, 49-71
- Jegadeesh, N., and A. Subrahmanyam, 1993, "Liquidity Effects of the Introduction of the S&P 500 Index Futures Contract on the Underlying Stocks," *Journal of Business*, 66
- Jones, C.M, G. Kaul, and M. L. Lipson, 1994, "Transactions, Volume and Volatility," *Review of Financial Studies*, 7, 631-651
- Madhavan, A., M. Richardson, and M. Roomans, 1997, "Why do Security Prices Change? A Transaction-level Analysis of NYSE Stocks," *Review of Financial Studies*, 10, 1035-1064
- Ronen, T., and D. G. Weaver, 2001, "Teenies' anyone?," *Journal of Financial Markets*, 4, 231-260
- Stoll, H.R., 1978, "The Pricing of Dealers Services: An Empirical Study of NASDAQ Stocks," *Journal of Finance*, 44, 115-134

Sunbrahmanyam, A., 1991, "A Theory of Trading in Stock Index Futures," *Review of Financial Studies*, 4, 17-51

**Table 1**  
**Number of Stocks**

Table contains the actual number of stocks available after filter in each stock category. TEF stocks are 10 stocks, which comprise the index used for TEF contract. Non-TEF stocks are stocks, which are in the index used for TEF contract. TSE-290 stocks are stocks, which are in TSE 300 index, but were not in TEF-10 category. TSE-300 stocks are the stocks, which comprised TSE 300 stock Index. The non-TSE stocks are the stocks, which were not in the TSE 300 index.

<b>Category</b>	<b>Number of Stocks</b>
TEF Stocks	10
Non-TEF Stocks	179
Matched Stocks	10

<b>Category</b>	<b>Number of Stocks</b>
TEF Stocks	10
TSE-290 Stocks	163
TSE-300 Stocks	173
Non-TSE Stocks	49

**Table 2**  
**Volume (TEF Contract)**

Table contains Volume for various stock categories around introduction of TEF futures contract. TEF stocks are 10 stocks, which comprise the index used for TEF contract. The non-TEF stocks are the stocks, which were not in the index. Pre-TEF period is from Dec 13, 1982 to Jan 26, 1983. Post-TEF period is from Jan 27, 1983 to Mar 9, 1983. Difference is Post-TEF volume minus Pre-TEF volume. T-Statistics are provided in parentheses.

Category	Volume		Difference (T-Stat)
	Pre-TEF	Post-TEF	
TEF Stocks	67804	66302	-1502 (-0.30)
Non-TEF Stocks	15445	15994	549 (0.71)
Matched Stocks	43563	38407	-5156 (-1.35)

\*\*\*, \*\*, \* denote 1%, 5% and 10% level of significance.

**Table 3**  
**Volume (TSE Contract)**

Table contains volume for various stock categories around introduction of TSE 300 futures contract. TEF stocks are 10 stocks, which comprise the index used for TEF contract. TSE-290 stocks are stocks, which are in TSE 300 index, but were not in TEF-10 category. TSE-300 stocks are the 300 stocks, which comprised TSE 300 stock Index. The non-TSE stocks are the stocks, which were not in the TSE 300 index. Pre-TSE period is from Dec 1, 1983 to Jan 13, 1984. Post-TSE is from Jan 16, 1984 to Feb 24, 1984. Difference is Post-TEF volume minus Pre-TEF volume. T-Statistics are provided in parentheses.

Category	Volume		Difference (T-Stat)
	Pre-TSE	Post-TSE	
TEF Stocks	64349	69269	4921 (0.77)
TSE-290 Stocks	15585	16345	761 (0.97)
TSE-300 Stocks	18466	19460	994 (1.15)

Table 3 (continued)

Category	Volume		Difference (T-Stat)
Non-TSE Stocks	9790	9912	122 (0.16)

\*\*\*, \*\*, \* denote 1%, 5% and 10% level of significance.

**Table 4**  
**Number of Transactions (TEF Contract)**

Table contains number of transactions for various stock categories around introduction of TEF futures contract. TEF stocks are 10 stocks, which comprise the index used for TEF contract. The non-TEF stocks are the stocks, which were not in the index. Pre-TEF period is from Dec 13, 1982 to Jan 26, 1983. Post-TEF period is from Jan 27, 1983 to Mar 9, 1983. Difference is Post-TEF number of transactions minus Pre-TEF number of transactions. T-Statistics are provided in parentheses.

Category	Number of Transactions		Difference (T-Stat)
	Pre-TEF	Post-TEF	
TEF Stocks	120.6	141.8	21.2 (2.11)**
Non-TEF Stocks	24.8	24.7	-0.2 (-0.25)
Matched Stocks	78.3	76.2	-2.1 (-0.37)

\*\*\*, \*\*, \* denote 1%, 5% and 10% level of significance.

**Table 5**  
**Number of Transactions (TSE Contract)**

Table contains number of transactions for various stock categories around introduction of TSE 300 futures contract. Table contains volume for various stock categories around introduction of TSE 300 futures contract. TEF stocks are 10 stocks, which comprise the index used for TEF contract. TSE-290 stocks are stocks, which are in TSE 300 index, but were not in TEF-10 category. TSE-300 stocks are the 300 stocks, which comprised TSE 300 stock Index. The non-TSE stocks are the stocks, which were not in the TSE 300 index. Pre-TSE period is from Dec 1, 1983 to Jan 13, 1984. Post-TSE is from Jan 16, 1984 to Feb 24, 1984. Difference is Post-TEF number of transactions minus Pre-TEF number of transactions. T-Statistics are provided in parentheses.

Category	Number of Transactions		Difference (T-Stat)
	Pre-TSE	Post-TSE	
TEF Stocks	103.0	120.8	17.9 (1.82)*
TSE-290 Stocks	18.7	19.9	1.2 (2.39)**

Table 5 (continued)

Category	Number of Transactions		Difference (T-Stat)
TSE-300 Stocks	23.6	25.8	2.2 (2.51)**
Non-TSE Stocks	16.1	15.9	-0.2 (-0.31)

\*\*\*, \*\*, \* denote 1%, 5% and 10% level of significance.

**Table 6****Trade Size (TEF Contract)**

Table contains trade size for various stock categories around introduction of TEF futures contract. TEF stocks are 10 stocks, which comprise the index used for TEF contract. The non-TEF stocks are the stocks, which were not in the index. Pre-TEF period is from Dec 13, 1982 to Jan 26, 1983. Post-TEF period is from Jan 27, 1983 to Mar 9, 1983. Difference is Post-TEF trade size minus Pre-TEF trade size. T-Statistics are provided in parentheses.

Category	Trade Size		Difference (T-Stat)
	Pre-TEF	Post-TEF	
TEF Stocks	553.0	500.6	-52.4 (-2.33)**
Non-TEF Stocks	635.8	684.7	48.9 (1.27)
Matched Stocks	521.7	463.5	-58.2 (-1.55)

\*\*\*, \*\*, \* denote 1%, 5% and 10% level of significance.

**Table 7**  
**Trade Size (TSE Contract)**

Table contains trade size for various stock categories around introduction of TSE 300 futures contract. Table contains volume for various stock categories around introduction of TSE 300 futures contract. TEF stocks are 10 stocks, which comprise the index used for TEF contract. TSE-290 stocks are stocks, which are in TSE 300 index, but were not in TEF-10 category. TSE-300 stocks are the 300 stocks, which comprised TSE 300 stock Index. The non-TSE stocks are the stocks, which were not in the TSE 300 index. Pre-TSE period is from Dec 1, 1983 to Jan 13, 1984. Post-TSE is from Jan 16, 1984 to Feb 24, 1984. Difference is Post-TEF trade size minus Pre-TEF trade size. T-Statistics are provided in parentheses.

Category	Trade Size		Difference (T-Stat)
	Pre-TSE	Post-TSE	
TEF Stocks	648.3	667.7	19.4 (0.39)
TSE-290 Stocks	803.6	805.5	1.9 (0.05)

Table 7 (continued)

Category	Trade Size		Difference (T-Stat)
TSE-300 Stocks	794.4	797.4	3.0 (0.08)
Non-TSE Stocks	581.2	645.8	64.6 (1.07)

\*\*\*, \*\*, \* denote 1%, 5% and 10% level of significance.

**Table 8****Unconditional Volatility (TEF Contract)**

Table contains unconditional Volatility for various stock categories around introduction of TEF futures contract. TEF stocks are 10 stocks, which comprise the index used for TEF contract. The non-TEF stocks are the stocks, which were not in the index. Pre-TEF period is from Dec 13, 1982 to Jan 26, 1983. Post-TEF period is from Jan 27, 1983 to Mar 9, 1983. Difference is Post-TEF volatility minus Pre-TEF volatility. T-Statistics are provided in parentheses. Reported volatility is 1000 times actual volatility.

Category	Volatility		Difference (T-Stat)
	Pre-TEF	Post-TEF	
TEF Stocks	0.0238	0.0209	-0.0029 (-0.8)
Non-TEF Stocks	0.1051	0.0702	-0.0349 (-3.77)***
Matched Stocks	0.0294	0.0241	-0.0054 (-1.70)*

\*\*\*, \*\*, \* denote 1%, 5% and 10% level of significance.

**Table 9**  
**Unconditional Volatility (TSE Contract)**

Table contains unconditional Volatility for various stock categories around introduction of TSE 300 futures contract. TEF stocks are 10 stocks, which comprise the index used for TEF contract. TSE-290 stocks are stocks, which are in TSE 300 index, but were not in TEF-10 category. TSE-300 stocks are the 300 stocks, which comprised TSE 300 stock Index. The non-TSE stocks are the stocks, which were not in the TSE 300 index. Pre-TSE period is from Dec 1, 1983 to Jan 13, 1984. Post-TSE is from Jan 16, 1984 to Feb 24, 1984. Difference is Post-TEF volatility minus Pre-TEF volatility. T-Statistics are provided in parentheses. Reported volatility is 1000 times actual volatility.

Category	Volatility		Difference (T-Stat)
	Pre-TSE	Post-TSE	
TEF Stocks	0.0088	0.0106	0.0018 (1.45)
TSE-290 Stocks	0.0396	0.0401	0.0006 (0.23)

Table 9 (continued)

Category	Volatility		Difference (T-Stat)
TSE-300 Stocks	0.0376	0.0382	0.0007 (0.3)
Non-TSE Stocks	0.0857	0.0984	0.0127 (0.55)

\*\*\*, \*\*, \* denote 1%, 5% and 10% level of significance.

**Table 10****Unconditional Quoted Percentage Bid-Ask Spreads (TEF Contract)**

Table contains unconditional Bid-Ask percentage spreads for various stock categories around introduction of TEF futures contract. TEF stocks are 10 stocks, which comprise the index used for TEF contract. The non-TEF stocks are the stocks, which were not in the index. Pre-TEF period is from Dec 13, 1982 to Jan 26, 1983. Post-TEF period is from Jan 27, 1983 to Mar 9, 1983. Difference is Post-TEF spreads minus Pre-TEF spreads. T-Statistics are provided in parentheses.

<b>Category</b>	<b>Percentage Spread</b>		<b>Difference (T-Stat)</b>
	Pre-TEF	Post-TEF	
TEF Stocks	0.0071	0.0066	-0.0004 (-2.58)**
Non-TEF Stocks	0.0195	0.0178	-0.0018 (-7.51)***
Matched Stocks	0.0072	0.0067	-0.0005 (-2.07)**

\*\*\*, \*\*, \* denote 1%, 5% and 10% level of significance.

**Table 11****Unconditional Quoted Percentage Bid-Ask Spreads (TSE Contract)**

Table contains unconditional Bid-Ask percentage spreads for various stock categories around introduction of TSE 300 futures contract. TEF stocks are 10 stocks, which comprise the index used for TEF contract. TSE-290 stocks are stocks, which are in TSE 300 index, but were not in TEF-10 category. TSE-300 stocks are the 300 stocks, which comprised TSE 300 stock Index. The non-TSE stocks are the stocks, which were not in the TSE 300 index. The “number of stocks” is actual number of stocks, which traded at least on one day during the time period analyzed. Pre-TSE period is from Dec 1, 1983 to Jan 13, 1984. Post-TSE is from Jan 16, 1984 to Feb 24, 1984. Difference is Post-TEF spreads minus Pre-TEF spreads. T-Statistics are provided in parentheses.

Category	Percentage Spread		Difference (T-Stat)
	Pre-TSE	Post-TSE	
TEF Stocks	0.0057	0.0059	0.0002 (1.04)
TSE-290 Stocks	0.0158	0.0157	-0.0002 (-0.95)

Table 11 (continued)

Category	Percentage Spread		Difference (T-Stat)
TSE-300 Stocks	0.0152	0.0151	-0.0002 (-0.87)
Non-TSE Stocks	0.0207	0.0201	-0.0006 (-1.07)

\*\*\*, \*\*, \* denote 1%, 5% and 10% level of significance.

**Table 12****Estimates of regressions of volatility on number of transactions and a dichotomous variable  $DUM_{TEF}$  for TEF contract**

Table contains results of the regressions where dependent variable is original volatility\*1000 and independent variables are number of transactions and a dichotomous variable  $DUM_{TEF}$ . The model is  $VAR = \alpha_0 + \alpha_1 * NUM + \alpha_2 * DUM_{TEF} + \varepsilon$ , where VAR is volatility\*1000, NUM is of number of transactions and  $DUM_{TEF}$  is a dichotomous variable which is equal to 0 in the Pre-TEF period and is equal to 1 in the Post-TEF period. Pre-TEF period is from Dec 13, 1982 to Jan 26, 1983. Post-TEF period is from Jan 27, 1983 to Mar 9, 1983. TEF stocks are 10 stocks, which comprise the index used for TEF contract. The non-TEF stocks are the stocks, which were not in the index. T-Statistics are provided in parentheses.

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Table 12 (continued)

Category	Intercept	Coefficient for Number of transactions	Coefficient for DUM <sub>TEF</sub> variable	Adjusted R <sup>2</sup>
	$\alpha_0$	$\alpha_1$	$\alpha_2$	
TEF Stocks	0.0206 (6.48) <sup>***</sup>	0.0000 (1.72) <sup>*</sup>	-0.0034 (-0.92)	0.00
Non-TEF Stocks	0.1075 (14.68) <sup>***</sup>	-0.0001 (-0.7)	-0.0349 (-3.82) <sup>***</sup>	0.00
Matched Stocks	0.0051 (2.17) <sup>**</sup>	0.0003 (16.27) <sup>***</sup>	-0.0048 (-1.82) <sup>*</sup>	0.31

\*\*\*, \*\*, \* denote 1%, 5% and 10% level of significance.

**Table 13****Estimates of pooled regression of volatility for TEF contract**

Table contains results of pooled regression model of volatility for TEF contract. The model is  $VAR_{ij} = \gamma_0 + \gamma_1 * NUM_{ij} + \gamma_2 * TEF10_i + \gamma_3 * TEF10_i * NUM_{ij} + \gamma_4 * MATCH_i + \gamma_5 * MATCH_i * NUM_{ij} + \gamma_6 * DUM_{TEF} + \gamma_7 * DUM_{TEF} * NUM_{ij} + \gamma_8 * DUM_{TEF} * TEF10_i + \gamma_9 * DUM_{TEF} * TEF10_i * NUM_{ij} + \gamma_{10} * DUM_{TEF} * MATCH_i + \gamma_{11} * DUM_{TEF} * MATCH_i * NUM_{ij} + \gamma_{12} * TREND_j$  where  $VAR_{ij}$  is volatility\*1000 for firm  $i$  on day  $j$ ,  $NUM_{ij}$  is the number of transactions for firm  $i$  on day  $j$  and  $TEF10_i$  is a dichotomous variable which is equal to 0 if firm  $i$  is not in the TEF index and 1 if it is one of the ten stocks which makes TEF index. Similarly  $MATCH_i$  is equal to 0 if the firm is not in the control sample and 1 if the firm is in control sample.  $DUM_{TEF}$  is 0 in the pre TEF futures period and 1 in the post TEF futures period.  $TREND_j$  is a trend variable, which is equal to day  $j$ . Pre-TEF period is from Dec 13, 1982 to Jan 26, 1983. Post-TEF period is from Jan 27, 1983 to Mar 9, 1983.

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Table 13 (continued)

Variable	Coefficient	Estimate	T Value
INTERCEPT	$\gamma_0$	0.0967	9.01***
NUM	$\gamma_1$	-0.0003	-1.58
TEF10	$\gamma_2$	-0.1046	-2.43**
TEF10*NUM	$\gamma_3$	0.0004	1.2
MATCH	$\gamma_4$	-0.1046	-2.82***
MATCH*NUM	$\gamma_5$	0.0005	1.38
DUM <sub>TEF</sub>	$\gamma_6$	-0.0943	-4.95***
DUM <sub>TEF</sub> *NUM	$\gamma_7$	0.0007	2.16**
DUM <sub>TEF</sub> *TEF10	$\gamma_8$	0.0602	1.06
DUM <sub>TEF</sub> *TEF10*NUM	$\gamma_9$	-0.0008	-1.66*
DUM <sub>TEF</sub> *MATCH	$\gamma_{10}$	0.0316	0.57
DUM <sub>TEF</sub> *MATCH*NUM	$\gamma_{11}$	-0.0005	-0.75
TREND	$\gamma_{12}$	0.0014	2.84***
Adj R <sup>2</sup>	0.00		

**Table 14****Tests of joint significance for pooled regression of volatility for TEF contract**

Table contains test of joint significance conducted in the model estimated in table 13.

Category	Variable	Coefficients	F-Value
Non-TEF	$DUM_{TEF}$	$\gamma_6$	24.51***
TEF-10	$DUM_{TEF} + DUM_{TEF} * TEF10$	$\gamma_6 + \gamma_8$	0.35
Match-TEF	$DUM_{TEF} + DUM_{TEF} * MATCH$	$\gamma_6 + \gamma_{10}$	1.22
Non-TEF	$DUM_{TEF} * NUM$	$\gamma_7$	4.67***
TEF-10	$DUM_{TEF} * NUM + DUM_{TEF} * TEF10 * NUM$	$\gamma_7 + \gamma_{\beta_9}$	0.08
Match-TEF	$DUM_{TEF} * NUM + DUM_{TEF} * MATCH * NUM$	$\gamma_7 + \gamma_{11}$	0.14

**Table 15****Estimates of regressions of volatility on number of transactions and a dichotomous variable  $DUM_{TSE}$  for TSE contract**

Table contains results of the regressions where dependent variable is original volatility\*1000 and independent variables are number of transactions and a dichotomous variable  $DUM_{TSE}$ . The model is  $VAR = \beta_0 + \beta_1 * NUM + \beta_2 * DUM_{TSE} + \varepsilon$ , where VAR is volatility\*1000, NUM is the number of transactions and  $DUM_{TSE}$  is a dichotomous variable which is equal to 0 in the Pre-TSE period and is equal to 1 in the Post-TSE period. Pre-TSE period is from Dec 1, 1983 to Jan 13, 1984. Post-TSE is from Jan 16, 1984 to Feb 24, 1984. TEF stocks are 10 stocks, which comprise the index used for TEF contract. TSE-290 stocks are stocks, which are in TSE 300 index, but were not in TEF-10 category. TSE-300 stocks are the 300 stocks, which comprised TSE 300 stock Index. The non-TSE stocks are the stocks, which were not in the TSE index. T-Statistics are provided in parentheses.

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Table 15 (continued)

Category	Intercept	Coefficient for Number of transactions	Coefficient t for $DUM_{TSE}$ variable	Adjusted $R^2$
	$\beta_0$	$\beta_1$	$\beta_2$	
TEF Stocks	0.0083 (8.11) <sup>***</sup>	0.0000 (0.94)	0.0017 (1.36)	0.00
TSE-290 Stocks	0.0408 (21.12) <sup>***</sup>	-0.0001 (-1.30)	0.0006 (0.27)	-0.00
TSE-300 Stocks	0.04 (23.42) <sup>***</sup>	-0.0001 (-3.97) <sup>***</sup>	0.0009 (0.4)	0.00
Non-TSE Stocks	0.0949 (4.83) <sup>***</sup>	-0.0005 (-0.89)	0.0126 (0.54)	-0.00

\*\*\*, \*\*, \* denote 1%, 5% and 10% level of significance.

**Table 16****Estimates of pooled regression of volatility for TSE contract**

Table contains results of pooled regression model of volatility for TSE contract. The model is  $VAR_{ij} = \delta_0 + \delta_1 * NUM_{ij} + \delta_2 * TSE290_i + \delta_3 * TSE290_i * NUM_{ij} + \delta_4 * TEF10_i + \delta_5 * TEF10_i * NUM_{ij} + \delta_6 * DUM_{TSE} + \delta_7 * DUM_{TSE} * NUM_{ij} + \delta_8 * DUM_{TSE} * TSE290_i + \delta_9 * DUM_{TSE} * TSE290_i * NUM_{ij} + \delta_{10} * DUM_{TSE} * TEF10_i + \delta_{11} * DUM_{TSE} * TEF10_i * NUM_{ij} + \delta_{12} * TREND_j + \delta_{12} * TREND_j$  where  $VAR_{ij}$  is volatility\*1000 for firm i on day j,  $NUM_{ij}$  is the number of transactions for firm i on day j and  $TEF10_i$  is a dichotomous variable which is equal to 0 if firm i is not in the TEF index and 1 if it is one of the ten stocks which makes TEF index. Similarly  $TSE290_i$  is equal to 0 if the firm is not in the TSS290 category and 1 if the firm is in the TSE 290 category.  $DUM_{TSE}$  is 0 in the pre TSE futures period and 1 in the post TSE futures period.  $TREND_j$  is a trend variable, which is equal to day j. Pre-TSE period is from Dec 1, 1983 to Jan 13, 1984. Post-TSE is from Jan 16, 1984 to Feb 24, 1984. T-Statistics are provided in parentheses.

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Table 16 (continued)

Variable	Coefficient	Estimate	T-Stat
INTERCEPT	$\delta_0$	0.0879	7.23***
NUM	$\delta_1$	-0.0004	-0.96
TSE290	$\delta_2$	-0.0523	-4.11***
TSE290*NUM	$\delta_3$	0.0004	0.75
TEF10	$\delta_4$	-0.0859	-3.35***
TEF10*NUM	$\delta_5$	0.0005	0.94
DUM <sub>TSE</sub>	$\delta_6$	0.0045	0.25
DUM <sub>TSE</sub> *NUM	$\delta_7$	-0.0002	-0.28
DUM <sub>TSE</sub> *TSE290	$\delta_8$	-0.0152	-0.88
DUM <sub>TSE</sub> *TSE290*NUM	$\delta_9$	0.0002	0.28
DUM <sub>TSE</sub> *TEF10	$\delta_{10}$	-0.0124	-0.35
DUM <sub>TSE</sub> *TEF10*NUM	$\delta_{11}$	0.0002	0.24
TREND	$\delta_{12}$	0.0004	1.22
Adj R <sup>2</sup>	0.01		

**Table 17****Tests of joint significance for pooled regression of volatility for TSE contract**

Table contains test of joint significance conducted in the model estimated in table 16.

Category	Variable	Coefficients	F-Value
Non-TSE	$DUM_{TSE}$	$\delta_6$	0.07
TSE 290	$DUM_{TSE} + DUM_{TSE} * TSE290$	$\delta_6 + \delta_8$	0.76
TEF 10	$DUM_{TEF} + DUM_{TSE} * TEF10$	$\delta_6 + \delta_{10}$	0.05

**Table 18**

**Estimates of regressions of time weighted spreads on volatility, price, volume  
and a dichotomous variable  $DUM_{TEF}$  for TEF contract**

Table contains results of the regressions where dependent variable is percentage time weighted spread and independent variables are volatility\*1000, price, volume and dichotomous variable  $DUM_{TEF}$ . The model is  $SPD = \eta_0 + \eta_1*VAR + \eta_2*PRC + \eta_3*VOL + \eta_4* DUM_{TEF} + \varepsilon$ , where SPD is time weighted spread, VAR, PRC, VOL are volatility\*1000, price and volume.  $DUM_{TEF}$  is a dichotomous variable, which is equal to 0 in the Pre-TEF period and is equal to 1 in the Post-TEF period. Pre-TEF period is from Dec 13, 1982 to Jan 26, 1983. Post-TEF period is from Jan 27, 1983 to Mar 9, 1983. TEF stocks are 10 stocks, which comprise the index used for TEF contract. The non-TEF stocks are the stocks, which were not in the index. T-Statistics are provided in parentheses.

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Table 18 (continued)

Category	Intercept	Coefficient for Volatility	Coefficient for Price	Coefficient for Volume	Coefficient for $DUM_{TEF}$ variable	Adj. $R^2$
	$\eta_0$	$\eta_1$	$\eta_2$	$\eta_3$	$\eta_4$	
TEF	0.0108 (48.85) <sup>***</sup>	0.0067 (4.83) <sup>***</sup>	-0.0001 (-22.82) <sup>***</sup>	0.000 (-3.04) <sup>***</sup>	-0.0002 (-1.49)	0.53
Non- TEF	0.025 (125.7) <sup>***</sup>	0.0071 (31.12) <sup>***</sup>	-0.0003 (-46.95) <sup>***</sup>	0.000 (-16.72) <sup>***</sup>	-0.001 (-5.07) <sup>***</sup>	0.28
Match Stocks	0.0104 (42.79) <sup>***</sup>	0.011 (4.37) <sup>***</sup>	-0.0001 (-19.73) <sup>***</sup>	0.000 (-6.63) <sup>***</sup>	-0.0003 (-2.02) <sup>**</sup>	0.43

\*\*\*, \*\*, \* denote 1%, 5% and 10% level of significance.

**Table 19****Estimates of pooled regression of spreads for TEF contract**

Table contains results of pooled regression model of spreads for TEF contract. The model is  $SPD_{ij} = \lambda_0 + \lambda_1*VAR_{ij} + \lambda_2*PRC_{ij} + \lambda_3*VOL_{ij} + \lambda_4*TEF10_i + \lambda_5*TEF10_i*VAR_{ij} + \lambda_6*TEF10_i*PRC_{ij} + \lambda_7*TEF10_i*VOL_{ij} + \lambda_8*MATCH_i + \lambda_9*MATCH_i*VAR_{ij} + \lambda_{10}*MATCH_i*PRC_{ij} + \lambda_{11}*MATCH_i*VOL_{ij} + \lambda_{12}*DUM_{TEF} + \lambda_{13}*DUM_{TEF}*VAR_{ij} + \lambda_{14}*DUM_{TEF}*PRC_{ij} + \lambda_{15}*DUM_{TEF}*VOL_{ij} + \lambda_{16}*DUM_{TEF}*TEF10_i + \lambda_{17}*DUM_{TEF}*TEF10_i*VAR_{ij} + \lambda_{18}*DUM_{TEF}*TEF10_i*PRC_{ij} + \lambda_{19}*DUM_{TEF}*TEF10_i*VOL_{ij} + \lambda_{20}*DUM_{TEF}*MATCH_i + \lambda_{21}*DUM_{TEF}*MATCH_i*VAR_{ij} + \lambda_{22}*DUM_{TEF}*MATCH_i*PRC_{ij} + \lambda_{23}*DUM_{TEF}*MATCH_i*VOL_{ij} + \lambda_{24}*TREND_j$  where  $SPD_{ij}$ ,  $VAR_{ij}$ ,  $PRC_{ij}$ ,  $VOL_{ij}$  are of spread, volatility\*1000, price, and volume for firm i on day j.  $TEF10_i$  is a dichotomous variable which is equal to 0 if firm i is not in the TEF index and 1 if it is one of the ten stocks which makes TEF index. Similarly  $MATCH_i$  is equal to 0 if the firm is not in the control sample and 1 if the firm is in control sample.  $DUM_{TEF}$  is 0 in the pre TEF futures period and 1 in the post TEF futures period.  $TREND_j$  is a trend variable, which is equal to day j. Pre-TEF period is from Dec 13, 1982 to Jan 26, 1983. Post-TEF period is from Jan 27, 1983 to Mar 9, 1983. TEF stocks are 10 stocks, which comprise the index used for TEF contract. The non-TEF stocks are the stocks, which were not in the index. T-Statistics are provided in parentheses.

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Table 19 (continued)

Variable	Coefficient	Estimate	T-Stat
INTERCEPT	$\lambda_0$	0.0267	90.94***
VAR	$\lambda_1$	0.0065	28.33***
PRC	$\lambda_2$	-0.0003	-32.59***
VOL	$\lambda_3$	0.0000	-10.89***
TEF10	$\lambda_4$	-0.0161	-7.5***
TEF10*VAR	$\lambda_5$	0.0109	0.6
TEF10*PRC	$\lambda_6$	0.0002	3.4***
TEF10*VOL	$\lambda_7$	0.0000	3.77***
MATCH	$\lambda_8$	-0.0157	-10.39***
MATCH*VAR	$\lambda_9$	-0.0009	-0.05
MATCH*PRC	$\lambda_{10}$	0.0003	10.38***
MATCH*VOL	$\lambda_{11}$	0.0000	2.58***
DUM <sub>TEF</sub>	$\lambda_{12}$	-0.0017	-3.42***
DUM <sub>TEF</sub> *VAR	$\lambda_{13}$	0.0052	6.98***
DUM <sub>TEF</sub> *PRC	$\lambda_{14}$	0.0000	3.37***
DUM <sub>TEF</sub> *VOL	$\lambda_{15}$	0.0000	2.90***
DUM <sub>TEF</sub> *TEF10	$\lambda_{16}$	0.0036	1.23
DUM <sub>TEF</sub> *TEF10*VAR	$\lambda_{17}$	-0.0205	-0.96

Table 19 (continued)

Variable	Coefficient	Estimate	T-Stat
$DUM_{TEF} * TEF10 * PRC$	$\lambda_{18}$	-0.0001	-0.81
$DUM_{TEF} * TEF10 * VOL$	$\lambda_{19}$	0.0000	-1.22
$DUM_{TEF} * MATCH$	$\lambda_{20}$	0.0023	1.06
$DUM_{TEF} * MATCH * VAR$	$\lambda_{21}$	0.0074	0.31
$DUM_{TEF} * MATCH * PRC$	$\lambda_{22}$	0.0000	-1.26
$DUM_{TEF} * MATCH * VOL$	$\lambda_{23}$	0.0000	-1.13
TREND	$\lambda_{24}$	0.0000	-3.00***
Adj R <sup>2</sup>	0.34		

\*\*\*, \*\*, \* denote 1%, 5% and 10% level of significance.

**Table 20****Tests of joint significance for pooled regression of spreads for TEF contract**

Table contains test of joint significance conducted in the model estimated in table 19.

Category	Variable	Coefficients	F-Value
Non-TEF	$DUM_{TEF}$	$\lambda_{12}$	11.68***
TEF 10	$DUM_{TEF} + DUM_{TEF} * TEF10$	$\lambda_{12} + \lambda_{16}$	0.45
Match	$DUM_{TEF} + DUM_{TEF} * MATCH$	$\lambda_{12} + \lambda_{20}$	0.09
Non-TEF	$DUM_{TEF} * VAR$	$\lambda_{13}$	48.74***
TEF 10	$DUM_{TEF} * VAR + DUM_{TEF} * TEF10 * VAR$	$\lambda_{13} + \lambda_{17}$	0.51
Match	$DUM_{TEF} * VAR + DUM_{TEF} * MATCH * VAR$	$\lambda_{13} + \lambda_{21}$	0.28
Non-TEF	$DUM_{TEF} * PRC$	$\lambda_{14}$	11.36***
TEF 10	$DUM_{TEF} * PRC + DUM_{TEF} * TEF10 * PRC$	$\lambda_{14} + \lambda_{18}$	0.06
Match	$DUM_{TEF} * PRC + DUM_{TEF} * MATCH * PRC$	$\lambda_{14} + \lambda_{22}$	0.01
Non-TEF	$DUM_{TEF} * VOL$	$\lambda_{15}$	8.41***
TEF 10	$DUM_{TEF} * VOL + DUM_{TEF} * TEF10 * VOL$	$\lambda_{15} + \lambda_{19}$	0.09
Match	$DUM_{TEF} * VOL + DUM_{TEF} * MATCH * VOL$	$\lambda_{15} + \lambda_{23}$	0.27

\*\*\*, \*\*, \* denote 1%, 5% and 10% level of significance.

**Table 21**

**Estimates of regressions of time weighted spreads on volatility, price, volume  
and a dichotomous variable  $DUM_{TSE}$  for TSE contract**

Table contains results of the regressions where dependent variable is percentage time weighted spread and independent variables are volatility\*1000, price, volume and dichotomous variable  $DUM_{TSE}$ . The model is  $SPD = \kappa_0 + \kappa_1*VAR + \kappa_2*PRC + \kappa_3*VOL + \kappa_4* DUM_{TSE} + \varepsilon$ , where SPD is time weighted spread, VAR, PRC, VOL are volatility\*1000, price and volume.  $DUM_{TSE}$  is a dichotomous variable, which is equal to 0 in the Pre-TSE period and is equal to 1 in the Post-TSE period. Pre-TSE period is from Dec 1, 1983 to Jan 13, 1984. Post-TSE is from Jan 16, 1984 to Feb 24, 1984. TEF stocks are 10 stocks, which comprise the index used for TEF contract. TSE-290 stocks are stocks, which are in TSE 300 index, but were not in TEF-10 category. TSE-300 stocks are the 300 stocks, which comprised TSE 300 stock Index. The non-TSE stocks are the stocks, which were not in the TSE index. T-Statistics are provided in parentheses.

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Table 21 (continued)

Category	Intercept	Coefficient for Volatility	Coefficient for Price	Coefficient for Volume	Coefficient for DUM <sub>TSE</sub> variable	Adjusted R <sup>2</sup>
	$\kappa_0$	$\kappa_1$	$\kappa_2$	$\kappa_3$	$\kappa_4$	
TEF Stocks	0.01 (52.57) <sup>***</sup>	0.0249 (6.82) <sup>***</sup>	-0.0001 (-27.16) <sup>***</sup>	0.000 (-4.34) <sup>***</sup>	-0.0001 (-0.62)	0.62
TSE-290 Stocks	0.0212 (113.58) <sup>***</sup>	0.0228 (29.74) <sup>***</sup>	-0.0003 (-44.95) <sup>***</sup>	0.0000 (-15) <sup>***</sup>	-0.0003 (-1.68) <sup>*</sup>	0.30
TSE-300 Stocks	0.0211 (118.68) <sup>***</sup>	0.0233 (30.96) <sup>***</sup>	-0.0003 (-49.75) <sup>***</sup>	0.0000 (-18.3) <sup>***</sup>	-0.0003 (-1.73) <sup>*</sup>	0.33
Non-TSE Stocks	0.0246 (60.23) <sup>***</sup>	0.0054 (13.03) <sup>***</sup>	-0.0002 (-22.86) <sup>***</sup>	0.0000 (-4.6) <sup>***</sup>	-0.001 (-2.16) <sup>**</sup>	0.22

\*\*\*, \*\*, \* denote 1%, 5% and 10% level of significance.

**Table 22****Estimates of pooled regression of spreads for TSE contract**

Table contains results of pooled regression model of spreads for TSE contract. The model is  $SPD_{ij} = \mu_0 + \mu_1*VAR_{ij} + \mu_2*PRC_{ij} + \mu_3*VOL_{ij} + \mu_4*TSE290_i + \mu_5*TSE290_i*VAR_{ij} + \mu_6*TSE290_i*PRC_{ij} + \mu_7*TSE290_i*VOL_{ij} + \mu_8*TEF10_i + \mu_9*TEF10_i*VAR_{ij} + \mu_{10}*TEF10_i*PRC_{ij} + \mu_{11}*TEF10_i*VOL_{ij} + \mu_{12}*DUM_{TSE} + \mu_{13}*DUM_{TSE}*VAR_{ij} + \mu_{14}*DUM_{TSE}*PRC_{ij} + \mu_{15}*DUM_{TSE}*VOL_{ij} + \mu_{16}*DUM_{TSE}*TSE290_i + \mu_{17}*DUM_{TSE}*TSE290_i*VAR_{ij} + \mu_{18}*DUM_{TSE}*TSE290_i*PRC_{ij} + \mu_{19}*DUM_{TSE}*TSE290_i*VOL_{ij} + \mu_{20}*DUM_{TSE}*TEF10_i + \mu_{21}*DUM_{TSE}*TEF10_i*VAR_{ij} + \mu_{22}*DUM_{TSE}*TEF10_i*PRC_{ij} + \mu_{23}*DUM_{TSE}*TEF10_i*VOL_{ij} + \mu_{24}*TREND_j$  where  $SPD_{ij}$ ,  $VAR_{ij}$ ,  $PRC_{ij}$ ,  $VOL_{ij}$  are of spread, volatility\*1000, price, and volume for firm  $i$  on day  $j$ .  $TEF10_i$  is a dichotomous variable which is equal to 0 if firm  $i$  is not in the TEF index and 1 if it is one of the ten stocks which makes TEF index. TSE-290 stocks are stocks, which are in TSE 300 index, but were not in TEF-10 category.  $DUM_{TSE}$  is 0 in the pre TSE futures period and 1 in the post TSE futures period.  $TREND_j$  is a trend variable, which is equal to day  $j$ . Pre-TSE period is from Dec 1, 1983 to Jan 13, 1984. Post-TSE is from Jan 16, 1984 to Feb 24, 1984. T-Statistics are provided in parentheses.

Table on next pages

Table 22 (continued)

Variable	Coefficient	Estimate	T-Stat
INTERCEPT	$\mu_0$	0.024	64.49***
VAR	$\mu_1$	0.0141	20.74***
PRC	$\mu_2$	-0.0002	-22.99***
VOL	$\mu_3$	0.0000	-6.74***
TSE290	$\mu_4$	-0.003	-6.83***
TSE290*VAR	$\mu_5$	0.0056	4.09***
TSE290*PRC	$\mu_6$	-0.0001	-4.15***
TSE290*VOL	$\mu_7$	0.0000	4.55***
TEF10	$\mu_8$	-0.0147	-8.26***
TEF10*VAR	$\mu_9$	0.0213	0.45
TEF10*PRC	$\mu_{10}$	0.0001	2.51**
TEF10*VOL	$\mu_{11}$	0.0000	6.08***
DUM <sub>TSE</sub>	$\mu_{12}$	-0.0013	-2.45**
DUM <sub>TSE</sub> *VAR	$\mu_{13}$	-0.0108	-14.24***
DUM <sub>TSE</sub> *PRC	$\mu_{14}$	0.0000	-0.22
DUM <sub>TSE</sub> *VOL	$\mu_{15}$	0.0000	3.71***
DUM <sub>TSE</sub> *TSE290	$\mu_{16}$	0.0001	0.24
DUM <sub>TSE</sub> *TSE290*VAR	$\mu_{17}$	0.0172	9.22***

Table 22 (continued)

Variable	Coefficient	Estimate	T-Stat
$DUM_{TSE} * TSE290 * PRC$	$\mu_{18}$	0.0000	0.5
$DUM_{TSE} * TSE290 * VOL$	$\mu_{19}$	0.0000	-4.02***
$DUM_{TSE} * TEF10$	$\mu_{20}$	0.0013	0.51
$DUM_{TSE} * TEF10 * VAR$	$\mu_{21}$	-0.0046	-0.08
$DUM_{TSE} * TEF10 * PRC$	$\mu_{22}$	0.0000	-0.13
$DUM_{TSE} * TEF10 * VOL$	$\mu_{23}$	0.0000	-3.36***
TREND	$\mu_{24}$	0.0000	2.43**
Adj R <sup>2</sup>	0.34		

\*\*\*, \*\*, \* denote 1%, 5% and 10% level of significance.

**Table 23****Tests of joint significance for pooled regression of spreads for TSE contract**

Table contains test of joint significance conducted in the model estimated in table 22.

Category	Variable	Coefficients	F-Value
Non-TSE	$DUM_{TSE}$	$\mu_{12}$	6.00**
TSE 290	$DUM_{TSE} + DUM_{TSE} * TSE290$	$\mu_{12} + \mu_{16}$	6.83***
TEF 10	$DUM_{TSE} + DUM_{TSE} * TEF10$	$\mu_{12} + \mu_{20}$	0.00
Non-TSE	$DUM_{TSE} * VAR$	$\mu_{13}$	202.73***
TSE 290	$DUM_{TSE} * VAR + DUM_{TSE} * TSE290 * VAR$	$\mu_{13} + \mu_{17}$	14.21***
TEF 10	$DUM_{TSE} * VAR + DUM_{TSE} * TEF10 * VAR$	$\mu_{13} + \mu_{21}$	0.08
Non-TSE	$DUM_{TSE} * PRC$	$\mu_{14}$	0.05
TSE 290	$DUM_{TSE} * PRC + DUM_{TSE} * TSE290 * PRC$	$\mu_{14} + \mu_{18}$	0.24
TEF 10	$DUM_{TSE} * PRC + DUM_{TSE} * TEF10 * PRC$	$\mu_{14} + \mu_{22}$	0.03
Non-TSE	$DUM_{TSE} * VOL$	$\mu_{15}$	13.73***
TSE 290	$DUM_{TSE} * VOL + DUM_{TSE} * TSE290 * VOL$	$\mu_{15} + \mu_{19}$	2.80*
TEF 10	$DUM_{TSE} * VOL + DUM_{TSE} * TEF10 * VOL$	$\mu_{15} + \mu_{23}$	0.05

\*\*\*, \*\*, \* denote 1%, 5% and 10% level of significance.

### Table 24

#### Changes in components of bid-ask spreads at the introduction of TEF contract

Table contains estimates of components of spreads and changes in components of spread at the introduction of TEF contract. Madhavan, Richardson, and Roomans (1997) model is used to estimate the asymmetric information component of the spread.

$$P_t - P_{t-1} = \phi(x_t - x_{t-1}) + \Delta\phi D_{TEF}(x_t - x_{t-1}) + \theta(x_t) + \Delta\theta D_{TEF}(x_t)$$

where  $P$ = trade price of a security at time  $t$  or  $t-1$ ,  $x$  is the sign indicator of the trade,  $\phi$  is the cost of supplying liquidity,  $\theta$  is the asymmetric information parameter, and  $D_{TEF}$  is a dichotomous variable, which is equal to 0 in the Pre-TEF period and is equal to 1 in the Post-TEF period. Pre-TEF period is from Dec 13, 1982 to Jan 26, 1983. Post-TEF period is from Jan 27, 1983 to Mar 9, 1983.  $\Delta$  indicates a changes in either liquidity or asymmetric parameters in the post period. TEF stocks are 10 stocks, which comprise the index used for TEF contract. The non-TEF stocks are the stocks, which were not in the index. A trade is considered to be a buy, if trade price is greater than mid-point of the spread at the time of the trade. T-Statistics are provided in parentheses.

Table on next page

Table 24 (continued)

Category	$\phi$	$\Delta\phi D_{TEF}$	$\theta$	$\Delta\theta D_{TEF}$	$\Delta\phi D_{TEF} + \Delta\theta D_{TEF}$
TEF	0.0898 (12.36)***	-0.0028 (-1.72)	0.0010 (1.87)*	0.0013 (1.66)	-0.0016 (-1.30)
Non-TEF	0.1108 (22.66)***	-0.0071 (-3.75)***	0.0073 (5.76)***	0.0045 (3.50)***	-0.0026 (-1.30)
Matched Stocks	0.1207 (6.30)***	0.0024 (0.61)	0.0045 (0.99)	0.0039 (1.18)	0.0034 (1.27)

\*\*\*, \*\*, \* denote 1%, 5% and 10% level of significance.

**Table 25****Changes in components of bid-ask spreads at the introduction of TSE contract**

Table contains estimates of components of spreads and changes in components of spread at the introduction of TSE contract. Madhavan, Richardson, and Roomans (1997) model is used to estimate the asymmetric information component of the spread.

$$P_t - P_{t-1} = \phi(x_t - x_{t-1}) + \Delta\phi D_{TSE}(x_t - x_{t-1}) + \theta(x_t) + \Delta\theta D_{TSE}(x_t)$$

where  $P$  = trade price of a security at time  $t$  or  $t-1$ ,  $x$  is the sign indicator of the trade,  $\phi$  is the cost of supplying liquidity,  $\theta$  is the asymmetric information parameter, and  $D_{TSE}$  is a dichotomous variable, which is equal to 0 in the Pre-TSE period and is equal to 1 in the Post-TSE period. Pre-TSE period is from Dec 1, 1983 to Jan 13, 1984. Post-TSE is from Jan 16, 1984 to Feb 24, 1984.  $\Delta$  indicates a changes in either liquidity or asymmetric parameters in the post period. TEF stocks are 10 stocks, which comprise the index used for TEF contract. TSE-290 stocks are stocks, which are in TSE 300 index, but were not in TEF-10 category. TSE-300 stocks are the 300 stocks, which comprised TSE 300 stock Index. The non-TSE stocks are the stocks, which were not in the TSE index. A trade is considered to be a buy, if trade price is greater than mid-point of the spread at the time of the trade. T-Statistics are provided in parentheses.

Table on next page

Table 25 (continued)

Category	$\phi$	$\Delta\phi D_{TEF}$	$\theta$	$\Delta\theta D_{TEF}$	$\Delta\phi D_{TEF} + \Delta\theta D_{TEF}$
TEF Stocks	0.0851 (16.64) <sup>***</sup>	-0.0035 (-1.39)	0.0010 (1.44)	0.0010 (1.28)	-0.0025 (-1.02)
TSE-290 Stocks	0.0928 (24.78) <sup>***</sup>	-0.0041 (-1.87) <sup>*</sup>	0.0081 (4.85) <sup>***</sup>	0.0009 (0.76)	-0.0032 (-1.53)
TSE-300 Stocks	0.0923 (26.08) <sup>***</sup>	-0.0041 (-1.96) <sup>*</sup>	0.0077 (4.87) <sup>***</sup>	0.0009 (0.81)	-0.0031 (-1.60)
Non-TSE Stocks	0.0749 (12.34) <sup>***</sup>	-0.0023 (-0.95)	0.0046 (1.83) <sup>*</sup>	0.0074 (1.71) <sup>*</sup>	0.0051 (1.29)

\*\*\*, \*\*, \* denote 1%, 5% and 10% level of significance.

# Financing Acquisitions with Contingent Value Rights (CVR's) and Put Options

*Abstract*

Under perfect capital markets the choice of type of financing of an acquisition would be irrelevant. This paper considers a particular kind of imperfection, viz., two-sided information asymmetry between the target and the acquirer, and investigates how such a problem may be mitigated by the choice of means of payment. We model the use of equity coupled with either put options or contingent value rights as a means of payment in acquisitions. We show that it is possible, under some circumstances, for acquirers to eliminate signaling costs with the use of these securities. Our model predicts that the use of CVR's and Put Options is better for the acquirer if the information asymmetry relating to its value is high. We further model use of such securities assuming imperfect resolution of the acquirer's type at expiry. We further conduct an empirical analysis of CVRs employed in mergers.

JEL Nos': G13, G34

Keywords: Contingent Value Rights, Mergers, Acquisitions

## 1. Introduction

In perfect capital markets with symmetric information the choice of medium of exchange in acquisitions is irrelevant. However, this is no longer true if there are capital market imperfections. This paper considers a particular kind of imperfection, viz., two-sided information asymmetry between the target and the acquirer, and investigates how such a problem may be mitigated by the choice of means of payment.

When there is two-sided asymmetry of information, the acquiring firm does not know the exact value of the target and the target firm does not know the exact value of the post-acquisition entity (i.e., the value of acquirer or the synergy gains or both). When only the acquirer is ignorant of the target's value, it benefits the acquirer to offer equity shares to the target (as opposed to cash) as in such a case the target partly internalizes its value mitigating the lemons problem faced by the acquirer (see, e.g., Hansen (1987)).

However, when both target and acquirer are unsure about the value of each other, just issuing equity does not solve the lemons problem faced by the target. In such cases, it may benefit acquirer to offer cash, in addition to equity, in order to finance the acquisition. Precisely because cash is costly from the perspective of the acquiring firm, the latter may be able to credibly signal the existence of high value by offering a mixture of cash and equity (see, e.g., Eckbo, Giammarino, Henckel

(1990)). In fact as Travlos (1987) and Huang and Walking (1987) document, cash offers are received more favorably than equity offers by the market.

Use of cash is costly for the acquirer. Ideally a high valued acquirer would like to credibly reveal its valuation and use an all equity offer. If the information asymmetry is expected to be resolved over time, then one solution is to make offer contingent on future stock price. A contract, which contains equity shares but provides insurance against low stock prices, would be more palatable to the target. If the share price is low the target is protected with the insurance and thus is willing to accept an offer with lower number of shares. In the last decade some firms have used contingent value rights (CVR's) coupled with equity shares as a medium of exchange in acquisitions. Though CVR's come in a variety of flavors, usually these securities resemble put options. They provide the target's shareholders additional payment if the stock price of the post-acquisition entity does not reach a pre-specified level. The additional payment may be in cash, equity or a combination of both. In our paper we model CVRs are instruments, which provide pre-specified additional number of shares if the share price does not reach a pre-specified level. We show that CVR's with equity may mitigate the two-sided asymmetric information problem in the context of acquisitions. In fact in certain cases, such a method of payment may completely eliminate signaling costs for acquirers. Consequently, in such cases (at least), CVR plus equity will be even better than cash plus equity as a medium of exchange. Since CVR's are similar to put options we model the use of put options and subsequently show that the use of CVR is better than use of put options. However our

model predicts in most cases a mixture of cash and equity dominate other offer, especially in cases of imperfect resolution of acquirer's value.

We first model use of put options coupled with equity as a medium of exchange. Post-acquisition, target's shareholders may exercise the put option if the value of their proportion of the post-acquisition firm (shares allocated to target) is less than the strike price. Thus the put option serves as an insurance policy for the target's shareholders. Therefore the target is willing to accept a lower number of shares as long as the strike price on the option is high enough. This insurance is cheap (sometimes cost free) for a high valued bidder as its high valuation will be revealed and thereby making value of put options small. If the share price at the option expiry is low target can exercise the options and thus have an assured minimum payoff. For some parameter values the options are never exercised and the only serve a signaling purpose. Our model also predicts a non-monotonic relationship between signaling costs and the difference between bidder types.

We further model use of contingent value rights instead of a put option. We define a CVR as a security, which provides additional shares of the merged company to the target shareholders if the share price does not reach a pre-specified level. If at the maturity of a CVR the share price is less than a pre-specified "exercise" price, a CVR will provide additional payment to the target. In reality this payment may be either in form of cash or additional shares. We model it as an additional allocation of predetermined number of shares. This payoff insurance is similar to put option and can cause the target to accept less of a proportion of the post-entity firm. Again target

is willing to accept the offer since its downside is limited due to insurance provided by the CVR. For a high value acquirer the probability of exercise of CVR is less than the low value acquirer. Therefore the expected number of shares that target will get both from initial offer and subsequent exercise of CVR is higher if the acquirer is low valued. We further model the possibility of imperfect resolution. Under imperfect resolution though there are still cases where symmetric information outcomes are possible, the parameter space become more restrictive.

The use of CVR's has been relatively sparse. Thus it is necessary to compare different offers and understand viability of each. Our model predicts that use of cash and equity dominates use of put options and CVR's except where the information symmetry relating to the acquirer is exceptionally high. For most of the parameter space the model predicts that the use of equity and cash is less costly than CVR's or put options. This matches with the empirical observations.

Our primary empirical objective is to look at the change in acquirer's trading costs due to introduction of CVR. In some cases the initial merger announcement includes details of CVR. In such cases we cannot isolate the impact of CVR announcement with that of merger announcement. However, in cases where the CVR offer is announced separately from the initial announcement of merger, we can study the impact of the CVR announcement. In such cases we do find that acquirer's spreads decrease after the CVR announcement. We also find an increase in spread subsequent to the expiry of CVR's, providing support to the hypothesis that CVR provide another venue of trading for informed traders. We are limited by the low

number of observations. Thus significance of any empirical result presented is suspect.

The paper is organized in 5 sections. Section 2 briefly reviews the literature. The basic structure of the model is presented in Section. The model with perfect resolution is presented in Section 4. The model is expanded to include imperfect resolution in section 5. Section 3 covers data and methodology. In section 4 we present empirical results and section 5 concludes.

## **2. Literature Review**

There is a rich stream of literature on external financing of projects. Under perfect markets financing vehicles are irrelevant (Miller and Modigliani 1958). Under information asymmetry Myers and Majluf (1984) show that investors see equity issuance as overvaluation. Eckbo and Masulis (1992) differentiate between regular equity offering and equity offering through rights issues. They predict that undervalued firms will prefer rights offering to regular equity offering. Brennan and Kraus (1987) show that non-dissipative equilibrium is not possible with securities, which have non-decreasing payoffs. However with the utilization of decreasing securities like put options a firm can give a credible costless signal. Firms have been using put options to mitigate costs of financing. Put options have been used during IPO process for SEO's to repurchase shares, among other uses.

An acquisition may also be understood as the financing of a project where the underlying benefit is unknown. Under the information asymmetry hypothesis, exact values are unknown to at least one of the parties. In a bargaining process where the

target cannot credibly commit to its valuations, the “lemon” problem arises. Target will only accept if the offer is more than its valuation. Thus acquirer’s optimal offer is based not upon unconditional valuations of the target, but rather upon the valuation of the target conditional upon acceptance of the offer. Samuelson (1984) models a bargaining game where the seller of an asset has strictly better information than the buyer. He shows that trade may not occur even if it is beneficial to both buyer and seller. In an acquisition setting, Hansen (1987) models a stock offer rather than a cash offer. A stock offer that costs the same to acquirer as a cash offer, induces target to accept in all states which it would have accepted given a cash offer, plus in some additional states. If the value of the acquirer is publicly known and value of the target is only known to itself, an equity offer dominates a cash offer in all states. A pure equity offer in such a case also dominates any mixed offer of cash and equity.

However, in the double lemons problem, where both target and acquirer are unsure about the value of each other’s assets, can create an equilibrium where acquirer offers stock when it is overvalued and cash when it is undervalued. Target using signals of medium of exchange and size of offer can determine the value of the acquirer. Acquirer chooses the medium and size of offer, such that it sustains target’s beliefs. Fishman (1989) models use of cash in offers as a signal of high valuation of the target by the acquirer. This in turn preempts competition from other prospective acquirers. An initial securities offer increases the probability of subsequent offers. In the model the probability of the target rejecting an offer is higher if securities are used instead of cash. Also, upon rejection of a securities offer,

the stock price of the target may drop. An agency consideration might imply that the manager acted against the interests of shareholders; however, in the model sometimes the target is better off rejecting an offer (leading to a reduction in price), than accepting a securities offer, where it would have been worse for target's shareholders.

Eckbo, Giammarino and Heinkel (1990) (henceforth "EGH") explicitly allow for mixed offers. The combination of cash and equity reveals acquirer's type in equilibrium. Acquirer of low type uses an all-equity offer and acquirer of high type uses a mixture of cash and equity. High type does not want to mimic low type in equilibrium since by mimicking low type it will have to offer a larger portion of the post-acquisition firm. High type thus distinguishes itself from the low type by offering a lower share of equity coupled with cash. Cash is of such an amount that low type finds the same offer to be unappealing. Thus in equilibrium the amount of cash used by the acquirer reveals its type. This separation is not without costs. In order to separate from the low type, the high type acquirer ends up offering more than it would have if its value was known to all. These costs are signaling costs. We study signaling costs of put option/CVR's used in conjunction with equity as a medium of exchange. We find that use of put options/CVR's can reduce signaling costs for the high type acquirer in many cases. These costs may even be eliminated for some parameter values.

There are theoretical models that employ use of CVR's. Hausch and Seward (1999) demonstrate use of transferable put rights and contingent value rights to improve value allocation among various parties in corporate bankruptcies. Gibson

and Singh (2001) (henceforth “GS”:) model the use of put options to mitigate adverse selection problems in the financing of projects. For the high type, issuance of a put option is not as costly as for the low type. Thus in equilibrium low type does not mimic the high type because of the costs involved in issuing under-priced put options. However, under the GS model there is a single sided information asymmetry and one is thus able to justify financing by selling put options only. In a two-sided information asymmetry, use of only put options to acquire a target is similar to using cash and hence inefficient. Even if there is enough available cash, acquirer may still want to acquire using equity financing.

Our model is related to those of GS and EGH. We model a two-sided information asymmetry problem. An acquirer identifies a synergistic opportunity in a target. Acquirer knows its own value and prospective synergy gains. Acquirer also knows the distribution of target’s value. Target knows its own value and knows the distribution of acquirer and synergy gains. We follow EGH in making synergy gains high enough, so that acquirer presents an offer where targets of all types will accept acquirer’s offer. Acquirer can use equity and put options/CVR’s as a source of medium of exchange. In equilibrium the high type of acquirer presents an offer, which includes equity rights and put options/CVR’s. The low type acquirer finds it prohibitively expensive to issue the same rights. Depending on the parameter values, the separating costs for the high type may be less as compared to using cash as a separating medium. It is also possible that the high type may face no signaling costs at all.

The timing and information structure of our model is similar to Chakraborty and Yilmaz (2004). They show that underinvestment caused by adverse selection can be solved without dissipation by the issuance of callable convertible securities. In their model the securities issued by the manager offer a payoff to the investor, which is independent of the private information of the manager. In our model the acquirer's offer (when CVR's are used) is similar in structure.

### 3. The Model

The structure of our model is very similar to that of EGH. Specifically, an acquirer has identified a potential target. The target knows its standalone value  $t$ . However the acquirer is uncertain about  $t$  and it is commonly known that his beliefs about  $t$  are represented by a uniform distribution. We normalize such that  $t \in [0,1]$ .

If the acquirer manages to acquire the target, then the value of the merged firm is  $V+t$ , where  $V_i$ , where  $V_i \in \{V_H, V_L\}$ , is known privately to the acquirer. Here  $V$  is thought of as the synergy gains of the acquisition, with the stand-alone value of the acquirer normalized to 0. We assume  $V$  and  $t$  are independent of each other and all parties are risk neutral. Following EGH and for simplicity we suppose that the synergy gains are high enough so that acquirer makes an offer acceptable to all target types<sup>2</sup>. We also assume the discount rate to be zero and that all agents are risk neutral.

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<sup>2</sup> If there is possibility of rejection, additional signal about the value of the acquirer and the target can be gained if the target rejects the offer. However as stated by EGH, this signal would be dependent on the particular specification of the synergy gains.

Our model is set in three periods. The timing and signal structure is similar to that of Chakraborty and Yilmaz (2004). At time period 0, the acquirer makes an offer to the target consisting of a choice of securities. The two offers of interest are equity coupled with a put option and equity coupled with a CVR. The offer is structured such that all target types accept that offer. The market (including the target) observes the offer and formulates a belief about the acquirer based on the offer. At time period 1 market observes a exogenous public signal  $m \in \{m_H, m_L\}$  of  $V$ , with

$$\Pr[m = m_i | V = V_i] = \beta \in \left(\frac{1}{2}, 1\right] \text{ for all } i. \quad (1)$$

$\beta$  is the precision of the signal. If  $\beta = 1$  then there is perfect resolution of the value of the firm. If  $\beta = 0.5$  the signal is worthless and none of the information asymmetry is resolved. Also the value of target is revealed at time 1. In the first part of our analysis we assume perfect resolution or  $\beta = 1$ . Subsequently we drop this condition. The signal  $m$  can also be viewed as representing cash flows realized by the merged firm between time 0 and 1, as long as these cash flows are negligible compared to the liquidation value of the firm.

At date 2 CVR's/put options allocated to the target's shareholders expire. If these securities are in the money, they are exercised; else they expire worthless. The stock price of the merged firm at expiry is conditional upon the signal  $m$ , target's value and the offer presented to the target. If the stock price is less than the strike price the CVR/put option is exercised, else these securities expire worthless.

If the offer is equity coupled with put options, the put options are exercised if they are in the money. Whether the options are in the money is in turn dependent on the market valuation of the merged firm conditioned upon the signal  $m$  and the offer. The strike price  $k$  is such that all the shares of the post-acquisition firm that were offered to target's shareholders can be tendered for a cumulative price of  $k$ , if the cumulative value of those shares is less than  $k$ . If the value of shares is greater than  $k$ , the options expire worthless. Upon exercise, if the merged firm's value is less than  $k$  it will not be able to pay the option and thus will go bankrupt. Under bankruptcy target's shareholders become complete owners of the merged entity. If the firm is able to pay, the acquirer's original shareholders become the complete owners after the payment is made<sup>3</sup>.

We further model CVR's in a similar setting. Though in reality CVR's may have exotic features, usually target shareholders will get additional equity if the market value(price) of merged entity is below the contract value (price). We model a situation where the exercise of the CVR is dependent on the price at date 2. If the CVR is exercised, the target's shareholders get additional shares, increasing their proportion of ownership in the new firm. If the offer consists of equity and CVR's, and at time 2 the share price is low, target's shareholders are allocated additional shares. Since we assume the total number of shares to be 1, we assume that upon exercise of the CVR, the additional shares are directly transferred from acquirer's shareholders to target's shareholder. In case of the put options the strike price was

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<sup>3</sup> We do not require that the firm have enough cash to pay the option to avoid bankruptcy, only that the firm's value is greater than the strike price.

compared to the value of the target to determine whether the put was in the money. However in case of CVR for simplicity we will assume that the CVR strike price is compared to the total value of the company. Essentially the CVR is in the money if the strike price  $X$  is greater than the market value of the acquirer at expiry.

#### **4. Perfect Resolution**

In this section we analyze a case where the signal  $m$  is perfect and thereby resolves all information asymmetry about the value of the merged firm at date 1. We analyze use of cash, put options and CVR's as signaling devices. Since only with the use of CVR does there exist a possibility of the pooling equilibrium therefore we also analyze the use of CVR under imperfect resolution of information.

To fix ideas, we have provided a separating equilibrium similar to one characterized by EGH in appendix 1, where the high type acquirer issues cash and equity and the low type acquirer issues only equity.

**Example 1:** Suppose  $V_H=4$ ,  $V_L=1$ , then a separating equilibrium can exist where the low type offer 0.5 shares and the high type offers 0.69231 on cash and 0.071429 in equity shares. As stated in appendix 1 only IC constraint for the low type is the binding constraint. If the low type mimics the high type its expected payoff is  $(1-0.0071429)*(1+.5-0.69231)= 0.74998$  which is less than its expected payoff of 0.75 if it stays true to its own type.

We first formulate our model where the signal at time period 1 is perfect. Under perfect resolution the use of put options can lead to a costless separation.

However, the use of CVR's for separation is better than the use of put options under perfect resolution. We further expand our analysis to include an imperfect signal.

#### **4.1 Perfect Resolution and Put Options**

With perfect resolution of information asymmetry, a separating equilibrium with the use of put options is possible. In the case of put options there can exist a separating equilibrium where acquirers can be distinguished with by their offers. A low type acquirer presents an all-equity offer and the high type acquirer presents an equity offer with a put option on the equity shares issued. The proportion of the merged firm offered to the target shareholders by the high type is lower compared to the proportion of the firm offered by the low type. Thus by the virtue of the offer itself the type of the acquirer is revealed to the market. In equilibrium both types find it prohibitively expensive to mimic each other. The high type does not mimic the low type because it will have to offer a higher proportion of shares if it mimics. The low type on the other hand finds it prohibitively expensive to issue the same put option used by the high type. The separation occurs due to the fact that use of put option on its shares is more expensive for the low type as compared to the high type.

*Proposition 1: There exists a separating equilibrium under perfect resolution and with the use of put options, where the low type acquirer uses an all equity offer and a high type acquirer uses an equity offer coupled with a put option.*

Proof: A detailed analysis of the use of put options is provided in appendix 3. A separating equilibrium can exist albeit at times the use of put options is very expensive for the high type. A portion of analysis presented in the appendix 3 is also

presented in the following subsection, to show that for certain parameter values it is possible for the high type to costlessly separate. We identify an equilibrium in which the following conditions hold. The low type offers equity shares only and the high type acquirer offers equity shares with put options. Both types of acquirers should find it prohibitively expensive to mimic each other. Options are never exercised, thereby making it a costless separation. Lastly, if the low type mimics the high type, targets of all types should exercise the option. The last condition is not a required condition for costless separation; however it does simplify the analysis.

*Proposition 2: There exist a costless separating equilibrium under perfect resolution and with the use of put options if*

$$\max\left(\frac{V_L + 1/2}{V_L + 1}, \frac{V_L + 1}{V_H + 1}\right) \leq k \leq \min(V_L, \alpha_H V_H) \quad (2)$$

The strike of the option in the above range is only dependent on  $V_L$  and is increasing in  $V_L$ . The costless separation does not occur when the low type's value is close to zero or when it is close to high type's value. The options will merely work as a signaling apparatus, costing nothing to high type. The high type's offer will be the same as if the high type value was known on date 0. The ability to costlessly separate is an important result of the model. If other securities (such as cash in EGH) are used for separation, high type ends up paying more than it would if its type were known. Since the costless separation does not hold for all values of acquirers, we expand this analysis in later sections to consider cases where issuance of options is costly to the high type acquirer.

### Low Type's offer

We analyze a separating equilibrium where a low type bidder offers a pure equity offer. In equilibrium, the type of bidder is revealed by its offer. The low type bidder offers an equity share  $\alpha_L$  to the target. The offer is the minimum of all offers such that it is acceptable even to the highest valued target. Or

$$\alpha_L(1 + V_L) \geq 1 \Rightarrow \alpha_L = \frac{1}{1 + V_L} \quad (3)$$

### High Type's offer

The high type bidder's offer consists of equity shares and a put option on those shares. The high bidder offers  $\alpha_H$  shares and a put option on  $\alpha_H$  shares with the strike price of  $k$ . Again The offer is the minimum of all offers such that it is acceptable even to the highest valued target. Or

$$\alpha_H(1 + V_H) \geq 1 \Rightarrow \alpha_H = \frac{1}{1 + V_H} \quad (4)$$

The high type also provides for a put option on  $\alpha_H$  shares to the target shareholders. We normalize the strike price  $k$  of the put option such that all the shares of the post-acquisition firm that were offered to the target's shareholder ( $\alpha_H$ ) can be tendered for a cumulative price of  $k$ , if the cumulative value of those shares is less than  $k$ . If the value of shares is greater than  $k$ , the options expire worthless.

### Conditions for equilibrium

We are looking for an equilibrium such that if the signal  $m$  reveals the acquirer to be of high type, the put option is not exercised. Since the value of the

merged firm is increasing in  $k$ , a target of value 0 gets the most benefit from the exercise of the option, i.e.

$$k \leq \alpha_H(V_H + 0) \Rightarrow k \leq \alpha_H V_H \quad (5)$$

Secondly, the low type must be able to pay off the option regardless of the target's value  $k \leq V_L$ <sup>4</sup>. Combining these two conditions which provide an upper range for the exercise price,

$$k \leq \min(V_L, \alpha_H V_H) \quad (6)$$

If the low type mimics the high type, its type will be revealed at date 1. We require that upon such a signal all target types find it beneficial to exercise the option. The strike price  $k$  has to be greater than values of the shares even for the highest type of target.

$$k \geq \alpha_H(V_L + 1) \Rightarrow k \geq \frac{V_L + 1}{V_H + 1} \quad (7)$$

#### *Incentive compatibility constraint for the low type*<sup>5</sup>

If all target types exercise the options, given that the acquirer is of low type, the incentive compatibility constraint for the low type is satisfied if

$$(1 - \alpha_L) * (E[t] + V_L) \geq V_L + E[t] - k \Rightarrow k \geq \frac{1/2 + V_L}{1 + V_L} \quad (8)$$

Thus the minimum strike price is given by

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<sup>4</sup> This condition makes separation more difficult to achieve

<sup>5</sup> IC constraint for the high type is  $(1 - \alpha_H) * (E[t] + V_H) \geq (1 - \alpha_L) * (E[t] + V_H)$ . This condition is satisfied since  $\alpha_H < \alpha_L$ .

$$k \geq \max\left(\frac{V_L + 1/2}{V_L + 1}, \frac{V_L + 1}{V_H + 1}\right) \quad (9)$$

**Example 2:** Suppose  $V_H=4$ ,  $V_L =1$ , then proposition 1's condition becomes  $\max(0.75,0.4) \leq k \leq \min(1,0.8)$ . Thus for any  $k$  between 0.75 and 0.8 there will be a costless separation. The high type will offer  $\alpha_H=0.2$  shares and a put option of 0.79. Any target will accept this offer since its payoff is  $0.2*(4+t) \geq t$ . Secondly low type's offer in equilibrium will be  $\alpha_L=0.5$  shares, which again will be accepted by all target types since  $0.5*(1+t) \geq t$ . The option will never be exercised since  $0.2*(4+0) \geq 0.79$  for all target types.

The high type will not mimic the low type since  $0.8*(4+t) > 0.5(4+t)$ . If the low type mimics the high type, target will exercise the option since  $0.2*(1+t) < 0.79$  for all target types. Thus the payoff to the low type from mimicking will be  $1+E[t]-0.79=0.71$ . This payoff is less than if low type were to offer 0.5 shares without the option. Since its payoff would be  $0.5*(1+E[t])=0.75$

It is not always possible for costless separation to occur. If the low type value is very low and there is a possibility of default a costless separation is not possible. It is also not possible if the low type's value is close to the high type's value. The costless separation zone with the use of put options is shown in figure 1. For example, if the in above example  $V_L= 0.05$  instead of 1, then the strike price necessary to separate has to be greater than 0.8 and costless separation is not possible. Incorporating bankruptcy (appendix 3) the IC constraint is solves for  $k \geq 0.8211$ .

Similarly if the value of the low type is close to that of the high type the separation may not be costless. For example if  $V_L=3$ , then the IC constraint for the low type solves for  $k \geq 0.8654$ .

#### 4.2 Perfect resolution and use of CVR's

In this section we model a security which is similar to the put options. However, as compared to the put option, the CVR is an option which presents additional shares to the target shareholders if a pre specified price is not reached. We look for a pooling equilibrium where both types of acquirers offer  $\alpha$  shares and a CVR option for  $\alpha'$  additional shares. The exercise of CVR is contingent upon the price at time 1. However if the signal  $m_i$  at time 1 is perfect, then if the signal  $m_i=m_L$  then the price will be  $V_L+t$ . similarly for  $m_i=m_H$  the price will be  $V_H+t$ . Depending upon the value of  $V_H$  and  $V_L$ , the pooling equilibrium can be costly or costless for the high type. Also unlike the case of put options, for simplicity the CVR is in the money if the strike price  $X$  is more than the market value of the merged firm at expiry.

##### **Costless Pooling: $V_H > V_L + 1$**

If the difference between the value of the high type and the low is large enough a pooling equilibrium can exist where the high type's payoff would be same as in the first best case. If  $V_H > V_L + 1$  holds then such an equilibrium is possible. We look for a pooling equilibrium where the initial allocation  $\alpha = \alpha_H$  shares and the CVR provides additional  $\alpha' = \alpha_L - \alpha_H$  shares. If the acquirer deviates from this offer the target assumes that the acquirer is of the low type.

*Proposition 3: Suppose  $V_H > V_L + 1$  then there exists a costless (non-unique) partial pooling equilibrium under perfect resolution of uncertainty where both type of acquirers issue  $\alpha_H$  shares and a CVR for  $\alpha_L - \alpha_H$  shares with a strike price of  $V_L + 1$ .*

For the high type acquirer the CVR will never be exercised, and for the low type it will always be exercised. Therefore in total high type has offered  $\alpha_H$  shares and low type offers  $\alpha_L$  shares. Given that the offer has zero signaling costs the high type will not deviate. Since the high type will not deviate from this offer, if any acquirer deviates from the offer the target will infer that the acquirer is of low type and demand a suitable offer. Thus the low type will not be able to benefit if it tries to present a different offer.  $\alpha_H$  and  $\alpha_L$  are constructed such that targets of all type will exercise the option.

For the offer to be same as high type first best offer, it has to be that target of all types exactly receive a total of  $\alpha_H$  shares. Therefore, given that acquirer is of high type, and all target types receive the same  $\alpha_H$  shares, it must be that either all the target types will or will not exercise the CVR. If all the target types do exercise the option therefore it must be that the low type and high type acquirer's offer is exactly the same, which is not possible if  $\sigma > 0$ . Therefore for costless equilibrium it must be that  $\alpha = \alpha_H$  shares. Also it must be that given a low type acquirer for all target types to accept the offer they must get at least  $\alpha_L$  shares. However a low type acquirer can always reveal its type and present an offer of  $\alpha_L$  shares, therefore it will never offer

more than  $\alpha_L$  shares. Therefore since  $\alpha = \alpha_H$  it must be that  $\alpha' = \alpha_L - \alpha_H$ . The strike price will be the lowest possible price for which target of all types exercise the CVR.

$$\text{Strike Price } X = V_L + 1$$

If the acquirer is of high type will always be above the exercise price since  $V_H > V_L + 1$ . Therefore in equilibrium the target shareholders will  $\alpha_H$  if the acquirer is of the high type and  $\alpha_L$  shares if the acquirer is of low type.

If the signal is perfect the CVR will not be exercised if the acquirer is of high type. The high type total offer is  $\alpha_H$ , which is same as its offer if the high type's value was known. Therefore, the high type will not incur any additional costs. If the acquirer is of low type, it will have to allocate additional shares and a combined payoff to the target will be exactly same as if the type of the acquirer were known. If the low type deviates it reveals that it is of low type and thus cannot benefit from deviation. Also since the payoff to the target shareholders is in terms of proportion of the new entity and not in cash, there is no bankruptcy consideration as in the case of put options.

**Example 3:** Suppose  $V_H = 4$ ,  $V_L = 1$ , then  $\alpha_H = 0.2$  and  $\alpha_L = 0.5$ . The offer consists of an initial allotment of 0.2 shares and a CVR which will provide additional 0.3 shares in case the share price does not reach a predetermined level  $X = 2$ . A high type acquirer target's payoff is  $= 0.2 * (4 + t)$ , which is greater than or equal to  $t$  for all  $t$ 's. For the low type acquirer the pay off to the target is  $\alpha_L$  shares, and thus the payoff is  $0.5 * (1 + t) \geq t$ . So target will accept the offer under equilibrium. Given that the acquirer is of low type, the CVR will always be exercised since  $X \geq V_L + 1$ . Also the CVR will never be

exercised if the acquirer is of high type  $X < V_H + 0$ . Therefore shares allocated to the target if acquirer is of high type are  $\alpha_H$  and for the low type are  $\alpha_L$ .

### Costly Pooling $V_H < V_L + 1$

If  $V_H < V_L + 1$  then the costless separation is not possible. We look for a pooling equilibrium with similar offer as in preceding case. Since the highest value target ( $t=1$ ) will not exercise the option given the acquirer is of the high type therefore the shares allocation  $\alpha = \alpha_H$  and  $\alpha' = \alpha_L - \alpha_H$  remains the same.

The additional costs incurred by the acquirer of the high type are affected by the probability of the CVR being exercised which is decreasing the value of  $V_H$  and  $\alpha'$  shares which is increasing in the  $V_H$ . The total payoff for the high type is

$$\begin{aligned}
 &= \text{Prob}[CVR \text{ is exercised}] * (1 - \alpha_H - \alpha') * (V_H + E[t | CVR \text{ is exercised}]) \\
 &\quad + (1 - \text{Prob}[CVR \text{ is exercised}]) * (1 - \alpha_H) * (V_H + E[t | CVR \text{ is not exercised}]) \\
 &= (V_L + 1 - V_H) * (1 - \alpha_H - \alpha') * \left( V_H + \frac{V_L + 1 - V_H}{2} \right) + (V_H - V_L) * (1 - \alpha_H) * \left( \frac{V_L + 2 - V_H}{2} \right)
 \end{aligned}
 \tag{10}$$

Figure 4 shows the payoff of the high type. The figure shows if the information asymmetry about the acquirer is high then a CVR offer is beneficial.

### 4.3 Comparison of Various Offers

There have been only a few mergers, which have employed securities similar to CVR's, thus necessitating the question of efficacy of these securities. In the boundaries of our model we compare the three different offers. We find that in most cases use of cash as a separating medium is more efficient than the use of put options

or CVR's. Figure 6 shows the payoff to the high type acquirer with the three offers. Only if the difference between the values of the high type acquirer and the low type acquirer is very big, does the payoff to the high type is more with the use of CVR's. Alternatively if the information asymmetry is small then the acquirer is better off using cash a separating equilibrium. This result seems to agree with the fact there have very few mergers where CVR's have been used as a method of payment.

### 5. Imperfect Resolution of Information Asymmetry and Use of CVR's

In imperfect resolution the type of the acquirer is not perfectly revealed by the signal. A perfect signal or  $\beta=1$  corresponds to the preceding section where resolution of information is perfect, while  $\beta=0.5$  would represent a case where none of the information asymmetry is resolved about the value of the acquirer. The price at expiry will be as follows

$$\begin{aligned} \text{Price given a high signal, } P_H &= (\text{Price} | m = m_H, t) = \beta V_H + (1 - \beta) V_L + t = A_H + t \\ \text{Price given a low signal, } P_L &= (\text{Price} | m = m_L, t) = \beta V_L + (1 - \beta) V_H + t = A_L + t \end{aligned} \quad (11)$$

where  $A_i$  is the market value of the acquirer alone given a signal  $i$ . Under perfect resolution  $A_i = V_i$ , and for  $0.5 < \beta < 1$  the order is  $V_H > A_H > A_L > V_L$ . The efficacy of the use of CVR's and payoff to the high type under perfect resolution was a function of difference between  $V_H$  and  $V_L$ . Similarly under imperfect resolution it is a function of difference between  $A_H$  and  $A_L$ . However the payoff to the target of type 1 becomes  $(\beta\alpha + (1-\beta)(\alpha+\alpha'))*(V_H+1)$  if the acquirer is of high type and  $((1-\beta)\alpha + \beta(\alpha+\alpha'))*(V_H+1)$  for the low type, where  $\beta$  is precision of the signal. The offer

should be acceptable to a risk neutral target i.e. in both cases the payoff should be greater than or equal to 1. Also both  $\alpha$  and  $\alpha'$  have to be restricted between 0 and 1.

The possibility of exercise of the CVR in case of the high type acquirer results from two sources. The source is similar to the perfect information case where the target's value is so low that share price of the post-acquisition firm fall below the exercise price. The second source is the imperfect signal. If the signal falsely reveals that acquirer is low type then the resulting share price is low and CVR is exercised. However even with imperfect signal, for some parameter value it is still possible for the high type to have same outcome as if its value was known. The high type payoff is

$$\begin{aligned} &= \text{Pr obability}[CVR is exercised] * (1 - \alpha - \alpha') * (V_H + E[t | CVR is exercised]) \\ &+ \text{Pr obability}[CVR is not exercised] * (1 - \alpha) * (V_H + E[t | CVR is not exercised]) \\ &= ((1 - \beta) + \beta[A_L + 1 - A_H])(1 - \alpha - \alpha') \left( V_H + \frac{A_L + 1 - A_H}{2} \right) + \beta(A_H - A_L) * (1 - \alpha) * \left( V_H + \frac{A_L + 2 - A_H}{2} \right) \end{aligned}$$

The figure 5 shows the payoff of the high type with imperfect signals. As can be seen as the precision of the signal decline the payoff to the high type decreases. The range of value for costless separation occurs also decreases.

*Proposition 4: For sufficiently high  $\beta$  there exists a costless pooling equilibrium under imperfect resolution where both types of acquirer offer some initial allotment*

$$\text{of } \alpha = \frac{(\beta - 1)\alpha_L + \beta\alpha_H}{2\beta - 1} \text{ shares and CVR for additional } \alpha' = \frac{\alpha_L - \alpha_H}{2\beta - 1} \text{ shares.}$$

Proof: See Appendix 5

**Example 4:** Suppose  $V_H=4$ ,  $V_L=1$  and  $\beta=0.9$ , then  $\alpha_H=0.2$ ,  $\alpha_L=0.5$   $\alpha=0.1625$  and  $\alpha'=0.375$ . Let the exercise price  $X=3$ . Given a high signal target's expected payoff is

$\geq$  its stand-alone value. Thus the offer will be acceptable to the target. High type expected payoff is 3.6 and low type expected payoff is 0.75.

## **6. Data and Methodology**

Our model assumes that target will never reject the offer. Thus merger will be completed with certainty. Thus our empirical analysis is restricted to the case in which completed contingent value rights were used by the bidder. The list is compiled by searching Factiva for contingent value rights. We identify the following dates for each merger announcement: initial announcement of merger, first mention of CVR, merger completion date, CVR's initial expiry date, and CVR's actual expiry date. The initial announcement of mergers in some cases does not contain any mention of CVR's. In those cases we have analyzed both the initial merger announcement and the subsequent announcement of CVR's. The date on which actual merger takes places or the merger is accepted by the target shareholders is termed the merger completion date. Some of CVR's have features whereby they expire worthless if the post-acquisition stock trades above a pre-specified level for pre-specified days. We identify these cases where the actual expiry of CVR is different than initially stated expiry date. In some cases CVR's expire on dates as originally stated. We identify a total of 8 observations.

We classify the trading days between different dates as periods. Period 1 is from 30 trading days prior to the initial announcement date to the initial announcement. Period 2 is from initial announcement of the merger to the first

announcement containing reference to CVR. In cases where both initial merger and use of CVR is announced on the same day, there is no period 2. Period 3 is from CVR announcement date to actual merger completion date.

### **Unconditional Volatility**

We define intraday volatility as the standard deviation of five-minute returns between 9:30 am and 4:00 pm. We divide every trading day into 78 five-minute trading windows and then calculate five-minute returns. We obtain trade data from the NYSE TAQ database for each firm in our sample and then use the midpoint of NBBO at the end of five-minute window as the price to calculate the return. The return is defined as the difference between the last price during the current five-minute window and the last price during the previous five-minute window divided by the last price during the previous five-minute window, or

$$r_j = \frac{p_j - p_{j-1}}{p_{j-1}} \quad (12)$$

Unconditional Volatility for day  $t$  is then calculated as

$$\sigma^2_t = \frac{1}{N-1} \sum_{j=1}^{78} (r_{jt} - \bar{r}_t)^2 \quad (13)$$

where,  $r_{jt}$  is the return for the  $j^{th}$  five-minute period on day  $t$  and  $\bar{r}_t$  is the average five-minute return for day  $t$ .

### **Regression analysis on volatility**

To control for confounding factors we perform regression analysis, which incorporates known relationships for the variables we examine. For example, Jones,

Kaul and Lipson (1994) document a relationship between the number of transactions and volatility. They find that trade size has no information beyond that of frequency of transactions. Therefore, we model volatility as a function of the number of transactions and dichotomous variables for announcement effect. Specifically, we employ the following model

$$VAR_{ij} = \beta_0 + \beta_1 * NUMOFTRANS_{ij} + \beta_2 * Dummy_j + \varepsilon \quad (14)$$

where  $VAR_{ij}$  is volatility for firm  $i$  on day  $j$ ,  $NUMOFTRANS_{ij}$  is the number of transactions for firm  $i$  on day  $j$  and  $Dummy_j$  is a dichotomous variable which is equal to 0 prior to the event date and 1 in the post event date<sup>6</sup>.

### Regression analysis on spreads

Similar to volatility, there may be confounding factors that may blur the actual changes in spreads around announcements. To test this, we model percentage spreads as a function of volatility, price, volume and dichotomous variable. The specification used is similar to that in Jegadeesh and Subramanyam (1993) and Stoll (1978)

$$PER_{ij} = \beta_0 + \beta_1 * VAR_{ij} + \beta_2 * PRC_{ij} + \beta_3 * VOL_{ij} + \beta_4 * Dummy_j + \varepsilon \quad (15)$$

where  $PER$ ,  $VAR$ ,  $PRC$ ,  $VOL$  are percentage spread, volatility, price, and volume for firm  $i$  on day  $j$  and  $dummy_j$  is a dichotomous variable which is equal to 0 if day  $j$  is in the period prior to the announcement and 1 if day  $j$  is in the post-announcement period. The variable of interest is  $\beta_4$ , which indicates how the spreads have changed post-announcement.

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<sup>6</sup> Since other authors have documented a relationship between volatility and share volume we also perform the regressions using volume instead of number of transactions. The results obtained are similar.

Larger variance increases the inventory carrying risk for a market maker. It also amplifies trading by informed traders and increases adverse selection risk for a market maker. Among others, Stoll (1978) and Coller and Yohn (1997) have found a positive relation between return variance and spreads. The volatility of returns also denotes information asymmetry and we expect its coefficient to be positively related to spreads. Therefore, we expect  $\beta_1$  to be positive.

For an equal number of shares traded, fixed costs are spread over a higher dollar volume for high-priced stocks. This yields a lower fixed cost component and hence lowers spreads. However in our formulation we have used percentage spreads rather than dollar spreads, which already incorporates the effect of price to a certain extent. Prior research such Demsetz (1968) and more recently Coller and Yohn (1997) have found a positive relation between prices and spreads. Therefore we expect  $\beta_3$  to be positive.

A higher trading volume provides greater opportunities for a market maker to offset any inventory imbalance, thereby reducing inventory risk for the market maker. Prior research has also identified a negative relation between spreads and trading volume (Demsetz (1968) and Coller and Yohn (1997)). We expect  $\beta_3$  to be negative.

## **7: Empirical Results**

The results are divided into three sections. The first section provides the results surrounding initial announcements of the merger. The second section contains the

results around the completion of merger. The third section contains results from the expiry of the CVR's.

### **7.1 Initial Announcements**

We first examine the impact of merger/CVR announcements. Recall that we divide our sample into two groups, depending upon whether the initial merger announcement contained a CVR announcement as well. If the initial announcement contained CVR information as well we term it “same day” announcement. If the initial merger announcement does not contain a CVR announcement it is termed an “initial” announcement. In cases of initial announcements the subsequent CVR announcement is termed as “CVR” announcement. “CVR” announcement is of particular interest to us as it isolates the impact of offer announcement with the confounding effect of merger announcement. The number of observations is limited; thus results are to be viewed with caution.

#### **Volume and Number of Transactions**

Tables 1 and 4 show the changes in volume and number of transactions respectively. For the “same day” announcements, volume and number of transactions for both the target and the acquirer increase. The average volume of the acquirer increases from 125,622 to 207,391 and this increase is significant at the 5% level. The average volume of the target increases from 3,004 to 15,603 and is not significant. The number of transactions for the acquirer increases from 52.1 to 107.1 and for the target from 2.6 to 5.1, both significant at the 1% level.

For the initial announcement, the average volume of the acquirer decreases from 102,096 to 54,999 and this decrease is significant at 1% level. Average volume of target increases from 129,695 to 193,881 and is significant at 5% level. The number of transactions for the acquirer decreases from 146.9 to 58.4 and for the target from 167.7 to 107.1. These decreases are significant at the 1% and 5% levels, respectively.

Volume changes at “CVR” announcement are opposite of “initial” announcement. The volume of the acquirer increases from 54,999 to 83,426 and that of the target decreases from 193,881 to 49,228. Both changes are significant at the 1% level. The number of transactions for the acquirer shows an insignificant increase from 58.4 to 62.1. The number of transactions for the target decrease from 107.1 to 24.6 and the decrease is significant at 1% level.

### **Trade Size**

The results for the trade size are presented in table 7. For the “same day” announcements all changes are insignificant. For the “initial announcement” the trade size for the target significantly increases by 1645. For the “CVR announcement” the trade size for the target decreases significantly and that of acquirer increases significantly.

Combined these results show that the “merger announcement” in itself impacts the target more than the acquirer. However the CVR announcement impacts acquirer more than it does target. This is weak evidence that CVR’s are structured

because of factors related to acquirer and help resolve some information asymmetry related to the acquirer's value.

## **Volatility**

### Unconditional Volatility

Table 10 shows the changes in unconditional volatility. There is no significant change in the unconditional volatility. For the "same day" announcements, volatility for the target decrease and for the acquirer increases. The volatility for the target decreases from 0.0758 to 0.0008. The volatility for the acquirer increases from 0.0032 to 0.0052. For the initial announcement volatility of the target increases from 0.0053 to 0.0069. The volatility of acquirer decreases from 0.0066 to 0.0041. These changes are insignificant. The volatility changes at "CVR" announcement are the opposite of "initial" announcement. The volatility of the target decreases from 0.0069 to 0.0018. The volatility of the acquirer increases from 0.0041 to 0.0138. The changes are insignificant.

### Regression Analysis of Volatility

Tables 19, 20 and 21 show the results from estimation of equation 14. The variable of interest is  $\beta_2$ . We find that only significant changes in volatility of target for the "same day" announcements. All changes in acquirer's volatility are insignificant.

## **Spreads**

Of prime interest in this study is the change in information asymmetry related to acquirer at the CVR announcement. Our model predicts that information

asymmetry related to the value of acquirer should decrease with the use of CVR's.

Also the true impact of a CVR announcement should be separated from the impact of a merger announcement itself. Thus of particular interest to us are those CVR announcements which are separate from merger announcements.

#### *Unconditional Percentage Spreads*

Table 13 shows the changes in time weighted unconditional percentage spreads. For the "same day" announcements, the effective spread for the target decreases from 0.0354 to 0.0247 and the decrease is significant at the 10% level. The percentage spread for the acquirer increases from 0.0272 to 0.0387 and is significant at 1% level. The initial announcement spreads for the target decrease from 0.0198 to 0.0117, and the decrease is significant at 1% level. The percentage spread for the acquirer decreases from 0.0348 to 0.0227 and is significant at the 1% level. For the "CVR" announcement, the percentage spread for the target increases from 0.0117 to 0.0212 and the increase is significant at the 1% level. The percentage spread for the acquirer decreases from 0.0227 to 0.0181 and is significant at the 10% level.

#### *Unconditional Percentage Effective Spreads*

Table 16 shows the changes in time-weighted unconditional percentage effective spreads. For the "same day" announcements, the effective spread for target decreases from 0.0352 to 0.017 and the decrease is significant at the 5% level. Effective spreads for acquirer increase from 0.0257 to 0.029 and is insignificant. For the initial announcement, effective spreads for the target decrease from 0.0136 to 0.0093, and the decrease is significant at 5% level. Effective spread for the acquirer

decreases from 0.0312 to 0.0267 and is insignificant. For the “CVR” announcement, effective spread for the target increases from 0.0093 to 0.0137 and the increase is significant at 1% level. The effective spread for the acquirer decreases from 0.0267 to 0.0131 and is significant at 1% level.

#### Regression Analysis of Spreads

Tables 24, 25 and 26 show the results from estimation of equation 15. The variable of interest is  $\beta_4$ . We find that for “same day” announcements and initial announcements there is a significant (at 1% level) reduction in target spreads. There is a small insignificant increase in spreads of the acquirer. However at the CVR announcement subsequent to merger announcement we find a significant increase in the spreads of the target and a significant decrease in the spreads of the acquirer. The decrease in spreads may indicate a decrease in information asymmetry related to the acquirer.

## **7.2 Merger Completion Announcement**

### ***Volume, Number of Transactions and Trade size***

Tables 2, 5 and 8 show changes in the volume, number of transactions and trade size of the acquirer around merger completion announcement. The volume decreases from 113,187 to 107,908. The number of transactions increases from 72.9 to 80.9. Both changes are insignificant. The trade size increases by 646 shares per trade and the increase is significant at 1% level. This is weak evidence of increased

informed trading. The increased trade size could also be due to institutional investors adjusting their portfolio after the merger.

### **Volatility**

#### Unconditional Volatility and Regression Analysis of Volatility

Table 11 shows changes in the unconditional volatility of the acquirer around merger completion announcement. We find that volatility decreases insignificantly from 0.0117 to 0.0029. Tables 22 shows the results from estimation of equations 14. The variable of interest is  $\beta_2$ . We find  $\beta_2$  to be negative and significant at 5% level.

### **Spreads**

#### Unconditional Percentage Spreads, Effective Spreads and Regression Analysis of Spreads

Table 14 shows the changes in unconditional percentage spreads around merger completion announcement. We find that spreads increase from 0.0231 to 0.0448 and the increase is significant at the 1% level. Table 17 shows the changes in effective spreads around merger completion announcement. We find that effective percentage spreads increase from 0.0168 to 0.0401. The increase is significant at the 1% level. Table 27 shows the result from estimation of equation 15. The coefficient of interest is  $\beta_4$ . We find  $\beta_4$  to be positive and significant at the 1% level.

### **7.3 CVR Expiry**

The value of CVR at expiry may range from zero to the contract price. A CVR expires worthless; the separation obtained by the acquirer was costless. We therefore divide the sample into acquirers for which CVR expired worthless and acquirers for

which CVR had positive value. The results of changes around CVR expiry are divided into three categories. The first category contains all acquirers. The second category contains acquirers for which the CVR expires worthless. The third category contains acquirers for which the CVR did not expire worthless.

### **Volume, Number of Transactions and Trade Size**

Tables 3, 6 and 9 show changes in volume, number of transactions and trade size of the acquirer around CVR expiry date. Volume of acquirers with costless CVR, decreases from 524,342 to 242,993 and the decrease is significant at the 5% level. The volume of acquirers for the costly CVR decreases from 399,698 to 289,952 and is significant at the 10% level. The number of transactions for acquirers with costless CVR decreases from 419.3 to 165.4 and the decrease is significant at the 1% level. However, the number of transactions for acquirers with costly CVR increases insignificantly from 181.6 to 214.9. Also the trade size for both categories decreases. Combined together the results support a general decrease in interest for the firm after the expiry of the CVR.

### **Volatility**

#### *Unconditional Volatility and Regression Analysis of Volatility*

Table 12 shows changes in volatility around CVR expiry. Unconditional Volatility for acquirers with costless CVR decreases from 0.0004 to 0.0003. The decrease is insignificant. Volatility for acquirers with costly CVR decreases from 0.0276 to 0.0005, which is significant at the 10% level. Table 23 shows the estimation

results of equation 14. The coefficient of interest  $\beta_2$  for both types of acquirers is positive, but insignificant.

### **Spreads**

#### *Unconditional Quoted Percentage Spreads, Effective Spreads and Regression for Spreads*

Table 15 contains changes in unconditional percentage spreads. Unconditional spreads for acquirers with costless expiry increase from 0.0134 to 0.0145. The increase is insignificant. Unconditional spreads for acquirers for costly expiry decrease from 0.0537 to 0.0071. The decrease is significant at 1% level. Table 18 shows changes in effective spread around CVR expiry date. Effective spreads around CVR expiry date decrease for both types of acquirers. For acquirers with costless CVR expiry, the spreads decrease insignificantly from 0.0109 to 0.0102. Effective spreads for acquirers with costly CVR expiry effective spreads decrease from 0.0377 to 0.0056 and the decrease is significant at the 1% level. Table 28 shows results from estimation of equation 15. The coefficient of interest  $\beta_4$  is positive though insignificant for both types of acquirers.

### **8. Conclusion**

Under perfect capital markets the choice of type of financing an acquisition would be irrelevant. However, under market imperfections the choice of financing becomes important. Prior models have utilized cash as a medium to separate high-valued bidders from low type bidders. These models also predict that signaling itself is costly for the high type. This study builds on the existing literature on the role of acquisition

financing under asymmetric information. We show that the use of equity coupled with put option or a CVR can serve as a signaling vehicle.

Our model is related to Eckbo, Giammarino, Henckel (1990), Gibson and Singh (2001) and Chakraborty and Yilmaz (2004). We first model a situation where the type of the bidder is perfectly revealed prior to the expiry. Under perfect resolution a separating equilibrium can be achieved where by the low type uses an all equity offer and the high type acquirer uses an equity offer coupled with a put option. The put option is more expensive for the low type than for the high type, therefore the low type finds mimicking to be prohibitively costly. The strike price of the put option does not change monotonically with difference between the two types. Also our model predicts that a costless separation is possible with the use of put options for some parameter values. In costless separation the high types offer has a put option with a strike price such that it is prohibitively expensive for the low type to mimic. However the strike price is low enough, so that no target will exercise the option given the acquirer is of the high type. Therefore the granting of options has no adverse consequence for the high type.

The model is further modified to analyze use of contingent value rights. CVR's in our model are defined as a binary option, which provide for additional allocation of shares if the share price does not reach a pre-specified level. We show that a continuum of partially pooling equilibriums is possible where the offer is such that the CVR provides additional shares if the share price of the post acquisition entity does not reach a pre-specified level. In equilibrium the target's shareholders are

initially allocated shares equal to the number of shares that high type would have offered given its value was known. They are also provided with a CVR, with a predetermined exercise price. Under perfect resolution if the difference between value of the low type and the high type acquirer is large enough the strike price of the CVR can be adjusted so that it is always exercised when the signal is low and never exercised when the signal is high. Therefore the high type acquirer does not incur and information asymmetry costs related to its valuation. If the difference between the high type and low type bidders is small then the high type has to incur some costs as it is possible that due to low target value the combined value would be lower than the strike price.

We further compare the payoff for the high type acquirer given different offers. The model predicts that use of cash and equity provides the highest payoff except in cases where the information asymmetry relating to the acquirer's value is very high. This may provide an explanation for the limited number of actual transactions that have utilized such securities. The use of CVR's is further analyzed under imperfect resolution of the acquirer's type at the expiry of the CVR. Similar to perfect resolution, with imperfect resolution a continuum of partially pooling equilibrium exist and in some cases it is costless for the high type acquirer. The additional costs incurred by the high type bidder are inversely related to the precision of the signal.

We further conduct empirical analysis of CVR's issued in a merger. Our main finding is that acquirer's spreads decrease subsequent to CVR announcement.

However the validity of the results may be limited due to limited number of observations.

This study develops a theoretical framework for the use of put options and CVR's in mergers and acquisition. We show that by using CVR's a high type acquirer may be able to eliminate the signaling costs in mergers. Overall use of put options and CVR's provides a useful medium for the signaling of acquirer's value.

### References

- Brennan, M., and A. Kraus, 1987, "Efficient Financing Under Asymmetric Information," *Journal of Finance*, Vol. 42, No. 5., 1225-1243.
- Chakraborty, A., and B. Yilmaz, 2004, "Asymmetric Information and Financing with Convertibles," Rodney L. White Center for Financial Research Working Paper No. 05-03.
- Coller, M., and T.L. Yohn, 1997, "Management Forecasts and Information Asymmetry: An Examination of Bid-Ask Spreads," *Journal of Accounting Research*, Vol. 35, Issue 2, 181-191.
- Demsetz, H., 1968, "The Costs of Transacting," *Quarterly Journal of Economics*, 82, 33-53.
- Eckbo, B.E, R.M. Giammarino, and R.L. Heinkel, 1990, "Asymmetric Information and the Medium of Exchange in Takeovers: Theory and Tests," *Review of Financial Studies*, Vol. 3, No. 4, 651-675.
- Eckbo, B.E., and R.W. Masulis, (1992) "Adverse selection and the rights offer paradox," *Journal of Financial Economics*, 32, 293-332.
- Fishman, M. J., 1989, "Preemptive Bidding and the Role of the Medium of Exchange in Acquisitions," *Journal of Finance*, 44, 41-57.
- Gibson, S., and R. Singh, 2000, "Using put warrants to reduce corporate financing costs," Working paper, University of Minnesota
- Hansen, R. G., 1987, "A Theory for the choice of Exchange Medium in the Market for Corporate Control," *Journal of Business*, 60, 75-95.
- Hausch, D.B. and J.K. Seward, "Mitigating the Corporate Valuation Problem in the Reorganization of Financially-Distressed Firms: Transferable Put Rights and Contingent Value Rights," Working Paper, University of Wisconsin Madison
- Huang, Y-S., and R.A. Walkling, 1987, "Abnormal Returns Associated with Acquisition Announcements: Payment Method, Acquisition Form, and Managerial Resistance," *Journal of Financial Economics*, 19, 329-349.
- Jegadeesh, N., and A. Subrahmanyam, 1993, "Liquidity Effects of the Introduction of the S&P 500 Index Futures Contract on the Underlying Stocks," *Journal of Business*, Vol. 66, No 2.

Jones, C.M, G. Kaul, and M. L. Lipson, 1994, "Transactions, Volume and Volatility," *Review of Financial Studies*, winter 1994 Vol.7, No. 4, pp 631-651.

Modigliani, F., and M.H. Miller, (1958) "The cost of capital, corporation finance and the theory of investment," *American Economic Review*, 48, 261-297.

Myers, S.C., and N.S.Majluf (1984) "Corporate Financing and Investment Decisions when firms have information investors do not have" *Journal of Financial Economics*, 13, 187-221.

Samuelson, W., 1984, "Bargaining under Asymmetric Information," *Econometrica*, Vol. 52, No. 4, 995-1006.

Stoll, H.R., 1978, "The Pricing of Dealers Services: An Empirical Study of NASDAQ Stocks," *Journal of Finance*, 44, 115-134.

Travlos, N.G., 1987, "Corporate Takeover Bids, Method of Payment, and Bidding Firms' Stock Returns," *Journal of Finance*, 42, 943-963.

**Table 1****Volume (Announcement Day)**

Table contains Volume around announcement day. The date on which a merger is first mentioned is called “Initial Date”. The first date where a reference to CVR is made is called “CVR Date”. Period 1 is from 30 trading days prior to the announcement to the announcement day. Period 2 is between “Initial Date” and “CVR date”. Period 3 is between “CVR Date” and actual merger date. For some mergers CVR’s are mentioned on the same day as the first announcement, these mergers are called “Same day announcement”. Mergers, for which “Initial Date” and “CVR date” are different, are classified “Different Day announcement”. For the stocks T-Statistics are provided in parentheses.

<b>Same Day Announcement Mergers</b>			
<b>Category</b>	<b>Volume</b>		<b>Difference</b>
			<b>(T-Stat)</b>
	Period 1	Period 3	
Target	3,004	15,603	12,599 (1.58)
Acquirer	125,622	207,391	81,770 (2.56)**

Table 1 (continued)

<b>Different Day Announcement Mergers-Initial Announcement</b>			
<b>Category</b>	<b>Volume</b>		<b>Difference (T-Stat)</b>
	Period 1	Period 2	
Target	129,695	193,881	64,186 (2.03)**
Acquirer	102,096	54,999	-47,097 (-3.47)***

<b>Different Day Announcement Mergers-CVR Announcement</b>			
<b>Category</b>	<b>Volume</b>		<b>Difference (T-Stat)</b>
	Period 2	Period 3	
Target	193,881	49,228	-144,653 (-5.81)***
Acquirer	54,999	83,426	28,427 (2.9)***

\*, \*\*, \*\*\* denote 10%, 5% and 1% level of significance.

**Table 2****Volume (Around Merger Completion)**

Table contains Volume around merger completion announcement day. Period before the announcement “Period 3” is between the CVR announcement date and actual merger completion date. Period after the announcement “Period 4” is 30 trading days after the completion of merger. T-Statistics are provided in parentheses.

<b>Merger Completion</b>			
<b>Category</b>	<b>Volume</b>		<b>Difference (T-Stat)</b>
	<b>Period 3</b>	<b>Period 4</b>	
Acquirer	113,187	107,908	-5,278  (-0.35)

**Table 3****Volume (Around CVR Expiry)**

Table contains Volume around CVR expiry. Period before the expiry day “Period 5” is between 30 trading days prior to the CVR expiry and CVR expiry date. Period after the CVR expiry “Period 6” is from day of CVR expiry to 30 trading days after the expiry. T-Statistics are provided in parentheses.

<b>CVR Expiry</b>			
<b>Category</b>	<b>Volume</b>		<b>Difference (T-Stat)</b>
	<b>Period 3</b>	<b>Period 4</b>	
Acquirer (all)	426,407	276,535	-149,872 (-2.9)***
Acquirer (costless)	524,342	242,993	-281,348 (-2.41)**
Acquirer (costly)	399,698	289,952	-109,746 (-1.89)*

**Table 4****Number of Transactions (Announcement Day)**

Table contains Number of Transactions around announcement day. The date on which a merger is first mentioned is called “Initial Date”. The first date where a reference to CVR is made is called “CVR Date”. Period 1 is from 30 trading days prior to the announcement to the announcement day. Period 2 is between “Initial Date” and “CVR date”. Period 3 is between “CVR Date” and actual merger date. For some mergers CVR’s are mentioned on the same day as the first announcement, these mergers are called “Same day announcement”. Mergers, for which “Initial Date” and “CVR date” are different, are classified “Different Day announcement”. For the stocks T-Statistics are provided in parentheses.

<b>Same Day Announcement Mergers</b>			
<b>Category</b>	Number of Transactions		Difference (T-Stat)
	Period 1	Period 3	
Target	2.6	5.1	2.6 (3.53)***
Acquirer	52.1	107.1	55 (3.75)***

**Table 4 (continued)**

<b>Different Day Announcement Mergers-Initial Announcement</b>			
<b>Category</b>	<b>Number of Transactions</b>		<b>Difference</b>
			<b>(T-Stat)</b>
	Period 1	Period 2	
Target	167.7	107.1	-60.7 (-1.96)*
Acquirer	146.9	58.4	-88.5 (-4.00)***

<b>Different Day Announcement Mergers-CVR Announcement</b>			
<b>Category</b>	<b>Number of Transactions</b>		<b>Difference</b>
			<b>(T-Stat)</b>
	Period 2	Period 3	
Target	107.1	24.6	-82.5 (-7.73)***
Acquirer	58.4	62.1	3.7 (0.53)

\*, \*\*, \*\*\* denote 10%, 5% and 1% level of significance.

**Table 5****Number of Transactions (Around Merger Completion)**

Table contains Number of Transactions around merger completion announcement day. Period before the announcement “Period 3” is between the CVR announcement date and actual merger completion date. Period after the announcement “Period 4” is 30 trading days after the completion of merger. T-Statistics are provided in parentheses.

<b>Merger Completion</b>			
<b>Category</b>	Number of Transactions		Difference (T-Stat)
	Period 3	Period 4	
Acquirer	72.9	80.9	8 (0.87)

**Table 6****Number of Transactions (Around CVR Expiry)**

Table contains number of transactions around CVR expiry. Period before the expiry day “Period 5” is between 30 trading days prior to the CVR expiry and CVR expiry date. Period after the CVR expiry “Period 6” is from day of CVR expiry to 30 trading days after the expiry. T-Statistics are provided in parentheses.

<b>CVR Expiry</b>			
<b>Category</b>	Number of Transactions		Difference (T-Stat)
	Period 3	Period 4	
Acquirer (all)	232.6	200.8	-31.8 (-0.92)
Acquirer (costless)	419.3	165.4	-253.9 (-2.73) <sup>***</sup>
Acquirer (costly)	181.6	214.9	33.3 (0.93)

**Table 7****Trade Size (Announcement Day)**

Table contains Trade Size around announcement day. The date on which a merger is first mentioned is called “Initial Date”. The first date where a reference to CVR is made is called “CVR Date”. Period 1 is from 30 trading days prior to the announcement to the announcement day. Period 2 is between “Initial Date” and “CVR date”. Period 3 is between “CVR Date” and actual merger date. For some mergers CVR’s are mentioned on the same day as the first announcement, these mergers are called “Same day announcement”. Mergers, for which “Initial Date” and “CVR date” are different, are classified “Different Day announcement”. For the stocks T-Statistics are provided in parentheses.

<b>Same Day Announcement Mergers</b>			
<b>Category</b>	<b>Trade Size</b>		<b>Difference (T-Stat)</b>
	<b>Period 1</b>	<b>Period 3</b>	
Target	1214	2630	1415 (1.47)
Acquirer	2139	1795	-345 (-1.31)

Table 7 (continued)

<b>Different Day Announcement Mergers-Initial Announcement</b>			
<b>Category</b>	<b>Trade Size</b>		<b>Difference (T-Stat)</b>
	<b>Period 1</b>	<b>Period 2</b>	
Target	802	2446	1645 (5.27) <sup>***</sup>
Acquirer	1080	878	-202 (-1.6)

<b>Different Day Announcement Mergers-CVR Announcement</b>			
<b>Category</b>	<b>Trade Size</b>		<b>Difference (T-Stat)</b>
	<b>Period 2</b>	<b>Period 3</b>	
Target	2446	1403	-1044 (-2.89) <sup>***</sup>
Acquirer	878	1123	245 (2.96) <sup>***</sup>

<sup>\*</sup>, <sup>\*\*</sup>, <sup>\*\*\*</sup> denote 10%, 5% and 1% level of significance.

**Table 8****Trade Size (Around Merger Completion)**

Table contains Trade Size around merger completion announcement day. Period before the announcement “Period 3” is between the CVR announcement date and actual merger completion date. Period after the announcement “Period 4” is 30 trading days after the completion of merger. T-Statistics are provided in parentheses.

<b>Merger Completion</b>			
<b>Category</b>	<b>Trade Size</b>		<b>Difference (T-Stat)</b>
	<b>Period 3</b>	<b>Period 4</b>	
Acquirer	1274	1930	656 (3.1)***

**Table 9****Trade Size (Around CVR Expiry)**

Table contains Trade Size around CVR expiry. Period before the expiry day “Period 5” is between 30 trading days prior to the CVR expiry and CVR expiry date. Period after the CVR expiry “Period 6” is from day of CVR expiry to 30 trading days after the expiry. T-Statistics are provided in parentheses.

<b>CVR Expiry</b>			
<b>Category</b>	<b>Trade Size</b>		<b>Difference (T-Stat)</b>
	<b>Period 3</b>	<b>Period 4</b>	
Acquirer (all)	4691	1263	-3428 (-4.71)***
Acquirer (costless)	1073	1143	70 (0.42)
Acquirer (costly)	5516	1301	-4214 (-4.77)***

**Table 10****Unconditional Volatility (Announcement Day)**

Table contains Volatility around announcement day. Volatility is 1000 times the actual volatility. The date on which a merger is first mentioned is called “Initial Date”. The first date where a reference to CVR is made is called “CVR Date”. Period 1 is from 30 trading days prior to the announcement to the announcement day. Period 2 is between “Initial Date” and “CVR date”. Period 3 is between “CVR Date” and actual merger date. For some mergers CVR’s are mentioned on the same day as the first announcement, these mergers are called “Same day announcement”. Mergers, for which “Initial Date” and “CVR date” are different, are classified “Different Day announcement”. For the stocks T-Statistics are provided in parentheses.

<b>Same Day Announcement Mergers</b>			
<b>Category</b>	<b>Volatility</b>		<b>Difference (T-Stat)</b>
	<b>Period 1</b>	<b>Period 3</b>	
Target	0.0758	0.0008	-0.075 (-1.02)
Acquirer	0.0032	0.0052	0.0021 (1.36)

Table 10 (continued)

<b>Different Day Announcement Mergers-Initial Announcement</b>			
<b>Category</b>	<b>Volatility</b>		<b>Difference (T-Stat)</b>
	Period 1	Period 2	
Target	0.0053	0.0069	0.0016 (0.35)
Acquirer	0.0066	0.0041	-0.0025 (-0.6)

<b>Different Day Announcement Mergers-CVR Announcement</b>			
<b>Category</b>	<b>Volatility</b>		<b>Difference (T-Stat)</b>
	Period 2	Period 3	
Target	0.0069	0.0018	-0.0051 (-1.31)
Acquirer	0.0041	0.0138	0.0097 (0.93)

\*, \*\*, \*\*\* denote 10%, 5% and 1% level of significance.

**Table 11****Unconditional Volatility (Around Merger Completion)**

Table contains Unconditional Volatility around merger completion announcement day. Period before the announcement “Period 3” is between the CVR announcement date and actual merger completion date. Period after the announcement “Period 4” is 30 trading days after the completion of merger. T-Statistics are provided in parentheses.

<b>Merger Completion</b>			
<b>Category</b>	Unconditional Volatility		Difference (T-Stat)
	Period 3	Period 4	
Acquirer	0.0117	0.0029	-0.0089 (-1.14)

**Table 12****Unconditional Volatility (Around CVR Expiry)**

Table contains Unconditional Volatility around CVR expiry. Period before the expiry day “Period 5” is between 30 trading days prior to the CVR expiry and CVR expiry date. Period after the CVR expiry “Period 6” is from day of CVR expiry to 30 trading days after the expiry. T-Statistics are provided in parentheses.

<b>Merger Completion</b>			
<b>Category</b>	<b>Unconditional Volatility</b>		<b>Difference (T-Stat)</b>
	<b>Period 3</b>	<b>Period 4</b>	
Acquirer (all)	0.0216	0.0004	-0.0211 (-1.78)*
Acquirer (costless)	0.0004	0.0003	-0.0001 (-0.42)
Acquirer (costly)	0.0276	0.0005	-0.0272 (-1.78)*

**Table 13****Unconditional Percentage spread (Announcement Day)**

Table contains Time Weighted Percentage spread around announcement day. The date on which a merger is first mentioned is called “Initial Date”. The first date where a reference to CVR is made is called “CVR Date”. Period 1 is from 30 trading days prior to the announcement to the announcement day. Period 2 is between “Initial Date” and “CVR date”. Period 3 is between “CVR Date” and actual merger date. For some mergers CVR’s are mentioned on the same day as the first announcement, these mergers are called “Same day announcement”. Mergers, for which “Initial Date” and “CVR date” are different, are classified “Different Day announcement”. For the stocks T-Statistics are provided in parentheses.

<b>Same Day Announcement Mergers</b>			
<b>Category</b>	<b>Percentage spread</b>		<b>Difference (T-Stat)</b>
	<b>Period 1</b>	<b>Period 3</b>	
Target	0.0354	0.0247	-0.0107 (-1.88)*
Acquirer	0.0272	0.0387	0.0115 (3.54)***

Table 13 (continued)

<b>Different Day Announcement Mergers-Initial Announcement</b>			
<b>Category</b>	<b>Percentage spread</b>		<b>Difference</b>
			<b>(T-Stat)</b>
	Period 1	Period 2	
Target	0.0198	0.0117	-0.0081 (-3.01)***
Acquirer	0.0348	0.0227	-0.0121 (-2.63)***

<b>Different Day Announcement Mergers-CVR Announcement</b>			
<b>Category</b>	<b>Percentage spread</b>		<b>Difference</b>
			<b>(T-Stat)</b>
	Period 2	Period 3	
Target	0.0117	0.0212	0.0095 (5.09)***
Acquirer	0.0227	0.0181	-0.0046 (-1.92)*

\*, \*\*, \*\*\* denote 10%, 5% and 1% level of significance.

**Table 14****Unconditional Percentage Spread (Around Merger Completion)**

Table contains Unconditional Percentage Spread around merger completion announcement day. Period before the announcement “Period 3” is between the CVR announcement date and actual merger completion date. Period after the announcement “Period 4” is 30 trading days after the completion of merger. T-Statistics are provided in parentheses.

<b>Merger Completion</b>			
<b>Category</b>	Unconditional Percentage Spread		Difference (T-Stat)
	Period 3	Period 4	
Acquirer	0.0231	0.0448	0.0217 (5.68)***

**Table 15****Unconditional Percentage Spread (Around CVR Expiry)**

Table contains Unconditional Percentage Spread around CVR expiry. Period before the expiry day “Period 5” is between 30 trading days prior to the CVR expiry and CVR expiry date. Period after the CVR expiry “Period 6” is from day of CVR expiry to 30 trading days after the expiry. T-Statistics are provided in parentheses.

<b>CVR Expiry</b>			
<b>Category</b>	<b>Unconditional Percentage Spread</b>		<b>Difference (T-Stat)</b>
	<b>Period 3</b>	<b>Period 4</b>	
Acquirer (all)	0.0448	0.0092	-0.0356 (-6.21)***
Acquirer (costless)	0.0134	0.0145	0.0011 (1.77)*
Acquirer (costly)	0.0537	0.0071	-0.0467 (-6.44)***

**Table 16****Unconditional Percentage Effective Spread (Announcement Day)**

Table contains Time Weighted Percentage effective spread around announcement day. The date on which a merger is first mentioned is called “Initial Date”. The first date where a reference to CVR is made is called “CVR Date”. Period 1 is from 30 trading days prior to the announcement to the announcement day. Period 2 is between “Initial Date” and “CVR date”. Period 3 is between “CVR Date” and actual merger date. For some mergers CVR’s are mentioned on the same day as the first announcement, these mergers are called “Same day announcement”. Mergers, for which “Initial Date” and “CVR date” are different, are classified “Different Day announcement”. For the stocks T-Statistics are provided in parentheses.

<b>Same Day Announcement Mergers</b>			
<b>Category</b>	Percentage effective spread		Difference (T-Stat)
	Period 1	Period 3	
Target	0.0352	0.017	-0.0182 (-2.27)**
Acquirer	0.0257	0.029	0.0032 (1.44)

Table 16 (continued)

<b>Different Day Announcement Mergers-Initial Announcement</b>			
<b>Category</b>	Percentage effective spread		Difference (T-Stat)
	Period 1	Period 2	
Target	0.0136	0.0093	-0.0043 (-2.44)**
Acquirer	0.0312	0.0267	-0.0045 (-0.91)

<b>Different Day Announcement Mergers-CVR Announcement</b>			
<b>Category</b>	Percentage effective spread		Difference (T-Stat)
	Period 2	Period 3	
Target	0.0093	0.0137	0.0043 (3.46)***
Acquirer	0.0267	0.0131	-0.0135 (-4.46)***

\*, \*\*, \*\*\* denote 10%, 5% and 1% level of significance.

**Table 17****Unconditional Percentage Effective Spread (Around Merger Completion)**

Table contains Unconditional Percentage Effective Spread around merger completion announcement day. Period before the announcement “Period 3” is between the CVR announcement date and actual merger completion date. Period after the announcement “Period 4” is 30 trading days after the completion of merger. T-Statistics are provided in parentheses.

<b>Merger Completion</b>			
<b>Category</b>	Unconditional Percentage Effective Spread		Difference (T-Stat)
	Period 3	Period 4	
Acquirer	0.0168	0.0401	0.0233 (6.16) <sup>***</sup>

**Table 18****Unconditional Percentage Effective Spread (Around CVR Expiry)**

Table contains Unconditional Percentage Effective Spread around CVR expiry. Period before the expiry day “Period 5” is between 30 trading days prior to the CVR expiry and CVR expiry date. Period after the CVR expiry “Period 6” is from day of CVR expiry to 30 trading days after the expiry. T-Statistics are provided in parentheses.

<b>CVR Expiry</b>			
<b>Category</b>	Unconditional Percentage Effective Spread		Difference (T-Stat)
	Period 3	Period 4	
Acquirer (all)	0.0325	0.0067	-0.0258 (-5.61)***
Acquirer (costless)	0.0109	0.0102	-0.0008 (-0.77)
Acquirer (costly)	0.0377	0.0056	-0.0321 (-5.69)***

**Table 19**

**Control Regressions for Volatility: For combined initial announcements of  
mergers and CVR's**

This table contains results of regressions performed to control for the well documented relationship between volatility and number of transactions. The data includes all initial announcements of mergers, which included a mention of CVR in the announcement. The model is  $VAR = \beta_0 + \beta_1 NUMOFTRANS + \beta_3 Dummy + \varepsilon$ . Where  $VAR$  is 1000 times the actual volatility.  $NUMOFTRANS$  is actual number of transactions divided by 1000 and  $Dummy$  is dichotomous variable, which is equal to 0 in the period before the announcement and is equal to 1 in period after the announcement. Period before the announcement "Period 1" is from 30 trading days prior to the announcement to the announcement day. Period after the announcement "Period 3" is between the initial announcement date and actual merger date.

	<b>Intercept</b>	<b>Num of Trans</b>	<b>Dummy</b>	<b>Adjusted R<sup>2</sup></b>
	$\beta_0$	$\beta_1$	$\beta_2$	
Target	0.0709 (1.9)*	1.7731 (0.83)	-0.08 (-1.85)*	0.01
Acquirer	0.0032 (2.22)**	-0.0002 (-0.02)	0.0021 (1.2)	-0.00

\*, \*\*, \*\*\* denote 10%, 5% and 1% level of significance.

**Table 20**

**Control Regressions for Volatility: For Initial Announcements of mergers  
without the announcement of CVR's**

This table contains results of regressions performed to control for the well documented relationship between volatility and number of transactions. The data includes all initial announcements of mergers, which included did not mention of CVR in the announcement. The model is  $VAR = \beta_0 + \beta_1 NUMOFTRANS + \beta_3 Dummy + \varepsilon$ . Where  $VAR$  is 1000 times the actual volatility.  $NUMOFTRANS$  is actual number of transactions divided by 1000 and  $Dummy$  is dichotomous variable, which is equal to 0 in the period before the announcement and is equal to 1 in period after the announcement. Period before the announcement "Period 1" is from 30 trading days prior to the announcement to the announcement day. Period after the announcement "Period 2" is between the initial announcement date and CVR announcement date.

	<b>Intercept</b>	<b>Num of Trans</b>	<b>Dummy</b>	<b>Adjusted R<sup>2</sup></b>
	$\beta_0$	$\beta_1$	$\beta_2$	
Target	0.0066 (0.9)	-0.0067 (-0.69)	0.0011 (0.14)	-0.00
Acquirer	0.0078 (1.99)**	-0.0081 (-0.93)	-0.0032 (-0.76)	-0.00

\*, \*\*, \*\*\* denote 10%, 5% and 1% level of significance.

**Table 21**  
**Control Regressions for Volatility: For CVR Announcements subsequent to merger announcement**

This table contains results of regressions performed to control for the well-documented relationship between volatility and number of transactions. The data includes CVR announcements, which were subsequent to the initial announcement of the merger. The model is  $VAR = \beta_0 + \beta_1 NUMOFTRANS + \beta_3 Dummy + \varepsilon$ . Where  $VAR$  is 1000 times the actual volatility.  $NUMOFTRANS$  is actual number of transactions divided by 1000 and  $Dummy$  is dichotomous variable, which is equal to 0 in the period before the announcement and is equal to 1 in period after the announcement. Period before the announcement “Period 2” is between the initial merger announcement and CVR announcement date. Period after the announcement “Period 3” is between CVR announcement date and actual merger date.

	<b>Intercept</b>	<b>Num of Trans</b>	<b>Dummy</b>	<b>Adjusted R<sup>2</sup></b>
	$\beta_0$	$\beta_1$	$\beta_2$	
Target	0.0078 (2.29)**	-0.0082 (-0.74)	-0.0058 (-1.01)	-0.00
Acquirer	0.0045 (2.64)***	-0.0062 (-0.63)	-0.0005 (-0.17)	-0.00

\*, \*\*, \*\*\* denote 10%, 5% and 1% level of significance.

**Table 22****Control Regressions for Volatility: For merger completion announcement**

This table contains results of regressions performed to control for the well documented relationship between volatility and number of transactions. The analysis is performed for time period surrounding the merger completion announcement. The model is  $VAR = \beta_0 + \beta_1 NUMOFTRANS + \beta_3 Dummy + \varepsilon$ . Where  $VAR$  is 1000 times the actual volatility.  $NUMOFTRANS$  is actual number of transactions divided by 1000 and  $Dummy$  is dichotomous variable, which is equal to 0 in the period before the announcement and is equal to 1 in period after the announcement. Period before the announcement “Period 3” is between the CVR announcement date and actual merger completion date. Period after the announcement “Period 4” is 30 trading days after the completion of merger.

	<b>Intercept</b>	<b>Num of Trans</b>	<b>Dummy</b>	<b>Adjusted R<sup>2</sup></b>
	$\beta_0$	$\beta_1$	$\beta_2$	
Acquirer	0.004 (6.29)***	-0.0001 (-0.03)	-0.0023 (-2.41)**	0.00

\*, \*\*, \*\*\* denote 10%, 5% and 1% level of significance.

**Table 23****Control Regressions for Volatility: For CVR expiry**

This table contains results of regressions performed to control for the well documented relationship between volatility and number of transactions. The analysis is performed for time period surrounding the CVR expiry date. The model is  $VAR = \beta_0 + \beta_1 NUMOFTRANS + \beta_3 Dummy + \varepsilon$ . Where  $VAR$  is 1000 times the actual volatility.  $NUMOFTRANS$  is actual number of transactions divided by 1000 and  $Dummy$  is dichotomous variable, which is equal to 0 in the period before the CVR expiry date and is equal to 1 in period after the CVR expiry date. Period before the expiry day “Period 5” is between 30 trading days prior to the CVR expiry and CVR expiry date. Period after the CVR expiry “Period 6” is from day of CVR expiry to 30 trading days after the expiry.

	<b>Intercept</b>	<b>Num of Trans</b>	<b>Dummy</b>	<b>Adjusted R<sup>2</sup></b>
	$\beta_0$	$\beta_1$	$\beta_2$	
Acquirer	0.0004 (4.1)***	0.0000 (0.03)	0.0000 (0.13)	0.00
Acquirer (costless)	0.0002 (1.6)	0.0004 (2.34)**	0.0000 (0.16)	0.03
Acquirer (costly)	0.0005 (3.82)***	-0.0002 (-1.12)	0.0000 (0.24)	0.00

\*, \*\*, \*\*\* denote 10%, 5% and 1% level of significance.

**Table 24**  
**Control Regressions for Spreads: For combined initial announcements of**  
**mergers and CVR's**

Table contains results of the regressions where dependent variable is percentage time weighted spread and independent variables are volatility, price, volume and dichotomous variable. The model is  $PERSPD = \beta_0 + \beta_1*VAR + \beta_2*PRC + \beta_3*VOL + \beta_4*dummy + \varepsilon$ , where PERSPD is time weighted percentage spread, VAR is actual volatility\*1000, PRC is the last trade price, VOL is actual share volume divided by 1,000,000. Dummy is dichotomous variable, which is equal to 0 in the period before the announcement and is equal to 1 in period after the announcement. Period before the announcement "Period 1" is from 30 trading days prior to the announcement to the announcement day. Period after the announcement "Period 3" is between the initial announcement date and actual merger date.

	<b>Intercept</b>	<b>VAR</b>	<b>PRC</b>	<b>VOL</b>	<b>Dummy</b>	<b>Adj. R<sup>2</sup></b>
	$\beta_0$	$\beta_1$	$\beta_2$	$\beta_3$	$\beta_4$	
Target	0.0036 (0.39)	0.0274 (5.45)***	0.0037 (3.36)***	-0.0032 (-0.23)	-0.0098 (-2.85)***	0.16
Acquirer	0.0529 (21.36)***	0.0433 (0.52)	-0.0017 (-15.81)***	-0.0066 (-1.51)	0.0002 (0.08)	0.66

\*, \*\*, \*\*\* denote 10%, 5% and 1% level of significance.

**Table 25****Control Regressions for Spreads: For Initial Announcements of mergers without the announcement of CVR's**

Table contains results of the regressions where dependent variable is percentage time weighted spread and independent variables are volatility, price, volume and dichotomous variable. The model is  $PERSPD = \beta_0 + \beta_1*VAR + \beta_2*PRC + \beta_3*VOL + \beta_4*dummy + \varepsilon$ , where PERSPD is time weighted percentage spread, VAR is actual volatility\*1000, PRC is the last trade price, VOL is actual share volume divided by 1,000,000. Dummy is dichotomous variable, which is equal to 0 in the period before the announcement and is equal to 1 in period after the announcement. Period before the announcement "Period 1" is from 30 trading days prior to the announcement to the announcement day. Period after the announcement "Period 2" is between the initial announcement date and CVR announcement date.

Table on next page

Table 25 (continued)

	<b>Intercept</b>	<b>VAR</b>	<b>PRC</b>	<b>VOL</b>	<b>Dummy</b>	<b>Adj. R<sup>2</sup></b>
	$\beta_0$	$\beta_1$	$\beta_2$	$\beta_3$	$\beta_4$	
Target	0.0393 (15.61)***	0.0397 (4.17)***	-0.0007 (-13.45)***	0.0067 (3.54)***	-0.0061 (-2.62)***	0.19
Acquirer	0.0755 (18.69)***	0.2129 (7.4)***	-0.0005 (-19.26)***	-0.1199 (-10.54)***	0.0035 (0.9)	0.33

**Table 26**

**Control Regressions for Spreads: For CVR Announcements subsequent to  
merger announcement**

Table contains results of the regressions where dependent variable is percentage time weighted spread and independent variables are volatility, price, volume and dichotomous variable. The model is  $PERSPD = \beta_0 + \beta_1*VAR + \beta_2*PRC + \beta_3*VOL + \beta_4*dummy + \varepsilon$ , where PERSPD is time weighted percentage spread, VAR is actual volatility\*1000, PRC is the last trade price, VOL is actual share volume divided by 1,000,000. Dummy is dichotomous variable, which is equal to 0 in the period before the announcement and is equal to 1 in period after the announcement. Period before the announcement “Period 2” is between the initial merger announcement and CVR announcement date. Period after the announcement “Period 3” is between CVR announcement date and actual merger date.

	<b>Intercept</b>	<b>VAR</b>	<b>PRC</b>	<b>VOL</b>	<b>Dummy</b>	<b>Adjusted R<sup>2</sup></b>
	$\beta_0$	$\beta_1$	$\beta_2$	$\beta_3$	$\beta_4$	
Target	0.0364 (21.47)***	0.0338 (3.79)***	-0.0009 (-17.64)***	0.012 (6.62)***	0.0061 (3.59)***	0.25
Acquirer	0.07 (23.5)***	0.2233 (8.19)***	-0.0004 (-19.07)***	-0.0637 (-7.19)***	-0.0292 (-10.16)***	0.29

**Table 27****Control Regressions for Spreads: For merger completion announcement**

Table contains results of the regressions where dependent variable is percentage time weighted spread and independent variables are volatility, price, volume and dichotomous variable. The model is  $PERSPD = \beta_0 + \beta_1*VAR + \beta_2*PRC + \beta_3*VOL + \beta_4*dummy + \varepsilon$ , where PERSPD is time weighted percentage spread, VAR is actual volatility\*1000, PRC is the last trade price, VOL is actual share volume divided by 1,000,000. Dummy is dichotomous variable, which is equal to 0 in the period before the announcement and is equal to 1 in period after the announcement. Period before the announcement “Period 3” is between the CVR announcement date and actual merger completion date. Period after the announcement “Period 4” is 30 trading days after the completion of merger.

	<b>Intercept</b>	<b>VAR</b>	<b>PRC</b>	<b>VOL</b>	<b>Dummy</b>	<b>Adj. R<sup>2</sup></b>
	$\beta_0$	$\beta_1$	$\beta_2$	$\beta_3$	$\beta_4$	
Acquirer	0.0464 (18.47)***	0.1982 (1.91)*	-0.0006 (-15.57)***	-0.0251 (-3.86)***	0.0143 (5.23)***	0.26

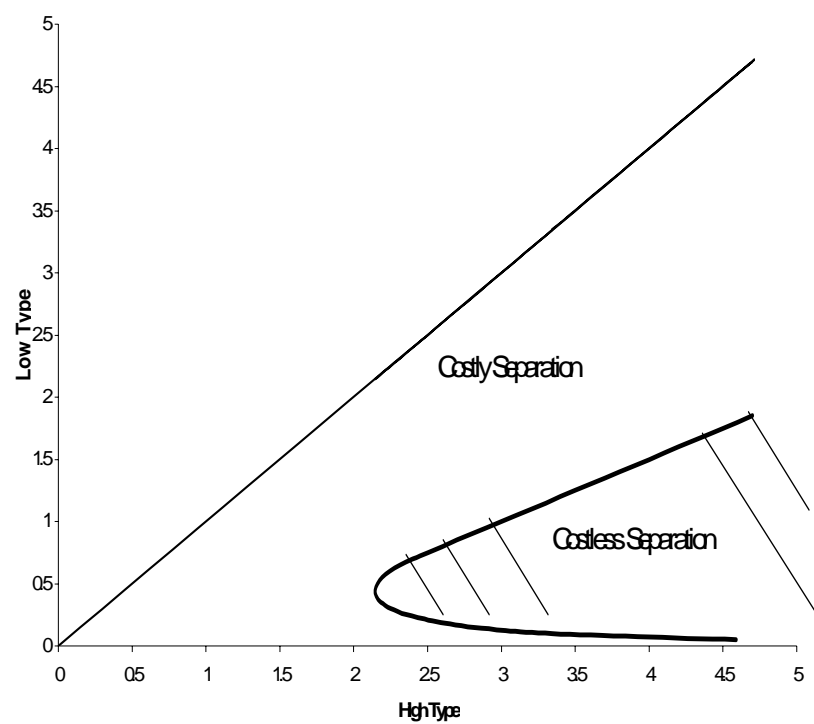
**Table 28****Control Regressions for Spreads: For CVR Expiry**

Table contains results of the regressions where dependent variable is percentage time weighted spread and independent variables are volatility, price, volume and dichotomous variable. The model is  $PERSPD = \beta_0 + \beta_1*VAR + \beta_2*PRC + \beta_3*VOL + \beta_4*dummy + \varepsilon$ , where PERSPD is time weighted percentage spread, VAR is actual volatility\*1000, PRC is the last trade price, VOL is actual share volume divided by 1,000,000. Dummy is dichotomous variable, which is equal to 0 in the period before the CVR expiry and is equal to 1 in period after CVR expiry date. Period before the expiry day “Period 5” is between 30 trading days prior to the CVR expiry and CVR expiry date. Period after the CVR expiry “Period 6” is from day of CVR expiry to 30 trading days after the expiry.

	<b>Intercept</b>	<b>VAR</b>	<b>PRC</b>	<b>VOL</b>	<b>Dummy</b>	<b>Adj. R<sup>2</sup></b>
	$\beta_0$	$\beta_1$	$\beta_2$	$\beta_3$	$\beta_4$	
Acquirer (all)	0.0115 (18.89) <sup>***</sup>	1.9763 (8.23) <sup>***</sup>	-0.0001 (-11.74) <sup>***</sup>	-0.002 (-3.71) <sup>***</sup>	0.0004 (0.70)	0.38
Acquirer (costless)	0.0183 (23.54) <sup>***</sup>	0.6556 (2.55) <sup>**</sup>	-0.0003 (-8.8) <sup>***</sup>	-0.001 (-2.19) <sup>**</sup>	0.0005 (1.07)	0.5
Acquirer (costly)	0.0096 (12.12) <sup>***</sup>	2.2787 (8.26) <sup>***</sup>	-0.0001 (-8.19) <sup>***</sup>	-0.0026 (-3.78) <sup>***</sup>	0.0002 (0.28)	0.38

*Figure 1: Costless Separation with the use of put options*

This figure shows the open-ended zone for costless separation with the use of put options. If the value of the high and low type acquirers is such that they fall in the shaded region then it is possible for the high type to costless separate.



**Figure 2: Minimum Strike Price**

The figures show the minimum possible strike price for the put option for separating equilibrium. The x-axis is the value of the low type acquirer. The dotted line is the strike price for costless separation. The first figure is for a high type value of 4 and the second figure is for a high type value of 8.

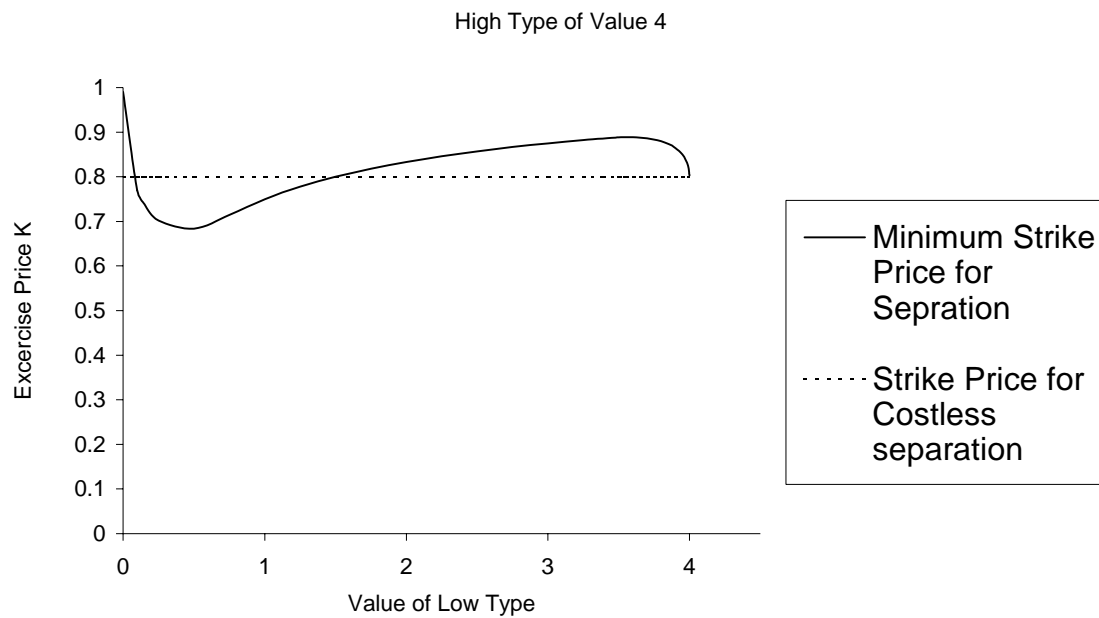
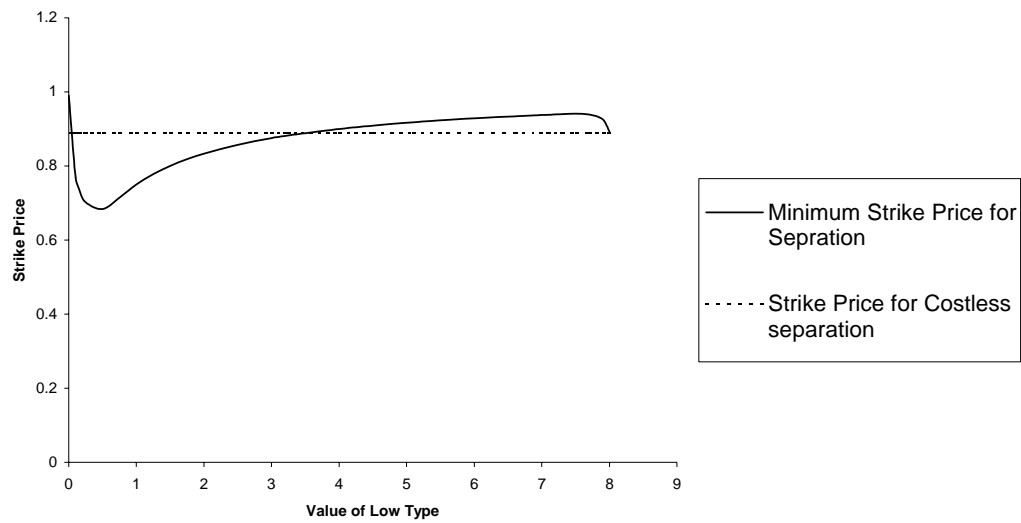


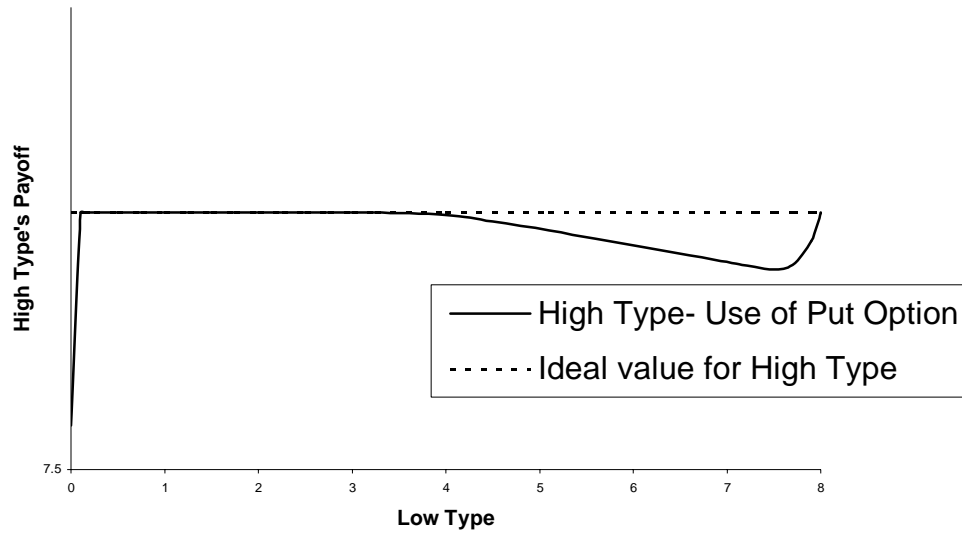
Figure 2 (continued)

Strike Price of High Type = 8



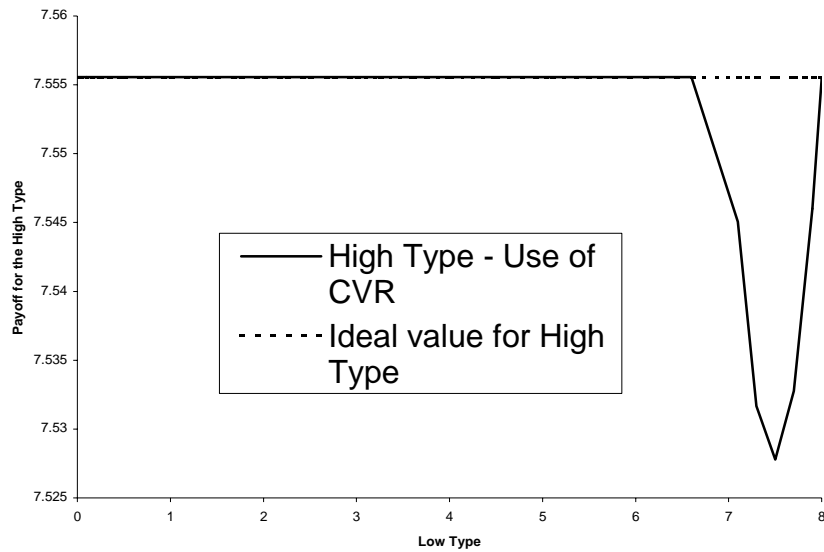
**Figure 3: High type's payoff with the use of Put Option**

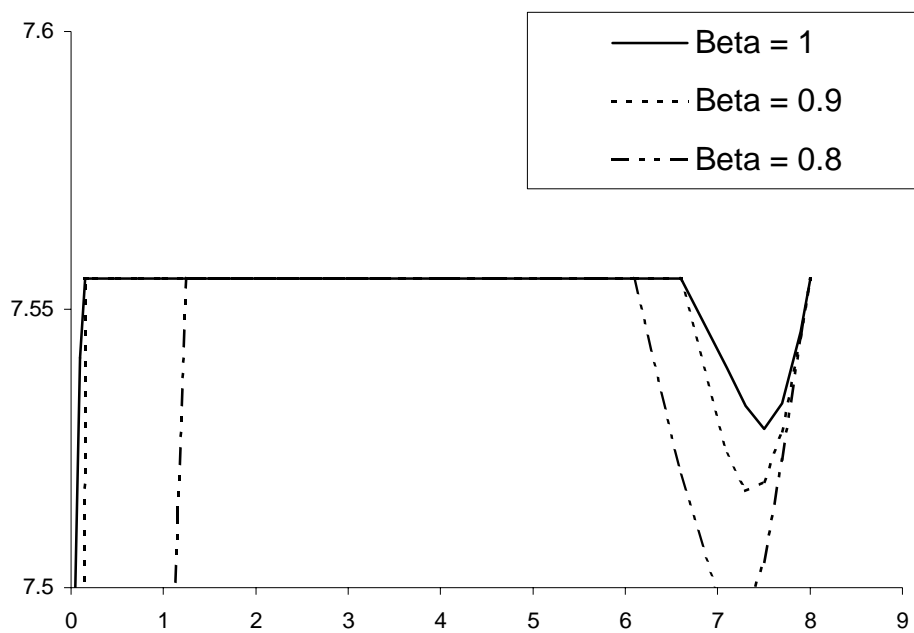
Figure shows the payoff of a high type acquirer if it separates using put options and equity. The high type's value is 8 and x-axis shows the value of the low type.



**Figure: 4 High type's payoff with the use of CVR and perfect resolution**

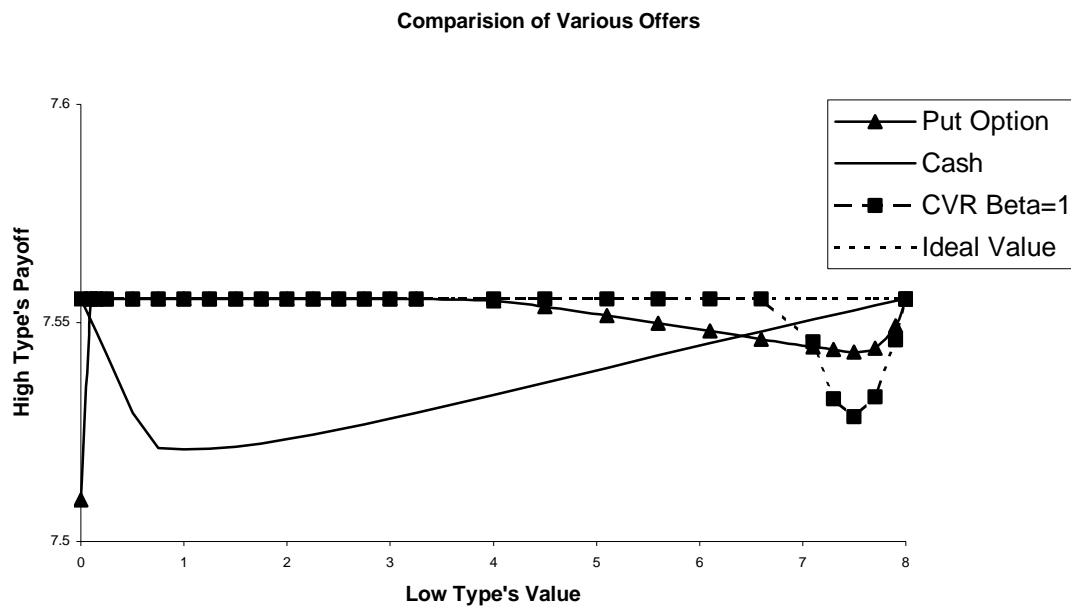
Figure shows the payoff of a high type acquirer if it separates using CVR's and equity. The high type's value is 8 and x-axis shows the value of the low type.



**Figure 5: High type's payoff with imperfect resolution of uncertainty**

**Figure: 6 High type's payoff under perfect resolution with the use of various offers**

Figure contains the options of various shows the payoff of a high type acquirer. The offers are use of cash in an separating equilibrium, use of put options in separating equilibrium, and use of CVR in a pooling equilibrium.



### **Appendix 1: Separating equilibrium with the use of cash**

In Hansen (1987) at date 0 value of acquirer is known and targets' value is revealed subsequent to merger. If only the value of the target is unknown, acquirer is better off offering equity instead of cash (Hansen 1987). The target internalizes some of its value, thus accepts at lower equity offer. However if the acquirer's value is unknown to the target, the target demands a higher proportion of equity. Thus for a high valued bidder an equity offer becomes expensive.

If only targets type was unknown the optimal offer would be an all equity offer by both bidder of high and low type (Hansen (1987)). If target type was known and bidder type was unknown the optimal offer by the high type bidder would be cash and low type would be indifferent between cash and equity. Under two sided asymmetry if both type of bidders offer equity only, the bidder of high type has to offer more than if its value was known. There can exist a separating equilibrium where the low type bidder offers equity only and high type bidder a mixture of cash and equity (EGH).

#### **Low Bidder's offer**

We analyze a separating equilibrium where low type bidder offers a pure equity offer. In equilibrium, the type of bidder is revealed by its offer. The low type bidder offers an equity share  $\alpha_L$  to the target. The offer is constructed such that it is acceptable even to the highest valued target. Or  $\alpha_L(T_H + V_L) \geq T_H$ . Thus number of

shares offered  $\alpha_L = \frac{1}{1+V_L}$ . The value for the bidders shareholders is  $(1-\alpha_L)(E[t] +$

$V_L)$  which is  $\left(1 - \frac{1}{1+V_L}\right)\left(\frac{1}{2} + V_L\right)$

### High Type's Offer

The high type bidder presents an offer consisting of cash and equity. Let the amount of cash be  $c$  and number of equity shares be  $\alpha_H$ . This offer has to be such that the combined payoff for the target of highest type ( $t=1$ ) is at least its value.

$$\alpha_H(1+V_H - c) + c \geq 1 \Rightarrow \alpha_H = \frac{1-c}{1+V_H - c} \quad (16)$$

The expected value for the original shareholders of high type firm is equity portion retained times the expected value of the post acquisition firm.

$$\left(1 - \frac{1-c}{1+V_H - c}\right) \left(\frac{1}{2} + V_H - c\right)$$

### *Incentive compatibility constraints*

Under separating equilibrium high type will offer a cash and equity offer mixture with just enough cash as to deter low type from mimicking. It can be shown low type's incentive compatibility constraint is binding. If the low type's IC holds then incentive compatibility constraint for the high type will also hold as shown below. The binding constraint is

$$\left(1 - \frac{1}{1+V_L}\right) \left(\frac{1}{2} + V_L\right) \geq \left(1 - \frac{1-c}{1+V_H - c}\right) \left(\frac{1}{2} + V_L - c\right) \quad (17)$$

The optimal value of cash offer  $c$  can be determined by equating the two sides of the inequality. The actual cash offer will be minimum of the  $c$  and  $V_L$ . We assume that if need be shareholders of low type will be able to offer a cash offer up to  $V_L$ . If the IC for the low type is binding then

$$(1 - \alpha_L)(E[t] + V_L) = (1 - \alpha_H)(E[t] + V_L - c) \Rightarrow \frac{(1 - \alpha_L)}{(1 - \alpha_H)} = \frac{(E[t] + V_L - c)}{(E[t] + V_L)} \quad (18)$$

The Incentive Compatibility constraint for the high type is

$$(1 - \alpha_H)(E[t] + V_H - c) \geq (1 - \alpha_L)(E[t] + V_H - c) \Rightarrow \frac{(E[t] + V_L - c)}{(E[t] + V_L)} \leq \frac{(E[t] + V_H - c)}{(E[t] + V_H)} \quad (19)$$

which holds true since  $V_H \geq V_L$ .

## Appendix 2: Costless Separation

Proof of Proposition 1: In proposition 1, we assume that limited liability constraint for the low type is satisfied or  $V_L \geq k$ . Also, in order for the separation to be costless  $k$

$$\leq \frac{V_H}{1+V_H}.$$

Therefore  $k \leq \min(V_L, \frac{V_H}{1+V_H})$ . Incentive constraint for the high type is satisfied, as

the separation is costless for the high type. For the IC constraint of the low type we first have to determine which target types will exercise if the low type mimics. Since  $s = \min(1, k*(1+V_H)-V_L)$  therefore if  $k*(1+V_H)-V_L \geq 1$  then all target types will

exercise the option. Or  $k \geq \frac{1+V_L}{1+V_H}$ . By assumption  $V_H \geq 1+V_L$  therefore

$\frac{V_L+0.5}{V_L+1} \geq \frac{1+V_L}{1+V_H}$  for  $V_L \geq 0$ . Therefore in the stated range if the low type mimics all

target types will exercise the option. The incentive compatibility constraint for the

low type becomes  $\left(1 - \frac{1}{1+V_L}\right) \left(\frac{1}{2} + V_L\right) \geq \left(V_L + \frac{1}{2} - k\right)$  or  $k = \frac{1}{2} \frac{1+2V_L}{1+V_L}$  for separation. At the

lower bound of  $V_L = \frac{\sqrt{2}}{2}$ ,  $k$  also equals  $\sqrt{2}/2$ . At the upper bound  $V_L = \frac{V_H-1}{2}$  or  $k$

$= \frac{V_H}{1+V_H}$ . Also  $k$  is increasing in  $V_L$  for entire range.

### Appendix 3: Use of put options to separate

*Lemma 1: There exists a separating equilibrium when  $V_L=0$ . At  $V_L=0$  the strike price needed to separate is the highest possible value of the target. High type bidder has to offer a put option with a strike price of 1 in order to separate.*

Proof: If  $V_L=0$  and is known by target, then the target will not agree to merge unless it retains all the shares or  $\alpha_L = 1$ . Low type's payoff in such a case is 0. In a separating equilibrium, the type of bidder is revealed from the offer, thus low type has to provide an offer that makes its payoff zero. Therefore to separate high type's offer has to be such that, payoff to the low type from mimicking is zero. This occurs only if the strike price of the option is equal to the highest possible type of target. If the strike price is less all-possible targets, then low type can mimic and obtain positive gains at least for some target types.

If the low type bidder is valued at 0, then separation can only be achieved by offering a put option with strike price of 1. At  $V_L = 0$ , if low type stays true to its type and presents an all equity offer, the proportion of shares offered to the target has to be 1. Thus low type would try to mimic high type for all values of strike price other than 1. If strike price  $k$  is less than 1, then low type's shareholders get zero, when target is less than strike price  $k$ . However with probability  $1-k$ , target will have a value of more than  $k$ . In those cases low type will be able to pay off the option and still be able to retain some value. In this case  $V_L=0$ ,  $s=1$  and  $z=k$ . Incentive compatibility constraint for the low type can thus be written as

$$(1 - \alpha_L) * (0 + \bar{t}) \geq (1 - k) * (0 + E[t | t \geq k] - k) + k * 0 \Rightarrow 0 \geq (1 - k) * (E[t | t \geq k] - k) \quad (20)$$

therefore either  $k=1$ , or  $E[t|t \geq k] - k = 0$ , again  $T=k$  or  $k=1$ . Given the assumption that  $t \sim U[0,1]$ , the IC constraint for the low type becomes

$$\left(1 - \frac{1}{1+0}\right)\left(\frac{1}{2} + 0\right) \geq \left(\frac{1-1}{1}\right)\left(1 - \frac{1}{1+V_H}\right)\left(\frac{1}{2} + \frac{1}{2} + 0\right) + \left(\frac{1-k}{1}\right)\left(0 + \frac{1+k}{2} - k\right) + k * 0 \Rightarrow 0 \geq (1-k)\left(\frac{-k}{2}\right) \quad (21)$$

which holds true for  $k=0,1$ . We can easily rule out  $k=0$ . Thus in order to separate when  $L=0$ , high type needs to present an offer with put option's strike price of 1.

Incentive Compatibility constraint for the high type

If the high type mimics the low type bidder, its shareholders payoff is zero, which is less than if it stayed true to its type. Thus high type would not mimic the low type bidder.

*Lemma 2: There exists a separating equilibrium for  $0 \leq V_L \leq k^*$ . Also for  $0 \leq V_L \leq k$  strike price  $k$  follows a U shaped pattern. Alternatively at  $V_L=0$   $k$  is decreasing in  $V_L$  and at  $V_L=k$ ,  $k$  is increasing  $V_L$ .*

For any value of  $V_L > 0$ , low type bidder has a strictly positive payoff if it remains true its own type. Therefore option strike price needed to separate for the high type is less than 1. The strike price  $k$  decreases initially with decrease in  $V_L$ . The minimum strike price is reached when  $V_L=0.4414$  where  $k=0.6821$  and  $V_H=2.1454$ .

Since  $k \leq \frac{V_H}{1+V_H}$  for costless separation, therefore for  $V_H < 2.1454$ , there can not exist

costless separation. From  $V_L=0.4414$  to  $V_L=k$ , there is a smaller increase in  $k$  also.

The strike price and  $V_L$  equal each other at  $V_L=k=\sqrt{2}/2$ . The minimum value of high type needed for costless separation if  $V_L=\sqrt{2}/2$  is  $V_H=1+\sqrt{2}$ .

Since we assume  $V_H > 1 + 2$ , therefore  $s = 1$  and  $z = k - V_L$ . The incentive compatibility constraint is transformed into  $(1 - \alpha_L)(\bar{t} + V_L) = (1 - k + V_L)(V_L + E[t | t > (k - V_L)] - k)$ . Using  $t \sim U[0, 1]$  we can solve for  $k$ .

$$k = \frac{1}{2} \frac{2 + 4V_L + 2V_L^2 - 2\sqrt{3V_L^2 + 2V_L^3 + V_L}}{1 + V_L} \quad (22)$$

and, 
$$\frac{\partial k}{\partial V_L} = \frac{1}{2} \frac{4V_L + 4 - \frac{6V_L + 1 + 6V_L^2}{\sqrt{3V_L^2 + V_L + 2V_L^3}}}{1 + V_L} - \frac{1}{2} \frac{2 + 2V_L^2 + 4V_L - 2\sqrt{3V_L^2 + V_L + 2V_L^3}}{(1 + V_L)^2} \quad (23)$$

At  $V_L$  close to zero  $k$  is decreasing in  $V_L$ . At the other boundary  $V_L = k$ , both  $V_L$  and  $k$  equal to  $\sqrt{2}/2$  and  $k$  is increasing in  $V_L$ .

IC constraint for the high type

Let 'q' be the target such that any target with value below 'q' exercises the option. We can determine q by using the following relation  $\alpha_H(V_H + q) \leq k$  or  $q = \max(k(1 + V_H) - V_H, 0)$ . Since  $V_H > 1$  therefore  $q = 0$ .

The incentive compatibility constraint for the high type is

$$(1 - q) \left( 1 - \frac{1}{1 + V_H} \right) \left( \frac{1}{2} + \frac{q}{2} + V_H \right) + (q) \left( V_H + \frac{q}{2} - k \right) \geq \left( 1 - \frac{1}{1 + V_L} \right) \left( \frac{1}{2} + V_H \right) \quad (24)$$

If  $q = 0$  then the IC constraint for the high type becomes

$$\left( 1 - \frac{1}{1 + V_H} \right) \left( \frac{1}{2} + V_H \right) \geq \left( 1 - \frac{1}{1 + V_L} \right) \left( \frac{1}{2} + V_H \right) \text{ which holds since } V_H \geq V_L.$$

*Lemma 3: There exists a costless separating equilibrium for  $k < V_L \leq \frac{V_H - 1}{2}$ . For*

$$k < V_L \leq \frac{V_H - 1}{2}, \text{ k is increasing } V_L.$$

Already shown in appendix 2.

*Lemma 4: There exists a separating equilibrium for  $\frac{V_H - 1}{2} \leq V_L \leq \frac{V_H - 1}{2} + \frac{\sqrt{V_H^2 - 1}}{2}$ .  $k$  is increasing  $V_L$  for the range.*

As the strike price of the option increases for  $V_L \geq \frac{V_H - 1}{2}$ , the option ceases to be costless for the high type bidder. If the low type's value is marginally greater than stated limit, target of very low value would be better off exercising the option. However for the low type all the target's still exercise the option so there is no change in the relationship between the strike price of the option needed to separate and the value of the low type. For all the target types to exercise the option till  $k*(1+V_H)-V_L \geq 1$ . Thus the limit is  $k=(1+V_L)/(1+V_H)$ . The IC constraint for the low type at  $k=(1+V_L)/(1+V_H)$  becomes

$$\left(1 - \frac{1}{1+V_L}\right) \left(\frac{1}{2} + V_L\right) \geq \left(V_L + \frac{1}{2} - \frac{1+V_L}{1+V_H}\right) \quad \text{which solves } V_L \leq \frac{V_H - 1}{2} + \frac{\sqrt{V_H^2 - 1}}{2}.$$

Also for the range  $\frac{V_H - 1}{2} < V_L \leq \frac{V_H - 1}{2} + \frac{\sqrt{V_H^2 - 1}}{2}$ ,  $k = \frac{1 + 2V_L}{2(1+V_L)}$  which is increasing in  $V_L$ .

*Lemma 5: There exists a separating equilibrium for  $\frac{V_H - 1}{2} + \frac{\sqrt{V_H^2 - 1}}{2} \leq V_L \leq V_H$ .  $k$  follows an inverted U shape as  $V_L$  increases in the range.*

In the range stated above if the low type mimics the high type, subsequent to acquisition not all target types will exercise the option. For

$$\frac{V_H - 1}{2} + \frac{\sqrt{V_H^2 - 1}}{2} < V_L \leq V_H, \quad s = k^*(1 + V_H) - V_L < 1. \text{ Thus the incentive compatibility}$$

constraint becomes

$$\left(1 - \frac{1}{1 + V_L}\right) \left(\frac{1}{2} + V_L\right) \geq (1 - k(1 + V_H) + V_L) \left(\frac{V_H}{1 + V_H}\right) \left(\frac{1}{2} + \frac{k}{2}(1 + V_H) + \frac{V_L}{2}\right) + (k(1 + V_H) - V_L) \left(\frac{V_L}{2} + \frac{k}{2}(1 + V_H) - k\right)$$

solving for k we obtain the following expression

$$k = \frac{1}{2} \frac{2V_L^2 + 2V_L + 2\sqrt{-2V_L^3 - 3V_L^2 - V_L + V_H + 3V_L V_H + 2V_L^2 V_H}}{(1 + V_L)(1 + V_H)}, \quad k$$

follows a inverted U shaped pattern for the range. IC constraint for the high type

$$\left(1 - \frac{1}{1 + V_L}\right) \left(\frac{1}{2} + V_L\right) \geq (1 - k(1 + V_H) + V_L) \left(\frac{V_H}{1 + V_H}\right) \left(\frac{1}{2} + \frac{k}{2}(1 + V_H) + \frac{V_L}{2}\right) + (k(1 + V_H) - V_L) \left(\frac{V_L}{2} + \frac{k}{2}(1 + V_H) - k\right)$$

is satisfied for the range.

The model predicts a non-linear relationship between option's strike price and difference between low type and high type. The relationship between k and  $V_L$  follows a rotated 'S' shape as shown in figure 2. Costless separation cannot occur if low types value is close to zero or close to the high type. Costless separation is also dependent on the difference between high type and target's maximum possible value. If the high type bidder and target are of equal size it is not possible to have a costless separation.

**Appendix 4: Impossibility of a costless separating equilibrium under imperfect resolution.**

Let us assume that the high type's offer is such that a separating equilibrium can occur. Thus in costless separation the type of the acquirer is revealed by the offer. Thus regardless of the signal at time 1, given high types offer, the target would chose not to exercise the option or at least be indifferent between exercising and not exercising the option. If the target will never exercise given high types offer, therefore low type could mimic the high type.

### Appendix 5: CVR's and Imperfect Resolution

For costless separation the expected payoff for the high type should be greater than  $(1-\alpha_H)*(V_H+0.5)$ . The conditions thus become  $\alpha+(1-\beta)\alpha'=\alpha_H$  and  $\alpha+\beta\alpha'=\alpha_L$ .

The equation solves

$$\alpha = \frac{-\alpha_L + \beta\alpha_H + \beta\alpha_L}{2\beta - 1} \text{ and } \alpha' = \frac{\alpha_L - \alpha_H}{2\beta - 1} \quad (25)$$

The above conditions can be modified to obtain the minimum value of  $\beta$  required such that  $\alpha$  is restricted between 0 and 1 and  $\alpha'$  is restricted between 0 and  $1-\alpha$ .

Constraints on  $\beta$  for CVR's and imperfect resolution of Uncertainty.

*$\alpha$  and  $\alpha'$  have to be greater than zero.*

$$\text{If } \alpha = \frac{-\alpha_L + \beta\alpha_H + \beta\alpha_L}{-1 + 2\beta} > 0 \text{ then } \beta > \frac{\alpha_L}{\alpha_L + \alpha_H}$$

$$\text{If } \alpha' = \frac{\alpha_L - \alpha_H}{-1 + 2\beta} > 0 \text{ then } \beta > 1/2 \text{ since } \alpha_L > \alpha_H$$

*$\alpha$  have to be less than one.*

$$\text{If } \alpha = \frac{-\alpha_L + \beta\alpha_H + \beta\alpha_L}{-1 + 2\beta} < 1 \text{ then } \beta > \frac{1 - \alpha_L}{2 - \alpha_L - \alpha_H}$$

*$\alpha'$  has to be less than  $1-\alpha$*

$$\text{If } \alpha' = \frac{\alpha_L - \alpha_H}{-1 + 2\beta} < 1 - \alpha \text{ then } \beta > \frac{1 - \alpha_H}{2 - \alpha_H - \alpha_L}$$

*The CVR's strike price  $X=A_L+I < A_H$*

$$\beta(V_H)+(1-\beta)(V_L) \geq \beta(V_L)+(1-\beta)(V_H)+1$$

$$\beta > \left( \frac{\alpha_L - \alpha_H + \alpha_L \alpha_H}{2(\alpha_L - \alpha_H)} \right)$$

Combining,

$$\beta > \max \left( \frac{1}{2}, \frac{\alpha_L}{\alpha_L + \alpha_H}, \frac{1 - \alpha_L}{2 - \alpha_L - \alpha_H}, \frac{1 - \alpha_H}{2 - \alpha_L - \alpha_H}, \frac{\alpha_L - \alpha_H + \alpha_L \alpha_H}{2(\alpha_L - \alpha_H)} \right)$$

Simplifying

$$\beta > \max \left( \frac{\alpha_L}{\alpha_L + \alpha_H}, \frac{1 - \alpha_H}{2 - \alpha_L - \alpha_H}, \frac{\alpha_L - \alpha_H + \alpha_L \alpha_H}{2(\alpha_L - \alpha_H)} \right) \quad (26)$$

## **Bibliography**

### **Essay 1: “Study of the Introduction of Stock Index Futures Contracts on Underlying Stocks: Evidence from Toronto Markets”**

Choi, H., and A. Subrahmanyam, 1994, “Using Intraday Data to Test for Effects of Index Futures on the Underlying Stock Markets,” *Journal of Futures Markets*, 14, 292-322.

Coller, M., and T.L. Yohn, 1997, “Management Forecasts and Information Asymmetry: An Examination of Bid-Ask Spreads,” *Journal of Accounting Research*, 35, 181-191.

Copeland, T., and D. Galai, 1983, “Information Effects on the Bid-Ask Spread,” *Journal of Finance*, 38, 1457-1469.

Demsetz, H., 1968, “The Costs of Transacting,” *Quarterly Journal of Economics*, 82, 33-53.

Gammill, J.F., and A.F. Perold, 1989, “The Changing Character of Stock Market Liquidity,” *Journal of Portfolio Management*, 15 (Spring), 13-18.

Glosten, L., and P. Milgrom, 1985, “Bid, Ask and Transaction Prices in a Specialist Market with Heterogeneously Informed Traders,” *Journal of Financial Economics*, 14, 71-100.

Gorton, G.B., and G.G. Pennacchi, 1990, “Financial Intermediaries and Liquidity Creation,” *Journal of Finance*, 45, 49-71.

Jegadeesh, N., and A. Subrahmanyam, 1993, “Liquidity Effects of the Introduction of the S&P 500 Index Futures Contract on the Underlying Stocks,” *Journal of Business*, 66.

Jones, C.M, G. Kaul, and M. L. Lipson, 1994, “Transactions, Volume and Spreads,” *Review of Financial Studies*, 7, 631-651.

Madhavan, A., M. Richardson, and M. Roomans, 1997, “Why do Security Prices Change? A Transaction-level Analysis of NYSE Stocks,” *Review of Financial Studies*, 10, 1035-1064.

Ronen, T., and D. G. Weaver, 2001, "Teenies' anyone?," *Journal of Financial Markets*, 4, 231-260.

Stoll, H.R., 1978, "The Pricing of Dealers Services: An Empirical Study of NASDAQ Stocks," *Journal of Finance*, 44, 115-134.

Sunbrahmanyam, A., 1991, "A Theory of Trading in Stock Index Futures," *Review of Financial Studies*, 4, 17-51.

## **Essay 2: "Financing Acquisitions with Contingent Value Rights (CVR's) and Put Options"**

Brennan, M., and A. Kraus, 1987, "Efficient Financing Under Asymmetric Information," *Journal of Finance*, Vol. 42, No. 5, 1225-1243.

Chakraborty, A., and B. Yilmaz, 2004, "Asymmetric Information and Financing with Convertibles," Rodney L. White Center for Financial Research Working Paper No. 05-03.

Coller, M., and T.L. Yohn, 1997, "Management Forecasts and Information Asymmetry: An Examination of Bid-Ask Spreads," *Journal of Accounting Research*, Vol. 35, Issue 2, 181-191.

Demsetz, H., 1968, "The Costs of Transacting," *Quarterly Journal of Economics*, 82, 33-53.

Eckbo, B.E., R.M. Giammarino, and R.L. Heinkel, 1990, "Asymmetric Information and the Medium of Exchange in Takeovers: Theory and Tests," *Review of Financial Studies*, Vol. 3, No. 4, 651-675.

Eckbo, B.E., and R.W. Masulis, (1992) "Adverse selection and the rights offer paradox," *Journal of Financial Economics*, 32, 293-332.

Fishman, M. J., 1989, "Preemptive Bidding and the Role of the Medium of Exchange in Acquisitions," *Journal of Finance*, 44, 41-57.

Gibson, S., and R. Singh, 2000, "Using put warrants to reduce corporate financing costs," Working paper, University of Minnesota .

Hansen, R. G., 1987, "A Theory for the choice of Exchange Medium in the Market for Corporate Control," *Journal of Business*, 60, 75-95.

Hausch, D.B. and J.K. Seward, "Mitigating the Corporate Valuation Problem in the Reorganization of Financially-Distressed Firms: Transferable Put Rights and Contingent Value Rights," Working Paper, University of Wisconsin Madison.

Huang, Y-S., and R.A. Walkling, 1987, "Abnormal Returns Associated with Acquisition Announcements: Payment Method, Acquisition Form, and Managerial Resistance," *Journal of Financial Economics*, 19, 329-349.

Jegadeesh, N., and A. Subrahmanyam, 1993, "Liquidity Effects of the Introduction of the S&P 500 Index Futures Contract on the Underlying Stocks," *Journal of Business*, Vol. 66, No 2.

Jones, C.M, G. Kaul, and M. L. Lipson, 1994, "Transactions, Volume and Spreads," *Review of Financial Studies*, winter 1994 Vol.7, No. 4, pp 631-651.

Modigliani, F., and M.H. Miller, (1958) "The cost of capital, corporation finance and the theory of investment," *American Economic Review*, 48, 261-297.

Myers, S.C., and N.S.Majluf (1984) "Corporate Financing and Investment Decisions when firms have information investors do not have" *Journal of Financial Economics*, 13, 187-221.

Samuelson, W., 1984, "Bargaining under Asymmetric Information," *Econometrica*, Vol. 52, No. 4, 995-1006.

Stoll, H.R., 1978, "The Pricing of Dealers Services: An Empirical Study of NASDAQ Stocks," *Journal of Finance*, 44, 115-134.

Travlos, N.G., 1987, "Corporate Takeover Bids, Method of Payment, and Bidding Firms' Stock Returns," *Journal of Finance*, 42, 943-963.