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The Value of OTC Derivatives: Case Study Analyses of Hedges by Publicly Traded Non-Financial Firms

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ABSTRACT

The goal of this study is to examine the value of over-the-counter (OTC) derivatives for publicly traded non-financial firms. We analyze several publicly traded firms that reported the use of OTC derivatives in their 10-K filings with the Securities and Exchange Commission (SEC), or to us directly, and develop four case studies based on this analysis.

To investigate the value of OTC derivatives, we assume these firms did not have access to OTC markets and replicate their hedges using derivative instruments available at the same time on the exchanges. Using historical data in each firm's 10-K reports and historical price time series for exchange-traded derivatives, we evaluate the effectiveness of the new hedges, the accounting treatment, and the impact on the earnings per share.

We also investigate the margin requirements for OTC derivatives transactions if non-financial firms were required to post margin on their non-cleared transactions or were required to clear and consequently post margin to clearing members or central counterparties directly. As of September 2013, non-financial firms are exempt from these requirements for hedging commercial risks, such as the case studies we investigate in this study. Overall, we find that OTC derivatives are more effective and reduce earnings volatility as compared to exchange-traded derivatives.

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CONTENTS

INTRODUCTION

Over the past 30-plus years, innovations in the OTC derivatives markets have fundamentally advanced the risk management practices of non-financial firms in value-adding ways. These advances in interest rate, currency and commodity derivatives instruments, and the resulting risk management applications, enable US firms to expand globally and be internationally competitive. As a result, these firms can be more successful and achieve business strategies and objectives, despite market volatilities. Academic research shows that derivatives also help lower the cost of capital of non-financial firms, both for debt and equity, and this in turn increases the enterprise value. Overall, the success of non-financial firms in managing risks benefits the macro economy and can help reduce systemic risk.

In the wake of the financial crisis, regulatory proposals were made that would enforce margin requirements on non-cleared derivatives for market participants. Such regulations would limit the ability of non-financial firms to effectively manage risk.

However, an exemption for non-financial companies was included within the US Dodd-Frank Act and European Market Infrastructure Regulation, which excuses those firms that use derivatives to hedge commercial risk from mandatory central clearing rules. Non-systemically important non-financial institutions will also be exempt from posting margin on non-cleared transactions, according to rules finalized by the Basel Committee on Banking Supervision and International Organization of Securities Commission in September 2013. Nonetheless, it is important to note there may be indirect costs for corporate end-users[1]. Dealers will face capital and funding costs from facilitating these trades, and may pass some or all of these costs onto their customers.. Currently, it is not possible to estimate the impact of such a cost transfer.

The approach we are taking in this paper is to assume a worst-case scenario where the corporations are required to post margin. Our study supports the adoption of the no-margin requirement for non-financial firms, since it shows they will face a substantial increase in hedging costs if they are not exempt.

[1] As of September 2013, the margin requirements for uncleared trades only apply to financial institutions and systemically important non-financial entities. Non-financial firms are exempt from clearing if the hedges are used for hedging commercial risk. There may be indirect impact. Under Basel III, dealers are required to hold higher capital for uncleared trades, and they also need to apply a credit valuation adjustment (CVA) capital charge. This charge may be high for uncleared, non-collateralized trades. The dealer may also hedge its exposure with another dealer – which would be subject to margin requirements (cleared or uncleared). The dealer may pass part or all of the funding cost, plus the capital charges, back to the non-financial. Under European rules, European banks do not need to apply a CVA charge when trading with a non-financial, but this exemption was not adopted in the US

In this study, we investigate the impact if non-financial firms were required to post margin and mark-to-market their positions. It is important to document the potential impact on non-financials if current requirements were reversed. Past testimonies have shown that margin requirements on OTC derivatives hedges would hurt the competitiveness of non-financial firms (FMC Corporation, April 11, 2013). It would also divert money from capital investments and research and development, which would most likely cause lower firm growth and, as a result, would lead to slower growth in the macro economy.[2]

The goal of our study is to further the understanding of the microeconomic aspects from the proposed new regulations of the OTC markets as of August 2013 (before the new margin rules for non-cleared OTC derivatives were finalized). To accomplish this, we examine the use of OTC derivatives by non-financial firms in four case studies, and then replicate the hedges using only exchange-traded derivatives. We first select the largest OTC derivative instruments: interest rate contracts, as identified by the Bank for International Settlements (BIS) in its report on the end-December 2012 global OTC derivatives markets (see BIS 2013).

The first two case studies focus on the use of the interest rate contracts – interest rate swaps. We then select the next largest derivative instruments – foreign currency contracts – and develop case study three, which illustrates a combination of interest rate and currency hedging. The fourth case study focuses on the fifth largest OTC derivatives group: commodity contracts (specifically, natural gas derivatives). The derivative instruments and risk categories discussed in the BIS report and reported in the derivative statistics on the BIS website, including the total notional principal amount outstanding (np) as of December 2012, are as follows:[3]

1. Interest rate contracts: forward rate agreements, interest rate swaps ($489,703 billion np globally; non-financial firms are $34,731 billion np (7.1%))
2. Foreign exchange contracts: forwards and forex swaps, currency swaps ($67,358 billion np globally; non-financial firms are $9,693 billion np (14.4%))
3. Credit default swaps: single-name instruments, multi-name instruments ($25,069 billion np globally; non-financial firms are $200 billion np (0.8%))
4. Equity-linked contracts: forwards and swaps, options ($6,251 billion np globally; non-financial firms are $755 billion np (12.1%))
5. Commodity contracts: forwards and swaps, options ($2,587 billion np; non-financial firms not available)

[2] A report by Keybridge Research (2010) provides analysis of the impact on non-financial firms if mandatory margin requirements were required. This research was done before the new rules were finalized and non-financials were exempted. While these results do not apply now, the findings are insightful, especially if the rules were changed in the future. The key findings are as follows: (1) About 72% of survey participants report that proposed regulations would have a significant impact on their hedging activities. (2) A 3% margin requirement, assuming no exemptions, would require total collateral of $33.1 billion for non-financial, publicly traded BRT firms. (3) Non-financial publicly traded BRT firms would likely respond to the imposition of margin requirements on OTC derivatives by reducing capital spending 0.9% to 1.1% (approximately $2 billion to $2.5 billion) and (4) Extending their estimates to S&P 500 companies indicates a reduction in capital spending of $5 billion to $6 billion per year and an estimated loss of 100,000 to 120,000 jobs.

[3] See Bank for International Settlements 2013 in the references and http://www.bis.org/statistics/derstats.htm.

Academic studies on the use of derivatives by non-financial firms have investigated many benefits in managing interest rate, currency and commodity price exposures. However, there are only a limited number of studies that investigate the interaction between OTC and exchange-traded derivatives, most likely due to the difficulty in obtaining data.[4] Clearly, this is an area where more research is needed. Our study is a step in that direction.

This study proceeds as follows. In the next section, we briefly describe the theoretical and empirical evidence on the value of using derivatives to manage risk by non-financial firms. In Section III, we discuss the hedge accounting treatment for derivatives under Financial Accounting Standard (FAS) 133. In Section IV, we present four case studies of firms using OTC contracts and replicate these transactions utilizing the closest exchange-traded contracts. This section also evaluates the effectiveness of these exchange-traded replications, the resulting accounting treatment, the impact on the earnings per share, and implications for capital requirements if required. Section IV concludes.

MOTIVATIONS FOR HEDGING AND THE VALUE IN USING DERIVATIVES TO MANAGE RISK BY NON_FINANCIAL FIRMS

Research has shown that there are important motivations for firms to hedge using derivatives and that hedging can increase firm value. Smithson and Simkins (2005) provide a comprehensive review of the literature in this area. Reasons for firms to hedge include to:

- Reduce expected taxes (Nance, Smith, and Smithson, 1993, and Graham and Rogers, 2002)
- Reduce expected costs of financial distress (Stulz, 1996)
- Reduce the costs associated with under-investment opportunities (Froot, Scharfstein, and Stein, 1993, Gay and Nam, 1998, among others), and
- Reduce agency costs (Smith and Stulz, 1985).

Studies including Nance, Smith, and Smithson (1993), Dolde (1995) and Géczy, Minton, and Schrand (1997), and Allayannis and Ofed (1998) have shown that hedging using foreign exchange derivatives is consistent with shareholder wealth maximization. Other studies have demonstrated the value of interest rate derivatives. For example, Simkins and Rogers (2000) find that firms using interest rate swaps to create synthetic fixed-rate financing are more likely to undergo credit-quality upgrades. This evidence is consistent with the use of risk management to reduce the probability of financial distress.

[4] Refer to the following studies for a few examples: Kavussanos and Vivikis (2004) use actual OTC data of forward freight agreements and find that OTC contracts provide more rapid information discovery relative to the spot markets. Switzer and Fan (2008) find evidence that supports substitutability between foreign exchange futures markets and the OTC market for the Canadian dollar. Other authors used implied prices instead of transaction prices, for example Grinblatt and Jagadeesh (1996), Park and Switzer (1997) and Gupta and Subrahmanyam (2000). These studies find mixed results depending on the market studied.

A number of studies have directly examined if hedging can increase firm value. Most studies have shown a positive relation between risk management and the value of the firm. For example, Allayannis and Weston (2001) examine the use of foreign currency (FX) derivatives by large non-financial firms between 1990 and 1995, and find that FX hedging is associated with a 4.8% premium for companies with FX exposure (as measured by foreign sales). Regarding hedging using commodity derivatives, Carter, Rogers, and Simkins (2005) show that fuel price hedging by airlines is associated with significantly higher firm values. A study of oil and gas firms by Jin and Jorion (2005) find that while hedging reduced the firm's stock price sensitivity to oil and gas prices, it did not appear to increase value. As the authors conclude: "One might even argue that investors take positions in oil producers precisely to gain exposure to oil prices. This seems logical given that investors in oil and gas productions firms should not necessarily benefit from hedging oil price risk."

Hedging can also help firms better manage cash flows. Academic research has shown that reductions in cash flow can lead to reduced capital investment. For example, Hovakimian and Havakimian (2009) find that a reduction in cash flow/lagged net capital leads to a reduction in capital expenditures/lagged net capital.

In summary, it is important to note that many, if not most, of the firms examined in our case studies hedge exclusively in the OTC markets because exchange-traded derivatives are not available, are less effective, are less efficient, or are much more expensive to manage. In our opinion, our research provides strong evidence of the value of OTC derivatives for non-financial firms and demonstrates how they can benefit the macro-economy. In turn, this increases the value of firms, which results in higher GDP and benefits the US economy. Therefore, any regulatory changes that reduce the effectiveness of corporate hedging by non-financial firms will most likely result in a reduction in the value of the firm and harm the US economy.

ACCOUNTING FOR DERIVATIVES UNDER FAS133

In this section, we summarize the accounting treatment for derivatives transactions under FAS 133, Accounting for Derivative Instruments and Hedging Activities, issued in 1998, and FASB Accounting Standards Codification Topic 815: Derivatives and Hedging, which apply to US GAAP financial statement preparers. All firms that have securities listed on US exchanges must apply these standards and private firms applying US GAAP.

It is necessary to discuss hedge accounting implications because replicating OTC derivatives using exchange-traded contracts can reduce the effectiveness of hedges, and hence impact financial statements.

Any potential regulation that impacts the ability of non-financial firms to hedge and receive hedge accounting treatment should be considered very carefully. If a firm's hedge does not qualify for hedge accounting, the derivative instruments must be marked-to-market (MTM) on a quarterly basis based on the fair value.[5] This will make the financial statements and resulting earnings-per-share not directly reflect risk management practices, increase earnings volatility and not reveal economic reality, and as a result, mislead shareholders.

The Financial Accounting Standards Board (FASB) issued Statement 133 to make a company's exposure to its derivative positions more transparent. Prior to FAS 133, most derivatives were carried off-balance-sheet and reported only in footnotes to the financial statement. Under FAS 133, changes in derivatives fair value are recorded either in the income statement or in a component of equity known as other comprehensive income, depending on the reason for holding the derivative position and the derivative's effectiveness in hedging.

Table 1 summarizes the balance sheet and income statement impact of cash flow hedges, fair-value hedges, and speculative transactions under FAS 133. Clearly, non-financial firms want their hedge transactions to receive hedge accounting treatment. To do this, they need to show their hedge will pass the effectiveness measure. To qualify, the firm must measure the effectiveness of the hedge at least each reporting period for the entire duration of the hedge. Any ineffective portion or excluded portion of the change in derivative value must be reported directly to earnings. In 2013, the FASB issued the Codification Update: Derivatives and Hedging Topic 815 to provide guidance on the risks that are permitted to be hedged in a fair-value or cash-flow hedge. For more information, refer to this update.[6]

According to the FASB, hedge effectiveness should take into account both historical performance (retrospective test) and anticipated future performance (prospective test). The FASB has provided only broad guidelines for testing hedge effectiveness. The FASB has two suggested approaches to measure historical performance: the '80-125 rule' (which all hedges must apply and meet, regardless of the method used to access effectiveness); and the correlation method.

[5] To clarify, a derivative is always MTM and failure to qualify for hedge accounting results in the firm not being able to mark the hedged item for the hedged risk (in a fair value hedge) or not having the ability to record the derivative MTM to other comprehensive income (in a cash flow hedge).

[6] Among those risks for financial assets and financial liabilities are the risks of changes in a hedged item's fair value or a hedged transaction's cash flows attributable to changes in the designated benchmark interest rate (referred to as interest rate risk). In the US, currently only the interest rates on direct Treasury obligations of the US government (UST) and the London Interbank Offered Rate (LIBOR) swap rate are considered benchmark interest rates. The update allows the inclusion of the federal funds effective swap rate as a US benchmark interest rate for hedge accounting purposes, in addition to UST and LIBOR.

According to the 80-125 rule (also referred to as the dollar-value-offset method), a hedge is deemed effective if the ratio of the change in value of the derivative to the change in value of the hedged item is between 80% and 125%, as follows:

$$\text{Effectiveness measure} = \Sigma^{n}_{i=2}(\Delta P_H)_i \,/\, \Sigma^{n}_{i=2}(\Delta P_D)_i$$

Where: $(\Delta P_H)_i = (P_H)_i - (P_H)_{i-1}$

$(\Delta P_D)_i = (P_D)_i - (P_D)_{i-1}$

P_H = the daily price of the hedged item

P_D = the daily price of the derivative

i = trading day i

n = total number of trading days in the period

According to the correlation measure, a hedge is deemed effective if the correlation between the changes in the value of the hedged item and the derivative is high. In other words, a hedge should be considered effective if the R-squared of the regression of this relation is at least 0.8. Furthermore, the slope of the regression line should be close to 1.0, but this is not explicitly referred to in FAS 133. For more information on hedge accounting, see Ernst and Young (2011).

Table 1

FAS 133 BALANCE SHEET AND INCOME STATEMENT IMPACTS OF CASHFLOW AND FAIR VALUE HEDGES

This table summarizes the balance sheet and income statement impacts of hedging according to FAS 133.

Type of Derivative	Balance Sheet Impact	Income Statement Impact
Cash Flow Hedge	Derivative (asset or liability) is reported at fair value. Changes in fair value of derivative are reported as components of other comprehensive income (balance sheet).	No immediate income statement impact. Changes in fair value of derivatives are reclassified into the income statement (from other comprehensive income in the balance sheet) when the expected (hedged) transaction affects the net income. Derivative must qualify for hedge accounting treatment.
Fair Value Hedge	Derivative (asset or liability) is reported at fair value or marked for the hedged risk (benchmark interest rates, foreign exchange rates etc.). Hedged item is also reported at fair value.	Changes in fair value are reported as income/loss in the income statement. Offsetting changes in fair value of the hedged item are also reported as an income/loss in the income statement.
Speculative Transaction	Derivative (asset or liability) is reported at fair value.	Changes in the fair value are reported as income/loss in the income statement.

CASE STUDY APPLICATIONS

CASE STUDY 1: HILTON HOTELS HEDGE USING AN INTEREST RATE SWAP

Hilton Hotels (hereafter referred to as Hilton), together with its subsidiaries, is involved with the ownership, management and development of hotels, resorts and timeshare properties and the franchising of lodging properties. During the period of the interest rate swap, Hilton owned and operated 60 hotels, leased and operated 203 hotels, owned an interest in and operated 53 hotels, managed 343 hotels owned by others and franchised 2,242 hotels owned and operated by third parties. Hilton was founded in 1946.

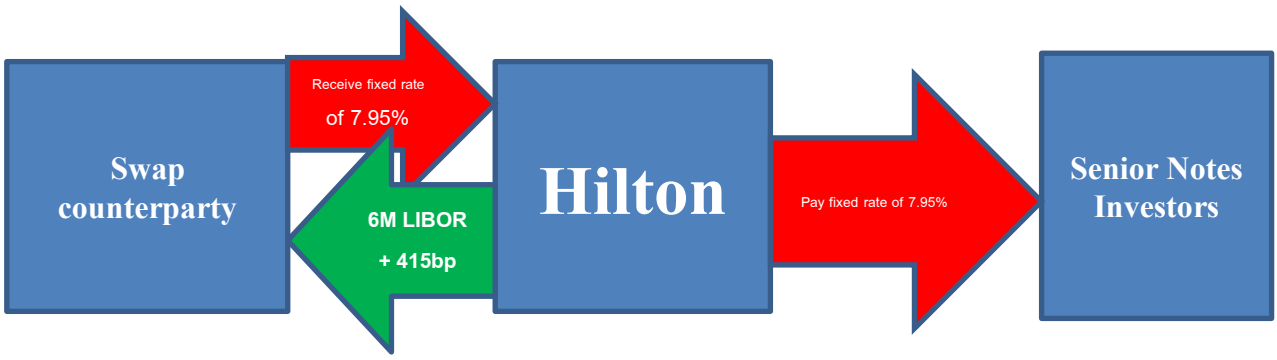
Description of the hedge

Hilton disclosed in its 2002 10-K that: "As of December 31, 2002, we had a derivative contract that swaps the fixed interest payments on our $375 million 7.95% senior notes due 2007 to a floating interest rate equal to the six-month LIBOR rate plus 415 basis points." It had issued fixed-rate senior notes that made semiannual payments based on the 7.95% coupon.

Hilton wanted to take advantage of the low interest rate environment and swapped their fixed interest payment for a floating-rate payment. The swap used is traded OTC. In this case study, we are going to replicate these OTC transactions using only exchange-traded contracts. The swap is illustrated in Figure 1. (Note: at the time of this Hilton hedge, interest rate swaps were not exchange-traded.)

Figure 1

ILLUSTRATION OF 2002 HILTON INTEREST RATE SWAP



Using eurodollar futures as a substitute for the swap

To replicate the 'pay floating' side of a swap, Hilton has to enter into a long position on a eurodollar futures (ED) strip of contracts with maturities matched as close as possible to the reset points of the swap. Since the first time the swap was reported was in its 2002 10-K, and the actual day for starting the swap is not available, we assume that the swap was initiated on 12/15/2002 (the day of the senior note coupon payment). The coupon payments are semiannual (six months), while the ED futures are of three-month maturities. To match the coupon payments, we must use two consecutive ED futures. Table 2 shows details of the actual coupon payment dates, as well as the actual ED futures contracts used to replicate hedge. Data on the ED futures are obtained from DataStream.

Table 2

EURODOLLAR FUTURES CONTRACTS USED TO REPLICATE THE HEDGE

Hedge Initiated on	12/15/2002
Coupon dates	**ED Futures expirations**
6/15/03	6/18/2003
	9/17/2003
12/15/03	12/17/2003
	3/17/2004
6/15/04	6/16/2004
	9/15/2004
12/15/04	12/15/2004
	3/16/2005
6/15/05	6/15/2005
	9/21/2005
12/15/05	12/21/2005
	3/15/2006
6/15/06	6/21/2006
	9/20/2006
12/15/06	12/20/2006
	3/21/2007
6/15/07	6/20/2007
	9/19/2007
12/14/07	12/19/2007
	3/19/2008

We need 20 different ED futures contracts to hedge the complete sequence of coupon payments. We use two-quarter strip rates because they are expected to correlate more closely with the six-month interest rates. In order to accomplish the conversion from fixed to floating – ie create a substitute for the swap – we need to calculate the yield associated with the strip of ED futures that extends for the same period as the swap.

Given our assumption about the initial spot value date of 12/15/2002, the first reset is on 6/15/2002 and subsequent reset dates fall on the December 15 and June 15. To calculate the futures hedge rates for all exposures, we use the futures prices of the two futures contracts that immediately follow the hedge value dates.

Table 3 shows the hedge value dates, futures contracts chosen, futures prices as of 12/15/2002, the corresponding futures rates, computed futures hedge rates and par yields.

Table 3

EURODOLLAR FUTURES CONTRACTS AND FUTURES PRICES

Hedge value dates	Futures	Futures Prices	Futures rate, R_{i1},R_{i2}	# Days, d_i	Synthetic coupons, R_i	Par Yield
12/15/02					1.41%	
6/15/03	6/18/2003	98.44	1.560%	180	1.70%	
	9/17/2003	98.16	1.840%			
12/15/03	12/17/2003	97.795	2.205%	180	2.41%	
	3/17/2004	97.395	2.605%			
6/15/04	6/16/2004	97	3.000%	180	3.19%	
	9/15/2004	96.64	3.360%			
12/15/04	12/15/2004	96.375	3.625%	180	3.74%	
	3/16/2005	96.175	3.825%			
6/15/05	6/15/2005	95.995	4.005%	180	4.10%	
	9/21/2005	95.845	4.155%			
12/15/05	12/21/2005	95.68	4.320%	180	4.41%	
	3/15/2006	95.54	4.460%			
6/15/06	6/21/2006	95.4	4.600%	180	4.69%	
	9/20/2006	95.275	4.725%			
12/15/06	12/20/2006	95.135	4.865%	180	4.96%	
	3/21/2007	95.01	4.990%			
6/15/07	6/20/2007	94.89	5.110%	179	5.20%	
	9/19/2007	94.785	5.215%			
12/14/07	12/19/2007	94.655	5.345%	180	5.44%	
	3/19/2008	94.535	5.465%			**3.68%**

Futures rates are obtained from futures prices as 100-futures price. For example, the rate for 6/18/2003 is computed as: $\frac{100-98.44}{100} = 1.56\%$. To obtain the synthetic coupon for 6/15/2003 (six-month money-market yield), we use a pair of futures (6/18/2003 and 9/17/2003). The following formula is used in the calculations:

$$\left(1 + R_i \frac{d_i}{360}\right) = \left(1 + R_{i1} \frac{0.5d_i}{360}\right)\left(1 + R_{i2} \frac{0.5d_i}{360}\right)$$

where
R_i is the synthetic coupon for hedging the ith rate reset
d_i is the actual number of days associated with the ith reset (i.e., 360-day calendar)
R_{i1} is the rate of the first futures contract associated with the ith exposure
R_{i2} is the rate of the second futures contract associated with the ith exposure

For example, the synthetic coupon (R_i) for 6/15/2003 is computed by using the following values in the equation above: $d_i = 180, R_{i1} = 1.56\%, R_{i2} = 1.84\%$. This gives $R_i = 1.70\%$. Following this procedure, we obtain all six-month rates (synthetic coupons, R_i).

The last step is to obtain the five-year par yield, which in a sense is the internal rate of return for all cash flows from the initiation of the hedge. The result is 3.68%. Given the market conditions at the end of 2002, one can use eurodollar futures to hedge the five-year exposure. However, the available fixed rate will be 3.68%.

Assume Hilton decides to enter such a hedge. At this point, we can immediately observe that there will be a mismatch between its fixed-rate obligation from the issued senior note (7.95%) and the available fixed rate from the eurodollar hedge of 3.68%. However, this is the only available hedge via exchange-traded contracts. Finding a particular fixed rate, which in the Hilton case is related to its credit risk, may be impossible even in today's availability of exchange-traded swap futures. As of the date of writing this case, there are two-, five-, 10- and 30-year swap futures offered by CME Group. None of them allow for any spread above three-month (3M) LIBOR, which means that if a hedger is looking for a particular fixed rate that differs from the one implied by the ED futures contracts, they will end up in a situation similar to the one described here about Hilton.

In order to compute the number of ED futures contracts to be purchased for each maturity, we have to keep in mind that each six-month exposure in reality will be composed of two three-month intervals. The first three-month interval can use the notional of $375 million, but we have to incorporate some interest adjustment for the second one. The following formula shows how we are going to make this adjustment:

$$375{,}000{,}000 \times \left(1 + R_{i1} \frac{0.5d_i}{360}\right)$$

Table 4 shows all computations that lead to the number of contracts to be purchased for each maturity, shown in the last column.

Table 4

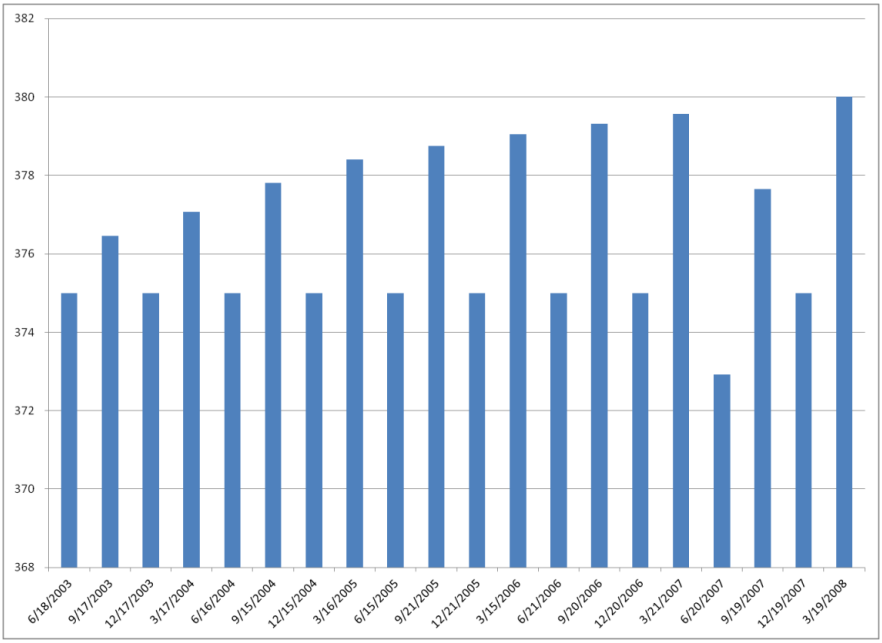
EURODOLLAR FUTURES CONTRACTS REQUIRED TO REPLICATE THE HEDGE

Hedge value dates	Futures	Futures rate, R_{i1},R_{i2}	d_i	Notional	BPVi	Hedges
12/15/02						
6/15/03	6/18/2003	1.560%	180	$375,000,000	9,375	375
	9/17/2003	1.840%		$376,462,500	9,412	376
12/15/03	12/17/2003	2.205%	180	$375,000,000	9,375	375
	3/17/2004	2.605%		$377,067,188	9,427	377
6/15/04	6/16/2004	3.000%	180	$375,000,000	9,375	375
	9/15/2004	3.360%		$377,812,500	9,445	378
12/15/04	12/15/2004	3.625%	180	$375,000,000	9,375	375
	3/16/2005	3.825%		$378,398,438	9,460	378
6/15/05	6/15/2005	4.005%	180	$375,000,000	9,375	375
	9/21/2005	4.155%		$378,754,688	9,469	379
12/15/05	12/21/2005	4.320%	180	$375,000,000	9,375	375
	3/15/2006	4.460%		$379,050,000	9,476	379
6/15/06	6/21/2006	4.600%	180	$375,000,000	9,375	375
	9/20/2006	4.725%		$379,312,500	9,483	379
12/15/06	12/20/2006	4.865%	180	$375,000,000	9,375	375
	3/21/2007	4.990%		$379,560,938	9,489	380
6/15/07	6/20/2007	5.110%	179	$375,000,000	9,323	373
	9/19/2007	5.215%		$379,764,010	9,441	378
12/14/07	12/19/2007	5.345%	180	$375,000,000	9,375	375
	3/19/2008	5.465%		$380,010,938	9,500	380

To obtain the number of futures contracts to be purchased for each maturity, we first compute the value of a basis point (BPVi) for each exposure (EXPi) by: $BPVi = EXPi \times 0.0001 \times 0.5\,\frac{d_i}{360}$. For example, for June-2003 futures, BPV = 375M x 0.0001 x 90/360 = 9,375. Given a $25 value of a basis point for the eurodollar futures contract, the number of contracts is 9,375/25 = 375. As a result, in order to replicate the position that Hilton had in the interest rate swap on 12/15/2002, it has to initiate a long position in a total number of 7,532 eurodollar futures contracts. Figure 2 shows the strip of eurodollar futures, their maturities, and the number of contracts to be purchased on 12/15/2002 as a substitute for the swap. For more information on using ED futures to replicate a swap, refer to Kawaller (1994) and Kawaller (1997).

Figure 2

STRIP OF EURODOLLAR FUTURES TO REPLICATE THE OTC SWAP



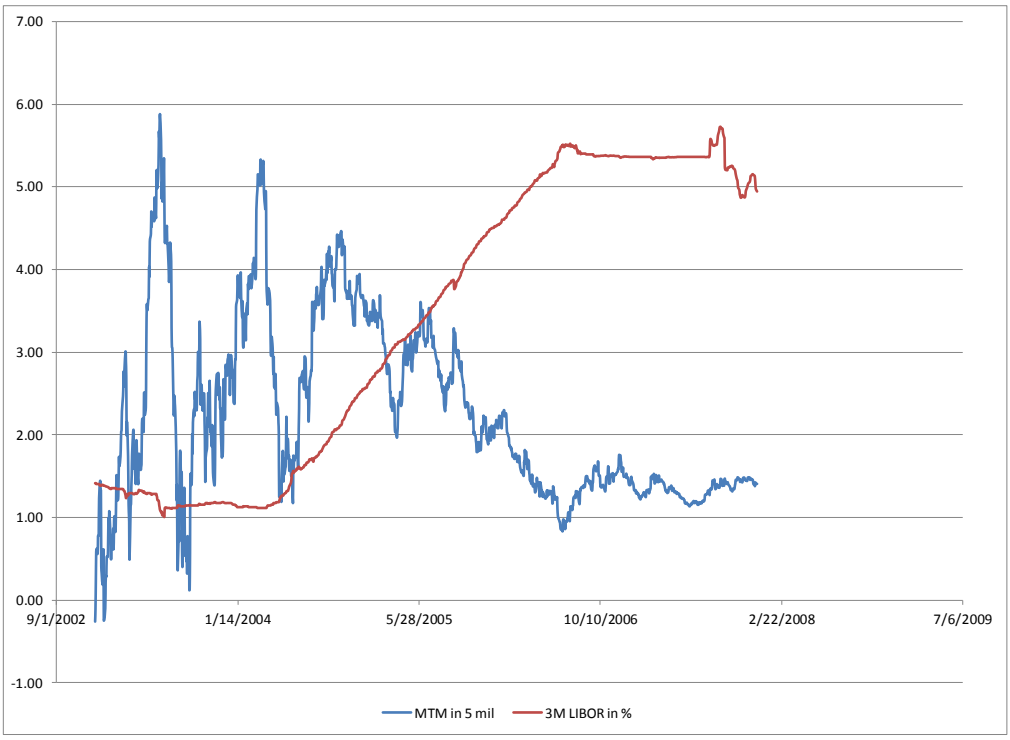
The replication of the OTC interest swap results in taking positions in 10 maturities of 7,532 futures contracts. Even if we assume that the ED futures have the ability to perfectly match the swap, the difference in the number of hedges that have to be maintained and watched, and the number of margin calls that would need to be met, is staggering. It is just one interest rate swap and there are 7,532 ED futures contracts. One should expect that the Hilton treasury department will have to increase the number of its employees in order to maintain all of the placed hedges. Additionally, the probability of somebody making a mistake – not closing a contract or not delivering on a margin call – will definitely increase and may become significant.

Mark-to-market of ED futures

Figure 3 shows the daily MTM of the futures contracts and the daily values of the 3M LIBOR rates. MTM values are computed by multiplying the number of contracts by the difference between the original and current ED implied rate. MTM is scaled by dividing by 5 million in order to make the chart readable. Daily correlation between the MTM values and the 3M LIBOR is -77%. Since Hilton's position in ED futures is equivalent to paying floating and receiving fixed, it benefits from decreasing values of the 3M LIBOR rates and loses if the rates start increasing. This is why, initially, it is on the winning side of the hedge, but its position weakens after 2004.

Figure 3

MARK-TO-MARKET ED FUTURES



Earnings impact

Hilton reported in its 10-K report that the interest rate swap qualifies as a fair-value hedge. In a fair-value hedge, as summarized in Section III, a company uses a derivative to hedge the exposure to changes in the fair value of a recognized asset or liability. In this case, the hedged liability is the issued senior notes that pay a fixed rate of 7.95%. Hilton discloses in its 10-K report: “We have an interest rate swap on certain fixed rate senior notes which qualifies as a fair value hedge. This derivative impacts earnings to the extent of increasing or decreasing actual interest expense on the hedged notes to simulate a floating interest rate. Changes in the fair value of the derivative are offset by an adjustment to the value of the hedged notes."

Based on this statement, we can conclude that only the interest expense item on the income statement will be affected by the swap. The entry for another item, net other (loss) gain, will have a value of zero, reflecting the difference between the fair value of the bond and the fair value of the swap.

The net income – and as a result, the earnings per share (EPS) – will change with our replication using exchange-traded derivatives, as we start changing the position that Hilton has taken from paying a floating side of a swap to being long a strip of eurodollar futures. We make the assumption that only the interest expense will change, and we are going to include the mark-to-market of all futures contracts in the interest expense as well.

Table 5 shows Hilton's income statement for the years 2002 through to 2006. There are no financial statements for year 2007, since Blackrock acquired Hilton in October 2007.

Table 5

HILTON HOTELS INCOME STATEMENT FROM 2002 THROUGH 2006

Hilton Hotels Corp.

HLT 432848109 2428008 NYSE Common stock

Income Statement - Annual (Industrial)

Source : FactSet Fundamentals

All figures in millions of U.S. Dollar, except per share items.

	Dec '02 Final	Dec '03 Final	Dec '04 Final	Dec '05 Final	Dec '06 Final
Net Sales	2,895.00	3,819.00	4,146.00	4,437.00	8,162.00
Cost of Revenue	1,563.00	2,566.00	2,722.00	2,770.00	5,597.00
Gross Income	1,332.00	1,253.00	1,424.00	1,667.00	2,565.00
Other Operating Expense	712.00	750.00	810.00	899.00	1,348.00
Operating Income after Depreciation	620.00	503.00	614.00	768.00	1,217.00
Interest Expense	328.00	295.00	274.00	259.00	498.00
Interest/Invest. Income	43.00	29.00	26.00	32.00	27.00
Equity in Affiliates	-19.00	34.00	43.00	27.00	41.00
Pretax Minority Interest	--	--	--	--	45.00
Pretax Adjustments	--	20.00	26.00	26.00	-24.00
Exceptional Charges (Credits)	14.00	6.00	5.00	-103.00	-72.00
Exceptional Charges (Credits) - Operating	17.00	22.00	5.00	7.00	--
Pretax Income	285.00	223.00	373.00	638.00	838.00
Income Taxes	81.00	53.00	127.00	166.00	259.00
Income After Taxes	204.00	170.00	246.00	472.00	579.00
After Tax Adjustments	-6.00	-6.00	-8.00	-12.00	-7.00
Extraordinary Credit (Charge)	--	--	--	--	--
Net Income After Extraordinaries	198.00	164.00	238.00	460.00	572.00
Basic Shares Outstanding	373.99	377.94	384.36	383.00	385.00
EPS	0.53	0.43	0.62	1.20	1.49

The last row of the table shows the actual EPS. In what follows, we compute EPS without having any hedge in place, EPS with the actual senior note interest, and EPS when the futures hedge is used instead of the interest rate swap. To do this, we first extract the value of the interest expense of everything else without the senior note interest and the effect of the swap. The illustration and notations are as follows:

Int.Exp. (a) = Interest expense actually reported
Int.Exp. (e) = Interest expense of everything else without the bond and the swap
Int.Exp. (b) = Interest expense on the bond (senior note with 7.95% coupon)

We can write the following expression:

Int.Exp.(a) = Int.Exp.(e) + [6M LIBOR + 415bp]*375M, where the last term reflects the effect of the swap. From here, Int.Exp.(e) = Int.Exp.(a) - [6M LIBOR + 415bp]*375M

Table 6 shows the actual pay and receive rates for the swap.

Table 6: Interest Rate Swap Pay and Receive Rates

Interest Rate Swap	2002	2003	2004	2005	2006
Maturity (years)	5	4	3	2	1
Notional	375	375	375	375	375
Avg. Pay	5.50%	5.30%	6.90%	8.90%	9.50%
Avg. receive	7.95%	7.95%	7.95%	7.95%	7.95%
Avg. rec.-Avg. pay	2.45%	2.65%	1.05%	-0.95%	-1.55%

For example, the calculations for 2002 are as follows. The interest expense for that year (Int.Exp.(a)) is 328. From the above table, the average pay rate (Avg.Pay) is 5.50% (6M LIBOR+415bp); therefore, the Int.Exp(e) = 328-5.5%*375 = 307. Now, we are ready to compute the interest expense without any hedge. It will be equal to:

Int.Exp(e) + Int.Exp(b) = 307 + 7.95%*375 = 337.

Table 7 shows the income statement, where the interest expense is substituted with the one computed above, and the net income and EPS are as a result changed.

Table 7

HILTON HOTELS INCOME STATEMENT CHANGES FROM 2002 THROUGH 2006

Hilton Hotels Corp.

HLT 432848109 2428008 NYSE Common stock

Income Statement - Annual (Industrial)

Source : FactSet Fundamentals

All figures in millions of U.S. Dollar, except per share items.

	Dec '02 Final	Dec '03 Final	Dec '04 Final	Dec '05 Final	Dec '06 Final
Net Sales	2,895.00	3,819.00	4,146.00	4,437.00	8,162.00
Cost of Revenue	1,563.00	2,566.00	2,722.00	2,770.00	5,597.00
Gross Income	1,332.00	1,253.00	1,424.00	1,667.00	2,565.00
Other Operating Expense	712.00	750.00	810.00	899.00	1,348.00
Operating Income after Depreciation	620.00	503.00	614.00	768.00	1,217.00
Interest Expense (e) + (b)	337.19	304.94	277.94	255.44	492.19
Interest/Invest. Income	43.00	29.00	26.00	32.00	27.00
Equity in Affiliates	-19.00	34.00	43.00	27.00	41.00
Pretax Minority Interest	0.00	0.00	0.00	0.00	45.00
Pretax Adjustments	0.00	20.00	26.00	26.00	-24.00
Exceptional Charges (Credits)	14.00	6.00	5.00	-103.00	-72.00
Exceptional Charges (Credits) - Operating	17.00	22.00	5.00	7.00	0.00
Pretax Income	275.81	213.06	369.06	641.56	843.81
Income Taxes	81.00	53.00	127.00	166.00	259.00
Income After Taxes	194.81	160.06	242.06	475.56	584.81
After Tax Adjustments	-6.00	-6.00	-8.00	-12.00	-7.00
Net Income After Extraordinaries	188.81	154.06	234.06	463.56	577.81
Basic Shares Outstanding	373.99	377.94	384.36	383.00	385.00
EPS	0.50	0.41	0.61	1.21	1.50

Table 8 shows a comparison between the actual EPS and the newly computed EPS.

Table 8

ACTUAL EPS VERSUS NEWLY COMPUTED EPS

	Actual EPS (with Interest Rate swap)	Simulated EPS with Senior Notes
Dec '02	0.53	0.50
Dec '03	0.43	0.41
Dec '04	0.62	0.61
Dec '05	1.20	1.21
Dec '06	1.49	1.50
Average	0.85	0.85
Median	0.62	0.61
Standard Deviation	0.46	0.48

The next step is to incorporate the results from the MTM of the futures into the income statement. We must add the effect on the interest expense of the futures contracts associated with a particular coupon payment date to the numbers already reported in the actual income statement. Table 9 shows a modified income statement where the interest expense is based on the rate of the senior note and the MTM effect of the futures.

Table 9

HILTON MODIFIED INCOME STATEMENT USING THE EXCHANGE TRADED FUTURES

Hilton Hotels Corp.
HLT 432848109 2428008 NYSE Common stock
Income Statement - Annual (Industrial)

Source : FactSet Fundamentals
All figures in millions of U.S. Dollar, except per share items.

	Dec '02 Final	Dec '03 Final	Dec '04 Final	Dec '05 Final	Dec '06 Final
Net Sales	**2,895.00**	**3,819.00**	**4,146.00**	**4,437.00**	**8,162.00**
Cost of Revenue	1,563.00	2,566.00	2,722.00	2,770.00	5,597.00
Gross Income	**1,332.00**	**1,253.00**	**1,424.00**	**1,667.00**	**2,565.00**
Other Operating Expense	712.00	750.00	810.00	899.00	1,348.00
Misc. Other Operating Expense	364.00	416.00	480.00	600.00	907.00
Depreciation & Amortization	--	--	--	--	--
Other Intangible Amortization	65.00	64.00	59.00	52.00	117.00
Depreciation	283.00	270.00	271.00	247.00	324.00
Operating Income after Depreciation	**620.00**	**503.00**	**614.00**	**768.00**	**1,217.00**
Interest Expense (e) + (b) + (f)	330.54	291.04	259.84	245.04	485.24
Interest/Invest. Income	43.00	29.00	26.00	32.00	27.00
Interest Income	43.00	29.00	26.00	32.00	27.00
Invest. Income	--	--	--	--	--
Other Interest/Investment Income	43.00	29.00	26.00	32.00	27.00
Equity in Affiliates	-19.00	34.00	43.00	27.00	41.00
Pretax Minority Interest	0.00	0.00	0.00	0.00	45.00
Pretax Adjustments	0.00	20.00	26.00	26.00	-24.00
Exceptional Charges (Credits)	14.00	6.00	5.00	-103.00	-72.00
Gain on Sale of Intang./Tang. Fixed Assets	-11.00	-2.00	--	103.00	72.00
Write-off of Financial Assets	3.00	--	--	--	--
Write off of Other Intangibles	--	4.00	5.00	--	--
Exceptional Charges (Credits) - Operating	17.00	22.00	5.00	7.00	0.00
Write-off of Fixed Assets	21.00	5.00	--	--	--
Write-Off of Optg. Financial Assets	--	17.00	5.00	7.00	--
Merger and Integration Expense	-4.00	--	--	--	--
Pretax Income	**282.46**	**226.96**	**387.16**	**651.96**	**850.76**
Income Taxes	81.00	53.00	127.00	166.00	259.00
Current Domestic Income Taxes	149.00	93.00	139.00	259.00	137.00
Current Foreign Income Taxes	--	--	--	--	55.00
Deferred Domestic Income Taxes	-68.00	-40.00	-12.00	-93.00	43.00
Deferred Foreign Income Taxes	--	--	--	--	24.00
Income After Taxes	**201.46**	**173.96**	**260.16**	**485.96**	**591.76**
After Tax Adjustments	-6.00	-6.00	-8.00	-12.00	-7.00
Net Income from Discontinued Operations	--	--	--	--	--
Minority Interest	6.00	6.00	8.00	12.00	7.00
Credits/Debits due to Changes in Accounting	--	--	--	--	--
Net Income After Extraordinaries	195.46	167.96	252.16	473.96	584.76
Basic Shares Outstanding	373.99	377.94	384.36	383.00	385.00
EPS	0.52	0.44	0.66	1.24	1.52

Table 10 shows a comparison between the actual EPS and the newly computed EPS. Note that the interest rate swap is the best option in terms of EPS volatility. Next is the futures hedge, and the worst case is no hedge at all. The OTC interest rate swap helps reduce volatility in EPS from 0.48 to 0.46 (a 4.2% reduction) or from 0.47 to 0.46 (a 2.1 % reduction) versus exchange-traded contracts. These are important results showing the benefits of OTC derivatives as compared to exchange-traded contracts, especially when you consider this is only one $375 million debt financing transaction for a firm with total long-term debt of $4,554 million and total assets of $8,348 million in 2002. Larger hedges in OTC markets can further reduce earnings volatility.

Table 10

HILTON ACTUAL ESP VERSUS THE ED FUTURES HEDGE AND NO HEDGE

	Actual EPS (with Interest Rate swap)	Simulated EPS with Senior Notes	Simulated EPS with Senior Notes and ED Futures
Dec '02	0.53	0.50	0.52
Dec '03	0.43	0.41	0.44
Dec '04	0.62	0.61	0.66
Dec '05	1.20	1.21	1.24
Dec '06	1.49	1.50	1.52
Average	0.85	0.85	0.88
Median	0.62	0.61	0.66
Standard Deviation	0.46	0.48	0.48

Due to being on the favorable side of the hedge, Hilton's cash flow benefited from the MTM of the ED futures contracts. This is why we see that the average EPS went up; however, the volatility increased as well.

CASE STUDY 2: WORTHINGTON INDUSTRIES HEDGE USING INTEREST RATE SWAP

At the time of the following hedge implemented in 2004, Worthington Industries, Inc. was primarily a diversified metal processing company. The firm was founded in 1955 and operates 47 manufacturing facilities worldwide, holds equity positions in nine joint ventures, and operates an additional 19 manufacturing facilities worldwide.

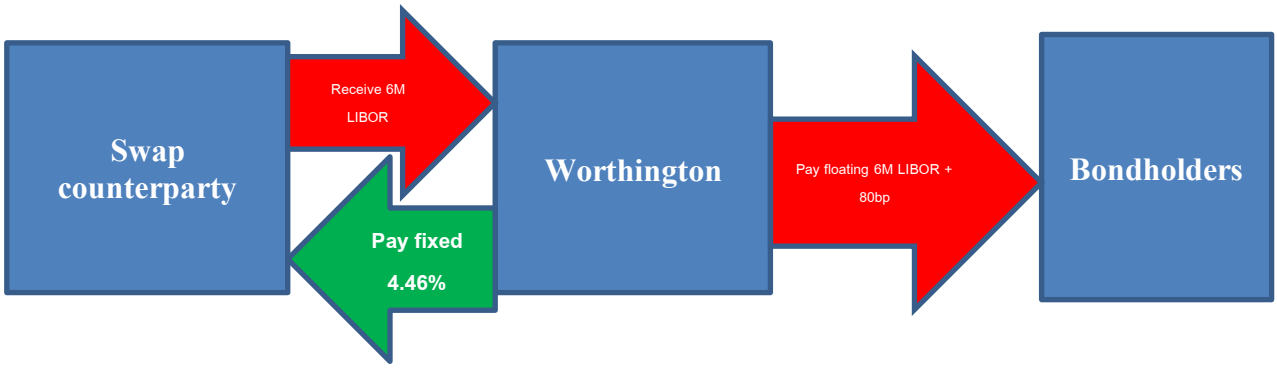
Description of the hedge

Effective December 17, 2004, Worthington Industries, Inc. issued $100,000,000 in aggregate principal amount of unsecured floating-rate senior notes due December 17, 2014 through a private placement. The 2014 notes bear interest at a variable rate equal to six-month LIBOR plus 80 basis points, as illustrated in Figure 3. This rate was 5.46% as of May 31, 2006. The 2014 notes are callable at Worthington Industries, Inc.'s option, at par, on or after December 17, 2006.

In anticipation of the issuance of the 2014 notes, Worthington Industries entered into an interest rate swap agreement in October 2004, which was amended in December 2004. Under the terms of the agreement, the firm receives interest on a $100,000,000 notional amount at the six-month LIBOR rate and pays interest on the same notional amount at a fixed rate of 4.46%. The resulting pay rate for Worthington is 4.46% + 80bp = 4.54%. (Note: at the time of this hedge, interest rate swaps were not available on exchanges.)

Figure 4

ILLUSTRATION OF 2004 WORTHINGTON INDUSTRIES RATE SWAP



Using ED futures as a substitute for the swap

To replicate the 'pay fixed' side of a swap, Worthington has to enter into a short position on an ED futures strip of contracts with maturities matched as close as possible to the reset points of the swap. The coupon payments are semiannual (six months), while the ED futures are of three-month maturities. To match the coupon payments, we need to use two consecutive ED futures and Table 11 shows details of the actual coupon payment dates, as well as the actual ED futures contracts used to replicate the hedge. Data on the ED futures are obtained from DataStream.

Table 11

EURODOLLAR FUTURES CONTRACT DATA

Hedge Initiated on	12/17/2004
Coupon Dates	**ED Futures Contracts**
6/17/2005	Sep-05
	Dec-05
12/17/2005	Mar-06
	Jun-06
6/17/2006	Sep-06
	Dec-06
12/17/2006	Mar-07
	Jun-07
6/17/2007	Sep-07
	Dec-07
12/17/2007	Mar-08
	Jun-08
6/17/2008	Sep-08
	Dec-08
12/17/2008	Mar-09
	Jun-09
6/17/2009	Sep-09
	Dec-09
12/17/2009	Mar-10
	Jun-10
6/17/2010	Sep-10
	Dec-12
12/17/2010	Mar-11
	Jun-11
6/17/2011	Sep-11
	Dec-11
12/17/2011	Mar-12
	Jun-12
6/17/2012	Sep-12
	Dec-12
12/17/2012	Mar-13
	Jun-13
6/17/2013	Sep-13
	Dec-13
12/17/2013	Mar-14
	Jun-14
6/17/2014	Sep-14
	Dec-14
12/17/2014	Dec-14

Following the described procedure in case study 1, Table 12 shows the hedge value dates, futures contracts chosen, futures prices as of 12/17/2004, corresponding futures rates, and computed futures hedge rates.

Table 12

EURODOLLAR FUTURES CONTRACTS, PRICES, RATES, AND OTHER DATA

Hedge value dates	Futures	Futures Prices	Futures rate, R_{i1},R_{i2}	# Days, d_i	Synthetic coupons, R_i
12/17/2004			2.52%		2.52%
6/17/2005	IEU0905	96.59	3.41%	180	3.51%
	IEU1205	96.43	3.57%		
12/17/2005	IEU0306	96.33	3.67%	180	3.72%
	IEU0606	96.255	3.74%		
6/17/2006	IEU0906	96.175	3.82%	180	3.89%
	IEU1206	96.09	3.91%		
12/17/2006	IEU0307	96.02	3.98%	180	4.04%
	IEU0607	95.935	4.07%		
6/17/2007	IEU0907	95.85	4.15%	180	4.22%
	IEU1207	95.755	4.24%		
12/17/2007	IEU0308	95.675	4.32%	180	4.40%
	IEU0608	95.575	4.43%		
6/17/2008	IEU0908	95.475	4.52%	180	4.61%
	IEU1208	95.365	4.63%		
12/17/2008	IEU0309	95.28	4.72%	180	4.80%
	IEU0609	95.185	4.82%		
6/17/2009	IEU0909	95.09	4.91%	180	4.99%
	IEU1209	95	5.00%		
12/17/2009	IEU0310	94.915	5.08%	180	5.16%
	IEU0610	94.825	5.18%		
6/17/2010	IEU0910	94.74	5.26%	180	5.34%
	IEU1210	94.655	5.35%		
12/17/2010	IEU0311	94.585	5.41%	180	5.49%
	IEU0611	94.515	5.49%		
6/17/2011	IEU0911	94.455	5.55%	180	5.62%
	IEU1211	94.375	5.63%		
12/17/2011	IEU0312	94.305	5.69%	180	5.77%
	IEU0612	94.245	5.76%		
6/17/2012	IEU0912	94.21	5.79%	180	5.86%
	IEU1212	94.155	5.85%		
12/17/2012	IEU0313	94.105	5.90%	180	5.96%
	IEU0613	94.055	5.94%		
6/17/2013	IEU0913	94.025	5.97%	180	6.04%
	IEU1213	93.99	6.01%		
12/17/2013	IEU0314	93.955	6.05%	180	6.11%
	IEU0614	93.925	6.07%		
6/17/2014	IEU0914	93.895	6.10%	180	6.17%
	IEU1214	93.86	6.14%		
12/17/2014	IEU1214	93.86	6.14%		6.23%

Using this information, we compute the par yield as 4.83%. This indicates that, using ED futures contracts at that point of time, one can simulate a hedge equivalent to a 4.83% swap paying fixed rate. Table 13 shows the notional value, as well as the number of contracts to be shorted. To replicate the swap, we need a total of 3,912 futures contracts.

Table 13

EURODOLLAR FUTURES SIMULATED HEDGE

Hedge value dates	Futures	Futures prices	Futures rate	Notional	BPV_i	Contracts
12/17/2004			2.52%			
6/17/2005	IEU0905	96.59	3.41%	$ 100,000,000	2500	100
	IEU1205	96.43	3.57%	$ 100,446,250	2511	100
12/17/2005	IEU0306	96.33	3.67%	$ 100,000,000	2500	100
	IEU0606	96.255	3.74%	$ 100,468,125	2512	100
6/17/2006	IEU0906	96.175	3.82%	$ 100,000,000	2500	100
	IEU1206	96.09	3.91%	$ 100,488,750	2512	100
12/17/2006	IEU0307	96.02	3.98%	$ 100,000,000	2500	100
	IEU0607	95.935	4.07%	$ 100,508,125	2513	101
6/17/2007	IEU0907	95.85	4.15%	$ 100,000,000	2500	100
	IEU1207	95.755	4.24%	$ 100,530,625	2513	101
12/17/2007	IEU0308	95.675	4.32%	$ 100,000,000	2500	100
	IEU0608	95.575	4.43%	$ 100,553,125	2514	101
6/17/2008	IEU0908	95.475	4.52%	$ 100,000,000	2500	100
	IEU1208	95.365	4.63%	$ 100,579,375	2514	101
12/17/2008	IEU0309	95.28	4.72%	$ 100,000,000	2500	100
	IEU0609	95.185	4.82%	$ 100,601,875	2515	101
6/17/2009	IEU0909	95.09	4.91%	$ 100,000,000	2500	100
	IEU1209	95	5.00%	$ 100,625,000	2516	101
12/17/2009	IEU0310	94.915	5.08%	$ 100,000,000	2500	100
	IEU0610	94.825	5.18%	$ 100,646,875	2516	101
6/17/2010	IEU0910	94.74	5.26%	$ 100,000,000	2500	100
	IEU1210	94.655	5.35%	$ 100,668,125	2517	101
12/17/2010	IEU0311	94.585	5.41%	$ 100,000,000	2500	100
	IEU0611	94.515	5.49%	$ 100,685,625	2517	101
6/17/2011	IEU0911	94.455	5.55%	$ 100,000,000	2500	100
	IEU1211	94.375	5.63%	$ 100,703,125	2518	101
12/17/2011	IEU0312	94.305	5.69%	$ 100,000,000	2500	100
	IEU0612	94.245	5.76%	$ 100,719,375	2518	101
6/17/2012	IEU0912	94.21	5.79%	$ 100,000,000	2500	100
	IEU1212	94.155	5.85%	$ 100,730,625	2518	101
12/17/2012	IEU0313	94.105	5.90%	$ 100,000,000	2500	100
	IEU0613	94.055	5.94%	$ 100,743,125	2519	101
6/17/2013	IEU0913	94.025	5.97%	$ 100,000,000	2500	100
	IEU1213	93.99	6.01%	$ 100,751,250	2519	101
12/17/2013	IEU0314	93.955	6.05%	$ 100,000,000	2500	100
	IEU0614	93.925	6.07%	$ 100,759,375	2519	101
6/17/2014	IEU0914	93.895	6.10%	$ 100,000,000	2500	100
	IEU1214	93.86	6.14%	$ 100,767,500	2519	101

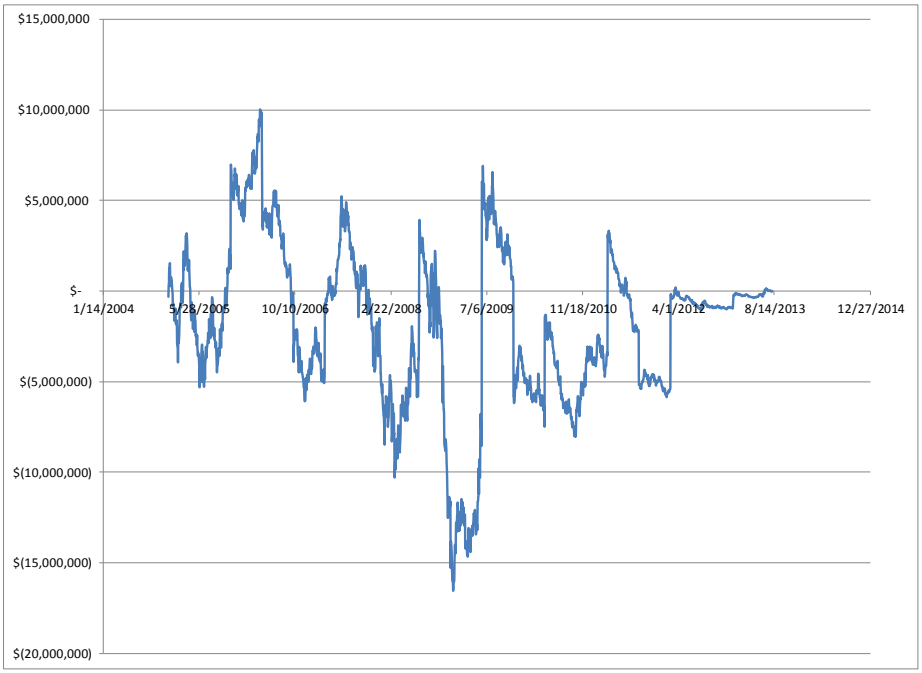
12/17/2014	IEU1214	93.86	6.14%	$	100,000,000	2500	100

Mark-to-market

Figure 5 shows the mark-to-market values of the futures hedge. Note the extreme variability in the MTM value of the hedge over the swap period.

Figure 5

MARK –TO- MARKET OF THE WORTHINGTON INDUSTRIES SIMULATED FUTURES HEDGE



Earnings impact

We follow the same type of procedure described in case study 1 to simulate the EPS impact without the actual hedge and with the substitute hedge. Table 14 shows the income statements from 2005 through to 2012.

Table 14

WORTHINGTON INDUSTRIES INCOME STATEMENTS (2005 THROUGH 2012)

Worthington Industries, Inc.								
WOR 981811102 2981932 NYSE Common stock								
Income Statement - Annual (Industrial)								
Source : FactSet Fundamentals								
All figures in millions of U.S. Dollar, except per share items.								
	May '05	**May '06**	**May '07**	**May '08**	**May '09**	**May '10**	**May '11**	**May '12**
	Final	Final	Final	Final	Final	Final	Final	Final
Net Sales	**3,078.88**	**2,897.18**	**2,971.81**	**3,067.16**	**2,631.27**	**1,943.03**	**2,442.62**	**2,534.70**
Cost of Revenue	2,580.01	2,525.55	2,610.18	2,711.41	2,456.53	1,663.10	2,086.47	2,201.83
Gross Income	**498.87**	**371.63**	**361.63**	**355.75**	**174.73**	**279.93**	**356.16**	**332.87**
Administrative Expense	225.92	214.03	232.49	231.60	210.05	218.32	235.20	227.97
Other Operating Expense	--	--	--	--	--	--	--	--
Research & Development	--	--	--	--	--	--	--	--
Operating Income after Depreciation	**272.96**	**157.60**	**129.15**	**124.15**	**-35.31**	**61.62**	**120.96**	**104.90**
Interest Expense	24.76	26.28	21.90	21.45	20.73	9.53	11.07	15.47
Equity in Affiliates	53.87	56.34	63.21	67.46	48.59	64.60	76.33	92.83
Pretax Adjustments	7.99	1.52	4.45	6.35	12.43	5.35	-8.09	7.54
Exceptional Charges (Credits)	0.00	-26.61	0.00	0.00	-13.90	-6.48	15.18	-5.82
Exceptional Charges (Credits) - Operating	5.61	0.00	0.00	18.11	139.98	39.65	-3.40	3.29
Pretax Income	**288.47**	**212.75**	**166.02**	**145.69**	**-145.97**	**78.16**	**182.53**	**177.26**
Income Taxes	109.06	66.76	52.11	38.62	-37.75	26.65	58.50	51.90
Income After Taxes	**179.41**	**145.99**	**113.91**	**107.08**	**-108.21**	**51.51**	**124.03**	**125.35**
After Tax Adjustments	0.00	0.00	0.00	0.00	0.00	-6.27	-8.97	-9.76
Net Income After Extraordinaries	**179.41**	**145.99**	**113.91**	**107.08**	**-108.21**	**45.24**	**115.07**	**115.60**
Basic Shares Outstanding	87.65	88.29	86.35	81.23	78.90	79.13	74.80	69.65
EPS (basic)	**2.05**	**1.65**	**1.32**	**1.32**	**-1.37**	**0.57**	**1.54**	**1.66**

The only item we changed is the interest expense. Table 15 shows how the income statement changes as we remove the effect of the swap and include the actual interest expense from the bond (ie no hedge).

Table 15

SIMULATED EARNINGS IMPACT ON WORTHINGTON INDUSTRIES INCOME STATEMENTS – NO HEDGE (2005 THROUGH 2012)

Worthington Industries, Inc.								
WOR 981811102 2981932 NYSE Common stock								
Income Statement - Annual (Industrial)								
Source : FactSet Fundamentals								
All figures in millions of U.S. Dollar, except per share items.								
	May '05	**May '06**	**May '07**	**May '08**	**May '09**	**May '10**	**May '11**	**May '12**
	Final	Final	Final	Final	Final	Final	Final	Final
Net Sales	**3,078.88**	**2,897.18**	**2,971.81**	**3,067.16**	**2,631.27**	**1,943.03**	**2,442.62**	**2,534.70**
Cost of Revenue	2,580.01	2,525.55	2,610.18	2,711.41	2,456.53	1,663.10	2,086.47	2,201.83
Gross Income	**498.87**	**371.63**	**361.63**	**355.75**	**174.73**	**279.93**	**356.16**	**332.87**
Administrative Expense	225.92	214.03	232.49	231.60	210.05	218.32	235.20	227.97
Other Operating Expense	--	--	--	--	--	--	--	--
Research & Development	--	--	--	--	--	--	--	--
Operating Income after Depreciation	**272.96**	**157.60**	**129.15**	**124.15**	**-35.31**	**61.62**	**120.96**	**104.90**
Interest Expense (e) + (b)	21.07	25.77	22.69	21.92	18.63	5.67	7.02	11.40
Equity in Affiliates	53.87	56.34	63.21	67.46	48.59	64.60	76.33	92.83
Pretax Adjustments	7.99	1.52	4.45	6.35	12.43	5.35	-8.09	7.54
Exceptional Charges (Credits)	0.00	-26.61	0.00	0.00	-13.90	-6.48	15.18	-5.82
Exceptional Charges (Credits) - Operating	5.61	0.00	0.00	18.11	139.98	39.65	-3.40	3.29
Pretax Income	**292.16**	**213.26**	**165.22**	**145.22**	**-143.86**	**82.02**	**186.58**	**181.33**
Income Taxes	109.06	66.76	52.11	38.62	-37.75	26.65	58.50	51.90
Income After Taxes	**183.10**	**146.50**	**113.11**	**106.61**	**-106.11**	**55.37**	**128.09**	**129.42**
After Tax Adjustments	0.00	0.00	0.00	0.00	0.00	-6.27	-8.97	-9.76
Net Income After Extraordinaries	**183.10**	**146.50**	**113.11**	**106.61**	**-106.11**	**49.10**	**119.12**	**119.66**
Basic Shares Outstanding	87.65	88.29	86.35	81.23	78.90	79.13	74.80	69.65
EPS (basic)	**2.09**	**1.66**	**1.31**	**1.31**	**-1.34**	**0.62**	**1.59**	**1.72**

Next, we add the effect of the futures hedge but only using the two contracts surrounding every coupon payment. Table 16 presents the results.

Table 16

SIMULATED EARNINGS IMPACT ON WORTHINGTON INDUSTRIES INCOME STATEMENTS – ED HEDGE (2005 THROUGH 2012)

Worthington Industries, Inc.								
WOR 981811102 2981932 NYSE Common stock								
Income Statement - Annual (Industrial)								
Source : FactSet Fundamentals								
All figures in millions of U.S. Dollar, except per share items.								
	May '05	**May '06**	**May '07**	**May '08**	**May '09**	**May '10**	**May '11**	**May '12**
	Final	Final	Final	Final	Final	Final	Final	Final
Net Sales	**3,078.88**	**2,897.18**	**2,971.81**	**3,067.16**	**2,631.27**	**1,943.03**	**2,442.62**	**2,534.70**
Cost of Revenue	2,580.01	2,525.55	2,610.18	2,711.41	2,456.53	1,663.10	2,086.47	2,201.83
Gross Income	**498.87**	**371.63**	**361.63**	**355.75**	**174.73**	**279.93**	**356.16**	**332.87**
Administrative Expense	225.92	214.03	232.49	231.60	210.05	218.32	235.20	227.97
Other Operating Expense	--	--	--	--	--	--	--	--
Research & Development	--	--	--	--	--	--	--	--
Operating Income after Depreciation	**272.96**	**157.60**	**129.15**	**124.15**	**-35.31**	**61.62**	**120.96**	**104.90**
Interest Expense (e) + Interest Expense (b) - Futures Effect on Interest	21.07	25.30	21.13	21.09	20.82	10.14	11.84	16.55
Equity in Affiliates	53.87	56.34	63.21	67.46	48.59	64.60	76.33	92.83
Pretax Adjustments	7.99	1.52	4.45	6.35	12.43	5.35	-8.09	7.54
Exceptional Charges (Credits)	0.00	-26.61	0.00	0.00	-13.90	-6.48	15.18	-5.82
Exceptional Charges (Credits) - Operating	5.61	0.00	0.00	18.11	139.98	39.65	-3.40	3.29
Pretax Income	**292.16**	**213.73**	**166.78**	**146.05**	**-146.05**	**77.55**	**181.76**	**176.17**
Income Taxes	109.06	66.76	52.11	38.62	-37.75	26.65	58.50	51.90
Income After Taxes	**183.10**	**146.97**	**114.67**	**107.44**	**-108.30**	**50.90**	**123.26**	**124.27**
After Tax Adjustments	0.00	0.00	0.00	0.00	0.00	-6.27	-8.97	-9.76
Net Income After Extraordinaries	**183.10**	**146.97**	**114.67**	**107.44**	**-108.30**	**44.63**	**114.29**	**114.51**
Basic Shares Outstanding	87.65	88.29	86.35	81.23	78.90	79.13	74.80	69.65
EPS (basic)	**2.09**	**1.66**	**1.33**	**1.32**	**-1.37**	**0.56**	**1.53**	**1.64**

As a last step, we incorporate the effect of all futures contracts (not only the two surrounding the coupon payments). Essentially, we MTM all of them and include the effect in the interest expense. Table 17 shows this.

Table 17

SIMULATED EARNINGS IMPACT ON WORTHINGTON INDUSTRIES INCOME STATEMENTS – ALL FUTURES (2005 THROUGH 2012)

Worthington Industries, Inc.								
WOR 981811102 2981932 NYSE Common stock								
Income Statement - Annual (Industrial)								
Source : FactSet Fundamentals								
All figures in millions of U.S. Dollar, except per share items.								
	May '05	**May '06**	**May '07**	**May '08**	**May '09**	**May '10**	**May '11**	**May '12**
	Final	Final	Final	Final	Final	Final	Final	Final
Net Sales	**3,078.88**	**2,897.18**	**2,971.81**	**3,067.16**	**2,631.27**	**1,943.03**	**2,442.62**	**2,534.70**
Cost of Revenue	2,580.01	2,525.55	2,610.18	2,711.41	2,456.53	1,663.10	2,086.47	2,201.83
Gross Income	**498.87**	**371.63**	**361.63**	**355.75**	**174.73**	**279.93**	**356.16**	**332.87**
Administrative Expense	225.92	214.03	232.49	231.60	210.05	218.32	235.20	227.97
Other Operating Expense	--	--	--	--	--	--	--	--
Research & Development	--	--	--	--	--	--	--	--
Operating Income after Depreciation	**272.96**	**157.60**	**129.15**	**124.15**	**-35.31**	**61.62**	**120.96**	**104.90**
Interest Expense (e) + Interest Expense (b) - MTM All Futures Effect on Interest	26.24	21.55	20.06	27.14	27.93	7.68	6.72	11.86
Equity in Affiliates	53.87	56.34	63.21	67.46	48.59	64.60	76.33	92.83
Pretax Adjustments	7.99	1.52	4.45	6.35	12.43	5.35	-8.09	7.54
Exceptional Charges (Credits)	0.00	-26.61	0.00	0.00	-13.90	-6.48	15.18	-5.82
Exceptional Charges (Credits) - Operating	5.61	0.00	0.00	18.11	139.98	39.65	-3.40	3.29
Pretax Income	**286.99**	**217.48**	**167.86**	**140.01**	**-153.17**	**80.01**	**186.88**	**180.86**
Income Taxes	109.06	66.76	52.11	38.62	-37.75	26.65	58.50	51.90
Income After Taxes	**177.93**	**150.72**	**115.74**	**101.39**	**-115.41**	**53.36**	**128.38**	**128.96**
After Tax Adjustments	0.00	0.00	0.00	0.00	0.00	-6.27	-8.97	-9.76
Net Income After Extraordinaries	**177.93**	**150.72**	**115.74**	**101.39**	**-115.41**	**47.09**	**119.41**	**119.20**
Basic Shares Outstanding	87.65	88.29	86.35	81.23	78.90	79.13	74.80	69.65
EPS (basic)	**2.03**	**1.71**	**1.34**	**1.25**	**-1.46**	**0.60**	**1.60**	**1.71**

Now, we summarize the combined results in Table 18, which shows the actual and simulated EPS. The results are striking. Using only exchange-traded contracts, there is a 3.39% change in the volatility of the EPS. As before, keep in mind that we are illustrating just one $100 million bond financing that incorporated an interest rate swap. Considering that most firms use more than one interest rate swap, the impact will be much greater on earnings volatility.

Table 18

RESULTS FOR WOTHINGTON INDUSTRIES SHOWING THE ACTUAL AND SIMULATED EPS

Year	Actual	With Floating Rate Note	With Floating Rate Note and Futures	With Floating Rate Note and All MTM Futures
May '05	$2.05	$2.09	$2.09	$2.03
May '06	$1.65	$1.66	$1.66	$1.71
May '07	$1.32	$1.31	$1.33	$1.34
May '08	$1.32	$1.31	$1.32	$1.25
May '09	-$1.37	-$1.34	-$1.37	-$1.46
May '10	$0.57	$0.62	$0.56	$0.60
May '11	$1.54	$1.59	$1.53	$1.60
May '12	$1.66	$1.72	$1.64	$1.71
Average	**1.09**	**1.12**	**1.10**	**1.10**
Median	**1.43**	**1.45**	**1.43**	**1.47**
Standard Deviation	**1.082**	**1.083**	**1.087**	**1.118**
% Change in EPS Standard Deviation relative to actual		0.11%	0.53%	3.39%

CASE STUDY 3: HILTON HOTELS HEDGE USING CHILEAN BOND AND CURRENCY AND INFLATION SWAP

This case study illustrates another Hilton Hotels hedge. We include this additional OTC derivatives hedge as a case study because it dramatically illustrates the types of custom hedges that can be effectively implemented in the OTC markets. Such a customized hedge is extremely difficult, if not impossible, to closely replicate on an exchange. We describe this OTC hedge in detail in the following section.

Description of the hedge

The news announcement for the Hilton Chilean Bond is presented in Figure 6. The transaction is described in Hilton's 10-K report: "In August 2001, we issued $100 million of 7.43% bonds due 2009 denominated in Chilean pesos. Payments of principal and interest on the bonds are to be adjusted for movements of the Unidad de Fomento, the Chilean inflation index published monthly by the Central Bank of Chile. We have swapped out all Chilean currency exchange rate and inflation risk by entering into a derivative contract which swaps the principal payment to a fixed US dollar amount of $100 million and fixed interest payments at 7.65% of that amount. The swap agreement qualifies for hedge accounting as a cash flow hedge of a foreign currency denominated liability. The gain or loss on the change in fair value of the derivative is included in earnings to the extent it offsets the earnings impact of changes in fair value of the hedged obligation. Any difference is deferred in accumulated comprehensive income, a component of stockholders' equity."

The entered hedge is a unique OTC structured trade. It hedges simultaneously the Chilean peso and Chilean inflation. At the time and currently, there is no exchange-traded contract on the Chilean peso or Chilean inflation to conduct the replication. Additionally, there is no futures contract traded on the Chilean peso versus US dollar, as well as futures contracts on Chilean inflation.

Figure 6

NEWS ANNOUNCEMENT OF HILTON CHILEAN BOND ISSUANCE

Hilton Completes Bond Sale of $100 Million; Hilton First U.S. Company to Issue Bonds in Chilean Pesos

BEVERLY HILLS, Calif.--(BUSINESS WIRE)--Aug. 27, 2001--Hilton Hotels Corporation (NYSE:HLT) today announced it has completed the issuance of $100 million of bonds in a transaction in which Hilton is the first U.S. corporation to issue bonds denominated in Chilean Pesos (CLP).

The issue is a 67.715 billion CLP euronote, equivalent to US$100 million. The 8-year euronote, due August 15, 2009, has a coupon of

- 7.43 percent and is payable semi-annually, to be adjusted for the movements of the Unidad de Fomento, the Chilean CPI index created in 1967 and published monthly by the Central Bank of Chile. The euronotes were rated Baa3, BBB- and BBB- by Moody's, S&P and Fitch, respectively.

Payments of interest and principal on the euronotes will be made in US dollars based on the prevailing CLP/USD foreign exchange rate. In the transaction, Hilton has swapped out all Chilean currency exchange rate and inflation risk. At a re-offer price of par, the transaction was priced at 155 basis points over the yield of the Central Bank of Chile 12-year Pagare Reajustable con Pago en Cupones reference bonds.

"This transaction was an innovative execution that allowed Hilton to access a new investor base," said Mariel C. Albrecht, senior vice

president and treasurer for Hilton Hotels Corporation.

The CLP euronote was not registered under the U.S. Securities Act of 1933 and may not be offered or sold in the U.S. absent registration or an applicable exemption from registration requirements. The CLP euronote was not registered under the Chilean Securities Act and may not be publicly offered in Chile absent registration. This press release is being issued pursuant to and in accordance with Rule 135c under the U.S. Securities Act of 1933, as amended.

CONTACT:	Hilton Hotels Corporation, Beverly Hills
	Marc Grossman, (310) 205-4030
	http://www.hilton.com

Hedge replication

In order to replicate this OTC hedge with exchange-traded contracts, we need futures contracts to hedge both the Chilean peso and Chilean inflation exposure. There are no traded contracts for hedging the inflation exposure. To hedge the Chilean currency, we found two plausible options: futures on the Brazilian real currency; and copper futures. Both of these futures have correlations of around 50% with the Chilean currency, as shown in Figures 7 and 8. These figures from Bloomberg show the correlations using weekly returns over the period August 2003 to August 2013. The reason we considered copper futures is due to the fact that a large component of the Chilean economy depends on the mining and export of copper. Data on the futures contracts for the Brazilian real and copper are obtained from DataStream.

Figure 7

CORRELATION BETWEEN THE CME BRAZILIAN REAL FUTURES AND THE CHILEAN PESO SPOT PRICE (2003-2013)

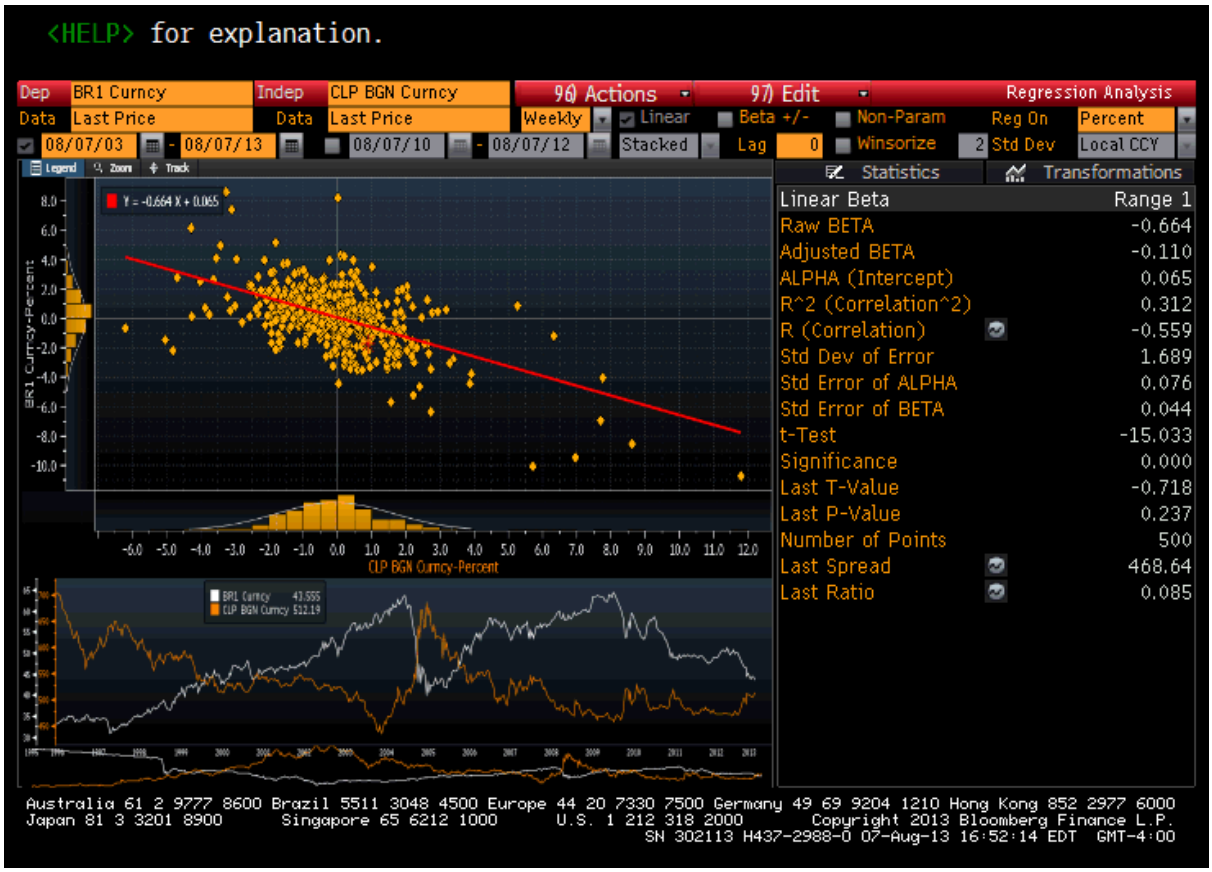
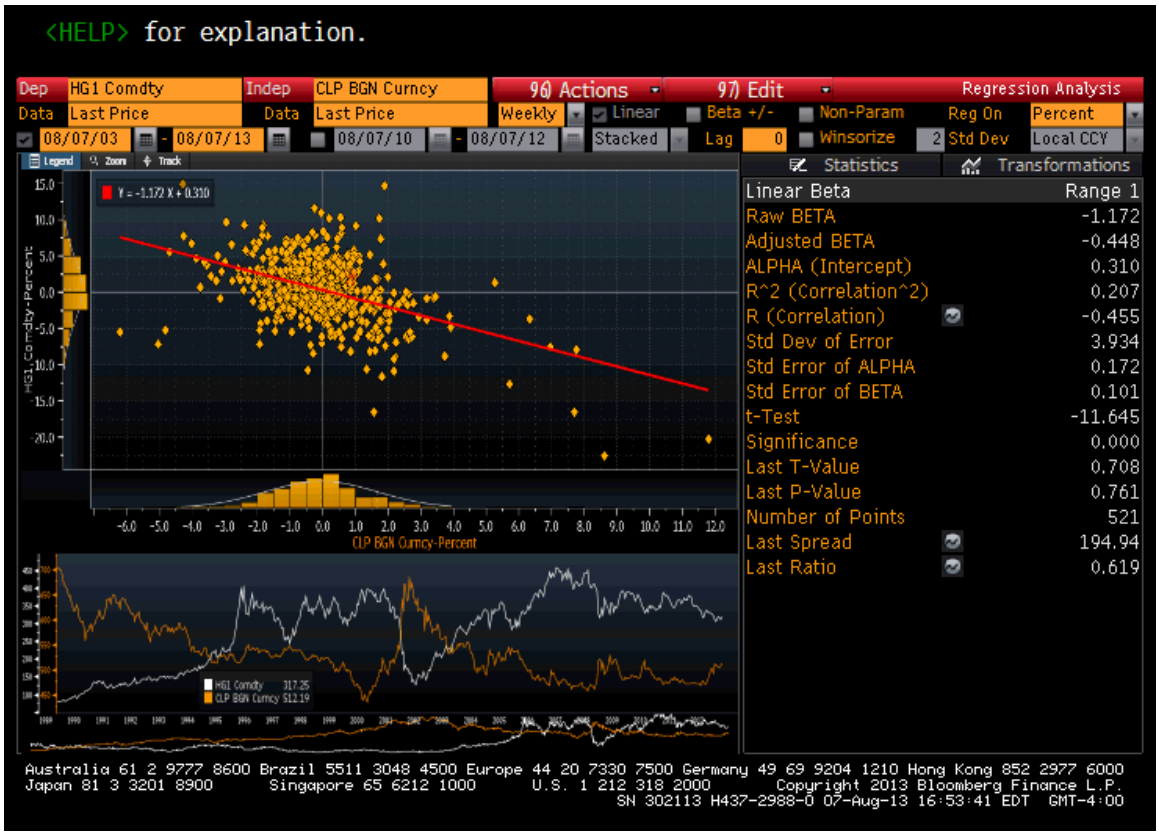


Figure 8

CORRELATION BETWEEN CME COPPER FUTURES AND THE CHILEAN PESO SPOT PRICE (2003-2013)



Since the correlation is around 50%, neither of the two contracts qualify for hedge accounting. However, since our goal is to try and use exchange-traded contracts in order to replicate the hedge as close as possible, we will use the Brazilian real contract (BRL) to replicate at least partially the Chilean pesos exposure. The BRL/USD futures expire on the last business day of the month, immediately preceding the contract month. For example, in order to hedge the coupon payment of the bond on August 31, 2001, we need to hedge with the September 2001 contract. For every semiannual coupon payment, we choose the appropriate contracts. Since payments are in August and February, the futures maturities are September and March.

At the time the bond was issued, only the September 2001 futures contract was available. Once it expired on August 31, 2001, the March 2002 became available. As a result, only one coupon payment at a time can be hedged. This problem further diminishes the use of the Brazilian real futures since we cannot hedge all coupon payments at the issuance of the bond; we have to roll the hedge every six months.

Table 19 shows the computation of the number of contracts by using optimal hedge ratios for cross hedging. To hedge the cash flow of every coupon, we enter a hedge six months earlier. *F* represents the Brazilian real futures and *S* represents the US dollar per Chilean peso exchange rate. To compute the optimal hedge ratio, we use: $h^* = \rho \frac{\sigma_S}{\sigma_F}$ and for the

number of futures contracts we use $N^* = \frac{h^* Q_A}{Q_F}$, where ρ is the correlation between the change in the Brazilian real futures prices and the change the US dollar per Chilean peso exchange rate for the period prior to entering the hedge. σ_S is the standard deviation of the change in the exchange rate and σ_F is the standard deviation of the change in the Brazilian real futures prices. Q_A is the size of the position being hedged (in our case, the coupon interest payment in peso adjusted for inflation) and Q_F is the size of the futures contract. To hedge this exposure, we need to take a long position on the Brazilian real futures. The last column of Table 19 shows the number of contracts to be purchased on the dates shown in the first column.

Table 19

HEDGE REPLICATION CALCULATIONS

Enter hedge on	Coupon dates	StDev ΔF	StDev ΔS	Corr.	Hedge Ratio	Interest in CLP	Interest in BRL	# Contracts
8/31/2001	2/28/2002	2.98%	2.50%	50.66%	0.43	2,546,931,622.51	9,807,869.28	42
2/28/2002	8/30/2002	4.84%	3.00%	81.15%	0.50	2,546,931,622.51	8,937,466.45	45
8/30/2002	2/28/2003	5.20%	2.83%	77.72%	0.42	2,551,082,382.73	10,893,714.27	46
2/28/2003	8/29/2003	6.47%	2.88%	71.47%	0.32	2,551,082,382.73	12,152,713.29	39
8/29/2003	2/27/2004	6.83%	2.84%	75.44%	0.31	2,528,944,994.93	10,736,548.76	34
2/27/2004	8/31/2004	6.33%	3.08%	68.79%	0.33	2,528,944,994.93	12,447,068.02	42
8/31/2004	2/28/2005	5.97%	2.97%	66.32%	0.33	2,553,975,336.81	11,997,773.75	40
2/28/2005	8/31/2005	5.69%	3.06%	63.90%	0.34	2,553,975,336.81	11,522,757.15	40
8/31/2005	2/28/2006	5.49%	2.98%	61.29%	0.33	2,558,377,658.25	11,183,299.30	37
2/28/2006	8/31/2006	5.45%	2.98%	57.78%	0.32	2,558,377,658.25	10,560,895.87	33

Table 20 shows the MTM of the futures contracts with the total value of the margin calls and the margin account balance on the coupon date. Note that at the beginning of the hedge, there are margin calls and the company has to have cash reserves to deliver on those calls.

Table 20

MARK-TO-MARKET OF THE FUTURES CONTRACTS

Hedge entered on	Coupon dates	Total value of margin calls	Margin Account Balance on Coupon Date
8/31/2001	2/28/2002	$ 119,877.16	$ 573,071.31
2/28/2002	8/30/2002	$ 373,295.84	$ 283,794.79
8/30/2002	2/28/2003	$ 422,827.68	$ 370,949.68
2/28/2003	8/29/2003	$ -	$ 460,160.37
8/29/2003	2/27/2004	$ -	$ 220,169.79
2/27/2004	8/31/2004	$ -	$ 340,352.54
8/31/2004	2/28/2005	$ -	$ 414,973.33
2/28/2005	8/31/2005	$ 85,149.79	$ 456,244.47
8/31/2005	2/28/2006	$ -	$ 411,799.16
2/28/2006	8/31/2006	$ 142,905.95	$ 330,553.47

Earnings impact

As a first step, we will identify the effect that this particular hedge had on earnings. In a similar way as we did with Hilton interest rate swap, we will compute the interest expense without the effect of the Chilean peso and inflation swap.

First, from the Hilton 10-K reports, it did not report any rate effect for the year 2001. Table 21 shows information on the swap as reported in Hilton's annual 10-K reports.

Table 21

CHILEAN PESO AND INFLATION SWAP

Chilean Peso, Inflation Swap	2002	2003	2004	2005	2006
Maturity (years)	More than 5	More than 5	5	4	3
Notional	100	100	100	148	145
Fair value	-6	21	43	59	57
Avg. Pay	7.70%	7.70%	7.70%	7.70%	7.70%
Avg. Receive	7.40%	7.40%	7.40%	7.40%	7.40%

We also need information on Chilean inflation in order to simulate the Chilean bond coupon payments. Table 22 shows the annual inflation in Chile from 2001 until 2006.

Table 22

ANNUAL INFLATION IN CHILE OVER 2001 THROUGH 2006

Year	Chile annual inflation
2001	3.57%
2002	2.49%
2003	2.82%
2004	1.06%
2005	3.05%
2006	3.40%

Additionally, the 10-K reports show that the bond was issued in August 2001, so we assume the coupon payments are semiannually paid in August and February of each year. Table 23 shows the semiannual Chilean peso/US dollar exchange rate, the bond principal in Chilean peso adjusted for inflation, and the coupon payments in Chilean peso and US dollar.

Table 23

DETAILS ON CHILEAN PESO EXCHANGE RATES AND CHILEAN BOND

	Chilean Peso per US Dollar	Bond Principal in Peso	Bond Principal in Peso adjusted for inflation	Interest in Peso	Interest in US Dollars
31-Aug-2001	662.45	67,715,000,000		2,515,612,250.00	$3,797,437.17
28-Feb-2002	672.25	67,715,000,000	68,558,051,750	2,546,931,622.51	$3,788,667.34
30-Aug-2002	710.50	67,715,000,000	68,558,051,750	2,546,931,622.51	$3,584,703.20
28-Feb-2003	749.20	67,715,000,000	68,669,781,500	2,551,082,382.73	$3,405,075.26
29-Aug-2003	697.45	67,715,000,000	68,669,781,500	2,551,082,382.73	$3,657,727.98
27-Feb-2004	591.75	67,715,000,000	68,073,889,500	2,528,944,994.93	$4,273,671.31
31-Aug-2004	624.35	67,715,000,000	68,073,889,500	2,528,944,994.93	$4,050,524.54
28-Feb-2005	572.90	67,715,000,000	68,747,653,750	2,553,975,336.81	$4,457,977.55
31-Aug-2005	541.15	67,715,000,000	68,747,653,750	2,553,975,336.81	$4,719,533.10
28-Feb-2006	517.33	67,715,000,000	68,866,155,000	2,558,377,658.25	$4,945,397.30
31-Aug-2006	540.15	67,715,000,000	68,866,155,000	2,558,377,658.25	$4,736,420.73

Incorporating the impact on the interest expense did not produce a significant difference in the earnings impact. It is important to keep in mind that the principal of this bond is only $100 million and Hilton's market capitalization on October 24, 2007 was $18 billion. Therefore, it is difficult to see a significant impact on earnings from a smaller

debt financing that is still very important to multinational firms such as Hilton. However, if a company like Hilton has several such hedges, its combined effect may introduce volatility in the EPS. To illustrate this, we will combine the interest rate swap (case study 1) with the Chilean peso and inflation swap (this case study). Table 24 shows the simulated EPS for this combination. We did not include the margin calls since their value is not significant enough to affect the EPS. As shown, the volatility in EPS increases by $0.02/share (i.e. $0.48 simulated as compared to $0.46 actual).

Table 24

COMBINATION OF CASE STUDY 1 AND CASE STUDY 2 HILTON HEDGES AND THE IMPACT ON EPS

	Actual EPS	Simulated EPS with Senior Notes	Simulated EPS with Senior Notes and ED Futures	Simulated EPS with the Chilean Bond	Simulated EPS with the Chilean Bond and US Senior notes and BRL futures
Dec '02	0.53	0.50	0.52	0.53	0.51
Dec '03	0.43	0.41	0.44	0.44	0.41
Dec '04	0.62	0.61	0.66	0.62	0.61
Dec '05	1.20	1.21	1.24	1.20	1.20
Dec '06	1.49	1.50	1.52	1.48	1.49
Average	0.85	0.85	0.88	0.85	0.84
Median	0.62	0.61	0.66	0.62	0.61
Standard Deviation	0.46	0.48	0.48	0.46	0.48

CASE STUDY 4: CORPORATION ENERGY HEDGE USING OTC NATURAL GAS DERIVATIVES

FMC is a large diversified chemical company that operates in agricultural, consumer and industrial markets globally and is a S&P 500 firm. Energy costs are approximately 7% of FMC's cost of sales and services and are diversified among coal, electricity and natural gas, with natural gas presenting the largest risk exposure.[7] During the fourth quarter of 2013, we had several conference calls with Thomas Deas (vice-president and treasurer) and Brian Blair (manager) at FMC to obtain information for developing this case study on its OTC natural gas hedges.

Description of the hedge

As of December 31, 2012, FMC had 8.3 million mmBtus (millions of British thermal units) in aggregate notional volume of outstanding natural gas commodity forward

[7] See FMC's 2012 10-K report, pages 39 and 80.

contracts to hedge forecasted purchases.[8] It is crucial for companies such as FMC to hedge energy price risk as efficiently and effectively as possible, because they may not be able to raise prices or improve productivity sufficiently to offset future increases in energy costs.

FMC uses a firm-wide approach to hedging its natural gas usage by aggregating volumes across the firm. It primarily uses OTC natural gas calendar strips to hedge its planned natural gas usage each month.[9] These OTC calendar strips make it possible to lock in a fixed monthly price for the entire year with varying monthly volumes, allowing FMC to identically match its forecasted scheduled usage per month throughout the year. This flexibility is only available in the OTC markets and allows FMC to better manage its cash flows and also maintain hedge accounting. While it is possible to replicate these hedges with futures contracts, it would take as many as 13 or more exchange-traded natural gas contracts to replicate one OTC calendar strip. We discuss this in detail in the next section.

Figure 9 shows FMC's monthly hedges in place for 2014 as of September 30, 2013, together with the weighted average monthly natural gas price achieved through hedging.[10] As shown, FMC has hedged a total of 5,309,744 mmBtus for 2014, with varying monthly volumes based on forecasted needs. Table 25 provides more details on these OTC calendar strip hedges. As shown, the 2014 calendar strips were first executed beginning on December 21, 2012, with more added on a monthly basis through to September 2013, which is the last date we have data from FMC and is the last hedge it placed.

FMC's hedging approach is to execute hedges in the market 10-12 times per year, about once a month, so it layers in next year's hedges at several points in time at prevailing market prices. This monthly average hedging approach is preferred over attempting to pick the best time (ie lower overall price) to execute the hedges all at once. In our opinion, this demonstrates sound risk management by FMC.

Figure 9

[8] See FMC's 2012 10-K report, page 81.

[9] A calendar strip is a series of futures or forward contracts that are monthly (January through December) for the year being hedged.

[10] At standard conditions, one mmBtu of natural gas is equal to one mcf of natural gas. Natural gas futures contracts are traded in mmBtu but natural gas is typically sold in $/mcf. Mcf stands for a thousand cubic feet of natural gas.

FMC 2014 OTC NATURAL GAS CALENDAR STRIP HEDGE VOLUMES AND AVERAGE PRICES

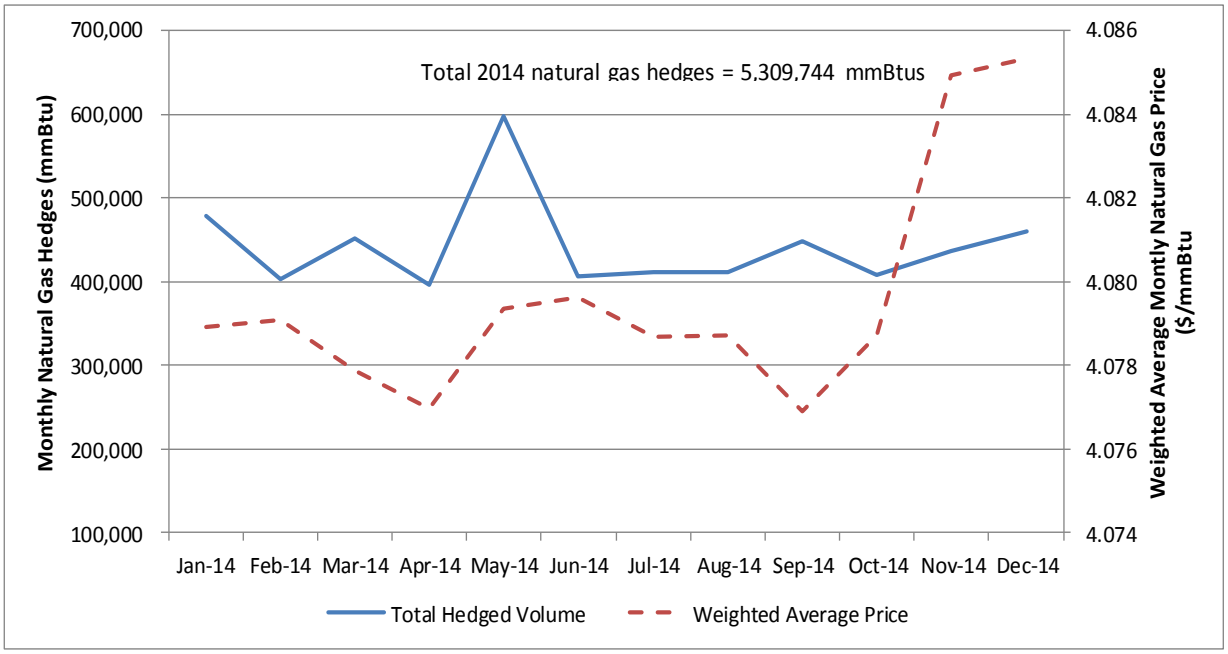


Table 25

FMC 2014 OTC CALENDAR STRIPS EXECUTED BEGINNING ON DECEMBER 21, 2012 THROUGH SEPTEMBER 2013

Natural Gas Volume Units in mmBTU

Date OTC Strip Executed	Strip Fixed Price	Jan-14	Feb-14	Mar-14	Apr-14	May-14	Jun-14	Jul-14	Aug-14	Sep-14	Oct-14	Nov-14	Dec-14	Total
12/21/2012	$4.091	41,710	34,917	38,973	32,717	54,202	34,900	33,793	33,894	38,694	34,760	39,420	41,820	459,800
1/25/2013	$4.113	41,710	34,917	38,974	32,717	54,202	34,900	33,793	33,894	38,695	34,760	39,420	41,820	459,802
2/22/2013	$3.9780	60,910	52,197	57,454	51,917	71,002	53,620	52,993	53,093	51,414	53,960	58,140	61,020	677,720
3/27/2013	$4.2130	48,110	40,677	45,134	39,117	59,802	41,140	40,193	40,293	42,935	41,160	45,660	48,219	532,440
4/27/2013	$4.3180	48,110	40,677	45,133	39,783	59,802	41,140	42,334	42,250	45,055	41,160	45,660	48,219	539,323
5/18/2013	$4.3820	48,110	40,680	45,130	39,785	59,800	41,140	42,335	42,250	45,050	41,160	45,660	48,220	539,320
6/12/2013	$4.0300	48,050	40,598	45,115	39,783	59,783	41,140	42,353	42,271	45,073	41,160	40,879	42,401	528,606
7/16/2013	$4.0450	48,050	40,600	45,115	39,780	59,785	41,140	42,355	42,270	45,070	41,160	40,880	42,400	528,605
8/8/2013	$3.7025	48,050	40,600	45,115	39,780	59,780	41,140	42,355	42,270	45,070	41,160	40,880	42,400	528,600
9/13/2013	$3.9430	45,956	37,805	46,201	41,096	59,264	35,659	38,220	38,119	51,432	38,034	39,957	43,785	515,528
Summary	$4.079	478,766	403,668	452,344	396,475	597,422	405,919	410,724	410,604	448,488	408,474	436,556	460,304	5,309,744

Hedge replication

While calendar strips are also traded on the New York Mercantile Exchange (NYMEX), these exchange-traded calendar strips have fixed monthly volumes of 10,000 mmBtu.[11] To replicate what it achieves in the OTC market by using the NYMEX contracts, FMC would need to do the following. First, it would need to take its lowest usage month and buy the closest NYMEX calendar strip. Then, to vary the volumes monthly, additional individual futures contracts must be added each month to hedge monthly volumes in excess of the calendar strip. This NYMEX replication of OTC hedges results in one calendar strip plus 12 monthly futures contracts (ie, a minimum of 13 futures contracts that must be individually managed going forward if monthly volumes vary by 10,000 mmBtu or more).

[11] For example, to hedge 30,000 mmBtu in a month using a NYMEX calendar strip, FMC would need to buy three calendar strips to obtain a hedge of 30,000 mmBtu/ month (360,000 mmBtu/year).

For example, consider the 2014 OTC calendar strip executed on February 22, 2013 at a fixed strip price of $3.978/mmBtu (see Table 25). The lowest volume for this OTC calendar strip is 51,414 mmBtu in September 2014 (see the row in the table for the February 22, 2013 strip). FMC would need to purchase five NYMEX calendar strips (10,000 x 5 = 50,000 mmBtu strip) to hedge this 2014 minimum volume throughout the year. Then, to hedge 60,910 mmBtu in January 2014, one additional futures contract would need to be purchased to hedge the additional 10,000 mmBtu. For February 2014, one E-mini futures contract would need to be purchased to match the expected usage of 52,197 mmBtu. [12] Of course, it will be impossible to fine-tune the hedge to match the exact volumes shown in Table 25 using NYMEX futures, even if using the E-mini futures contracts.

A similar procedure will need to implemented for the remaining months of the year. Overall, when using the OTC markets, FMC only needs to hedge using one calendar strip contract with a fixed price for the year, as compared to 13 exchange-traded contracts, because the OTC contracts can be structured to whatever the end-user needs on a monthly basis. Furthermore, FMC finds that the liquidity is much greater in the OTC markets.

Mark-to-market and stress testing using Monte Carlo simulation

Table 26 shows the detailed MTM calculations for the positions in Table 25 if calculated using December 26, 2013 closing NYMEX futures prices. On December 26, the combined hedges for 2014 have an MTM gain of $1,186,510.

[12] E-mini natural gas futures contracts are traded on the NYMEX in 2500 mmBtu volumes (i.e., 1/4th the size of the standard futures contract).

Table 26

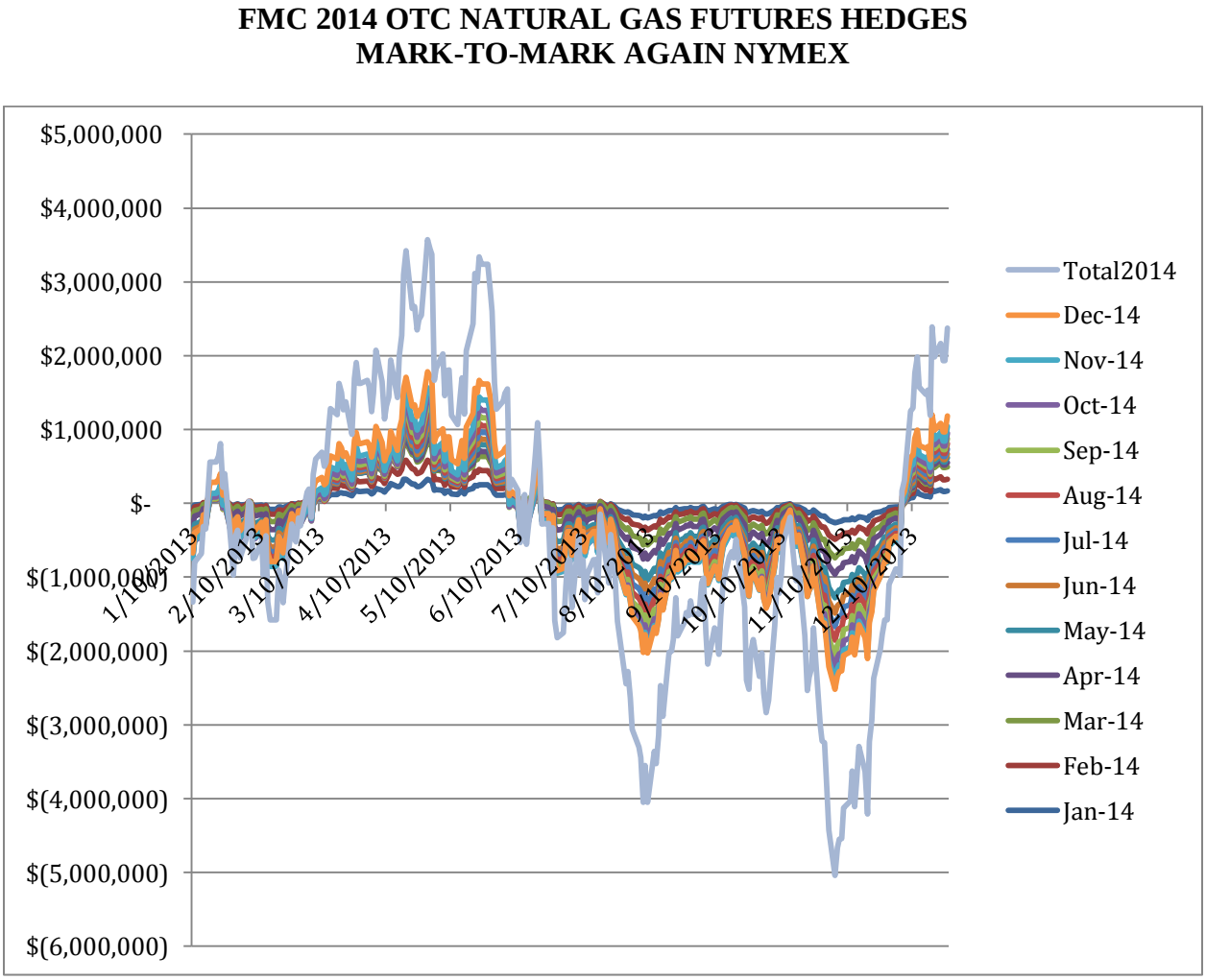
FMC 2014 NATURAL GAS FUTURES HEDGES MARK-TO-MARKET AGAINST NYMEX PRICES ON DECEMBER 26, 2013

		Jan-14	Feb-14	Mar-14	Apr-14	May-14	Jun-14	Jul-14	Aug-14	Sep-14	Oct-14	Nov-14	Dec-14	Total
	Hedge Volume	41,710	34,917	38,973	32,717	54,202	34,900	33,793	33,894	38,694	34,760	39,420	41,820	459,800
Fixed Price	Price	$4.091	$4.091	$4.091	$4.091	$4.091	$4.091	$4.091	$4.091	$4.091	$4.091	$4.091	$4.091	$4.091
12/21/2012	NYMEX	$4.433	$4.476	$4.441	$4.220	$4.192	$4.212	$4.239	$4.249	$4.236	$4.255	$4.294	$4.399	$4.303
	Unit Difference	$0.342	$0.385	$0.350	$0.129	$0.101	$0.121	$0.148	$0.158	$0.145	$0.164	$0.203	$0.308	$0.212
	Marked to market	$14,265	$13,443	$13,641	$4,220	$5,474	$4,223	$5,001	$5,355	$5,611	$5,701	$8,002	$12,881	$97,817
	Hedge Volume	41,710	34,917	38,974	32,717	54,202	34,900	33,793	33,894	38,695	34,760	39,420	41,820	459,802
Fixed Price	Price	$4.113	$4.113	$4.113	$4.113	$4.113	$4.113	$4.113	$4.113	$4.113	$4.113	$4.113	$4.113	$4.113
1/25/2013	NYMEX	$4.433	$4.476	$4.441	$4.220	$4.192	$4.212	$4.239	$4.249	$4.236	$4.255	$4.294	$4.399	$4.303
	Unit Difference	$0.320	$0.363	$0.328	$0.107	$0.079	$0.099	$0.126	$0.136	$0.123	$0.142	$0.181	$0.286	$0.190
	Marked to market	$13,347	$12,675	$12,783	$3,501	$4,282	$3,455	$4,258	$4,610	$4,759	$4,936	$7,135	$11,961	$87,702
	Hedge Volume	60,910	52,197	57,454	51,917	71,002	53,620	52,993	53,093	51,414	53,960	58,140	61,020	677,720
Fixed Price	Price	$3.9780	$3.9780	$3.9780	$3.9780	$3.9780	$3.9780	$3.9780	$3.9780	$3.9780	$3.9780	$3.9780	$3.9780	$3.978
2/22/2013	NYMEX	$4.433	$4.476	$4.441	$4.220	$4.192	$4.212	$4.239	$4.249	$4.236	$4.255	$4.294	$4.399	$4.303
	Unit Difference	$0.455	$0.498	$0.463	$0.242	$0.214	$0.234	$0.261	$0.271	$0.258	$0.277	$0.316	$0.421	$0.325
	Marked to market	$27,714	$25,994	$26,601	$12,564	$15,194	$12,547	$13,831	$14,388	$13,265	$14,947	$18,372	$25,689	$221,108
	Hedge Volume	48,110	40,677	45,134	39,117	59,802	41,140	40,193	40,293	42,935	41,160	45,660	48,219	532,440
Fixed Price	Price	$4.2130	$4.2130	$4.2130	$4.2130	$4.2130	$4.2130	$4.2130	$4.2130	$4.2130	$4.2130	$4.2130	$4.2130	$4.213
3/27/2013	NYMEX	$4.433	$4.476	$4.441	$4.220	$4.192	$4.212	$4.239	$4.249	$4.236	$4.255	$4.294	$4.399	$3.595
	Unit Difference	$0.220	$0.263	$0.228	$0.007	($0.021)	($0.001)	$0.026	$0.036	$0.023	$0.042	$0.081	$0.186	($0.618)
	Marked to market	$10,584	$10,698	$10,291	$274	($1,256)	($41)	$1,045	$1,451	$988	$1,729	$3,698	$8,969	$48,429
	Hedge Volume	48,110	40,677	45,133	39,783	59,802	41,140	42,334	42,250	45,055	41,160	45,660	48,219	539,323
Fixed Price	Price	$4.3180	$4.3180	$4.3180	$4.3180	$4.3180	$4.3180	$4.3180	$4.3180	$4.3180	$4.3180	$4.3180	$4.3180	$4.318
4/27/2013	NYMEX	$4.433	$4.476	$4.441	$4.220	$4.192	$4.212	$4.239	$4.249	$4.236	$4.255	$4.294	$4.399	$3.595
	Unit Difference	$0.115	$0.158	$0.123	($0.098)	($0.126)	($0.106)	($0.079)	($0.069)	($0.082)	($0.063)	($0.024)	$0.081	($0.723)
	Marked to market	$5,533	$6,427	$5,551	($3,899)	($7,535)	($4,361)	($3,344)	($2,915)	($3,695)	($2,593)	($1,096)	$3,906	($8,021)
	Hedge Volume	48,110	40,680	45,130	39,785	59,800	41,140	42,335	42,250	45,050	41,160	45,660	48,220	539,320
Fixed Price	Price	$4.3820	$4.3820	$4.3820	$4.3820	$4.3820	$4.3820	$4.3820	$4.3820	$4.3820	$4.3820	$4.3820	$4.3820	$4.382
5/18/2013	NYMEX	$4.433	$4.476	$4.441	$4.220	$4.192	$4.212	$4.239	$4.249	$4.236	$4.255	$4.294	$4.399	$3.595
	Unit Difference	$0.051	$0.094	$0.059	($0.162)	($0.190)	($0.170)	($0.143)	($0.133)	($0.146)	($0.127)	($0.088)	$0.017	($0.787)
	Marked to market	$2,454	$3,824	$2,663	($6,445)	($11,362)	($6,994)	($6,054)	($5,619)	($6,577)	($5,227)	($4,018)	$820	($42,537)
	Hedge Volume	48,050	40,598	45,115	39,783	59,783	41,140	42,353	42,271	45,073	41,160	40,879	42,401	528,606
Fixed Price	Price	$4.0300	$4.0300	$4.0300	$4.0300	$4.0300	$4.0300	$4.0300	$4.0300	$4.0300	$4.0300	$4.0300	$4.0300	$4.030
6/12/2013	NYMEX	$4.433	$4.476	$4.441	$4.220	$4.192	$4.212	$4.239	$4.249	$4.236	$4.255	$4.294	$4.399	$3.595
	Unit Difference	$0.403	$0.446	$0.411	$0.190	$0.162	$0.182	$0.209	$0.219	$0.206	$0.225	$0.264	$0.369	($0.435)
	Marked to market	$19,364	$18,107	$18,542	$7,559	$9,685	$7,487	$8,852	$9,257	$9,285	$9,261	$10,792	$15,646	$143,837
	Hedge Volume	48,050	40,600	45,115	39,780	59,785	41,140	42,355	42,270	45,070	41,160	40,880	42,400	528,605
Fixed Price	Price	$4.0450	$4.0450	$4.0450	$4.0450	$4.0450	$4.0450	$4.0450	$4.0450	$4.0450	$4.0450	$4.0450	$4.0450	$4.045
7/16/2013	NYMEX	$4.433	$4.476	$4.441	$4.220	$4.192	$4.212	$4.239	$4.249	$4.236	$4.255	$4.294	$4.399	$3.595
	Unit Difference	$0.388	$0.431	$0.396	$0.175	$0.147	$0.167	$0.194	$0.204	$0.191	$0.210	$0.249	$0.354	($0.450)
	Marked to market	$18,643	$17,499	$17,866	$6,961	$8,788	$6,870	$8,217	$8,623	$8,608	$8,644	$10,179	$15,010	$135,908
	Hedge Volume	48,050	40,600	45,115	39,780	59,780	41,140	42,355	42,270	45,070	41,160	40,880	42,400	528,600
Fixed Price	Price	$3.7025	$3.7025	$3.7025	$3.7025	$3.7025	$3.7025	$3.7025	$3.7025	$3.7025	$3.7025	$3.7025	$3.7025	$3.703
8/8/2013	NYMEX	$4.433	$4.476	$4.441	$4.220	$4.192	$4.212	$4.239	$4.249	$4.236	$4.255	$4.294	$4.399	$3.595
	Unit Difference	$0.731	$0.774	$0.739	$0.518	$0.490	$0.510	$0.537	$0.547	$0.534	$0.553	$0.592	$0.697	($0.108)
	Marked to market	$35,101	$31,404	$33,317	$20,586	$29,262	$20,961	$22,723	$23,101	$24,045	$22,741	$24,181	$29,532	$316,953
	Hedge Volume	45,956	37,805	46,201	41,096	59,264	35,659	38,220	38,119	51,432	38,034	39,957	43,785	515,528
Fixed Price	Price	$3.9430	$3.9430	$3.9430	$3.9430	$3.9430	$3.9430	$3.9430	$3.9430	$3.9430	$3.9430	$3.9430	$3.9430	$3.943
9/13/2013	NYMEX	$4.433	$4.476	$4.441	$4.220	$4.192	$4.212	$4.239	$4.249	$4.236	$4.255	$4.294	$4.399	$3.595
	Unit Difference	$0.490	$0.533	$0.498	$0.277	$0.249	$0.269	$0.296	$0.306	$0.293	$0.312	$0.351	$0.456	($0.348)
	Marked to market	$22,518	$20,150	$23,008	$11,384	$14,757	$9,592	$11,313	$11,664	$15,070	$11,867	$14,025	$19,966	$185,314
		Jan-14	Feb-14	Mar-14	Apr-14	May-14	Jun-14	Jul-14	Aug-14	Sep-14	Oct-14	Nov-14	Dec-14	Total
Summary	Total HV	478,766	403,668	452,344	396,475	597,422	405,919	410,724	410,604	448,488	408,474	436,556	460,304	5,309,744
	% Hedged	81%	80%	80%	81%	82%	81%	81%	81%	80%	85%	81%	82%	81%
	WA Price	$4.079	$4.079	$4.078	$4.077	$4.079	$4.080	$4.079	$4.079	$4.077	$4.079	$4.085	$4.085	$4.080
	NYMEX	$4.433	$4.476	$4.441	$4.220	$4.192	$4.212	$4.239	$4.249	$4.236	$4.255	$4.294	$4.399	$4.303
	Unit Difference	$0.354	$0.397	$0.363	$0.143	$0.113	$0.132	$0.160	$0.170	$0.159	$0.176	$0.209	$0.314	$0.223
	Marked to market	$169,523	$160,220	$164,263	$56,705	$67,290	$53,740	$65,842	$69,914	$71,358	$72,004	$91,271	$144,378	$1,186,510

Figure 10 illustrates the FMC 2014 OTC calendar strip hedges shown in Table 25 if marked to market daily in 2013 (through to December 26) against NYMEX futures prices. Note: since these hedges are currently in place and will not expire until 2014, we show current mark-to-market using the latest data available at the time of writing this case study. NYMEX futures prices are obtained from DataStream. As shown, there is

high variance in the MTM for 2013 with a maximum of a $1,786,228 gain, a minimum of a $2,519,801 loss, a mean loss of 214,457and a standard deviation of $950,559.

Figure 10



Over the period 2008-2013, natural gas futures prices (front-month contract) have been very volatile, as illustrated in Figure 11. Given these extreme price movements, it is crucial to conduct stress testing of the hedge portfolio and analyze the risk of the MTM requirements. Given the recent collapse in natural gas prices, we select 2011 to 2013

prices, fit the data to a distribution using @Risk, and conduct Monte Carlo simulation. One of the best fits is a Weibull distribution, as shown in Figure 12.

Figure 11

NATURAL GAS FUTURES DAILY FRONT MONTH PRICES IN $/mmBtu FOR 2008-2013

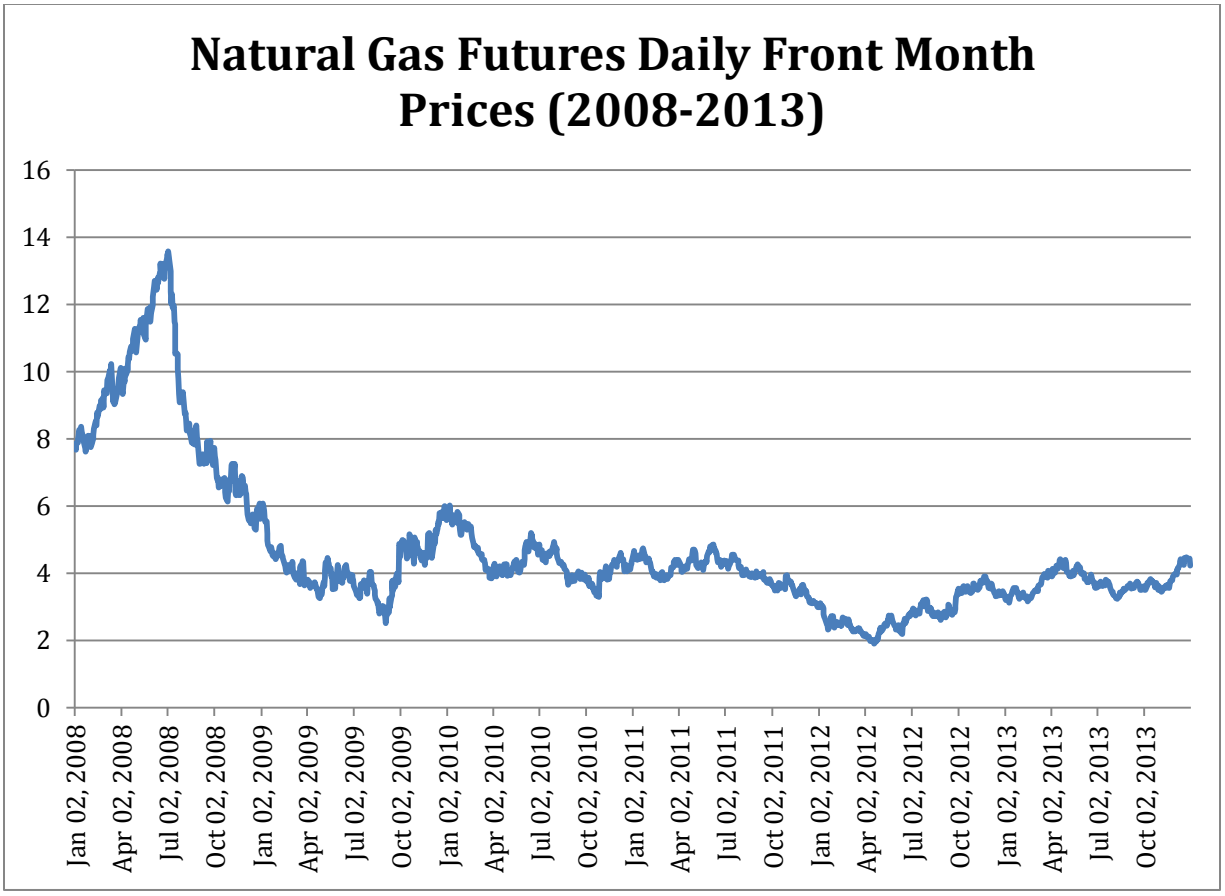
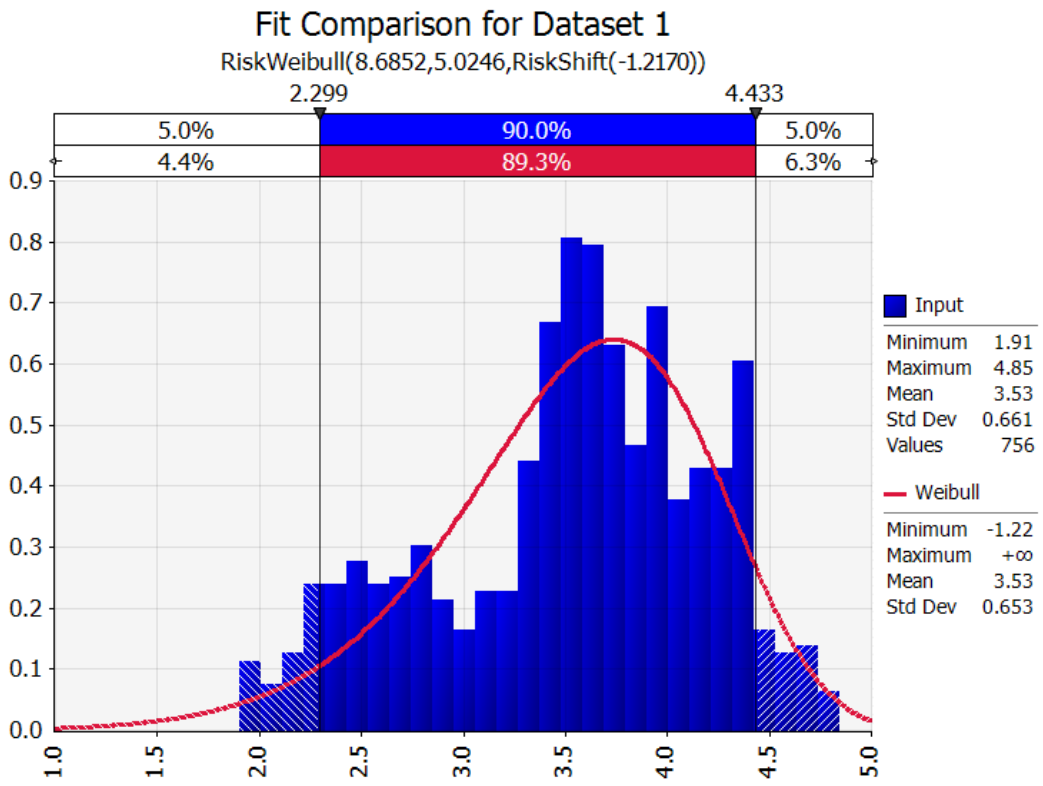


Figure 12

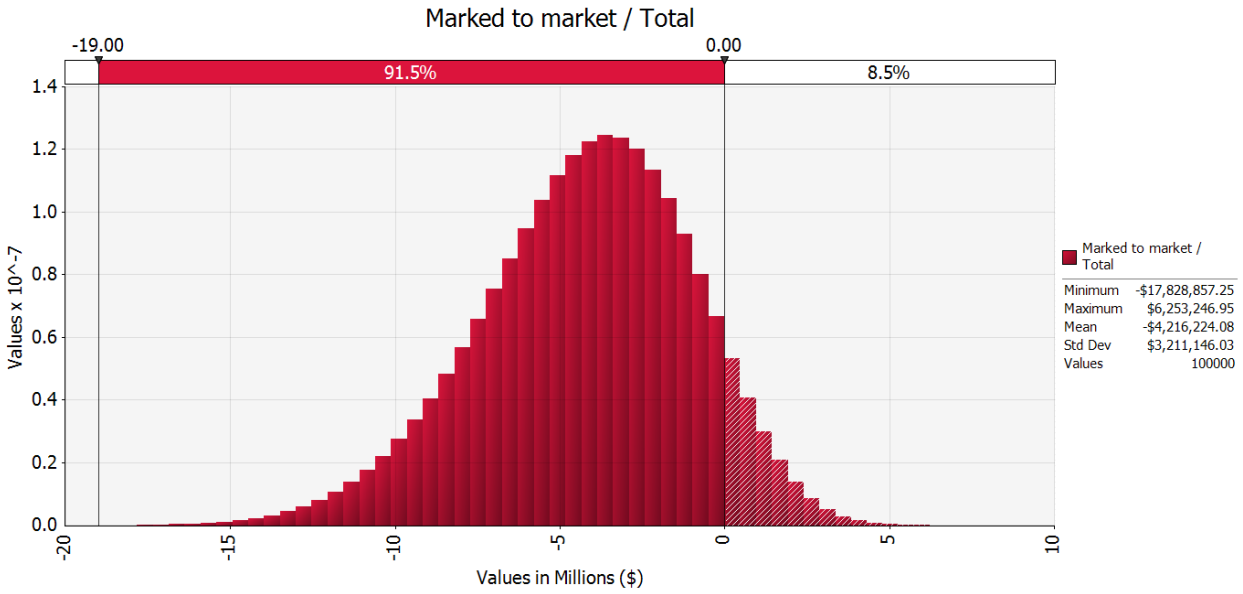
RISK DISTRIBUTION FIT FOR 2011-2013 DAILY PRICES



We run 100,000 simulations of the FMC portfolio MTM requirements, and the results are presented in Figure 13. The MTM ranges from a loss of $17,828,857 to a gain of $6,253,247, with a mean loss of $4,216,224. There is a 91.5% probability that the MTM will be a loss. It is important to note that this understates the actual MTM because we have assumed netting in the calculations. Actual posting of margins will be larger.

Figure 13

MONTE CARLO SIMULATION OF THE MTM



Costs of end-user margining

FMC does not post any collateral currently for its OTC hedges under the collateral agreements it has in place with its counterparties. If FMC was required to post a 3% or 10% margin on its total hedged volume of 5,309,744 shown in Table 25, this would represent margin requirements of $649,854 and $2,166,180, respectively, at a natural gas price of $4.08/mmBtu. Furthermore, FMC would need to hold more cash reserves to meet potential margin calls due to MTM variability such as that exhibited in Figures 10 and 13.

FMC, like most non-financial firms, does not have the trading desk of a bank. FMC has two staff members responsible for these positions and they do it along with many other work responsibilities. If exchange-traded instruments had to be used, the approximately 12 OTC positions would become roughly 144 positions for FMC, making it very difficult to manage at that point. This would require additional staff and/or increased investments in computer systems for tracking. Overall, forcing OTC instruments to be cleared would make hedging much more difficult to manage for firms like FMC, would be less efficient and effective, would require additional cash reserves, and would increase costs.

CONCLUSION

The objective of this study is to demonstrate the value of OTC derivatives to non-financial firms. Non-financial firms are now exempt from uncleared margin rules, which were finalized in September 2013.[13] As a worst-case scenario, this study documents that if the current rules were changed and made clearing mandatory for non-financial firms, it would have a significant and negative economic impact. Four case studies are presented where OTC derivative hedges are replicated using only exchange-traded derivatives available at the time of the hedge. In all cases, exchange-traded derivatives were less effective.

Important implications of our findings are as follows:

- There are not always suitable exchange-traded derivatives available to replace OTC hedges.
- OTC hedges can be more efficient and effective as compared to exchange-traded alternatives.
- OTC hedges can reduce earnings per share volatility as compared to the exchange-traded alternatives.
- MTM and resulting margin requirements can impact the liquidity of non-financial firms and increase costs of operations.
- Exchange-traded derivatives can lead to increased ineffectiveness and may potentially not qualify for FAS 133 hedge accounting.
- The costs of end-user margining will be significantly higher if mandatory clearing was required for non-financial firms. As discussed earlier, non-financial are exempt.

Overall, the cases studied provide anecdotal evidence to illustrate the value of the OTC markets. These case studies can be used as a basis for a larger study to future knowledge on the many benefits that OTC markets provide, especially to non-financial firms.

[13] For more information, see ISDA's website at http://www2.isda.org/.

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