HEDGING PRESSURE, DELIVERY RISK, AND RISK PREMIUMS IN FUTURES MARKET: EMPIRICAL EVIDENCE

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Abstract

This article contains an empirical analysis of the determinants of futures risk premiums in the presence of hedging pressure and delivery risks. If hedging pressure and delivery risk jointly explain the portion of futures risk premium unexplained by the systematic risk, then we conclude that the asset and futures markets are not fully integrated. The analysis in this paper is an extension of Bessembinder (1992) in that the current analysis also considers the possibility of delivery risk as an additional determinant of futures risk premiums in the presence of both hedging pressure and delivery risk. The evidence based on weekly data of futures and futures options contracts traded in the CBOT during January 1991 and February 2004 implies a degree of segmentation between asset and futures markets and supports the net hedging pressure and delivery risks as additional determinants of risk premiums in futures market.

I. Introduction

The difference between the expected price of a futures contract and the current futures price is the risk premium or the market price for transferring the risk of an asset underlying the futures contract. If the asset and futures markets are fully integrated, the risk premiums for systematic risk in asset and futures markets should be equal, whereas the zero-beta returns in futures (asset) market should be zero (risk-free rates). One early study of risk premium in the context of asset and futures markets is Bessembinder (1992) who documents that, especially for the futures contracts that can be settled by delivery, the futures risk premiums depend not only on the systematic risk but also on the residual risk conditional on net hedging pressure (i.e., net supply of futures contracts).

Accordingly, Bessembinder (1992) concluded that the asset and futures markets were not fully integrated in the presence of hedging pressure effect in futures market, especially in the market where futures contracts can be settled by delivery. For these contracts, however, short position holders have flexibilities in waiting and choosing the cheapest-to-deliver (CTD) assets for deliveries during delivery month. Since these delivery-related options are valuable to a short position, the short position's cost of delivery that reflects the value of delivery option is positive (i.e., the short position's net receipt amount or "the futures settlement price times the CTD's conversion factor minus the CTD price" is negative). The expected value of delivery options differ by different types of traders and may change over time as different futures traders face different transaction costs and have different expectations on the trade-off between expected delivery cost and expected net-carry benefit of the expected CTD. Furthermore, the CTD itself changes over time due to imperfections in the conversion factoring system. Hence, even prior to delivery month, traders face not only the futures price risk but also delivery risk.

Although it is well known that the presence of delivery risk tends to lower the futures equilibrium price (e.g., Bellalah, 1999) as well as the futures price volatility (e.g., Hwang and Satchell, 2000), the effect of the delivery risk on futures risk premium (i.e., the difference between the expected and current futures prices) is not known. A question that arises from these studies is whether the hedging pressure effect that Bessembinder (1992) found is contaminated by the delivery risk that might be related to hedging pressure.

Recent literature on delivery risk shows that the presence of delivery risk can make the quantity and price uncertainties facing hedgers non-linear in futures prices and lead to substantial hedging demands for futures options contracts as well. Tompkins (2003) suggests that all determinants of futures options risk premium are similar to determinants of futures risk premium. The literature therefore indicates that, although the delivery risk like hedging pressure is not a systematic risk, it might be a significant determinant of the futures risk premium as well.

Motivated by this conjecture, the study in this article examines the possibility of delivery risk as an additional determinant of the futures risk premium. By doing so, it unravels the potential linkage between the equilibrium futures risk premium implication of hedging pressure and the partial equilibrium implication of delivery risk on hedging demands for futures options.

As an empirical model of futures risk premium, we extend the empirical specification in Hirshleifer model (1988) to incorporate the futures option risk premium as an additional determinant of futures risk premium. This direct test of delivery risk as a determinant of futures risk premium is implemented on weekly sample data on futures and futures options contracts traded in the CBOT during January 1991 and February 2004. Consistent with implications of recent literature on delivery risk, the results suggest that the delivery risk is indeed an additional determinant of futures risk premium. In that the hedging pressure effect is a nonredundant determinant of futures risk premium, our results provide stronger supports to the earlier findings in Bessembinder (1992) that the asset and futures markets are not fully integrated and the hedging pressure is an important determinant of futures risk premium.

The remaining sections are as follows. Section II explains an empirical model of futures risk premium that incorporates the delivery risk in addition to the systematic risk and the hedging pressure as the determinants. Section III describes the data, whereas Section IV discusses the main results. Section V provides robustness tests of the main results, while Section VI concludes the study.

II. Futures Risk Premium in the Presence of Delivery Risk

1. Hedging Implication of Delivery Risk

The mathematical demonstration of the hedging implication of delivery risk is complex.[1] Hence, its intuition is illustrated in Figure 1. In the absence of delivery risk, futures price converges to the spot price of the par delivery grade underlying the futures contract (P_A) on the delivery day. Hence, the hedgers' exposures, which are assumed to be linear in P_A, can be fully hedged by taking positions only in futures. The presence of delivery risk, however, causes futures price to converge to the cheapest-to-deliver price on the delivery day.

Panel A (a simple case of delivery risk involving two deliverables) illustrates the case where the non-par delivery grade can be cheaper than the par delivery grade and hence the futures payoff becomes piecewise linear in the par-delivery price. Thus, hedgers cannot fully hedge their exposures (which are linear in P_A) using only futures contracts (whose payoffs are piecewise linear in P_A). In this case, hedgers can fully hedge their exposures as shown in Panel B by taking positions in both futures and futures options (with strike

[1] The mathematical demonstration is available upon request.

price *k*), whose payoffs are linear in the par-delivery or hedgers' underlying asset price.

In the case of *n* deliverable grades, futures payoffs is multiple piecewise-linear in the par-delivery price. As the number of deliverables increases, the futures payoff would approximate a smooth concave function in the par-delivery price. Hedgers will take positions in both futures and multiple futures options (with different strike prices) to make the positions' payoff approximately linear in the par-delivery price. In fact, there are other sources that lead to the non-linearity between hedgers' exposures and the par-delivery price[2], which also gives rise to the hedging role of futures options.

2. A Model of Futures Risk Premium

To incorporate the delivery risk as a determinant of the futures risk premium, we extend the Hirshleifer's (1988) model of futures risk premium and its econometric specification provided in Bessembinder (1992), which is well supported by empirical evidence (e.g., Bessembinder, 1992; de Roon, et al., 2000).

Hirshleifer's (1988) model incorporates two market imperfections. First, some claims are nonmarketable, as in Mayers (1972). Second, in the spirit of Merton's (1987) model of the effects on nonparticipation in security markets, participation in futures markets is limited by the existence of fixed setup costs.

[2] This literature includes Chang and Wong (2003) analyze the hedging strategy of the nonlinear currency exposure. Moschini and Lapan (1992; 1995) examine the optimal hedge of the nonlinear revenue in production business. Mahul (2002) studies hedging the nonlinear basis risk.

Abstracting from daily settlement complexities and considering marginal speculators whose preference functions show constant absolute risk aversion, he derives an equilibrium model of futures risk premium as follows:

$$\pi = \beta_{\pi m} E(\tilde{R}_m) + d\sigma_\pi \sqrt{2\lambda' t(1-\rho_{\pi m}^2)} \qquad (1)$$

In his resulting equilibrium, futures risk premium (π) depends on both systematic risk ($\beta_{\pi m}$) and residual risk (σ_π). The sign of the residual risk premium ($\sigma_\pi \sqrt{2\lambda' t(1-\rho_{\pi m}^2)}$) depends on the sign of net hedging pressure (d), whereas the magnitude of the residual risk premium increases in the marginal speculator's constant absolute risk aversion coefficient ($2\lambda'$), the fixed cost for trading futures (t), and the degree of segmentation between futures and stock markets ($1-\rho_{\pi m}^2$).

Although not reported here, we can show that in the presence of both hedging pressure and delivery risk, the futures risk premium will be determined as follows:[3]

$$\pi = \beta' E(\tilde{R}_m) + d\,\sigma' \sqrt{2\lambda' t} + \Gamma E(\tilde{R}_o) \qquad (2)$$

where the futures risk premium (π) depends not only on the systematic risk (β') and the residual risk conditional on the net hedging pressure (σ') but also on the option covariance risk (Γ; a proxy for the delivery risk).

[3] Derivation details are in the Appendix.

In the presence of delivery risk, the systematic risk $\beta' = (\beta_{\pi m} - \beta_{\pi o}\beta_{om})/(1-\rho_{om}^2)$ is adjusted for its covariance with futures options, the residual risk conditional on net hedging pressure ($\sigma' = \sigma_\pi \sqrt{\gamma / 1-\rho_{om}^2}$, where $\gamma = 1-\rho_{om}^2 - \rho_{o\pi}^2 - \rho_{\pi m}^2 + 2\beta_{mo}\beta_{o\pi}\beta_{\pi m}$) adjusts the standard deviation of futures returns (σ_π) to its covariance with futures options, and the futures options covariance risk ($\Gamma = (\beta_{\pi o} - \beta_{\pi m}\beta_{mo}) / 1-\rho_{om}^2$) nets out futures options covariance with the systematic risk and the residual risk conditional on net hedging pressure.

The futures risk premium in equation (2) is determined by the net systematic risk (which adjusts for its covariance with futures options), the net residual risk (which adjusts for its covariance with futures options), and the net option covariance risk (which is orthogonal to systematic risk and residual risk conditional on net hedging pressure). In other words, the futures risk premium in our model is determined by the three risk factors, namely, systematic risk (β'), hedging pressure risk (σ'), and option covariance risk (Γ).

3. **Estimation Methodology**

Our econometric estimation takes two-step cross-sectional regression approach, which is adopted from Fama and MacBeth (1973). In the first step the time-series of the three risk factors (β'_t, σ'_t, Γ_t) are complied contract-by-contract from the slope coefficients conditional at week *t* (denoted by subscript *t*). These coefficients (hereafter betas; $\beta_{Fm,t}$, $\beta_{mF,t}$, $\beta_{Fo,t}$, $\beta_{oF,t}$, $\beta_{om,t}$ and $\beta_{mo,t}$) are estimated from time-series regressions which the variables are weekly futures returns, stock market returns (returns on value-weighted CRSP index) and futures option returns, using the data for the prior 50 weeks.

In the second step we estimate the day-by-day cross-sectional regressions of futures returns on the estimated three risk factors.[4] The output of our second-step regressions is a time series of factor risk premiums, which takes the following form:

$$R_{Ft} = \delta_{0t} + \beta'_t \delta_{1t} + \sigma'_t d_t \delta_{2t} + \Gamma_t \delta_{3t} + \varepsilon_t \quad (2)$$

where $\beta'_t = (\beta_{Fm,t} - \beta_{Fo,t}\beta_{om,t})/(1-\rho^2_{om,t})$, $\sigma'_t = \sigma_{Fmo,t} / \sqrt{1-\rho^2_{om,t}}$, and $\Gamma_t = (\beta_{Fo,t} - \beta_{Fm,t}\beta_{mo,t})/(1-\rho^2_{om,t})$ the time-varying risk factors, δ_{1t}, δ_{2t}, and δ_{3t} denote the factor premiums for the respective risks, δ_{0t} denotes an intercept, and ε_t denotes a random error.

The final estimated premium for each factor is the average of the daily premiums. Each of the final estimated premiums was used to test whether the factor on average has a non-zero expected premium. As shown by Shanken (1992), the calculated standard errors of the final estimate from simple Ordinary Least Squares (OLS) understate the true standard error due to estimation error in the estimated betas. Thus, to correct for the estimation error,

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[4] On the estimation of factor risk premiums using a two-step cross-sectional regression approach, Shanken (1992) shows that the estimation of daily cross-sectional regressions yields more asymptotically efficient coefficient estimates.

each regression was estimated with Newey-West heteroskedasticity and autocorrelation consistent estimates of covariance matrices.

Our results will be compared to the results of Hirshleifer model, which is reported in Bessembinder (1992).[5]

III. Data

The data set cover consist of settlement prices of 13 futures and futures option contracts traded in the CBOT during the period from January 2000 to February 2004. The settlement data are obtained mainly from the Datastream International Database and the New York Board of Trade (NYBOT), whereas the total returns on CRSP value-weighted equity index are obtained from the Center for Research in Security Prices (CRSP). Net futures positions of large traders in the Commitments of Traders reports are provided by Commodity Futures Trading Commission (CFTC).

The selected contracts were classified into two groups: six contracts with delivery options (Treasury bonds, 10-year Treasury notes, cocoa, coffee, cotton, world sugar) and seven contracts without delivery risk (three-month

[5] In the absence of delivery risk, our equation (3) will reduce to the econometric specification of Hirshleifer model: namely, $R_{Ft} = \delta_{0t} + \beta_{Fm,t}\delta_{1t} + \sigma_{Fm,t} d_t \delta_{2t} + \varepsilon_t$. For details, see Bessembinder (1992).

Eurodollars, S&P500 index, Japanese yen, Swiss franc, Canadian dollar, Australian dollar, British pound).[6]

The returns on futures and futures options were computed as percentage changes in the contracts' settlement prices.[7] To prevent the effects of stale prices and microstructure, the following procedure was applied to generate the returns on three types of futures options (e.g., calls, puts, and straddle positions).[8] First, the price data of near-expiration options were collected from the option prices with the nearest expiry month, except within the expiry month when the prices of the second-nearest contract were used. Then, the moneyness of each option was determined by using its underlying price (the futures price) from the beginning of the *t*th week and the nearest in-the-money and the nearest out-of-the-money options were selected from the data collection. Finally, the weekly option returns from the equal-weighted prices of two nearest-the-money options were calculated. Meanwhile, the time-series of futures returns was calculated from the corresponding futures prices, which were underlying the futures options.

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[6] Both three-month Eurodollars and S&P500 index contracts are cash settled based on the Final Settlement Rule of the Chicago Mercantile Exchange (CME), while each of the five currency contracts is physically delivered at a specific final settlement price determined by the Trading Floor Pit Committee, CME. The futures and futures option contracts were selected on various assets underlying the contracts and their economic importance, as evidenced by the relatively large trading volumes and open interests.

[7] Although computing futures return as percentage change in futures prices is consistent with the empirical literature on pricing, it is noteworthy that this futures return is a misnomer. Due to zero initial investment cost, futures return cannot be defined as a percentage change in futures value with respect to its investment cost but should be defined as dollar change in futures prices (Black (1976)). Nevertheless, measuring futures return as a percentage is widely used because it makes return analysis comparable across futures contracts as well as other assets.

[8] Straddle is a long position in one call and one put at the same exercise price.

For both futures and futures options, each return was computed using successive prices on a contract for a specific expiry date and never across contracts with different dates of expiry. For Eurodollar futures, the quoted settlement price does not reflect the delivery price. The index price basis in which the contract is quoted is equal to 100 minus the annualized futures LIBOR (London Interbank Offered Rate). These quoted prices were converted to implied delivery prices; thus the return on Eurodollar futures was computed as the percentage change in these implied delivery prices.

[Insert Table 1 here]

The summary statistics of weekly returns on futures and futures options are reported in Table 1. They confirm stylized facts about the returns reported in previous studies. Average futures returns in panel A are relatively small, ranging from -0.50% to 0.22% per week, and are significant at the 5% level only for two contracts. These results are largely consistent with those in Bessembinder (1992) and DeRoon, Nijman and Veld (2000).

The average returns on near-the-money futures options are substantially large in absolute value than futures returns. Most call futures returns are positive while most put futures returns are negative. Average returns on call futures options, excluding the call returns on S&P500, Coffee, and Cotton, considerably exceed the average returns on their underlying securities (futures returns) of 3% - 10.5% per week. Conversely, all average put option returns, except for those returns on S&P500, Coffee, and Cotton, are considerably lower than average risk-free returns (i.e., returns on one-month U.S. Treasury bill), the difference ranging from 0.8% to 6.4% per week. The futures option returns are, by and large, consistent with the theory of expected option returns proposed by Coval and Shumway (2001) and the magnitudes of the futures option returns are comparable to those reported by Coval and Shumway.[9]

Nevertheless, the discrepancy of the average option returns on S&P500, Coffee, and Cotton probably arises from the negative mean returns on futures underlying the options. Then the positive correlation between call futures options and their underlying security leads to the negative call returns on these contracts. Similarly, the negative correlation between put futures options and their underlying security causes the average put returns on these contracts to be positive.

Overall, the return behavior of futures options reflects an option's characteristic that can be used to lever positions in the underlying asset. The leverage effect arises from the fact that, with a relatively small investment, an option allows investors to assume much of the risk associated with the option's underlying asset. As implied by the pricing model of Black and Scholes (1973), this implicit leverage should be priced in option returns.

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[9] Coval and Shumway (2001) show that, if call options are written on securities with expected returns above the risk free rate, the expected call returns should exceed expected returns on the underlying securities. Conversely, put options should earn expected returns below that of the underlying security. Coval and Shumway also report average daily call and put returns on near-the-money options on futures contracts for the period of October 1988 to August 1999. Call and put returns on Treasury futures are 0.53 % and -1.51 % while the Eurodollar call and put returns are 1.20% and -1.51% respectively.

Average returns on straddle futures options are also reported in Table 1. Each straddle is an equal-weighted combination of at-the-money put futures and at-the-money call futures the same maturity. Average returns on straddle options, excluding straddle returns on coffee and Swiss franc contracts, are positive, ranging from 0.02% to 2.98% per week and mostly insignificant.

Panel B in Table 1 shows the return correlation matrices for futures, calls, puts, straddle options, and the value-weighted CRSP stock index. As expected, the futures returns are positively correlated with call returns and negatively correlated with put returns. These correlations confirm the characteristics of the call options and the usefulness of the put options as instruments for portfolio insurance.

IV. Empirical Analysis

The following analyses focus on testing the hypothesis of the model in equation (2) that futures option returns can explain average futures returns and risk premiums. This hypothesis should be valid regardless of whether call futures, put futures, or both futures options are available in the economy. Therefore, the following tables present the regression results of the model in (2) using different types of futures option returns: call, put, straddle and call-put spread respectively. The straddle is created by buying an at-the-money call and an at-the-money put. The call-put spread is created by buying an at-the-money call and selling an at-the-money put.

[Insert Table 2 here]

Table 2 reports the results of the model in equation (2) using call futures returns. Panel A contains averages of the three estimated factors compiled from the time-series regressions, which the variables are returns on futures, call futures, and stock market, over the prior 50 weeks and standard deviations of residuals from the 50-week rolling regressions of futures returns on call futures returns and stock market returns (the first step of Fama-MacBeth regressions). Panel B presents the average factor risk premiums estimated from the cross-sectional regressions of futures returns on the three estimated factors (the second step of Fama-MacBeth regressions). The average factor risk premiums captured by the futures option returns are reported separately for the futures contracts with delivery risk and those without delivery risk. The results of the Hirshleifer's regression, provided in columns 3 to 6, are used as a benchmark against which the regression of our model can be evaluated in order to illustrate the marginal contribution of the futures option returns.

The regression results indicate the importance of call returns in explaining the cross-section of average futures returns. A significant effect of call futures returns on futures returns is found for the contracts with delivery risk. Average of factor risk premiums captured by call futures returns is 4.3% per week, with *t*-statistics of 2.20, for the contracts with delivery risk while the average factor premiums for the contracts without delivery risk are relatively small and insignificant. The average risk premiums captured by call returns are substantial for the contracts with delivery risk, ranging from 0.10% to 0.32% per week. Among these contracts, the risk premiums for agricultural futures are larger than those for Treasury futures.

A considerable increase in average adjusted *R-square* of the regressions indicates some improvement from Hirshleifer (1988) model. However, the average intercept is still significant at the 1% level and the test for the hypothesis that all factor premiums are jointly zero, indicated by Hotelling T^2 statistic, suggests that the model in equation (2) using call option returns offers a statistically insignificant improvement.

[Insert Table 3 here]

Table 3 shows the results of the model in equation (2) using put futures returns. The results indicate the significant effect of put returns on the cross-section of the average futures returns. For all contracts with delivery risk, except Treasury bond futures, the average risk premiums captured by put returns are large in both practical and statistical terms, ranging from 0.11% to 0.41% per week. Again, the premiums for agricultural futures are substantially larger than those for interest rate futures. For the futures contracts without delivery risk, the average premiums captured by put returns are relatively small and statistically insignificant, ranging from -0.07% to -0.02% per week. Residual risk premiums, on average, are also economically and statistically significant. The average adjusted *R-square* from the regressions in equation (2) using put futures returns increases considerably relative to the *R-square* the regressions of Hirshleifer (1988). However, the average intercept is still significant and Hotelling T^2 statistic indicates all factor premiums are insignificantly different from zero. This suggests a similar conclusion to the regression results using call futures returns in Table 2.

[Insert Table 4 here]

Table 4 provides the results of the model in equation (2) using returns on straddle futures options. Using the straddle returns provides a test of whether volatility risk is priced in futures returns.[10] The results show that the straddle returns have significant power to explain average futures returns. The average risk premiums captured by the straddle returns are statistically significant, at the 1% level, and large in absolute value, ranging from -0.35% to 0.14% per week, for the contracts with delivery risk. For the futures contracts without delivery risk, the average risk premiums captured by straddle returns are also significant but relatively smaller, ranging from -0.08% to 0.09% per week.

Average adjusted *R-square* of the regressions suggests an improvement over Hirshleifer model. The average premiums for the systematic risk and the

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[10] As addressed by Coval and Shumway (2001), straddle returns are useful for capturing the volatility of underlying returns. A straddle's characteristic allows us to detach the leverage effect and focus on the pricing of volatility of the security return. This is because the straddle positions are formed by buying an at-the-money call and an at-the-money put with the same maturity. Due to the offset between the payoffs of near-the-money call and put options caused by their underlying price change, straddle return is not sensitive to futures return per se but sensitive to the volatility of futures return. Specifically, when volatility is higher than expected, the straddles have positive returns. When volatility is lower than expected, the straddles have negative returns. Since straddle has a large, positive volatility beta, it allows investors to hedge the volatility of the underlying returns. This would make the straddle return capture the volatility risk associated with a futures position.

hedging-conditioned residual risk are also statistically significant. The Hotelling T^2 statistic confirms the test results by rejecting the hypothesis that all factor premiums are jointly zero at the 1% significance level. Collectively, the statistical tests indicate the model in equation (2), using straddle returns, has significant power to explain the cross-section of average futures returns. In addition, these results would suggest that volatility risk is priced in average futures returns.

[Insert Table 5 here]

Table 5 reports the results of the model in equation (2) using returns on the call-put spreads. The results show that the spread returns have significant power to explain average futures returns. The average risk premiums captured by the spread returns are statistically significant, at the 1% level, and large in absolute value, ranging from -0.16% to -0.47% per week, for the contracts with delivery risk. For the futures contracts with no delivery risk, the average risk premiums captured by the spread returns are also insignificant and relatively smaller in absolute value, ranging from -0.04% to -0.14% per week.

Average adjusted *R-square* of the regressions indicates an improvement over Hirshleifer model. The average premiums for the other two risk factors as well as the average intercept are also statistically significant. The Hotelling T^2 statistic confirms the test results by rejecting the hypothesis that all premiums are jointly zero at the 5% significance level. This suggests that the model in equation (2) significantly explains the cross-section of average futures returns.

V. Robustness Test

The empirical evidence presented so far indicates the importance of futures option returns in explaining average futures returns and risk premiums. However, an alternative explanation of these results in section 4.1 might be given by the high correlation between derivatives and their underlying. In other words, the significant effect of futures options on futures risk premiums may arise because of the interaction between futures returns and futures option returns.

To see whether futures option returns indeed contains an additional power to explain futures risk premiums, we test the hypothesis of the model in equation (2) using residual returns on futures options, which are orthogonal to futures returns and stock market returns. By doing so, we abstract from the correlation between futures option and futures contract and focus on the marginal contribution of residual returns on futures options to explain average futures risk premiums.

The residual returns on futures options ($\varepsilon_{o,t}$) are obtained from the equation

$$\varepsilon_{o,t} = R_{o,t} - \alpha - \beta_{om} R_{m,t} - \beta_{oF} R_{F,t} \tag{3}$$

where $R_{o,t}$, $R_{m,t}$ and $R_{F,t}$ are futures option return, stock market return and futures return at time t respectively; β_{om} and β_{oF} denote unconditional slope coefficients estimated from a time-series regression of futures option returns on futures returns and stock market returns; α is an intercept of the regression.

[Insert Table 6 here]

Table 6 reports average factor risk premiums estimated from the Fama-MacBeth regressions in equation (2) using different types of residual returns on futures options: call, put, straddle and call-put spread respectively. The results show that, the significant effects of futures option returns exist, even after purging the component of futures option returns that may be explained by futures returns and stock market returns. Although the pricing relations between futures returns and residual returns on futures options are somewhat weaker than the relations between futures returns and futures option returns reported in Tables 2 – 5, these results still provide convincing evidence for the role of futures options in determining futures returns and risk premiums.

VI. Conclusions

This paper empirically tests a model of futures risk premium in the presence of both hedging pressure and delivery risk. The evidence based on weekly data of futures and futures options contracts traded in the CBOT during January 1991 and February 2004 implies a degree of segmentation between asset and futures markets and supports the net hedging pressure and delivery risks as additional determinants of risk premiums in futures market. Our study contributes to the futures risk premium literature by identifying a new important determinant of futures risk premium: namely, futures option returns (a proxy for delivery risk).

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Appendix. The Derivation of Empirical Model

The empirical model is an extension of Hirshleifer model (1988). It is derived assuming the presence of both hedging pressure effect and delivery risk. The derivation consists of several steps that are only listed here. The details are available upon request.

Step 1. Derivation of the first order conditions;

$$\max_{y,z} EU(\tilde{W}_i) = \max_{y,z} E(\tilde{W}_i) - \frac{\lambda_i}{2}\operatorname{var}(\tilde{W}_i) \tag{A1}$$

$$E(\tilde{U}_h) = E[a_h - t + \tilde{g}_h + x_h\tilde{R}_m + y_h\tilde{\Pi} + z_h\tilde{R}_o] - \frac{\lambda_h}{2}\operatorname{var}\left[a_h - t + \tilde{g}_h + x_h\tilde{R}_m + y_h\tilde{\Pi} + z_h\tilde{R}_o\right] \tag{A3h}$$

$$E(\tilde{U}_s) = E[a_s - t + x_s\tilde{R}_m + y_s\tilde{\Pi} + z_s\tilde{R}_o] - \frac{\lambda_s}{2}\operatorname{var}[a_s - t + x_s\tilde{R}_m + y_s\tilde{\Pi} + z_s\tilde{R}_o] \tag{A3s}$$

$$E(\tilde{U}_{r1}) = E[a_{r1} - t` + x_{r1}\tilde{R}_m + z_{r1}\tilde{R}_o] - \frac{\lambda_{r1}}{2}\operatorname{var}[a_{r1} - t` + x_{r1}\tilde{R}_m + z_{r1}\tilde{R}_o] \tag{A3r}$$

$$E(\tilde{U}_{r2}) = E[a_{r2} + x_{r2}\tilde{R}_m] - \frac{\lambda_{r2}}{2}\operatorname{var}[a_{r2} + x_{r2}\tilde{R}_m] \tag{A3q}$$

Step 2. Derivation of the futures market equilibrium

$$\Pi^* = E(\tilde{f}) - f = \theta\operatorname{cov}(\tilde{\Pi}, b\bar{g} + \bar{x}\tilde{R}_m + \bar{z}\tilde{R}_o) \tag{A11}$$

where $\theta = \frac{(\lambda_H\lambda_S)/(\lambda_H + \lambda_S)}{H+S}$; $b = \frac{H}{H+S}$; $\bar{g} = \frac{1}{H}\sum_{h=1}^{H}\tilde{g}_h$; $\bar{x} = \frac{x_H + x_S}{H+S}$; $\bar{z} = \frac{z_H + z_S}{H+S}$.

$$f^* = E(\tilde{f}) - \theta\operatorname{cov}(\tilde{\Pi}, b\bar{g} + \bar{x}\tilde{R}_m + \bar{z}\tilde{R}_o) \tag{A12}$$

Step 3. Futures risk premium given the number of traders

$$\pi^* = \theta\operatorname{cov}(\tilde{\pi}, b\bar{g} + \bar{x}\tilde{R}_m + \bar{z}\tilde{R}_o) \tag{A13}$$

Steps 4, 5, 6 and 7 are not listed here.

Step 8. Final result of tedious derivation

$$\pi = \beta' E(\tilde{R}_m) + d\,\sigma'\sqrt{2\lambda' t} + \Gamma E(\tilde{R}_o) \tag{1}$$

where $\beta' = \frac{(\beta_{\pi m} - \beta_{\pi o}\beta_{om})}{1-\rho_{om}^2}$; $\sigma' = \sigma_\pi\sqrt{\frac{\gamma}{1-\rho_{om}^2}}$; $\Gamma = \frac{(\beta_{\pi o} - \beta_{\pi m}\beta_{mo})}{1-\rho_{om}^2}$;

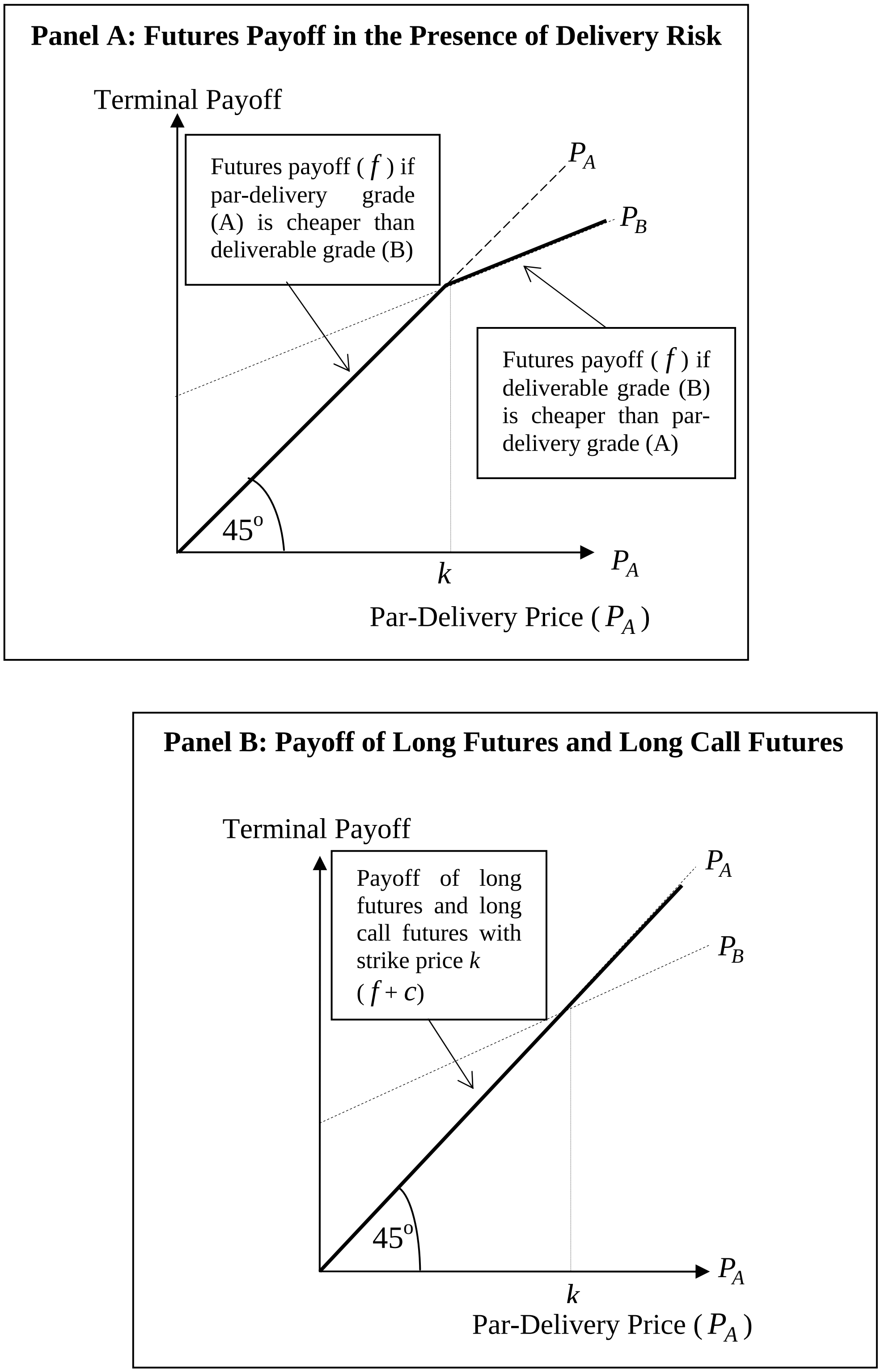

Figure 1 Hedging with Futures and Call Futures Options

Panel A shows the futures payoff in the presence of delivery risk.
Panel B shows the payoff of long positions in futures and call futures options.

Table 1 Summary Statistics

Panel A reports sample mean returns (% per week) and standard deviation for futures and three types of options on futures: call , put, and straddle. Straddle is created by taking long positions in an at-the-money call and an at-the-money put. Panel B shows the return correlation matrix for all four types of contracts and value-weighted CRSP stock index (VW-CRSP). *n* denotes the sample size in weeks.The sample period is from January 2000 (May 2000 for Cocoa, Coffee, Cotton, and Sugar) to February 2004. * denotes statistical significance at the 5% level.

Panel A:	*n*	Futures (%)		Call (%)		Put (%)		Straddle (%)	
		Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Contract with Delivery Risk									
30-Year T-Bond	215	0.16	1.43	6.81	50.84	-5.30	42.31	1.17	9.73
10-Year T-Note	215	0.13	0.99	6.91*	43.90	-6.29*	40.34	0.38	10.39
Cocoa	196	0.04	0.50	3.61	49.70	-0.71	51.22	0.02	15.54
Coffee	196	-0.50	4.94	-2.25	82.46	1.79	36.34	-1.59	22.24
Cotton	196	-0.20	3.72	-1.22	51.84	3.23	44.84	0.76	11.36
Sugar	196	0.30	4.43	3.77	47.31	-0.41	40.75	0.13	11.82
Contract wihtout Deliry Risk									
Eurodollar	215	0.01*	0.03	5.96*	39.09	-3.79	40.34	0.14	9.76
S&P 500	215	-0.04	2.86	-0.33	32.00	0.48	48.83	0.21	9.20
Japanese Yen	215	0.01	1.34	2.23	42.25	-1.14	21.18	0.54	11.44
Swiss Franc	215	0.18	1.48	3.88*	24.98	-5.74	45.97	-1.02	10.43
Canadian Dollar	215	0.05	0.94	3.17	40.97	-1.61	31.26	0.31	6.07
Australian Dollar	215	0.22*	1.54	10.73*	50.79	-5.47*	33.33	2.98*	14.01
British Pound	215	0.07	1.14	3.60	39.16	-1.83	20.28	0.74	9.64

Panel B: Correlation matrix		Futures	Call	Put	Straddle	VW CRSP
30-Year T-Bond	Futures	1	0.859	-0.895	0.284	-0.230
	Call		1	-0.875	0.523	-0.198
	Put			1	-0.208	0.203
	Straddle				1	-0.071
	VW CRSP					1
10-Year T-Note	Futures	1	0.808	-0.826	0.100	-0.362
	Call		1	-0.806	0.315	-0.319
	Put			1	0.069	0.315
	Straddle				1	-0.076
	VW CRSP					1
Cocoa	Futures	1	0.763	-0.798	-0.015	-0.028
	Call		1	-0.588	0.371	-0.043
	Put			1	0.210	0.023
	Straddle				1	0.003
	VW CRSP					1
Coffee	Futures	1	0.844	-0.787	0.761	0.128
	Call		1	-0.649	0.828	0.096
	Put			1	-0.530	-0.100
	Straddle				1	0.105
	VW CRSP					1

Table 1 Summary Statistics

Panel B: (continued)		Futures	Call	Put	Straddle	VW CRSP
Cotton	Futures	1	0.907	-0.892	0.161	0.051
	Call		1	-0.836	0.274	0.043
	Put			1	0.083	-0.066
	Straddle				1	0.025
	VW CRSP					1
Sugar	Futures	1	0.840	-0.839	0.063	-0.006
	Call		1	-0.741	0.306	-0.001
	Put			1	0.100	0.031
	Straddle				1	0.043
	VW CRSP					1
Eurodollar	Futures	1	0.791	-0.767	0.127	-0.282
	Call		1	-0.739	0.269	-0.194
	Put			1	0.123	0.233
	Straddle				1	0.027
	VW CRSP					1
S&P500	Futures	1	0.929	-0.932	-0.857	0.976
	Call		1	-0.981	-0.875	0.910
	Put			1	0.948	-0.915
	Straddle				1	-0.845
	VW CRSP					1
Japanese Yen	Futures	1	0.920	-0.921	0.860	-0.024
	Call		1	-0.972	0.967	-0.008
	Put			1	-0.907	0.007
	Straddle				1	-0.007
	VW CRSP					1
Swiss Franc	Futures	1	0.912	-0.908	-0.863	-0.252
	Call		1	-0.923	-0.805	-0.220
	Put			1	0.904	0.240
	Straddle				1	0.218
	VW CRSP					1
Canadian Dollar	Futures	1	0.896	-0.872	0.837	0.246
	Call		1	-0.921	0.924	0.237
	Put			1	-0.884	-0.240
	Straddle				1	0.240
	VW CRSP					1
Australian Dollar	Futures	1	0.876	-0.800	0.876	0.237
	Call		1	-0.842	-0.800	0.188
	Put			1	0.825	-0.211
	Straddle				1	0.195
	VW CRSP					1
British Pound	Futures	1	-0.930	0.963	0.903	-0.090
	Call		1	-0.907	-0.890	-0.117
	Put			1	0.898	0.114
	Straddle				1	-0.101
	VW CRSP					1

Table 2 The Risk Effect Captured by Returns on Call Futures Options

The table presents (in Panel B) average factor risk premiums estimated from the day-by-day Fama-MacBeth (1973) regressions of the cross-section of futures returns (R_{Ft}) on the estimated factors of two following models.

Hirshleifer's (1988) model : $R_{Ft} = \delta_{0t} + \beta_{Fm,t}\delta_{1t} + \sigma_{Fm,t} d_t \delta_{2t} + \varepsilon_t$

The extended model with futures options: $R_{Ft} = \delta_{0t} + \beta'_t \delta_{1t} + \sigma'_t d_t \delta_{2t} + \Gamma_t \delta_{3t} + \varepsilon_t$

$$\beta'_t = \frac{(\beta_{Fm,t} - \beta_{Fo,t}\beta_{om,t})}{1-\rho^2_{om,t}} \; ; \; \sigma'_t = \frac{\sigma_{Fmo,t}}{\sqrt{1-\rho^2_{om,t}}} ; \; \Gamma_t = \frac{(\beta_{Fo,t} - \beta_{Fm,t}\beta_{mo,t})}{1-\rho^2_{om,t}}$$

δ_{1t}, δ_{2t} , δ_{3t} are factor premiums for systematic risk, residual risk and the risks captured by call futures returns respectively. The estimated factors are slope coefficient ($\beta_{Fm,t}$) and standard error of residuals ($\sigma_{Fm,t}$) from time-series regressions of futures returns on stock market returns over the prior 50 weeks; and the factors of β'_t, σ'_t and Γ_t compiled from the parameters estimated from regressions, which the variables are returns on futures, call futures, stock market, using data for the prior 50 weeks. d_t denotes an indicator equal to 1 for net long futures positions of hedgers and -1 for net short positions. Panel A reports average estimated factors and average estimated premiums for each futures contract. t-statistics in parentheses are for the hypothesis that average factor premium is zero. Hotelling's T^2 statistics in square brackets are for the hypothesis that all factor premiums are jointly zero. **, * denote significance at the 1 % and 10% levels. All test statistics are based on Newey-West heteroskedasticity and autocorrelation estimates of covaraince matrices. R^2 denotes the average adjusted *R-square* of the regressions. n denotes weekly observations over the period of January 2000 (May 2000 for Cocoa, Coffee, Cotton, Sugar) to February 2004.

		Hirshleifer's Model				**The Extended Model with Call Futures Options**					
Panel A		Esimated Factor		Estimated Premium (%)		Estimated Factor			Estimated Premium (%)		
	n	$\beta_{Fm,t}$	$d_t \sigma_{Fm,t}$	Sys. risk	Res. risk	β'_t	$d_t \sigma'_t$	Γ_t	Sys. Risk	Res. Risk	Options
Contract with Delivery Risk											
30-Year T-Bond	215	-0.02	0.00	0.00	-0.01	-0.02	0.00	0.03	0.00	-0.01	0.11
10-Year T-Note	215	-0.03	0.00	0.00	0.01	-0.03	0.00	0.02	0.00	0.01	0.10
Cocoa	196	0.04	0.01	0.00	0.02	0.13	0.01	0.04	0.01	0.04	0.19
Coffee	196	0.03	-0.01	0.00	-0.03	0.01	-0.01	0.07	0.00	-0.04	0.30
Cotton	196	0.07	0.04	-0.01	0.14	0.12	0.02	0.05	0.00	0.13	0.23
Sugar	196	0.01	0.03	0.00	0.09	-0.03	0.01	0.08	0.00	0.07	0.32
Contract without Delivery Risk											
Eurodollar	215	0.10	-0.04	-0.01	-0.13	0.11	-0.02	0.07	0.00	-0.15	0.11
S&P 500	215	0.28	-0.01	-0.02	-0.03	0.35	-0.01	0.03	0.01	-0.05	0.04
Japanese Yen	215	0.45	0.00	-0.04	0.01	0.54	0.00	0.06	0.02	0.01	0.10
Swiss Franc	215	-0.02	-0.01	0.00	-0.02	-0.04	0.00	0.03	0.00	-0.02	0.06
Canadian Dollar	215	-0.04	0.00	0.00	-0.02	-0.09	0.00	0.04	0.00	-0.02	0.07
Australian Dollar	215	0.02	-0.01	0.00	-0.02	0.01	0.00	0.02	0.00	-0.02	0.04
British Pound	215	0.03	0.00	0.00	-0.02	0.03	0.00	0.03	0.00	-0.02	0.05
Panel B		δ_{0t}	δ_{1t}	δ_{2t}	R^2	δ_{0t}	δ_{1t}	δ_{2t}	$\delta_{3t\,w\,del.risk}$	$\delta_{3t\,wo\,del.risk}$	R^2
Factor risk premium		0.001	-0.001	0.035	0.01	0.002	0.000	0.064	0.043	0.017	0.12
		(2.87)**	(-0.64)	(2.44)*	[1.48]	(4.16)**	(0.27)	(1.97)*	(2.20)*	(1.04)	[0.69]

Table 3 The Risk Effect Captured by Returns on Put Futures Options

The table presents (in Panel B) average factor risk premiums estimated from the day-by-day Fama-MacBeth (1973) regressions of the cross-section of futures returns (R_{Ft}) on the estimated factors of two following models.

Hirshleifer's (1988) model :

$$R_{Ft} = \delta_{0t} + \beta_{Fm,t}\delta_{1t} + \sigma_{Fm,t} d_t \delta_{2t} + \varepsilon_t$$

The extended model with futures options:

$$R_{Ft} = \delta_{0t} + \beta'_t\,\delta_{1t} + \sigma'_t\, d_t \delta_{2t} + \Gamma_t \delta_{3t} + \varepsilon_t$$

$$\beta'_t = \frac{(\beta_{Fm,t} - \beta_{Fo,t}\beta_{om,t})}{1-\rho^2_{om,t}}\ ;\ \sigma'_t = \frac{\sigma_{Fmo,t}}{\sqrt{1-\rho^2_{om,t}}}\ ;\ \Gamma_t = \frac{(\beta_{Fo,t} - \beta_{Fm,t}\beta_{mo,t})}{1-\rho^2_{om,t}}$$

δ_{1t}, δ_{2t} , δ_{3t} are factor premiums for systematic risk, residual risk and the risks captured by put futures returns respectively. The estimated factors are slope coefficient ($\beta_{Fm,t}$) and standard error of residuals ($\sigma_{Fm,t}$) from time-series regressions of futures returns on stock market returns over the prior 50 weeks; and the factors of β'_t, σ'_t and Γ_t compiled from the parameters estimated from regressions, which the variables are returns on futures, put futures, stock market, using data for the prior 50 weeks. d_t denotes an indicator equal to 1 for net long futures positions of hedgers and -1 for net short positions. Panel A reports average estimated factors and average estimated premiums for each futures contract. t-statistics in parentheses are for the hypothesis that average factor premium is zero. Hotelling's T^2 statistics in square brackets are for the hypothesis that all factor premiums are jointly zero. **, * denote significance at the 1 % and 10% levels. All test statistics are based on Newey-West heteroskedasticity and autocorrelation estimates of covaraince matrices. R^2 denotes the average adjusted *R-square* of the regressions. n denotes weekly observations over the period of January 2000 (May 2000 for Cocoa, Coffee, Cotton, Sugar) to February 2004.

		Hirshleifer's Model				The Extended Model with Put Futures Options					
Panel A	***n***	Esimated Factor		Estimated Premium (%)		Estimated Factor			Estimated Premium (%)		
		$\beta_{Fm,t}$	$d_t\,\sigma_{Fm,t}$	Sys. risk	Res. risk	β'_t	$d_t\,\sigma'_t$	Γ_t	Sys. Risk	Res. Risk	Options
Contract with Delivery Risk											
30-Year T-Bond	215	-0.02	0.00	0.00	-0.01	-0.08	0.00	0.01	0.02	-0.02	-0.03
10-Year T-Note	215	-0.03	0.00	0.00	0.01	-0.03	0.00	-0.03	0.01	0.01	0.11
Cocoa	196	0.04	0.01	0.00	0.02	0.10	0.00	-0.04	-0.03	0.04	0.17
Coffee	196	0.03	-0.01	0.00	-0.03	-0.01	-0.01	-0.08	0.00	-0.05	0.33
Cotton	196	0.07	0.04	-0.01	0.14	0.05	0.02	-0.11	-0.02	0.21	0.41
Sugar	196	0.01	0.03	0.00	0.09	-0.05	0.01	-0.09	0.02	0.10	0.35
Contract without Delivery Risk											
Eurodollar	215	0.10	-0.04	-0.01	-0.13	0.18	-0.03	-0.07	-0.06	-0.22	-0.07
S&P 500	215	0.28	-0.01	-0.02	-0.03	0.32	-0.01	-0.02	-0.10	-0.07	-0.02
Japanese Yen	215	0.45	0.00	-0.04	0.01	0.18	0.00	-0.05	-0.06	0.01	-0.04
Swiss Franc	215	-0.02	-0.01	0.00	-0.02	0.01	0.00	-0.04	0.00	-0.03	-0.04
Canadian Dollar	215	-0.04	0.00	0.00	-0.02	-0.02	0.00	-0.03	0.01	-0.02	-0.03
Australian Dollar	215	0.02	-0.01	0.00	-0.02	0.00	0.00	-0.03	0.00	-0.03	-0.03
British Pound	215	0.03	0.00	0.00	-0.02	0.02	0.00	-0.04	-0.01	-0.03	-0.04
Panel B		δ_{0t}	δ_{1t}	δ_{2t}	R^2	δ_{0t}	δ_{1t}	δ_{2t}	$\delta_{3t\ w\ del.risk}$	$\delta_{3t\ wo\ del.risk}$	R^2
Factor risk premium		0.001	-0.001	0.035	0.01	0.002	-0.003	0.089	-0.039	0.010	0.15
		(2.87)**	(-0.64)	(2.44)*	[1.48]	(4.35)**	(-1.10)	(2.63)*	(-3.10)**	(0.59)	[1.64]

Table 4 The Risk Effect Captured by Returns on Straddle Futures Options

The table presents (in Panel B) average factor risk premiums estimated from the day-by-day Fama-MacBeth (1973) regressions of the cross-section of futures returns (R_{Ft}) on the estimated factors of two following models.

Hirshleifer's (1988) model : $R_{Ft} = \delta_{0t} + \beta_{Fm,t}\delta_{1t} + \sigma_{Fm,t} d_t \delta_{2t} + \varepsilon_t$

The extended model with futures options: $R_{Ft} = \delta_{0t} + \beta'_t \delta_{1t} + \sigma'_t d_t \delta_{2t} + \Gamma_t \delta_{3t} + \varepsilon_t$

$$\beta'_t = \frac{(\beta_{Fm,t} - \beta_{Fo,t}\beta_{om,t})}{1-\rho^2_{om,t}}\ ;\ \ \sigma'_t = \frac{\sigma_{Fmo,t}}{\sqrt{1-\rho^2_{om,t}}}\ ;\ \ \Gamma_t = \frac{(\beta_{Fo,t} - \beta_{Fm,t}\beta_{mo,t})}{1-\rho^2_{om,t}}$$

Straddle is created by buying an at-the-money call and an at-the-money put. δ_{1t}, δ_{2t} , δ_{3t} are factor premiums for systematic risk, residual risk and the risks captured by straddle futures option returns respectively. The estimated factors are slope coefficient ($\beta_{Fm,t}$) and standard error of residuals ($\sigma_{Fm,t}$) from time-series regressions of futures returns on stock market returns over the prior 50 weeks; and the factors of β'_t, σ'_t and Γ_t compiled from the parameters estimated from regressions, which the variables are returns on futures, the straddle, stock market, using data for the prior 50 weeks. d_t denotes an indicator equal to 1 for net long futures positions of hedgers and -1 for net short positions. Panel A reports average estimated factors and average estimated premiums for each futures contract. t-statistics in parentheses are for the hypothesis that average factor premium is zero. Hotelling's T^2 statistics in square brackets are for the hypothesis that all factor premiums are jointly zero. **, * denote significance at the 1 % and 10% levels. All test statistics are based on Newey-West heteroskedasticity and autocorrelation estimates of covaraince matrices. R^2 denotes the average adjusted *R-square* of the regressions. n denotes weekly observations from January 2000 (May 2000 for Cocoa, Coffee, Cotton, Sugar) to February 2004.

Panel A	n	Hirshleifer's Model				The Extended Model with Straddle Futures Options					
		Esimated Factor		Estimated Premium (%)		Estimated Factor			Estimated Premium (%)		
		$\beta_{Fm,t}$	$d_t\sigma_{Fm,t}$	Sys. risk	Res. risk	β'_t	$d_t\sigma'_t$	Γ_t	Sys. Risk	Res. Risk	Options
Contract with Delivery Risk											
30-Year T-Bond	215	-0.02	0.00	0.00	-0.01	-0.06	0.00	-0.04	0.02	-0.02	0.08
10-Year T-Note	215	-0.03	0.00	0.00	0.01	-0.13	0.00	0.07	0.04	0.02	-0.15
Cocoa	196	0.04	0.01	0.00	0.02	-0.12	0.01	-0.07	0.04	0.04	0.14
Coffee	196	0.03	-0.01	0.00	-0.03	0.02	-0.01	0.06	-0.01	-0.06	-0.13
Cotton	196	0.07	0.04	-0.01	0.14	0.09	0.03	0.17	-0.03	0.20	-0.35
Sugar	196	0.01	0.03	0.00	0.09	0.06	0.03	0.07	-0.02	0.17	-0.14
Contract without Delivery Risk											
Eurodollar	215	0.10	-0.04	-0.01	-0.13	0.06	-0.04	0.01	-0.02	-0.26	0.01
S&P 500	215	0.28	-0.01	-0.02	-0.03	0.21	-0.01	-0.08	-0.06	-0.06	-0.07
Japanese Yen	215	0.45	0.00	-0.04	0.01	0.68	0.00	0.01	-0.21	0.01	0.01
Swiss Franc	215	-0.02	-0.01	0.00	-0.02	-0.08	0.00	0.06	0.02	-0.03	0.05
Canadian Dollar	215	-0.04	0.00	0.00	-0.02	0.01	0.00	-0.09	0.00	-0.03	-0.08
Australian Dollar	215	0.02	-0.01	0.00	-0.02	0.02	0.00	0.10	-0.01	-0.03	0.09
British Pound	215	0.03	0.00	0.00	-0.02	0.02	0.00	0.10	-0.01	-0.02	0.09
Panel B		δ_{0t}	δ_{1t}	δ_{2t}	R^2	δ_{0t}	δ_{1t}	δ_{2t}	$\delta_{3t\ w\ del.risk}$	$\delta_{3t\ wo\ del.risk}$	R^2
Factor risk premium		0.001	-0.001	0.035	0.01	0.002	-0.003	0.069	-0.020	0.009	0.03
		(2.87)**	(-0.64)	(2.44)*	[1.48]	(4.77)**	(-2.71)**	(3.81)**	(-3.00)**	(2.51)*	[4.42]**

Table 5 The Risk Effect Captured by Returns on Call-Put Spreads

The table presents (in Panel B) average factor risk premiums estimated from the day-by-day Fama-MacBeth (1973) regressions of the cross-section of futures returns (R_{Ft}) on the estimated factors of two following models.

Hirshleifer's (1988) model : $$R_{Ft} = \delta_{0t} + \beta_{Fm,t}\delta_{1t} + \sigma_{Fm,t} d_t \delta_{2t} + \varepsilon_t$$

The extended model with futures options: $$R_{Ft} = \delta_{0t} + \beta'_t\, \delta_{1t} + \sigma'_t\, d_t \delta_{2t} + \Gamma_t \delta_{3t} + \varepsilon_t$$

$$\beta'_t = \frac{(\beta_{Fm,t} - \beta_{Fo,t}\beta_{om,t})}{1-\rho^2_{om,t}}\ ;\ \sigma'_t = \frac{\sigma_{Fmo,t}}{\sqrt{1-\rho^2_{om,t}}};\ \ \Gamma_t = \frac{(\beta_{Fo,t} - \beta_{Fm,t}\beta_{mo,t})}{1-\rho^2_{om,t}}$$

Call-put spread is created by buying an at-the-money call and selling an at-the-money put. δ_{1t}, δ_{2t} , δ_{3t} are factor premiums for systematic risk, residual risk and the risks captured by returns on call-put spreads respectively. The estimated factors are slope coefficient ($\beta_{Fm,t}$) and standard error of residuals ($\sigma_{Fm,t}$) from time-series regressions of futures returns on stock market returns over the prior 50 weeks; and the factors of β'_t, σ'_t and Γ_t compiled from the parameters estimated from regressions, which the variables are returns on futures, the spread, stock market, using data for the prior 50 weeks. d_t denotes an indicator equal to 1 for net long futures positions of hedgers and -1 for net short positions. Panel A reports average estimated factors and average estimated premiums for each futures contract. t-statistics in parentheses are for the hypothesis that average factor premium is zero. Hotelling's T^2 statistics in square brackets are for the hypothesis that all factor premiums are jointly zero. **, * denote significance at the 1 % and 10% levels. All test statistics are based on Newey-West heteroskedasticity and autocorrelation estimates of covaraince matrices. R^2 denotes the average adjusted *R-square* of the regressions. n denotes weekly observations from January 2000 (May 2000 for Cocoa, Coffee, Cotton, Sugar) to February 2004.

		Hirshleifer's Model				**The Extended Model with Call-Put Spread Futures Options**					
Panel A	***n***	Esimated Factor		Estimated Premium (%)		Estimated Factor			Estimated Premium (%)		
		$\beta_{Fm,t}$	$d_t\,\sigma_{Fm,t}$	Sys. risk	Res. risk	β'_t	$d_t\,\sigma'_t$	Γ_t	Sys. Risk	Res. Risk	Options
Contract with Delivery Risk											
30-Year T-Bond	215	-0.02	0.00	0.00	-0.01	-0.03	0.00	0.04	-0.01	-0.03	-0.16
10-Year T-Note	215	-0.03	0.00	0.00	0.01	-0.02	0.00	0.03	-0.01	0.02	-0.12
Cocoa	196	0.04	0.01	0.00	0.02	0.17	0.00	0.06	0.04	0.06	-0.23
Coffee	196	0.03	-0.01	0.00	-0.03	-0.03	0.00	0.11	-0.01	-0.05	-0.47
Cotton	196	0.07	0.04	-0.01	0.14	0.01	0.01	0.10	0.00	0.19	-0.41
Sugar	196	0.01	0.03	0.00	0.09	-0.05	0.01	0.09	-0.01	0.12	-0.39
Contract without Delivery Risk											
Eurodollar	215	0.10	-0.04	-0.01	-0.13	0.16	-0.02	0.09	0.04	-0.29	-0.14
S&P 500	215	0.28	-0.01	-0.02	-0.03	0.33	-0.01	0.03	0.09	-0.11	-0.04
Japanese Yen	215	0.45	0.00	-0.04	0.01	0.32	0.00	0.05	0.08	0.01	-0.09
Swiss Franc	215	-0.02	-0.01	0.00	-0.02	-0.02	0.00	0.04	0.00	-0.03	-0.07
Canadian Dollar	215	-0.04	0.00	0.00	-0.02	-0.05	0.00	0.04	-0.01	-0.03	-0.06
Australian Dollar	215	0.02	-0.01	0.00	-0.02	0.00	0.00	0.03	0.00	-0.04	-0.04
British Pound	215	0.03	0.00	0.00	-0.02	0.02	0.00	0.04	0.00	-0.03	-0.06
Panel B		δ_{0t}	δ_{1t}	δ_{2t}	R^2	δ_{0t}	δ_{1t}	δ_{2t}	$\delta_{3t\ w\ del.risk}$	$\delta_{3t\ wo\ del.risk}$	R^2
Factor risk premium		0.001	-0.001	0.035	0.01	0.003	0.003	0.131	-0.042	-0.016	0.12
		(2.87)**	(-0.64)	(2.44)*	[1.48]	(5.06)**	(1.11)	(2.92)**	(-3.44)**	(-0.95)	[1.36]

Table 6 Effect of Residual Futures Option Returns on Futures Returns

The table reports average factor risk premiums estimated from the day-by-day Fama-MacBeth (1973) regressions of the cross-section of futures returns (R_{Ft}) on the estimated factors of stock market returns (β'_t), standard deviation of residual risk for futures market (σ'_t) and residual returns on futures options (Γ_t).

$$R_{Ft} = \delta_{0t} + \beta'_t \delta_{1t} + \sigma'_t d_t \delta_{2t} + \Gamma_t \delta_{3t} + \varepsilon_t$$

$$\beta'_t = \frac{(\beta_{Fm,t} - \beta_{Fo,t}\beta_{om,t})}{1-\rho^2_{om,t}} \; ; \; \sigma'_t = \frac{\sigma_{Fmo,t}}{\sqrt{1-\rho^2_{om,t}}} ; \; \Gamma_t = \frac{(\beta_{Fo,t} - \beta_{Fm,t}\beta_{mo,t})}{1-\rho^2_{om,t}}$$

δ_{1t}, δ_{2t} and δ_{3t} denote the factor premiums for systematic risk, residual risk and the risks captured by futures option returns respectively. The estimated factors are compiled from the time-series regressions which the variables are futures returns, stock market returns (value-weighted CRSP index) and residual returns on futures options, using data for the prior 50 weeks. d_t denotes an indicator equal to 1 for net long futures positions of hedgers and equal to -1 for net short positions. t-statistics in parentheses are for the hypothesis that average of factor premiums is zero. Hotelling's T^2 statistics in square brackets are for the hypothesis that all factor premiums are jointly zero. **, * denote significance at the 1 % and 10% levels respectively. All test statistics are based on Newey-West heteroskedasticity and autocorrelation estimates of covaraince matrices. The testing period is from January 2000 to February 2004.

Type of Futures Options	δ_{0t}	δ_{1t}	δ_{2t}	$\delta_{3t\ w\ del.risk}$	$\delta_{3t\ wo\ del.risk}$
Call	0.002	-0.003	0.056	0.082	-0.012
	(2.82)**	(-1.16)	(1.88)*	(2.13)*	(-0.67)
Put	0.002	-0.001	0.090	-0.023	0.018
	(2.75)**	(-1.22)	(1.93)*	(2.04)*	(1.02)
Straddle	0.001	-0.004	0.036	-0.018	-0.004
	(1.86)*	(-2.88)**	(1.89)*	(-1.65)*	(-0.22)
Call-Put Spreads	0.002	-0.002	0.006	-0.053	-0.021
	(2.85)**	(-1.50)	(2.25)*	(-2.17)*	(-1.07)