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Corporate financial hedging and firm value: A meta-analysis

Jerome Geyer-Klingeberg[a], Markus Hang[b], Andreas Rathgeber[c]

Abstract

This paper presents a quantitative review of the empirical literature analyzing the firm value effects of corporate financial hedging. Using meta-regression analysis to accumulate a hand-collected data set of 1016 estimates for the hedging premium reported in 71 previous studies, we find that the reported firm value effects of hedging are systematically higher for foreign exchange hedgers as compared to interest rate and commodity price hedgers, for studies published in higher ranked journals, and for models estimated with firm fixed effects and controls for endogeneity. Our results also suggest that hedging premiums increase significantly when a study also considers operational hedging strategies in addition to financial hedging. Moreover, we detect geographical differences providing evidence for a larger hedging effect in less developed financial markets and countries with higher tax rates. Taking together the existing literature and assuming a 'best practice' study design, we predict an overall hedging premium of 1.8% for foreign currency hedgers and a firm value discount of -0.8% (-0.6%) for interest rate (commodity price) hedgers.

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Introduction

Corporate hedging behavior[1] and its impact on firm valuations have attracted widespread attention in the corporate finance literature (among many others, Allayannis and Weston, 2001; Bartram et al., 2011; Bessler et al., 2019; Carter et al., 2006; Giambona et al., 2018; Jin and Jorion, 2006; MacKay and Moeller, 2007; Pérez-González and Yun, 2013). Despite a long series of empirical evidence investigating firm-level data to determine if corporate hedging is a value-enhancing strategy, literature remains largely unsettled, particularly in regard to two dimensions. First, the empirical estimates for the impact of hedging on corporate values range from large positive premiums to zero and even negative effects. Second, the design of the empirical studies that produced these varying outcomes is rather diverse in terms of the applied econometric methods, measurement of the hedging and the firm value variable, the time period of the sample, examined countries, and other aspects of data and methodology. The discordance of the empirical evidence and the variability in study designs make it challenging to evaluate what general hedging premium the literature implies and how the heterogeneity in the reported results is driven by differences in data and methods. To address these questions, we apply meta-analysis.

This meta-analysis aggregates 71 primary studies providing 1016 estimates for the effect of corporate hedging on the firm value of non-financial companies. Meta-analysis is a set of statistical methods for the collection and synthesis of existing empirical research results. It is widely applied in various areas of economics and management, and more recently also in financial economics (among others, Feld et al., 2013; Geyer-Klingeberg et al., 2020; Hang et al., 2018; Holderness, 2018; Kysucky and Norden, 2016; van Ewijk et al., 2012). With this approach, we contribute to the literature in several ways. First, we determine how the authors' choices about methods and data influence the hedging premiums reported in their studies. Moreover, we extend the limited evidence on the country-level determinants of the value effects of corporate hedging by testing a new set of previously unexamined macroeconomic variables as contingency factors for the hedging premium. The findings from the heterogeneity analysis disentangle the large variability of existing empirical results by showing which aspects of data, methods,

[1] Corporate hedging refers to all measures to reduce and control corporate exposure to risks. There are different strategies to hedge: *Financial* hedging makes use of derivative instruments or other financial hedging methods like foreign debt, foreign assets, or hedging substitutes such as cash management or dividend policy. *Operational* hedging refers to the use of various real options within a company, like opening a foreign subsidiary or flexibility in the adjustment of production volumes. The title of this study reflects that the majority of the articles included in our meta-analysis report estimates for the firm value impact of financial hedging activities, especially the use of financial derivatives. Nevertheless, the meta-analysis results also allow us to derive inferences about the impact of other hedging strategies.

and other study characteristics determine the hedging premium. Future improvements in model specification and estimation techniques could be evaluated against the benchmark provided by these results. Second, we aggregate the wide research record on the hedging/firm value relation and present accumulated hedging premiums for different types of risk exposures, while building on recent discussions about data mining and selective reporting in empirical finance studies by taking advantage of the capability of meta-analysis to detect and correct for publication bias. The aggregated hedging premiums can be interpreted as a 'consensus' effect combining all available empirical information. Such a 'consensus' and its influencing factors might also be of high interest for corporate decision-makers when defining their hedging strategies.

Our results suggest the following key findings. (i) Following recent discussions about selective reporting of favorable research results and publication bias (e.g., Geyer-Klingeberg et al., 2020; Harvey, 2017; Kim and Ji, 2015), we find that journal quality is a decisive factor for the reported firm value effects. The value impact of hedging is, on average, 2% lower for estimates published in higher ranked journals. (ii) The impact of the risk exposure type on the size of the hedging premium has been intensively examined in prior literature without reaching a clear consensus (e.g., Allayannis et al., 2012; Carter et al., 2006; Jin and Jorion, 2006). Pooling all previous empirical results, we find that the size of the premium is systematically smaller for interest rate and commodity price hedgers as opposed to foreign exchange hedgers. (iii) In line with discussions on the impact of the econometric model specification (e.g., Gilje and Taillard, 2017; Gormley and Matsa, 2014; Mitton, 2019), we find that studies that omit controls for firm fixed effects and endogeneity show a strong upward bias in the reported hedging premiums. (iv) Adding to previous results on the interaction between operational and financial hedging (e.g., Allayannis et al., 2001; Kim et al., 2006), our meta-analysis reveals that primary studies controlling for operational hedging in their regression models report significantly larger hedging premiums compared to studies focusing on financial hedging only. (v) We find evidence for the hypothesis that differences in hedging premiums are not alike across countries and world regions. Market access to financial derivatives and the level of a country's tax rate determine the firm value creation through corporate hedging. (vi) Accounting for several sources of bias and assuming a 'best practice' study design, we predict an average mark-up in firm value of 1.8% for foreign exchange

hedgers, a negative discount of -0.8% for interest rate hedgers, and a -0.6% discount for commodity price hedgers.

The remainder of this paper is structured as follows. Section 2 briefly reviews the related literature. Section 3 describes the data collection. The methodological approach of meta-analysis is outlined in Section 4. Section 5 discusses the sources of heterogeneity in the collected hedging premiums. Section 6 presents and discusses the results of the empirical analysis. Section 7 concludes. An online appendix[2] provides further details about the sample, applied methodology, and robustness tests.

Related literature

Theory

Modigliani and Miller (1958)'s irrelevance theorem implies that under the assumption of a perfect capital market, corporate hedging is irrelevant for firm value. In a frictionless market, individual investors can hedge on their own (instead of the company hedging on their behalf), because they have access to the same information and the same hedging instruments. If the assumptions of a perfect capital market are violated, there are several channels through which hedging at the firm-level may affect shareholder value and create a hedging premium. In such an imperfect market, cash flow volatility is costly due to financial distress (Smith and Stulz, 1985), convex tax functions (Smith and Stulz, 1985), external financing (Froot et al., 1993), or information asymmetry between the firm and its shareholders (DeMarzo and Duffie, 1991). As hedging is an instrument to improve cash flow stability, it may reduce the costs of market friction and thereby positively affect shareholder value.

In contrast to the various theoretical arguments on how the relaxation of the assumptions of a perfect capital market creates opportunities for corporate hedging to be beneficial for shareholders, other arguments suggest that hedging might also be associated with a discount in firm value. For example, MacKay and Moeller (2007) highlight that hedging is not costless and if hedging costs outweigh benefits, it might not be valuable. In a similar vein, hedging can be associated with agency costs and monitoring problems for shareholders if managers make selective hedging decisions to protect their

[2] The Online Appendix is available at https://myweb.rz.uni-augsburg.de/~geyerkje/research%20files/HedgeValue_Appendix.pdf

individual interests or to increase risk exposures for speculative purposes (Brown et al., 2006; Smith and Stulz, 1985; Tufano, 1996).

Empirical evidence in primary research

In a seminal article, Allayannis and Weston (2001) analyze a sample of 720 US firms and find that the average increase in firm value (measured by Tobin's Q) is about 5% for firms using foreign exchange derivatives. Initiated by this empirical study, a comprehensive literature stream on the value impact of hedging developed. Many succeeding articles build upon Allayannis and Weston (2001) but change one or several aspects in terms of data, methods, and overall study design.

A first aspect of the difference between studies in this field relates to the examined industry and, connected with that, the type of risk exposure. For US high-tech firms, Gleason et al. (2005) show that financial hedging of exchange rate risk is value increasing. Similar, Carter et al. (2006) observe that financial derivatives usage for jet fuel hedging enhances firm value in the airline industry by more than 10%. For pharmaceutical and biotech firms, Choi et al. (2013) find that the use of financial derivatives for hedging is associated with greater firm value and that the value increase is larger for firms that are subject to greater information asymmetry and higher growth opportunities. In contrast to the sector-specific findings for a positive hedging premium, Jin and Jorion (2006) provide empirical evidence that hedging is not rewarded by higher valuations in the oil and gas industry.

Another dimension to cluster the primary literature is the country analyzed in the data set. Allayannis et al. (2012) present an international study covering a broad sample of firms from 39 countries with significant exchange rate exposures. They report strong evidence for both internal firm-level and external country-level governance to be associated with significant hedging premiums. In single country studies, Clark and Judge (2009), Gómez-González et al. (2012), Búa et al. (2013), Jankensgård (2015), and Bae et al. (2018) reveal a value-enhancing effect of corporate hedging for firms in the United Kingdom, Colombia, Spain, Sweden, and South Korea, respectively. The opposite effect (i.e., a negative or zero value impact of hedging) is reported by Nguyen and Faff (2007), Khediri (2010), Li et al. (2014), Ayturk et al. (2016), and dos Santos et al. (2017) for companies in Australia, France, New Zealand, Turkey, and Brazil.

Literature also addresses various methodological challenges occurring in the empirical analysis of the hedging/firm value nexus. Much discussion evolved as both variables, corporate hedging and firm value, are endogenous, i.e., hedging can affect firm value, but firm value can also affect hedging. To control for endogeneity, Bartram et al. (2011) match derivatives users and non-users depending on their estimated propensity to use derivatives. They document a positive effect of derivatives use on firm value, which is however sensitive to endogeneity and omitted variable concerns. Pérez-González and Yun (2013) exploit the introduction of weather derivatives as an exogenous shock to the firm's ability to hedge weather risk. They use this natural experiment to control for endogeneity and conclude that derivatives lead to higher firm valuations. Other studies implement an instrumental variable approach where they instrument the use of hedging with variables that are likely to affect hedging but not likely to affect firm value (Allayannis et al., 2012; Fauver and Naranjo, 2010; Lau, 2016).

Another intensively discussed aspect is the differentiation between hedging strategies. Especially older studies in the field assume that derivatives hedging, as an instrument of financial hedging, is equivalent to hedging in general. More recent research considers the existence of other hedging mechanisms beyond financial hedging, such as operational strategies (Almeida et al., 2017; Chod et al., 2010; Hankins, 2009; Hoberg and Moon, 2017). For example, Allayannis et al. (2001) find that shareholders benefit from operational hedging strategies only when used in combination with financial hedging strategies. In a similar vein, Kim et al. (2014) report that both operational and financial hedging activities are valuable for non-family firms, but do not create value in family firms.

Related reviews

A group of related meta-analyses synthesizes empirical studies examining the determinants of corporate hedging decisions (Arnold et al., 2014; Geyer-Klingeberg et al., 2019; Geyer-Klingeberg et al., 2018a; Hang et al., 2020). In contrast to these studies, we focus on the firm value effect of corporate hedging. Other authors present qualitative reviews of the corporate hedging literature and its impact on firm value, but without a statistical integration of empirical findings (Ammon, 1998; Aretz and Bartram, 2010; Judge, 2007; Krause and Tse, 2016; Ramlall, 2010; Sahoo, 2015; Triki, 2005). The study closest to this paper is by Bessler et al. (2019), who perform a meta-analysis of 47 studies to aggregate and compare correlation coefficients between corporate hedging behavior and Tobin's Q. As a key result, they find a

statistically significant, but small mean correlation coefficient of 0.044. In their subgroup analysis, hedging of foreign exchange risk is found to be consistently associated with higher shareholder value, while there is not clear evidence for hedging of interest rate and commodity price risk.

The approach and results presented in this paper extend the study by Bessler et al. (2019), especially with regard to three aspects. First, our statistical measure to be aggregated is the actual hedging premium instead of the correlation coefficient between both variables. A key advantage of the hedging premium over correlation coefficients is that it allows interpreting the economic magnitude of the accumulated effects, instead of the statistical relation between the two variables. Second, Bessler et al. (2019) follow the meta-analysis method by Hunter and Schmidt (2004) to calculate weighted mean correlations for different subgroups depending on the data and methods used in the primary studies. This approach spotlights single contingency factors of the hedging/firm value link. In contrast, we use meta-regression analysis to simultaneously model the impact of different moderator variables in a multiple regression framework that accounts for the interrelations among these variables. This method has also the advantage of explicitly controlling and correcting for publication bias. A third distinction stems from the variables analyzed as moderators for the size and direction of the hedging premium. As an extension of the work by Bessler et al. (2019), we explore several new directions, especially regarding the estimation and model characteristics of the primary studies, as well as the macroeconomic differences among the countries examined in the primary data samples.

Sample selection

Data collection

To identify the empirical studies analyzing the impact of hedging on firm value, we performed a keyword search[3] in multiple electronic databases[4]. We also conducted a backward search in the reference lists of the identified papers and screened all articles citing those studies (via the 'cited by' option in Google Scholar). The last study was added in March 2018. The literature search and the subsequent analyses are in line with the guidelines by the Meta-Analysis for Economics Research Network (Havranek et al., 2020; Stanley et al., 2013).

[3] The search term consists of keywords linking terms for hedging (hedging, hedger, risk management, derivatives, option, swap, forward, future) and firm value (firm value, premium, Tobin's Q, market-to-book ratio).
[4] Academic Search Premier, Business Source Premier, EconLit, Google Scholar, and the SSRN working paper database.

During the sample selection process only studies meeting the following selection criteria are considered: (i) Estimates from a regression analysis are reported, where the dependent variable is a measure of firm value and an explanatory variable is a measure of corporate hedging. (ii) The data sample refers to non-financial companies[5]; (iii) Statistical measures of the precision of the regression parameter measuring the value effect of hedging are reported (standard errors, *t*-statistics, or *p*-values).

In addition to the selection criteria, we consider the following aspects during the manual data extraction from the studies: (iv) To avoid any ex-ante selection bias, e.g., by just focusing on journal articles, studies are included independent of their publication status. Our methodological approach explicitly controls for variation in study quality. (v) To better explore differences across countries, we drop observations referring to multi-country samples.[6] (vi) Studies routinely report multiple estimates for the firm value effects of hedging, e.g., for different risk exposures, alternative model specifications, or other robustness tests. We follow a common best practice in meta-analysis research (among others, Feld et al., 2013; Geyer-Klingeberg et al., 2018b; Kysucky and Norden, 2016; Rusnak et al., 2013) and sample all available estimates. This multiple sampling approach increases the power of meta-analysis tests and enhances the accuracy of estimates due to the larger sample[7]. As the inclusion of multiple estimates per study violates the assumption of statistical independence, we explicitly control for data clustering at the study-level and also the between-study level in the estimation of the meta-regression model.

The application of the selection criteria produces a final sample of 71 primary studies published between 2001 and 2018. These studies report 1016 regression estimates for the hedging/firm value relation. The full list of included studies is reported in Online Appendix A.

Calculation of hedging premiums

The studies in our sample use several variants of the following baseline regression model:

$$Q_{it} = \alpha + \beta H_{it} + \sum_{j=1}^{m} \gamma_j X_{jit} + \eta_i + \zeta_t + \varepsilon_{it} \quad (1)$$

[5] This is a common procedure in the hedging literature, which is reasoned by the fact that most financial firms are also market makers in derivatives markets (Allayannis and Weston, 2001). Hence, their rationales for using derivatives may be different from non-financial firms.
[6] If an estimate for the hedging premium refers to one specific country, we can clearly assign a value of the macroeconomic factors defined in Section 5.
[7] Moreover, selecting just one estimate per study requires objective selection rules to decide which estimate to prefer and also leads to a loss of information about within-study variation (Stanley and Doucouliagos, 2012).

where i and t are firm and time subscripts; Q is a measure of firm value; H is a measure of corporate hedging activities; X represents a vector of control variables; and ε is the error term. The coefficients η_i and ζ_t capture firm-specific and time-specific effects.[8]

The parameter of interest to be aggregated in our meta-analysis is $\hat{\beta}$, which is the estimated regression coefficient of the hedging variable and can be interpreted as a premium (or discount) of hedging. As authors use different functional forms and model specifications, the collected estimates are not directly comparable across studies. A first distinction relates to the dependent variable. There are studies estimating the model in a level-level specification as shown above. However, the majority of studies applies a log-level specification, i.e., they use the natural logarithm of Q. A second distinction regards the definition of the hedging variable H, which is either a dummy variable that is equal to one for hedging firms and zero for non-hedgers, or a continuous variable measuring the actual hedging volume. As meta-analysis requires the underlying effect sizes to be comparable, we transform the reported estimates $\hat{\beta}$ such that they represent the hedging premium HP. This measure quantifies the average percentage markup (or discount) in firm value for hedging firms compared to non-hedgers (if H is a dummy variable) or the percentage markup (or discount) of a firm with an average hedge ratio compared to non-hedgers (if H is a continuous variable). For the calculation of the hedging premiums, we use the regression coefficients and descriptive statistics reported in the studies. To account for the fact that the hedging premium is estimated with error, we calculate the corresponding standard error $SE(HP)$ to capture precision.[9] The Online Appendix B describes the calculation of the hedging premium in detail.

Methodology

We employ meta-regression analysis to derive generalizations about the hedging premiums reported in the empirical literature and to explore the conditional factors that drive variation among them. In a meta-regression model, the estimates for the hedging premium collected from the previous literature are regressed on a set of variables measuring differences in method, data, and other aspects of study design (Stanley and Jarrell, 1989):

[8] Cross-country studies may also include country fixed effects.

[9] As an extension of Eq. (1), about 10% of estimates for $\hat{\beta}$ represent interactions of the hedging variable with other firm characteristics (e.g., capital expenditures). For these estimates, we follow Havranek et al. (2016) and evaluate the interaction term at the sample mean of the interacting variable to calculate the hedging premium. We then use the delta method to approximate the corresponding standard errors of the hedging premiums. For details, see Online Appendix B.

$$HP_{ij} = \beta_0 + \beta_1 SE(HP_{ij}) + \sum_{k=2}^{m} \beta_k Z_{kij} + \varepsilon_{ij}, \text{ with } \varepsilon_{ij} \sim N(0; SE(HP_{ij})^2), \quad (2)$$

where i and j are estimate and study subscripts; HP are the estimates of the hedging premium calculated from the empirical results reported in the primary studies; $SE(HP_{ij})$ is the standard error of the estimates, which is included to control for publication bias[10]; Z denotes a vector of m variables capturing heterogeneity across the collected premiums; ε is the error term. The intercept β_0 represents the mean hedging premium conditional on $SE = 0$ and $Z = 0$. The meta-regression coefficients β_k reflect the average effect of the particular study characteristic on the estimated hedging premium. Accordingly, the explanatory variables can be interpreted as moderators for the relationship between firm value and hedging. These moderators are discussed in the subsequent Section 5.

We estimate Eq. (2) using weighted least squares (WLS) to accommodate heteroscedasticity, which is a standard procedure to obtain efficient meta-regression estimates (Stanley and Doucouliagos, 2012). Moreover, we apply robust standard errors to control for dependency among the collected hedging premiums. We use two clusters following Cameron et al. (2011): at the level of the individual studies and the level of the country the hedging premiums refer to. Moreover, we follow Kysucky and Norden (2016) and winsorize extreme observations at the 1% and 99% quantile. The methodological details are outlined in Online Appendix C.[11]

Why identified hedging premiums vary

Data and method choices

We expect several methodological and data aspects of the primary studies to determine the size and direction of the reported estimates for the hedging premium (see Table 1).

<<< INSERT TABLE 1 ABOUT HERE >>>

Journal quality. To consider quality differences not captured by the subsequent data and method characteristics, a dummy variable marks if premiums are observed from one of the most influential journals in (financial) economics. A journal is assigned to this group if its Scimago Journal Ranking

[10] Publication bias arises when researchers or editors/reviewers discard undesired results from publication (Begg and Berlin, 1988; Rothstein et al., 2005; Stanley, 2005). Undesirable outcomes might be statistically insignificant effects, outcomes without support of the ex-ante hypothesis, outcomes that are inconsistent with theoretical predictions, or outcomes that do not agree with what is found in the previous empirical literature. If uncontrolled, such an active selection of preferred statistical results might distort the summarized effects in a meta-analysis (Doucouliagos and Stanley, 2013).

[11] In addition, Online Appendix D outlines common issues occurring in a meta-analysis and how we approached them.

(SJR) exceeds 1.00.[12] We expect lower hedging premiums in higher ranked journals. This assumption is based on the hypothesis of higher quality regarding data and methods in those journals, which is assured by the rigorous review process with multiple referees and revision rounds. Moreover, top journal studies often examine larger samples, i.e., standard errors are usually lower and, thus, also small hedging effects produce statistical significance. Accordingly, there might be no need to find large effects to offset large standard errors, which reduces the risk of selective reporting of large hedging premiums causing publication bias.

Geographical region. We cluster the countries examined in the primary studies into five geographical areas using dummy variables indicating whether a specific observation belongs to a certain region or not. The baseline category is North America, which accounts for 52% of the estimates in our sample. Following discussions about country-level differences in corporate hedging behavior (Allayannis et al., 2012; Bartram et al., 2009), we predict better access to hedging instruments in more developed world regions (North America and Europe), which facilitates hedging at the shareholder-level and, thus, might result in lower hedging premiums.

Sample year. To capture structural changes in the hedging/firm value nexus over time, we code a dummy variable to be one for studies with an average sample year after 2001. This breakpoint represents the mid of the average sample years across all studies in the sample[13]. Another motivation for this breakpoint is the sharp increase in the derivatives market turnover starting after 2001 (Figure 1). This increase in derivatives turnover could reflect a higher demand for corporate hedging, which might be rewarded by a higher hedging premium.

<<< INSERT FIGURE 1 ABOUT HERE >>>

Measurement of hedging. We collect information on whether an estimate of the hedging premium refers to foreign exchange, interest rate, or commodity price hedgers by coding a dummy variable for each risk type. As some studies analyze mixed exposures, which always include foreign exchange hedgers, we use both the foreign exchange hedgers and the mixed exposure group as baseline category. In line with previous literature (Allayannis et al., 2012; Carter et al., 2006; Jin and Jorion, 2006), we

[12] The journals in this category are The Journal of Finance, Journal of Corporate Finance, Review of Financial Studies, Review of Finance, Journal of International Economics, and Energy Economics.
[13] We prefer a breakpoint dummy over the average sample year, as the average sample year is highly correlated with other variables exhibiting time trends (e.g. the macro variables explained in the next section).

predict systematic differences in the hedging premiums for the three exposure types. Foreign exchange risk often arises from complex foreign activities and currency streams across various countries and world regions. Accordingly, the FX risk exposure could be difficult to observe by outside investors and firms might hedge more effectively due to better information. In contrast, interest rates and commodity prices might be associated with less information asymmetry for shareholders. Moreover, for commodity price risk previous literature argues that investors might prefer to leave it unhedged, as they want to actively invest in the commodity risk (e.g., of gold mines, oil & gas companies, or airlines) (Jin and Jorion, 2006).

We also code whether an observed estimate of the hedging premium comes from a model where the independent variable is a hedging dummy variable or a continuous hedging measure. While continuous measures convey more detailed information than a simple dummy variable, the hedging volume often depends on accounting rules. The continuous measures used in the 71 primary studies are notional values of derivatives obtained from annual reports (48%), actual hedge ratios[14] obtained from internal company information (42%), fair values of derivatives obtained from annual reports (1%), or other continuous measures like the number of different contracts used for hedging (9%). In summary, it is not clear whether to expect a larger or smaller hedging premium for dummy measures as compared to continuous measures.

Risk reduction can be obtained by different financial and operational strategies (Allayannis et al., 2001). Thus, equating hedgers with derivatives users bears the risk of incorrectly defining firms without derivatives holdings as non-hedging firms, although they could just employ alternative strategies for hedging (Allayannis et al., 2001; Guay and Kothari, 2003; Hankins, 2009; Hoberg and Moon, 2017). To control for the impact of the hedging definition on the reported premium, we define a dummy that is equal to one if a study defines hedgers as derivatives users, and zero if studies also consider alternative strategies beyond derivatives use in their hedging definition. Following previous literature on the complementary relation between operational and financial hedging (Allayannis et al., 2001; Hang et al., 2020), we predict that studies accounting for alternative hedging strategies report larger hedging premiums.

[14] This is typically measured by the actual quantity that is hedged (e.g., the volume of oil production hedged) divided by the actual risk exposure (e.g., the total oil production).

If a firm is a non-hedger, this might either be driven by its explicit decision against hedging or by the absence of a risk exposure. To avoid biased inferences, several authors propose the exclusion of firms without ex-ante exposure from the primary study's data sample (among others, Allayannis and Weston, 2001; Magee, 2013). We code a dummy variable for studies focusing on firms or industries with an ex-ante risk exposure and expect those studies to find larger hedging premiums due to the more precise distinction of the treatment group (hedgers) and the control group (non-hedgers). A further dummy variable denotes whether a study reports estimates for the firm value implications of single derivatives instruments, such as options, futures, or swaps, as opposed to multiple instruments being used for hedging. As companies usually employ several different instruments to hedge their various exposures (Bodnar et al., 1998), the analysis of single derivatives instrument might not cover the full hedging strategy. Hence, we expect lower hedging premiums for estimates focusing on single instruments.

Measurement of firm value. The studies in our sample quantify firm value by a measure of Tobin's Q.[15] However, this measure requires information about the market value of long-term debt and the replacement costs of fixed assets, which is usually not easy to obtain. Therefore, most studies apply approximations of Tobin's Q by the market-to-book ratio. We control for differences in the definition of firm value by two dummy variables denoting whether firm value is measured by a simple market-to-book ratio or alternatively by more advanced measures of Tobin's Q (base category). Following Allayannis and Weston (2001), who find small differences in the hedging premium using alternative measures for firm value, we have no clear ex-ante expectation for the impact of the firm value definition on the size of the reported premium.

Estimation characteristics. Bias in the primary regression estimates might arise from unobserved heterogeneity across groups of firms. If these unobserved group factors are correlated with the variables of interest, omitted variable bias might infect the estimated parameters. In regressions with a firm value proxy as dependent variable, firm fixed effects have been shown to be an important factor (Gormley and Matsa, 2014). To control for this, we code a dummy variable that is equal to one for hedging premiums obtained from regression models estimated with firm fixed effects and zero otherwise. In line with recent econometric literature suggesting that, in the presence of unobserved group heterogeneity, the fixed

[15] Tobin's Q is defined by the ratio of the market value of financial claims and the replacement cost of the firm's assets.

effects estimator is consistent for models with Tobin's Q as dependent variable (Gormley and Matsa, 2014), we expect studies including firm fixed effects in their models to report lower hedging premiums.

Another major threat for the validity of empirical studies arises from endogenous relations among the regression variables and the error term. A crucial source of endogeneity is reverse causality, i.e., firms with higher values tend to hedge rather than hedging causes higher firm values.[16] Especially more recent studies address the endogeneity problem by using instrumental variable approaches. A dummy variable in our meta-analysis signals cases where researchers explicitly address the endogeneity problem in their models by instrumental variable approaches or other relevant methods.[17] We hypothesize that studies that do not control for endogeneity over-estimate the hedging premium.

Empirical research on corporate hedging has shown that hedgers exhibit different firm characteristics than non-hedgers (Géczy et al., 1997; Mian, 1996; Nance et al., 1993). Hence, firms do not randomize their hedging activities, which might generate a selection bias in the estimation of the value effects of hedging. To control for this bias, several authors apply a two-step Heckman regression (Heckman, 1979). A dummy variable is coded to be one if an estimate is observed from a model that applies such a two-stage procedure to control for selection bias. We expect lower premiums in studies accounting for this aspect in their models.

As a common remedy to avoid biased standard errors due to non-independent observations or non-constant variance of residuals, authors apply robust estimations for the standard errors (Petersen, 2008). We consider this correction by another dummy variable and expect lower premiums for studies accounting for robust errors in their estimation. Moreover, some estimates of the hedging premium are obtained from models with interaction terms between the independent hedging measure and other corporate variables (e.g., the size of the risk exposure). We capture those estimates with interaction terms by a corresponding dummy variable.

Control variables. While examining the impact of a certain risk exposure (e.g., foreign exchange risk), some studies control for the impact of hedging other risk exposures which might be correlated (e.g., interest rate risk). To take account for these cases, we add a binary variable to track if a primary

[16] As ordinary least squares estimation of Eq. (1) relies on the exogeneity assumption of the regressors, hedging premiums without accounting for endogeneity might be biased.
[17] 69% of the models with endogeneity correction use instrumental variables via two or three stage least squares regressions, 23% use generalized method of moment (GMM) estimation, the remaining 9% use other methods.

regression model includes more than one variable for different hedging exposures in the same model. We expect the premium of a specific exposure to be lower if the model also considers controls for other exposures in the same regression.

The primary studies include a wide set of controls to filter out the impact of other variables that might impact firm value. Common controls are measures for firm size, liquidity, leverage, dividend policy, operational hedging[18], and managerial ownership. As firm size is included in over 97% of the models, we do not explicitly control for its inclusion. For the other variables, we code dummy variables. If estimates are collected from regressions including this control variables, the respective dummy is equal to one, and zero otherwise. Following the reasoning outline before, we predict a positive sign for operational hedging, i.e., studies controlling for operational hedging estimate larger premiums. The expected sign for the other variables depends on the correlation between the control variable and the corporate hedging variable/the firm value variable. From a previous meta-analysis of 175 studies on the determinants of corporate hedging by Geyer-Klingeberg et al. (2019), we can observe that the literature taken together finds the following impact of the controls on the hedging variable: liquidity (negative), leverage (positive), dividend policy (positive), and managerial ownership (mixed). From another meta-analysis by Hang et al. (2020) we know that the overall relation between liquidity and firm value is positive, and negative for leverage and dividend policy. For managerial ownership they do not report results. Taken this previous evidence together, we predict larger hedging premiums for studies controlling for liquidity, smaller premiums for studies controlling for leverage, dividend policy, and managerial ownership.

Country-level differences

Previous authors point out that country-level variables determine the value implications of hedging, e.g., through external governance (Allayannis et al., 2012). We add to this literature by analyzing which country-level factors promote or inhibit the impact of hedging on firm value. With meta-analysis, we can take advantage of the full set of countries examined across all studies. Based on the country and sample period being reported, we construct average values of several macroeconomic variables that are

[18] Following Allayannis et al. (2001), studies including a measure for geographical diversification are considered as controlling for operational hedging.

assumed to condition the degree of market frictions in a country and thus, based on the positive theory of corporate hedging, also have an impact on the value generation through hedging.[19] If not stated otherwise, the country data is obtained from World Bank Open Data (World Bank, 2017a, b, c, d).

<<< INSERT TABLE 2 ABOUT HERE >>>

Financial and economic development. Basic theory assumes hedging to be costless. However, in practice, hedging is associated with transaction costs. Following Bartram et al. (2009), we use the natural logarithm of the average daily derivatives trading volume in foreign exchange and interest rate markets (scaled by the country's GDP) to measure the size and liquidity of markets for financial hedging instruments.[20] Since the development of derivatives markets and other financial markets is highly correlated, we also consider the logarithm of the country's average stock trading volume (scaled by GDP) as a further proxy for the maturity of local financial markets. Moreover, we follow Bartram et al. (2009) and include the trade magnitude (sum of imports and exports scaled by GDP) as another measure of economic development. Finally, we define a dummy variable classifying whether the countries examined in the primary studies are members of the OECD or not. We predict that the hedging premium should be higher in countries with less developed markets, where transaction costs might be higher and, thus, access to derivatives instruments for hedging might be constrained.

Legality and governance. In line with Allayannis et al. (2012), we analyze different variables for a country's governance mechanisms and its legal environment. We predict that in countries with higher values for the rule-of-law index[21] hedging premiums should be lower because companies encounter lower transaction costs to enter complex financial contracts like derivatives (Bartram et al., 2009). As a further measure of agency costs, we examine indices of shareholder rights and creditor rights. This is based on the hypothesis that in countries with significant rights for shareholders and creditors, agency costs for reducing information asymmetries should be lower and thus, according to shareholder value maximization theory, value creation through hedging might be lower as well. Finally, we analyze the ownership concentration measure by Dahlquist et al. (2003) and hypothesize that tighter concentration

[19] If a study's sample period does not exactly correspond to the data available from the external sources, we follow Kysucky and Norden (2016) and use the closest available country-year observation.
[20] This data is obtained from the Bank of International Settlements (BIS). As this information is only available on a triennial basis (starting in 1995), we estimate the missing annual values by linear interpolation.
[21] The rule-of-law index measures the effectiveness of the legal system.

of market capitalization of closely held shares suggests lower shareholder diversification and, thus, higher value generation through hedging because less diversified shareholders have more incentives to hedge at the firm-level (Smith and Stulz, 1985).

Financial distress and taxes. To quantify differences in financial distress costs, we use the logarithm of the number of years between fillings for insolvency in court until resolution of the distressed assets. As a long period of resolution implies higher costs of financial distress, we predict a positive relation with the observed hedging premium because hedging smooths the effect of financial distress costs. Analogously to Bartram et al. (2009), we also use the heterogeneity of a country's financial and overall risk factors to test financial distress theory. We use both the financial and the composite[22] risk indices by the International Country Risk Guide (PRS Group, 2015) and predict larger hedging premiums in countries with higher risk.[23] Finally, we use the country's tax rate as a proxy for the tax smoothing effect of hedging. The hypothesis is that countries with higher tax rates should exhibit larger hedging premiums because the tax-reduction effect of hedging probably increases with the tax rate. However, it should be noted that this is just a rough proxy, as the tax effect of hedging depends on the convexity of the tax schedule (Smith and Stulz, 1985).

Empirical results

This section is divided in three parts. In Section 6.1, we present the results for the heterogeneity analysis focusing on the impact of data and method choices on the reported hedging premiums. The subsequent Section 6.2 shows the findings for the macroeconomic factors as drivers of the hedging premium. Finally, Section 6.3 reports the mean hedging premium implied by the literature.

Data and method choices as drivers of hedging premium variation

Main results

Table 3 reports the results for the meta-regression model (Eq. 2) with the variables for data and method choices from Table 1 as moderator variables Z. Since the majority of explanatory variables are dummies, their estimated coefficients reflect the average impact on the reported hedging premiums if the study

[22] This is the sum of economic, financial, and political risk factors.
[23] These indices are inverse measures of country risk, i.e., higher scores imply lower risk.

design deviates from the base group in that specific aspect, holding all other things equal. Significant variables in the meta-regression show that the respective variable indeed affects the hedging premiums found in the literature.

<<< INSERT TABLE 3 ABOUT HERE >>>

Column (1) shows the baseline model using the inverse of the hedging premiums' variance as weights for the WLS regression to put more emphasis on the more precise and, thus, more reliable findings in the literature. Moreover, standard errors are clustered at the study-level and country-level to control for non-independency of the observations for the hedging premium. Column (2) adds regional cluster variables. Column (3) uses the interaction between the hedging premiums' variance and the number of estimates reported per study as alternative weights in the WLS regression. Column (4) is a reduced model using the general-to-specific approach.

We see five key results to be derived from Table 3, which provide new explanations for the diverse results in the literature, but also confirm aspects of previous discussions. For the interpretation, we refer to the baseline model (Column 1).

Journal quality. The meta-regression results indicate that hedging premiums that are found in the highest ranked journals are systematically different from the empirical findings reported in other journals and unpublished work; even after controlling for all other aspects regarding data and methods. Other things being equal, top journal studies report a significantly lower impact of hedging on firm value of 2.0% on average. Accordingly, journal quality obviously matters for the size of the reported hedging premium, which is in line with our ex-ante hypothesis.

North America vs. other regions. The estimated meta-regression coefficients for the world regions indicate the average difference in hedging premiums compared to North America. We find that hedging premiums are not all alike across the world. According to Column (2), the markup in firm value through corporate hedging is 3.9% larger for firms located in Latin America than in the US. The coefficient for East Asia indicates corporate hedging to be less valuable than in the US. In contrast, there is no systematic difference in the hedging premiums of European or South Asian firms as compared to US companies. While the result for Europe could be explained by the similarity of both markets in terms of both economic maturity and accessibility to hedging instruments, the missing evidence for a systematic

difference of South Asian firms might be driven by the low number of observations in our sample (only 3% of the estimates refer to South Asia). However, regional cluster are only rough estimates of the real macroeconomic divers for country-level differences in hedging premiums. Therefore, we extend the analysis in this regard in Section 6.2.

Risk exposure type. When breaking down the observed hedging premiums by the different risk exposures, we see clear differences. On average across the literature, interest rate hedgers and commodity price hedgers exhibit a lower firm value of 2.6% and 2.3% as compared to foreign exchange hedgers. This remarkable difference among the major types of financial risk is in line with common sense in the literature (Allayannis et al., 2012; Jin and Jorion, 2006). In a robustness test (Online Appendix F), we examine whether hedging premiums for FX hedgers are still different when estimated together in the same primary regression model with interest rate and/or commodity price hedgers. The results show that the FX premium is significantly larger than interest rate and commodity price premiums even when observed from models that correct for the impact of other risk exposures.

Firm fixed effects and endogeneity control. Considering firm fixed effects in the primary studies' regression models significantly reduces the size of the reported premiums by -2.3% on average, i.e., unobserved heterogeneity on the individual firm-level creates an upward bias in the estimation of hedging premiums. Another source of bias in the primary estimation comes from endogeneity. When studies control for endogeneity in their estimation via instrumental variables or other approaches, they tend to report lower hedging premiums of -1.3% on average. This is especially interesting for the intensive discussion of endogeneity issues and reverse causality between firm value and corporate hedging (e.g. Aretz and Bartram, 2010). Our results provide an indication that not accounting for this issue in an empirical study leads to an overestimation of the hedging premium. However, the statistical significance of the result is not stable and drops to the 10% level in the reduced model (Column 4).

Derivatives usage vs. broader hedging definition. The results suggest that studies equalizing hedgers with derivatives users find lower premiums by -5.1% on average. This implies that the firm value premium of using derivatives for hedging is not equal to the broader concept of a hedging premium including non-derivatives hedging methods as well.[24] Beyond an extended definition of the dependent

[24] It should be noted that the number of observations including a broader hedging definition is rather small (5%). Thus, results for this variable can only be interpreted as a first indication of differences between derivatives usage and other hedging strategies.

hedging variable in the primary regression, some studies also add other hedging methods as a control variable in their models. We find evidence that omitting a control for operational hedging causes a downward bias on the size of reported premiums (-1.1% on average). As for both variables (accounting for other hedging methods in the definition of the dependent variable or by adding an independent variable as control) hedging premiums increase when operational hedging is accounted for, we could infer that financial hedging in conjunction with operational hedging has a larger firm value effect than financial hedging only. A similar finding is reported by Allayannis et al. (2001) suggesting that financial and operational hedging are rather complements than substitutes, since a comprehensive corporate risk management approach might require different hedging strategies. The outcome that the impact of hedging is different when accounting for other hedging strategies is also subject of an ongoing discussion in the literature (Amberg and Friberg, 2016; Hoberg and Moon, 2017).

Further results

The breakpoint variable for the time period after 2001 indicates a distinct trend in hedging premiums over time. The time effect is reflected by a 2.5% larger premium for samples with an average sample year after 2001. This finding might be reasoned by the strong growth in international trade and export ratios, as well as increased global market volatility since the 2000s (e.g., during the financial crisis in 2007/2008 and the European debt crisis since 2009). The extended uncertainty also affects corporate risk exposures and thus might require more need for risk management at the firm-level.

For the different hedging measures (dummy vs. continuous hedging variable), our results suggest significantly larger premiums of 0.9% for binary hedging variables.[25] However, it should be noted that the impact of the continuous hedging measure depends on the accounting standards under which the hedging volume has been reported and the actual measurement of the continuous variable.[26]

Regarding the set of control variables, we find that models controlling for other risk exposures report lower premiums on average. This indicates that the different exposure types are correlated and omitting

[25] It should be noted that the hedging premiums collected from primary models with a continuous hedging variable are evaluated at the sample mean hedging volume, i.e., they show the hedging premium the study implies for an average hedger. In contrast, the hedging premiums for the binary variable refer to the difference between hedgers and non-hedgers. Thus, the evaluation of the continuous variable at the sample mean might drive the systematically lower premiums as compared to models using a binary hedging variable. See also Online Appendix B.

[26] In a robustness test (Online Appendix G), we examine the impact of major accounting changes and find that the hedging premium increased with each change. Moreover, we break down the continuous hedging measures in notional amounts, actual hedge ratios, fair values, and other hedging measures. The results suggest that fair values and actual hedge ratios yield systemically lower hedging premiums of 2.2% and 1.9% as compared to notional amounts.

other exposures as control from the primary regression might bias the estimated hedging premium. Moreover, the negative sign of the coefficients for managerial ownership indicates that adding this variable as control to the primary regression reduces the effect of hedging on firm value.

Even after controlling for various aspects of study design, the significant coefficient for the primary standard error indicates publication bias. Without publication bias, the hedging premiums' standard error and the estimate for the premium should be independent quantities. But if primary study authors actively change their data and methods to find hedging premiums to be large enough to offset large standard errors, i.e., to reach statistical significance, correlation between the estimates' standard errors and the hedging premium occurs (Ashenfelter et al., 1999; Stanley, 2005). The sign of the coefficient is positive in all models, which reveals that positive premiums are systematically overrepresented in the literature. We will further examine this issue in Section 6.3.

Macroeconomic factors as drivers of hedging premium variation

The regional clusters examined in Table 3 are rough estimates of geographical differences, since they do not quantify the real macroeconomic and institutional dissimilarities across countries. Therefore, we replace the regional dummies by the other country-level variables defined in Table 2. An important strength of meta-regression is that it allows adding new information from external sources to the original primary study based on the investigated country and time period. For the hedging literature, this is especially valuable as existing studies usually refer to data from a single country and thus, by construction of their samples, cannot analyze cross-country differences. With meta-analysis, we can build an international sample of hedging premia from all countries analyzed in the previous literature. The macroeconomic variables are assigned to the studies as average values of the time series corresponding to the country and time period examined in the study.

Calculating the correlation coefficients among these variables reveals large interdependencies with correlations above 0.90.[27] Therefore, we compute the meta-regression results separately for each country-level variable. Table 4 reports the corresponding results. The estimation is based on the baseline specification (Column 1 in Table 3) but replaces the regional clusters by the macroeconomic variables.

[27] See Online Appendix E for the correlation matrix.

<<< INSERT TABLE 4 ABOUT HERE >>>

Financial and economic development. We find evidence that the access to derivatives instruments for hedging (measured by the local market's derivatives trading volume) moderates how hedging impacts firm value. Accordingly, hedging premiums are larger in countries with less liquid derivatives markets, where investors face additional costs and hedging at the firm-level becomes preferable against hedging at the individual shareholder level. If we see market liquidity as a proxy for transaction costs, this finding shows that, in contrast to standard hedging theory where hedging is often assumed to be costless, the costs of hedging are an important conditional factor for whether hedging is valuable or not. This finding is supported by the results for the country's stock trading volume, which can be seen as a proxy for the development of financial markets in general. As further proxies for economic development, the country's trade magnitude and OECD membership confirm that economic and financial development drive how hedging influences firm value. Hedging premiums decrease with stronger economic and financial development. This might probably be driven by the fact that market inefficiencies providing motivation for corporate hedging are lower in more developed countries.

Legality and governance. Legality and governance factors (Panel B) do not moderate the size of the hedging premium. Accordingly, we cannot confirm previous evidence by Allayannis et al. (2012) that external governance factors explain differences in the hedging premium. An explanation for this finding could be that, rather than country-level differences in governance and legality, the firm-level differences in governance could matter for the value premium of hedging. However, in a meta-analysis we can only compare the between-study and between-country differences in the reported hedging premiums, but not the individual firms analyzed in the primary data sets.

Financial distress and taxes. We find evidence that hedging premiums are, on average, larger in countries with higher tax rates. Following basic hedging theory (Mayers and Smith, 1982; Smith and Stulz, 1985), corporate hedging can smooth cash flows under a convex tax schedule, such that the taxable income less often falls into the progressive region of the tax schedule (i.e., where the marginal tax rate is greater than the average tax rate paid by the firm). Although the actual tax rate is not an ideal proxy for the convexity in the tax schedule, it gives some indication of the potential for value creation through hedging due to lower tax payments.

Overall, the results for the country-level determinants propose that beyond the common firm-level channels, also country-specific differences condition whether corporate hedging is valued by investors. So far, the theoretical explanations of corporate hedging largely abstract from country-specific features, thereby supposing that the theories are equally important for firms from different countries. However, the outcomes of this meta-analysis challenge this assumption and give rise to the proposition that the classical hedging theories should be extended by a further dimension covering the country-specific surroundings, especially the financial market conditions and tax rate schemes.

Mean hedging premium implied by the literature

Publication bias analysis

The previous heterogeneity analysis provides estimates for the differences in hedging premiums if certain study factors are present/absent, as well as for the sensitivity of hedging premiums against macroeconomic variables. However, it does not reveal the mean hedging premium across the literature. In this section, we derive estimates for the overall hedging premium implied by the previous studies.

When estimating mean effects via meta-analysis, we have to account for the distorting impact of publication bias. To explore publication bias in the hedging/firm value literature, Figure 2 illustrates the funnel plots and histograms of the estimates collected from the primary studies. A funnel plot depicts the magnitude of the estimated hedging premiums on the horizontal axis and the estimates' precision (the inverse standard error) on the vertical axis. Asymmetry in the funnel plot indicates publication bias (Egger et al., 1997).

<<< INSERT FIGURE 2 ABOUT HERE >>>

Figure 2(a) shows the funnel plots for all estimates in the sample as well as for the median estimate per study. From the plots we see some evidence that the right tail of the funnel is heavier, i.e., studies reporting negative hedging premiums appear less often than positive estimates. This is an indication for publication selection in favor of a positive firm value effect through hedging. Figure 2(b) illustrates the histogram of the absolute *t*-statistics of the value estimates. Without selection for statistical significance, we would expect a monotonic decreasing function. However, the plot provides evidence that *t*-ratios at the margin of common critical values are overreported (especially around $t = 2$, which indicates statistical significance at the 5% level). In the second histogram, we take the median values to control

for the fact that some studies report many similar *t*-values. It becomes apparent that the fraction of estimates is about three times higher when *t*-ratios reach a value close to two. A similar but less extensive pattern can be seen for the critical values of the 1% significance level around $t = 2.7$. This simple graphical analysis provides first evidence that researchers might select estimates for the hedging premium based on the positive sign and statistical significance of the effect.[28]

To test whether the graphical implications are also supported by statistical analysis, we use the model from Eq. (2) without moderators Z and replace $SE(HP)$ with $SE(HP)^2$ because simulation studies have shown that using a non-linear term yields a better estimate of the genuine effect corrected for publication bias (Stanley and Doucouliagos, 2014):

$$HP_{ij} = \gamma_0 + \gamma_1 SE\left(HP_{ij}\right)^2 + \eta_{ij}, \text{ with } \eta_{ij} \sim N(0; SE(HP_{ij})^2), \quad (3)$$

where the estimated slope coefficient $\hat{\gamma}_1$ captures asymmetry in the funnel plot and thus the presence and magnitude of publication bias. The intercept $\hat{\gamma}_0$ quantifies the mean hedging premium corrected for publication bias. The results of the test are reported in Table 5 for the full sample (Column 1), for a model using the interaction between the hedging premiums' variance and the number of estimates reported per study as weights in the WLS regression (Column 2), and separately for the three risk exposure types (Columns 3-5).

<<< INSERT TABLE 5 ABOUT HERE >>>

Across all models, we find indication for publication bias because γ_1 is statistically significant with a positive sign. This reveals that positive premiums are systematically overrepresented in the literature. The estimate for the intercept is the mean hedging premium assuming no publication bias ($SE(HP)^2 \rightarrow 0, E(HP) \rightarrow \hat{\gamma}_0$). The results suggest a positive overall hedging premium across the literature, i.e., taking all 1016 estimates collected from 71 primary studies together implies a hedging premium of 1.4%. When breaking the mean effects down by the type of risk exposure, we find that foreign exchange hedgers have a firm value mark-up of 2.5% against non-hedgers. For interest rate hedgers the effect is 0.01% and statistically insignificant. For commodity price hedgers the mean premium is -1.0%.

[28] A similar finding was recently exposed by Harvey et al. (2016) for factor studies on the cross-section of expected returns.

The distortion due to publication can also be illustrated by a comparison of the corrected mean effects with the simple average premiums. The arithmetic mean across all hedging premiums in our sample is 6.4%[29], while the corrected mean effect from the baseline model is 1.4% (Column 1). Accordingly, without accounting for publication selection, we exaggerate the mean effect more than fourfold. In summary, the selective reporting of positive and significant hedging premiums distorts the view about the true underlying effect. If the simple average across the literature, which is uncorrected for publication bias, represents the common impression about the impact of hedging on firm value, our analysis uncovers that this view is highly exaggerated.

Best practice estimates

Besides publication bias, the heterogeneity analysis in Sections 6.1 and 6.2 reveal that the hedging premium is conditional on various study-specific factors. To consider these contingency factors also in the estimation of the mean hedging premium, we create a synthetic study and predict the hedging premium by substituting 'best practice' values for the explanatory variables. We calculate the predicted estimates for two different scenarios: (i) using the estimated regression parameters of the baseline model in Table 3 (Column 1) to explore the impact of differences in the methodological variables; (ii) using the estimated parameters from the analysis of the macroeconomic factors in Table 4.

We define the 'best practice' case as follows. First of all, we filter out publication bias and set *SE* to zero. Next, we substitute a value of one for the breakpoint variable to model a study examining recent sample data. Moreover, we prefer a study controlling for ex-ante exposure. We also prefer an advanced statistical approach using robust standard errors and a model controlling for self-selection bias, endogeneity, and firm fixed effects. For the firm value proxy, we assume a non-simple approximation of Tobin's Q. Moreover, we estimate the hedging premium for a top journal article because the meta-results have shown a systematic difference in hedging premiums. To minimize the impact of misspecification bias, we choose a model including all control variables. As there is no clear preference, we choose the sample mean for the remaining variables.[30] Due to the fundamental differences in the

[29] The arithmetic mean across all hedging premiums is 9.7% for FX hedgers, 2.1% for interest rate hedgers, and 3.3% for commodity price hedgers.
[30] Among others, we set the sample mean for the type of hedging variable (dummy vs. continuous) because both measures come with caveats and there is no clear preference which is the better proxy.

value effects for the different risk exposure types, all estimates are computed separately for foreign exchange, interest rate, and commodity price hedgers. However, it should be noted that any specification of such a benchmark study remains somewhat subjective.

To quantify how the mean hedging premium changes due to model misspecification in primary studies, we report the predicted values for the best practice model without controlling for these biases (Panel A). In addition, we add the derivatives markets volume and the tax rate as important findings from the analysis of country-level heterogeneity. We estimate the model with the same configuration for the before-mentioned variables and report results for a scenario when substituting the maximum value in the sample (high) and substituting the scenario with the sample minimum value (low) (Panel B). All findings are reported in Table 6.

<<< INSERT TABLE 6 ABOUT HERE >>>

The predictions imply a hedging premium of 1.8% for FX hedgers, -0.8% for interest rate hedgers, and -0.6% for commodity price hedger. These values can be interpreted as the mean estimate for the hedging premium implied by the entire empirical literature and given a study with best practice research design after controlling for publication selection and misspecification biases. Accordingly, if we take all available estimates and assume an 'ideal' study, we find the values reported above.

Panel A shows the impact when deviating from the best practice study design. If correction for firm fixed effects are omitted, we find larger and positive premiums for all three exposure types. When leaving out the control for endogeneity as well, the resulting bias increases the mean premiums even further. Finally, omitting relevant control variables for operational hedging and managerial ownership, which have been shown to be important controls in the previous meta-regression, creates an upward bias in the hedging premium. This experiment illustrates the strong impact of model estimation and specification on the final results. By making slight changes in the model design, hedging premiums change heavily. Thus, we conclude that the primary authors' choices have a strong impact on the final result.

Best practice estimates for the important country-level moderators (Panel B) uncover the hedging premium when accounting for differences in financial development and regional tax schemes. When derivatives volumes are low, predicted premiums are positive for the three exposures types and show

values up to 2.7% for foreign exchange hedger. In contrast, for regions like the US with highly developed derivatives markets, the hedging premium is just 0.7% for foreign exchange hedgers and negative for the other two risk exposures. Finally, when inserting the sample maximum of the country's tax rate, we find clear positive effects of hedging and low or even negative premia for countries with lower tax rates.

Conclusion

There is a long-running debate in finance literature whether or not corporate hedging adds value to non-financial firms. Previous empirical studies reveal diverse effects ranging from value discounts to large value premiums of hedging firms. However, little is known about the drivers of variability in existing findings. We extend the previous literature by a statistical accumulation of the existing results in this area of research. Using meta-analytic methods, we aggregate empirical findings of 71 primary studies and identify various sources of heterogeneity in the value effects of hedging. The findings of the meta-analysis can be summarized as follows:

(1) The results from the heterogeneity analysis suggest that several aspects of data and method choices explain the large variation in previous findings. We find that better journals (in terms of higher impact factors) report lower hedging premiums by 2% on average, indicating that journal quality is an important determinant for the size of the hedging premium. Moreover, value effects of hedging largely depend on the type of the risk exposure to be hedged. Interest rate and commodity price hedging is associated with systematically lower firm values than foreign exchange hedging. In terms of estimation methods, controlling for fixed effects and endogeneity issues is crucial for the detected premium. Omitting these aspects in the primary regression creates a strong upward bias in the estimated hedging effects. Finally, our results suggest that accounting for operational hedging reveals significantly larger premiums compared to studies defining hedgers only as derivatives users. The evidence proposes that operational hedging and financial hedging have a joint impact on firm value.

(2) We test the impact of country-level and regional differences measuring conditions under which hedging should be more or less valuable. Our findings uncover that the value impact of hedging is smaller in countries with high derivatives and stock trading volumes, OECD member countries, and countries with lower tax rates. No evidence could be found that a country's legal environment

and governance factors explain differences in reported hedging premiums. The same holds for the proxies measuring financial distress costs.

(3) The literature on corporate hedging suffers from both an upward bias in the size of reported hedging premiums and an overrepresentation of marginally significant results. These effects cause a biased picture of the true underlying effect. The overall mean hedging premium corrected for publication bias is about four times lower than the simple average of reported hedging premiums. Finally, we create a synthetic 'best practice' study and predict the mean hedging premiums corrected for publication bias and other errors in model specification. The mean hedging premium across the literature reveals a firm value mark-up for foreign currency hedgers of 1.8%, a negative discount of -0.8% for interest rate hedgers, and a negative value impact for commodity price hedgers of -0.6%.

As the majority of observations in the meta-analysis refers to derivatives hedging, our findings should rather be interpreted as aggregation and comparison of derivatives premiums as opposed to the broader concept of a hedging premium that also covers other hedging strategies. This also reveals the limits of meta-analysis, as any review can only aggregate what is being reported in previous studies. If previous results miss out an important aspect in the definition of hedgers, also meta-analysis bears this restriction. Nevertheless, both the moderator for definition of the hedging variable and the control whether primary studies include variables for operational hedging in their regressions give some indication of the impact of other hedging strategies on firm value. In a similar direction, we cannot fully rule out the impact of endogeneity on our results. Although we explicitly examine if primary studies account for reverse causality between hedging and firm value in their regression by instrumental variables or other approaches, there is only one study in our sample examining a real natural experiment. With more studies evolving, future meta-research in this field could explicitly examine whether hedging premiums obtained from those studies are systematically different.

The results from this meta-analysis could guide future empirical research on hedging, as they show the potential sources of bias and reveal which study characteristics determine empirical outcomes. Future enhancements in estimation techniques and data might be evaluated against the benchmark given by the meta-regression findings. Bayesian approaches relying on objective a-priori distributions could

also refer to the meta-analytic findings showing the accumulated knowledge of the previous literature. Furthermore, the outcomes for the macroeconomic determinants point at several compelling avenues for further research. For example, in contrast to the examined country-level variables that are derived from classical hedging theory on market frictions, other aspects unrelated to the standard theory, like a country's risk culture, might explain differences in the value premia of hedging.

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Table 1. Description of data and method choices driving hedging premiums

Variable	Description	Mean	Std. Dev.
Journal quality			
Top journal	= 1 if a study is published in a journal with a Scimago Journal Ranking (SJR) above 1.00, 0 otherwise	0.22	0.42
Geographical region			
North America*	= 1 if a study's sample refers to firms from North America, 0 otherwise	0.52	0.50
Europe	= 1 if a study's sample refers to firms from Europe, 0 otherwise	0.25	0.43
East Asia & Pacific	= 1 if a study's sample refers to firms from East Asia & Pacific, 0 otherwise	0.09	0.28
South Asia	= 1 if a study's sample refers to firms from South Asia, 0 otherwise	0.03	0.18
Latin America	= 1 if a study's sample refers to firms from Latin America, 0 otherwise	0.11	0.31
Sample year			
After 2001	= 1 if the average year of sample data in a study is after 2001, 0 otherwise	0.51	0.50
Measurement of hedging			
Foreign exchange hedgers*	= 1 if the estimate refers to FX hedgers only or hedgers of mixed exposures including FX, 0 otherwise	0.42	0.49
Interest rate hedgers	= 1 if the estimate refers to interest rate hedgers only, 0 otherwise	0.10	0.30
Commodity price hedgers	= 1 if the estimate refers to commodity price hedgers only, 0 otherwise	0.29	0.45
Hedging dummy variable	= 1 if a dummy variable is used as a hedging measure, 0 if a continuous variable is used	0.68	0.47
Derivatives users	= 1 if hedgers are defined as derivatives users, 0 if the hedging definition includes further strategies beyond derivatives usage (e.g., operational hedging strategies)	0.94	0.23
Control for ex-ante exposure	= 1 if the estimate refers to firms with an ex-ante risk exposure, 0 otherwise	0.44	0.50
Focus on specific instruments	= 1 if the estimate refers to a specific group of derivatives instruments (e.g. options or futures only), 0 otherwise	0.10	0.31
Measurement of firm value			
Market-to-book ratio	= 1 if Tobin's Q is measured by simple market-to-book ratio, 0 if Tobin's Q is measured alternatively following Chung and Pruitt (1994), Perfect and Wiles (1994) or Lewellen and Badrinath (1997)	0.66	0.47
Estimation characteristics			
Control for firm fixed effects	= 1 if estimation controls for firm fixed effects, 0 otherwise	0.21	0.41
Control for endogeneity	= 1 if estimation controls for reverse causality between the firm value measure and the hedging measure, 0 otherwise	0.20	0.40
Control for sample selection	= 1 if estimation controls for sample selection bias, 0 otherwise	0.03	0.17
Robust errors	= 1 if heteroscedasticity robust and/or cluster robust errors are reported, 0 otherwise	0.45	0.50
Interaction term	= 1 if the hedging variable enters the regression model in interaction with other variables, 0 otherwise	0.13	0.33
Control variables			
Control for other risk exposures	= 1 if a model includes two or more estimates for different risk exposures, 0 otherwise	0.30	0.46
Control for operational hedging	= 1 if the model includes a measure for operational hedging, 0 otherwise	0.52	0.50
Control for managerial ownership	= 1 if the model includes a measure for managerial ownership, 0 otherwise	0.17	0.37
Control for liquidity	= 1 if the model includes a measure for liquidity, 0 otherwise	0.34	0.47
Control for leverage	= 1 if the model includes a measure for debt ratio, 0 otherwise	0.91	0.29
Control for dividend policy	= 1 if the model includes a measure for dividend policy, 0 otherwise	0.74	0.44

Notes: This table presents the definition and summary statistics of the variables measuring data-related and methodological heterogeneity across studies. All variables are manually collected from studies estimating the value effects of corporate hedging. (*) marks the omitted category in the meta-regression analysis.

Table 2. Description of macroeconomic factors driving hedging premiums

Variable	Description	Mean	Std. Dev.
Financial and economic development			
Derivatives market volume	Logarithm of the country's average daily derivatives trading volume in FX and IR markets scaled by GDP (BIS, 2016a, b)	0.13	0.21
Stock trading volume	Logarithm of the country's average stock trading volume scaled by GDP (World Bank, 2017c)	4.46	0.77
Trade magnitude	Logarithm of the country's average sum of exports and imports scaled by GDP (World Bank, 2017b)	3.49	0.48
OECD member	= 1 if a country is a member of the OECD, 0 otherwise	0.82	0.39
Legality and governance			
Rule-of-law	A country's average rule-of-law index (World Bank, 2017d)	1.18	0.75
Shareholder rights	A country's average aggregate index of shareholder rights protection (World Bank, 2017a)	5.46	1.99
Creditor rights	A country's average aggregate index of creditor rights protection (World Bank, 2017a)	8.20	3.43
Ownership concentration	A country's average measure of ownership concentration (Dahlquist et al., 2003)	0.24	0.25
Financial distress and taxes			
Time to resolve insolvency	Logarithm of the country's average time (in years) between filling for insolvency in court until the resolution of distressed assets (World Bank, 2017a)	0.88	0.34
Financial risk	Logarithm of the country's average International Country Risk index for financial risk (PRS Group, 2015) [Higher values indicate less risky environment]	3.60	0.09
Composite risk	Logarithm of the country's average International Country Risk composite risk index (PRS Group, 2015) [Higher values indicate less risky environment]	4.32	0.07
Tax rate	Logarithm of the country's average company tax rate (World Bank, 2017a)	3.80	0.24

Notes: This table presents the definition and summary statistics of the variables measuring geographical and country-level heterogeneity across studies. Values of the country-level variables are assigned according to the country and observation period examined in the primary studies.

Table 3. Data and method choices as drivers of corporate hedging premiums

	(1) Baseline model	(2) Regional differences	(3) Alternative weights	(4) Reduced model
Journal quality				
Top journal	-0.020***	-0.025***	-0.025***	-0.020***
	(-3.61)	(-5.51)	(-3.07)	(-5.89)
Sample year				
After 2001	0.025**	0.031***	0.040***	0.026***
	(2.51)	(2.86)	(4.85)	(3.88)
Geographical region				
Europe vs. North America		0.002	-0.007	-0.010
		(0.11)	(-0.56)	(-0.66)
East Asia & Pacific vs. North America		-0.024*	-0.020***	-0.018*
		(-1.70)	(-2.97)	(-1.96)
South Asia vs. North America		-0.002	-0.014	-0.018
		(-0.12)	(-0.80)	(-1.16)
Latin America vs. North America		0.039**	0.044***	0.020**
		(2.31)	(3.65)	(2.04)
Measurement of hedging				
Interest rate hedgers vs. FX hedgers	-0.026***	-0.026***	-0.014***	-0.028***
	(-6.62)	(-8.08)	(-2.58)	(-7.99)
Commodity price hedgers vs. FX hedgers	-0.023***	-0.021***	-0.034***	-0.022**
	(-3.35)	(-2.60)	(-4.26)	(-2.25)
Hedging dummy variable	0.009**	0.012**	0.022***	0.009
	(2.53)	(2.54)	(3.43)	(1.58)
Derivatives users	-0.051***	-0.043**	-0.033**	-0.033***
	(-3.78)	(-2.12)	(-2.14)	(-2.60)
Control for ex-ante exposure	0.007	0.011	0.030***	
	(0.81)	(0.94)	(2.83)	
Focus on specific instruments	-0.031**	-0.026	-0.029**	-0.033**
	(-2.34)	(-1.33)	(-2.00)	(-2.26)
Measurement of firm value				
Market-to-book ratio	-0.006	-0.017	-0.030***	
	(-0.38)	(-1.52)	(-3.30)	
Estimation characteristics				
Control for firm fixed effects	-0.023**	-0.027*	-0.012	-0.021
	(-2.07)	(-1.85)	(-1.35)	(-1.42)
Control for endogeneity	-0.013**	-0.011	-0.009	-0.009*
	(-2.11)	(-1.54)	(-1.08)	(-1.71)
Control for sample selection bias	-0.001	0.003	0.159**	
	(-0.03)	(0.14)	(2.43)	
Robust errors	0.002	0.016**	0.008	
	(0.21)	(2.38)	(0.79)	
Interaction term	-0.021*	-0.008	-0.003	-0.020***
	(-1.75)	(-1.36)	(-0.86)	(-2.94)
Control variables				
Control for other risk exposures	-0.021***	-0.018***	-0.002	-0.018***
	(-5.07)	(-4.75)	(-0.39)	(-4.89)
Control for operational hedging	0.011***	0.017***	0.012*	0.006
	(2.65)	(3.35)	(1.83)	(0.93)
Control for managerial ownership	-0.032***	-0.014**	-0.006	-0.022***
	(-2.60)	(-1.98)	(-0.48)	(-2.88)
Control for liquidity	0.010	0.009	0.009	
	(1.12)	(0.88)	(0.98)	
Control for leverage	-0.019	-0.015	-0.012	
	(-1.28)	(-1.06)	(-0.94)	
Control for dividend policy	-0.012	-0.020***	-0.011*	
	(-1.21)	(-3.03)	(-1.72)	
Publication bias				
Primary standard error (SE)	0.898***	0.809***	0.336	0.845***
	(6.00)	(4.78)	(1.59)	(5.05)
Constant	0.086***	0.068*	0.060*	0.051***
	(3.48)	(1.93)	(1.87)	(3.70)
No. of studies	71	71	71	71

No. of primary observations	1016	1016	1016	1016

Notes: This table reports the results of Eq. (2). Reported coefficients reflect the average impact on the reported hedging premiums if the study design deviates from the base group of this specific aspect, all other things being equal. Definitions of the explanatory variable can be found in Table 1. Columns (1), (2), (4) are estimated by weighted least squares estimation using the inverse of the estimates' squared standard errors as weights. Column (3) uses the interaction between the estimates' squared standard errors and the number of estimates per study as weights. Column (4) is a reduced model based on a general-to-specific approach. The *t*-statistics of the regression parameters reported in parentheses are based on robust errors, clustered at study-level and country-level.

$^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.10$

Table 4. Macroeconomic drivers of corporate hedging premiums

	(1)	(2)	(3)	(4)
Panel A: Financial and economic development				
Derivatives market volume	-0.028**			
	(-2.43)			
Stock trading volume		-0.019**		
		(-2.19)		
Trade magnitude			-0.024***	
			(-2.66)	
OECD member				-0.025***
				(-2.65)
Constant	0.086***	0.153***	0.154***	0.102***
	(3.31)	(4.87)	(3.09)	(3.97)
	(5)	(6)	(7)	(8)
Panel B: Legality and governance				
Rule-of-law	-0.008*			
	(-1.65)			
Shareholder rights		0.002		
		(0.62)		
Creditor rights			-0.003	
			(-1.18)	
Ownership concentration				0.020
				(0.81)
Constant	0.090***	0.077**	0.109***	0.077**
	(3.45)	(2.32)	(6.35)	(2.39)
	(9)	(10)	(11)	(12)
Panel C: Financial distress and taxes				
Time to resolve insolvency	0.018			
	(1.12)			
Financial risk		-0.060		
		(-1.32)		
Composite risk			-0.061	
			(-1.29)	
Tax rate				0.049**
				(2.46)
Constant	0.065*	0.300*	0.344	-0.106
	(1.84)	(1.73)	(1.64)	(-1.11)
Controls from Tab. 3 included	Yes	Yes	Yes	Yes
No. of studies	71	71	71	71
No. of primary observations	1016	1016	1016	1016

Notes: This table presents the results of the same meta-regression model as shown in Column (2) of the previous Table 3, but the dummies for geographical regions are substituted by the country-level variables defined in Table 2. These variables are assigned to the hedging premiums based on the sample year and country reported in each study. All models are estimated by weighted least squares estimation using the inverse of the estimates' squared standard errors as weights. The *t*-statistics of the regression parameters reported in parentheses are based on robust errors, clustered at study-level and country-level.

$^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.10$

Table 5. Mean hedging premium after correcting for publication bias

	(1) Full sample	(2) Full sample, Alternative weights	(3) FX hedgers only	(4) Interest rate hedgers only	(5) Commodity price hedgers only
Constant: $\hat{\gamma}_0$	0.014***	0.016***	0.025***	0.001	-0.010***
	(3.07)	(6.10)	(3.45)	(0.08)	(-2.87)
SE^2: $\hat{\gamma}_1$	3.879***	2.037***	5.483***	3.726**	3.770***
	(4.22)	(3.42)	(2.61)	(2.10)	(8.04)
Mean hedging premium after PB correction	1.4%	1.6%	2.5%	0.1%	-1.0%
Arithmetic mean w/o PB correction	6.4%	6.4%	9.7%	2.1%	3.3%
No. of studies	71	71	37	17	24
No. of primary observations	1016	1016	424	98	292

Notes: This table reports the results of $HP_{ij} = \lambda_0 + \lambda_1 SE(HP_{ij})^2 + \varepsilon_{ij}$, where HP_{ij} is the ith estimate of the hedging premium reported in the jth study. We use the variance of the hedging premium estimates as it has been shown to yield a better correction for publication selection than its standard error. $\hat{\gamma}_1$ measures the presence and magnitude of publication bias. $\hat{\gamma}_0$ captures the mean hedging premium corrected for publication bias. Columns (1), (3) and (4) are estimated by weighted least squares estimation using the inverse of the estimates' squared standard errors as weights. Column (2) uses the interaction between the estimates' squared standard errors and the number of estimates per study as weights. The *t*-statistics of the regression parameters reported in parentheses are based on standard errors adjusted for within-study and across-study correlation.

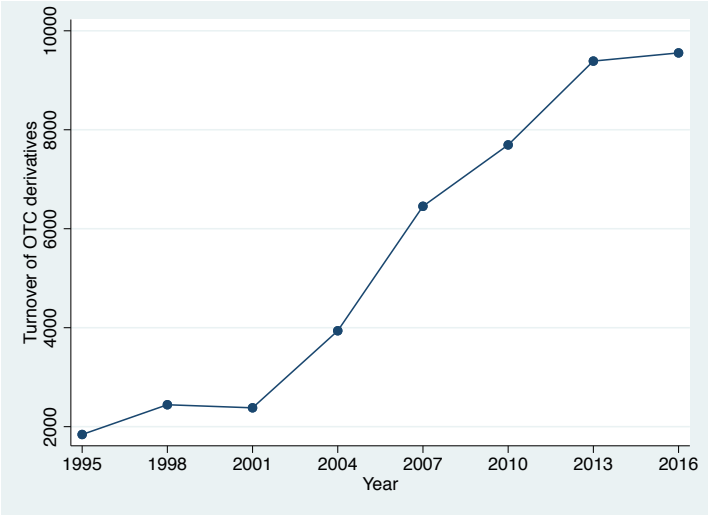
$^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.10$

Table 6. Best practice estimates for the hedging premium

	FX hedgers	Interest rate hedgers	Commodity price hedgers
Overall best practice	1.8%	-0.8%	-0.6%
Panel A: Data and model choices			
Without control for firm fixed effects	4.0%	1.4%	1.7%
Without control for firm fixed effects and endogeneity	5.3%	2.8%	3.0%
Without control for firm fixed effects, endogeneity, operational hedging and managerial ownership	7.4%	4.8%	5.1%
Panel B: Macroeconomic factors			
Derivatives market volume (high)	0.7%	-1.9%	-1.5%
Derivatives market volume (low)	2.7%	0.1%	0.6%
Tax rate (high)	6.7%	4.0%	4.6%
Tax rate (low)	0.9%	-1.9%	-1.2%

Notes: This table reports the predicted hedging premiums obtained by substituting best practice values for the variables in the meta-regression model. The overall best practice and Panel A values are estimated using results from Table 3 (Column 1). Panel B is based on the results of Table 4.

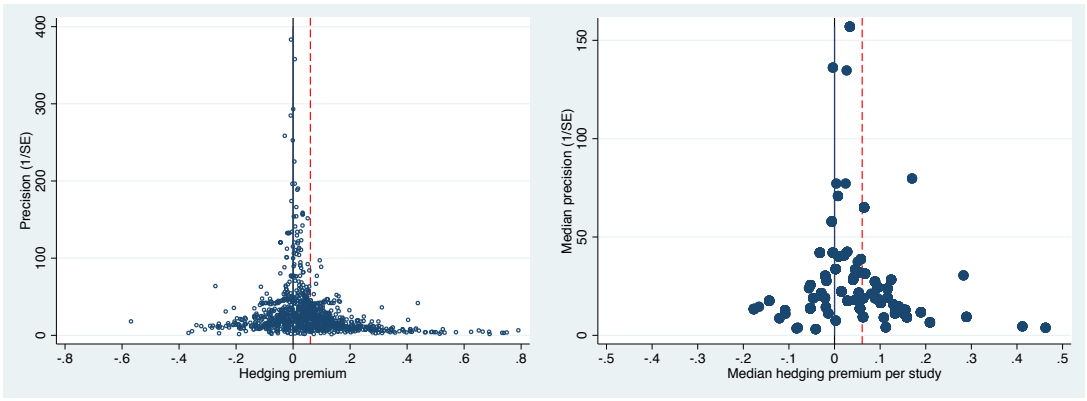
Figure 1. Development of derivatives trading volume



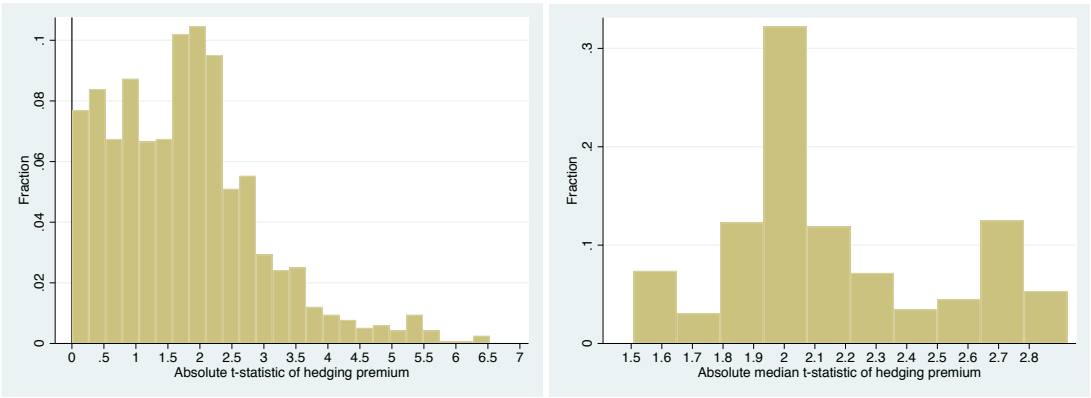
Notes: The figure shows the global sum of notional amounts (daily average) in foreign exchange and interest rate OTC instruments in billions of US dollars (BIS, 2016a, b)

Figure 2. Funnels plots and distribution of significance levels

(a)



(b)



Notes: The funnel plots in (a) show the (median) hedging premiums observed from the primary studies and their precision, which is the inverse of the estimates' standard errors reported in the 71 primary studies. In the absence of publication bias, the funnels should be symmetrically distributed around the most precise estimates, which are clustered around the top of the funnel. The dashed lines in red show the sample means. Figures (b) show the *t*-statistics of the hedging premiums and the median *t*-statistics per study around $t = 2$. Estimates with large *t*-statistics > 7 are excluded from the graph, but not from the subsequent statistical analysis.