
A new use for single stock futures

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Received (in revised form): 20th November, 2006

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Practical applications

This paper presents an effective static hedging technique for the foreign exchange risk in overseas equity investment. The high correlation between single stock futures and the underlying stock, combined with the daily marking to market of the futures margin account and the ability to manage that account in a foreign currency, are shown to provide a hedge free of the usual requirement for covariance forecasts.

Abstract

Single stock futures, introduced in the United States in 2002, offer a benefit not previously discussed in the financial literature. They can serve as near-perfect hedging instruments for overseas investors who wish to assume the equity risk, but not the concomitant foreign exchange risk. Prior to the introduction of these instruments, such investors were obliged either to adopt less effective hedging strategies, such as a static hedge using foreign exchange forwards, or to trade illiquid OTC products, whose pricing is dependent on the accuracy of a covariance forecast. In this paper, this new application is presented in theory and tested in practice and found to be robust even in challenging market conditions.

Journal of Derivatives & Hedge Funds (2007) **13**, 59–65. doi:10.1057/palgrave.jdhf.1850058

Keywords: currency risk; overseas equity investment; single stock futures

A NEW USE FOR SINGLE STOCK FUTURES

Capturing the diversification benefits of overseas equity investment entails exposure to foreign exchange rate risk. Management of this risk is essential to avoid erosion of such benefits. A static hedge, in the form of a forward repurchase of the investor's domestic currency, is certain to be imperfect, because the investor cannot know what quantity of currency will be needed. A dynamic hedge, requiring rebalancing the forward contract according to the evolution of the overseas equity value, exposes the investor to significant transactions costs as well as repricing risk.

A substantial literature exists on this topic,¹ in which authors propose more sophisticated risk management strategies. It is generally possible to classify these as either variance-minimisation or

utility-maximisation strategies. Such strategies require accurate forecasts of stock and foreign exchange returns, volatilities and correlations. As Gardner and Stone² show, implementation of these techniques merely substitutes estimation or forecasting risk for foreign exchange risk. Thus, investors who attempt to implement such strategies face a paradox: those who believe themselves capable of such accurate forecasting have little or no need to hedge, whereas those who are uncertain about such forecasts have the greatest need to hedge but are, by definition, ill-equipped to implement the hedging strategies advocated.

Furthermore, such strategies do not discriminate between the two sources of variance, namely the equity risk and the foreign exchange risk. Investors might be perfectly willing to assume the equity risk, but anxious to avoid the foreign exchange risk. For such investors, regardless of the implementation difficulties, variance-minimisation is suboptimal and utility maximisation requires two different risk aversion coefficients, an issue which is not addressed in the literature.

In this paper, it is shown that single stock futures can act as an almost perfect hedging instrument for such investors. The hedge is static, thus minimising transactions costs; the investor retains the desired exposure to the equity risk, but lays off the unwanted foreign exchange risk; no forecasting is required for the implementation and the instruments are exchange-traded and reasonably liquid.

The paper is organised as follows: first the requirements for a perfect hedging instrument are outlined and two derivative securities which come close to meeting these exacting specifications are identified. These two securities, as well as a static forward hedge and an unhedged strategy, are then tested on a sample of

80 US stocks over a 12-month period from the viewpoint of portfolio managers accounting in five different currencies. The final section concludes that using single stock futures, overseas investors are able to take on their desired exposure to equity risk with minimal exposure to foreign exchange rate risk.

THE PERFECT HEDGING INSTRUMENT

The perfect financial instrument for overseas investors who seek only equity risk and who wish to avoid foreign exchange rate risk, would offer domestic currency returns perfectly correlated with the foreign currency returns of the overseas equity and would be available at zero premium. For some years, an instrument has existed which meets these specifications almost perfectly. Quanto forwards can be used as forward contracts on foreign stocks priced in the investor's local currency and the exchange rate at which the equity payoff is received is fixed at the outset. Thus, such instruments remove all foreign exchange risk. Reiner³ shows how to price quanto options and put-call parity leads from that to a quanto forward price.

Denoting the fixed exchange rate (expressed as units of the investor's domestic currency per unit of the foreign currency) by E_{fixed} , the stock price (expressed in units of the foreign currency) as S , the foreign currency interest rate as r_f , the dividend yield on the stock as q , the time to maturity as t , the volatility of the foreign exchange rate as σ_{FX} , the volatility of the stock as σ_S , and the correlation between the returns on the foreign exchange and the returns on the stock as ρ , the fair price, F_{quanto} , of a quanto forward is

$$F_{quanto} = E_{fixed} S e^{(r_f - q - \rho \sigma_{FX} \sigma_S)t} \quad (1)$$

The derivation of equation (1) is in the Appendix 1. The price reflects a standard stock

forward contract valuation, $Se^{(r_f - q)t}$, translated into the local currency at the specified rate, E_{fixed} , and further discounted at the covariance rate, $\rho\sigma_{FX}\sigma_S$. Thus, use of such an instrument mitigates, although does not remove, the forecasting problem. The investor who uses such a product is still exposed to the risk of a faulty covariance forecast over the investment period.

In late 2002, exchange trading commenced in the US of a new instrument which also comes close to meeting the exacting specifications sought for a perfect hedging instrument. Single stock futures are zero-premium instruments with very high correlations with the US dollar returns of the underlying stock. As with other financial futures contracts, simple arbitrage arguments mean that the fair value futures price, F_{SSF} is simply the spot price compounded at the cost of carry rate, $r_f - q$. Thus,

$$F_{SSF} = Se^{(r_f - q)t} \quad (2)$$

and hence no forecast of the covariance or its components is necessary.

While single stock futures are priced in US dollars, rather than the investor's local currency, the cashflows involved all arise in the margin account, which overseas investors can manage in any of a wide range of currencies. Margin requirements for these products are currently 20 per cent.

Investors who purchase equities in an overseas cash market have the full value of their investment exposed to foreign exchange risk for the full holding period. By contrast, the margin system, with its daily marking-to-market, means that those who trade the same view with single stock futures expose only the daily returns on the futures contract to such risk and each daily return for one day only. They face basis risk if the stock and its futures contract are not perfectly correlated and they may suffer an

interest rate penalty on the cash deposited as margin. This latter problem can be avoided by depositing acceptable exchange-traded securities as margin. Empirical analysis of these two effects follows later in the paper, but at this stage, without loss of generality, consider the two strategies in a zero-interest environment, in which the stock and its futures contract are perfectly correlated.

Denote one day's local currency return as r_{lc} , one day's US dollar return on the stock as $r_{\$stock}$ and one day's foreign currency return (expressed in terms of a long US dollar position) as r_{fx} . It follows that, for an investment in the cash market,

$$\begin{aligned} r_{lc} &= (1 + r_{\$stock})(1 + r_{fx}) - 1 \\ &= r_{\$stock} + r_{fx} + r_{\$stock}r_{fx} \\ \therefore \frac{dr_{lc}}{dr_{fx}} &= 1 + r_{\$stock} \end{aligned} \quad (3)$$

while, for an equivalent investment in the single stock futures market,

$$\begin{aligned} r_{lc} &= r_{\$stock}(1 + r_{fx}) \\ &= r_{\$stock} + r_{\$stock}r_{fx} \\ \therefore \frac{dr_{lc}}{dr_{fx}} &= r_{\$stock} \end{aligned} \quad (4)$$

Comparison of equations (3) and (4) shows that single stock futures expose the overseas investor to significantly less foreign exchange risk than a straightforward cash holding. The one-day investment horizon is also important, because the margin system permits withdrawal of all funds in excess the maintenance margin level each day. Thus, the single stock futures strategy exposes only the individual daily returns to a single day's foreign exchange risk. In contrast, foreign exchange risk exposure in the cash strategy comprises the time varying US dollar value of the whole position integrated over the entire investment period.

Thus, a single stock futures contract has almost all of the characteristics of the perfect hedging instrument, without the exposure to the covariance forecasting risk embedded in quanto forwards.

EMPIRICAL ANALYSIS

The year 2003 was a particularly testing year for overseas investors holding US equities. US dollar weakness badly eroded significant equity gains. This presents ideal conditions for an empirical evaluation of the different hedging strategies proposed. It was also the first full calendar year after the introduction of the single stock futures. The database employed comprises 79 of the 81 companies with single stock futures contracts (SSFs) listed on OneChicago throughout 2003⁴ as well as the Diamonds ETF.

For each company, it is assumed that US, European, Swiss, British, Japanese and Australian portfolio managers have initial local currency endowments sufficient to purchase 100 shares on 31st December, 2002. The following investment strategies are then analysed:

- (1) Unhedged — full cash endowment used to purchase stocks with no currency hedge. Dividend payments are assumed to be translated back into local currency on day of payment and to be deposited at local overnight interest rates.
- (2) FX forward — full cash endowment used to purchase stocks, together with one year short position in a USD forward contract in the amount of the initial investment. Dividend payments are assumed to be translated back into local currency on day of payment and to be deposited at local overnight interest rates.

- (3) Stock futures — long SSFs in a size of 100 stocks (200 after the stock split in the case of those three companies in the sample which implemented a two for one stock split during 2003) with cash not tied up in margin accounts earning local currency overnight interest rates. The futures contracts assumed traded are the quarterly expiries, with rollover assumed one week before expiry.
- (4) Quanto forwards — long a quanto forward contract in a size of 100 shares. The initial cash endowment is assumed held on overnight deposit in the local currency. In order to provide the most stringent comparison of single stock futures with quanto forwards, it is assumed that the investors had perfect knowledge of covariances required to price the quanto forwards. In this way, the covariance forecasting risk embedded in the use of quanto forwards is assumed away.

Positions are marked to market daily. The median returns and correlations with the US dollar returns of the stocks are shown in Table 1.

It is no surprise that Table 1 shows the candidate hedging strategies all do an effective job in improving returns over the unhedged strategies. They reflect a sample period chosen in part because of the adverse impact of exchange rate risk. The correlation analysis shows that all hedging strategies show a significantly ($p < 1\%$) greater correlation with the US dollar stock returns than the equivalent unhedged strategies.

Table 2 analyses the median excess returns observed in the local currency returns of the different strategies compared with the US dollar returns from holding the stocks.

Table 1: Median returns and correlations with US dollar stock returns of different strategies

		Median returns				Correlations (R^2) with US dollar stock returns			
	<i>N</i>	Unhedged (%)	FX forward (%)	Stock futures (%)	Quanto forward (%)	Unhedged	FX Forward	Stock futures	Quanto forward
Currency	<i>N</i>								
USD	80	41.1		40.2		1.0000		0.9712	
EUR	80	18.1	39.3	37.3	42.4	0.8945	0.9958	0.9710	0.9994
CHF	80	26.7	37.3	38.2	39.0	0.9067	0.9960	0.9709	0.9995
GBP	80	28.0	41.1	42.0	44.2	0.9487	0.9978	0.9712	0.9994
JPY	80	27.7	36.9	38.2	39.1	0.9424	0.9979	0.9710	0.9995
AUD	80	5.9	37.8	38.9	45.8	0.9013	0.9925	0.9688	0.9993

Table 2: Median daily excess returns from the strategies and correlations with the foreign exchange rate

	Unhedged		FX forward		Stock futures		Quanto forwards	
	r_{xs}	R^2	r_{xs}	R^2	r_{xs}	R^2	r_{xs}	R^2
EUR	-0.72	1.00	-0.04	0.13	-0.08	0.00	0.04	0.00
CHF	-0.44	1.00	-0.11	0.36	-0.06	0.01	-0.07	0.02
GBP	-0.40	1.00	0.00	0.26	-0.05	0.00	0.08	0.01
JPY	-0.41	1.00	-0.12	0.41	-0.06	0.00	-0.06	0.00
AUD	-1.16	1.00	-0.09	0.17	-0.07	0.00	0.13	0.00
All	-0.44	1.00	-0.08	0.23	-0.05	0.00	0.04	0.01

The daily excess return, r_{xs} , is defined as the daily return observed in the local currency strategy minus the daily return observed in a US dollar holding of the stock. For ease of presentation, all values of r_{xs} are multiplied by 10^3

Table 2 reveals the merits of the single stock futures and quanto forwards strategies over the static FX forward strategy. The key point is not that the excess returns are slightly higher for these two strategies than for the FX forward strategy: the differences, while statistically significant ($p < 1\%$) in almost all cases, are of little economic significance. The observation that the correlations of these excess returns with the

foreign exchange are significantly ($p < 1\%$) positive for the FX forward strategy, but essentially zero for the single stock futures and quanto forward strategies demonstrates the superiority of these two hedging instruments in removing foreign exchange risk.

One final test needs conducting. A portfolio manager would want to know how the implementation of these strategies affects the

Table 3: Median proportionate change in returns variance arising from the strategies

	<i>Unhedged</i>	<i>FX forward</i>	<i>Stock future</i>	<i>Quanto forward</i>
EUR	0.146	-0.122	-0.148	0.018
CHF	0.366	-0.021	-0.045	0.009
GBP	0.144	-0.024	-0.071	0.036
JPY	0.124	-0.009	-0.066	-0.012
AUD	0.168	-0.194	-0.224	0.041
All	0.176	-0.072	-0.107	0.018

Defining σ_S as the volatility of the returns to a US dollar investor and σ_c as the volatility of the local currency returns to an overseas investor, the proportionate change in returns variance is calculated as $(\sigma_c^2 - \sigma_S^2)/\sigma_S^2$. All observations are significantly ($p < 1\%$) different from zero and all hedging strategy values are significantly different ($p < 1\%$) from their unhedged equivalents.

overall variance of returns. Table 3 shows the median proportionate change in returns variance arising from the strategies.

Table 3 shows that these hedging strategies make a significant ($p < 1\%$) contribution to variance reduction in the sample period chosen.

CONCLUSION

The variance-minimising and utility-maximising hedging strategies presented in the literature are not necessarily optimal for an overseas investor, because they fail to discriminate between the sources of variance. An equity investor is likely to be quite willing to assume the equity risk, but very keen to hedge the foreign exchange risk. Furthermore, the variance-minimising and utility-maximising hedging strategies embed a paradox. Effective implementation calls for accurate forecasting skills: those who are capable of such accurate forecasting have relatively little requirement to hedge. The hedging requirement is most acute for those who are, by definition, least capable of implementing such strategies. Conventional

static hedging carries quantity risk: dynamic hedging carries repricing risk and significant transactions costs. In this paper, three hedging strategies appropriate to overseas equity investors have been tested in demanding market conditions: static hedging using FX forward contracts, static hedging using quanto forwards and a new hedging strategy: replication of the equity position using single stock futures. All three are effective in that they reduce significantly the exposure to foreign exchange risk. Quanto forwards and single stock futures are significantly more effective than static FX forward contracts, since the latter leave the gains on the equity holding exposed to currency risk over the entire investment horizon. It is difficult to choose between quanto forwards and single stock futures. In the sample analysed, the former generated marginally higher returns, but with a marginally higher variance of returns. The latter have the benefits of being exchange-traded and of not requiring a covariance forecast for their pricing. Both are exposed to basis risk, if they are terminated before their maturity date, but the hedging performance

shown in this paper indicates that this is of little significance.

Neither strategy is either variance minimising or utility-maximising. Both, however, achieve the desirable objective of leaving equity investors with exposure to risks within their competence, namely equity risk, and effectively remove the concomitant foreign exchange risk. The use of single stock futures as a currency hedging instrument is a new innovation and could, of course, also be applied to stock index futures as a means of achieving exposure to overseas equity market risk without incurring currency risk.

Acknowledgments

The author is grateful to William J Rainer, former chairman of OneChicago, for suggesting the topic, to Sotiris Staikouras, Roy Batchelor and seminar participants at Cass Business School and Kent State University for helpful comments on earlier drafts and to OneChicago for the provision of data. Any remaining errors are the author's responsibility.

References and Notes

- 1 For a comprehensive review, see Bartram, S.M. and Gunter, D. (2001) 'International Portfolio Investment: Theory, Evidence and Institutional Framework', University of Michigan Business School Working Paper 01-006.
- 2 Gardner, G.W. and Douglas, S. (1995) 'Estimating Currency Hedge Ratios for International Portfolios', *Financial Analysts Journal* (November–December), pp. 58–64.
- 3 Reiner, E. (1992) 'Quanto Mechanics', *Risk Magazine*, Vol. 5, No. 3, pp. 59–63.
- 4 Biogen and Merck underwent significant capital reorganisation during 2003 and are omitted for clarity of presentation.

Appendix

Derivation of equation (1)

Reiner *op. cit.* shows that quanto call and put options can be valued as

$$c = E_{fixed}(Se^{(r_f - r_c - q - \rho\sigma_{FX}\sigma_S)t}N(d_1) - Xe^{-r_c t}N(d_2))$$

$$p = E_{fixed}(Xe^{-r_c t}N(-d_2) - Se^{(r_f - r_c - q - \rho\sigma_{FX}\sigma_S)t}N(-d_1))$$

$$d_1 = \frac{\ln(S/X) + (r_f - q - \rho\sigma_{FX}\sigma_S + 0.5\sigma_S^2)t}{\sigma_S\sqrt{t}}$$

$$d_2 = d_1 - \sigma_S\sqrt{t}$$

in which c and p represent respectively the fair value quanto call and put option premia, r_c represents the local currency interest rate, X the foreign currency strike price of the option and the remaining symbols are as specified in the main body of this paper.

A zero premium quanto forward can be created by combining a long position in a quanto call with a short position in an identically-specified quanto put with the strike price chosen such that the premium received from writing the put equals the premium paid for buying the call. Such a position commits the portfolio manager at option maturity to acquiring the stock at the strike price, $X_{forward}$, specified in the option contracts, translated into the local currency at the exchange rate, E_{fixed} , also specified in the option contract. This is the specification of a quanto forward contract. Denoting the quanto forward price as F_{quanto} , we see:

$$c - p = 0$$

$$\therefore E_{fixed}(Se^{(r_f - r_c - q - \rho\sigma_{FX}\sigma_S)t}N(d_1)$$

$$- X_{forward}e^{-r_c t}N(d_2))$$

$$- E_{fixed}(X_{forward}e^{-r_c t}N(-d_2)$$

$$- Se^{(r_f - r_c - q - \rho\sigma_{FX}\sigma_S)t}N(-d_1)) = 0$$

$$\therefore E_{fixed}(Se^{(r_f - r_c - q - \rho\sigma_{FX}\sigma_S)t} - X_{forward}e^{-r_c t}) = 0$$

$$\therefore E_{fixed}X_{forward} = E_{fixed}Se^{(r_f - q - \rho\sigma_{FX}\sigma_S)t}$$

$$\therefore F_{quanto} = E_{fixed}Se^{(r_f - q - \rho\sigma_{FX}\sigma_S)t}$$