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The Use of Financial Futures as Hedging Vehicles

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Abstract: In this paper, we investigate minimum risk hedges and hedging effectiveness measures for five financial instruments: S & P 500, Dow Jones Industrials, Nasdaq 100, Treasury Bonds, and 10 year Treasury Notes. Analysis indicates the relative desirability of positions in futures contracts to minimize the risk of spot exposure. Results also show hedging effectiveness increases with the investment horizon.

Key words: hedging effectiveness; financial futures and hedge ratios

JEL code: G13

1. Introduction

Slowly but surely, markets are showing signs of bottoming out of the economic sluggishness caused by the subprime mortgage crisis happened circa in 2008. This downturn is officially called the "Great Recession". Series of Quantitative Easing spearheaded by the Fed Chairman has been followed. Undoubtedly, Treasury bonds and notes prices soared spurred by the super low interest rates and investors small and big looking for safe havens. Even the stock prices respond positively and have reached the level to necessitate the need for hedging. While many studies report empirical evidence on the relationships between futures and spot markets, surprisingly there are not many works done on the relationship between maturity of futures contracts and hedging effectiveness.

The traditional method of determining the number of futures in a hedge is simply to measure the position in the underlying asset and to take an equal but opposite position in futures contracts. Now this method can be called a naïve approach. The first alternative to this approach was suggested by Ederington (1979) who defined a measure for the effectiveness of a hedge. Another one was proposed by Johnson and Walther (1984), who applied the "α-t" model of Fishburn (1977), and Howard and D'Antonio (1984; 1987). Some applied this idea to hedge a global portfolio. Thomas (1988) argued that international equity portfolios benefit from currency hedging. Perold and Shulman (1988) claimed that even after accounting for transaction costs due to hedging, currency hedging appeared to be the dominant strategy for a global fund manager. Using a hedge ratio of unity, they avoided the complexities of perfect hedge and total loss of control of the volatility. Cantaluppi (1994) found that currency hedging was beneficial but needed the integration of hedging and investment decisions. Glen and Jorion (1993) delved into the portfolio containing bonds for the search of improvement of the performance.

This study is designed to analyze hedging effectiveness and to determine the size of the minimum risk futures position for hedging each of five broadly traded financial products: S & P 500, Dow Jones Industrials, Nasdaq 100, Treasury Bonds, and 10 year Treasury Notes. The strategy of minimizing financial risk with cocktails of futures

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instruments has been analyzed extensively in the literature. While theoretically holding a multiple portfolio of spot and futures positions may be desirable, practically managing such a portfolio requires centralized management facilities and experts. It also assumes stability or continued forecasting of cross-market correlation relationships.

A hedging usually carried out by buying (selling) a futures contract to initiate a hedge and closing out the position when the spot market transaction occurs by selling (buying) the contract in the futures market rather than taking delivery. Risk is reduced to the extent that the gain (loss) in the futures position offsets the loss (gain) on the spot position. Three types of analysis are conducted in this study. First, the minimum risk hedge ratio and associated hedging effectiveness are determined for each security assuming one week investment horizons. Summary statistics are presented for each product. Second, since length of investment (hedging) horizons and time to delivery may affect the minimum risk hedge rates and hedging effectiveness, one, two and four week hedges are examined with contracts separated into three month periods representing time to delivery (ranging from closest to delivery (0-3 months) to that with 9-12 months remaining to delivery). The variation in the minimum risk hedge ratios and hedging effectiveness of contracts with different periods left to delivery over alternative investment horizons are analyzed. Third, while stock and interest futures markets both provide similar hedging opportunities for contracts with equal time to delivery and investment horizons, differences in market characteristics may result in segmentations between markets. A comparison of overall equity and (government) debt markets in terms of hedging effectiveness is examined.

Analysis indicates the desirability of various size positions in futures contracts per unit of spot contracts to obtain minimum risk hedges. Results also show edging effectiveness increases with the hedger's holding period and is sensitive to a contract's time to delivery. The next section contains a brief summary of pervious empirical results on stock and debt futures markets and of the theoretical basis for the hedge ratios and the hedging effectiveness measures used in this study. A more detailed description of the data set is presented in Section III along with an analysis of the results. In the final section, conclusions are presented and areas of future work explored.

2. Measurement of Hedging Effectiveness

Using the basic assumptions and principles of portfolio theory, it can be shown that the optimal hedge ratio (HR*), and hedging effectiveness of a market or contract(s) is related to the covariance between the spot and futures prices changes and the variances of futures price changes. In this case, the hedge ratio implies the weight of futures position in the portfolio or proportion of the given spot positions (long or short) that is hedged. A positive (negative) HR* indicates a purchase (sale) of futures and is the solution of the following equation:

$$\text{Min Var}(C_{Ht}) = \text{Var}(C_{st}) + X^2_f \text{Var}(C_{ft}) + 2X_j\text{Cov}(C_{st}, C_{ft}) \quad (1)$$

Subject to:

$$C^0_{Ht} = E(C_{st}) + X_f E(C_{ft}) \quad (2)$$

Where

C_{st}, C_{ft} = the price change during period t of the spot and futures contracts,

C^0_{Ht} = the target changes in value during period of a portfolio invested in a fixed level of spot currency and a future contract in proportion X_f,

X_f= the proportion of the portfolio held in future contracts; X^*_f equals the optimal hedge ratio (HR*) with $X_f < 0$ representing a short position and $X_f > 0$ a long position.

Above equation is similar to the two asset portfolio variance model. But in this case the spot X_f is fixed at 1.0 and does not appear explicitly in the expression. Also risk and return are defined in terms of changes in value rather than return since the cost of setting up the position is effectively zero. Since the object of most hedging is to receive the maximum amount of price change risk reduction, the problem can be reduced to that of determining the minimum risk hedge ratio HR^*_m or simply the value of X_f at which the unconstrained objective function (1) reaches a minimum. The object of analysis is to measure hedging effectiveness for these risk minimizing hedges represented by a futures position in the proportion of HR*m. This minimum risk hedge ratio can be found by setting the partial derivative of the portfolio variance with respect to X_f equal to 0 and solving for X^*_f.

$$\frac{\partial \, \mathrm{Var}(C_{Ht})}{\partial X_f} = 2\, X_f \, \mathrm{Var}(C_f) + 2\, \mathrm{Cov}\,(C_s, C_f) = 0 \tag{3}$$

$$X^*_f = - \frac{\mathrm{Cov}(C_s, C_f)}{\mathrm{Var}\,(C_f)} = HR^*_m$$

The value of X^*_f is equivalent to the negative of the slope coefficient of a regression of spot price changes on futures price changes and is easily determined given a data set of such price changes. The measure of hedging effectiveness E^*_f for the minimum risk hedge is defined as the reduction in variance as a propotion of total variance that results from maintaining a hedged ($X_f \neq 0$) rather than unhedged position ($X_f = 0$). E^*_f reduces to the coefficient of determination for the regression of spot on futures' price changes:

$$E^*_f = - \frac{\mathrm{Cov}(C_s) - \mathrm{Var}\,(C_H)}{\mathrm{Var}\,(C_f)} = 1 - \frac{\mathrm{Var}\,(C_H)}{\mathrm{Var}(C_s)} \tag{4}$$

$$E^*_f = - \frac{\mathrm{Cov}(C_s, C_f)^{\,2}}{\mathrm{Var}(C_s)\mathrm{Var}(C_f)} = R^2$$

As the correlation between the spot and futures price increases, the effectiveness of futures contract for reducing the risk of a particular spot position increases. The unity R^2 implies we have achieved the perfect hedge.

3. Data Set and Results

Five major financial instruments, i.e., S & P 500, Dow Jones Industrials, Nasdaq 100, Treasury Bonds, and 10 year Treasury Notes were utilized in this study. All futures contracts call for delivery in March, June, September, and December. Therefore all 20 contracts were investigated. Futures price data were collected from the Wall Street Journal, and Investor's Business Daily using weekly Friday's closing prices of contract during the period March 2007 to December 2011 traded in Chicago Mercantile Exchange Group. Closing prices of spot Treasury Securities on each Friday were collected from the Treasury Department and closing prices of spot stock indices were collected from the Wall Street Journal and Investor's Business Daily.

Tables 1, 2, and 3 contain the results for each financial futures contract of estimating minimum risk hedge ratio (HR*) and hedging effectiveness measures (E^*_f). Results support the hedging usefulness of the various futures markets. All hedge ratios exhibit significant at five percent level. Nonetheless, the hedge ratios were significantly less than one, meaning that a naïve one-for-one futures to spot hedge is not interpreted as the average proportional reduction in spot price change variance that could have been realized by hedging with the minimum risk hedge ratio (HR^*_f) over the period.

Table 1 Futures Hedging Effectiveness Result (2007-2011) (Hedging Duration: One Week)

S & P 500			Dow Jones Industrials	
Months included	EF*	HR*	EF*	HR*
All	0.643	0.569	0.431	0.339
0-3	0.834	0.725	0.528	0.329
3-6	0.739	0.812	0.395	0.249
6-9	0.357	0.294	0.297	0.328
9-12	0.713	0.822	0.493	0.535
NASDAQ 100			Treasury Bonds	
Months included	EF*	HR*	EF*	HR*
All	0.529	0.430	0.552	0.712
0-3	0.567	0.523	0.429	0.639
3-6	0.518	0.329	0.626	0.721
6-9	0.460	0.698	0.392	0.711
9-12	0.551	0.523	0.814	0.902
Treasury Notes (10 year)				
Months included	EF*	HR*		
All	0.421	0.602		
0-3	0.492	0.583		
3-6	0.735	0.941		
6-9	0.453	0.620		
9-12	0.557	0.681		

Table 2 Futures Hedging Effectiveness Result (2007-2011) (Hedging Duration: Two Weeks)

S & P 500			Dow Jones Industrials	
Months included	EF*	HR*	EF*	HR*
All	0.825	0.784	0.782	0.595
0-3	0.592	0.830	0.285	0.439
3-6	0.839	0.822	0.520	0.729
6-9	0.935	0.978	0.621	0.644
9-12	0.883	0.922	0.543	0.502
NASDAQ 100			Treasury Bonds	
Months included	EF*	HR*	EF*	HR*
All	0.835	0.743	0.659	0.850
0-3	0.793	0.913	0.910	0.942
3-6	0.931	0.762	0.731	0.794
6-9	0.791	0.690	0.712	0.621
9-12	0.998	0.873	0.546	0.575
Treasury Notes (10 year)				
Months included	EF*	HR*		
All	0.582	0.839		
0-3	0.809	0.850		
3-6	0.933	0.945		
6-9	0.569	0.795		
9-12	0.915	0.893		

Table 3 Futures Hedging Effectiveness Result (2007-2011) (Hedging Duration: Four Weeks)

S & P 500			Dow Jones Industrials	
Months included	EF*	HR*	EF*	HR*
All	0.915	0.969	0.772	0.820
0-3	0.943	0.939	0.850	0.913
3-6	0.899	0.932	0.738	0.867
6-9	0.853	0.987	0.708	0.869
9-12	0.932	0.966	0.792	0.793
NASDAQ 100			Treasury Bonds	
Months included	EF*	HR*	EF*	HR*
All	0.818	0.788	0.815	0.966
0-3	0.838	0.745	0.887	0.832
3-6	0.748	0.822	0.791	0.932
6-9	0.724	0.912	0.738	0.953
9-12	0.823	0.749	0.812	0.854
Treasury Notes (10 year)				
Months included	EF*	HR*		
All	0.683	0.998		
0-3	0.715	0.921		
3-6	0.692	1.012		
6-9	0.632	0.969		
9-12	0.692	1.283		

The results also indicate that hedging effectiveness increases with the length of the investment horizon. For all financial instruments, generally speaking, hedges of four weeks duration were twice effective as one week hedge positions. This indicates that hedging effectiveness increases with the length of the holding period. Also it shows that the contract closest to delivery tends to provide the most effective hedge. Surprisingly, however, the nine to twelve month delivery contracts have high level of hedging effectiveness, even though there are only very scarce liquidity, i.e., open interests and trading volumes. Among stock index futures, S & P 500 futures index is most effective tool for hedge. In the meantime, Dow John Industrial shows weakest effectiveness. This may be due to fact that DJI is non-deliverable and hedgers should close the position before the maturity rather than take delivery as they can in other indices. In the interest instruments, Treasury Bonds shows better hedging effectiveness than the Treasury Notes throughout hedging durations.

4. Conclusions

In this study, new set of analysis is done to the hedging potential of financial futures contracts. Brief hedging effectiveness measures and optimal hedge ratios are presented for a sample of weekly price observations on 20 futures contracts for five futures contracts. In most cases, the futures markets are shown to have consistently high hedging effectiveness. Hedging performance is weakest when a hedge of short duration (one week) was required and increased when one moved to longer hedging horizons. Among stock index futures, Dow Jones Industrials futures for all hedge durations are somewhat inferior as hedging tools compared with other stock futures indices although they provide significant reduction in risk exposure when compared to a completely unhedged position.

This may be a just reflection that the DJI contracts are not deliverable, so traders and hedgers alike should close position before maturity. In the interest instruments, Treasury Notes futures maintain the least variation of hedging effectiveness throughout lengths of duration among contracts studied. But T-Bonds futures have higher hedging effectiveness. Because the nearby contract is usually most liquid, it increases the usefulness for hedging purposes. Results also indicate it has the highest level of hedging effectiveness. But the study does not indicate the nearby contract as the best hedging instrument, because in actual hedging situations we have to consider the transaction costs related with rollovers whenever the nearest contracts mature. Further research is needed for the realistic hedging effectiveness including reasonable transaction costs.

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