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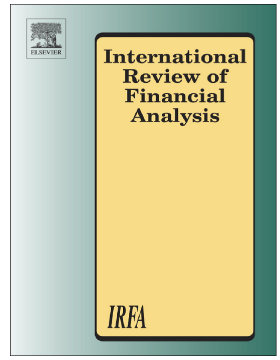

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Does Corporate Hedging Enhance Shareholder Value? A Meta-Analysis

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Abstract

The theories underpinning corporate use of derivatives are well developed. Furthermore, there exist compelling economic reasons why hedging should lead to enhanced shareholder value, but empirical evidence in support of a substantial value increase from hedging is, at best, mixed. In this paper, we synthesize the empirical evidence for value enhancement in firms' hedging with derivatives using a statistical meta-analysis combining data from 47 different studies. Our findings indicate that firms' hedging with derivatives have larger Tobin's Q, a commonly used measure of value creation. A variety of moderating variables are assessed, providing evidence of heterogeneity in the value relevance of corporate hedging. In particular, we find that relatively higher firm value is primarily associated with hedging of foreign exchange risk.

Keywords: Corporate Hedging, Derivatives, Firm Value, Meta Analysis

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1. Introduction

Large unexpected changes in exchange rates, interest rates or commodity prices may result in substantial fluctuations in firm profitability and market value. Considered from the perspective of a diversified international investor, such volatility is less critical for portfolio risk, due to offsetting asset price fluctuations and the ability to manage undesirable risks (Stulz, 1996). Economic value creation from risk management is commonly linked to capital market imperfections. Empirical evidence for hedging benefits and any increase in shareholder value have, however, been mixed (Fauver and Naranjo, 2010; Carter *et al.*, 2006; Jin and Jorion, 2006; Allayannis and Weston, 2001). In this paper, we reassess the benefits of corporate hedging with derivatives, using meta-analysis to draw on prior findings detailed across a large set of extant research articles.

Statistical meta-analysis is an evidence-based approach to aggregate a body of research findings, with the aim of producing generalized inference and overcoming small-sample issues associated with individual studies (Hunter and Schmidt, 2004). Meta-analysis differs from qualitative reviews, which tend to focus upon the state-of-the-art in a limited field of research. While meta-analysis has been adopted extensively in medical research and similar areas, only a small number of studies have applied these methods to financial economics and related fields.[1] In this paper, we aggregate the findings of prior studies on the relationship between corporate hedging with derivatives and shareholder value (measured using Tobin's Q).

Our study provides a number of contributions. First, we use accumulated evidence from previous research to make statistical inference regarding the value-relevance of corporate hedging for non-financial firms.[2] While the work relates to Arnold *et al.* (2014), who use a

[1]For example, Kysucky and Norden (2016) examine the benefits of bank relationship lending, Rusnak *et al.* (2013) consider the link between monetary policy tightening and short-run price increases, Ahmed *et al.* (2013) conduct a meta-analysis of the value relevance of IFRS adoption, Bumann *et al.* (2013) and Valickova *et al.* (2015) consider influences on economic growth, and Veld *et al.* (2018) examine the abnormal returns associated with seasoned equity offerings.

[2]Non-financial firms are alternately known as industrial firms throughout the literature. In this paper, financial firms are excluded from our analysis, as their business model, risk exposures and hedging strategies are very different from industrial firms. Banks as financial intermediaries specialize in risk transformation

meta-analysis to clarify the determinants of corporate hedging, we apply these methods to isolate the links between derivatives hedging and Tobin's Q. The work also relates to, but builds upon, previous work documenting the accumulated evidence on corporate hedging in a qualitative fashion (Aretz and Bartram, 2010). Second, we consider factors relevant in explaining the heterogeneity in findings for corporate hedging and value across the literature. In particular, we demonstrate that the nature of risk hedged has a central influence on findings. Third, we shed fresh light on a contentious issue in financial economics, specifically, whether risk management is value enhancing for non-financial firms.

The detailed analysis provides evidence that corporate hedging with derivatives increases shareholder value. While the effect size is small (the mean correlation between value and hedging is 0.044), it is statistically distinguishable from zero. We provide statistical evidence of heterogeneity between studies, motivating the use of a variety of moderating variables. In particular, the type of risk hedged is of central importance. Only hedging of foreign exchange (FX) risk is found to be consistently associated with increased shareholder value. Changes in shareholder value related to hedging commodity price (CMDY) risk are indistinguishable from zero, while hedging of interest rate (IR) risk is only found to be statistically significant when all specifications from all studies are examined simultaneously. A larger effect is also documented for working papers relative to published papers.

This paper is organized as follows. In the following section we briefly summarize the theories underpinning risk management, describe some relevant empirical literature and develop our hypothesis. Section 3 details the methodology employed in the meta-analysis. In Section 4, we outline the approach used in identifying relevant studies and highlight some pertinent characteristics relating to our sample. Section 5 reports our empirical findings and

and management and profit by taking on certain risks. They transform liquidity risk, interest rate risk, default risk, and foreign exchange risk (Bessler and Kurmann, 2014) and immunize, diversify or hedge the risks that they do not want or cannot hold given their limited equity. Commodity price risk is usually not part of bank exposure. Banks could hedge all these risks with financial derivatives (Bessler *et al.*, 2016). Moreover, financial firms are regulated entities which are obliged to hold a minimum quantity of capital and which may be subject to bail-in of creditors (Conlon and Cotter, 2014), in contrast to industrial firms. For the use of financial derivatives by US banks see (Li and Marinč, 2014).

discusses implications.

2. Related Literature and Hypothesis

Risk management is pervasive across non-financial firms. Using survey data, Bodnar *et al.* (2016) indicate that more than 50% of firms employ risk management strategies to one extent or another. In spite of the prevailing use of risk management, and the tremendous growth of trading volume in derivatives markets, the empirical evidence for value enhancement from risk management is mixed. While many articles indicate benefits from hedging, the literature is not unanimous on the topic. Considering the theoretical literature on financial risk management, the motives underpinning financial risk management are well-established. Here we provide a brief outline of the theoretical motivation for hedging, and highlight some of the important and diverse contributions from the empirical literature.

Under a variety of well-defined assumptions surrounding perfect capital markets without taxes, information asymmetries or transaction costs, with value-maximizing agents and investors with equal access to financial markets, the Modigliani and Miller (1958) debt irrelevance theorem implies that firms would not engage in hedging activities, as these would not add value. In perfect capital markets, an individual investor would not require the firm to hedge on their behalf, as they can achieve the same hedging objectives on their own (homemade diversification and hedging). Relaxing the assumptions, a variety of papers have isolated specific frictions which, when loosened, may result in shareholder benefits from hedging (see DeMarzo and Duffie (1991), for example).

Several theories have been proposed linking value creation in firms with financial risk management. Here, we provide an outline of some of the most widely documented theories.[3] Much of the literature on risk management has focused on reasons why firms might decide to hedge. While many explanations have been put forth, Stulz (1996) categorizes the value

[3] For a thorough treatise of the alternative theories underpinning value creation through financial hedging, see Aretz and Bartram (2010) and Aretz *et al.* (2007).

enhancing characteristics as linked to the potential to reduce bankruptcy costs and taxes, and lower managerial compensation. Hedging may be beneficial as it may help to alleviate the costs of financial distress and, also, under a convex tax schedule, may help to reduce the expected value of tax liabilities (Smith and Stulz, 1985; Mayers and Smith, 1982). Hedging may also enhance firm value through increased debt capacity, with elevated leverage providing further benefits from the tax shield (Leland, 1998).

Senior company management may hold a significant proportion of their wealth in firm-level securities, resulting in an undiversified portfolio. Risk averse managers may demand extra compensation for bearing such undiversified risk. To the extent that any benefits from hedging are greater than this extra compensation, hedging may enhance shareholder value (Smith and Stulz, 1985). Moreover, firms may have a comparative advantage in markets where they have access to non-public information (Stulz, 1996). Risk management allows the firm to take additional risks in areas where it has a comparative advantage by decreasing volatility across other business lines.[4]

Froot *et al.* (1993) describe a mechanism through which hedging assists firms in maintaining sufficient internally generated funds to take advantage of investment opportunities with positive net present value. This helps to ease the underinvestment problem whereby financially constrained firms with little equity and risky debt may choose not to invest in positive net-present-value projects. Corporate risk management may also help to alleviate the asset-substitution problem, whereby firms with low equity value shift towards riskier investments. By reducing the risk associated with firm value, financial hedging reduces the attractiveness of riskier assets for shareholders.

Despite these convincing economic arguments, the empirical evidence for value enhancement from hedging is mixed. Allayannis and Weston (2001) provide early evidence of an increase in firm value (Tobin's Q) of almost 5%, on average, for firms using foreign currency

[4]A related empirical literature considers whether firms selectively hedge, but the impact on value in terms of Tobin's Q has not been documented (Chernenko and Faulkender, 2011; Adam and Fernando, 2006; Brown *et al.*, 2006).

derivatives. Carter *et al.* (2006) highlight an increase in Tobin's Q of more than 10% for airlines which choose to hedge against future price fluctuations in jet fuel. With respect to international evidence, Bartram *et al.* (2003) find mixed results conditional upon both exposures and the risk under consideration, with only IR hedging consistently associated with higher firm value. In single country studies, Jankensgård (2015), Vivel Búa *et al.* (2015), as well as Clark and Judge (2009), report evidence of a relatively higher value for firms using derivatives in Sweden, Spain and the UK, respectively.

In contrast to the aforementioned studies, Jin and Jorion (2006) find that, while hedging is associated with a reduction in risk, there is little difference in valuation effects between firms which hedge and those that do not hedge amongst oil and gas producers. Fauver and Naranjo (2010) highlight a weak relationship between hedging and firm value, with a negative effect isolated for firms with agency or monitoring problems. Focusing on the UK, Panaretou (2014) reports evidence that hedging is value enhancing for FX risks, but only weak evidence in the case of interest rate hedging. In contrast, Belghitar *et al.* (2013) find no evidence that derivative usage is associated with firm value for a sample of French firms over the period $2002-2005$. Based on a sample of Australian firms, Nguyen and Faff (2007) document a negative relationship between the use of derivatives and firm value, with notable significance for IR derivatives.

The above review highlights the disparate empirical evidence regarding the value-enhancing prospects from derivatives hedging. In contrast, as described earlier, many well motivated theoretical reasons underpin the link between firm value and risk management with derivatives. In order to shed light on the empirical support for increased value from financial hedging, we use meta-analysis to provide a synthesis of the empirical evidence. Specifically, the following hypothesis is tested:

Hypothesis 1. *Hedging with derivatives is associated with an increase in firm value (Tobin's Q).*

3. Methodology

Individual studies may be susceptible to artifacts which may result in weakened inference. Hunter and Schmidt (2004) cite a variety of such artifacts, including sampling error, measurement error in the dependent and independent variables and dichotomization of dependent or independent variables of interest. Meta-analysis may enable us to correct for biases found at an individual study-level by using data aggregated across a series of studies. For example, if sampling error is random at the individual study level, it can be estimated and controlled for at the meta-analysis level. For a large overall sample size, the sample error in the average meta-analysis correlation is bounded.

In order to perform a meta-analysis of whether derivatives hedging enhances firm value, we first need to compute an effect size for each study, requiring a common relevant statistic. Inference in the papers described here depend upon various forms of regression analysis, with resultant problems in direct comparison due to different measurement units. To overcome this problem, a common effect size for each study is estimated in the form of partial correlation, calculated using $\sqrt{\frac{t^2}{t^2+df}}$, where t is the t-statistic associated with the independent variable of interest and df are the degrees of freedom determined using the sample size and accounting for the number of model parameters.

Following the random effects approach detailed by Hunter and Schmidt (2000), a sample-weighted mean correlation is calculated as

$$\bar{r} = \frac{\sum r_i \times N_i}{\sum N_i} \tag{1}$$

where N_i and r_i are the sample size and partial correlation coefficient for study i respectively. The observed variance (S_o^2) and the sampling error variance (S_e^2) for K individual studies are, respectively, estimated using

$$S_o^2 = \frac{\sum N_i (r_i - \bar{r})^2}{\sum N_i} \tag{2}$$

$$S_e^2 = \frac{(1-\bar{r})^2 K}{\sum N_i}. \tag{3}$$

Observed variance is the variance of the sample under consideration, which relates to the population variance plus some sampling error. Thus, the variation in observed correlations is greater than that of the population by a factor equal to the sampling error variance.

A 95% confidence interval which excludes zero provides support for the strength of the effect size, and is given as

$$\left[\bar{r} - (\sqrt{S_o^2/K}) \times 1.96; \bar{r} + (\sqrt{S_o^2/K}) \times 1.96\right]. \tag{4}$$

Hedges (1982) and Rosenthal and Rubin (1982a,b) recommend a chi-square test (χ^2) to determine whether the observed variance is greater than could be expected (heterogeneous) from sampling error. If the chi-square test is not statistically significant, then the estimated population effect size is taken as constant across studies, removing any requirement for moderating variables. The chi-square test statistic, Q, is estimated as

$$Q_{k-1} = \frac{N S_e^2}{(1-\bar{r}^2)^2}. \tag{5}$$

Hunter and Schmidt (2004) also describe further techniques to indicate a requirement for moderating variables. A rule of thumb is that a share of the variance from sampling error (VSE) above 75% is associated with an homogeneous population (Hunter and Schmidt, 2004). The I^2 statistic estimates the percentage of variation due to heterogeneity, rather than chance and is given by $\frac{Q-df}{Q}$, where the degrees of freedom $df = K - 1$. A high I^2 value is indicative of heterogeneity between studies.

If there is significant heterogeneity, subgrouping by theoretically motivated moderator variables should be considered, with the aim of providing increased explanatory power.[5] The process of subgrouping continues until all residual variance is deemed to be insignificant, or until all available theoretically motivated moderator variables are evaluated. If a moderating effect is pervasive, the within sub-group variation should be decreased relative to the entire sample, while the between sub-group variation should be significant. The VSE should also increase, relative to the overall sample, if a moderating relationship exists.

Using meta-analysis to synthesize results from multiple papers may result in an inflated variance of the mean effect size and introduce bias in cases where dependent effect sizes are treated as independent (Scammacca *et al.*, 2014). Throughout the financial economics literature, and related fields, researchers tend to test multiple specifications to provide robust support for their findings. These multiple specifications, however, often use the same data sample and cannot be treated as independent.

In order to address the issue of dependent effect sizes, Card (2012) proposes two parsimonious approaches, both of which we adopt here. First, the researcher can select a single effect size from each study, representative of the outcomes detailed in the paper (in this paper we refer to this as the baseline approach). Second, an aggregated effect size for each paper can be calculated by averaging across all given effect sizes. Here we employ an observation weighted average. Concerns previously highlighted regarding this approach are that it may punish studies where the authors have diligently explored the robustness of their results for varying parameters (Scammacca *et al.*, 2014). Third, we calculate an average effect size incorporating all specifications detailed in all papers, with all the caveats previously outlined in the presence of dependent effect sizes.

[5] An alternative methodology would be to employ random effects meta-regression, where dummy variables are employed to represent the moderating variables. In our case, however, the number of potential moderating variables is large relative to the sample size (47), potentially hindering inference from such analysis.

4. Meta-Analysis Sample

4.1. Sample

Throughout the literature studying the value enhancing capacity of derivatives hedging, the pervasive measure of value is Tobin's Q, defined as the ratio of the firm's market value to replacement cost of assets. While a small number of papers consider alternative measures, we focus exclusively on studies where results pertaining to Tobin's Q are outlined. To this end, a systematic search for relevant papers with Tobin's Q as a measure of value, and using combinations of search terms such as "derivatives", "hedging", "firm value" and "profitability", was performed. The initial search for relevant papers was conducted using Econlit, SSRN, JSTOR and Google Scholar, identifying both published studies in addition to working papers, all written in English. Second, a systematic search of 41 relevant scholarly journals was conducted.[6]

This search resulted in an initial sample of 82 papers. We exclude papers with a singular focus on determinants of hedging (7), papers focused on risk as the variable of interest (3), those which do not report results related to Tobin's Q (9), theory papers and papers of a descriptive nature (7), studies where inference is only based upon regression interaction terms (3) and preprint versions of published papers (6). Finally, we identified 47 studies, 30 published and 17 working papers, which meet the criteria to be included in our meta-analysis.

A variety of moderating effects are examined in our analysis. In terms of the types of risk

[6] The journals searched were Applied Economics, Applied Financial Economics, Energy Economics, European Financial Management, European Journal of Finance, Financial Management, Financial Markets, Institutions and Instruments, Finance Research Letters, International Journal of Finance and Economics, International Journal of Managerial Finance, International Review of Financial Analysis, Journal of Banking and Finance, Journal of Business Finance and Accounting, Journal of Corporate Finance, Journal of Emerging Market Finance, Journal of Empirical Finance, Journal of Finance, Journal of Financial and Quantitative Analysis, Journal of Financial Economics, Journal of Financial Intermediation, Journal of Financial Markets, Journal of Financial Research, Journal of Financial Services Research, Journal of Futures Markets, Journal of International Business Studies, Journal of International Economics, Journal of International Financial Markets, Institutions and Money, Journal of International Money and Finance, Journal of Money, Credit and Banking, Journal of Multinational Financial Management, Journal of Risk and Insurance, Journal of Risk Finance, Managerial Finance, Management Science, Quantitative Finance, Research in International Business and Finance, Review of Finance, Review of Corporate Finance Studies, Review of Financial Studies, Review of Quantitative Finance and Accounting, World Finance Journal.

hedged, Nelson *et al.* (2005) provide evidence that any outperformance firms achieve from hedging can be attributed to large firms that hedge currency risk. For this reason, we consider the form of risk hedged as a moderating variable. Throughout the literature analyzing the benefits of hedging, many studies have focused on a binary measure indicating simply whether a firm hedges or not. A more nuanced approach is to consider the relative size of hedging carried out, captured, for example, by the net position hedged divided by total assets.[7] As the latter can be expected to provide an indication of the importance of the magnitude of hedging on company value, we subdivide our data into studies using continuous and dummy independent variables. Peer reviewed articles published in journals have undergone a rigorous review process, perhaps filtering papers where results or methodology are less robust or less common. To decipher whether the review process results in papers with differential effect size, we split our sample into journal published papers and unpublished working papers.[8] Finally, high volatility in emerging market currencies may generate a demand for hedging in firms from emerging markets (this may also influence commodity prices and interest rates). For this reason, we subdivide our findings into studies considering emerging and developing markets.

4.2. Sample Overview

Table 1 provides details of the final sample of papers. The earliest paper in the sample is Allayannis and Weston (2001), where the relationship between use of currency derivatives and firm value was first investigated using a U.S. sample from 1990 − 1995. 17 studies are from before 2010, while 30 studies are from the period from 2010 onwards, highlighting an

[7]In related work, a naive one-to-one futures hedge ratio has been shown to outperform sophisticated econometric models out-of-sample (Wang *et al.*, 2015). There is a considerable related literature concerned with determining the optimal futures hedging ratio for an array of securities, for differing hedging objectives, horizons and econometric specifications (See for example, Conlon *et al.* (2016), Bessler and Wolff (2014), Conlon and Cotter (2013), Chen *et al.* (2003) and Cecchetti *et al.* (1988).)

[8]Note that this can be distinguished from publication bias, which refers to the so-called "file drawer problem", where less than significant results remain unpublished, either as working papers or in journals. In our study we attempt to partially mitigate against this problem by including both published and unpublished works but fully acknowledge the possibility of unpublished works which have not made it into the public domain.

increasing empirical interest in an important international and corporate finance topic. 35% of studies are based upon data from the United States and 36% from European countries. Common to all studies examined are multiple specifications, each considering a representative derivatives variable. For example, some papers report results broken out by the form of risk hedged, and refer to both continuous and dummy indicators (hedged or not) of derivatives hedging.

[Table 1 about here.]

The total number of effect sizes extracted from each paper varies from one (Mohammad, 2014; Iatridis, 2012) to 25 (dos Santos *et al.*, 2017). The paper with the largest number of observations is Fauver and Naranjo (2010), with a total of $131,902$ observations across 16 specifications, accounting for 28.7% of observations across all studies. When only a single baseline specification is considered from each study, Fauver and Naranjo (2010) contributes $11,085$ observations, which is 22.6% of the total across all studies. Given the potential for this single-country study to dominate the analysis, we later perform robustness analyses excluding it. Considerable variation in the average effect size is observed, ranging from -0.107 (Phan *et al.*, 2014) to 0.333 (Gleason *et al.*, 2005). Across all studies, the minimum and maximum effect sizes are -0.277 (Lin and Chang, 2009) and 0.886 (Kapitsinas, 2008) respectively, highlighting the significant potential for heterogeneity in the sample. Table 1 also highlights diversity in the hedged risks analyzed. While 21 papers consider a single risk type (either FX, IR or CMDY risk), the remaining papers examine multiple risks either simultaneously or separately.

The range of findings highlighted in Table 1 underlines the mixed results reported in the literature to-date. 12 studies (24.5%) report a negative average effect size, while 23 papers (48%) indicate an average effect size less than 0.05. These initial findings provide motivation for employing a systematic meta-analysis to clarify the role that hedging plays in enhancing firm value.

5. Empirical Results

Findings from a series of meta-analyses investigating the relationship between derivatives hedging and firm value are now detailed in Tables 2 through 4. The respective tables correspond to alternative methods employed, in order to treat the issue of non-independent samples within each paper, as described in Section 3.

5.1. Baseline Results

Table 2 and Figure 1(i) outline the baseline meta-analysis, where we selected a single representative baseline model from each paper. In order to identify a baseline regression, we isolate the first table in each paper which details the relationship between Tobin's Q and derivatives hedging. As researchers often iteratively include control variables within regressions, and we are interested in the effect size after controlling for alternative drivers, the baseline regression is then selected as the first specification detailed which includes all integral control variables proposed. A consistent approach is followed across all studies. Considering all 47 papers, the mean effect size was 0.044, indicating a positive relationship between firm value, measured as Tobin's Q, and hedging. Significance of these findings is highlighted by 95% confidence intervals which do not overlap with zero. The Q statistic rejects the null hypothesis that effect size variance is exclusively due to sampling error. This is also highlighted by the large I^2 value.

[Table 2 about here.]

[Figure 1 about here.]

For this reason, we consider numerous moderating variables in an attempt to reduce heterogeneity. The first moderating variable included is risk type, breaking out risk between FX, IR and CMDY and any risk (where no risk categorization is present). This segmentation results in a striking finding. Only in the case of companies hedging FX risk do we find a significant relationship between hedging and firm value, signified by confidence intervals which do not overlap with zero. Moreover, the difference in effect sizes between FX and each of IR and CMDY is significantly different from zero. For CMDY the effect size is almost indistinguishable from zero, perhaps a consequence of the very diverse fundamentals associated with the different commodities included in studies such as crude oil, natural gas and gold. Nelson *et al.* (2005) indicate similar findings for firms hedging either IR or CMDY, with no evidence of superior stock performance and market valuation.

Two distinct independent variables are employed throughout the literature to capture the value relevance of hedging. First, a dummy variable is employed which merely indicates whether a firm uses financial derivatives to hedge or not. Second, continuous variables are used as representative of the volume of hedging performed by a company, better distinguishing between firms that hedge only a little from those with substantial hedge portfolios. We find that the continuous variable has an effect size of 0.062, which is greater than that found for the entire sample of papers, while the effect size for the dummy variable is 0.038. In both cases, the Q-statistic is smaller but still sufficiently large to reject the null hypothesis that variance is due to sampling error.

Next, we consider whether the publication status of a paper affects our findings. Contrasting unpublished research (working papers) with articles published in refereed journals, we provide clear evidence. The average effect size for working papers is 0.085, much greater than that of published papers, 0.026, and greater than the sample average (0.044). In both cases, the effect size is statistically different from zero, and we find evidence that the difference in effect sizes is significant at the 10% level. These findings may be supportive of the notion that published papers undergo a peer review process, potentially resulting in a higher standard of rigor. An alternative explanation might be that published papers are incentivized to follow similar methodologies and provide a greater number of robustness checks. Our findings here are in contrast to previous evidence of "publication bias" in the medical sciences, whereby the effect size associated with published papers tends to be stronger than unpublished works (Thornton and Lee, 2000).

The tendency for volatility of emerging market interest rates and currencies, and any associated impact on commodity costs for firms in emerging economies may result in differential value creation relative to developed markets. While we find a larger effect size (0.068) for emerging markets, the difference between emerging and developed markets is not found to be significant. Given the large number of relevant studies, we also isolate papers considering only US and European firms. While the effect size is significantly different than zero in all cases, the differences between USA and Europe are also not significant in the baseline case. One potential explanation for the lower value creation found amongst developed markets might be the introduction of the Euro in 2001, previously shown to have resulted in a reduction in risk amongst European and non-European firms (Bartram and Karolyi, 2006).

The econometric methodology adopted may influence findings. For this reason, we examine subgroups of papers using OLS-based methods (including fixed effects regression) and those using other methods. While the effect size is only significant in the case of OLS, no evidence of a significant difference between the two econometric subgroupings is indicated.

Finally, we perform two robustness analyses. First, the average effect size is winsorized at the 1% and 99% levels. Findings are largely unchanged from the baseline findings for all studies. Second, we re-examine the impact of hedging on firm value excluding Fauver and Naranjo (2010), the study with the largest number of overall observations. As our analysis is weighted according to the number of observations from each study, this gives us an indication of the influence of a single populous study on our findings. Excluding Fauver and Naranjo (2010), the average effect size is found to increase from a baseline of 0.044 to 0.060, indicating evidence for a strong influence.

5.2. Paper Average Effect Size

In Table 3 and Figure 1(ii) we account for all relevant specifications in each paper, accounting for sample dependence within each paper by determining the observation weighted average effect size. While we observe some alteration to the average effect sizes estimated, our primary findings are unchanged. Considering all studies, the average effect size is again found to be positive with confidence intervals which do not overlap with zero, indicating a positive impact of hedging on firm value.

[Table 3 about here.]

Isolating the effect size according to the risk type under examination, we again observe that FX hedging alone has a significant effect size, indicating a positive relationship between derivatives hedging and firm value. Similar to the baseline results detailed, we find that the effect size is greater when the independent variable representing hedging is continuous rather than a dummy, but the difference in effect sizes is not significant. Furthermore, the effect size associated with working papers is significantly larger than that relating to published papers, in keeping with previous findings.

The only notable difference between the baseline findings and that using the average paper effect sizes occurs when we include region as a moderating variable. Here, emerging markets have a positive effect size of 0.051 and for which confidence intervals do not overlap with zero. Moreover, the Q-statistic is lower relative to the full sample and only significant at a 5% level. The difference between emerging and developed market effect sizes is found to be significantly different from zero at the 5% level. While the average effect size for USA is indistinguishable from zero, the mean correlation for European firms is significantly larger at 0.044.

While the subgrouping of papers employing OLS presents an effect size significantly different from zero, this is not the case for the other methods grouping. The difference in mean correlation between the two is not, however, found to be significant. Finally, robustness analysis confirms our earlier findings. After winsorizing at the 1% and 99% levels, results are little altered. Excluding the paper with the biggest influence, Fauver and Naranjo (2010), the mean effect is larger by 0.012.

5.3. All Specifications Effect Size

In this final section, we test the robustness of our findings to the inclusion of all specifications reported in all papers. While this approach has been considered in previous papers, there are some caveats to be mindful of. First, the average effect size may be biased by including multiple non-independent samples from the same paper. Second, calculation of the observed variation, the sampling error and associated statistics may be influenced by using non-independent samples. Finally, the average effect size may be influenced by selectivity inherent in the choice of specifications to be presented in each paper.

Findings are presented in Table 4 and Figure 1(iii). While the effect size is weakened relative to previous tables, evidence of a positive relationship between Tobin's Q and derivative hedging is again presented. Reviewing the findings for the various moderating variables under consideration, results are largely supportive of those presented earlier with one exception. The largest effect size is found for FX risk, and differences in mean correlation between FX and other risks are significant at a 1% level. In contrast to early results using either baseline or average effect sizes, here we present evidence that hedging of IR risk is associated with increased value, although the effect size is smaller than that found for FX risk. While no paper has focused exclusively on the value proposition of IR hedging, Bartram *et al.* (2003) and Belghitar *et al.* (2008) find strong evidence of positive valuation effects for firms using IR derivatives.

[Table 4 about here.]

Studies employing a continuous, rather than dummy variable, are found to have a larger effect size. The mean correlation associated with working papers is 0.042 while that for published papers is 0.007. Emerging markets present a larger effect size than developed markets, while the effect size for Europe is significantly greater than that presented for the US. Finally, results after winsorizing the sample are unchanged, while the effect size increases dramatically when Fauver and Naranjo (2010) is excluded.

Regardless of the meta-analysis aggregation approach employed, we find strong evidence that derivatives hedging is associated with an increase in Tobin's Q, supporting the hypothesis outlined in Section 2. This provides the first quantitative evidence consolidating the disparate findings in the literature regarding the value relevance of corporate hedging with derivatives.

6. Conclusion

The use of financial risk management amongst non-financial firms is widespread (Bodnar *et al.*, 2016) and the trading volume of exchange and OTC derivatives is growing fast. While various studies have considered the implications of financial hedging using derivatives on firm value, evidence for resultant increases in firm value is mixed. For example, Allayannis and Weston (2001) indicate that hedging adds value in the case of firms concerned about foreign exchange risk. In contrast, Jin and Jorion (2006) suggest that hedging does not add value amongst a sample of oil and gas firms. Given the inconclusive evidence and the heterogeneity of risks firms are exposed to, we carry out a meta-analysis to synthesize the previous literature on the value enhancing properies of hedging with derivatives.

We adopt various approaches to deal with the issue of dependent samples and multiple specifications within each paper. Results, however, are comparable in each case. Financial hedging with derivatives is found to be associated with an increase in Tobin's Q amongst non-financial firms. The effect sizes found are small (less than 0.044) but significantly different from zero. Given the evidence for sample heterogeneity, various moderating variables are also considered. Only hedging of foreign exchange risk is found to be consistently associated with increased firm value across each of the baseline, paper average and all specification approaches. Limited evidence of value enhancement from hedging interest rate risk is found, but only when all specifications from all papers are considered simultaneously. No evidence of enhanced value from commodity hedging is found, possibly a consequence of the diverse risks encountered and similarity in corporate strategies. Stronger results are evidenced for working papers relative to published papers, and a variety of other moderating variables are examined.

The findings detailed here suggest that hedging with derivatives adds to firm value, but further research is indicated. In particular, building upon Bartram *et al.* (2003), further large-sample, cross-country and cross-industry evidence would help to clarify the circumstances under which derivatives hedging is most valuable. Future work might also consider robustness of findings to the use of Tobin's Q, the dominant measure of performance across the relevant literature. A variety of adjustments to this measure have been proposed to deal with issues such as biased estimation (Erickson and Whited, 2012; Lewellen and Badrinath, 1997). Finally, the strong recent evidence for selective hedging by firms may obfuscate inference regarding the value relevance of hedging (Adam and Fernando, 2006; Brown *et al.*, 2006). While the focus has largely been on selective hedging within particular sectors, more general conclusions regarding the trade-off between hedging and speculation within firms and the links with performance are warranted.

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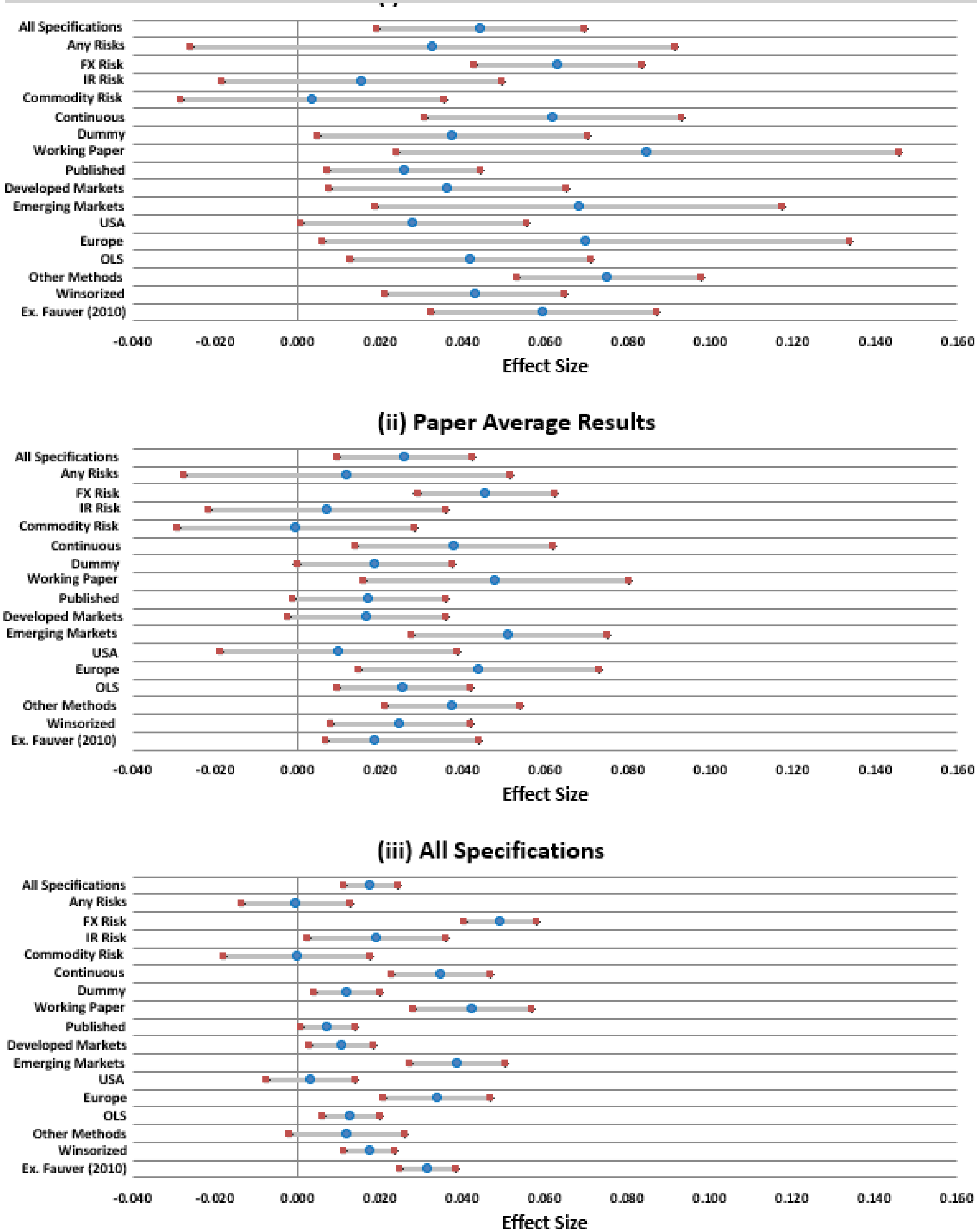

Figure 1: **Derivatives Hedging and Value - Effect Size Results**
These plots highlight the effect size both for all risks and subsamples according to various moderating variables. (i) Baseline results highlights the effect size for a single baseline specification from each paper (ii) Paper average results details the effect size using an observation weighted effect size for each paper, and (iii) All specifications examines the effect size using all specification from all papers. The average effect size in each case is shown in blue, while 95% confidence intervals are shown using red squares and grey error bars. Ex. Fauver (2010) refers to a robustness analysis considering all papers without Fauver and Naranjo (2010).

Authors	Risks Hedged	Country	Observations	Number of Effect Sizes	Average Effect Size	Minimum Effect Size	Maximum Effect Size
Ahmed *et al.* (2014)	FX, IR, CMDY	UK	13,824	6	0.002	-0.075	0.056
Allayannis and Weston (2001)	FX	USA	14,370	7	0.051	0.030	0.068
Allayannis *et al.* (2012)	FX, IR	USA	6,786	6	0.044	0.020	0.071
Ayturk *et al.* (2016)	FX, IR, CMDY, ALL	Turkey	19,213	14	0.019	-0.037	0.096
Bae *et al.* (2016)	FX	Korea	5,140	2	-0.011	-0.020	-0.009
Bartram *et al.* (2003)	FX, IR, CMDY	Global(48)	26,542	12	0.011	-0.054	0.079
Belghitar *et al.* (2008)	FX, IR	UK	1,190	4	0.140	0.107	0.158
Belghitar *et al.* (2013)	FX	France	2,009	10	0.010	-0.116	0.071
Berrospide *et al.* (2010)	FX	Brazil	4,529	4	0.061	0.054	0.067
Vivel Búa *et al.* (2015)	FX	Spain	8,304	24	0.053	-0.017	0.236
Carter *et al.* (2006)	CMDY	USA	913	4	0.108	0.029	0.184
Chang *et al.* (2010)	FX	USA	5,208	5	0.073	0.069	0.076
Chen and Shao (2010)	FX, CMDY	China	3,304	8	0.090	0.078	0.106
Chen *et al.* (2008)	CMDY	USA	384	4	-0.005	-0.015	0.006
Choi *et al.* (2013)	FX, IR, ALL	USA	6,441	21	0.066	-0.023	0.141
Clark and Judge (2009)	FX	UK	3,367	11	0.102	0.096	0.100
Clark and Mefteh (2010)	FX	France	704	7	0.173	0.108	0.359
Clark *et al.* (2006)	FX	France	1,056	6	0.092	0.063	0.122
Fauver and Naranjo (2010)	ALL	USA	131,902	16	-0.041	-0.097	0.022
Gleason *et al.* (2005)	FX	USA	1,080	5	0.333	0.305	0.341
Gómez-González *et al.* (2012)	FX	Colombia	18,144	4	0.051	0.031	0.074
Hagelin *et al.* (2007)	FX	Sweden	1,848	6	0.073	0.011	0.060
Iatridis (2012)	ALL	UK	1,249	1	0.114	0.114	0.114
Jankensgård (2015)	FX	Sweden	962	5	0.127	0.109	0.140
Jin and Jorion (2006)	CMDY	USA	2,233	7	-0.025	-0.063	0.022
Rossi Júnior and Laham (2008)	FX, ALL	Brazil	16,320	8	0.102	0.038	0.198
Kapitsinas (2008)	FX, IR, ALL	Greece	2,388	11	0.272	0.101	0.886
Khediri and Folus (2010)	ALL	France	1,600	5	-0.060	-0.089	-0.033
Khediri (2011)	FX, IR, ALL	France	8,760	12	-0.022	-0.070	0.056
Kim *et al.* (2006)	FX	USA	2,120	5	0.093	0.088	0.097
Korkeamäki *et al.* (2016)	CMDY	USA	1,295	5	0.084	0.058	0.107
Lin and Chang (2009)	FX, CMDY	Global(32)	4,647	21	0.045	-0.277	0.216
Lookman (2004)	CMDY, IR	USA	3,054	10	-0.033	-0.136	0.194
Luo (2016)	FX	China	4,122	6	0.084	0.027	0.201
Magee (2013)	FX	USA	10,337	9	0.036	-0.037	0.080

Marami and Dubois (2013)	IR	USA	25,310	10	0.038	-0.001	0.091
Mohammad (2014)	CMDY	USA	65	1	0.206	0.206	0.206
Naito and Laux (2011)	ALL	USA	1,702	4	-0.103	-0.174	0.078
Nguyen and Faff (2010)	FX, CMDY, IR, ALL	Australia	10,272	24	-0.052	-0.206	0.064
Nguyen and Faff (2007)	FX, IR, CMDY	Australia	2,568	6	-0.074	-0.143	-0.012
Nova *et al.* (2015)	FX, IR	UK	10,058	14	0.024	-0.113	0.169
Panaretou (2014)	FR, IR, CMDY	UK	18,190	16	0.031	-0.029	0.102
Phan *et al.* (2014)	CMDY	USA	4,400	6	-0.107	-0.123	-0.087
Pramborg (2004)	FX	Sweden	1,110	3	0.086	0.072	0.102
dos Santos *et al.* (2017)	ALL	Brazil	43,070	25	0.011	-0.036	0.066
Treanor *et al.* (2014)	CMDY	USA	1,949	7	0.099	0.031	0.157
Walker *et al.* (2014)	FX, IR, CMDY	South Africa	1,804	4	-0.038	-0.091	0.024

Table 1: **Studies included in the meta-analysis of hedging and firm value.**
Risks hedged are foreign exchange (FX), interest rate (IR), commodity (CMDY) and any combination of these three (ALL). Observations refers to the total number of observations across all relevant specifications considered from a study, while number of effect sizes indicates the number of specifications available. Average, minimum and maximum effect sizes are calculated for each study. The effect size in each case is estimated in each case from the t-statistic detailed, as described in Section 3.

	K	N	Mean Correlation	$CI95_{Lo}$	$CI95_{Hi}$	VSE	Q	I^2	Test for Significance			
All Papers												
1) All Risks	47	49,134	0.044***	0.019	0.069	12.35%	416.29***	88.71%				
Risk Types									2)	3)	4)	5)
2) Any Risks	13	23,176	0.033	-0.026	0.092	4.78%	290.31***	95.52%	\	-	-	-
3) FX Risk	33	28,967	0.063***	0.043	0.083	32.23%	116.00***	71.55%	-	\	***	***
4) IR Risk	15	13,537	0.016	-0.018	0.050	24.79%	62.59***	76.03%	-	***	\	-
5) Commodity Risk	17	9,669	0.004	-0.028	0.036	39.07%	43.99***	61.36%	-	***	-	\
Independent Variable									6)	7)		
6) Continuous	27	19,323	0.062***	0.031	0.093	20.41%	149.67***	81.96%	\	-		
7) Dummy	31	37,800	0.038**	0.005	0.070	9.51%	351.70***	91.19%	-	\		
Paper Publication Status									8)	9)		
8) Working Paper	17	15,450	0.085***	0.024	0.146	6.62%	302.75***	94.38%	\	*		
9) Published	30	33,684	0.026***	0.007	0.044	33.45%	94.62***	68.29%	*	\		
Region									10)	11)	12)	13)
10) Developed Markets	39	36,795	0.036**	0.008	0.065	12.64%	332.27***	88.26%	\	-		
11) Emerging Markets	8	12,339	0.068***	0.019	0.117	12.75%	71.70***	88.84%	-	\		
12) USA	18	23,270	0.028**	0.001	0.056	21.98%	86.85***	79.27%			\	-
13) Europe	17	10,787	0.070**	0.006	0.134	8.65%	225.44***	92.46%			-	\
Econometric Methods									14)	15)		
14) OLS	41	40,957	0.042***	0.013	0.071	11.16%	400.21***	89.76%	\	*		
15) Other Methods	6	8,177	0.075***	0.053	0.098	23.96%	23.96***	37.41%	*	\		
Robustness												
16) Winsorized	47	49,134	0.043***	0.021	0.065	16.50%	310.82***	84.88%				
17) Excl. F&N (2010)	46	38,049	0.060***	0.032	0.087	13.44%	385.28***	88.06%				

Table 2: **Baseline Results - Derivatives Hedging and Value**
This table uses meta-analysis to estimate the effect size between derivatives hedging by firms and performance. A single representative baseline specification is used for each paper. K is the number of samples and N is the aggregate number of observations. Mean correlation is a sample-size weighted correlation, $CI95_{Lo}$ and $CI95_{Hi}$ are upper and lower confidence intervals at the 95^{th} percentile, VSE is the share of variance associated with sampling error, Q is the Q-statistic test to determine whether the observed variance is heterogeneous and I^2 estimates the percentage of variation across studies due to heterogeneity, rather than chance. F&N (2010) refers to Fauver and Naranjo (2010). The test for significance tests the null hypothesis that the difference in mean correlation between two groupings is zero. ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels respectively.

	K	N	Mean Correlation	$CI95_{Lo}$	$CI95_{Hi}$	VSE	Q	I^2	Test for Significance			
All Papers												
1) All Risks	47	47,108	0.026***	0.009	0.042	30.12%	164.70***	71.46%				
Risk Types									2)	3)	4)	5)
2) Any Risks	13	20,097	0.012	-0.028	0.052	12.22%	109.13***	88.09%	\	-	-	-
3) FX Risk	33	30,844	0.046***	0.029	0.062	45.20%	79.98***	58.74%	-	\	**	***
4) IR Risk	15	14,145	0.007	-0.021	0.036	33.30%	45.82***	67.26%	-	**	\	-
5) Commodity Risk	17	9,742	0.000	-0.029	0.029	48.03%	35.51***	51.12%	-	***	-	\
Independent Variable									6)	7)		
6) Continuous	28	22,726	0.038***	0.014	0.062	29.21%	103.63***	72.98%	\	-		
7) Dummy	31	34,586	0.019**	0.000	0.038	31.47%	102.42***	69.73%	-	\		
Paper Publication Status									8)	9)		
8) Working Paper	15	14,196	0.048***	0.016	0.080	25.97%	63.63***	76.43%	\	*		
9) Published	30	31,766	0.017**	0.001	0.036	35.39%	88.00***	65.91%	*	\		
Region									10)	11)	12)	13)
10) Developed Markets	39	34,755	0.017*	-0.002	0.036	29.86%	135.47***	71.21%	\	**		
11) Emerging Markets	8	12,353	0.051***	0.028	0.075	54.85%	16.14**	50.43%	**	\		
12) USA	18	19,749	0.010	-0.019	0.039	23.64%	77.95***	76.91%			\	*
13) Europe	17	10,340	0.044***	0.015	0.073	44.74%	41.62***	59.15%			*	\
Econometric Methods									14)	15)		
14) OLS	41	40,184	0.025***	0.008	0.042	34.09%	126.72***	67.65%	\	-		
15) Other Methods	21	30,998	0.019	-0.007	0.044	19.45%	112.28***	81.30%	-	\		
Robustness												
16) Winsorized	47	47,108	0.026***	0.010	0.042	31.30%	158.45***	70.34%				
17) Excl. F&N (2010)	46	38,917	0.038***	0.021	0.054	36.87%	134.76***	65.86%				

Table 3: **Paper Average Results - Derivatives Hedging and Value**
This table uses meta-analysis to estimate the effect size between derivatives hedging by firms and performance. An observation-weighted average effect size is estimated for each paper. K is the number of samples and N is the aggregate number of observations. Mean correlation is a sample-size weighted correlation, $CI95_{Lo}$ and $CI95_{Hi}$ are upper and lower confidence intervals at the 95^{th} percentile, VSE is the share of variance associated with sampling error, Q is the Q-statistic test to determine whether the observed variance is heterogeneous and I^2 estimates the percentage of variation across studies due to heterogeneity, rather than chance. F&N (2010) refers to Fauver and Naranjo (2010). ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels respectively.

	K	N	Mean Correlation	$CI95_{Lo}$	$CI95_{Hi}$	VSE	Q	I^2	Test for Significance			
All Papers												
1) All Risks	405	411,989	0.018***	0.011	0.025	20.95%	207.92***	79.83%				
Risk Types									2)	3)	4)	5)
2) Any Risks	99	187,284	0.000	-0.013	0.013	12.01%	824.95***	88.00%	\	***	*	-
3) FX Risk	174	129,699	0.049***	0.041	0.058	39.00%	492.88***	64.70%	***	\	***	***
4) IR Risk	52	59,992	0.019**	0.003	0.036	23.19%	233.38***	77.72%	*	***	\	-
5) Commodity Risk	81	37,070	0.000	-0.018	0.018	33.34%	243.76***	66.77%	-	***	-	\
Independent Variable									6)	7)		
6) Continuous	175	113,413	0.035***	0.023	0.047	23.70%	793.38***	77.94%	\	***		
7) Dummy	236	302,803	0.012***	0.004	0.020	20.25%	1196.86***	80.28%	***	\		
Paper Publication Status									8)	9)		
8) Working Paper	140	126,096	0.042***	0.028	0.057	14.71%	1037.00***	86.50%	\	***		
9) Published	266	287,949	0.007**	0.001	0.014	30.15%	897.93***	70.38%	***	\		
Region									10)	11)	12)	13)
10) Developed Markets	333	303,539	0.011***	0.003	0.019	21.07%	1634.28***	79.62%	\	***		
11) Emerging Markets	73	110,506	0.039***	0.027	0.051	25.24%	312.50**	76.64%	***	\		
12) USA	127	177,751	0.003	-0.008	0.014	18.06%	709.92***	82.11%			\	***
13) Europe	155	95,832	0.034***	0.021	0.047	23.81%	699.45***	77.84%			***	\
Econometric Methods									14)	15)		
14) OLS	387	345,571	0.013***	0.006	0.020	18.40%	1200.23***	82.41%	\	-		
15) Other Methods	85	119,806	0.012	-0.002	0.026	15.63%	557.98***	84.76%	-	\		
Robustness												
16) Winsorized	405	411,989	0.018***	0.011	0.024	23.28%	1806.04***	77.58%				
17) Excl. F&N (2010)	395	323,941	0.032***	0.025	0.039	25.05%	1683.06***	76.53%				

Table 4: **Results using All Specifications - Derivatives Hedging and Value**
This table uses meta-analysis to estimate the effect size between derivatives hedging by firms and performance. All specifications examined in each paper are included in calculated the average effect size. K is the number of samples and N is the aggregate number of observations. Mean correlation is a sample-size weighted correlation, $CI95_{Lo}$ and $CI95_{Hi}$ are upper and lower confidence intervals at the 95^{th} percentile, VSE is the share of variance associated with sampling error, Q is the Q-statistic test to determine whether the observed variance is heterogeneous and I^2 estimates the percentage of variation across studies due to heterogeneity, rather than chance. F&N (2010) refers to Fauver and Naranjo (2010). ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels respectively.

Highlights:

- The relationship between financial hedging and firm value creation is examined
- Statistical meta-analysis used to synthesize results from 47 empirical studies
- Firms' using derivatives to hedge risks have larger Tobin's Q
- Greater firm value found to be primarily associated with hedging of FX risk
- An array of moderating variables are assessed

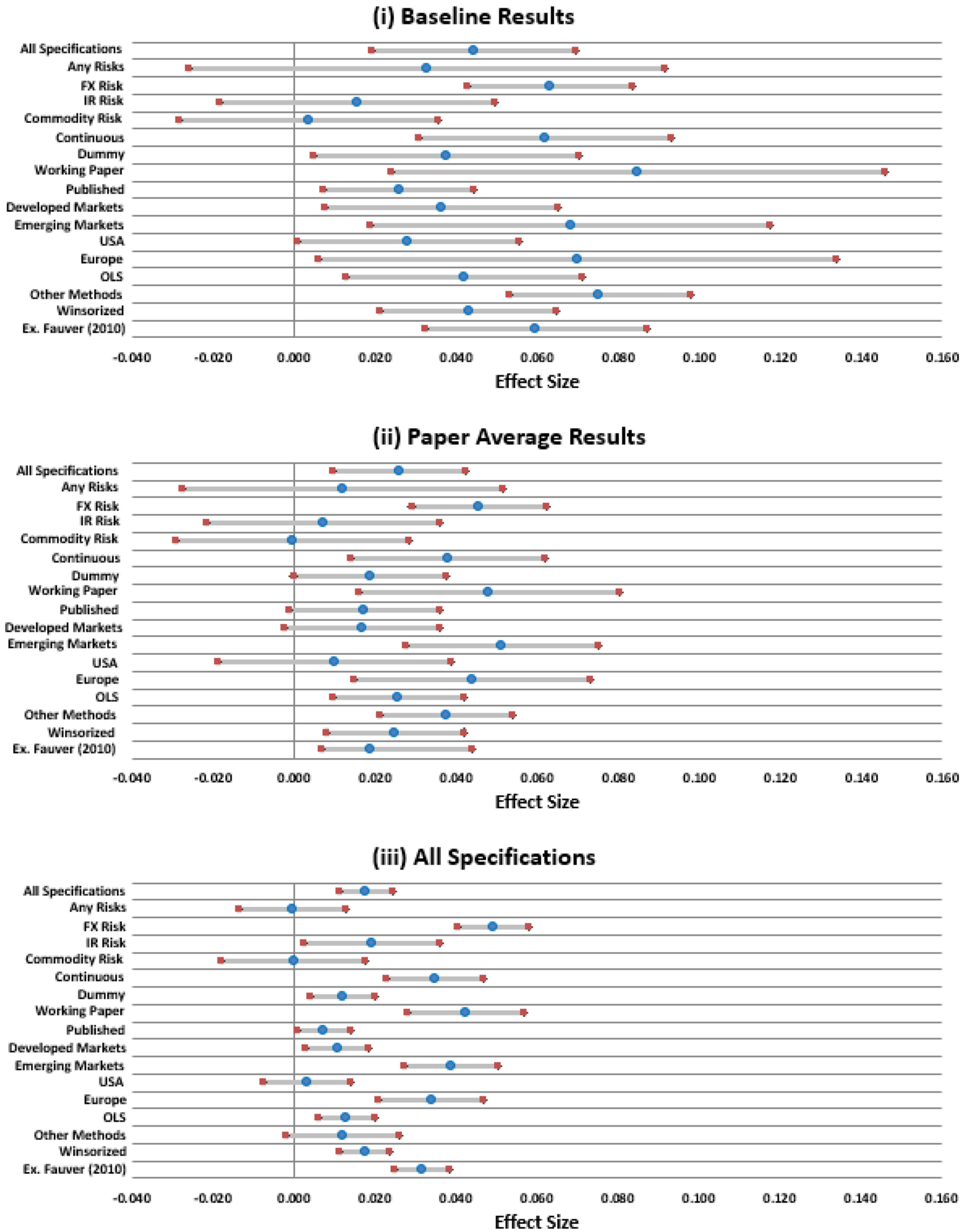
(i) Baseline Results
All Specifications
Any Risks
FX Risk
IR Risk
Commodity Risk
Continuous
Dummy
Working Paper
Published
Developed Markets
Emerging Markets
USA
Europe
OLS
Other Methods
Winsorized
Ex. Fauver (2010)
-0.040
-0.020
0.000
0.020
0.040
0.060
0.080
0.100
0.120
0.140
0.160
Effect Size
(ii) Paper Average Results
All Specifications
Any Risks
FX Risk
IR Risk
Commodity Risk
Continuous
Dummy
Working Paper
Published
Developed Markets
Emerging Markets
USA
Europe
OLS
Other Methods
Winsorized
Ex. Fauver (2010)
-0.040
-0.020
0.000
0.020
0.040
0.060
0.080
0.100
0.120
0.140
0.160
Effect Size
(iii) All Specifications
All Specifications
Any Risks
FX Risk
IR Risk
Commodity Risk
Continuous
Dummy
Working Paper
Published
Developed Markets
Emerging Markets
USA
Europe
OLS
Other Methods
Winsorized
Ex. Fauver (2010)
-0.040
-0.020
0.000
0.020
0.040
0.060
0.080
0.100
0.120
0.140
0.160
Effect Size

Figure 1