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The Value Effects of Foreign Currency and Interest Rate Hedging: The UK Evidence

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ABSTRACT

In this paper we use UK data to present empirical evidence on the valuation and debt capacity effects of foreign currency (FC) and interest rate (IR) hedging. We build on recent studies that have presented mixed results on the link between hedging, leverage and firm value. Our results provide evidence of a significant relationship between firm value, measured as Tobin's Q, and foreign currency and interest rate hedging. These findings are much stronger than those found in previous studies that have examined US firms. Our empirical evidence suggests that this is due to the fact the US studies include in their non-hedging sample other hedging firms, such as firms using non-derivative methods for hedging, which can bias the results against finding positive leverage and firm value effects. The larger value effects in our results could also be due to institutional differences in the bankruptcy codes between the UK and the US that cause higher expected financial distress costs for UK firms and therefore greater benefits generated by hedging. When we look at debt capacity and the tax shield effects of hedging, we find that investors reward interest rate hedgers with a larger hedging premium than that rewarded for FC hedging. In fact, our results show that the debt capacity benefits of interest rate only hedging are around six times those generated by FC only hedging. Finally, the debt capacity results in relation to IR hedging and the Tobin's Q results show that derivative hedging generates more value than non-derivative hedging.

JEL Classification: F30, G32, G33

Keywords: Firm value; Foreign currency hedging; Interest rate hedging; Derivatives; Debt capacity; Leverage; Financial distress.

I. INTRODUCTION

The positive theory of corporate hedging developed by Smith and Stulz (1985) is based on the demonstration that imperfect capital markets can create conditions where corporate hedging becomes economically justified because it can add value to the firm. Many studies have examined what these conditions are and why firms might be using derivatives for hedging. The key question for shareholders, however, is whether hedging does, in fact, add value to the firm. Empirical research on this question is relatively recent, generally focused on the US and, since commodity price hedging seems to be generally limited to specific industries, has concentrated on interest rate and foreign currency hedging. In this paper we extend this literature and study the value effects of the interest rate (IR) and foreign currency (FC) hedging practices of a sample taken from the top 500 non-financial firms in the UK ranked by market value as of year-end 1995.

The UK data for this period is well adapted to the value testing we propose for several reasons. At the time the UK had (and still has) a large number of firms with foreign operations. These firms were facing continuous currency risk because the pound had been floating since its withdrawal from the European currency mechanism in 1992. The economy was highly industrialized and open with developed, generally unrestricted capital markets and trading partners that were predominantly in the same conditions. Thus, the financing and hedging decisions by the firms in our sample are likely to reflect economic and financial criteria rather than the result of constraints imposed by shallow domestic capital markets, bureaucratic controls and the like. Furthermore, the year 1995 is at the midpoint of the years included in the studies cited in this paper and, thus, serves as a good point of comparison.

The innovation in this study that makes our results so interesting is that we organize the tests so that the value effects of each type of hedging, both interest rate and foreign currency, and each type of instrument, both derivative and non-derivative, can be isolated and estimated independently in order to eliminate any potential bias. The failure of other studies to do this weakens their results and probably explains why the evidence is so mixed. For example, in a study that measures the effect of derivatives use on Tobin's Q as a proxy for firm value, Bartram, Brown and Fehle (2004) find a significant positive value effect for all derivative users taken together but perversely only for firms without any financial price exposure. Furthermore, when broken down according to hedging type, no value effects are found for FC derivative users and interest rate derivatives use generates positive valuation effects for firms with and without interest rate exposure. Also, contrary to expectations the extent of the increase in value is larger for firms with very little interest rate exposure. The problem is that when they break down the sample by hedging type, their sample of non-FC (IR) hedgers includes hedgers that also hedge other kinds of risk. Consequently, their tests are likely to understate the value generated from FC (IR) hedging.

The other studies using Tobin's Q suffer from the same kind of problem and results are mixed. Allayannis and Weston (2001) find that FC derivatives use is associated with an increase in firm value while Allaynnis, Ihrig and Weston (2001) find that FC operational hedging increases firm value only when combined with derivatives. Kim, Mathur and Nam (2006) find that both operational hedging and financial hedging add to firm value but unlike Allayannis et al. (2001) they find that operational hedging

generates up to five times more value than financial hedging.[1] Nain (2004) finds that firms that choose not to hedge FC risk in industries where FC derivatives use is prevalent had 5% lower Tobin's Q than their hedged competitors. Allayannis, Lel and Miller (2004) find that the FC hedging premium is statistically significant and economically large only for firms that have strong internal and external corporate governance. Where commodity hedging is concerned, results are also mixed. Lookman (2004) reports that once agency conflicts have been controlled for, valuation effects associated with hedging become largely insignificant. Carter et al. (2004) find that jet fuel hedging increases value while Jin and Jorion (2006) find no value effects from hedging in the US oil and gas sectors.[2]

Results are also inconclusive when the value added from hedging is associated with a specific explanation of why firms hedge. This literature revolves around the debt capacity benefits of hedging developed by Stulz (1996), Ross (1997), and Leland (1998), who show that by reducing the probability of financial distress, hedging increases debt capacity. In this framework hedging increases a firm's ability to take on more debt (i.e., debt capacity). If firms respond by adding to their leverage, this will lead to an increase in interest deductions, which in turn generates incremental tax shield benefits that can increase firm value. Three studies investigate the debt capacity effects due to FC hedging with mixed results. Using a hedging dummy dependent variable for a sample of US firms both Géczy *et al.* (1997) and Graham and Rogers (2002) find that leverage is not affected by FC hedging. Bartram *et al*. (2004) employ a sample of close to 5000 firms from around the world. They find that hedging is associated with an increase in leverage ranging from 3% for FC derivative users, 9% for all derivative users, 11% for IR derivative users and 15% for commodity derivative users. These translate into a mean increase in value of 0.32% for currency derivative users, 0.82% for general derivative users, 1.28% for interest rate derivative users and 1.71% for commodity price derivative users. The larger debt capacity effect for commodity price hedging is curious, given that the link between interest rate hedging, debt capacity and leverage is a more obvious relation than commodity price hedging, debt capacity and hedging.

Borokovich *et al*. (2004) also examine the debt capacity effects of IR hedging. They find a positive and statistically significant relationship between leverage and IR derivative use for a sample of U.S. firms, which is consistent with the argument that firms that hedge bankruptcy risk can increase leverage and make greater use of the interest tax shield from debt. Where commodity price hedging is concerned, Dionne and Triki (2004) find that the relation between debt and risk management for U.S. and Canadian gold mining firms goes mainly in the direction of firms hedging in order to decrease the financial distress costs caused by leverage, rather than firms managing risk in order to increase their debt capacity.

Besides the problem in the Tobin's Q tests of including other hedgers in the sample of FC (IR) hedgers and thereby blurring the effect of the type of hedging being tested, debt capacity tests also include firms that might be hedging IR (FC) and/or commodity price exposure in the non-hedging sample. Under the reasonable assumption that the hedging activities of these "other" hedgers would also induce higher debt capacity, the inclusion of these "other" hedging firms in the non-hedging sample might make it more difficult to detect the leverage effects associated with hedging. This problem would be especially pronounced for FC hedging tests where the

majority of "other" hedgers are interest rate hedgers, for whom the leverage effects are likely to be relatively higher.[3]

In this paper, we first run the tests as in the foregoing papers. We then correct for the potential bias by eliminating the "other" hedgers from the hedging and non-hedging samples and re-run the tests. This paper makes several contributions to the literature.

First of all, we find that both FC and IR hedging are significant explanatory variables for firm value creation when measured as Tobin's Q and when measured as a tax shield through increased debt capacity. Their effects are also larger than those reported in previous studies examining US firms. Where FC hedging is concerned, this is probably due, at least in part, to the fact that UK firms face significantly higher levels of FC exposure relative to their US counterparts. For example, Allayannis and Weston (2001) report that the mean (median) level of foreign sales is 18 percent (3 percent) for their sample of US firms during the period 1990-95. For our sample (1994-95) the average level of foreign sales is nearly double at 35 percent and the median, at 29 percent, is over nine times that of US firms. The Tobin's Q and debt capacity effects might also be due to the fact that the UK bankruptcy code confers greater rights to creditors than the US code. Thus, if the UK rules make liquidation more likely for firms in financial distress, then UK firms potentially face higher expected costs of financial distress than firms in the US, thereby raising the potential gains to be made through hedging.

In a second contribution we show that controlling for "other" hedgers in the samples of non-hedgers changes the results considerably. In the Tobin's Q tests for both FC and IR derivatives hedging, the coefficient is positive and significant with and without the controls. However, after controlling for "other" hedgers, the coefficient is 72% larger for FC derivatives and 52% larger for IR derivatives with higher p-values for both. The results are even more pronounced for the debt capacity tests. In the tests that include "other" hedgers in the non-hedging sample, the coefficient for all FC hedgers is small and not significant. When we exclude "other" hedgers from the non-hedging sample, the coefficient is over three times larger with a p-value of 0.000. When we look at "FC derivatives users" before controlling for "other" hedgers, the coefficient is negative and significant. After controlling for "other" hedgers, the coefficient is positive and significant. Interestingly, the inclusion of other hedgers in the IR analysis does not affect the sign or the significance of the IR hedging coefficient in the second stage estimation, which is positive and highly significant with or without other hedgers.

A third contribution concerns the debt capacity effects of FC and IR hedging where we control for the cross effects of FC and IR hedging on debt capacity by using samples of FC only hedgers and IR only hedgers. Our results show that firms that only hedge FC generate significant positive debt capacity and hence value effects, but that IR hedging creates substantially more firm value from debt capacity (over 6 times as much) than FC hedging. This is consistent with the notion that IR hedging facilitates more leverage because lenders might make the incremental debt contingent on the commitment to hedge. Without the commitment to hedge, the new debt financing would not be forthcoming. Results for the Tobin's Q analysis are more ambiguous. FC only hedging generates similar value effects to that of FC hedgers who might also be IR hedgers while in the IR only hedgers' specification the coefficient is not significant.

The final contribution gives evidence that derivative only hedging is superior to other types of hedging. Although in the debt capacity tests we find that all FC hedging created more value than FC derivative hedging, IR derivative hedging created more value than all IR hedging. In the Tobin's Q analysis restricting hedgers to derivative users generated larger coefficients for both IR and FC hedging (after excluding other hedgers) than when the more inclusive definitions of hedging were employed. This suggests that derivatives hedging is more value enhancing than other hedging methods.

The remainder of the paper proceeds as follows. Section II describes the sample. Sections III and IV present the results and Section V concludes.

II. SAMPLE DESCRIPTION AND SOURCES OF DATA ON FOREIGN CURRENCY AND INTEREST RATE HEDGING

The sample consists of 412 non-financial firms taken from the top 500 non-financial firms in the UK ranked by market value as of year-end 1995. The data on FC and IR hedging was obtained from qualitative risk management disclosures in annual reports. This study classifies firms as FC (IR) hedgers as those that make any reference in their annual report to hedging their FC (IR) exposures. We recognise that firms utilise a range of hedging techniques, which include non-derivative as well as derivative based hedges. Therefore, our definition of FC (IR) includes both derivative and non-derivative hedging. Examples of the latter include the use of FC debt financing to hedge the exposures arising from foreign operations and the attempt to match the interest rate profile of the firm's debt with that of its operating cash flows, such as the decision to issue fixed rate debt financing.

Panel A of Table 1 shows that 70.4 percent of firms in our sample are classified as foreign currency hedgers, whereas only 44.4 percent were deemed to be interest rate hedgers. Corresponding figures for US firms shows that FC hedging activity is less widespread in the US but participation in IR hedging is comparable to that of the UK.[4] We also provide a breakdown of FC (IR) hedgers by identifying the combinations of exposures hedged. Panel B shows that 47.2 percent of FC hedgers hedged both FC and IR and 44.1 percent only hedged FC. The corresponding figures for the IR hedging sample are 74.9 and 15.3 percent respectively. Panel C shows that the sample of FC (IR) non-hedgers consists of both non-hedging firms and firms hedging other exposures. In the FC non-hedging sample 25.5 percent are other hedgers, these being mostly IR hedgers. In the case of the IR non-hedging sample 60.3 percent are hedging other exposures. The inclusion of these hedgers in the FC and IR non-hedging sample might bias the empirical results against a significant positive hedging premium and or debt capacity effect. Since the IR non-hedging sample contains a far greater proportion of other hedgers we would expect the bias to be greater in the IR hedging value tests. Panel E shows that the FC and IR non-derivative using samples contain a majority of other hedgers, 53.8 and 63.6 percent, respectively. This suggests the potential for a greater bias when looking at the value effects of FC (IR) derivative hedging.

Table 1
Foreign currency (FC), interest rate (IR) and commodity price (CP) hedging activity disclosures by UK firms

	Foreign Currency		Interest Rate	
Panel A: FC (IR) Hedging Activity	**No.**	**%**	**No.**	**%**
Hedging FC (IR) exposure	290	70.4	183	44.4
Not hedging FC (IR) exposure	6	1.5	9	2.2
No disclosure on FC (IR) hedging	116	28.1	220	53.4
Total	412	100.0	412	100.0
Panel B: FC (IR) Hedgers Hedging Other Exposures	**No.**	**%**	**No.**	**%**
FC (IR) hedging only	128	44.1	28	15.3
FC & IR hedging	137	47.2	137	74.9
FC & CP hedging	7	2.4	0	0.0
FC & IR & CP hedging	18	6.2	18	9.8
Total	290	100.0	183	100.0
Panel C: FC (IR) Non-Hedgers Hedging Other Exposures	**No.**	**%**	**No.**	**%**
Not hedging any category of exposure	91	74.5	91	39.7
IR hedging	28	23.0	0	0.0
FC hedging	0	0.0	128	55.9
FC (IR) & CP hedging	0	0.0	7	3.1
CP hedging	3	2.5	3	1.3
Total	122	100.0	229	100.0
Panel D: Firms Using Derivatives For Hedging	**No.**	**%**	**No.**	**%**
FC (IR) derivatives	215	52.2	162	39.3
FC (IR) non-derivative user	197	47.8	250	60.7
Total	412	100.0	412	100.0
Panel E: FC (IR) Non-Derivative Users	**No.**	**%**	**No.**	**%**
Not hedging any category of exposure	91	46.2	91	36.4
IR hedging	28	14.2	21	8.4
FC hedging	75	38.1	128	51.2
FC (IR) & CP hedging	0	0.0	7	2.8
CP hedging	3	1.5	3	1.2
Total	197	100.0	250	100.0

Table 1 presents data on the number of FC (IR) hedgers amongst the sample of 412 firms. Panel A provides data on the number of FC (IR) hedging firms. A firm is defined as a FC (IR) hedger if it provides a qualitative disclosure of any FC (IR) hedging activity in its annual report. Panel B presents data on combinations of exposures hedged by FC (IR) hedgers. Panel C gives details of other exposures hedged by firms not hedging FC (IR) exposure. Panel D provides details of the use of FC (IR) derivatives for FC (IR) hedging and panel E presents a breakdown of the constituents of FC (IR) non-derivative users.

Table 2 presents summary statistics of the main variables used in this study. The mean value of total assets for our sample is £1010 million and the mean market value of equity is £1582 million. In this study we employ Tobin's Q as a proxy for firm value. We define Tobin's Q as the book value of total assets minus the book value of equity plus the market value of equity divided by the book value of total assets. The numerator approximates the market value of the firm and the denominator approximates the replacement cost of assets. The distribution of Tobin's Q in our sample is skewed, since

the median value (1.887) is smaller than its mean (2.448). To correct for this we use the natural log of Q. Using the natural log has the additional advantage that changes in this variable can be interpreted as percent changes in firm value.

The mean level of foreign sales as a proportion of total sales is 35 percent for our sample. This level of foreign sales activity is at least double that reported for US firms around the same period. For example, Allayannis and Weston (2001) indicate that foreign sales were on average 18 percent of total sales for 720 US firms during the period 1990-95 and Graham and Rogers (2002) reports foreign sales of 10 percent for their sample of US firms in 1994.

Table 2
Variables – summary statistics

Variables	N	Mean	Median	Std. Dev.	Min	Max
Total assets (millions)	400	1010.26	244.36	2592.05	11.33	28741.20
Market value of equity (millions)	400	1582.01	423.58	3520.61	64.70	31658.63
Tobin's Q	356	2.45	1.89	1.99	0.42	17.81
Leverage	364	0.19	0.15	0.15	0.00	0.85
Dividend yield (%)	366	3.58	3.52	1.63	0.00	8.65
Foreign sales ratio (%)	412	34.85	28.65	32.01	0.00	96.00
Industry diversification dummy	412	0.28	0.00	0.45	0.00	1.00
R&D ratio (%)	412	0.80	0.00	1.74	0.00	10.00
Return on capital employed (%)	347	15.22	12.04	19.65	-42.21	228.94
Tax loss carry forwards dummy	412	0.36	0.00	0.48	0.00	1.00
Interest cover	400	16.88	6.89	26.40	-20.63	100.00
Cash ratio	400	0.48	0.31	0.67	0.00	6.88
Average tax rate	370	0.32	0.33	0.11	-0.53	1.21
Market-to-book ratio	365	4.16	2.36	11.08	-9.45	164.33
Asset tangibility	340	0.485	0.463	0.222	0.010	0.980

Table 2 provides summary information for the variables used in the analysis. Total assets are the book value of total assets less current liabilities. Market value of equity is the share price multiplied by the number of ordinary shares in issue. Tobin's Q is the book value of total assets minus the book value of equity plus the market value of equity divided by the book value of total assets. Leverage is the book value of total debt and preference capital as a proportion of the book value of total debt plus the market value of equity. Dividend yield is the gross dividend divided by share price. Foreign sales ratio is the foreign sales by destination divided by total sales. Industry diversification dummy takes on the value of one if the firm operates in more than one business segment. R&D ratio is research and development expenditure divided by total sales. Return on capital employed is the pre-tax profit plus total interest charges divided by total capital employed plus borrowings repayable within 1 year less total intangibles. Tax loss carry forwards is a dummy variable equal to 1 if the firm has tax loss carry forwards. Interest cover ratio is the profit before interest and tax divided by interest payments. Cash ratio is total cash and cash equivalents divided by total current liabilities. Average tax rate is the firms published tax divided by published pre-tax profit. Market-to-book value ratio is the market value of equity divided by book value of equity, where the book value of equity is measured as equity capital and reserves (excluding preference capital) less goodwill and other intangibles. Asset tangibility is total assets minus current assets divided by total assets.

III. FIRM VALUE AND FOREIGN CURRENCY AND INTEREST RATE HEDGING: A TOBIN'S Q ANALYSIS

Since there are so many well documented determinants of firm value, we employ a multivariate approach to investigate the value effects of hedging. To infer that hedging increases the value of the firm, we need to exclude the effect of all other variables that could have an impact on firm value (Tobin's Q). In common with several previous studies we control for size, profitability, leverage, growth opportunities, ability to access financial markets, geographic and industrial diversification.

We employ three variations for our measure of hedging. In common with much of the extant empirical literature we define FC (IR) hedging as the use of FC (IR) derivatives, in our second definition we incorporate non-derivatives FC (IR) hedging, our third definition looks at FC (IR) only hedgers. Table 3 presents the regression results for both FC (models 1 to 5) and IR hedging (models 6 to 10). When we define FC (IR) hedging as the use of FC (IR) derivatives then firms that hedge FC (IRs) using non-derivative methods will be effectively defined as non-hedgers. We expect this to have an adverse impact on the size of hedging premium since hedging theory predicts that any type of hedging should have a positive effect on firm value. Model 1 shows that the coefficient on the FC derivative dummy is positive and significant despite the inclusion of other hedgers (IR hedgers and non-derivative FC hedgers) in the non-hedging sample. In model 2 we transfer non-derivative FC hedgers into the FC hedging sample (i.e., adopt a wider definition of FC hedging), as expected, this results in an increase in the hedging coefficient, the hedging premium is now 13.1% up from 8.5%. This suggests that non-derivative FC hedging also adds to firm value. Models 3 and 4 rerun the specifications in models 1 and 2 but exclude other hedgers from the non-hedging sample. In both instances the coefficient increases, albeit only slightly for all FC hedgers. A comparison of the hedging coefficients in models 3 and 4 indicates that restricting the definition of hedging to derivatives (model 3) generates a larger hedging premium than the more inclusive definition (model 4). In specifications 1 to 4 the sample of FC hedgers includes firms that are also IR hedgers. Therefore, it is possible that some proportion of the resulting hedging premium is due to IR hedging. In model 5 we examine how much of the hedging premium is the result of FC hedging in particular by excluding from the FC hedging sample firms that also hedge IR exposure. The results show that the hedging premium is significant and slightly larger at 15.3 percent.

As with FC hedging, for both definitions of IR hedging we see an increase in the size of the hedging coefficient (premium) when we remove the other hedgers from the non-IR hedging sample. The IR hedging results also provide further evidence that derivatives hedging is potentially more value enhancing than non-derivative hedging. In the bias free tests of model 8 and model 9 the IR hedging premium is 18.6% when hedgers are defined as IR derivative users and 15.6% when we expand our hedging definition to include firms that use only non-derivative IR hedging techniques.

Table 3
Multivariate analysis of value effects of foreign currency and interest rate hedging

Independent Variables	FC Hedging				
	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**
FC derivative hedging	0.085**		0.147**		
	(0.043)		(0.064)		
All FC hedging		0.131**		0.132**	0.153**
		(0.054)		(0.063)	(0.070)
IR derivative hedging					
All IR hedging					
Log of total assets	-0.087***	-0.086***	-0.104***	-0.086***	-0.151***
	(0.019)	(0.018)	(0.021)	(0.019)	(0.031)
Leverage	-1.410***	-1.447***	-1.402***	-1.535***	-1.749***
	(0.183)	(0.187)	(0.248)	(0.216)	(0.354)
ROCE	0.008***	0.008***	0.007**	0.008***	0.008**
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Dividend yield	-0.053***	-0.057***	-0.069***	-0.056***	-0.043**
	(0.013)	(0.013)	(0.016)	(0.014)	(0.020)
Foreign sales ratio	0.001	0.001	0.001	0.001	-0.002
	(0.008)	(0.001)	(0.001)	(0.001)	(0.001)
R&D ratio	0.028*	0.031*	0.030*	0.030*	0.044*
	(0.017)	(0.017)	(0.018)	(0.017)	(0.024)
Diversification dummy	0.024	0.020	0.051	0.030	0.064
	(0.042)	(0.043)	(0.051)	(0.044)	(0.070)
No. of observations	336	336	259	318	176
F-statistic	52.21	55.40	40.51	51.24	24.57
Adj R^2	0.5764	0.5800	0.5718	0.5678	0.5420

Independent Variables	IR Hedging				
	Model 6	**Model 7**	**Model 8**	**Model 9**	**Model 10**
IR derivative hedging	0.122***		0.186**		
All IR hedging	(0.042)		(0.072)		
Log of total assets		0.114***		0.156**	-0.024
		(0.043)		(0.069)	(0.106)
Leverage	-0.098***	-0.097***	-0.115***	-0.109***	-0.226***
	(0.00)	(0.020)	(0.024)	(0.023)	(0.051)
ROCE	-1.511***	-1.505***	-1.597***	-1.500***	-1.193***
	(0.00)	(0.189)	(0.242)	(0.220)	(0.307)
Dividend yield	0.008**	0.008**	0.006*	0.006*	0.004
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Foreign sales ratio	-0.053***	-0.054***	-0.062***	-0.067**	-0.082***
	(0.00)	(0.013)	(0.018)	(0.016)	(0.030)
R&D ratio	0.002**	0.002**	0.002**	0.002**	0.004
	(0.00)	(0.001)	(0.001)	(0.001)	(0.003)
Diversification dummy	0.029*	0.028*	0.036*	0.035*	0.072**
	(0.00)	(0.017)	(0.021)	(0.021)	(0.032)
No. of observations	0.023	0.021	0.022	0.019	0.076
F-statistic	(0.00)	(0.042)	(0.063)	(0.059)	(0.132)
Adj R^2					

***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

Table 3 presents the results for OLS regressions on the effect of FC (IR) hedging on a firm's market value. The dependent variable is the natural log of Tobin's Q, which is measured as the natural log of the book

value of assets minus the book value of equity plus the market value of equity divided by the book value of assets. The numerator approximates the market value of the firm and the denominator approximates the replacement cost of assets. The regressions include control variables for size, leverage, profitability, dividend yield, foreign sales, R&D expenditure and industry diversification. Log of total assets is the natural log of book value of total assets less current liabilities. Leverage is the book value of total debt and preference capital as a proportion of the book value of total debt plus the market value of equity. Return on capital employed (ROCE) is the pre-tax profit plus total interest charges divided by total capital employed plus borrowings repayable within 1 year less total intangibles. Dividend yield is the gross dividend divided by share price. Foreign sales ratio is the foreign sales by destination divided by total sales. R&D ratio is research and development expenditure divided by total sales. Industry diversification dummy takes on the value of one if the firm operates in more than one business segment. White (1980) corrected standard errors are reported in parentheses.

At first glance this result is unusual since a firm's final interest rate exposure would be the same irrespective of the method of hedging. For example, a firm that issues fixed rate debt has the same interest rate exposure, and therefore would be expected to achieve the same value benefits, as one that issues floating-rate debt and swaps it to a fixed rate. However, it could be argued that hedging IR exposure with derivatives confers greater flexibility in altering interest rate characteristics of a debt portfolio, particularly in response to changing company circumstances (the generation of large levels of surplus cash) or changes in the macroeconomic environment (the steepness of the yield curve).[5] For example, an advantage of an interest rate or currency swap is that it allows firms to adjust exposure profiles without having to undo the underlying transactions. The major advantages of swaps in restructuring corporate debt are lower costs, increased flexibility, and more rapid execution. They have also been used to create lower-cost synthetic debt issues. Therefore, the inherent flexibility that derivative tools possess over substitute hedging strategies is possibly a driver of the greater value. It might also be that, because of accounting disclosure requirements, derivatives hedging can be more readily observed by investors whereas non-derivative hedging is less transparent or that it might be difficult to disentangle (or distinguish) non-derivative hedging from other financial activities of the firm.

In model 10 we examine the value effects for IR only hedgers and find, contrary to expectations, that the hedging coefficient is negative and statistically insignificant. This suggests that it is FC hedging that is driving the results, but, since this specification contains only 15 IR hedgers the power of the tests are very weak, which might explain the result. Our overall results, however, suggest that investors reward IR hedgers with a larger hedging premium than that generated by FC hedging. The IR hedging coefficient in models 6, 8 and 9 is higher than the corresponding coefficients for FC hedging (models 1, 3 and 4). For example, model 3 indicates a 14.7% value effect from FC derivative hedging, the corresponding result for IR derivative hedging is 18.6% (model 8).

Finally, the coefficients on several of the control variables are in line with what earlier literature finds. For example, size, leverage and dividend yield are negatively related to value, whereas growth opportunities (measured by R&D expenditure scaled by total sales) and profitability are positively related to firm value.

IV. HEDGING, DEBT CAPACITY AND FIRM VALUE

To estimate the valuation effects from enhanced debt capacity and leverage due to hedging we follow Graham and Rogers (2002) and estimate the determinants of the capital structure and FC and IR hedging decisions simultaneously with a two-stage estimation technique. In the first stage, two separate regressions are performed using FC (IR) hedging and the leverage ratio, respectively, as dependent variables. We use equation 1 to obtain predicted probabilities of FC (IR) hedging:

$$\log\frac{P_i}{1-P_i} = \beta_0 + \beta_1 \text{Tax}_i + \beta_2 \text{Leverage}_i + \beta_3 \text{Exp}_i + \beta_4 \text{Sub}_i + \beta_5 \text{TCosts}_i + \varepsilon_i \quad (1)$$

where Tax = Tax loss carry forward; Leverage = Leverage; Exp = Financial price exposure; Sub = Hedging substitutes; and Tcosts = Transaction costs.

We specify the model of the capital structure decision following Rajan and Zingales (1995) to obtain predicted leverage ratios:

$$\text{Leverage}_i = \delta_0 + \delta_1 \text{Tangible assets}_i + \delta_2 \text{R \& D}_i + \delta_3 \text{Logsize}_i + \delta_4 \text{ Profitability}_i + \varepsilon_i \quad (2)$$

In the second stage, structural equations are estimated using the predicted values from the first-stage regressions as explanatory variables. The structural equations are:
FC (IR) hedging decision:

$$\log\frac{P_i}{1-P_i} = \beta_0 + \beta_1 \text{Tax}_i + \beta_2 \text{Leverage}_i^* + \beta_3 \text{Exp}_i + \beta_4 \text{Sub}_i + \beta_5 \text{TCosts}_i + \varepsilon_i \quad (3)$$

Capital structure decision:

$$\begin{aligned}\text{Leverage}_i = {} & \delta_0 + \delta_1 \text{Tangible assets}_i + \delta_2 \text{R \& D}_i + \delta_3 \text{Logsize}_i \\ & + \delta_4 \text{ Profitability}_i + \delta_5 \text{Hedging}^* + \varepsilon_i\end{aligned} \quad (4)$$

In equation (3), Leverage* is the predicted value of the leverage ratio obtained from the first-stage estimation of the capital structure decision equation (equation (2)). In equation (4), Hedging* is the predicted probability of hedging obtained from the first-stage estimation of the FC (IR) hedging equation (equation (1)).

We report the results for FC and IR hedging in table 4. The first row of table 4 reports the estimated coefficient on the FC hedging variable and its p-value in the second stage leverage regression. We initially estimate stages one and two of the simultaneous equations system with our full sample which incorporates non-FC hedgers that include other hedgers, such as firms that only hedge interest rate exposure. In the second stage leverage regression column 1 of table 4 shows that the predicted probability of hedging is positively related to leverage but not statistically significant. This indicates that FC hedging by UK firms does not increase their debt capacity.

We re-estimate both stages of the simultaneous equations system but this time excluding other hedgers from the non-hedging sample, which are made up mainly of interest rate hedgers. The results in column 2 of Table 4 show that the predicted probability of foreign currency hedging is now a significant factor in determining

leverage. The estimated coefficient from a second-stage leverage regression suggests that foreign currency hedging is associated with a 0.1867 increase in the leverage ratio. We quantify the size of the tax benefit provided by the increased debt capacity for each foreign currency hedging firm by taking the product of the estimated coefficient on the foreign currency hedging variable, the firm's average tax rate, and value of total debt and then scale this by the market value of the firm's assets (lagged one year). For all foreign currency hedgers the increase in leverage translates into a mean (median) estimated increase in firm value of 1.29 (1.04) percent.

This value effect of foreign currency hedging is larger than the 0.32 percent reported by Bartram *et al*. (2004) for a sample of over 4000 worldwide firms. Furthermore, for a sample of US firms and using a binary foreign currency hedging variable both Géczy *et al*. (1997) and Graham and Rogers (2002) do not find that currency hedging significantly increases the leverage ratio in their second stage regressions. All three studies investigate foreign currency derivative use rather than foreign currency hedging. This narrow definition of foreign currency hedging might bias the results if firms use tools other than derivatives for foreign currency hedging. Furthermore, if the non-currency derivative sample also includes interest rate or commodity price derivative users the bias will be more severe.

Table 4
Quantifying the debt tax benefit of foreign currency and interest rate hedging

	#1	#2	#3	#4	#5	#6	#7	#8	#9
Estimated coefficient on FC (IR) hedging in 2nd stage leverage regression	0.049 (0.11)	0.186 (0.000)	-0.092 (0.00)	0.094 (0.00)	0.139 (0.00)	0.507 (0.00)	0.747 (0.00)	0.237 (0.000)	0.629 (0.00)
Mean		1.294%		0.630%	0.778%	3.998%	5.985%	1.867%	5.089%
Median		1.046%		0.497%	0.628%	3.494%	5.285%	1.575%	5.188%
Std. Dev.		1.053%		0.555%	0.726%	2.771%	4.035%	1.360%	2.930%
99th percentile		5.510%		2.946%	4.097%	14.186%	20.914%	6.622%	10.446%
95th percentile		3.103%		1.547%	1.730%	8.392%	12.332%	4.353%	10.446%
90th percentile		2.327%		1.142%	1.596%	7.097%	10.502%	3.299%	8.958%
75th percentile		1.636%		0.785%	0.975%	5.073%	7.807%	2.199%	7.471%
25th percentile		0.608%		0.293%	0.363%	2.166%	3.267%	0.099%	2.811%
10th percentile		0.269%		0.129%	0.122%	1.449%	2.171%	0.688%	0.671%
5th percentile		0.164%		0.078%	0.076%	0.695%	1.025%	0.328%	0.553%
1st percentile		0.080%		0.031%	0.047%	0.422%	0.622%	0.197%	0.553%
Number of observations		319		260	176	227	212	215	91
Number of hedgers		254		190	107	160	144	147	19
Adj R-Sq		0.3837		0.3694	0.3597	0.5231	0.5586	0.4158	0.8734

#1: All FC Hedgers (NH include other hedgers)
#2: All FC Hedgers (NH exclude other hedgers)
#3: FC Derivative users (NH include other hedgers)
#4: FC Derivative users (NH exclude other hedgers)
#5: FC Only Hedgers (NH exclude other hedgers)
#6: All IR Hedgers (NH exclude other hedgers)
#7: IR Derivative users (NH exclude other hedgers)
#8: FC & IR Hedgers (NH exclude other hedgers)
#9: IR Only Hedgers (NH exclude other hedgers)

Table 4 summarises the contribution of the debt tax benefit associated with FC (IR) hedging to a firm's market value. The value estimates are calculated for each firm that hedges FC (IR) exposure by taking the product of the estimated influence of the FC (IR) hedging on the leverage ratio (i.e., the estimated coefficient on the FC (IR) variable in the second-stage leverage regression), the firm's average tax rate, and the value of total debt. This value is divided by the market value of equity (including preferred stock) plus the book value of debt. Since average tax rates are most likely lower than marginal tax rates these calculations may understate the increase in the value of the firm due to FC (IR) hedging.

A. Using an Alternative Definition of Hedging

The definition of FC hedging employed in this study is more inclusive than that used in several previous studies, which tend to restrict their analysis to FC derivative users. In order to facilitate comparisons with these studies we repeat the above analysis but define FC hedgers as firms that use FC derivatives and firms that hedge FC exposure but use methods other than derivatives are classified as non-FC derivative users together with firms that do not hedge FC exposure. The results in column 3 of table 4 show that the hedging coefficient is negative and significant. This perverse result implies that hedging lowers debt capacity opposite to that predicted. In similar analyses Géczy *et al.* (1997) and Graham and Rogers (2002) report an insignificant hedging coefficient in their second stage leverage regression. These results might be due to the fact that non-currency derivative users include interest rate hedgers and other foreign currency hedgers. Since the capital structure effects are not unique to the source of exposure hedged, nor which method of hedging is used, the inclusion of other hedgers in the non-FC derivative sample makes the detection of a leverage effect more difficult. Column 4 of table 4 shows that when interest rate hedgers and other foreign currency hedgers are removed from the non-FC derivative user sample, the estimated hedging coefficient in the second stage leverage regression is 0.0938 and significant at less than one percent, which implies an increase in firm value of 0.63 percent. This suggests that how non-derivative using foreign currency hedgers and interest rate only derivative users (or hedgers) are treated has a significant bearing on the estimated effect of FC hedging on leverage and consequently the estimated tax benefits of hedging.

B. The Value Effects for Foreign Currency Only Hedgers

The results in the previous sections indicate that foreign currency hedging increases firms' debt capacity and consequently leads to an increase in firm value. However, the validity of the strength of this link can be called into question because of the structure of the foreign currency hedging sample.

Closer inspection of the foreign currency hedging sample reveals a few interesting characteristics. Panel B of Table 1 shows that 44.1 percent of foreign currency hedgers are foreign currency only hedgers and 53.4 percent of foreign currency hedgers also hedge interest rate exposure. It could be argued that since over half the sample of foreign currency hedgers are also interest rate hedgers it is quite possible that this group of firms is driving the leverage results. This is because leverage is potentially of greater relevance to interest rate hedging firms because firstly it is a source of interest rate exposure and secondly lenders might agree to providing debt finance if firms commit to hedging the resulting interest rate exposure.

Since foreign currency hedging firms include interest rate hedgers these results might in part be driven by interest rate hedgers. The Bartram *et al*. analysis suffers from this problem since they include all FC derivative users, which incorporates firms that use both interest rate and FC derivative users. The empirical tests in this section control for this by investigating the value effects for firms that only hedge foreign currency exposure. We firstly exclude "other" hedging firms from the non-foreign currency hedging sample. We then re-run the regression excluding interest rate hedgers and or commodity price hedgers from the FC hedging sample leaving a sample of firms that only hedge FC exposure. The result in column 5 of table 4 shows that the predicted probability of foreign currency only hedging is a significant factor in determining leverage. The estimated coefficient from a second-stage leverage regression suggests that foreign currency only hedging is associated with a 0.1388 increase in the leverage ratio, which generates a mean estimated increase in firm value of 0.78 percent. As expected the value effect for FC only hedgers is lower than that observed previously for all FC hedgers (which include interest rate hedging firms). An important implication of this result is that it shows that the observed link between leverage and foreign currency hedging and therefore the resulting value effect is not driven by the inclusion of foreign currency hedging firms that also hedge interest rate exposure. This demonstrates empirically, to our knowledge for the first time, an unequivocal link between firm leverage, firm value and the foreign currency hedging decision.[6]

C. The Debt Capacity Benefits of Interest Rate Hedging

There is much anecdotal evidence which suggests that banks and other lending institutions will provide external debt funding on the understanding that borrowing parties commit to hedging existing or any resulting interest rate exposure. These hedging requirements might be set out in a loan covenant. This implies that there is a clear link between IR hedging and a firm's ability to raise debt capital. Given this link, we believe it follows that there should be a stronger relationship between interest rate hedging and debt capacity than that observed between FC hedging and debt capacity. This will manifest itself in the form of greater debt capacity benefits from interest rate hedging than foreign currency hedging. The results in table 4 show this to be the case. Firstly, for IR hedging we find that the estimated coefficient on the IR hedging variable in the second stage leverage equation is positive and highly significant with or without other hedgers (mainly FC hedgers) in the non-IR hedging sample. To facilitate comparisons with the FC hedging results we report the IR hedging results with other hedgers excluded from the non-IR hedging sample. Column 6 shows that the mean debt capacity benefits generated by IR hedging amount to 3.99 percent of the market value of assets, which is three times that achieved by FC hedging (1.29 percent). When we restrict IR hedging to firms that use IR derivatives (column 7) our results show that the average debt capacity benefit goes up to 5.98 percent. This suggests that IR derivatives hedging generates more debt capacity than non-derivatives IR hedging, which is consistent with our earlier findings using Tobin's Q.

The results in columns 6 and 7 suggest that IR hedging confers greater debt capacity benefits than FC hedging. An interesting question is by how much. One way to look at this is to compare the benefits generated by FC only hedging with those generated by firms that hedge both FC and IR. Column 8 reports the results for the

latter. These results indicate that a combination of FC and IR hedging generates more than double the debt interest tax shield benefits than that generated by FC hedging alone (1.87 percent versus 0.78 percent). However, since the samples of IR hedgers in these tests are also FC hedgers it is not possible to discern from this the extent to which IR hedging generates more debt capacity. We investigate this by estimating the value effects of IR only hedging. Column 9 of table 4 presents the results for IR only hedgers. The results show that, as expected, the debt capacity benefits of IR hedging are greater than those generated by FC only hedging (column 6). Our analysis indicates that the value effects due to IR hedging are six times greater than those generated by FC hedging.

V. CONCLUSION

In this study we employ UK data to quantify the effects of FC and IR hedging on firm value. We find that both FC and IR hedging are significant explanatory variables for firm value creation when measured as Tobin's Q and when measured as a tax shield through increased debt capacity. Their effects are also larger than those reported in previous studies examining US firms. We show that controlling for "other" hedgers in the samples of non-hedgers makes the value creation effect both larger and more significant. When we control for the cross effects of FC and IR hedging on debt capacity by using samples of FC only hedgers and IR only hedgers, our results show that firms that only hedge FC generate significant positive debt capacity and hence value effects, but that IR hedging creates substantially more firm value from debt capacity (over 6 times as much) than FC hedging. Where Tobin's Q is concerned, FC only hedging generates similar value effects to that of FC hedgers who might also be IR hedgers while in the IR only hedgers specification the coefficient is not significant.

When we compare hedging techniques, we find that derivative only hedging is generally superior to other types of hedging. Although in the debt capacity tests we find that all FC hedging created more value than FC derivative hedging, IR derivative hedging created more value than all IR hedging. In the Tobin's Q analysis restricting hedgers to derivative users generated larger coefficients for both IR and FC hedging (after excluding other hedgers) than when the more inclusive definitions of hedging were employed. This suggests that derivatives hedging is more value enhancing than other hedging methods.

ENDNOTES

1. Kim et al. (2006) find that financial hedging adds 5.4% to firm value on average and operational hedging increase firm value in the range of 4.8–23.5%.
2. Carter et al. (2005) find that jet fuel hedging by airlines increases value in the range of 12-16%.
3. Loan providers might insist that firms put in place interest rate hedges as part of their loan agreements; in effect the loan will only be made available if the firm agrees to hedge the resulting interest rate exposure.
4. For example, Allayannis and Ofek (2001) report that 44% of US firms use FC derivatives and Howton and Perfect (1998) find that 45% of US firms use IR derivatives.

5. The steeper the yield curve the more attractive floating interest rates become relative to long-term fixed rates. The slope of the yield curve might also pick up expectations of a recession.
6. In unreported analysis we ran the regressions including "other" hedgers in the non-hedging sample. The results showed that the hedging coefficient in the second stage leverage regression was no longer significant.

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APPENDIX
Variable definitions

This table presents the definitions of variables employed for the analysis of hedging value for UK non-financial firms. It provides the variable's definition and the source of data for the variable. All variables are computed as three-year averages up to one year prior to the 1995 year -end, unless stated otherwise.

Variable	Variable Description (Source)
Total assets	Book value of total assets less current liabilities. (Datastream)
Market value of equity	Share price multiplied by the number of ordinary shares in issue. (Datasteam)
Tobin's Q	Book value of total assets minus the book value of equity plus the market value of equity divided by the book value of total assets. (Datastream)
Leverage	Book value of total debt and preference capital as a proportion of the book value of total debt plus the market value of equity. (Datastream)
Dividend yield	Gross dividend divided by share price. (Datastream)
Foreign sales ratio	Foreign sales by destination divided by total sales for the year ended 1994. (Annual report)
Industry diversification dummy	Industry diversification dummy takes on the value of one if the firm operates in more than one business segment. (Annual report)
Research and development expenditure	Research and development expenditure divided by total sales. (R&D Scoreboard compiled by Company Reporting Ltd.)
Return on capital employed	Pre-tax profit plus total interest charges divided by total capital employed plus borrowings repayable within 1 year less total intangibles. (Datastream)
Tax loss carry forwards	A dummy variable equal to 1 if the firm has tax loss carry forwards for the year ended 1995. (Annual report)
Interest cover ratio	Profit before interest and tax divided by interest payments. (Datastream)
Cash ratio	Total cash and cash equivalents divided by total current liabilities. (Datastream)
Average tax rate	Published tax divided by published pre-tax profit. (Datastream)
Market-to-book value ratio	The market value of equity divided by book value of equity, where the book value of equity is measured as equity capital and reserves (excluding preference capital) less goodwill and other intangibles. (Datastream)
Asset tangibility	Total assets minus current assets divided by total assets. (Datastream)